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Kavshna

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Preface

Dear IIT-JEE Aspirants,

Success Magnet for IIT-JEE was launched three years back with an objective to guide the aspiring students with a versatile package of questions similar to what is exactly asked in JEE. These questions are made by our expert faculty and have been updated nicely as per the standard and requirement of JEE. Within a span of three years, Success Magnet has become the first choice of every IIT-JEE aspirant. The Success Magnet has been widely appreciated by our students across India and received tremendous praise from all corners.

Every year large number of questions asked in IIT-JEE resemble with the questions which have been given in Success Magnet. For example in Paper-I of IIT-JEE 2010, 29% of Chemistry, 46.4% of Mathematics and 36% of Physics questions were already what was given in Success Magnet. Similarly, in Paper–II of IIT-JEE 2010, 11% of Chemistry, 52.6% of Mathematics and 16% of Physics questions were already what was given in Success Magnet. This is not a mere coincidence but the output of painstaking and thorough research of our experienced faculty. Every year, we come up with a revamped version of Success Magnet that reflects the evolving pattern of IIT-JEE questions and make our students comprehend the tricks of the exam and succeed.

For all aspirants, this has become an indispensable tool to not only crack, but excel in IIT-JEE. I sincerely believe that you will use Success Magnet to your advantage and come out with flying colours.

Wish you all the best!

J.C. CHAUDHRY
Chairman & Managing Director
Aakash IIT-JEE

About Success Magnet

Success Magnet is a versatile and success worthy package containing 2680 questions based on IIT-JEE pattern. It is a blend of expertise and experience of faculty of Aakash IIT-JEE and an essence for IIT-JEE 2011 aspirants.

There are around 1256 questions on multiple choice pattern, 428 questions on assertion and reason pattern, 153 matrix match type questions, 456 questions on comprehension, 223 subjective questions, 114 integer answer type questions and 50 multiple true-false type questions.

The questions have been framed chapterwise, so as to help students revise and feel confident about every chapter. In the last, miscellaneous questions are also given which are based upon the concepts on two or more than two chapters. The answers of these questions are also provided at the end.

Each student on enrollment shall be provided with a username and password. He/she can use this password to see the hints of the typical questions given in the Success Magnet on our website "www.aakashiitjee.com" from 26th September, 2010.

There will be conducted four online tests for IIT-JEE 2011. The first test will be conducted on **8th Nov., 2010.**

This package has 8 sections.

(i) **Section A** contains 949 straight objective questions which have only one correct answer.

(ii) **Section B** contains 307 multiple choice questions which have multiple correct answer.

(iii) **Section C** contains 152 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer.

(iv) **Section D** contains 428 questions. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason).

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

(v) **Section E** contains 153 questions. Each question contains statements given in 2 columns. Statements in the first column have to be matched with statements in the second column.

(vi) **Section F** contains 223 subjective questions.

(vii) **Section G** contains 114 Integer answer type questions.

(viii) **Section H** contains 50 Mutliple True-False type questions.

JEE Cut-off Marks 2010

Category	Merit List Cut-off (For Eligibility)	Subjectwise cut-off (For Eligibility)			Marks obtained by Last candidate in the list
		Chemistry	Maths	Physics	
Open Category	190	19	17	19	190
OBC	171	18	16	18	171
SC/ST/PD	95	10	9	10	95
Preparatory (PD)	48	5	5	5	73
Preparatory (ST)	48	5	5	5	84

Note : Though every care has been taken to publish the Success Magnet correctly, the company shall not be responsible for typographical error/s if any.

*Students can send their feedback about Success Magnet at "**suggestionsmd@aakashinstitute.com**"*

Mechanics

UNIT 1

This Unit Includes

Units & Measurement, Kinematics, Laws of Motion, Work, Energy & Power, Motion of System of Particles and Rigid Body, Oscillations, Gravitation, Properties of Bulk Matter, Waves

SECTION - A

Straight Objective Type

This section contains 334 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. In the formula $P = P_0\, e^{\frac{-hc}{x}}$, h is Planck's constant and c is speed of light. The dimensional formula for x is

   (1) $[M^1L^2T^{-2}]$ (2) $[M^0L^1T^0]$

   (3) $[M^1L^3T^{-2}]$ (4) $[M^0L^0T^0]$

2. In C.G.S system of units, the unit of pressure is dyne/cm^2. In a new system of units, the unit of mass is 1 milligram, unit of length is 1 mm and unit of time is 1 millisecond. Let the unit of pressure in this new system is dyn. The value of 1 dyn is equal to

   (1) 10^{+4} dyne/cm^2 (2) 1 dyne/cm^2

   (3) 10^{-2} dyne/cm^2 (4) 10^{-3} dyne/cm^2

3. The mass of a body is measured as 10.1 kg. The possible percentage error in the measurement is

   (1) ±1% (2) ±0.1%

   (3) ±10% (4) ±0.01%

4. Which of the following quantities has a unit but no dimensions?

   (1) Refractive index

   (2) Absolute permittivity

   (3) Gravitational constant

   (4) Solid angle

5. Which of the following quantities is not dimensionless?

   (1) Relative density

   (2) Relative permeability

   (3) Relative velocity

   (4) Specific gravity

6. Four persons use the same stopwatch (of least count 100 ms) to measure the time-period of a pendulum. Which of following assertions is possibly correct?

   (1) First person says that the time period is 3.75 s

   (2) Second person says that the time period is 2.1 s

   (3) Third person says that the time period is 3.70 s

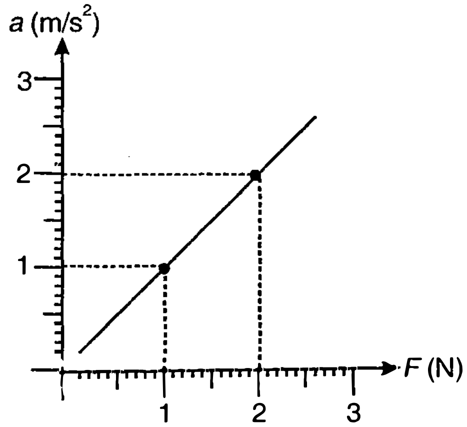
   (4) Fourth person says that the time period is 2.92 s

7. Let main scale division of a vernier callipers is 1 mm. With zero of vernier coinciding with the zero of main scale, the 50th division of vernier scale coincides with 49th division of main scale. The least count of the vernier is

   (1) 0.1 mm (2) 0.01 mm

   (3) 0.2 mm (4) 0.02 mm

8. In an experiment to determine the inertial mass of an object using Newton's second law, following graph is obtained between net force on the object and the acceleration produced in it. The mass of the object within error limits is



(1) 1.0 kg

(2) 1 kg

(3) (1.0 ± 0.1) kg

(4) (1.0 ± 0.2) kg

9. Which one of the following has dimensions different from other three?

(1) $\dfrac{\text{Potential energy}}{\text{Weight}}$

(2) Pressure

(3) $\sqrt{\dfrac{\text{Force}}{\text{Pressure}}}$

(4) $\dfrac{(\text{Velocity})^2}{\text{Acceleration}}$

10. Let x, y and z be three physical quantities having different dimensions. Which of the following mathematical operations must be meaningless?

(1) $\dfrac{x}{y} = z$

(2) $\dfrac{x \times y}{x + y} = z$

(3) $x^2y^3 = z$

(4) $z = x^2 + y^3$

11. A physical quantity x is being calculated by measuring y and z and using the formula $x = y \times z$. In a particular set of values, the value of y is measured with an error of +10%, whereas the value of z is measured with an error of –10%. For this particular set of values, the error in the calculation of x will be

(1) 0% (2) 20%

(3) –1% (4) 10%

12. In a new system of units, the fundamental quantities mass, length and time are replaced by acceleration 'a', density 'ρ' and frequency 'f'. The dimensional formula for force in this system is

(1) $[\rho a^4 f]$ (2) $[\rho a^4 f^{-6}]$

(3) $[\rho^{-1} a^{-4} f^6]$ (4) $[\rho^{-1} a^{-4} f^{-1}]$

13. In an experiment to measure the focal length of an equiconvex lens, following measurements were made $|u|$ = 0.30 cm, $|v|$ = 0.60 cm. The image formed is real. The focal length of the lens within error limits is

(1) (0.20 ± 0.01) cm

(2) (0.20 ± 0.02) cm

(3) (0.20 ± 0.0055) cm

(4) (0.20 ± 0.005) cm

14. The displacement of a particle starting from rest and moving under a constant acceleration is calculated by the formula $S = \frac{1}{2}at^2$. If there occurs an error of 30% in the measurement of time interval t, what error will be introduced in the calculation of S?

(1) 15% (2) 60%

(3) 69% (4) 30%

15. In a given co-ordinate system, a vector quantity is given as $\vec{A} = 3\hat{j} + 4\hat{k}$. In another co-ordinate system choosen arbitrarily, $\vec{A}$ cannot be

(1) $5\hat{i}$ (2) $5\hat{j}$

(3) $\frac{5}{2}(\hat{i} + \sqrt{3}\hat{j})$ (4) $5(\hat{i} + \hat{j})$

16. A vector $\overrightarrow{OA} = 3\hat{i}$ is rotated by an angle θ about its starting point *O* in *x–z* plane in clockwise sense, as seen by an observer located at a point on $+y$-axis. The new vector will be

(1) $3\cos\theta\hat{i} + 3\sin\theta\hat{j}$

(2) $3[\cos\theta\hat{i} + \sin\theta\hat{k}]$

(3) $3[\cos\theta\hat{i} - \sin\theta\hat{k}]$

(4) $3[\sin\theta\hat{i} - \cos\theta\hat{k}]$

17. In an experiment to measure the length of a rod by four different instruments, the measurement are reported as

(A) 200.0 cm

(B) 20 cm

(C) 20.00 cm

(D) 0.2000 cm

From the above data, we can infer that

(1) All measurements have same accuracy

(2) A has least accuracy

(3) B has least accuracy

(4) D has least accuracy

18. 1 m is nearly equal to

(1) 0.105×10^{-5} ly (2) 1×10^{-16} ly

(3) 1.05×10^{-16} ly (4) 10.5×10^{-16} ly

19. Let there be two vectors $\vec{a}$ and $\vec{b}$ such that $\vec{a}+\vec{b}$ is in same direction as $\vec{a}-\vec{b}$. Select the correct alternative.

(1) $\vec{a}\times\vec{b} = 0$

(2) $|\vec{a}| > |\vec{b}|$

(3) Both (1) & (2) must be simultaneously true

(4) $\vec{a}\cdot\vec{b} = 0$

20. The number of significant figures in the number 0.029982×10^{-5} are

(1) 6 (2) 5

(3) 7 (4) 4

21. The length of a pendulum is measured as 20.0 cm. The time interval for 100 oscillations is measured as 90 s with a stop watch of 1 s resolution. The accuracy in the determination of '*g*' is

(1) 1% (2) 2%

(3) 3% (4) 4%

(IIT-JEE 2008)

21(a). Student I, II and III perform an experiment for measuring the acceleration due to gravity (*g*) using a simple pendulum. They use different lengths of the pendulum and / or record time for different number of oscillations. The observations are shown in the table.

Least count for length = 0.1 cm

Least count for time = 0.1 s

Student	Length of the Pendulum (cm)	Number of oscillations (n)	Total time for (n) oscillations (s)	Time period (s)
I	64.0	8	128.0	16.0
II	64.0	4	64.0	16.0
III	20.0	4	36.0	9.0

If E_I, E_{II} and E_{III} are percentage errors in g, i.e., $\left(\frac{\Delta g}{g}\times 100\right)$ for students I, II and III respectively,

(1) $E_I = 0$

(2) E_I is minimum

(3) $E_I = E_{II}$

(4) E_{II} is minimum

22. A particle travels to the right with a velocity $v = \frac{5}{4+x}$, where *x* is its position on the line along which it is moving. The acceleration of the particle at $x = 2$, is

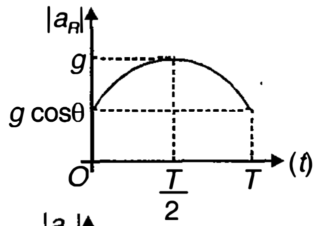
(1) – 0.116 units

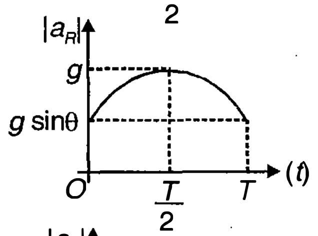
(2) 0.116 units

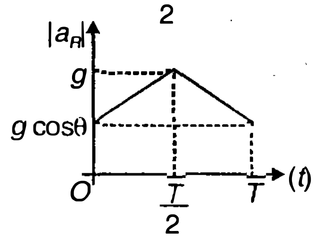
(3) 1.16 units

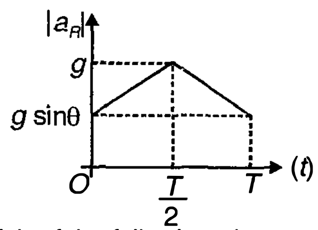
(4) – 0.232 units

23. Which of the following plots correctly represents the variation of the magnitude of radial acceleration $|a_R|$ with time t for a particle projected at $t = 0$ with speed v_0 at an angle θ above the horizontal?

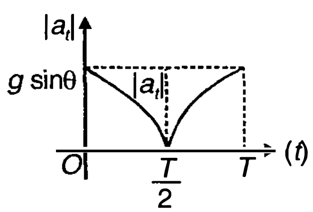
(1) 

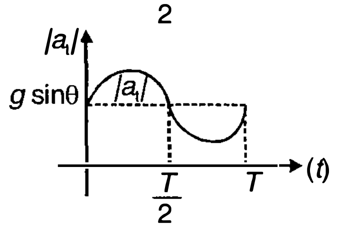
(2) 

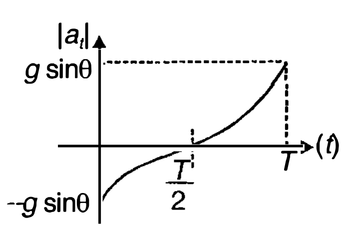
(3) 

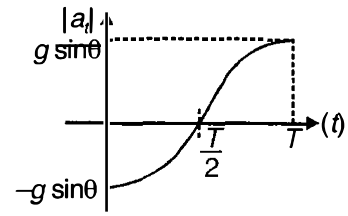
(4) 

24. Which of the following plots correctly represents the variation of the magnitude of tangential $|a_t|$ with time t for a particle projected at $t = 0$ with speed v_0 at an angle θ above the horizontal?

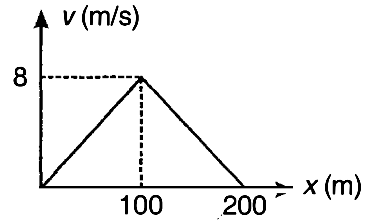
(1) 

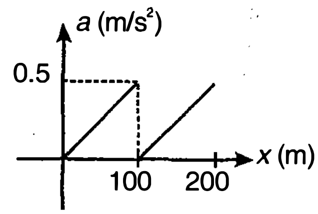
(2) 

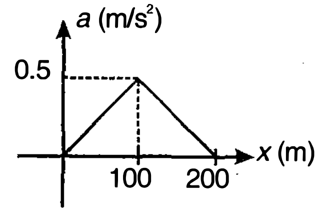
(3) 

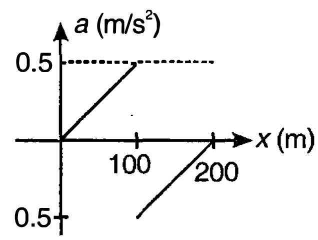
(4) 

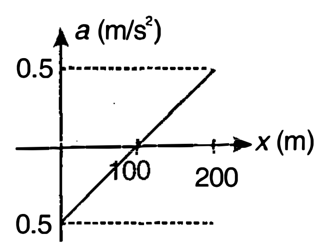
25. The v-x graph for a car in a race on a straight road is given. Identify the correct a-x graph



(1) 

(2) 

(3) 

(4) 

26. For a particle moving along circular path, the radial acceleration a_r is proportional to time t. If a_t is the tangential acceleration, then which of the following will be independent of time t?

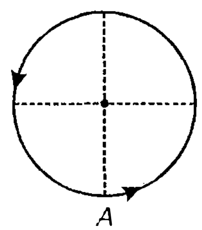
(1) a_t

(2) $a_r . a_t$

(3) $\frac{a_r}{a_t}$

(4) $a_r (a_t)^2$

27. A particle is describing uniform circular motion in the anti-clockwise sense such that its time period of revolution is T. At $t = 0$ the particle is observed to be at A. If θ_1 be the angle between acceleration at $t = \frac{T}{4}$ and average velocity in the time interval 0 to $\frac{T}{4}$ and θ_2 be the angle between acceleration at $t = \frac{T}{4}$ and the change in velocity in the time interval 0 to $\frac{T}{4}$, then



(1) $\theta_1 = 135^\circ$, $\theta_2 = 45^\circ$

(2) $\theta_1 = 135^\circ$, $\theta_2 = 135^\circ$

(3) $\theta_1 = 45^\circ$, $\theta_2 = 135^\circ$

(4) $\theta_1 = 45^\circ$, $\theta_2 = 45^\circ$

28. A particle is projected with speed v_0 at angle θ above the horizontal such that the ratio of kinetic energy at highest point to that at the point of projection is 3 : 4, then change in velocity of the particle between point of projection and the highest point will be

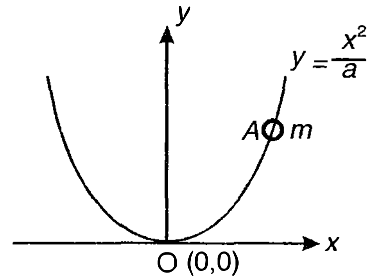
(1) $\frac{v_0}{2}$ vertically downward

(2) $\frac{v_0}{2}$ vertically upward

(3) $2 v_0\sqrt{3}$ due east

(4) $\frac{v_0\sqrt{3}}{2}$ vertically downward

29. In the given figure, a smooth parabolic wire track lies in the vertical plane (x-y plane). The shape of track is defined by the equation $y = \left(\frac{x^2}{a}\right)$ (where a is constant). A ring of mass m which can slide freely on the wire track, is placed at the position A (a, a). The track is rotated with constant angular speed ω such that there is no relative slipping between the ring and the track then ω is equal to



(1) $\sqrt{\frac{g}{a}}$

(2) $\sqrt{\frac{g}{2a}}$

(3) $\sqrt{\frac{2g}{a}}$

(4) $(2)^{\frac{1}{4}}\left(\frac{g}{a}\right)^{\frac{1}{2}}$

(IIT-JEE 2009)

29a. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y-axis vertical) with a bead of mass m on it. The bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x-axis with a constant acceleration a. The distance of the new equilibrium position of the bead, where the bead can stay at rest w.r.t. the wire, from the y-axis is

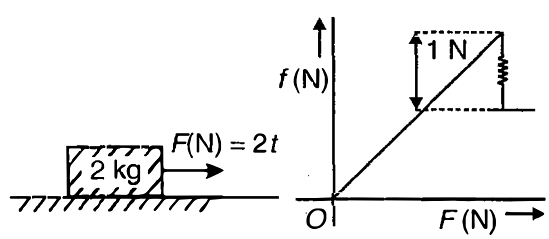
(1) $\frac{a}{gk}$

(2) $\frac{a}{2gk}$

(3) $\frac{2a}{gk}$

(4) $\frac{a}{4gk}$

30. A block of mass m = (2 kg) is placed on a rough horizontal surface and is being acted upon by a time dependant force F(N) = $2t$ (where t is in second). The coefficient of static friction between the block and the horizontal surface is $\mu_s = 0.20$. The frictional force f developed between the block and the surface versus force F(N) plot is as shown.



The velocity of the block at t = 4 s will be

(1) 2.5 m/s

(2) 5 m/s

(3) 1 m/s

(4) 3 m/s

31. A ball is projected from origin with speed 20 m/s at an angle 30º with x-axis. The x-coordinate of the ball at the instant when the velocity of the ball becomes perpendicular to the velocity of projection will be

(1) $40\sqrt{3}$ m (2) 40 m

(3) $20\sqrt{3}$ m (4) 20 m

32. There are three vectors $\vec{P}$, $\vec{Q}$ and $\vec{R}$. The angle between $\vec{P}$ and $\vec{Q}$ is 60º and $\vec{R}$ is perpendicular to the plane containing the vectors $\vec{P}$ and $\vec{Q}$. Consider the following relations.

(a) $\vec{P} + \vec{Q} + \vec{R} = 0$

(b) $\vec{P} \times \vec{Q} = \vec{R}$

(c) $\vec{P} \times \vec{R} = \vec{Q}$

The possible relations are

(1) (a) & (b) (2) (a) & (c)

(3) (b) & (c) (4) Only (b)

33. Three particles moves in a straight line with initial velocities v_1, v_2 and v_3 ($v_1 < v_2 < v_3$) each with constant retardation 'a' such that motion continues for more than one second before velocity of each particle becomes zero. If s_1, s_2 and s_3 respectively be the distances travelled in the last one second before velocity becomes zero, then

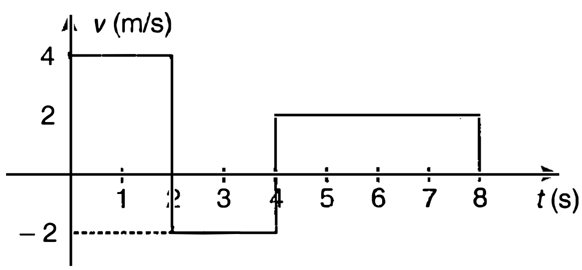
(1) $s_1 = \frac{v_1^2}{2a}$, $s_2 = \frac{v_2^2}{2a}$, $s_3 = \frac{v_3^2}{2a}$

(2) $s_1 > s_2 > s_3$

(3) $s_1 = s_2 = s_3$

(4) $s_1 < s_2 < s_3$

34. A body is moving in a straight line as shown in velocity-time graph. The displacement and distance travelled by the body in 8 s are respectively



(1) 20 m, 12 m (2) 12 m, 20 m

(3) 12 m, 12 m (4) 20 m, 20 m

35. A man is moving with constant velocity 10 m/s in a direction 60º E of N and a dog is moving with constant velocity 10 m/s in direction 30º W of N on a horizontal field, then the path of the dog as observed by the man will be

(1) Straight

(2) Parabolic

(3) Circular

(4) Dog will appear to be in rest

36. If the angle of projection of a particle from the horizontal is doubled keeping the speed of projection same, the particle strikes the same target on the ground, then the ratio of time of flight in the two cases will be

(1) 1 : 1 (2) 1 : 2

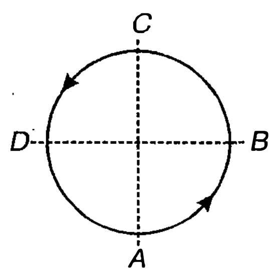
(3) $2 : \sqrt{3}$ (4) $1 : \sqrt{3}$

37. The block A has mass m_1 and is attached to a spring having a stiffness k. The natural length of the spring is l_0. Another block B of mass m_2 is pressed against block A so that the compression in the spring is d. The arrangement is released from rest from this position. The coefficient of friction between the blocks and the ground beneath is μ. The block B will get separated from A if

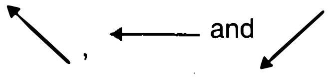
(1) $d \le \frac{2(m_1 + m_2)\mu g}{k}$ ~~(2)~~ $\cancel{d \le}\ \frac{(m_1 + m_2)\mu g}{k}$

(3) $d > \frac{2(m_1 + m_2)\mu g}{k}$ (4) $d > \frac{(m_1 + m_2)\mu g}{k}$

38. Four persons A, B, C and D are all moving on the same circular track with same constant speed in the anti-clockwise direction. At any instant they are located at the positions shown in figure, then the velocity of B, C and D as observed by A will have the respective directions



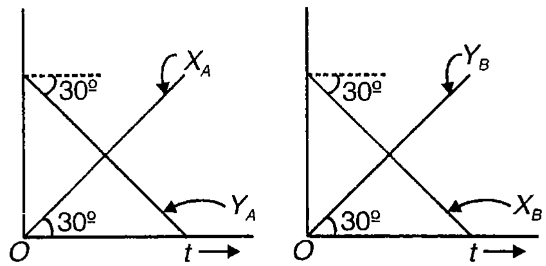
(1) 

(2) 

(3) 

(4) 

39. Displacement versus time plot for two particles A and B is shown below. X_A, X_B and Y_A, Y_B refer to x and y coordinates of particles A and B.



Velocity of particle A with respect to particle B is

(1) $0\hat{i} + 0\hat{j}$ (2) Dependent of time t

(3) $\frac{2}{\sqrt{3}}\hat{i} - \frac{2}{\sqrt{3}}\hat{j}$ (4) $-\frac{2}{\sqrt{3}}\hat{i} + \frac{2}{\sqrt{3}}\hat{j}$

40. A particle starts its motion from rest and moves with constant acceleration for time t_1 and then it retards with constant rate for time t_2 until it comes to rest. Then the ratio of maximum speed and average speed during the complete motion will be

(1) 2 : 1 (2) 1 : 2

(3) $t_1 : t_2$ (4) $t_2 : t_1$

41. A particle is moving in a straight path with an acceleration $a = bt^n$, where b is a positive constant ($n \neq -1$). The relation between the velocity and the position vector of the particle at time t = 1 s [Assuming particle is in rest at origin at $t = 0$]

(1) $v = r$ (2) $v = (n + 2)r$

(3) $v = \frac{(n+3)r}{2}$ (4) $v = \frac{(n+1)r}{2}$

42. A body moving with a constant speed describes a circular path whose radius vector is given by $\vec{r} = 15\,(\cos pt\,\hat{i} + \sin pt\,\hat{j})$ m, where p is in rad/s, and t is in second. What is its centripetal acceleration at t = 3 s?

(1) $45p^2$ m/s^2 (2) $5p^2$ m/s^2

(3) $15p$ m/s^2 (4) $15p^2$ m/s^2

43. A particle is moving along the path given by $y = \frac{C}{6}t^6$ (where C is a positive constant). The relation between the acceleration (a) and the velocity (v) of the particle at t = 5 s is

(1) $5a = v$ (2) $a = 5v$

(3) $a = \sqrt{v}$ (4) $a = v$

44. If the seat of a boy on a vertical merry-go-round revolving with a constant speed breaks up suddenly so that the boy starts falling, he can have a subsequent motion directed

(1) Tangentially to the direction of revolution

(2) Towards the centre of the merry-go-round i.e. radially inwards

(3) Radially outwards

(4) Towards a direction specified in either of (1), (2) & (3)

45. When forces $\vec{F}_1, \vec{F}_2, \vec{F}_3 \ldots\ldots \vec{F}_n$ act on a particle, the particle remains in equilibrium. If $\vec{F}_1$ is now removed then acceleration of the particle is

(1) $\frac{\vec{F}_1}{m}$ (2) $-\frac{\vec{F}_1}{m}$

(3) $\frac{\vec{F}_2 + \vec{F}_3 + \ldots + \vec{F}_n - \vec{F}_1}{m}$ (4) $\frac{\vec{F}_2}{m}$

46. If $\vec{a}$ denotes a unit vector along an incident light, $\vec{b}$ a unit vector along refracted ray into a medium having refractive index x (relative to first medium) and $\vec{c}$ a unit vector normal to boundary of two media and directed towards first medium, then law of refraction is

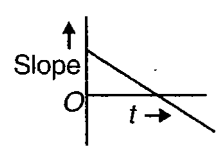
(1) $\vec{a}\cdot\vec{c} = x\,(\vec{b}\cdot\vec{c})$

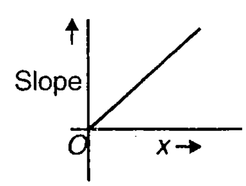
(2) $\vec{a}\times\vec{c} = x\,(\vec{c}\times\vec{b})$

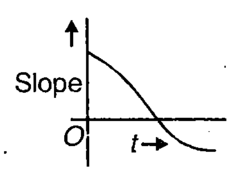
(3) $\vec{a}\times\vec{c} = x\,(\vec{b}\times\vec{c})$

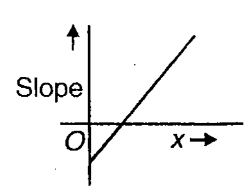
(4) $x(\vec{a}\times\vec{c}) = (\vec{b}\times\vec{c})$

47. A heavy particle is projected with a velocity at an angle with the horizontal into a uniform gravitational field. The slope of the trajectory of the particle varies as

(1) 

(2) 

(3) 

(4) 

48. A particle of mass m is projected from the ground with an initial velocity v at an angle θ with the horizontal. The magnitude of angular momentum of the particle with respect to the point of projection, when it strikes the ground will be

(1) $\dfrac{(2mv^3 \sin 2\theta)}{g}$ (2) $\dfrac{(mv^2 \sin 2\theta)}{g}$

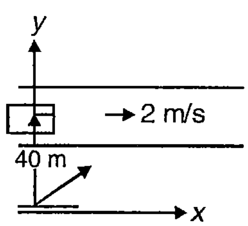
(3) $\dfrac{(mv^3 \sin\theta \cos\theta)}{2g}$ (4) $\dfrac{(2mv^3 \sin^2\theta \cos\theta)}{g}$

49. A projectile is launched at $t = 0$, with velocity u at an angle θ with the horizontal. The ratio of the rate of change of speed and radius of curvature at the point of projection is

(1) $\dfrac{2g^2 \sin\theta.\cos\theta}{u^2}$ (2) $\dfrac{2g^2 \sin\theta}{u^2}$

(3) $\dfrac{g^2 \sin\theta}{u^2}$ (4) $\dfrac{g^2 \sin\theta.\cos\theta}{u^2}$

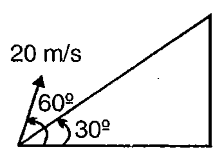
50. A block B is floating in the river, at time $t = 0$, the position of the block is as shown in figure. River is flowing with speed 2 m/s. A stone is thrown with a velocity $\vec{v} = (v_1\hat{i} + v_2\hat{j} + 20\hat{k})$ m/s such that the stone hits the block. The value of v_2 is



(1) 10 m/s (2) 2 m/s

(3) 4 m/s (4) 20 m/s

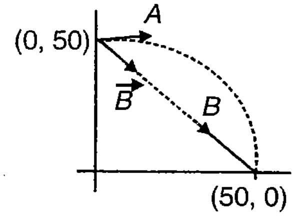
51. A particle is thrown from a point on an incline plane, with a velocity of 20 m/s at an angle of 60º with the horizontal, angle of incline plane is 30º. At what time the velocity of the projectile becomes parallel to the incline plane?



(1) $\dfrac{\sqrt{3}}{2}$ s (2) $\dfrac{2}{\sqrt{3}}$ s

(3) $\sqrt{3}$ s (4) $\dfrac{1}{\sqrt{3}}$ s

52. Both particles A and B at $t = 0$ are located at point (0 m, 50 m). The particle B moves with a constant velocity and particle A move on a circle given by $\dfrac{x^2}{2500} + \dfrac{y^2}{2500} = 1$, with a speed 5π m/s. Find velocity of B, so that both particle hits, simultaneously at (50 m, 0 m)



(1) $\dfrac{10}{\sqrt{3}}(\hat{i} - \hat{j})$ (2) $\dfrac{5}{\sqrt{3}}(\hat{i} - \hat{j})$

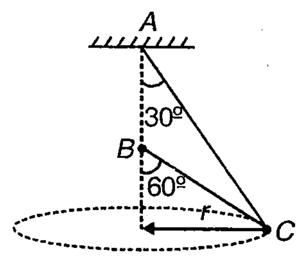
(3) $10(\hat{i} - \hat{j})$ (4) $5(\hat{i} - \hat{j})$

53. A uniform circular ring of mass per unit length λ and radius R is rotating with angular velocity ω about its own axis in a gravity free space. Tension in the ring is

(1) Zero (2) $\dfrac{1}{2}\lambda R^2\omega^2$

(3) $\lambda R^2\omega^2$ (4) $\lambda R\omega^2$

54. A single wire ACB passes through a ring C which revolves at a constant speed in the horizontal circle of radius r, as shown in the figure. The speed of revolution is



(1) $\sqrt{rg}$ (2) $\sqrt{2rg}$

(3) $2\sqrt{2rg}$ (4) $2\sqrt{rg}$

55. A particle of mass m being slide down a fixed smooth sphere from the top. What is its tangential acceleration. When it breaks off the sphere?

(1) $\dfrac{2g}{3}$ (2) $\dfrac{\sqrt{5}g}{3}$

(3) g (4) $\dfrac{g}{3}$

56. A second's pendulum is suspended in a car which is travelling with a constant speed of 10 m/s around a circle of radius 10 m. If the pendulum undergoes small oscillations about its equilibrium position, its period of oscillation will be

(1) $\sqrt{2\sqrt{2}}$ s (2) $\sqrt{2}$ s

(3) 2 s (4) 4 s

57. A particle of mass m is suspended by a string of length l from a fixed rigid support. A horizontal velocity $v_0 = \sqrt{3gl}$ is imparted to it suddenly. What is the angle made by the string with the vertical when the acceleration of the particle is inclined to the string by 45º?

(1) 45º (2) 60º

(3) 0º (4) 90º

58. What are possible speeds of two objects if they move uniformly towards each other, they get 4 m closer in each second and if they move uniformly in the same direction with the original speeds they get 4.0 m closer in each 10 s?

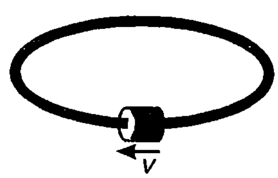
(1) 2.8 m/s and 1.2 m/s

(2) 5.2 m/s and 4.6 m/s

(3) 3.2 m/s and 2.1 m/s

(4) 2.2 m/s and 1.8 m/s

59. A collar of negligible size slides over the surface of horizontal circular rod for which coefficient of friction is 0.3. The collar is projected with a speed of 4 m/s and the radius of the ring is 10 cm. The distance moved by the collar before coming to rest is (g = 9.8 m/s^2)



(1) 0.6 m

(2) 0.3 m

(3) 1 m

(4) 2 m

60. A particle moves along the positive branch of the curve $y = \frac{x^2}{2}$ where $x = \frac{t^2}{2}$, x and y are measured in metres and t in seconds. At t = 2 s, the velocity of the particle is

(1) $2\hat{i} - 4\hat{j}$ m/s (2) $4\hat{i} + 2\hat{j}$ m/s

(3) $2\hat{i} + 4\hat{j}$ m/s (4) $4\hat{i} - 2\hat{j}$ m/s

61. A heavy particle is projected from a point on the horizontal at an angle 60º with the horizontal, with a speed of 10 m/s. Then the radius of curvature of its path at the instant of its crossing the same horizontal is (g = 10 m/s^2)

(1) Infinite (2) 10 m

(3) 11.54 m (4) 20 m

62. The velocity of a particle moving in the x-y plane is given by $\frac{dx}{dt} = 8\pi \sin 2\pi t$, $\frac{dy}{dt} = 5\pi \cos 2\pi t$. When t = 0, x = 8 and y = 0. The path of the particle is ___________.

(1) A straight line (2) A circle

(3) An ellipse (4) Parabola

63. The motion of a body falling from rest in a resisting medium is described by the equation $\frac{dv}{dt} = a - bv$, where a and b are constants. The velocity at any time t is ___________.

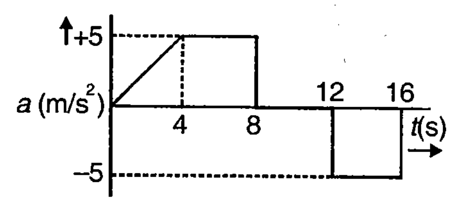
(1) $a(1-e^{b^2t})$

(2) abe^{-t}

(3) $\frac{a}{b}(1-e^{-bt})$

(4) $ab^2(1-t)$

64. The acceleration of a train between two stations 2 km apart is shown in the figure. The maximum speed of the train is



(1) 60 m/s (2) 30 m/s

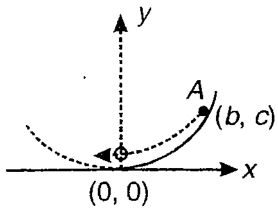
(3) 120 m/s (4) 90 m/s

65. A particle moving with uniform acceleration along a straight line covers distances a and b in successive interval of p and q seconds. The acceleration of the particle is

(1) $\frac{pq(p+q)}{2(bp-aq)}$ (2) $\frac{2(aq-bp)}{pq(p-q)}$

(3) $\frac{bp-aq}{pq(p-q)}$ (4) $\frac{2(bp-aq)}{pq(p+q)}$

66. A small ball of mass m starts from rest from point A (b, c) on a smooth slope which is a parabola. The normal force that the ground exerts at the instant, the ball arrives at lowest point (0, 0) is (take acceleration due to gravity g)



(1) $mg\left(\frac{b^2+4c^2}{b^2}\right)$ (2) $\frac{4\,mgc^2}{b^2}$

(3) mg (4) $3\,mg$

67. A projectile is aimed at a mark on a horizontal plane through the point of projection and falls 6 m short when its elevation is 30º but overshoot the mark by 9 m when its elevation is 45º. The angle of elevation of projectile to hit the target on the horizontal plane

(1) $\sin^{-1}\left[\frac{1}{5}\left(\frac{3\sqrt{3}}{2}+2\right)\right]$

(2) $\cos^{-1}\left[\frac{1}{5}\left(\frac{3\sqrt{3}}{2}+2\right)\right]$

(3) $\frac{1}{2}\cos^{-1}\left[\frac{1}{5}\left(\frac{3\sqrt{3}}{2}+2\right)\right]$

(4) $\frac{1}{2}\sin^{-1}\left[\frac{1}{5}\left(\frac{3\sqrt{3}}{2}+2\right)\right]$

68. A load W is to be raised by a rope from rest to rest through a height a; the greatest tension which the rope can safely bear is nW. Then the least time in which the ascent can be made is

(1) Zero

(2) $\frac{na}{(n-1)}$

(3) $\left[\frac{2na}{(n-1)g}\right]^{\frac{1}{2}}$

(4) None of these

69. A lift ascends with constant acceleration f, then with constant velocity and finally stops under constant retardation f. If the total distance ascended is s and total time occupied is t, then time during which the lift ascended with constant velocity is

(1) $\frac{t}{2}$ (2) $\frac{t^2}{4\,s}$

(3) $\sqrt{t^2-4\,s/f}$ (4) $\frac{3t}{4}$

70. A point moves in a straight line in such a manner that its retardation is proportional to its speed. Then

(1) Distance is proportional to the increase in speed

(2) Distance is proportional to the speed destroyed

(3) Average velocity of the particle is constant

(4) None of these

71. A train stopping at two stations 2 kms apart on a straight line takes 4 minutes for the journey. Assume that its motion is first uniformly accelerated and then uniformly retarded. Select the correct alternative

(*Here x and y are the magnitudes of acceleration and retardation respectively in km/min²)

(1) $\frac{1}{x}+\frac{1}{y}=2$ (2) $\frac{1}{x}-\frac{1}{y}=4$

(3) $\frac{1}{x}+\frac{1}{y}=4$ (4) $\frac{x}{y}=4$

72. A batsman hits a ball at an angle of 30º to the horizontal with an initial speed of 15 m/s. A fielder 70 m away in the direction of the hit starts immediately to catch the ball. The speed with which the fielder should run so as to catch the ball just before it touches the ground is

(1) 10 m/s (2) 33 m/s

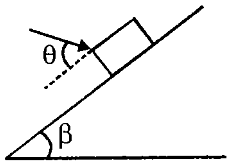
(3) 6.5 m/s (4) 13 m/s

73. A block of mass 10 kg is placed in a car going down an incline of inclination 60º. If the coefficient of friction between the block and car floor is $\frac{1}{\sqrt{3}}$. Find the acceleration a of car down the incline so that the block doesn't slip on the car surface

(1) $a \geq \frac{g}{\sqrt{3}}$ (2) $a \geq \frac{2g}{\sqrt{3}}$

(3) $a < \frac{g}{\sqrt{3}}$ or $a > \frac{2g}{\sqrt{3}}$ (4) $\frac{g}{\sqrt{3}} \leq a \leq \frac{2g}{\sqrt{3}}$

74. The minimum force required to keep a block of mass m in equilibrium on a rough inclined plane with inclination β and coefficient of friction μ ($< \tan\beta$)



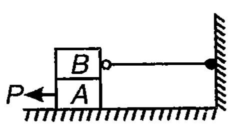
(1) $\dfrac{mg(\cos\beta - \mu\cos\beta)}{1+\mu}\sqrt{1+\mu^2}$

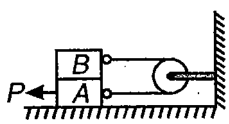
(2) $\dfrac{mg(\cos\beta - \mu\sin\beta)}{1+\mu}\sqrt{1+\mu^2}$

(3) $\dfrac{mg(\sin\beta - \mu\cos\beta)}{1+\mu}\sqrt{1+\mu^2}$

(4) $\dfrac{mg(\sin\beta - \mu\sin\beta)}{1+\mu}\sqrt{1+\mu^2}$

75. Each of the two blocks shown in the figure has a mass m. The coefficient of friction for all surfaces in contact is μ. A horizontal force P is applied to move the bottom block. The value of P, for which acceleration of block A is same in both cases is





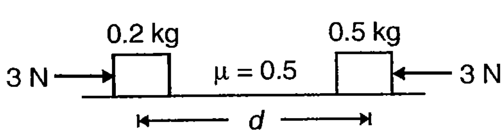
(1) $2\mu mg$

(2) μmg

(3) $3\mu mg$

(4) $\frac{2}{3}\mu mg$

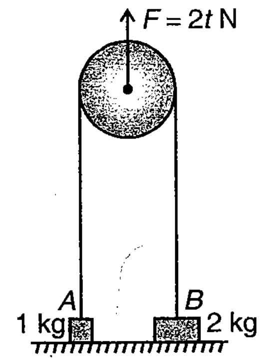
76. Two blocks of masses 0.2 kg and 0.5 kg, are placed d distance apart on a rough horizontal surface (μ = 0.5) and are acted upon by two forces of magnitude 3 N each as shown in figure at time $t = 0$. They collide each other at $t = 2$ s. The value of d is

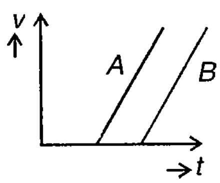


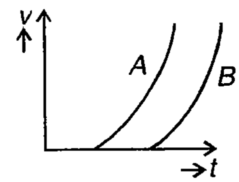
(1) 5 m (2) 22 m

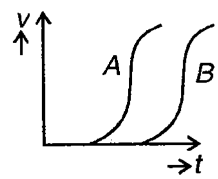
(3) 17 m (4) 12 m

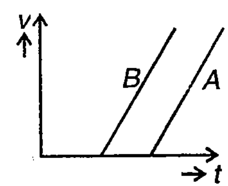
77. Two blocks A and B of masses 1 kg and 2 kg respectively are placed on a smooth horizontal surface. They are connected by a massless inextensible string going over a pulley as shown. The pulley is being acted upon by a vertical force of magnitude varying with time as $F = 2t$ N. Which of the following represent the velocity-time variation of A and B?



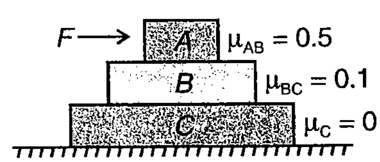
(1)


(2)


(3)


(4)


78. Three blocks A, B and C of masses 2 kg, 3 kg and 4 kg are placed as shown. Coefficient of friction between A and B is 0.5 and that between B and C is 0.1. The surface is frictionless. The maximum force F that can be applied horizontally onto A such that the three blocks move together is

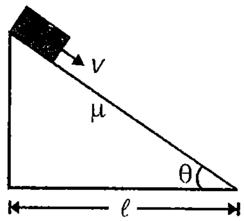


Frictionless

(1) 12.22 N (2) 13 N

(3) 11.25 N (4) None of these

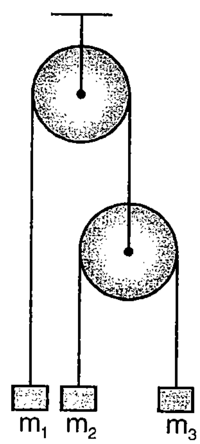
79. A small body starts sliding down on inclined plane of inclination θ, where base length is equal to ℓ. The coefficient of friction between the body and the surface is μ. If the angle θ is varied keeping ℓ constant. The time of sliding will be least for the relation



(1) $\tan 2\theta = -\frac{1}{\mu}$ (2) $\tan\theta = +\frac{1}{\mu}$

(3) $\tan 2\theta = -\frac{1}{2\mu}$ (4) $\tan\theta = \mu$

80. In the arrangement shown in figure, pulleys are massless and frictionless and threads are inextensible. The Block of mass m_1 will remain at rest, if



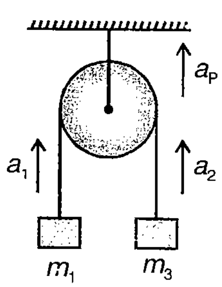
(1) $\frac{1}{m_1} = \frac{1}{m_2} + \frac{1}{m_3}$

(2) $m_1 = m_2 + m_3$

(3) $\frac{4}{m_1} = \frac{1}{m_2} + \frac{1}{m_3}$

(4) $\frac{1}{m_3} = \frac{2}{m_2} + \frac{3}{m_1}$

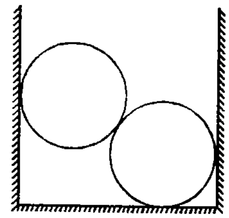
81. Two masses m_1 and m_2 are connected by a massless inextensible string going over a pulley. If the accelerations of m_1, m_2 and pulley w.r.t. ground be $\vec{a}_1, \vec{a}_2$ and $\vec{a}_p$, then which of the following is correct (assume only gravity forces)?



(1) $\vec{a}_1 + \vec{a}_2 = \vec{0}$ (2) $\vec{a}_1 + \vec{a}_2 = 2\vec{a}_p$

(3) $\vec{a}_1 - \vec{a}_2 = \vec{a}_p$ (4) $\vec{a}_1 = \vec{a}_p - \vec{a}_2$

82. Two identical spheres of radii 10 cm each are placed between two rigid vertical walls as shown. The spacing between the walls is 36 cm. Then the force of contact between the two spheres if the weight of each is W is



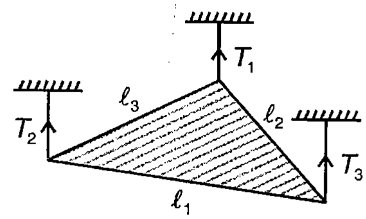
(1) 1.67 W

(2) 1.25 W

(3) 1.33 W

(4) 0.75 W

83. A triangular plate of mass m is tied at the three vertices by threads keeping the plate in equilibrium & such that the plane of plate is kept horizontal. If T_1, T_2, T_3 represent the tensions in the three threads and ℓ_1, ℓ_2 and ℓ_3 represent the side lengths as shown, then



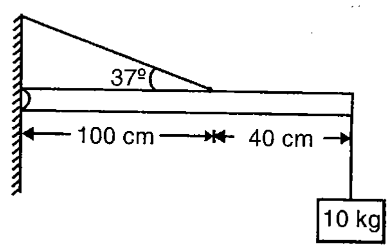
(1) $\frac{T_1}{\ell_1} = \frac{T_2}{\ell_2} = \frac{T_3}{\ell_3}$

(2) $\frac{T_1}{\ell_2\ell_3} = \frac{T_2}{\ell_1\ell_3} = \frac{T_3}{\ell_1\ell_2}$

(3) $T_1 = T_2 = T_3 = \frac{mg}{3}$

(4) None of these

84. For the uniform 5 kg beam shown in figure. The horizontal component of the force exerted by the hinge on the system is



(1) 292 N (2) 25.2 N

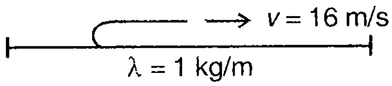
(3) 100 N (4) 234 N

85. A cart containing sand is moving under the action of a constant force F. A hole is opened at the bottom so that sand flows out at a constant rate μ kg/s. If velocity of cart at any instant is v then the thrust force due to this change of mass is

(1) μv (2) μv^2

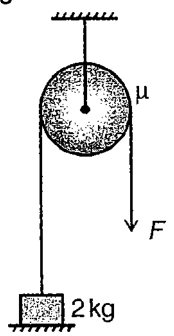
(3) $F - \mu v$ (4) Zero

86. A long pliable carpet is laid on ground. One end of the carpet is bent back and pulled backwards with constant velocity 16 m/s. If mass/length of carpet is 1 kg/m, the minimum force needed to pull the moving part is



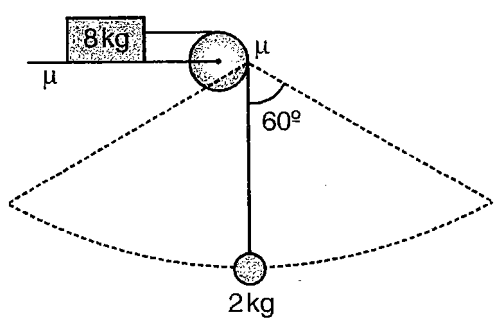
(1) 4 N (2) 8 N
(3) 16 N (4) 128 N

87. A block of mass 2 kg is to be lifted with constant velocity by applying force F down the rope that passes over a pulley having coefficient of friction μ. The pull required is



(1) $2ge^{\frac{\pi\mu}{2}}$
(2) $2g$
(3) $2ge^{\pi\mu}$
(4) $2ge^{\frac{\pi\mu}{4}}$

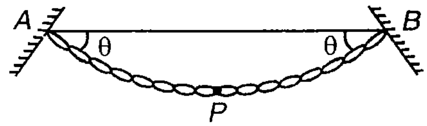
88. In the system shown, the mass $m = 2$ kg oscillates in a circular arc of amplitude 60º, the minimum value of coefficient of friction between mass = 8 kg and surface of table to avoid slipping is



(1) 0.25 (2) 0.50
(3) 0.40 (4) None of these

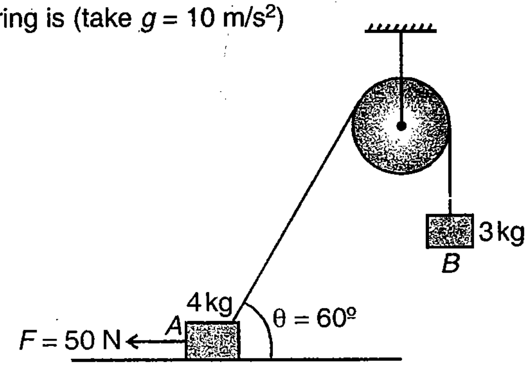
89. A car goes on a banked track with angle of banking 37º. It comes across a turn of radius 100 m. If coefficient of friction between the tyres and the surface is $\frac{1}{\sqrt{3}}$, then the maximum velocity with which the car can take the turn, assuming $g = 10$ m/s^2, is
(1) 48.38 m/s (2) 55.76 m/s
(3) 27.38 m/s (4) None of these

90. A flexible chain of mass m hangs between two fixed points A and B at the same level. The inclination of the chain with the horizontal at the two points of support is θ. The tension at the mid point of the chain is



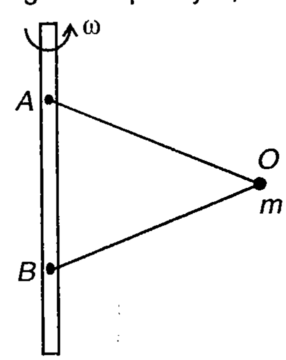
(1) $\frac{mg}{\tan\theta}$ (2) $\frac{mg}{2\tan\theta}$
(3) Zero (4) $mg\frac{(\sin\theta+\cos\theta)}{2}$

91. A block of mass 4 kg placed on a horizontal surface is connected to another mass of 3 kg by a massless inextensible string going over a pulley as shown. A force of $F = 50$ N is applied horizontally on A as shown. At the instant, θ is 60º. The tension in the string is (take $g = 10$ m/s^2)



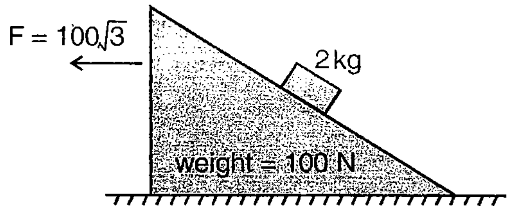
(1) 41.05 N (2) 34.3 N
(3) 35.72 N (4) 53.06 N

92. A particle O, of mass m is attached to a vertical rod with two inextensible strings AO & BO of equal lengths ℓ. If ℓ be the distance between the points of suspension on the vertical rod and the setup rotates with angular frequency ω, then



(1) Tension in thread BO is greater
(2) Tension in thread AO is greater
(3) Tension in the two threads are equal
(4) Tension in AO or BO is greater according as ω is anticlockwise or clockwise

93. An inclined plane of weight 100 N & angle of inclination 30º is acted upon by a horizontal force of $100\sqrt{3}$ N as shown. A block of mass 2 kg was kept on the inclined plane initially. Assuming frictionless contacts. The acceleration of mass 2 kg w.r.t. ground is (take g = 10 m/s²)



(1) 6.37 m/s² (2) 12 m/s²

(3) 10 m/s² (4) 5.77 m/s²

94. A ball of mass m is dropped from a height h on a smooth horizontal rigid plane. It makes an elastic collision and rises to the same height. The average force exerted by the ball on the plane over a sufficiently long time interval is

(1) Zero

(2) Cannot be calculated from the given data

(3) mg

(4) $2mg$

95. A thin circular wire of radius R rotates about its vertical diameter with an angular velocity ω. For a small bead on the wire to remain at the lowermost position

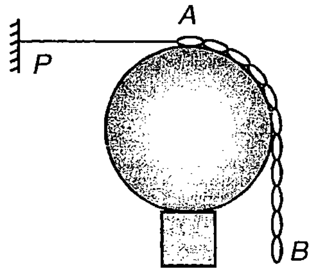
(1) ω should be zero

(2) $\omega \le \sqrt{\frac{g}{R}}$

(3) $\omega \le \sqrt{\frac{2g}{R}}$

(4) $\omega \ge \sqrt{\frac{g}{R}}$ & $\omega \le \sqrt{\frac{2g}{R}}$

96. A chain of mass per unit length λ and length 1.5 m rests on a fixed smooth sphere of radius $R = \frac{2}{\pi}$ m such that A end of chain is at the top of sphere while the other end is hanging freely. Chain is held stationary by a horizontal thread PA. The tension in the thread is



(1) $\lambda g\left(\frac{1}{2}+\frac{2}{\pi}\right)$ (2) $\lambda g\left(\frac{\pi}{2}+\frac{2}{\pi}\right)$

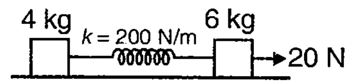
(3) $\lambda g\left(\frac{2}{\pi}\right)$ (4) None of these

97. A body of mass 4 kg is moving at speed 2 m/s on circular path of radius 1 m speed of particle is continuously increasing at rate of 3 m/s². Force acting on particle at the instant when speed 2 m/s is

(1) 28 N (2) 12 N

(3) 20 N (4) 16 N

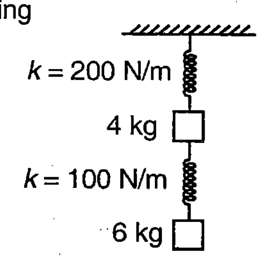
98. Two blocks of mass 4 kg and 6 kg are attached by a spring of spring constant k = 200 N/m, both blocks are moving with same acceleration. Find elongation in spring



(1) 4 cm (2) 10 cm

(3) 6 cm (4) 2 cm

99. Two blocks of 4 kg and 6 kg are attached by springs, they are hanging in vertical position, lower spring breaks due to excessive force. Acceleration of 4 kg block just after breaking



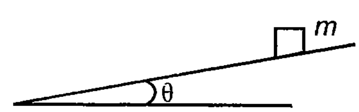
(1) 15 m/s²

(2) 25 m/s²

(3) 10 m/s²

(4) Zero

100. A block of mass m is placed on an inclined plane and angle of inclination is increasing with respect to time. Coefficient of friction is $\frac{3}{4}$, which of the following is incorrect? [$\tan^{-1} 3/4 = 37°$]



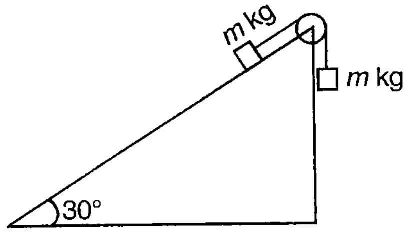
(1) When body is at rest $\vec{N} + \vec{f} + \vec{mg} = 0$

(2) $f = mg\sin\theta$ when $\theta < 37°$

(3) $f = \mu mg\cos\theta$ when $\theta \ge 37°$

(4) When body is at rest $N\cos\theta = mg$

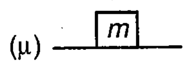
101. Two blocks are connected by massless string and pulley. As the blocks are left to move, the force by pulley on the clamp is



(1) $\frac{3\sqrt{3}\,mg}{4}$ (2) $\frac{mg}{4}\times\frac{\sqrt{3}}{2}$

(3) mg (4) $\frac{mg}{2}$

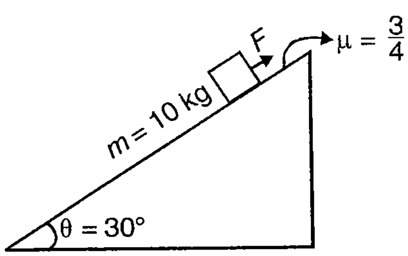
102. A block of mass m is placed over a rough surface find minimum force required to move block, it is given coefficient of friction between block and ground is μ



(1) μmg (2) $\frac{\mu mg}{\sqrt{1+\mu^2}}$

(3) $\frac{\mu mg}{2}$ (4) $2\mu mg$

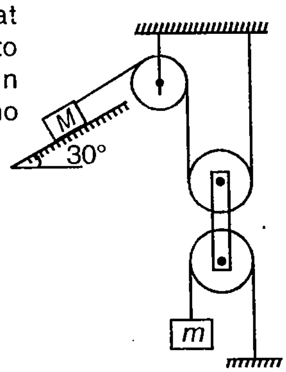
103. A block of 10 kg is placed on rough inclined surface find range of force F along inclined plane so that block remains at rest



(1) $0 < F < 115$ (2) $10 < F < 115$

(3) $15 < F < 115$ (4) $10 < F < 100$

104. In the arrangement shown, neglect the mass of the ropes and pulley. What must be the value of m to keep the system in equilibrium? There is no friction anywhere



(1) M

(2) $2M$

(3) $\frac{M}{2}$

(4) $\frac{M}{4}$

105. A car of mass m is travelling at a slow velocity v_0. It is subjected to a drag resistance of the wind, which is proportional to its velocity, the constant of proportionality being k. The distance covered by the car before its speed becomes half is

(1) $\frac{mv_0}{k}$ (2) $\frac{2\,mv_0}{k}$

(3) $\frac{mv_0}{2k}$ (4) $\frac{mv_0}{4k}$

106. A ball A moving with momentum $2i + 4j$ collides with ball B moving with momentum $6\hat{j}$. After collision momentum of ball B is $10\hat{j}$. Which of the following statement is correct?

(1) After collision momentum of A is $4\hat{i}$

(2) After collision momentum of A is parallel to momentum of B.

(3) After collision momentum of A is $2\hat{i}$

(4) If $\vec{P_A}$ and $\vec{P_B}$ are momentum of balls A and B, then $\Delta(p_A + p_B) = 0$

107. A ball of 1 kg moving with velocity $\vec{v} = 3\hat{i} + 4\hat{j}$ collides with a wall and after collision moves with velocity $\vec{v} = -2\hat{i} + 6\hat{j}$. Which of the following unit vector is perpendicular to wall? (Assume smooth surface)

(1) $\frac{1}{5}(-3\hat{i} - 4\hat{j})$ (2) $\frac{1}{\sqrt{29}}(-5\hat{i} + 2\hat{j})$

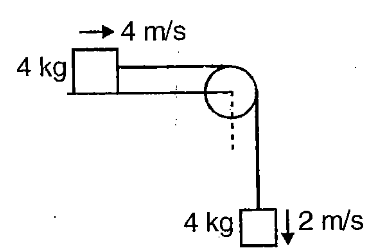
(3) $\frac{1}{\sqrt{40}}(-2\hat{i} + 6\hat{j})$ (4) $\frac{1}{\sqrt{29}}(5\hat{i} - 2\hat{j})$

108. An object of mass 40 kg having velocity $4\hat{i}$ m/s collides with another object of mass 40 kg having velocity $3\hat{j}$. If the collision is perfectly inelastic, then the loss of mechanical energy

(1) 250 J (2) 100 J

(3) 125 J (4) 35 J

109. Two blocks of same mass (4 kg) are placed according to diagram. Initial velocities of bodies are 4 m/s and 2 m/s and the string is taut. Find the impulse on 4 kg when the string again becomes taut



(1) 24 N-s (2) 6 N-s

(3) 4 N-s (4) 2 N-s

110. A body of mass 2 kg is projected with initial speed 10 m/s and at an angle 60° with horizontal, find resultant of centripetal force and tangential force at highest point of trajectory ($g = 10$ m/s^2)

(1) 20 (2) 20 tan 60

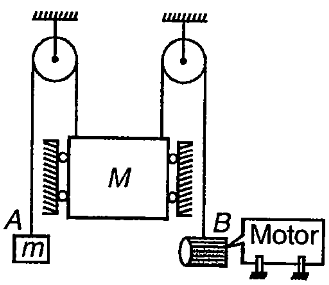
(3) 20 cos 60 (4) $10\sqrt{3}$

111. A uniform ring, having radius a and mass m is to be rotated in the horizontal plane about its own axis with constant angular velocity ω. What would be the tension in the ring and nature of force?

(1) $\frac{MR\omega^2}{2\pi}$ tensile (2) $MR\omega^2$ tensile

(3) $\frac{MR\omega^2}{2}$ compressive (4) $MR\omega^2$ compressive

112. The elevator has a mass M and the counter weight at A has a mass m. The motor supplies a constant force F on the cable at B. Neglecting the mass of the pulley and cable, the speed of the elevator at time t after starting from rest is



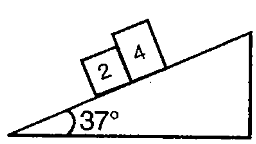
(1) $\frac{F+(m-M)g}{(M+m)}t$

(2) $\frac{F-Mg}{(M+m)}t$

(3) $\frac{F-(M+m)g}{(M+m)}t$

(4) $\left(\frac{F}{M+m}\right)t$

113. In the figure shown, the wedge is fixed and the masses are released from rest. The coefficient of friction between 4 kg and wedge is 0.8 and between 2 kg and wedge is 0.6. Which of the following statement is/are correct?



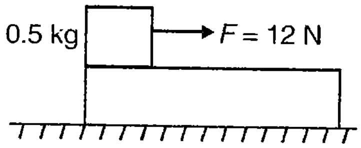
(1) $\vec{a}$ of blocks must be same

(2) Friction force on 4 kg is 24 N

(3) Friction force on 2 kg is 12 N

(4) Normal reaction between block is nonzero

114. A block of mass 0.5 kg is pulled by 12 N force on a fixed block. Speed of block is constant. Find total contact force applied by lower block on upper block



(1) 12 N (2) 5 N

(3) 13 N (4) 17 N

115. The mean kinetic energy of a particle of mass m moving under a constant acceleration in any interval of time when initial and final velocities are u_1 and u_2

(1) $\frac{1}{2}m(u_1^2+u_2^2)$ (2) $\frac{1}{2}m(u_1^2-u_2^2)$

(3) $\frac{1}{6}m(u_1^2+u_2^2+u_1u_2)$ (4) Zero

116. A heavy particle hangs from a point O, by a string of length a; It is projected horizontally with a velocity $v=\sqrt{(2+\sqrt{3})\,ag}$. The angle with the downward vertical, string makes when it becomes slack is

(1) $\theta=\sin^{-1}\left(\frac{-1}{\sqrt{3}}\right)$ (2) $\theta=\cos^{-1}\left(\frac{-1}{\sqrt{3}}\right)$

(3) $\theta=\cos^{-1}\left(\frac{1}{\sqrt{2}}\right)$ (4) $\theta=\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$

117. A heavy particle hanging vertically from a fixed point by a light inextensible cord of length l is struck by a horizontal blow which imparts to it a velocity $2\sqrt{(gl)}$. Then

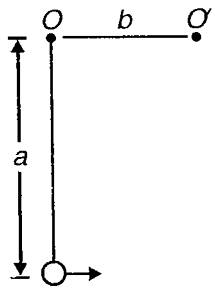
(1) The cord become slack when the particle has risen to a height $\frac{4l}{3}$ above the fixed point

(2) The cord become slack when the particle has risen to a height $\frac{2l}{3}$ above the fixed point

(3) The cord becomes slack when particle is at a height $\frac{l}{3}$ above the fixed point

(4) None of these

118. A particle is hanging from a fixed point O by means of a string of length a. There is a small smooth nail O' in the same horizontal line with O at a distance b ($< a$) from O'. The minimum velocity with which particle should be projected from its lowest position in order that it may make a complete revolution round the nail without string becoming slack



(1) $\sqrt{3gl}$

(2) $\sqrt{5gl}$

(3) $\sqrt{\{(5a-3b)g\}}$

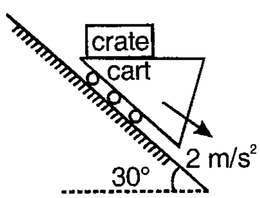
(4) $\sqrt{\{(5b-3a)g\}}$

119. A heavy particle of weight w, attached to a fixed point by a light inextensible string describes a circle in a vertical plane. The tension in the string has the values mw and nw respectively when the particle is at the highest and lowest points in the path. Then

(1) $m + n = 6$ (2) $\frac{m}{n} = 2$

(3) $m - n = -6$ (4) $n - m = -6$

120. The cart A is restricted to move down with an acceleration 2 m/s^2. There is no friction between the crate and the cart. The mass of crate is 10 kg. The normal force exerted by the cart on the crate is (g = 10 ms^{-2})



(1) 90 N

(2) 100 N

(3) 20 N

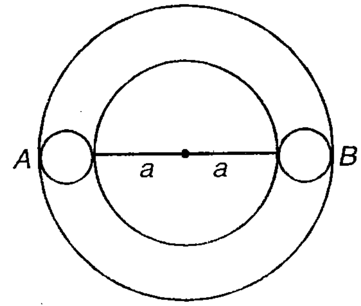
(4) 70 N

121. A ball of mass M strikes another ball of mass m at rest. If they separate in mutually perpendicular directions, then the coefficient of impact (e) is

(1) $\frac{M}{m}$ (2) $\frac{m}{M}$

(3) $\frac{m}{2M}$ (4) Zero

122. Two identical spheres A, B are in a smooth horizontal circular groove at opposite ends of a diameter. A is projected along the groove at impinges on B in a time interval T. Let e be the coefficient of restitution; then



(1) The second impact will occur at the same time T

(2) The second impact will occur after time $\frac{2T}{e}$

(3) The second impact will occur at the time $2T$

(4) None of these

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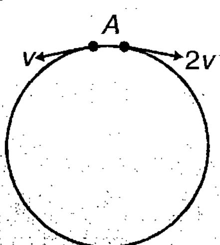
122(a) Two small particles of equal masses start moving in opposite directions from a point A in a horizontal circular orbit. Their tangential velocities are v and $2v$, respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at A, these two particles will again reach the point A?



(1) 4 (2) 3

(3) 2 (4) 1

123. A sphere of mass m falls on a smooth hemisphere of mass M resting with its plane face on smooth horizontal table, so that at the moment of impact line of centres makes an angle α with the vertical. The velocity of sphere just before impact is u and e is the coefficient of restitution

(1) The velocity of hemisphere after impact will be zero

(2) The hemisphere will move with a velocity

$$v = \frac{mu \sin\alpha}{m\cos^2\alpha}$$

(3) The hemisphere will move with a velocity

$$v = \frac{mu \sin\alpha\cos\alpha\ (1+e)}{(M + m\sin^2\alpha)}$$

(4) None of these

124. A particle moves with a velocity $5\hat{i} - 3\hat{j} + 6\hat{k}$ m/s under the influence of a constant force $\vec{F} = 10\hat{i} + 10\hat{j} + 20\hat{k}$ N. The instantaneous power applied to the particle is

(1) 200 J/s (2) 40 J/s

(3) 140 J/s (4) 170 J/s

125. A loaded spring gun of mass M fires a 'shot' of mass m with a velocity v at an angle of elevation θ. The gun is initially at rest on a horizontal frictionless surface. After firing the centre of mass of the gun-shot system

(1) Moves with a velocity $\frac{vm}{M}$

(2) Moves with a velocity $\frac{vm}{M\cos\theta}$ in the horizontal direction

(3) Moves with a velocity $\frac{mv\sin\theta}{M+m}$ along vertical

(4) Moves with velocity $v(M-m)/(M+m)$ in horizontal direction

126. A particle of mass 15 kg has an initial velocity $\vec{v}_i = \hat{i} - 2\hat{j}$ m/s. It collides with another body and the impact time is 0.1 s, resulting in a velocity $\vec{v}_f = 6\hat{i} + 4\hat{j} + 5\hat{k}$ m/s after impact. The average force of impact on the particle is

(1) $15[5\hat{i} + 6\hat{j} + 5\hat{k}]$

(2) $15[5\hat{i} + 6\hat{j} - 5\hat{k}]$

(3) $150[5\hat{i} - 6\hat{j} + 5\hat{k}]$

(4) $150[5\hat{i} + 6\hat{j} + 5\hat{k}]$

127. A man of mass M stands at one end of a plank of length L which lies at rest on a frictionless surface. The man walks to the other end of the plank. If the mass of plank is $\frac{M}{3}$, the distance that the man moves relative to the ground is

(1) $\frac{3L}{4}$ (2) $\frac{L}{4}$

(3) $\frac{4L}{5}$ (4) $\frac{L}{3}$

128. A particle of mass m moves on the x-axis under the influence of a force of attraction towards the origin is given by $\vec{F} = \frac{-k}{x^2}\hat{i}$. If the particle starts from rest at $x = a$, the speed it will attain to reach the point $x = x$ will be

(1) $\sqrt{\frac{2k}{m}}\left[\frac{a-x}{ax}\right]^{1/2}$ (2) $\sqrt{\frac{2k}{m}}\left[\frac{a+x}{ax}\right]^{1/2}$

(3) $\sqrt{\frac{k}{m}}\left[\frac{ax}{a-x}\right]$ (4) $\sqrt{\frac{m}{2k}}\left[\frac{a-x}{ax}\right]^{1/2}$

129. A 20 kg body is displaced on a rough plane with a friction coefficient $\mu = 0.5$ with a variable force $F = (4x^2 + 115)$ N. The kinetic energy of the block after the block has travelled a distance 5 m is (where x is displacement)

(1) $\frac{755}{2}$ J (2) $\frac{755}{4}$ J

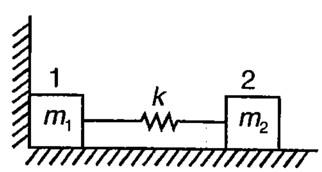
(3) $\frac{755}{3}$ J (4) $\frac{755}{6}$ J

130. A body of mass M moving with a speed u has a 'head on' collision with a body of mass m originally at rest. If $M >> m$, the speed of the body of mass m after collision, will be nearly

(1) $\frac{um}{M}$ (2) $\frac{uM}{m}$

(3) $\frac{u}{2}$ (4) $2u$

131. Two bars connected by a weightless spring of stiffness k rest on a smooth horizontal plane as shown in figure. Bar 2 is shifted a small distance x to the left and then released. The velocity of the centre of inertia of the system after bar 1 breaks off the wall is



(1) $\frac{x\sqrt{m_2 k}}{m_1 + m_2}$ (2) $\frac{kx}{m_1 + m_2}$

(3) Zero (4) $\frac{\sqrt{m_1 k}\ x}{m_1 + m_2}$

132. A ball is projected from a point in a horizontal plane and makes one rebound if the second range is equal to the greatest height. Then

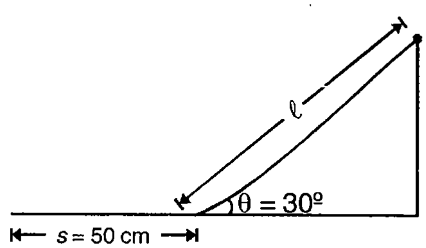
(1) Angle of projection $\alpha = \tan^{-1}(4)$

(2) Angle of projection $\alpha = \tan^{-1}(4e)$ where e is the impact coefficient

(3) Angle of projection is 45°

(4) The greatest height $= \left(\dfrac{eu^2 \sin^2\alpha}{2g}\right)$

133. A particle of mass $m = 50$ g slides with zero initial velocity down an inclined plane set at an angle $\theta = 30^\circ$ to the horizontal, having traversed the distance $s = 50$ cm along the horizontal plane, the disc stop. The length (ℓ) of the inclined plane is (assuming the friction coefficient for both inclined and horizontal planes is $\mu = 0.15$)



(1) 0.10 m (2) 0.20 m

(3) 0.15 m (4) 0.30 m

134. The kinetic energy of a particle continuously increases with time

(1) The resultant force must be parallel to the velocity of particle

(2) The resultant force must be at an angle less than 90° with velocity

(3) Potential energy must decrease

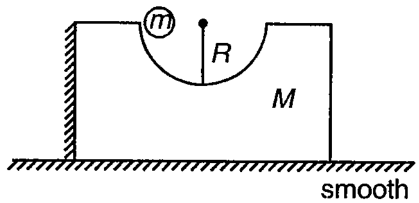
(4) Linear momentum of particle must be decreasing continuously

135. A small body of mass m is located on a horizontal plane at the point O. The body acquires a horizontal velocity u. The mean power developed by the friction force during the whole time of motion if the friction coefficient is μ

(1) $\frac{1}{2} mu\mu g$ (2) $\frac{1}{2}\frac{mug}{\mu}$

(3) $2mumg$ (4) $\frac{2mug}{\mu}$

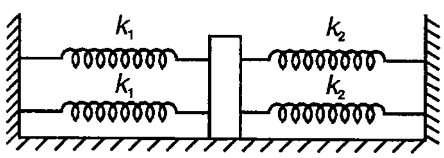
136. The system shown is released from rest. Mass of ball is m kg and that of wedge is M kg respectively. When ball reaches at heighest point on other side of the wedge, velocity of ball and wedge is (initially wedge is kept at rest against a wall)



(1) $\frac{M\sqrt{2gR}}{m+M}$ (2) $\frac{M\sqrt{2gR}}{M}$

(3) $\frac{M}{m}\sqrt{2gR}$ (4) $\frac{m\sqrt{2gR}}{m+M}$

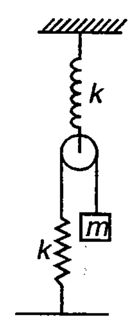
137. A block of mass m is attached to four unstretched massless springs of spring constant k_1 and k_2 as shown in figure. The block is displaced towards right through distance X and is released. Speed of block when displacement of block is X/2 from mean position is



(1) $\sqrt{2(k_1+k_2)\frac{X}{m}}$ (2) $\sqrt{\frac{3(k_1+k_2)x^2}{2m}}$

(3) $\sqrt{\frac{(k_1k_2)}{3(k_1+k_2)}\frac{X}{m}}$ (4) $\sqrt{\frac{(k_1+k_2)}{(k_1+k_2)}\frac{x}{m}}$

138. A system is released from rest as shown in figure. Kinetic energy of mass m when its moves distance x in downward direction is (initially both spring are unstretched and all spring are massless)



(1) $10\,mgx$ (2) $\frac{10mgx - kx^2}{10}$

(3) $mgx - kx^2$ (4) $mgx - \frac{kx^2}{2}$

139. Force $\vec{F} = y\hat{i} + x\hat{j}$ acts upon a particle of mass m.

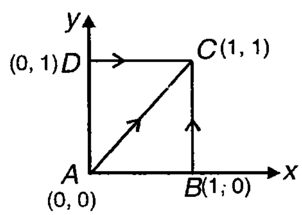
(1) Potential energy is given by $U = -\frac{xy}{2} + C$, where C is constant

(2) Force is conservative in nature and potential energy $U = -xy + C$, where C is constant

(3) Force is non conservative in nature

(4) Origin is the unstable equilibrium position

140. A particle of mass m moves from A to C under the action of force $\vec{F} = 2xy\hat{i} + y^2\hat{j}$, along different path as shown in figure.



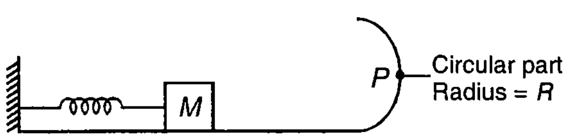
(1) Force is conservative in nature

(2) Work done by force is $\frac{8}{5}$ J when particle moves along path ABC

(3) Force is non conservative in nature and work done along path AC is 1 J

(4) Work done along path ADC is $\frac{14}{5}$ J.

141. A smooth track is shown in figure. A block of mass M is pushed against a spring of spring constant K fixed at the left end and is then released. Find the initial compression of the spring so that the normal reaction at point P is zero



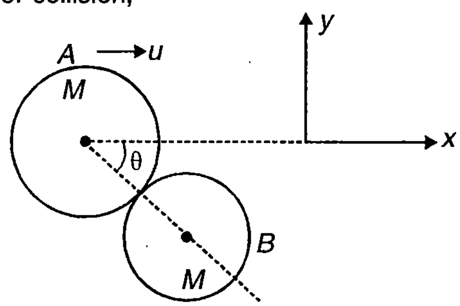
(1) $\sqrt{\frac{3MgR}{K}}$

(2) $\sqrt{\frac{2MgR}{K}}$

(3) $\sqrt[\frac{1}{2}]{\frac{MgR}{K}}$

(4) $\sqrt{\frac{MgR}{K}}$

142. A ball of mass M collides with a similar ball at rest as shown in figure. Initially velocity of ball is u m/s. After collision,



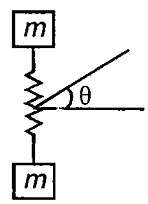
(1) Speed of ball B is $u \sin\theta$

(2) Velocity of ball A is $u\sin^2\theta\hat{i} + u\sin\theta\cos\theta\hat{j}$

(3) Speed of ball A is $u \cos\theta$

(4) Velocity of ball B is $u\cos\theta\sin\theta\hat{i} + 4\cos^2\theta\hat{j}$

143. A spring mass system is shown in figure. It is projected at an angle θ with horizontal. Path of centre of mass is



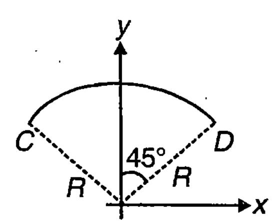
(1) A circle

(2) A straight line

(3) A parabola

(4) An ellipse

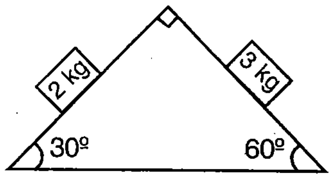
144. A circular *arc CD* of thin wire frame of radius R and mass M with centre at origin makes an angle of 90º at the origin. The y-coordinate centre of mass of the *arc* lies at



(1) $\frac{\sqrt{2}R}{\pi}$ (2) $\frac{R}{2\pi}$

(3) $\frac{2R}{\pi}$ (4) $\frac{2\sqrt{2}R}{\pi}$

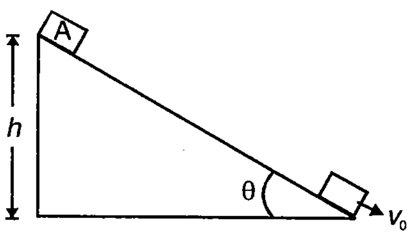
145. Figure shows a fixed wedge on which two blocks of masses 2 kg and 3 kg are placed on its smooth inclined surfaces. When the two blocks are released from rest, the x-component of the acceleration of centre of mass of the two blocks



(1) $\frac{\sqrt{3}g}{20}$ (2) $\frac{g}{20}$

(3) $\frac{\sqrt{3}g}{10}$ (4) $\frac{g}{10}$

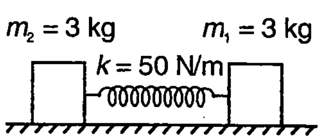
146. A block A is released from rest from the top of a fixed wedge of height h as shown in figure. If velocity of block when it reaches the bottom of incline is v_0. The time of sliding is



(1) $\frac{2h\sin\theta}{v_0}$ (2) $\frac{2h}{v_0}$

(3) $\frac{2h\,\text{cosec}\,\theta}{v_0}$ (4) $\frac{h}{v_0}$

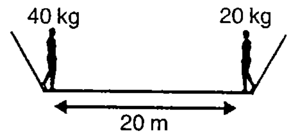
147. On a spring block system shown in figure, a time varying force $F = 5t$ N is applied on 2 kg mass. After 10 s, velocity of 3 kg mass is 30 m/s. velocity of 2 kg mass at this instant is



(1) 50 m/s (2) 80 m/s

(3) 20 m/s (4) 90 m/s

148. Two men of masses 40 kg and 20 kg are standing on a boat of mass 100 kg. Length of boat is 20 m. Neglect the friction between water and boat. Find the displacement of the boat when both person reach at middle of boat



(1) $\frac{5}{4}$ m, towards right (2) $\frac{5}{4}$ m, towards left

(3) $\frac{5}{8}$ m, towards right (4) $\frac{5}{8}$ m, towards left

149. The potential energy of a 4 kg particle free to move along the x-axis is given by

$$U(x) = \frac{x^3}{3} - \frac{5x^2}{2} + 6x + 3$$

Total mechanical energy of the particle is 17 J. Then the maximum kinetic energy is

(1) 10 J (2) 2 J

(3) 9.5 J (4) 0.5 J

150. A body of mass m is moving in a plane along a circle of radius r. Its angular momentum about the axis of rotation is L. The centripetal force acting on the particle will be

(1) $\frac{L^2}{mr}$ (2) $\frac{L^2}{mr^3}$

(3) $\frac{L^2 m}{r}$ (4) $\frac{L^2}{mr^2}$

151. A body of mass m is thrown at an angle θ to the horizontal with the initial velocity u. The instantaneous power of gravity as a function of time is

(1) $mg(gt + u\cos\theta)$ (2) $mg(gt - u\cos\theta)$

(3) $mg(gt - u\sin\theta)$ (4) $mg(gt + 4\sin\theta)$

152. A particle moves in circular path with decreasing speed then choose correct statement

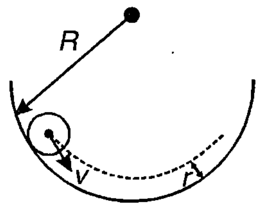
(1) Angular momentum remains constant

(2) Acceleration $(\vec{a})$ is towards centre

(3) Particle moves in spiral path with decreasing radius

(4) Direction of angular momentum is constant

153. Figure shows a smooth ball of mass m and radius r sliding down a concave surface of radius R as shown. The kinetic energy of the body is



(1) $\frac{1}{2}mv^2$

(2) $\frac{1}{2}mv^2 + \frac{1}{2}(mR^2)\,\omega^2,\ \omega = \frac{v}{R}$

(3) $\frac{1}{2}mv^2 + \frac{1}{2}m(R-r)^2\,\omega^2,\ \omega = \frac{v}{R-r}$

(4) $\frac{1}{2}mv^2 + \frac{1}{5}mr^2\omega^2,\ \omega = \frac{v}{R-r}$

154. A particle is projected from ground with speed u such that the horizontal range is R and maximum height is H. The angular velocity of the particle about the point of projection, when it is at the highest point of its trajectory is

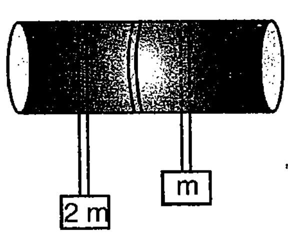
(1) $\dfrac{HRu}{(R^2+4H^2)\sqrt{R^2+16H^2}}$

(2) $\dfrac{4\,HRu}{(R^2+4H^2)\sqrt{R^2+16H^2}}$

(3) $\dfrac{u}{H}$

(4) $\dfrac{uR}{H\sqrt{R^2+16H^2}}$

155. Figure shows a cylinder mounted on a horizontal axle. A massless string is wound on it two and half turn and connected to two masses m and 2 m. If the system is in limiting equilibrium. The coefficient of friction between the string and the pulley surface is



(1) $\frac{2\pi}{5}\ln 2$ (2) $\frac{5}{\pi}\ln 2$

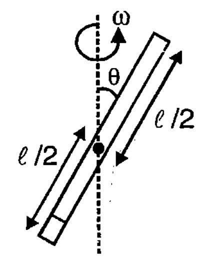
(3) $\frac{5}{2\pi}\ln 2$ (4) $\frac{1}{5\pi}\ln 2$

156. Two masses m_1 kg and m_2 kg passes over an atwood machine. The ratio of masses m_1 and m_2 for string passing over the pulley will just start slipping over its surface, given the friction coefficient between the string and pulley surface is 0.2

(1) e^1 (2) e^{π}

(3) $e^{0.2}$ (4) $e^{0.2\pi}$

157. Total energy of the inclined rod of mass m and length ℓ, rotating with angular velocity ω, about a vertical axis xx', shown in figure is



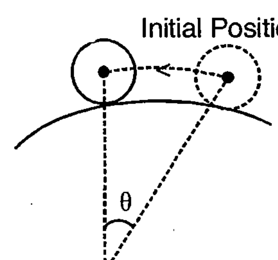
(1) $\frac{1}{12}m\omega^2\,\ell^2\sin^2\theta$

(2) $m\omega^2\ell^2\sin^2\theta$

(3) $\frac{1}{24}m\omega^2\,\ell^2\sin^2\theta$

(4) $\frac{1}{3}m\omega^2\,\ell^2\sin^2\theta$

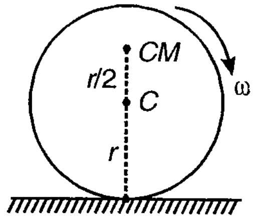
158. A uniform ball (solid sphere) is rolling without slipping on a convex bridge. The mass of the ball is m. The radius of the ball is r and radius of curvature for the bridge is R. If the angle θ is increasing at a rate ω, the kinetic energy of the ball in the centre of mass frame is



(1) $\frac{1}{5}mr^2\omega^2\left(1+\frac{R}{r}\right)^2$ (2) $\frac{2}{5}mr^2\omega^2\left(1-\frac{R}{r}\right)^2$

(3) $\frac{2}{5}\dfrac{mr^2\omega^2}{\left(1+\frac{R}{r}\right)^2}$ (4) $\frac{2}{5}\dfrac{mr^2\omega^2}{\left(1-\frac{R}{r}\right)^2}$

159. A non-uniform sphere has its centre of mass at a distance $\frac{r}{2}$ from the centre, where r is the radius of the sphere. This sphere rolls without slipping on a horizontal surface such that the angular velocity is ω which is constant. Consider the instant shown in figure.



Select the correct statement :

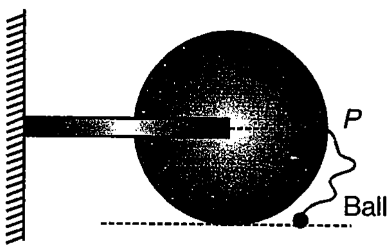
(1) The speed of the centre C is constant

(2) The speed of the centre of mass is constant

(3) The speed of the centre of mass is $\frac{r}{2}\omega$ at the instant shown

(4) The speed of the centre C is $\frac{r}{2}\omega$ at the instant shown

160. Figure shows a disc of mass M and radius R hinged at the centre. A small ball of mass $\frac{M}{2}$ is attached to point P with a thread of length $2R$ and held at rest at position shown. Now, the ball is released to fall under gravity with what angular speed the disc starts turning when the string becomes taut?



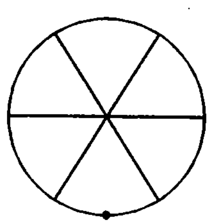
(1) $\sqrt{\frac{g}{2R}}$

(2) $\sqrt{\frac{g}{R}}$

(3) $\sqrt{\frac{R}{g}}$

(4) $\sqrt{\frac{2g}{R}}$

161. A wheel of radius r consists of a thin uniform rim of mass m and six thin spokes mass m. What is the moment of inertia of the wheel about axis passing through A and perpendicular to the plane?



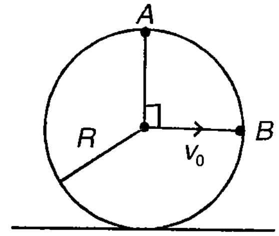
(1) $6\ mr^2$

(2) $4\ mr^2$

(3) $3\ mr^2$

(4) $10\ mr^2$

162. A ring of radius R is rolling over rough horizontal surface with velocity v_0. Two points are located at A and B on rim of ring. Find angular velocity of A w.r.t. B



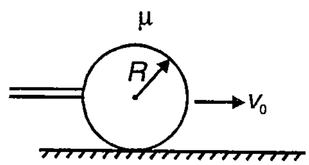
(1) $\frac{v_0}{R}$

(2) $\frac{\sqrt{2}\,v_0}{R}$

(3) $\frac{2v_0}{R}$

(4) $\frac{v_0}{R\sqrt{2}}$

163. A billiard ball is struck by a cue. The line of action of the applied impulse is horizontal and passes through the centre of the ball. The initial velocity of the ball is v_0. If R is the radius, M is the mass of the ball and μ is the coefficient of friction between the ball and the floor. The distance travelled by the ball before it ceases to slip on the floor is



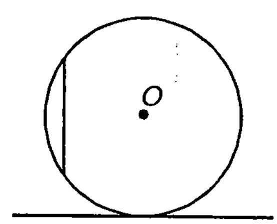
(1) $\frac{49v_0^2}{12\mu g}$

(2) $\frac{12v_0^2}{49\mu g}$

(3) $\frac{2v_0^2}{7\mu g}$

(4) $\frac{7v_0^2}{2\mu g}$

164. A rod of length 2 m is kept vertical inside smooth spherical shell of radius 2 m. The rod starts slipping inside shell. Mass of rod is 4 kg. Then angular speed of rod in horizontal position about centre of sphere



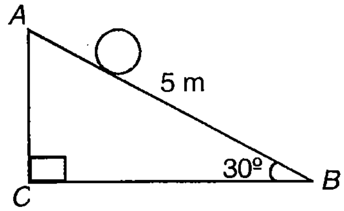
(1) 4.6 rad/s

(2) 3.2 rad/s

(3) 6.8 rad/s

(4) 7.2 rad/s

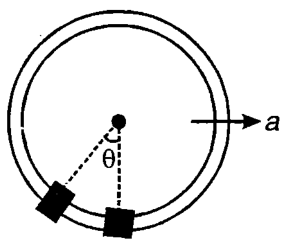
165. Length AB in figure shown is 5 m. The body is released from A. Friction is sufficient for pure rolling to take place. The maximum time which anybody (which can roll) can take to reach bottom is



(1) 8 s (2) 2 s

(3) 6 s (4) 4 s

166. If a vertical circular frame start from rest with a constant acceleration a and the smooth sliding collar A is initially at rest in the bottom position $\theta = 0$. Find the maximum position θ_{max} reached by the collar



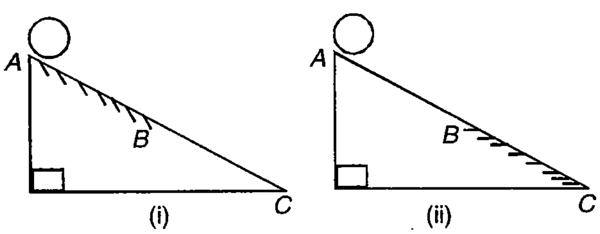
(1) $\tan^{-1}\left(\frac{a}{g}\right)$

(2) $\tan^{-1}\left(\frac{2a}{g}\right)$

(3) $2\tan^{-1}\left(\frac{a}{g}\right)$

(4) $\tan^{-1}\left(\frac{a}{2g}\right)$

167. In both figures all other factors are same except that in figure (i) AB is rough and BC is smooth while in figure (ii) AB is smooth and BC is rough. Kinetic energy of ball on reaching bottom is



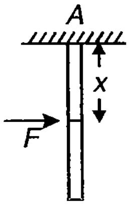
(1) Same in both the cases

(2) Greater in case (i)

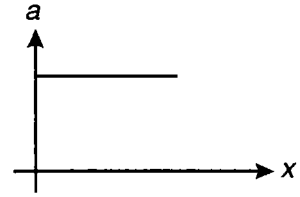
(3) Greater is case (ii)

(4) Information insufficient

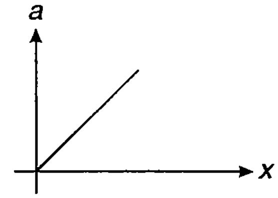
168. A rod of mass m and length l is hinged at one of its end A as shown in figure. A force F is applied at distance x from A. The acceleration of centre of mass (a) varies with x as



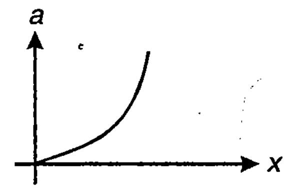
(1)



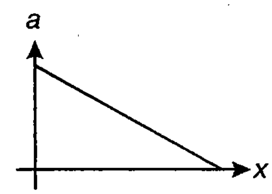
(2)



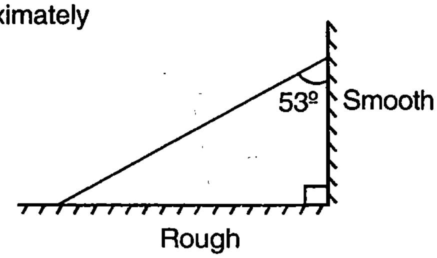
(3)



(4)



169. A uniform ladder of mass 10 kg leans against smooth vertical wall making an angle 53º with it. The other end rests on rough horizontal floor. Then friction coefficient just necessary for ladder to be at rest is approximately



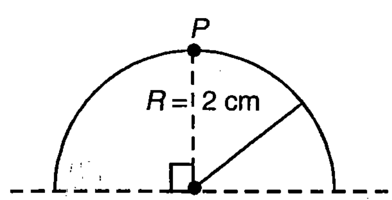
(1) 0.45

(2) 0.55

(3) 0.75

(4) 0.67

170. Moment of inertia of a semicircular ring of mass $\left(\pi = \frac{22}{7}\right)$ kg and radius 2 cm about the axis passing through point P and perpendicular to its plane is

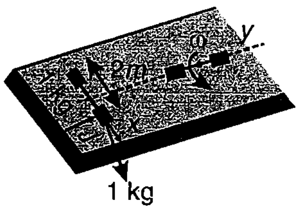


(1) 20.2×10^{-4} kgm^2 (2) 9.12×10^{-4} kgm^2

(3) 30.21×10^{-4} kgm^2 (4) 32.12×10^{-4} kgm^2

171. Two blocks of mass 1 kg are rigidly connected to the rod of negligible mass and are initially at rest on smooth horizontal surface. An impulse of 15 Ns is imparted to one sphere in the y direction in short period of time.

Find the angular velocity of the rod when it becomes perpendicular to the x-axis?



(1) 7.5 rad/s (2) 15 rad/s

(3) 3.75 rad/s (4) 10 rad/s

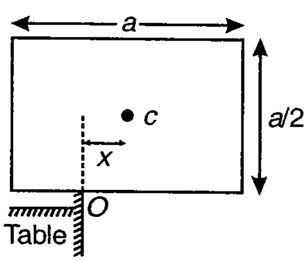
172. The uniform rectangular slab is released from rest in the position shown. Determine the value x for which angular acceleration is a maximum?

(1) $\frac{a}{4}$

(2) $\frac{a}{3}$

(3) $\frac{a}{\sqrt{6}}$

(4) $\frac{a}{\sqrt{3}}$



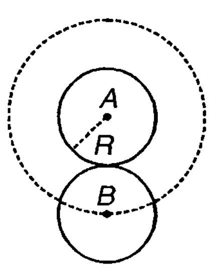
173. Two identical discs of mass M and radius R are in contact with each other on smooth horizontal surface. The disc A is fixed while B start rolling on circular path such that there is no slipping. The disc B makes one revolution around A in T time. Calculate kinetic energy of the disc B

(1) $\frac{16 M\pi^2 R^2}{T^2}$

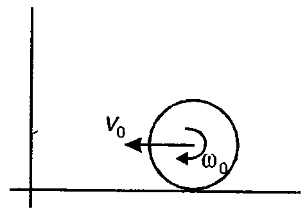
(2) $\frac{3\pi^2 MR^2}{T^2}$

(3) $\frac{24\pi^2 MR^2}{T^2}$

(4) $\frac{12\pi^2 MR^2}{T^2}$



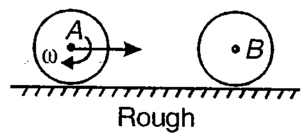
174. A solid sphere has linear velocity v_0 = 4 m/s and angular velocity ω_0 = 9 rad/s as shown. Ground on which it is moving is smooth. It collides elastically with rough wall of coefficient of friction μ. Radius of sphere 1 m and mass 2 kg. Then what is coefficient of friction if sphere after colliding rolls without slipping?



(1) $\frac{1}{2}$ (2) $\frac{2}{3}$

(3) $\frac{1}{3}$ (4) $\frac{1}{4}$

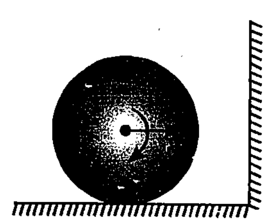
175. A solid sphere is rolling without slipping on rough ground as shown in figure. It collides elastically with an identical another sphere at rest. There is no friction between two spheres. Radius of each sphere is R and mass is m. Then linear velocity of first sphere after it again start rolling without slipping is



(1) $\frac{2}{5}\omega R$ (2) $\frac{2}{7}\omega R$

(3) $\frac{7}{10}\omega R$ (4) $\frac{7}{5}\omega R$

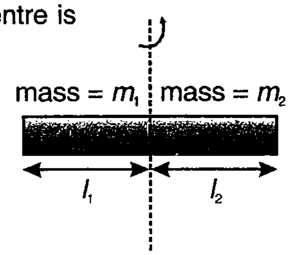
176. A solid cylinder of mass m and radius R is rolling without slipping on a smooth horizontal surface with speed v as shown in figure. It undergoes an elastic collision with rough vertical wall. If the coefficient of friction between cylinder and wall is 1. The angular impulse imparted to the cylinder about the top-most point is



(1) mvR (2) 2 mvR

(3) Zero (4) $\sqrt{2}$ mvR

177. The moment of inertia of the composite rod about an axis perpendicular to its length and passing through its geometrical centre is



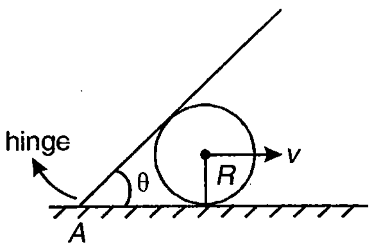
(1) $(m_1+m_2)\left(\frac{l_1^2}{3}+\frac{l_2^2}{3}\right)$

(2) $(m_1+m_2)\left(\frac{l_1^2}{12}+\frac{l_2^2}{12}\right)$

(3) $\frac{(m_1+m_2)(l_1+l_2)^2}{12}$

(4) $\frac{m_1l_1^2}{3}+\frac{m_2l_2^2}{3}$

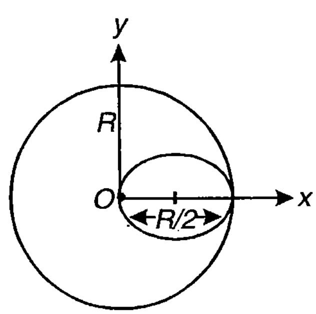
178. A plank is hinged on horizontal surface at point A as shown in figure, find angular velocity of plank about point A at instant given in figure. Solid sphere only translates with velocity v and radius of sphere is R



(1) $\frac{2v\sin\frac{\theta}{2}}{R}$ (2) $\frac{2v\cos^2\frac{\theta}{2}}{R}$

(3) $\frac{2v\sin^2\frac{\theta}{2}}{R}$ (4) $\frac{2v\sin\theta}{R}$

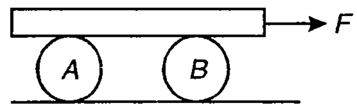
179. A circular plate of radius $\frac{R}{2}$ is cut from one edge of thin circular plate of radius R. The moment of inertia of remaining portion about an axis through O perpenclicular to plane of plate is



(1) $\frac{11MR^2}{24}$ (2) $\frac{7MR^2}{12}$

(3) $\frac{13MR^2}{32}$ (4) $\frac{5MR^2}{7}$

180. In given figure for pure rolling of spheres



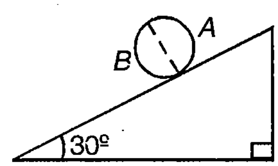
(1) Friction on B between plank and spheres is in backward direction

(2) Friction on A between plank and spheres is in forward direction and B in backward direction

(3) Friction between plank and spheres on both in forward direction

(4) Friction between plank and spheres on both in backward direction

181. A ring shown in figure is made up of two semicircular rings A and B of mass 2 kg and 4 kg respectively. The ring has diameter of 1 m. The ring rolls without slipping then angular acceleration of ring is



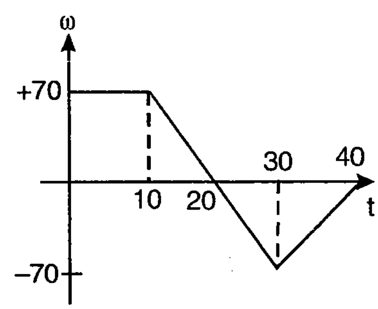
(1) 5.2 rad/s^2

(2) 4.32 rad/s^2

(3) 6.84 rad/s^2

(4) 2.32 rad/s^2

182. Variation of angular speed with time is given in figure for merry go round which starts rotating at $t = 0$ then during 10 s to 20 s merry go round



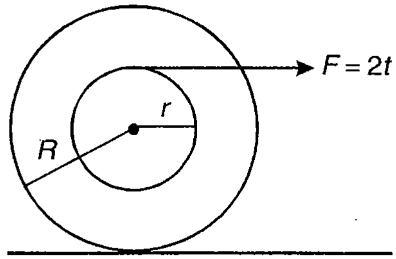
(1) Rotates clockwise at constant rate

(2) Rotates clockwise and slows down

(3) Rotates anti-clockwise at constant rate

(4) Rotates anti-clockwise and slows down

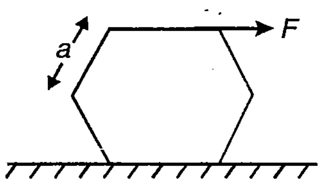
183. A time varying force $F = 2t$ is applied on spool as shown in figure. The angular momentum of spool at time t about bottom of spool is



(1) $\dfrac{r^2t^2}{R}$ (2) $\dfrac{(R+r)^2t^2}{r}$

(3) $(r + R)t^2$ (4) Data is insufficient

184. When force F acts on side of hexagonal body for what range of coefficient of friction body will topple?



(1) $\mu > 0.29$ (2) $\mu < 0.29$

(3) $\mu > 0.21$ (4) $\mu < 0.21$

185. Choose incorrect statement for particle moving along circular path of constant radius

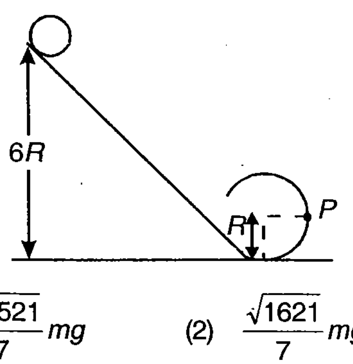
(1) Centripetal acceleration is always perpendicular to velocity vector

(2) Centripetal acceleration is always perpendicular to angular velocity

(3) Angular acceleration is always perpencdicular to velocity vector

(4) Angular velocity is always perpendicular to angular acceleration

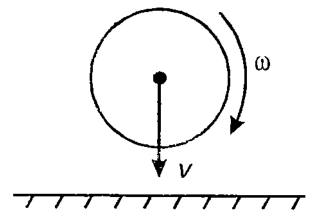
186. A small solid sphere rolls down as given in figure then force on sphere when it is at point P



(1) $\dfrac{\sqrt{2521}}{7}mg$ (2) $\dfrac{\sqrt{1621}}{7}mg$

(3) $\dfrac{\sqrt{2025}}{7}mg$ (4) $\dfrac{\sqrt{2549}}{7}mg$

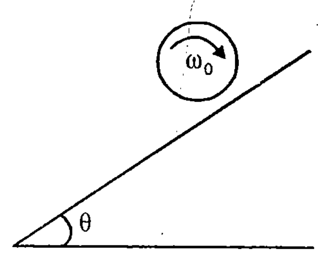
187. A ball rotating with angular velocity ω about its centre of mass strikes a rough horizontal surface as shown. After collision path of center of mass of ball will be



(1) Parabola to right (2) Parabola to left

(3) Straight line (4) Circle

188. A solid cylinder of radius R is spinned and then placed on an incline having coefficient of friction $\mu = \tan\theta$. The cylinder continues to spin without falling for time



(1) $\dfrac{R\omega_0}{3g\sin\theta}$ (2) $\dfrac{R\omega_0}{2g\sin\theta}$

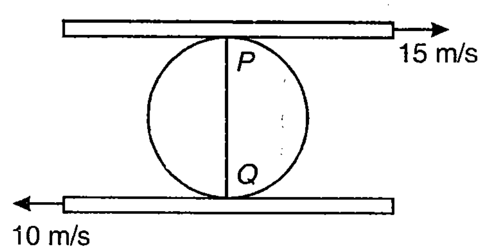
(3) $\dfrac{R\omega_0}{g\sin\theta}$ (4) $\dfrac{2R\omega_0}{g\sin\theta}$

189. A solid sphere of mass 2 kg rolls on smooth horizontal surface at 10 m/s. It then rolls up a smooth inclined plans of inclination 30º. Height attained by sphere before stopping

(1) 10 m (2) 5 m

(3) 7 m (4) 6 m

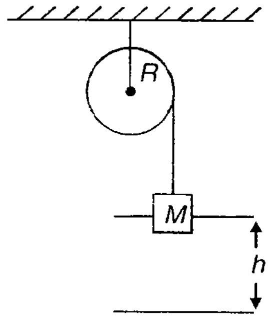
190. A cylinder of radius 10 cm rides between two horizontal bars moving in opposite directions shown in figure. Where is instantaneous axis of rotation of roller. Neglect slipping at P and Q



(1) 6 cm from Q (2) 4 cm from Q

(3) 8 cm from Q (4) 2 cm from Q

191. Pulley is rotating & frictionless and can be taken as solid cylinder as shown in figure. If block starts from rest and falls by distance h. Then speed of block is proportional to



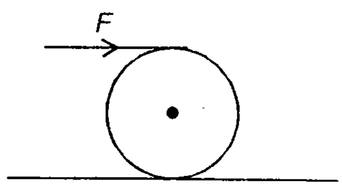
(1) R

(2) $\frac{1}{R}$

(3) $\frac{1}{R^2}$

(4) Do not depend on R

192. The ball will move faster if



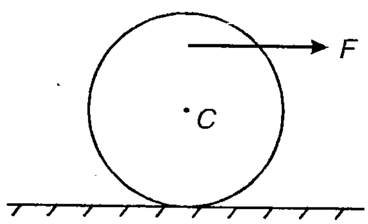
(1) Friction is absent between ball and surface

(2) Friction is present between ball and surface

(3) Velocity of ball is independent of friction between ball and surface

(4) None of these

193. Direction of friction on ball if ball moves on rough surface



(1) Backward

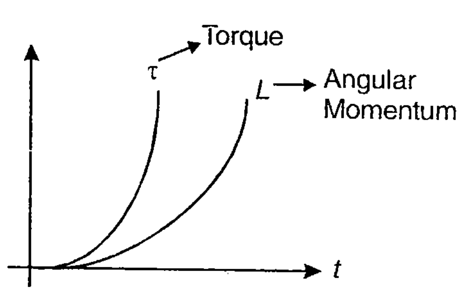
(2) Forward

(3) Zero

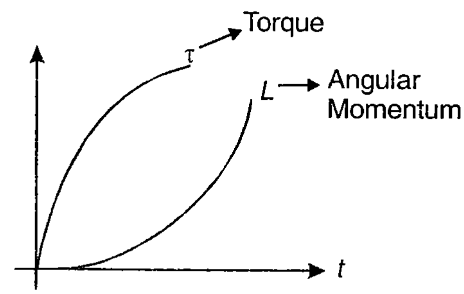
(4) Information insufficient

194. A particle is projected with initial velocity u at an angle α above horizontal then variation of torque and angular momentum about starting point, with time will be

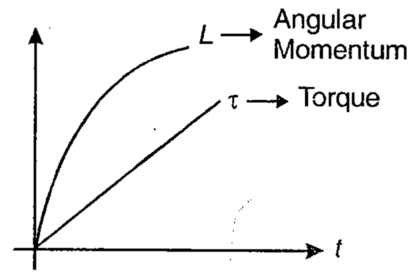
(1)



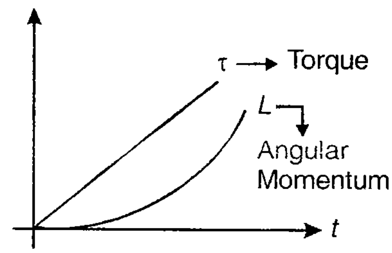
(2)



(3)



(4)

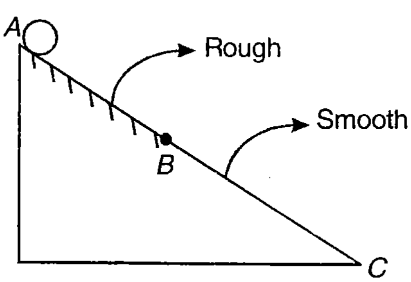


195. A particle moving in circle with angular velocity ω about center. Then angular velocity of particle about any point on circumference of circle

(1) $\frac{\omega}{2}$ (2) ω

(3) $\frac{\omega}{3}$ (4) $\frac{\omega}{4}$

196. In figure, solid cylinder rolls from A to B and then from B to C then ratio of K.E. translation to rotational when cylinder reaches C given $AB = BC$



(1) $\frac{3}{5}$ (2) 5

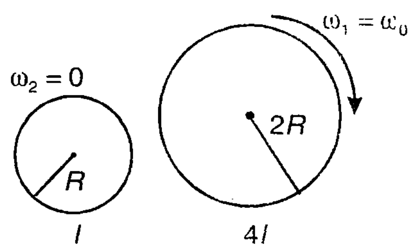
(3) $\frac{7}{5}$ (4) 6

197. A particle of mass 2 kg located at position $(\hat{i}+\hat{j})$ units has velocity $2(\hat{i}-\hat{j}+\hat{k})$ units. Its angular momentum about origin is

(1) Zero (2) $8\hat{k}$

(3) $12\hat{k}$ (4) $\hat{i}-\hat{j}-2\hat{k}$

198. Two cylinders in completely rotational motion rotate about these centres as shown in figure (initial conditions). Now they are touched with each other surfaces are rough then final angular velocity of small cylinder is (Surfaces are rough)



(1) $\frac{\omega_0}{4}$ (2) ω_0

(3) $\frac{\omega_0}{2}$ (4) $\frac{\omega_0}{8}$

199. In above example final angular velocity of bigger cylinder is

(1) $\frac{\omega_0}{4}$ (2) ω

(3) $\frac{\omega_0}{2}$ (4) $\frac{\omega_0}{8}$

200. The minimum and maximum distance of a satellite from the centre of the earth are $2R$ and $4R$, respectively, where R is the radius of earth and M is the mass of earth. The radius of curvature at the point of maximum distance is

(1) $\frac{8R}{3}$ (2) $\frac{4R}{3}$

(3) $\frac{3R}{8}$ (4) $\frac{3R}{4}$

201. An artificial satellite of earth releases a package. If air resistance is neglected, the point where the package will hit (w.r.t. the position at the time of release) will be

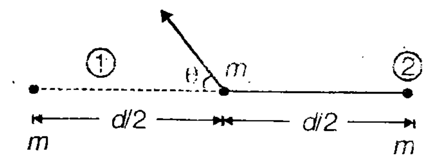
(1) Ahead

(2) Exactly below

(3) Behind

(4) It will never reach the earth

202. A particle of mass m_0 is projected from the mid point of the line joining two fixed particles each of mass m. If the separation between the particles is d, the minimum escape velocity of projection of the particles is



(1) Not a function of d

(2) Not a function of m

(3) Not a function of mass m_0

(4) It is a function of angle θ

203. A satellite is revolving around a planet of mass M is an elliptic orbit of semi majorc axis a. The orbital speed of the satellite when it is at a distance r from the planet will be given by

(1) $\sqrt{GM\left(\frac{2}{r}-\frac{1}{a}\right)}$ (2) $\sqrt{GM\left(\frac{2}{r}+\frac{1}{a}\right)}$

(3) $\sqrt{GM\left(\frac{4}{r}-\frac{1}{a}\right)}$ (4) $\sqrt{GM\left(\frac{4}{r}+\frac{1}{a}\right)}$

204. The minimum colatitude (λ), which can directly receive a signal from geostationary satellite is (take parking orbit of satellite $h \approx 6\ R_e$)

(1) $\lambda=\sin^{-1}\left(\frac{1}{7}\right)$ (2) $\lambda=\cos^{-1}\left(\frac{1}{7}\right)$

(3) $\lambda=\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (4) $\lambda=\cos^{-1}\left(\frac{2}{\sqrt{3}}\right)$

205. An earth satellite is moved from one stable circular orbit to another higher stable circuit orbit. Which one of the following quantities increases for the satellite as a result of this change?

(1) Gravitational force

(2) Gravitational potential energy

(3) Angular velocity

(4) Linear orbital speed

206. Two particles of mass m and M are initially at rest and infinitely separated from each other. Due to mutual interaction they approach each other. Their relative velocity of approach at a separation distance d between them is

(1) $\sqrt{\frac{2Gd}{(M+m)}}$ (2) $\sqrt{\frac{2G(M+m)}{d}}$

(3) $\frac{2G(M+m)}{d}$ (4) $\frac{2Gd}{M+m}$

207. A body is projected at an angle with the horizontal in the uniform gravitational field of the earth, the angular momentum of the body about the point of projection as it proceeds along its path

(1) Remains constant

(2) Increases

(3) Decreases

(4) Initially decreases and after its highest increases

208. Two stars of masses M and m, M being greater than m are separated by a distance D. At a point between the two stars, their gravitational fields are equal in magnitude but opposite in direction. At that point a test object will feel no force. This point is

(1) At the C.M. of the two-star system

(2) Between the C.M. and the mid point between the two stars

(3) Between the C.M. and the star of Mass M

(4) Between the mid-point of the two stars and the star of mass m

209. For the earth-moon system let M and m be the masses of the earth and the moon respectively. Let $\vec{v}$ be the instantaneous relative velocity. The total kinetic energy of this system in the centre of mass frame will be given by

(1) $\frac{1}{2}\frac{mM}{(m+M)}v^2$ (2) $\frac{1}{2}mv^2 + \frac{1}{2}Mv^2$

(3) $\frac{1}{2}mv^2$ (4) $\frac{1}{2}Mv^2$

210. The escape velocity on the surface of the earth is v_0. If M and R are the mass and radius of the earth respectively, then the escape velocity on another planet of mass $2M$ and radius $\frac{R}{2}$ will be

(1) $4\,v_0$ (2) $2\,v_e$

(3) v_e (4) $\frac{v_0}{2}$

211. Let R_s and R_m be the distance of the geostationary satellite and moon from the centre of the earth. Then $\frac{R_m}{R_s}$ is

(1) $(29)^{1/2}$ (2) $(29)^{2/3}$

(3) 29 (4) $(29)^{3/2}$

212. A satellite is moving in a circular orbit around the earth with a diameter $2R$. At a certain point a rocket fixed to the satellite is fired such that it increases the velocity of the satellite tangentially. The resulting orbit of the satellite would be

(1) Same as before

(2) Circular orbit with diameter greater than $2R$

(3) Elliptical orbit with minor axis $2R$

(4) Elliptical orbit with major axis $2R$

213. A satellite in a circular orbit about the earth has a kinetic energy E_K. What is the minimum amount of energy to be added so that it escape from the earth?

(1) $\frac{E_K}{4}$ (2) $\frac{E_K}{2}$

(3) E_K (4) $2E_K$

214. In the case of geostationary satellite, the

(1) Rotation of the earth and the revolution of the satellite need not to be about common axis

(2) Rotation of the earth and revolution of the satellite will be in opposite directions

(3) Angular velocity of the earth's rotation and angular velocity of revolution of the satellite will be equal and be in the same direction

(4) Angular velocity of the earth's rotation and angular velocity of revolution of the satellite will not be equal

215. If the earth is a point mass of 6×10^{24} kg revolving around the sun at a distance of 1.5×10^8 km, then angular momentum of earth around the sun is

(1) 1.2×10^{18} kg m^2/s

(2) 1.8×10^{29} kg m^2/s

(3) 1.5×10^{37} kg m^2/s

(4) 2.7×10^{40} kg m^2/s

216. Two planets A and B have the same material density. If the radius of A is twice that of B then the ratio of the escape velocity $\frac{V_A}{V_B}$ is

(1) 2 (2) $\sqrt{2}$

(3) $\frac{1}{\sqrt{2}}$ (4) $\frac{1}{2}$

217. A satellite is moving in a circular orbit at a height of 100 km above the earth's surface. A person inside the satellite feel weightless because

(1) Acceleration due to gravity is almost zero at such a height

(2) The earth does not exert any force on the person

(3) The satellite moves in circular orbit under the gravitational pull of earth

(4) The forces due to the earth and the moon are almost compensated at such a height

218. The escape velocity of a particle of mass m

(1) Varies as m^2

(2) Varies as m

(3) Varies as m^{-1}

(4) Is independent of its mass

219. If R is the radius of the earth, ρ its mean density and G the gravitational constant, then the earth's surface potential will be nearly equal to

(1) $-\frac{\pi\rho G}{R^2}$

(2) $-\frac{4}{3}\pi R^3\rho G$

(3) $-\frac{4}{3}\pi\rho R^2 G$

(4) $-\frac{4}{3}\pi\frac{R}{\rho}G$

220. A piece of copper having an internal cavity weighs 264 g in air and 221 g in water. Density of copper is 8.8 g/cc. The volume of the cavity is

(1) 8 cc (2) 13 cc

(3) 17 cc (4) 23 cc

221. A conical vessel at rest on its base is filled with water having weight W. The force exerted by water on the base is

(1) $> W$

(2) $< W$

(3) $= W$

(4) $\frac{W}{2}$

222. A cylinder of mass M and density d_1 hanging from a string is lowered into a vessel of cross-sectional area A, containing a liquid of density $d_2 (d_2 < d_1)$ until it is fully immeresed. The increase in pressure at the bottom of the vessel is

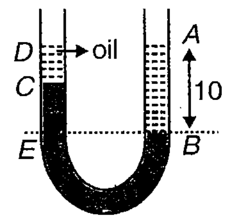
(1) $\frac{Md_1g}{d_2A}$

(2) $\frac{Mg}{A}$

(3) $\frac{Md_2g}{d_1A}$

(4) Zero

223. A vertical U-tube of uniform cross-section contains mercury in both of its arms. Glycerine (density 1.3 gcm^{-3}) column of length 10 cm is introduced into one of the arms. Oil of density 0.8 g cm^{-3} is poured in the other arm until the upper surfaces of the oil and glycerine are in the same horizontal level. Density of mercury is 13.6 gcm^{-3}. The length of the oil column is



(1) 4.9 cm (2) 6.8 cm

(3) 9.6 cm (4) 11.2 cm

224. Water flows at 10 cc/s through an opening at the bottom of a tank in which the water is 2 m deep. The rate of flow of water if an additional pressure 20 kPa is applied to the top of water

(1) 20 cc/s

(2) $10\sqrt{2}$ cc/s

(3) $20\sqrt{2}$ cc/s

(4) 10 mm/s

225. A block of mass 4 kg and volume 5×10^{-4} m^3 is suspended by a spring balance in a lift which is accelerating. The apparent weight shown by the spring balance is 3 kg. Now the block is immersed in water in container inside the lift. The apparent weight in kg shown by the spring balance is

(1) 3.125 (2) 2.5

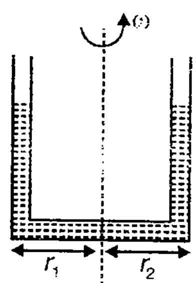
(3) 2.625 (4) 2.375

226. A smooth spherical ball of radius 1 cm and density 4×10^3 kg/m³ is dropped gently in a large container containing viscous liquid of density 2×10^3 kg/m³ and $\eta = 0.1$ N–s/m². The distance travelled by the ball in $t = 0.2$ s after it attains terminal velocity is

(1) $\frac{8}{9}$ m up (2) $\frac{8}{5}$ m up

(3) $\frac{8}{9}$ m down (4) $\frac{8}{5}$ m down

227. A U-tube filled with liquid is being rotated about an axis with angular speed ω as shown in the figure. The difference in heights of liquid in two arms is



(1) $\frac{\omega^2}{2g}(r_1^2 - r_2^2)$

(2) $\frac{\omega^2}{g}(r_1^2 - r_2^2)$

(3) $\frac{2\omega^2}{g}(r_1^2 + r_2^2)$

(4) $\frac{\omega^2}{2g}(r_1^2 + r_2^2)$

228. A horizontal stream of water with velocity v_0 and rate of flow μ hits a plate that deflect water in horizontal plane through an angle $\theta = 60°$ with the horizontal. If the velocity of water when it leaves the plate equal to v_0. Then the force exerted by the water on the plate is

(1) μv_0 (2) $\frac{\mu v_0 \sqrt{3}}{2}$

(3) $\frac{\mu v_0}{2}$ (4) Zero

229. A block of mass 1 kg is floating in a container filled with water with 2 cm submerged. When a stone is placed on block, 2.4 cm block gets submerged, the mass of stone is

(1) 100 g (2) 200 g

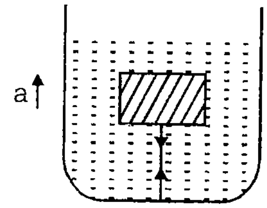
(3) 1 kg (4) 400 g

230. A liquid of density ρ flows steadily through a tube of radius r at a speed v. The least power of the engine to maintain this rate of flow is

(1) $\frac{\pi r^2 v}{2\rho}$ (2) $\frac{\pi r^2 v^2 \rho}{2}$

(3) $\rho \pi r^2 v^3$ (4) $\frac{\pi r^2 \rho}{2v}$

231. The tension in a string holding a solid block below the surface of a liquid of density greater than that of solid as shown in figure is T_0, when the system is at rest. Tension in the string if the system has upward acceleration 'a' will be



(1) $T_0(a + g)$ (2) $T_0\left\{1 + \left(\frac{a}{g}\right)\right\}$

(3) T_0 (4) $< T_0$

232. Equal volumes of two non-viscous incompressible and immiscible liquids of densities ρ_1 and ρ_2 are poured into two limbs of a circular tube of radius R kept vertical such that half of the tube in filled with liquid. The angular position of interface from vertical is

(1) $\tan^{-1}\left(\frac{\rho_1 - \rho_2}{\rho_1 + \rho_2}\right)$ (2) $\tan^{-1}\left(\frac{\rho_2}{\rho_1}\right)$

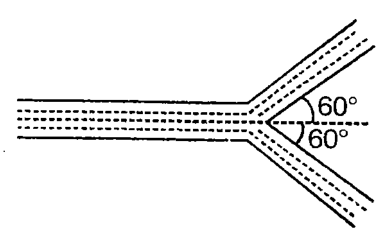
(3) $\tan^{-1}\left(\frac{\rho_1 + \rho_2}{\rho_1 - \rho_2}\right)$ (4) $\sin^{-1}\left(\frac{\rho_1 - \rho_2}{\rho_1 + \rho_2}\right)$

233. A gas bubble of diameter D rises steadily through a liquid of density ρ at the speed of v. The coefficient of viscosity of the solution is

(1) $\frac{D^2 g\rho}{9v}$ (2) $\frac{D^2 g\rho}{18v}$

(3) $\frac{2D^2 g\rho}{9v}$ (4) $\frac{D^2 g\rho}{v}$

234. Fresh water issues from the nozzle with a velocity of 20 m/s at the rate of 0.03 m³/s and is split into two equal streams by the fixed vane and deflected through 60° as shown in figure. The force required to hold the vane on place is



(1) 300 N towards right

(2) 300 N towards left

(3) 600 N towards right

(4) 600 N towards left

235. A rectangular container of base dimensions 2m × 1m and height 0.5 m is filled with water upto height of 0.2 m. The mass of the empty container is 1 kg. The coefficient of friction between container and plane is 0.5. The container is placed on the plane inclined at 45° to the horizontal. The angle of the water surface to the horizontal is

(1) $\tan^{-1}\left(\frac{1}{2}\right)$ (2) $\tan^{-1} 2$

(3) $\tan^{-1}\left(\frac{1}{3}\right)$ (4) $\tan^{-1} 3$

236. An air-filled balloon floats in water with half of its volume submerged. To what depth inside water should it be taken so that it remains in equilibrium there? Take atmospheric pressure to be equal to 10 m of water-height

(1) 5 m (2) 10 m

(3) 15 m (4) 20 m

237. A drop of water of volume V is pressed between two glass plates so as to spread to an area A. If T is the surface tension, the normal force required to separate the glass plates

(1) $\frac{A^2}{V}$ (2) $\frac{2TA^2}{V}$

(3) $\frac{4TA^2}{V}$ (4) $\frac{TA^2}{2V}$

238. A solid glass rod of radius r is placed inside a glass cylinder of internal radius R. This glass rod is placed coaxially with the cylinder and in contact with the bottom of cylinder and perpendicular to the surface of liquid of density ρ in the glass cylinder. The height to which water will rise in the region between the rod and the cylinder due to surface tension is (The angle of contact is 0° and surface tension is T)

(1) $\frac{2T}{(R-r)\rho g}$ (2) $\frac{T}{(R+r)\rho g}$

(3) $\frac{2T}{(R^2-r^2)\rho g}$ (4) $\frac{2T}{(R^2+r^2)\rho g}$

239. A large number of droplets, each of radius a, coalesce to form a big drop of radius b. Assume that the energy released in the process is converted into kinetic energy of the drop. The velocity of the drop is (σ = surface tension, ρ = density of droplet)

(1) $\left[\frac{\sigma}{\rho}\left(\frac{1}{a}-\frac{1}{b}\right)\right]^{\frac{1}{2}}$ (2) $\left[\frac{2\sigma}{\rho}\left(\frac{1}{a}-\frac{1}{b}\right)\right]^{\frac{1}{2}}$

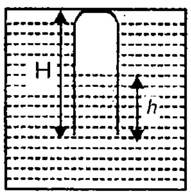
(3) $\left[\frac{3\sigma}{\rho}\left(\frac{1}{a}-\frac{1}{b}\right)\right]^{\frac{1}{2}}$ (4) $\left[\frac{6\sigma}{\rho}\left(\frac{1}{a}-\frac{1}{b}\right)\right]^{\frac{1}{2}}$

240. A small ball of density ρ is immersed in a liquid of density $\sigma(>\rho)$ to a depth h and released. The height above the surface of water upto which the ball jumps is

(1) $\left(\frac{\sigma}{\rho}-1\right)h$ (2) $\left(\frac{\rho}{\sigma}-1\right)h$

(3) $\left(\frac{\rho}{\sigma}+1\right)h$ (4) $\left(\frac{\sigma}{\rho}+1\right)h$

241. A tube of length H is open at one end. It is lowered into a tank of mercury as shown in figure with open end downward. The closed end is just on the surface. The mercury is pushed into the tube to a height h. If the atmosphere pressure is H of mercury, then choose correct relation. Neglect surface tension



(1) $(2H+h)(H+h) = H^2$

(2) $(2H-h)(H-h) = H^2$

(3) $(2H+h)(H-h) = H^2$

(4) $(2H-h)(H+h) = H^2$

242. Two soap bubbles of different radii (r_1 and r_2) come in contact and form a double bubble. The radius of interface is r. At any point of contact, three surfaces of radii r_1, r_2 and r are in contact. Choose the correct option

(1) Angle between any two surface is not same

(2) Angle between surfaces with radii r_1 and r_2 is greater than the angle between surfaces with radii r_1 and r

(3) Angle between surfaces with radii r_1 and r_2 is smaller than the angle between surfaces with radii r_1 and r

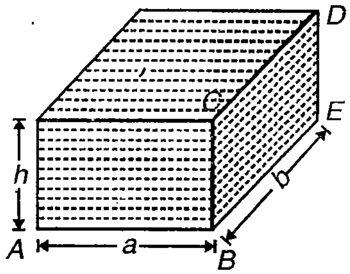
(4) Angle between any two surface is same

243. A body of density d_1 is counter poised by weight Mg of density d_2 in air of density d. Then the true mass of the body is

(1) M (2) $M\left(1-\frac{d}{d_2}\right)$

(3) $M\left(1-\frac{d}{d_1}\right)$ (4) $M\left(1-\frac{d}{d_2}\right)\Big/\left(1-\frac{d}{d_1}\right)$

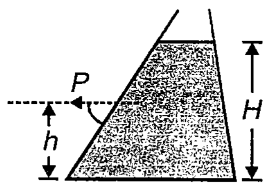
244. Torque on the side wall of a vessel $BCDE$ as shown in figure, about the bottom edge BE is



(1) $\frac{1}{2}\rho gbh^3$ (2) $\frac{1}{2}\rho gah^3$

(3) $\frac{1}{6}\rho gabh^2$ (4) $\frac{1}{6}\rho gbh^3$

245. A vessel contains a liquid of density ρ as shown in figure. The gauge pressure at a point P is



(1) $h\rho g$ (2) $H\rho g$

(3) $(H-h)\rho g$ (4) $(H-h)\rho g\cos\theta$

246. A cubical steel block of side 10 cm is floating in mercury. To what height should water be poured over mercury so that water surface just covers the top surface of cube? (density of steel & mercury are 7.8 g/cm^3 and 13.6 g/cm^3 respectively)

(1) 4.2 cm (2) 4.6 cm

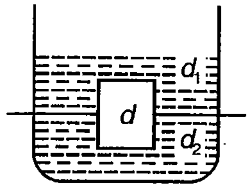
(3) 5.8 cm (4) 9.6 cm

247. Drops of liquid (L_1) of density d are floating half immersed in a liquid of density ρ. If the radius of the drop is r. Surface tension of the liquid having density ρ is

(1) $\frac{r^2g}{2}(3d-\rho)$ (2) $\frac{r^2g}{3}(d-2\rho)$

(3) $\frac{r^2g}{2}(d-3\rho)$ (4) $\frac{r^2g}{3}(2d-\rho)$

248. A cylindrical block of density d stays fully immersed in a beaker filled with two immiscible liquids of different densities d_1 and d_2. The block is in equilibrium with one half of it in liquid-1 and other half in liquid-2. If the block is given a displacement downward and released, then



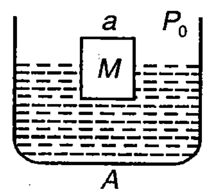
(1) It executes SHM

(2) It executes periodic motion but not SHM

(3) The frequency of oscillation is independent of the size of cylinder

(4) The displacement of the centre of the cylinder is symmetric about its equilibrium position

249. A liquid of density ρ is filled in a vessel of cross-sectional area A upto height h. A block of mass M and cross-sectional area a is made to float in it as shown in figure. The pressure at the bottom of the vessel will be



(1) $P_0 + h\rho g$ (2) $P_0 + h\rho g + \frac{Mg}{a}$

(3) $P_0 + h\rho g + \frac{Mg}{A}$ (4) $h\rho g + \frac{Mg}{A}$

250. 125 water droplets, each of radius r, coalesce to form a single drop. The energy released raises the temperature of the drop. If σ represents surface tension, ρ represents density, S represents specific heat and J represents mechanical equivalent of heat, then the rise in temperature of the drop is

(1) $\frac{12\sigma}{5Jr\rho S}$ (2) $\frac{12\sigma\rho}{7JrS}$

(3) $\frac{2\sigma\rho}{S\rho r}$ (4) Zero

251. A vessel having area of cross-section A contains a liquid upto height H. At the bottom of the vessel, there is a small hole having area of cross-section a. Then the time taken for the liquid level to fall from height H_1 to H_2 is given by

(1) $\sqrt{2g(H_1-H_2)}$ (2) $\frac{A}{a}\sqrt{\frac{2}{g}}(\sqrt{H_1}-\sqrt{H_2})$

(3) $\frac{A}{a}\sqrt{\frac{g}{2}}(\sqrt{H_1}-\sqrt{H_2})$ (4) $\sqrt{2gH}$

252. Two vertical parallel glass plates are partially submerged in water. The distance between the plate is d and their width is ℓ. Assume that the water between the plates does not reach the upper edges of the plates and that the wetting is complete. The water will rise to height (ρ = density of water and σ = surface tension of water)

(1) $\frac{2\sigma}{\rho g d}$ (2) $\frac{3\sigma}{\rho g d}$

(3) $\frac{4\sigma}{\rho \ell g}$ (4) $\frac{5\sigma}{\rho g \ell}$

253. A cylindrical vessel is filled with a liquid of density ρ upto height h and placed on a horizontal surface. Coefficient of friction between the vessel and surface is μ. What should be the minimum area of a hole near the bottom of the vessel so that when the hole is unplugged, vessel begins to move? Mass of vessel and liquid is M

(1) $\frac{\mu M}{\rho h}$ (2) $\frac{2\mu M}{\rho h}$

(3) $\frac{\mu M}{2\rho h}$ (4) $\frac{\sqrt{2}\mu M}{\rho h}$

254. A metal piece is trapped in an ice-cube floating in water. If ice melts and metal sinks, the level of water will

(1) Increase (2) Decrease

(3) Remain unchanged (4) Cannot be predicted

255. A material has density ρ and bulk modulus k. The increase in the density of the material when it is subjected to an external pressure P from all sides is

(1) $\frac{P}{\rho k}$ (2) $\frac{k}{\rho P}$

(3) $\frac{\rho P}{k}$ (4) $\frac{\rho k}{P}$

256. A steel wire is suspended vertically from a rigid support. When loaded with a weight in air, it extends by ℓ_a, when the weight is completely immersed in water, the extension is reduced to ℓ_w. The relative density of the material of the weight is

(1) $\frac{\ell_a}{\ell_a - \ell_w}$ (2) $\frac{\ell_a}{\ell_w}$

(3) $\frac{\ell_w}{\ell_a - \ell_w}$ (4) $\frac{\ell_w}{\ell_a}$

257. One end of a uniform wire of length l and d weight W is attached rigidly to a point in the roof and weight W is suspended from its lower end. If S is the area of cross-section of the wire, the stress in the wire at height $\frac{3L}{4}$ from its lower end is

(1) $\frac{W_1}{S}$ (2) $\left(W + \frac{W_1}{4}\right)S$

(3) $\frac{\left(W_1 + \frac{3W}{4}\right)}{S}$ (4) $\frac{W_1 + W}{S}$

258. The displacement function of an oscillating body is given by $x = 0.3\sin\left(10\pi t + \frac{\pi}{6}\right)$ where x is in metre and t in seconds then

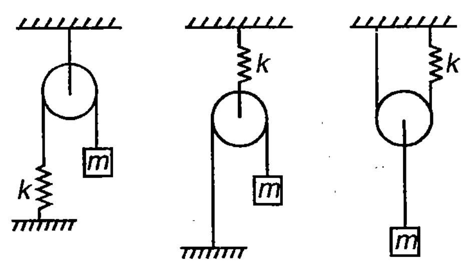
(1) The period of oscillation is 5 s

(2) The body starts its motion from equilibrium

(3) The minimum time body takes to reach equilibrium is $\frac{1}{12}$ second

(4) All of these

259. Figure shows three systems in which a block of mass m can execute S.H.M. What is ratio of frequency of oscillation?



(i) (ii) (iii)

(1) 2 : 1 : 4 (2) 1 : 2 : 4

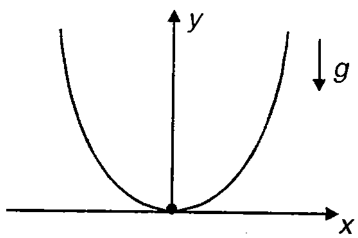
(3) 4 : 2 : 1 (4) 3 : 2 : 1

260. A particle executes S.H.M. in a straight line. In first second starting from rest it travels a distance p and in next second it travels q in same direction. Then amplitude of S.H.M. is

(1) $\frac{2p^2}{3q - p}$ (2) $\frac{3p^2}{3p - q}$

(3) $\frac{3p^2}{3q - p}$ (4) $\frac{2p^2}{3p - q}$

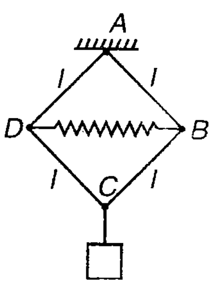
261. A particle of mass 5×10^{-5} kg is placed at lowest point of smooth parabola $x^2 = 40y$ (x and y in cm). If it is displaced slightly such that it is constrained to move along parabola, angular frequency of oscillation will be approximately



(1) $\sqrt{\frac{g}{5}}$ (2) $\sqrt{\frac{g}{20}}$

(3) $\sqrt{\frac{g}{10}}$ (4) None of these

262. Four weightless rods of length l each are connected by hinged joints and form a rhombus. Hinge A is fixed and load is suspended to hinge C. Hinge D and B are connected by weightless spring of length $1.5l$ in undeformed state. In equilibrim the rods form angle 30º with vertical, then time period of oscillation of load is



(1) $T = 2\pi\sqrt{\frac{l\sqrt{3}}{g}}$ (2) $T = 2\pi\sqrt{\frac{l\sqrt{3}}{10g}}$

(3) $T = 2\pi\sqrt{\frac{l}{2\sqrt{3}g}}$ (4) $T = 2\pi\sqrt{\frac{l\sqrt{3}}{5g}}$

263. Two simple pendulums of lengths 1 m and 4 m are both given small displacements in the same direction at the same instant. They will again be in phase after the shorter pendulum has completed

(1) 1/3 oscillation (2) 1/2 oscillation

(3) 4/3 oscillation (4) 3/4 oscillation

264. A particle executes SHM between $x = -A$ to $x = +A$. The time taken for it to go from 0 to $\frac{A}{2}$ is T_1 and to go from $\frac{A}{2}$ to A is T_2 then $\frac{T_1}{T_2}$ is

(1) 2 (2) $\frac{1}{2}$

(3) 4 (4) $\frac{1}{4}$

265. In SHM, the distances of particles from middle point of its path at three consecutive seconds are found to be x, y and z. Then time period of SHM is

(1) $2\pi\cos^{-1}\left(\frac{x+z}{2y}\right)$ (2) $2\pi\tan^{-1}\left(\frac{x+y}{z}\right)$

(3) $\frac{2\pi}{\sin^{-1}\left(\frac{x+z}{2y}\right)}$ (4) $\frac{2\pi}{\cos^{-1}\left(\frac{x+z}{2y}\right)}$

266. Find amplitude of SHM of particle, if at distances x_1 and x_2 from equilibrium position its velocities are v_1 and v_2 respectively

(1) $\sqrt{\frac{v_1^2x_2^2 - v_2^2x_1^2}{v_1^2 - v_2^2}}$ (2) $\sqrt{\frac{v_1^2x_1^2 - v_2^2x_2^2}{v_1^2 - v_2^2}}$

(3) $\sqrt{\frac{v_1^2x_2^2 - v_2^2x_1^2}{v_1^2 + v_2^2}}$ (4) $\sqrt{\frac{x_1^2 - x_2^2}{v_1x_2 - v_2x_1}}$

267. Choose correct statements related to potential energy variation in SHM.

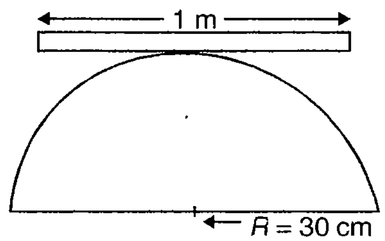
(1) Potential energy increases as one moves away from equilibrium

(2) $\frac{dU}{dx} > 0$ for all displacements

(3) $\frac{dU}{dt} > 0$ for all time

(4) Potential Energy is maximum at equilibrium

268. A uniform meter scale is balanced on fixed semicircular cylinder of radius 30 cm as shown. One end of scale is slightly depressed and released. Time period of oscillation is



(1) π s (2) $\frac{\pi}{2}$ s

(3) $\frac{\pi}{3}$ s (4) $\frac{\pi}{4}$ s

269. Relationship between velocity amd displacement of particle is $4v^2 = 25 - x^2$. Then time period of oscillation is

(1) π s (2) 2π s

(3) 3π s (4) 4π s

270. A particle is executing SHM of amplitude A and angular frequency ω. The average acceleration of particle for half the time period is (starting from mean position)

(1) $\frac{2A\omega^2}{\pi}$ (2) $\frac{A\omega^2}{\pi}$

(3) $\frac{3A\omega^2}{2\pi}$ (4) $\frac{A\omega^2}{2}$

271. Displacement-time equation of two particles moving along x axis are $x_1 = 8 + 3\sin\omega t$ & $x_2 = 4\cos\omega t$ here $\omega = \pi$ rad/s. Two particles will collide after a time

(1) 1 s

(2) 2 s

(3) 3 s

(4) Not possible

272. In above problem, the particles are at minimum distance after time nearly

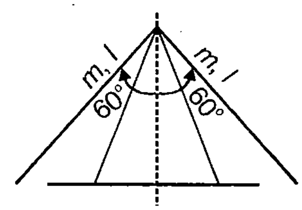
(1) 1 s

(2) 1.8 s

(3) 2 s

(4) None of these

273. Two identical thin rods each of mass m and length l, are joined at 120° angle as shown in figure. This object is balanced on a sharp edge. Find the time period of small oscillations of this object



(1) $2\pi\sqrt{\frac{l}{3g}}$ (2) $4\pi\sqrt{\frac{l}{3g}}$

(3) $\pi\sqrt{\frac{l}{g}}$ (4) $\pi\sqrt{\frac{3l}{g}}$

274. Two pendulums have time-periods T and $\frac{5T}{4}$. They start S.H.M. at the same time from the mean position. What will be the phase difference between them when the smaller pendulum has completed one oscillation?

(1) 60° (2) 72°

(3) 90° (4) 120°

275. Two masses M and m are suspended together by a massless spring of spring constant k. When masses are in equilibrium M is removed without disturbing system. The amplitude of oscillation is

(1) $\frac{Mg}{k}$ (2) $\frac{mg}{k}$

(3) $\frac{(M+m)g}{k}$ (4) $\frac{(M-m)g}{k}$

276. A particle moves according to $x = a\cos\left(\frac{\pi}{2}t\right)$. The distance covered by it in time interval between $t = 0$ to $t = 3$ s is

(1) $2a$ (2) $3a$

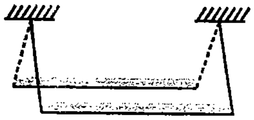
(3) $4a$ (4) a

277. Find time period of a uniform disc of mass m and radius r suspended through point $\frac{r}{2}$ away from centre, oscillating in a plane parallel to its plane

(1) $2\pi\sqrt{\frac{2r}{3g}}$ (2) $4\pi\sqrt{\frac{r}{2g}}$

(3) $2\pi\sqrt{\frac{3r}{2g}}$ (4) None of these

278. A uniform rod of mass $m = 1.5$ kg suspended by two identical threads 90 cm as in figure. Then find time period of oscillation of rod



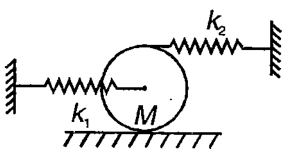
(1) 2 s (2) 2.1 s
(3) 2.4 s (4) 1.9 s

279. A thin uniform plate shaped as an equilateral triangle with height h performs small oscillations about the horizontal axis. Find oscillation period

(1) $T = 2\pi\sqrt{\dfrac{h}{g}}$ (2) $T = \pi\sqrt{\dfrac{2h}{g}}$

(3) $T = \pi\sqrt{\dfrac{h}{g}}$ (4) $T = \pi\sqrt{\dfrac{h}{2g}}$

280. A disc of mass M is connected to two springs k_1 and k_2 as shown find time period of oscillation



(1) $2\pi\sqrt{\dfrac{2m}{(k_1+4k_2)}}$ (2) $2\pi\sqrt{\dfrac{m}{k_1+4k_2}}$

(3) $2\pi\sqrt{\dfrac{3m}{2(k_1+4k_2)}}$ (4) $2\pi\sqrt{\dfrac{2m}{3(k_1+2k_2)}}$

(IIT-JEE 2009)

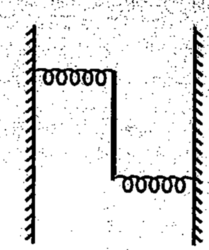
280(a) A uniform rod of length L and mass M is pivoted at the centre. Its two ends are attached to two springs of equal spring constants k. The springs are fixed to rigid supports as shown in the figure, and the rod is free to oscillate in the horizontal plane. The rod is gently pushed through a small angle θ in one direction and released. The frequency of oscillation is

(1) $\dfrac{1}{2\pi}\sqrt{\dfrac{2k}{M}}$

(2) $\dfrac{1}{2\pi}\sqrt{\dfrac{k}{M}}$

(3) $\dfrac{1}{2\pi}\sqrt{\dfrac{6k}{M}}$

(4) $\dfrac{1}{2\pi}\sqrt{\dfrac{24k}{M}}$

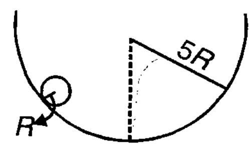


281. The potential energy of harmonic oscillator of mass 2 kg in its mean position is 5 J. If its total energy is 9 J and its amplitude is 0.01 m, its time period will be

(1) $\dfrac{\pi}{100}$ s (2) $\dfrac{\pi}{50}$ s

(3) $\dfrac{\pi}{20}$ s (4) $\dfrac{\pi}{10}$ s

282. A solid sphere (radius R) rolls without slipping in cylindrical trough (radius $5R$). Find time period of small oscillations



(1) $2\pi\sqrt{\dfrac{28R}{g}}$ (2) $\pi\sqrt{\dfrac{28R}{5g}}$

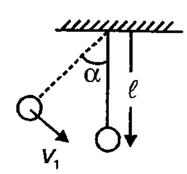
(3) $2\pi\sqrt{\dfrac{5R}{28g}}$ (4) $2\pi\sqrt{\dfrac{28R}{5g}}$

283. Consider a spring that exerts restoring force $F = -kx$ for $x > 0$, $F = -2kx$ for $x < 0$. A mass m on frictionless surface is attached to this spring displaced to $x = A$ and released. Find time period of motion

(1) $5.36\sqrt{\dfrac{m}{k}}$ (2) $5.36\sqrt{\dfrac{m}{2k}}$

(3) $5.36\sqrt{\dfrac{2m}{k}}$ (4) None of these

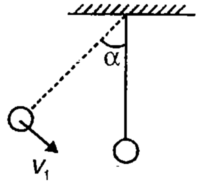
284. A simple pendulum of length ℓ, imparted initial velocity v_1 toward mean position, at an initial angular displacement α. Amplitude of oscillation of pendulum is (Assuming that maximum angular displacement of bob is small)



(1) $\sqrt{2\ell^2\alpha^2 + \dfrac{v_1^2\,\ell}{g}}$ (2) $\sqrt{2\ell^2\alpha^2 - \dfrac{v_1^2\,\ell}{g}}$

(3) $\sqrt{\ell^2\alpha^2 - \dfrac{v_1^2\,\ell}{g}}$ (4) $\sqrt{\ell^2\alpha^2 + \dfrac{v_1^2\,\ell}{g}}$

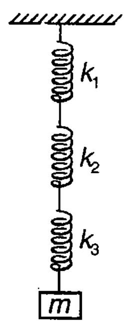
285. A simple pendulum of length ℓ is tilted at an angle α and imparted an initial velocity v_1 towards mean position. Initial phase of bob A is given as (A_1 is amplitude) (Assuming that maximum angular displacement of bob is small)



(1) $\sin^{-1}\left(\frac{\ell\alpha}{A_1}\right)$ (2) $\cos^{-1}\left(\frac{\ell\alpha}{A_1}\right)$

(3) $\pi - \sin^{-1}\left(\frac{\ell\alpha}{A_1}\right)$ (4) $\pi - \cos^{-1}\left(\frac{\ell\alpha}{A_1}\right)$

286. A block of mass m is suspended from a series combination of three light springs as shown in figure. If $k_1 : k_2 : k_3 = 1 : 2 : 3$, the ratio of elastic potential energies stored in three springs in equilibrium state is



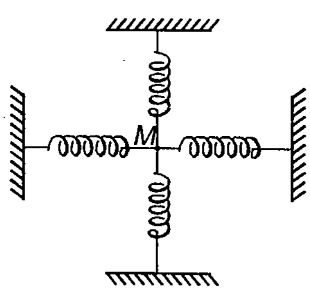
(1) $3 : 2 : 1$

(2) $1 : 2 : 3$

(3) $3 : \frac{3}{2} : 1$

(4) $1 : \frac{3}{2} : 3$

287. Four identical springs are connected to a mass M = 100 gm in a horizontal plane as shown in figure. Length of each spring is 20 cm and each spring is having a tension of 20 N. Neglecting gravity, the time period of small oscillations of mass M along a line perpendicular to the plane of figure is



(1) 0.03π s (2) 0.003π s

(3) 0.3π s (4) 3π s

288. Force acting on a block is $F = -2x + 4$ (F in newton and x in metres)

(1) Motion of block is periodic but not SHM

(2) Motion of block is not periodic

(3) Motion of block is SHM about origin

(4) Motion of block is SHM about $x = 2$ m

289. The potential energy of a particle is given as a function of its x-coordinate as $u_x = \frac{p}{x^2} - \frac{q}{x}$, where p and q are positive constant. The angular frequency of oscillation is m is mass of the particle (against small displacement from mean position)

(1) $\sqrt{\frac{2q^4}{mp^3}}$ (2) $\sqrt{\frac{q^4}{2mp^3}}$

(3) $\sqrt{\frac{8q^4}{mp^3}}$ (4) $\sqrt{\frac{q^4}{8mp^3}}$

290. An ice-cube of edge 10 cm is floating in water. Time-period of small vertical oscillations of the cube is (specific gravity of ice is 0.9)

(1) 0.6 s (2) 1.6 s

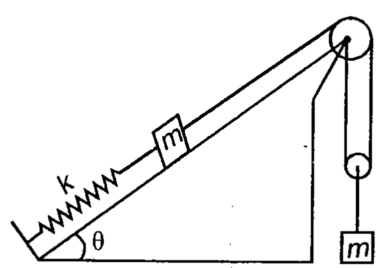
(3) 2.4 s (4) 3.6 s

291. A uniform thin bar pendulum of length 120 cm is beating seconds. Find least distance of axis from centre of gravity

(1) 0.14 m (2) 0.28 m

(3) 0.36 m (4) None of these

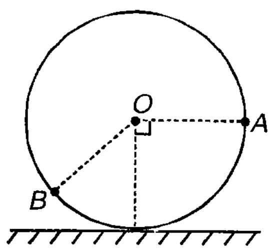
292. Calculate natural frequency ω of the system shown in figure



(1) $\sqrt{\frac{5k}{4m}}$ (2) $\sqrt{\frac{2k}{3m}}$

(3) $\sqrt{\frac{4k}{5m}}$ (4) None of these

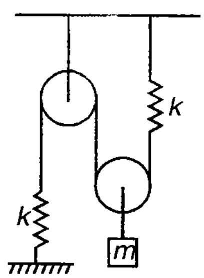
293. A disc of mass $M = 4$ kg radius $R = 1$ m is attached with two blocks A and B of masses 1 kg and 2 kg respectively on rim and is resting on horizontal place as shown in figure. Find angular frequency of small oscillation of arrangement



(1) $2\ s^{-1}$ (2) $(12)^{\frac{1}{4}}\ s^{-1}$

(3) $(14)^{\frac{1}{4}}\ s^{-1}$ (4) $(18)^{\frac{1}{4}}\ s^{-1}$

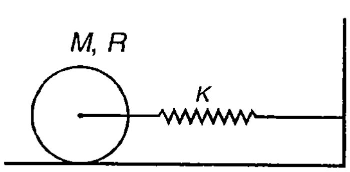
294. Find time period of oscillation for arrangement shown in figure



(1) $2\pi\sqrt{\frac{m}{2k}}$ (2) $2\pi\sqrt{\frac{2m}{k}}$

(3) $\pi\sqrt{\frac{m}{k}}$ (4) $\pi\sqrt{\frac{m}{2k}}$

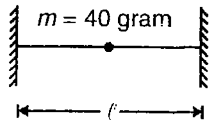
295. A solid cylinder attached to horizontal massless spring can roll without slipping along horizontal surface. Find time period of oscillation



(1) $2\pi\sqrt{\frac{M}{2k}}$ (2) $\pi\sqrt{\frac{3M}{2k}}$

(3) $\pi\sqrt{\frac{2M}{3k}}$ (4) $2\pi\sqrt{\frac{3M}{2k}}$

296. The period of small oscillation is a horizontal plane performed by a ball of mass $m = 40$ gram, fixed at the middle of a horizontally stretched string $\ell = 1.0$ m in length. Assume tension in the string is constant and equal to $T = 10$ N



(1) 0.2 s

(2) 0.4 s

(3) 0.6 s

(4) 0.1 s

(IIT-JEE 2008)

296(a) The centre of mass of the disk undergoes simple harmonic motion with angular frequency ω equal to

(1) $\sqrt{\frac{k}{M}}$ (2) $\sqrt{\frac{2k}{M}}$

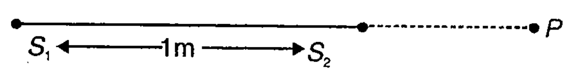
(3) $\sqrt{\frac{2k}{3M}}$ (4) $\sqrt{\frac{4k}{3M}}$

297. A harmonic wave is travelling on a stretched string. At any particular instant, the smallest distance between two particles having same displacement which is equal to half of amplitude is 4 cm. Find smallest separation between two particles which have same values of displacement equal to amplitude

(1) 4 cm (2) 12 cm

(3) 24 cm (4) 8 cm

298. Two coherent sources S_1 and S_2 separated by a distance of 1m give out sound waves of frequency 50 Hz. At P maximum intensity is observed. If speed of sound in air is 300m/s, what is the phase relationship between the two sources S_1 and S_2 ?



(1) S_1 is leading in phase as compared to S_2 by $\frac{\pi}{6}$

(2) S_1 is leading in phase as compared to S_2 by $\frac{\pi}{3}$

(3) S_1 is lagging in phase as compared to S_2 by $\frac{\pi}{6}$

(4) S_1 in lagging in phase as compared to S_2 by $\frac{\pi}{3}$

299. Regarding open organ pipe, which of following is correct?

(1) Both ends are pressure antinodes

(2) Both ends are displacement nodes

(3) Both ends are pressure nodes

(4) Both (1) & (2)

300. At t = 0, a transverse wave pulse travelling in negative x direction with speed 2 m/s in wire is given by $y = \frac{4}{x^2}$ given that $x \neq 0$ then transverse velocity of particle at x = 2 m and t = 2 s is

(1) $\frac{-2}{27}$ m/s (2) $\frac{2}{27}$ m/s

(3) $\frac{1}{27}$ m/s (4) $\frac{-1}{27}$ m/s

301. The frequency of first overtone of a closed organ pipe of length L is f_1. A hole is made at a distance $\frac{L}{6}$ from the closed end. Now the frequency of first overtone of open pipe is f_2. Then $\frac{f_1}{f_2}$ is

(1) $\frac{4}{5}$ (2) $\frac{5}{4}$

(3) $\frac{8}{5}$ (4) $\frac{5}{8}$

302. Two corks are 10 m apart in a lake. Each goes up and down with period 5 s. It is observed that when one is at its highest point, other one is at lowest point. The possible speed of wave is

(1) 2.5 m/s

(2) 5 m/s

(3) 40 m/s

(4) 4 m/s

303. When source and detector are stationary and wind blows at speed V_w = 10 m/s, speed of sound is v = 330 m/s, find apparent wavelength of sound in direction of wind if wavelength of sound is 33 m

(1) 33 m (2) 1 m

(3) 34 m (4) $\frac{1089}{32}$ m

304. If maximum speed of particle in a medium carrying a travelling wave is V_0, then find speed of particle when displacement is half of maximum value

(1) $\frac{v_0}{2}$ (2) $\frac{\sqrt{3}}{4}v_0$

(3) $\frac{\sqrt{3}}{2}v_0$ (4) v_0

305. The statement "Doppler effect increases the intensity of wave as received by detector, when source is approaching detector" is

(1) True

(2) False

(3) Irrelevant

(4) Information is insufficient

306. Two tuning forks A and B when sounded together produce 4 beats/s. When B is loaded with wax, the beat frequency remains same. If frequency of A is 212 Hz then frequency of B before loading is

(1) 208 Hz (2) 212 Hz

(3) 216 Hz (4) Irrelevant

307. A plane progressive wave of frequency 50 Hz, travelling along positive x-axis is represented as

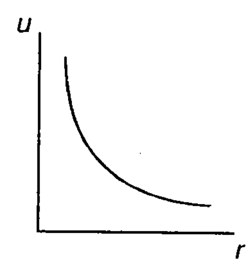
$y = (5 \times 10^{-5}\text{m}) \sin(100\,\pi t)$

at x = 0, wave speed is 300 m/s. Maximum difference in displacements at x = 0 and x = – 3m is

(1) 5×10^{-5} m (2) 2.5×10^{-4} m

(3) 5×10^{-4} m (4) 10^{-4} m

308. A source is giving out plane progressive waves in a medium. r is the perpendicular distance of any point in medium from source and u is energy density at that point. According to the variation of u with r as shown in graph which of the following statements is correct ?



(1) Density of the medium is uniform throughout

(2) Density of medium increases with r

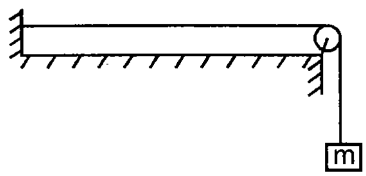
(3) Density of medium decreases with r

(4) None of these

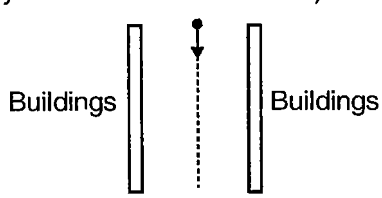
309. When a string is vibrating in standing wave pattern the power transmitted across an antinode, compared to power transmitted across node is
(1) More (2) Less
(3) Same (zero) (4) Same (nonzero)

310. A plane progressive wave of amplitude 10^{-4} m is propagating in a homogeneous medium of density 200kg/m^3. Space density of oscillation energy of particles of medium is $0.16\pi^2$; J/m^3. Frequency of the wave is
(1) 100 Hz (2) 200 Hz
(3) 400 Hz (4) 800 Hz

311. A transverse wave is passing through a string shown in figure. Mass density of the string is 1 kg/m^3 and cross section area of string is 0.01 m^2. Equation of wave in string is $y = 2(\sin 20t - 10x)$. The hanging mass is (in kg)
(1) 40
(2) 0.2
(3) 0.004
(4) None of these

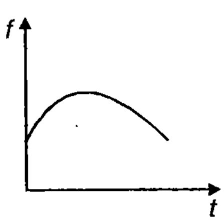


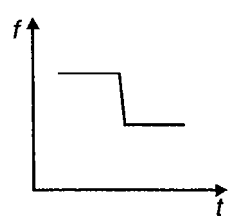
312. A road runs midway between two parallel rows of building. A motorist moving with a speed of 36 km/hr sounds the horn. He hears the echo one second after he has sounded the horn. The approximate distance between the two rows of buildings is (given velocity of sound in air is 330 m/s)

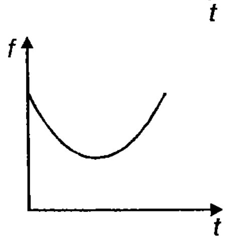


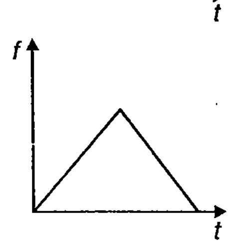
(1) 165 m (2) 156 m
(3) 651 m (4) 561 m

313. A police man on traffic signal sees an approaching car blowing horn and passing him. Velocity of car is constant then graph of frequency of sound heard by policeman with time is

(1) 

(2) 

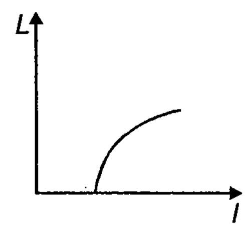
(3) 

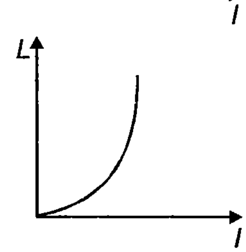
(4) 

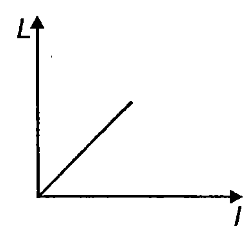
314. Equation of a longitudinal wave is given as $y = 10^{-2}\sin 2\pi\left(1000t + \frac{50x}{17}\right)$ (all SI units). At $t = 0$, change in pressure is maximum at $x =$
(1) 0.34 (2) 0.255
(3) 0.085 (4) All of these

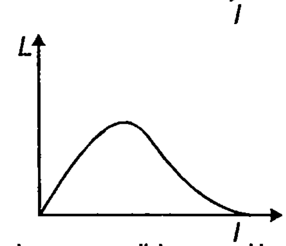
315. A disc of radius 20 m is rotating uniformly with angular frequency $\omega = 10$ rad/s. A source is fixed to rim of disc. The ratio of maximum and minimum frequency heard by observer far away from disc in plane of disc is (take speed of sound 330 m/s)
(1) $\frac{33}{13}$ (2) $\frac{33}{53}$
(3) $\frac{13}{53}$ (4) $\frac{53}{13}$

316. Which of following represents loudness versus intensity of sound graph?

(1) 

(2) 

(3) 

(4) 

317. Maximum possible sound level in dB of sound waves in air is (given that density of air = 1.3 kg/m^3, $v = 332$ m/s and atmospheric pressure $P = 1.01 \times 10^5$ N/m^2)
(1) 190 dB (2) 49 dB
(3) 250 dB (4) 150 dB

318. Two sound waves of wave-length 1 m and 1.01 m in gas produce 10 beats in 3 s. The velocity of sound in gas is

(1) 360 m/s (2) 300 m/s

(3) 337 m/s (4) 330 m/s

319. A closed organ pipe of length 2 m filled with a gas resonates in fundamental mode with a given tuning fork. An open organ pipe of same length filled with air also resonates in fundamental mode with the same tuning fork. The experiment is carried at 27°C temperature when speed of sound in air is 330 m/s. The speed of sound in gas at 7°C is

(1) 520 m/s (2) 438 m/s

(3) 638 m/s (4) 620 m/s

320. ~~A row boat is moving~~ with speed 15 m/s. When it moves in direction of water wave, boat swing upward in every 0.8 s and in opposite direction swings upward in 0.6 s. Then wavelength of transverse component of water wave is

(1) 15 m (2) 10.3 m

(3) 21.6 m (4) Insufficient information

321. Temperature dependence of speed of sound could be expressed as, $v = k\sqrt{T}$, where k is some positive constant. In a medium sound is travelling along x-axis. At $x = 0$, temperature is T_1 and at $x = l$, temperature is T_2 and the temperature varies linearly with x. Time taken by sound to travel from $x = 0$ to $x = l$ is

(1) $\dfrac{2l}{k\left(\sqrt{T_1}+\sqrt{T_2}\right)}$ (2) $\dfrac{l}{k\left(\sqrt{T_1}+\sqrt{T_2}\right)}$

(3) $\dfrac{l}{2k\left(\sqrt{T_1}+\sqrt{T_2}\right)}$ (4) $\dfrac{l}{2k\left(\sqrt{T_1}+\sqrt{T_2}\right)^2}$

322. There are two pipes each of length 2 m, one is closed at one end and other is open at both ends. The speed of sound in air is 340 m/s. The frequency at which both can resonate is

(1) 340 Hz (2) 510 Hz

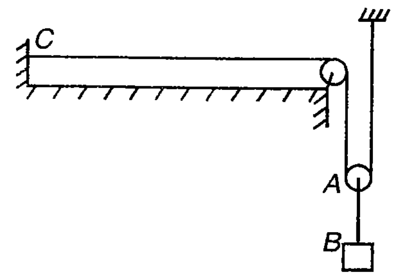
(3) 42.5 Hz (4) None of these

323. A closed organ pipe oscillating in its first overtone is in unison with a tuning fork of frequency 330 Hz. If ΔP_0 is the maximum value of pressure amplitude, what is pressure amplitude at the middle of the organ pipe ? (Speed of sound in air is 330 m/s)

(1) $\dfrac{\Delta P_0}{\sqrt{2}}$ (2) $\dfrac{\Delta P_0}{2}$

(3) $\dfrac{\Delta P_0}{4}$ (4) $\dfrac{\Delta P_0}{3}$

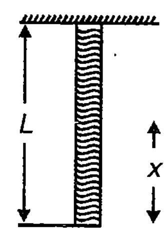
324. Density of all strings is same. The ratio of transverse wave speeds in strings *AB* and *AC* is



(1) $\sqrt{2}$ (2) $\dfrac{1}{\sqrt{2}}$

(3) 2 (4) $\dfrac{1}{2}$

325. A heavy but uniform rope of length *L* is suspended from a ceiling. A particle is dropped from the ceiling at the instant the bottom end is given the jerk. Where will the particle meet the pulse?



(1) $\dfrac{L}{3}$ distance from bottom

(2) $\dfrac{L}{3}$ distance from top

(3) At mid-point of the rope

(4) $\dfrac{L}{4}$ distance from bottom

326. The fundamental frequency of a sonometer wire increases by 6 Hz if its tension is increased by 44%, keeping the length constant. The change in the fundamental frequency of the somometer wire When length of the wire is increased by 20% keeping the original tension in the wire is

(1) Frequency will decrease by 5 Hz

(2) Frequency will increase by 5 Hz

(3) No change in frequency

(4) Frequency will increase by 10 Hz

327. A point source of sound is placed in a non-absorbing medium. Two points A and B are at distances of 1 m and 2 m, respectively from source. The ratio of amplitudes of wave at A and B is

(1) 1 : 1 (2) 1 : 4

(3) 1 : 2 (4) 2 : 1

328. One end of a string of length L is tied to ceiling of lift accelerating upwards with an acceleration 3g. The other end of the string is free. The linear mass density of string varies linearly from 0 to λ from bottom to top. Then correct statement for wave travelling in string

(1) Wave speed is increasing as it travels from bottom to top

(2) Acceleration of wave on string is uniform

(3) Time taken by pulse to reach from bottom to top will be $\sqrt{\frac{2L}{g}}$

(4) All of these

329. Intensity of sound wave is

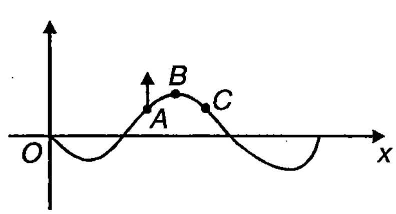
(1) Increased by four times when pressure amplitude becomes twice and frequency remains the same

(2) Increased by four times when displacement amplitude becomes twice and frequency remains the same

(3) Increased by four times when displacement remains same and frequency becomes twice

(4) All of these

330. At any instant, wave travelling along a string is shown in figure. Here point A is moving upwards. Which of following statement is true?



(1) Wave is travelling to right

(2) Displacement amplitude of wave is equal to displacement of B at this instant

(3) At this instant C also moves upward

(4) None of these

331. A wave represented by $y = 2\cos(4x - \pi t)$ is superposed with another wave to form a stationary wave such that the point $x = 0$ is a node. The equation of other wave is

(1) $2\sin(4x + \pi t)$ (2) $-2\cos(4x - \pi t)$

(3) $-2\cos(4x + \pi t)$ (4) $-2\sin(4x - \pi t)$

332. There is a set of 4 tuning forks, one with lowest frequency vibrating at 552 Hz. By using any two forks at time, the beat frequencies heard are 1, 2, 3, 5, 7, 8. The possible frequencies of other three forks are

(1) 553, 554 and 560 Hz

(2) 553, 555 and 560 Hz

(3) 553, 556 and 558 Hz

(4) 551, 554 and 560 Hz

333. The fundamental frequency n of a string, if n_1, n_2 .... are fundamental frequencies of segments of stretched string is

(1) $n_1 + n_2 + n_3 + \text{........}$

(2) $\sqrt{n_1 \times n_2 \times n_3 \text{..........}}$

(3) $\left(\frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3} + \text{.......}\right)^{-1}$

(4) None of these

334. If a string fixed at both ends vibrates in three loops, the wavelength is 10 cm. The length of string is

(1) 5 cm

(2) 15 cm

(3) 30 cm

(4) None of these

SECTION - B

Multiple Choice Questions

This section contains 115 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **MORE THAN ONE** is correct.

Choose the correct answers :

1. The least count of a stop watch is $\frac{1}{5}$ s. Two persons (A and B) use this watch to measure the time period of an oscillating pendulum. Person A takes the time period of 30 oscillations and person B takes the time period of 50 oscillations. Neglecting all other sources of error, we can say that

   (1) Absolute error in measurement by A is greater than that of B

   (2) Absolute error in measurement by A is equal to that of B

   (3) Accuracy in measurement by B is greater than that of A

   (4) Accuracy in measurement by A is equal to that of B

(IIT-JEE 2008)

1(a). Student I, II and III perform an experiment for measuring the acceleration due to gravity (g) using a simple pendulum. They use different lengths of the pendulum and / or record time for different number of oscillations. The observations are shown in the table.

Least count for length = 0.1 cm

Least count for time = 0.1 s

Student	Length of the Pendulum (cm)	Number of oscillations (n)	Total time for (n) oscillations (s)	Time period (s)
I	64.0	8	128.0	16.0
II	64.0	4	64.0	16.0
III	20.0	4	36.0	9.0

If E_I, E_{II} and E_{III} are percentage errors in g, i.e., $\left(\frac{\Delta g}{g} \times 100\right)$ for students I, II and III respectively,

(1) $E_I = 0$ (2) E_I is minimum

(3) $E_I = E_{II}$ (4) E_{II} is minimum

(IIT-JEE 2010)

1(b). A student uses a simple pendulum of exactly 1 m length to determine g, the acceleration due to gravity. He uses a stop watch with the least count of 1 second for this and records 40 seconds for 20 oscillations. For this observation, which of the following statement(s) is (are) true?

(1) Error ΔT in measuring T, the time period, is 0.05 seconds

(2) Error ΔT in measuring T, the time period, is 1 second

(3) Percentage error in the determination of g is 5%

(4) Percentage error in the determination of g is 2.5%

2. The mass of an object is 20.0 kg. Its mass expressed in grams is

   (1) 20.0 ◊ 10^3 g (2) 20000.0 g

   (3) 20000 g (4) 2.00 ◊ 10^4 g

3. The vector $\vec{A}$ is given by $\vec{A} = t\hat{i} - \sin\pi t\hat{j} + t^2\hat{k}$. Then

   (1) The magnitude of $\vec{A}$ at t = 1 s, is $|\vec{A}| = \sqrt{2}$.

   (2) The derivative of $\vec{A}$ i.e., $\frac{d\vec{A}}{dt}$ at t = 1 s, $\hat{i}+\pi\hat{j}+2\hat{k}$

   (3) The value of $\left|\vec{A} \times \frac{d\vec{A}}{dt}\right|$ at t = 1 s, is $\sqrt{2\pi^2+1}$

   (4) The value of $\vec{A}\cdot\frac{d\vec{A}}{dt}$ at t = 1 s, is 3

4. The measured values of two resistance R_1 and R_2 are as $R_1 = (100 \pm 0.3)\,\Omega$, and $R_2 = (200 \pm 0.4)\,\Omega$. Then

   (1) The value of $R_1 + R_2$ is $(300 \pm 0.7)\ \Omega$

   (2) The value of R_2 ñ R_1 is $(100 \pm 0.1)\ \Omega$

   (3) The value of R_2 ñ R_1 is $(100 \pm 0.7)\ \Omega$

   (4) The value of effective resistance R_{p_n} when connected in parallel, is given by $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$. Then $R_p = (66.7 \pm 0.18)\ \Omega$

5. In an experiment to determine the radius of a chalk by screw gauge, the diameter is measured and radings are d_1 = 1.002 cm, d_2 = 1.004 cm and d_3 = 1.006 cm. Select the correct alternatives
   (1) Mean absolute error in radius is 0.0013 cm
   (2) Mean absolute error in diameter is 0.0013 cm
   (3) Absolute error in first measurement d_1 is 0.002 cm
   (4) % age error in the measurement of diameter is 0.13%

6. Let ε_0 be the absolute permittivity, ε_r be the relative permittivity, μ_0 and μ_r be the absolute and relative permeability respectively. If M represents mass, L represents length, T represents time and I represents current, then
   (1) $[\varepsilon_0] = [M^{-1} L^{-3} T^{-2} I]$ (2) $[(\varepsilon_0\mu_0)^2] = [M^0 L^{-4} T^4]$
   (3) $[\varepsilon_r\mu_r] = [M^0 L^{-2} T^2]$ (4) $[\varepsilon_r] = [\mu_r]$

7. Regarding vectors, which of the following is a correct statement?
   (1) Two equal vectors can never give zero resultant
   (2) Three non-coplanar vectors can not give zero resultant
   (3) If $\vec{a}\cdot(\vec{b}\times\vec{c}) = 0$ and $|\vec{a}| \neq |\vec{b}| \neq |\vec{c}|$, then $\vec{a}+\vec{b}+\vec{c}$ can never be a null vector
   (4) If $\vec{a}\times\vec{b} = 0$ and $|\vec{a}| = |\vec{b}|$, then $\vec{a}+\vec{b}$ can be zero

8. Let three vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ are related as $\vec{a}+\vec{b}=\vec{c}$. The angle between $\vec{a}$ and $\vec{b}$ is θ. Select the correct alternative
   (1) Angle between $\vec{c}$ and $\vec{b}$ is greater than $\frac{\theta}{2}$ if $|\vec{a}|>|\vec{b}|$
   (2) Angle between $\vec{c}$ and $\vec{a}$ is less than $\frac{\theta}{2}$ if $|\vec{a}|>|\vec{b}|$
   (3) Angle between $\vec{c}$ and $\vec{b}$ can be $\pi-\theta$, for some values of $\vec{a}$, $\vec{b}$
   (4) Angle between $\vec{c}$ and $\vec{b}$ cannot be $\pi-\theta$, for any values of $\vec{a}$, $\vec{b}$.

9. An object is moving in the xy plane with the position as a function of time given by $\vec{r} = x(t)\hat{i} + y(t)\hat{j}$. Point O is at $\vec{r} = 0$. The object is definitely moving towards O when
   (1) $v_x > v_0$, $v_y < 0$ (2) $v_x < 0$, $v_y < 0$
   (3) $xv_x + yv_y < 0$ (4) $xv_y - yv_x = 0$

10. An aeroplane is flying horizontally with constant velocity v_0 at a height h from the ground. At an instant, it is vertically above a cannon (on the ground). At the same instant, a shell is fired to hit the aeroplane with muzzle speed u
    (1) Angle of projection must be equal to $\cos^{-1}\left(\frac{v_0}{u}\right)$
    (2) Muzzle speed should not be less than $\sqrt{2gh + v_0^2}$
    (3) Angle of projection cannot be less than $\cos^{-1}\left(\frac{v_0}{\sqrt{v_0^2+2gh}}\right)$
    (4) None of these

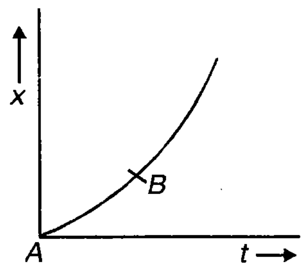
11. A boat moves relative to water with a velocity which is n times the river flow velocity
    (1) If $n < 1$, boat cannot cross the river
    (2) If $n = 1$, boat cannot cross the river without drifting
    (3) If $n > 1$, boat can cross the river along shortest path
    (4) Boat can cross the river whatever is the value of n (excluding zero value)

12. The motion of a body is given by the equation $\frac{dv}{dt} = 6.0 - 3v$, where v is the speed in m/s and t in seconds. If the body was at rest at $t = 0$
    (1) The terminal speed is 2.0 m/s
    (2) The magnitude of the initial acceleration is 6.0 m/s^2
    (3) The speed varies with time as $v = 2(1-e^{-3t})$ m/s
    (4) The speed is 1.0 m/s when the acceleration is half of the initial value

13. The velocity of a particle moving in the positive direction of x-axis varies as $v = 10\sqrt{x}$. Assuming that at $t = 0$ particle was at $x = 0$. Then
    (1) The initial velocity of the particle is zero
    (2) The initial velocity of the particle is 2.5 m/s
    (3) The acceleration of the particle is 2.5 m/s^2
    (4) The acceleration of the particle is 50 m/s^2

14. A particle moving in a straight line with constant acceleration has speeds 7 m/s at A and 17 m/s at B. M is the mid-point of AB. Then
    (1) The speed at M is 12 m/s
    (2) The average speed between A and M is 10 m/s
    (3) The average speed between M and B is 15 m/s
    (4) The ratio of the time to go from A to M and that from M to B is 3 : 2

15. Displacement-time graph of a particle moving along a straight line as shown in figure below

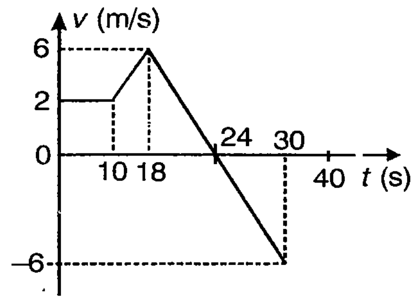


    (1) Average velocity is always less than instantaneous velocity
    (2) Initial velocity is equal to zero
    (3) Initially velocity increases and then becomes constant
    (4) Acceleration never becomes negative

16. The velocity of a particle is zero at t = 0. then
    (1) The acceleration at t = 0 may be zero
    (2) If acceleration is zero from t = 0 to t = 10 s, the speed is also zero in this interval
    (3) If acceleration is zero from t = 0 to t = 10 s, the displacement is also zero in this interval
    (4) If the speed is zero from t = 0 to t = 10 s, the acceleration is also zero in this interval

17. Two particles A and B are initially 20 m apart. A is behind B. Particle A starts moving with a uniform velocity of 5 m/s towards B. Particle starting from rest has an acceleration of 1 m/s^2 in the direction of velocity of A. Then
    (1) The minimum distance between the two particles is 10 m
    (2) The minimum distance between the two particles is 7.5 m
    (3) The minimum distance between the two is at t = 5 s
    (4) The minimum distance between the two is at t = 10 s

18. A particle moves in a straight line with the velocity as shown in figure. At t = 0, x = –16 m
    (1) The maximum value of the position coordinate of the particle is 54 m
    (2) The maximum value of the position coordinate of the particle is 36 m



    (3) The particle is at the position of 36 m at t = 18 s
    (4) The particle is at the position 36 m at t = 30 s

19. A particle moves along the x-axis as follows. It starts from rest at t = 0 from a point x = 0 and comes to rest at t = 1 at a point x = 1. No other information is available about its motion for the intermediate time ($0 < t < 1$). If α denotes the instantaneous acceleration of the particle, then
    (1) α cannot remain positive for all t in the interval $0 \le t \le 1$
    (2) $|\alpha|$ cannot exceed 2 at any point in its path
    (3) $|\alpha|$ must be $\ge$ 4 at some point or points in its path
    (4) α must change sign during the motion, but no other assertion can be made with the information given

20. A boat sails at a speed $v_1 = (3\hat{i} + 4\hat{j})$ km/hr relative to water. If the water flows with a speed $v_2 = \hat{i}$ km/hr. If the river width $\vec{d} = 100\,\text{m}\,\hat{j}$, then
    (1) Trajectory of boat is straight line
    (2) Time of crossing the river is 1.5 min
    (3) Angle of heading is $\tan^{-1}\left(\frac{4}{3}\right)$ with direction of flow, relative to water
    (4) Drift of boat in the direction of flow is 100 m

21. A particle suspended by a thread
    (1) Cannot move with constant speed in vertical circle
    (2) Is moving with constant speed along a circle then the thread is tracing surface is cone
    (3) Exerts no force on point of suspension because its weight is balanced by tension in the thread
    (4) May exerts force of constant magnitude on point of suspension when it moves along a circle

22. A particle tied with a string is whirled along a vertical circle

(1) Acceleration of particle is always directed towards centre

(2) Acceleration is directed along vertically downward when particle is at lowest position

(3) Acceleration at highest point cannot be less than g

(4) Acceleration is greater than g when string is horizontal

23. In case of a simple pendulum of length L

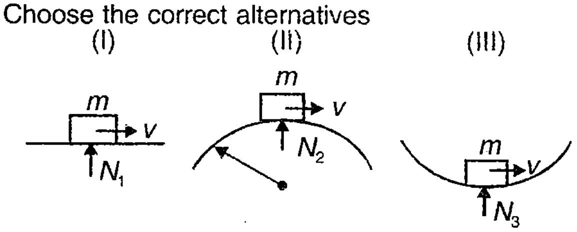
(1) The tension at the lowest point for just circular motion is 6 mg

(2) The velocity v at the lowest point for just circular motion is $\sqrt{5gL}$

(3) The pendulum will loop if $v \geq \sqrt{5gL}$

(4) The motion of bob of pendulum is of variable acceleration

24. Choose the correct alternatives



The figure shows a block of mass m moving without friction along three tracks with same speed v

(1) $N_1 = mg$

(2) $N_2 = mg - \dfrac{mv^2}{R}$

(3) $N_3 = mg + \dfrac{mv^2}{R}$

(4) If fig (II), the block will leave path, if $v > \sqrt{gR}$

25. A particle moves in the xy plane according to the law $x = a \sin(\omega t)$ and $y = a(1-\cos\omega t)$ where a and ω are constants. Then the particle traces ______

(1) A parabola

(2) A straight line equally inclined to x and y axis.

(3) A circle

(4) A distance proportional to time

26. An object may have

(1) Varying speed without having varying velocity

(2) Varying velocity without having varying speed

(3) Non-zero acceleration without having varying velocity

(4) Non-zero acceleration without having varying speed

27. A particle is hurled into air from a point on the horizontal ground at an angle with the vertical. If the air exerts a resistive force proportional to the speed of the projectile

(1) The path of the projectile will be symmetrical about the vertical line through its highest position

(2) At the highest point, the velocity is horizontal

(3) The time for ascent equal the time for descent

(4) The total energy of the projectile is not conserved

28. The speed (v) of a particle moving along a straight line, when it is at a distance (x) from a fixed point on the line is given by $v^2 = 108-9x^2$. All quantities in MKS units

(1) The motion is uniformly accelerated along the straight line

(2) The magnitude of acceleration at a distance 3 m from the fixed point is 27 m/s^2

(3) The motion is simple harmonic about a fixed point

(4) The maximum displacement from the fixed point is 4 cm

29. The instantaneous velocity of a particle at a given instant is the time derivative of its position vector and the instantaneous acceleration is the time derivative of its velocity. Therefore

(1) The instantaneous velocity depends on the instantaneous position vector

(2) The instantaneous velocity is independent of the instantaneous position vector

(3) The instantaneous acceleration is independent of instantaneous velocity

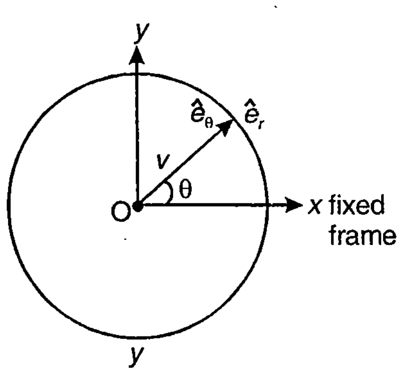
(4) The instantaneous acceleration is depends on instantaneous velocity

30. A particle, initially at rest is subject to two forces; one is constant, the other is a retarding force proportional to the particle velocity. In the subsequent motion of the particle
    (1) The acceleration will increase from zero to a constant value
    (2) The acceleration will decrease from its initial value to zero
    (3) The velocity will increase from zero to a maximum and then decrease
    (4) The velocity will increase from zero to a constant value

31. A lift of very broad-floor moving vertically upward is accelerating down with a constant acceleration 'g'. At an instant when its velocity is v_0, a stone is projected from a point on the floor of the lift at an elevation θ. Then the trajectory of stone is
    (1) A parabola in the lift frame
    (2) A straight line in the lift frame
    (3) A parabola in the ground frame
    (4) A straight line in the ground frame

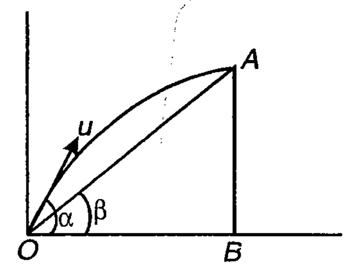
32. A coordinate system Σ is fixed with respect to the earth (assumed flat and motionless) A bullet is fired from the tail gun of an airplane with a muzzle velocity of 260 m/s. The airplane is moving horizontally with a velocity of 230 m/s. Consider another frame Σ' is attached with the airplane
    (1) The path of the bullet is parabolic with an initial horizontal velocity of 30 m/s in Σ' frame
    (2) The path of the bullet is parabolic with an initial horizontal velocity of 30 m/s in Σ frame
    (3) The path of the bullet will be straight line with an initial horizontal velocity of 260 m/s in Σ' frame
    (4) The path of the bullet will be parabolic with an initial horizontal velocity of 260 m/s in Σ' frame

33. A fly crawls with constant speed v along the radial spoke of a wheel which is rotating with constant angular speed ω. Initially the fly starts from centre of the wheel along x-axis. Then



    (1) The actual velocity of the fly in fixed frame Σ is $\vec{v} = v\hat{e}_r + r\omega\hat{e}_\theta$
    (2) The actual velocity of the fly in fixed frame Σ is $\vec{v} = v\omega\hat{e}_r + v\hat{e}_\theta$
    (3) The position of fly at any instant $\vec{r} = \dfrac{v.\theta}{\omega}\hat{e}_r$
    (4) The position of fly at any instant $\hat{r} = \dfrac{vt}{\omega}\hat{e}_r$

34. A particle is projected at an angle α with the horizontal from a point O on a plane which is inclined at an angle β to the horizontal and moves upwards in a vertical plane containing the line of greatest slope through the point. The particle is moving horizontally when it strikes the plane at a point A

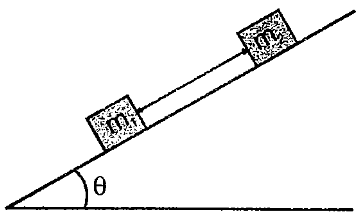


    (1) The time taken to reach point A, $T = \dfrac{u\sin\alpha}{g}$
    (2) The maximum height of the particle $= \dfrac{u^2\sin^2\alpha}{2g}$
    (3) The horizontal distance $OB = \dfrac{u^2\sin 2\alpha}{2g}$
    (4) $\alpha = \tan^{-1}(2\tan\beta)$

35. Two particles A and B start simultaneously from the same point and move in a horizontal plane. A has an initial velocity u_1 due east and acceleration a_1 due north. B has an initial velocity u_2 due north and acceleration a_2 due east
    (1) Their path must intersect at same point
    (2) They must collide at some point
    (3) They will collide only if $a_1u_1 = a_2u_2$
    (4) If $u_1 > u_2$ and $a_1 < a_2$ the particles will have the same speed at some point of time

36. Which of the following is/are correct?
    (1) Tension in a string is an electromagnetic force
    (2) If action is gravitational force its reaction cannct be a nuclear force
    (3) Newton's third law of motion is a universal law
    (4) Centrifugal force balances the centripetal force for a particle in uniform circular motion

37. Two blocks having masses m_1 & m_2 are connected by a thread & are placed on an inclined plane with thread initially in a state of no tension. Thread will not develop any tension if



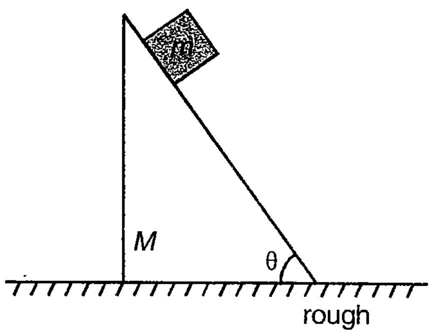
(1) $m_1 < m_2$

(2) Plane is smooth

(3) No friction acts on m_1 while it acts on m_2

(4) No friction acts on m_2 while it acts on m_1

38. A block of mass m is placed on a prism of mass M. The inclined surface is smooth and inclination with horizontal is θ. The horizontal surface is sufficiently rough to prevent slipping of prism. If the block of mass m slides down the inclined face then



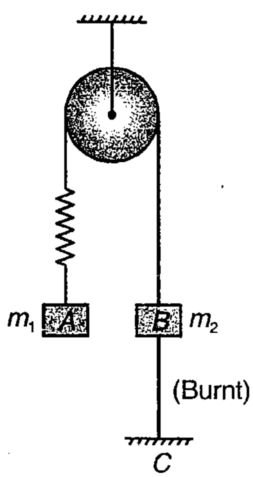
(1) Acceleration of block along the inclined surface is $g\sin\theta$

(2) Frictional force is $\frac{1}{2}mg\sin 2\theta$

(3) Maximum frictional force is $\frac{mg}{2}$

(4) Friction force will be maximum when $\theta = 45^{\circ}$

39. In the system shown $m_1 > m_2$. System is held at rest by thread BC. Just after lower thread is burnt,



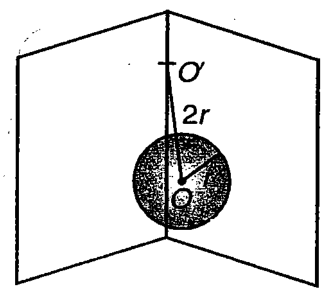
(1) Acceleration of m_2 is upwards

(2) Magnitude of acceleration of both blocks will be $\left(\frac{m_1 - m_2}{m_1 + m_2}\right)g$

(3) Acceleration of m_1 will be equal to zero

(4) Magnitudes of acceleration of two blocks will be non-zero & unequal

40. A ball of mass m & radius r rests against two perpendicular walls and is kept in equilibrium by a thread of length $2r$ (massless) tied to a point lying on the corner line of the walls. Let R_A and R_B the reactions by the walls and T be the tension in the rope, then



(1) $R_A = R_B = \frac{mg}{\sqrt{2}}$

(2) $T = \sqrt{2}\,mg$

(3) $T = mg$

(4) $R_A = \frac{mg}{2}, \quad R_B = \frac{mg}{\sqrt{2}}$

41. Which of the following is true?

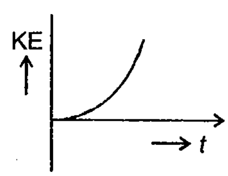
(1) Rolling friction appears due to deformation at the point of contact

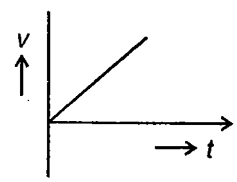
(2) All perfectly rigid wheels experience rolling friction

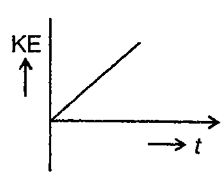
(3) For identical surfaces in contact coefficient of static friction > coefficient of sliding friction

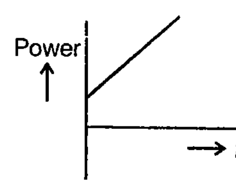
(4) Friction is component of total contact force parallel to surface of contact

42. A block is resting over a smooth horizontal plane. A constant horizontal force starts acting at $t = 0$. Which of the following graphs is correct?

(1)


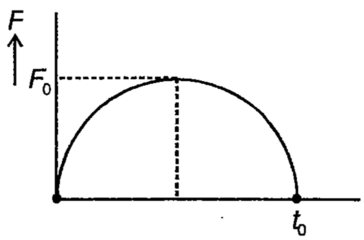
(2)


(3)


(4)


43. For a particle of mass m, average force applied on the particle in an interval of time is directed along
    (1) Averge acceleration vector of particle
    (2) Velocity vector of particle
    (3) Along the change in velocity vector
    (4) Perpendicular to velocity vector

44. A variable force acts on a particle of mass m from $t = 0$ to $t = t_0$. the F-t plot is a semicircle. The particle is initially at rest then



    (1) Impulse imparted to particle is infinite
    (2) Impulse imparted to particle is $\frac{1}{2}\pi F_0^2$
    (3) Velocity acquired by particle is $\pi\frac{F_0^2}{2m}$
    (4) Momentum gain is $\frac{1}{2}\pi F_0^2$

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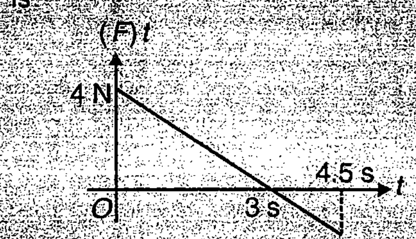
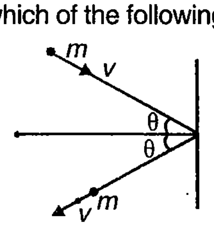
44(a). A block of mass 2 kg is free to move along the x-axis. It is at rest and from $t = 0$ onwards it is subjected to a time-dependent force $F(t)$ in the x direction. The fore $F(t)$ varies with t as shown in the figure. The kinetic energy of the block after 4.5 seconds is



(A) 4.50 J (B) 7.50 J
(C) 5.06 J (D) 14.06 J

45. A ball moving with velocity v and mass m strikes against a wall at an angle θ and is reflected at the same angle, then which of the following is incorrect?

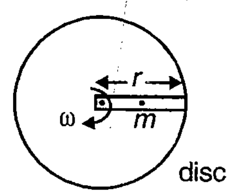


    (1) $\Delta|\vec{p}| \neq 0$
    (2) $|\Delta\vec{p}| = 0$
    (3) $\Delta K \neq 0$
    (4) $\Delta|\vec{p}| = 0$

46. Two bodies are initially at rest. They start moving towards each other due to mutual attraction. Which of the following is/are correct?

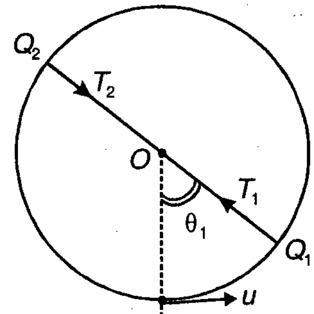
    (1) $\vec{a}_{cm} = 0$
    (2) $\Sigma\Delta\vec{p} = 0$
    (3) $\vec{v}_{cm}$ = Zero
    (4) They will collide at their centre of mass

47. A ball of mass m is placed in smooth groove at the center of disc and frame starts to rotate with angular speed ω, which of the following statement is incorrect?



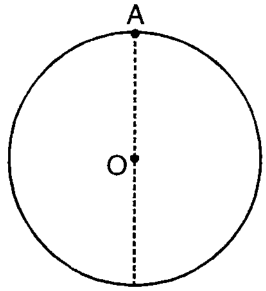
    (1) Net force on ball is towards center
    (2) Motion of ball is in radially outward direction w.r.t. centre
    (3) Centripetal force is $mr\omega^2$
    (4) Motion of ball is circular

48. A heavy particle hanging vertically from a point by a light inextensible string of length l is started so as to make a complete revolution in a vertical plane. Then



    (1) Sum of tensions at the ends of any diameter is constant
    (2) Sum of tensions at the ends of any diameter is independent on angle θ with vertical
    (3) Tension does no work
    (4) $T_1 + T_2 = \frac{m}{l}[2u^2 - 4gl]$

49. A particle slides down on the outside surface of a smooth vertical circle of radius (a) due to its weight starting from rest at the highest point. Select the correct alternative



(1) It will leave the circle at an angle $\theta = \cos^{-1}\left(\frac{2}{3}\right)$ from vertical

(2) It will leave the circle at a vertical distance $\frac{a}{3}$ below A

(3) Velocity of the particle when it leaves the circle is $\left(\frac{2ag}{3}\right)^{1/2}$

(4) None of these

50. A particle is projected horizontally with a velocity $\sqrt{\frac{1}{2}ag}$ from highest point of the outside of a fixed smooth sphere of radius a. Then

(1) Particle will leave the sphere where contact force becomes zero

(2) Particle will leave the sphere at a vertical distance $\frac{a}{6}$ below from the point of projection

(3) Particle will leave the contact at an angle $\theta = \cos^{ñ1}\left(\frac{5}{6}\right)$ from the vertical

(4) None of these

51. Two smooth spheres A and B of masses 4 kg and 8 kg move with velocities 9 m/s and 3 m/s in opposite directions. If A rebounds with velocity 1 m/s, then

(1) The velocity of sphere B after the impact 2 m/s

(2) The coefficient of impact $e = \frac{1}{4}$

(3) The loss of kinetic energy = 180 J

(4) None of these

(IIT-JEE 2010)

51(a). A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverses its direction and moves with a speed of 2 $ms^{ñ1}$. Which of the following statement(s) is (are) correct for the system of these two masses?

(1) Total momentum of the system is 3 kg $ms^{ñ1}$

(2) Momentum of 5 kg mass after collision is 4 kg $ms^{ñ1}$

(3) Kinetic energy of the centre of mass is 0.75 J

(4) Total kinetic energy of the system is 4 J

52. Three equal spheres are in a straight line on a table and one moves towards the other two which are at rest and not in contact, if $e = \frac{1}{2}$, then

(1) There are two impacts between them

(2) There are three impacts between them

(3) The ratio of their final velocities is 13 : 15 : 63

(4) The ratio of their final velocities is 13 : 15 : 36

53. A sphere impinges directly on an identical sphere which is at rest. Then

(1) First sphere comes to rest and second sphere move with same velocity if collision is perfectly elastic

(2) After the impact both the sphere will combine and move together with common velocity if collision is perfectly inelastic

(3) After the impact their velocities will be in ratio (1 ñ e) : (1 + e) if collision is partially plastic collision

(4) Loss in kinetic energy = $\frac{1}{2}(1-e^2)$ of original kinetic energy is collision is partially plastic

(IIT-JEE 2010)

53(a). A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverses its direction and moves with a speed of 2 $ms^{ñ1}$. Which of the following statement(s) is (are) correct for the system of these two masses?

(1) Total momentum of the system is 3 kg $ms^{ñ1}$

(2) Momentum of 5 kg mass after collision is 4 kg $ms^{ñ1}$

(3) Kinetic energy of the centre of mass is 0.75 J

(4) Total kinetic energy of the system is 4 J

54. A series of n elastic balls whose masses are m, em, e^2m, ... etc. are at rest separated by intervals with their centres on a straight line. Here, e is coefficient of restitution for the collision. The first is made to impinge directly on the second with velocity u. Then

(1) The first $(n-1)$ balls will be moving with the same velocity $(1-e)\,u$

(2) The last one ball will move with velocity u

(3) The kinetic energy of the system is $\frac{1}{2}mu^2(1-e+e^n)$

(4) None of these

55. A particle (mass m) falling vertically from a height h impinges on a horizontal fixed plane and rebounds to a height h_1. Then

(1) Change in momentum of particle $= (e+1)m\sqrt{2gh}$

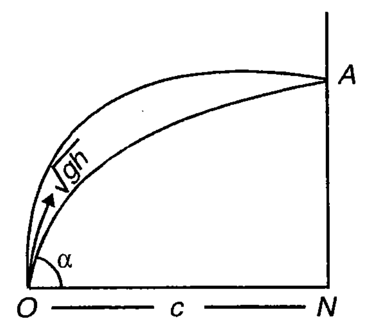
(2) Impulse imparted to plane $= (e+1)m\sqrt{2gh}$

(3) $h_1 = e^2h$

(4) $T_1 = eT$

where T and T_1 are the time taken to fall on plane and to go maximum height after rebond respectively

56. An imperfectly elastic ball is projected with velocity $\sqrt{gh}$ at an angle α with the horizontal, so that it strikes a vertical wall distant c from the point of projection, and returns to the point of projection. Then



(1) Time from A to $O = \dfrac{c}{\sqrt{(gh)}\cos\alpha}$

(2) Time from A to $O = \dfrac{c}{e\sqrt{gh}\cos\alpha}$

(3) Time from O to $A = \dfrac{c}{\sqrt{gh}\cos\alpha}$

(4) The coefficient of restitution $= \dfrac{c}{(h\sin2\alpha - c)}$

57. Two waves

$y_1 = 3\sin(512\,\pi t)$

and $y_2 = \sin(504\,\pi t)$

superpose at $x = 0$

Then choose the correct options out of the following

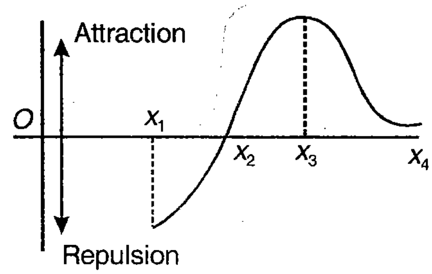
(1) The resulting wave has a frequency 508 Hz

(2) Frequency of amplitude variation is 4 Hz

(3) Beat frequency is 4 Hz

(4) Ratio of maximum intensity to minimum intensity at $x = 0$ is 9

58. The diagram given shows how the net interaction force between two particles A and B is related to the distance between them, when the distance between them varies from x_1 to x_4. Then



(1) The potential energy of the system increases from x_1 to x_2

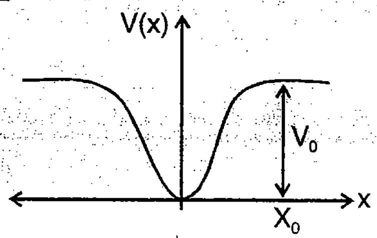
(2) Potential energy of the system increases from x_2 to x_3

(3) Potential energy of the system increase from x_3 to x_4

(4) Kinetic energy increases from x_1 to x_2 and decreases from x_2 to x_3

(IIT-JEE 2010)

58(a). When a particle of mass m moves on the x-axis in a potential of the form $V(x) = kx^2$, it performs simple harmonic motion. The corresponding time period is proportional to $\sqrt{\frac{m}{k}}$, as can be seen easily using dimensional analysis. However, the motion of a particle can be periodic even when its potential energy increases on both sides of $x = 0$ in a way different from kx^2 and its total energy is such that the particle does not escape to infinity. Consider a particle of mass m moving on the x-axis. Its potential energy is $V(x) = \alpha x^4$ $(\alpha > 0)$ for $|x|$ near the origin and becomes a constant equal to V_0 for $|x| \geq X_0$ (see figure).



1. If the total energy of the particle is E, it will perform periodic motion only if

(1) $E < 0$ (2) $E > 0$

(3) $V_0 > E > 0$ (4) $E > V_0$

2. For periodic motion of small amplitude A, the time period T of this particle is proportional to

(1) $A\sqrt{\frac{m}{\alpha}}$ (2) $\frac{1}{A}\sqrt{\frac{m}{\alpha}}$

(3) $A\sqrt{\frac{\alpha}{m}}$ (4) $\frac{1}{A}\sqrt{\frac{\alpha}{m}}$

3. The acceleration of this particle for $|x| > X_0$ is

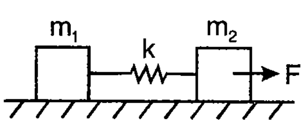
(1) Proportional to V_0

(2) Proportional to $\frac{V_0}{mX_0}$

(3) Proportional to $\sqrt{\frac{V_0}{mX_0}}$

(4) Zero

59. Two bars connected by a weightless spring of stiffness k and length (in non-deformed state) l_0 rest on a horizontal plane. A constant horizontal force F starts acting on one of the bars as shown in figure. Then



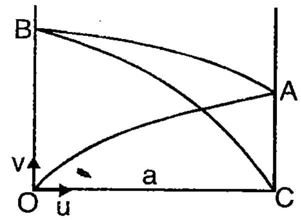
(1) When $m_1 = m_2 = m$ then maximum elongation in the spring is $\frac{F}{k}$

(2) When $m_1 = m_2 = m$, then maximum compression in the spring = $\frac{F}{k}$

(3) When the masses are different, then maximum compression in the spring is zero

(4) The maximum elongation in the spring $= \frac{2Fm}{k(m_1 + m_2)}$

60. A ball is projected from a point in one of the two smooth parallel vertical walls against the other in a plane perpendicular to both after being reflected at each wall impinge again on the second at a point in the same horizontal plane as it started. The distance between two walls is a, b is the free range on a horizontal plane and e be the coefficient of elasticity



(1) The total time take in moving from O to C is $\frac{a}{e^2u}(e^2 + e + 1)$

(2) The free range on the horizontal plane $b = \frac{2uv}{g}$

(3) $be^2 = a(e^2 + e + 1)$

(4) All of these are correct

61. Two perfectly inelastic bodies of masses m_1 and m_2 moving with velocities u_1 and u_2 in the same direction impinge directly. Then select the correct alternative

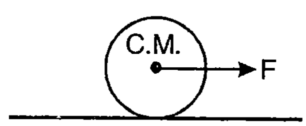
(1) Their is no loss in kinetic energy

(2) The loss in kinetic energy is $\frac{m_1m_2}{2(m_1 + m_2)}(u_1 - u_2)^2$

(3) After the collision, they move with common velocity

(4) Their is no loss in momentum of the system

62. A solid cylinder of mass M and radius R is rolled without slipping horizontally on rough surface as shown, then



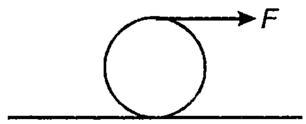
(1) Acceleration of centre of mass is $\frac{2F}{3M}$

(2) Tangential acceleration of top most point is $\frac{4F}{3M}$

(3) Friction force is in backward direction

(4) Friction force is $\frac{F}{3}$ in magnitude

63. A solid sphere of radius R is rolled by force F acting at top of sphere as shown in figure. There is no slipping & initially sphere is in rest position then



Rough

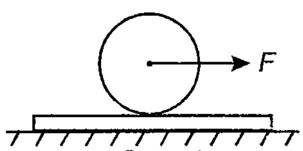
(1) Work done by force F when centre of mass moves distance S is 2 FS

(2) Speed of centre of mass when it moves distance S is $\sqrt{\frac{20FS}{7M}}$

(3) The friction force is $\frac{3F}{7}$

(4) The friction force is in forward direction

64. A disc of mass m and radius R is placed over plank of mass m. There is sufficient friction between disc & plank to prevent slipping. A force F is applied at centre of disc then



Smooth

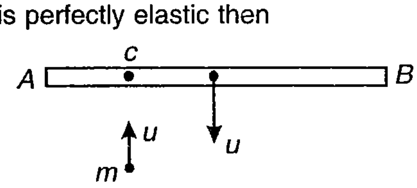
(1) Acceleration of plank is $\frac{F}{2m}$

(2) Acceleration of plank is $\frac{F}{4m}$

(3) Friction force between disc and plank is $\frac{F}{4}$

(4) Friction force between disc and plank is $\frac{F}{3}$

65. A rod AB of mass 3 m & length 4 a is freely falling in horizontal position & c is point distant a from A. When speed of rod is u, the point c collides with particle of mass m which is moving vertically upward with speed u. If impact between particle & rod is perfectly elastic then



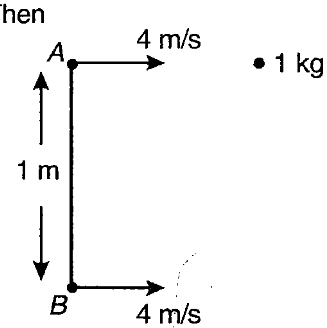
(1) Velocity of particle after impact $\frac{29}{19}u$ downward

(2) Angular velocity of rod immediately after impact $\frac{12u}{19a}$

(3) Angular velocity of rod immediately after impact $\frac{18u}{19a}$

(4) Speed of B immediately after impact $\frac{27}{19}u$ downward

66. Two point masses A & B each of 1 kg joined by 1 m rod (light) translates on horizontal surface as shown in figure. A particle of mass 1 kg at rest on horizontal surface sticks to ball as it collides with ball A. Then



(1) Linear speed of ball A just after collision is 2 m/s

(2) Linear speed of ball B just after collision is 4 m/s

(3) Velocity of centre of mass of system is $\frac{8}{3}$ m/s

(4) Angular speed of system about centre of mass after collision 2 rad/s

67. A door of corridor 2 m high & width 1 m weighs 10 kg. The door is supported by two hinges at distance 25 cm from ends. If magnitudes of forces exerted by hinges on door are equal, then

(1) Horizontal force exerted by hinge on door is $\frac{100}{3}$ N

(2) Vertical force exerted by hinge on door is 50 N

(3) Total force by one hinge on door is 60 N approx

(4) None of these

68. Two identical cylinders one rotating at angular speed 100 π rad/s is bought in contact with other cylinder at rest, surface of both cylinder are rough. If both acquire common acceleration 2 π rad/s^2, then

(1) Time after which they achieve equal angular speed is 50 s

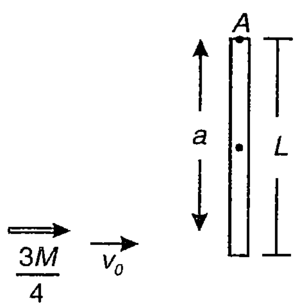
(2) Time after which they achieve equal angular speed is 25 s

(3) Angular speed (common) is 25 π rad/s

(4) Angular speed (common) is 50 π rad/s

69. A ring, Disc, Solid sphere and hollow sphere each of mass m and different radius start together from rest at top of inclined plane and roll down without slipping
   (1) All will reach the bottom of incline together
   (2) Body with maximum radii will reach bottom first
   (3) They will reach in order solid sphere, disc, hollow sphere and ring
   (4) All of them will have same knetic energy at the bottom of incline

70. A rod of length L and mass M can rotate freely around a pivot A. A bullet of mass $\frac{3M}{4}$ and velocity V hits the rod at distance $a = \frac{2L}{3}$ from A and gets embedded in the rod



   (1) Angular momentum of system around A immediately before bullet hits the rod mv_0a
   (2) Angular momentum of system immediately after bullet hits the rod $\frac{mv_0L}{2}$
   (3) Momentum of system before and after collision mv_0
   (4) Angular momentum of system immediately after collision mv_0a

71. If net force on rigid body is zero. Then which statement are true?
   (1) Linear velocity of COM is zero
   (2) Angular velocity of rigid body may vary
   (3) Angular momentum of rigid body about any axis of rotation may vary
   (4) None of these

72. Which of following statements are correct for rolling without slipping on rough horizontal ground?
   (1) Acceleration of point in contact with ground is zero
   (2) Speed of some points are zero
   (3) Friction force may or may not be zero
   (4) Work done by friction may or may not be zero

73. Which of following statements are correct?
   (1) If bicycle accelerates on road, friction on rear wheel is in forward direction
   (2) If bicycle accelerates on road, friction on front wheel is in backward direction
   (3) Friction on both wheels in forward direction
   (4) Friction on both wheels in backward direction

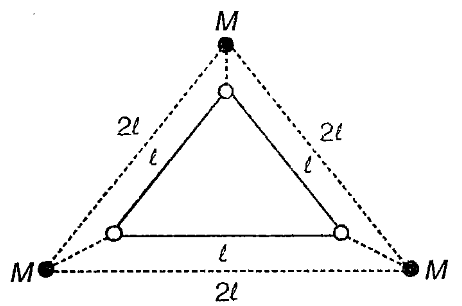
74. A rigid body rolls purely on a rough surface. Its centre C moves with a constant speed 10 m/s. Then any point on surface of rigid body's peripheral has speed 'V' such that
   (1) $0 \le V \le 20$
   (2) $V = 10$, if point is in a horizontal line containing centre
   (3) $V = 10\sqrt{2}$, if point is in a horizontal line containing centre
   (4) $V = 10$, if line joining centre to the point makes angle 60º with horizontal and below C

75. An artificial satellite is in a circular orbit around the earth. The universal gravitational constant start decreasing at time $t = 0$ at a constant rate with respect to time t. Then the satellite has its
   (1) Path gradually spiraling out away from the centre of the earth
   (2) Path gradually spiraling in towards the centre of the earth
   (3) Angular momentum about the centre of the earth remains constant
   (4) Potential energy increase

76. Imagine a satellite of sun in a circular orbit around the sun, midway between the sun and the earth. Then
   (1) The period of the satellite is nearly 129 days
   (2) The period of the satellite depends upon mass of sun M_s as $T \propto \frac{1}{\sqrt{M_s}}$
   (3) The speed of the satellite equal the escape velocity of the earth
   (4) The acceleration of the satellite is four times the acceleration of the earth

77. Two satellites of same mass of a planet having circular orbits have periods of revolution 32 days and 256 days. If the radius of orbit of the first is x, then the
   (1) Radius of the orbit of the second is $8x$
   (2) Radius of the orbit of the second is $4x$
   (3) Total mechanical energy of the second is greater than that of the first
   (4) Kinetic energy of the second is less than that of the first

78. Three particle of mass M each are lying on the corners of an equilateral triangle of side l . the length of each side of the triangle is made twice



(1) P.E. on increasing the length is $\frac{-3GM^2}{2\ell}$

(2) Work done by external agent = $\frac{3GM^2}{2\ell}$

(3) Work done by gravitational field = $\frac{-3GM^2}{2\ \ell}$

(4) Gravitational potential at the centre of new $\Delta = -3\sqrt{3}\frac{GM}{2\ell}$

79. A beaker containing water with a total mass of 10 kg is placed on the pan of a balance A. A solid body of mass 5 kg and density 5 g/cc suspended from a spring balance B is gently lowered in water contained in the beaker, so that gets fully immersed without touching the beaker

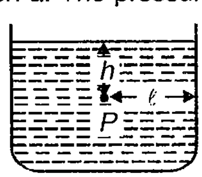
(1) The reading shown by the balance A is 11 kgf

(2) The reading shown by the balance B is 6 kgf

(3) The reading shown by the balance A is 1 kgf

(4) The reading shown by the balance B is 4 kgf

80. A closed tank is completely filled with a liquid of density ρ and placed on a cart. The cart is given an acceleration a. The pressure at the point P is



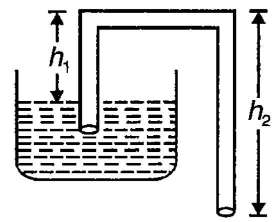
(1) $\rho(gh + a\ell)$, if the acceleration is horizontally towards right

(2) $\rho h(g + a)$, if the acceleration is vertically upward

(3) $\rho[h(g + a\sin\alpha) + \ell a\cos\alpha]$, if acceleration is inclined upward to the horizontal by an angle α

(4) $\rho h(g - a)$, if acceleration is vertically downward

81. The working of a siphon is shown in the figure, transfer liquid from higher level to a lower level if



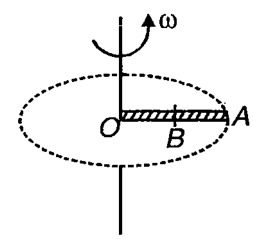
(1) $h_2 > h_1$

(2) $h_2 < h_1$

(3) h_1 should be less than barometric height

(4) h_1 should be more than barometric height

82. A rod OA of mass m and length L is rotating in a horizontal circle about point O as shown in figure. B is the mid-point of rod. If T represents tension in the rod at any point and U represents elastic potential energy per unit volume at any point of rod, then choose correct alternative(s), t_0 is tension at point O.



(1) $T_0 = \frac{4}{3}T_B$

(2) $T_0 = \frac{m\omega^2 L}{2}$

(3) $U_0 = \frac{16}{9}U_B$

(4) $T_A = 0$

83. A cubical vessel, open from the top, is of side L and filled with a liquid A of density ρ

(1) The torque of hydrostatic force on a side wall about axis passing through one of the bottom edges is $\frac{\rho g L^4}{6}$

(2) The ratio of magnitude of torque on side wall to the torque on base about the same axis is 1 : 2

(3) The ratio of magnitude of torque on one side wall to the torque on base about the same axis is 1 : 3

(4) The torque of hydrostatic force on a side wall about axis passing through one of the bottom edges is $\frac{2\rho g L^4}{9}$

84. If a glass full of water upto height of 10 cm has a bottom of area 10 cm^2, top of area 30 cm^2 and volume 1 litre, then the

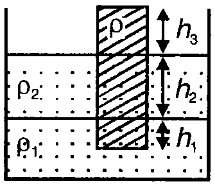
(1) Force exerted by the water on the bottom is 102 N downward

(2) Force exerted by atmosphere on water is 303 N downwards

(3) Resultant force exerted by the sides of the glass on the water is 211 N upwards

(4) Resultant force exerted by the side of the glass on the water is 211 N downwards

85. A solid of uniform cross-section and having density ρ is floating in two immiscible liquids of densities ρ_1 and ρ_2 as shown in figure. Then choose the correct options out of the following



(1) If $\rho < \rho_2 < \rho_1$, h_1, must be zero

(2) If $\rho < \rho_2 < \rho_1$, h_1, may be zero

(3) If $\rho_2 < \rho < \rho_1$, h_1, may be zero

(4) If $\rho_2 < \rho < \rho_1$, h_1, must be non-zero

86. A tank is filled upto height h with a liquid and is placed on a platform of height h from the ground

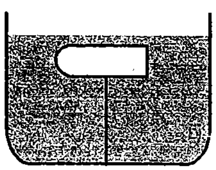
(1) Range is maximum when depth of hole from free surface is h

(2) Range is maximum when depth of hole from free surface is $2h$

(3) Maximum range is $2h$

(4) Maximum range is h

87. A string is holding a solid block below the surface of the liquid as shown in figure. If the system is given an upward acceleration a, then as compared to previous state



(1) Tension in string will be $\left(1+\frac{a}{g}\right)$ times

(2) Tension in string will be $\left(1-\frac{a}{g}\right)$ times

(3) Upthrust force of block become $\left(1+\frac{a}{g}\right)$ times

(4) Upthrust force of block become $\left(1-\frac{a}{g}\right)$ times

88. A wooden block with a stone placed on its top, floats in water in a container. If stone falls in water

(1) Upthrust force on block will decreases

(2) Stone will now displace lesser volume of water, equal to $\frac{m \text{ stone}}{\rho \text{ stone}}$

(3) Level of water in container will fall down

(4) Fraction of submerged volume of block will decrease

89. In SHM

(1) Potential energy & kinetic energy may be equal at mean position

(2) Potential energy & kinetic energy may be equal at extreme position

(3) Potential energy may be zero at extreme position

(4) Total energy of SHM oscillates harmonically

90. A particle of mass 1 kg is moving where potential energy varies as displacement $U = 10(1-\cos 2x)$ then

(1) Time period for SHM $2\pi\sqrt{\frac{1}{20}}$

(2) Speed of particle is maximum at $x = 0$

(3) Amplitude of oscillation is $\frac{\pi}{4}$

(4) Time period for SHM is $2\pi\sqrt{\frac{1}{40}}$

91. In spring block system, force constant of spring is k = 16 N/m. Mass of block is 1 kg. Maximum kinetic energy of block is 8 J. Then

(1) Amplitude of oscillation is 1 m

(2) At displacement equal to half amplitude, potential energy in spring is 2 J

(3) At displacement equal to half amplitude, kinetic energy is 6 J

(4) Angular frequency of oscillation is 16 rad/s

92. A person having mass 50 kg is standing on a platform which is oscillating vertically with an angular frequency of 2 rad/s^2 and amplitude 50 cm. Choose the correct options (g = 10 m/s^2)

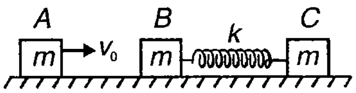
(1) Person experiences a maximum weight of 80 kg at the highest point

(2) Person experiences a maximum weight of 60 kg at the lowest point

(3) Person experiences a minimum weight of 40 kg at the highest point

(4) Person experiences a minimum weight of 40 kg at the lowest point

93. Two identical masses are connected by a spring and placed on a smooth surface. A third identical mass moving with speed v_0 collides with one of the two masses elastically. Choose the correct option



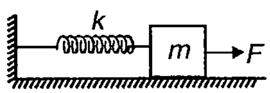
(1) Centre of mass of the two blocks connected by spring moves with a constant speed $v_0/2$ after collision

(2) Two blocks connected by spring oscillate simple harmonically about their centre of mass with time period $T = 2\pi\sqrt{\dfrac{m}{2k}}$

(3) Maximum compression in spring is $\sqrt{\dfrac{mv_0^2}{2k}}$

(4) Block A comes to rest after impact with B and B starts moving with speed v_0

94. A block of mass m is connected to a spring of stiffness k and placed on a smooth horizontal surface. A constant force F is pulling the block as shown in the figure. Choose the correct options



(1) Block performs SHM

(2) The equilibrium position of block occurs when spring is stretched by $\dfrac{F}{k}$

(3) The time period of oscillation of block is $T = 2\pi\sqrt{\dfrac{m}{k}}$

(4) The amplitude of motion is $\dfrac{F}{k}$

95. A particle moves in *x*-*y* plane according to equation $\vec{S} = (2\hat{i} + \hat{j})\cos\omega t$. The motion of particle is

(1) On straight line (2) On ellipse

(3) Periodic (4) SHM

96. A mass of 5 kg has P.E. as function of x, $U = 400 + 60x^2$, then

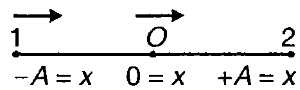
(1) Motion is SHM

(2) Acceleration is $|a| = 24x$

(3) Angular frequency is $\sqrt{24}$ rad/s

(4) $T = \dfrac{\pi}{\sqrt{6}} s$

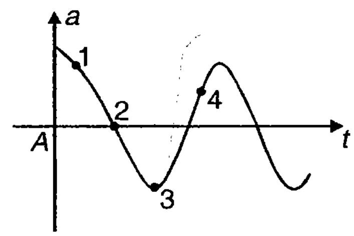
97. Two particles undergo SHM along same line with same period of (T) and equal amplitudes (A). At particular instant one particle is at $x = -A$ and the other is at $x = 0$. They move in same direction. They will cross each other at



(1) $t = \dfrac{4T}{3}$ (2) $t = \dfrac{3T}{8}$

(3) $x = \dfrac{A}{2}$ (4) $x = \dfrac{A}{\sqrt{2}}$

98. Acceleration-time graph of particle executing SHM is given. The correct options are



(1) Displacement of particle is negative at 1

(2) Velocity of particle is positive at 2

(3) Potential energy of particle at 3 is maximum

(4) Speed of particle at 4 is decreasing

99. Density of liquid varies with depth as $\rho = (2 \text{ gm/cm}^4)h$. A small ball of density 8 gm/cm^3 is released from surface of liquid. Then

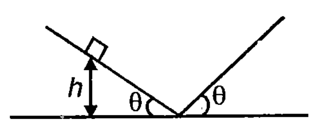
(1) Ball will execute SHM of amplitude 4 cm

(2) Mean position of ball will be at depth 2 cm

(3) Ball will sink upto maximum depth of 8 cm

(4) Ball will sink upto maximum depth of 4 cm

100. A particle slides back and forth between two inclined frictionless planes as shown. Which of following statements are correct?



(1) Motion is oscillatory

(2) Motion is SHM

(3) $T = \dfrac{4}{\sin\theta}\sqrt{\dfrac{2h}{g}}$

(4) $T = \sqrt{\dfrac{2h}{g}}\sin\theta$

101. If two orthogonal SHM of same frequency having initial phase difference of $\frac{\pi}{2}$ act simultaneously on particle free to move. The particle will move in

(1) Straight line (2) Parabola

(3) Circle (4) Ellipse

102. Mark correct statements w.r.t. perfect standing waves

(1) Two waves that form it, would carry equal amounts of power in opposite directions

(2) Average rate of energy transfer is zero at every point

(3) Flow of energy is there within a segment formed by two nodes

(4) In transverse standing wave on a string, energy is transferred from one end to other

103. Three consecutive resonant frequencies of string are 90 Hz, 150 Hz and 210 Hz then

(1) The maximum possible fundamental frequency of vibration of this string is 30 Hz

(2) The given frequencies are 3rd, 5th and 7th harmonic

(3) The given frequencies are 1st, 2nd & 3rd harmonic

(4) The given frequencies are 1st, 2nd and 3rd overtone

104. Two pulses travelling on same string are described by equations

$$y_1 = \frac{5}{(3x-4t)^2+2} \text{ and } y_2 = \frac{-5}{(3x+4t-6)^2+2}.$$

Mark out correct statements

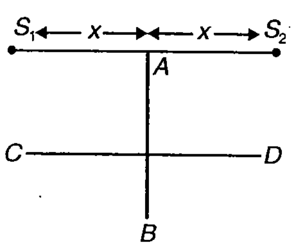
(1) At $t=\frac{4}{3}$ s the two waves cancel each other every where

(2) At $t=\frac{3}{4}$ s the two waves cancel each other every where

(3) At $x = 1$ the two waves cancel each other at all times.

(4) At all points two waves cancel each other

105. Two speakers are placed as shown in figure below. Mark correct statements



(1) If person is moving along AB he will hear sound loud, faint, loud and so on

(2) If person moves on CD he will hear sound loud, faint, loud and so on

(3) If person moves on AB he will hear sound with continously decreasing intensity

(4) If person moves on CD he will hear uniformly intense sound

106. Which of following represent equation of wave?

(1) $y = (3x + 4t)^3$

(2) $y = 3\sin(3x - 4t) + 4\cos(3x - 4t)$

(3) $y = \sin(3x - 2t) + \cos(3x - 4t)$

(4) $y = \frac{1}{3x+4t}$

107. A wave is going from one medium to another, then which of property may/must change?

(1) Frequency

(2) Wavelength

(3) Velocity

(4) Amplitude

108. The displacement of string carrying a travelling wave is given by $y = A\sin(kx - \omega t + \delta)$. At $t = 0$ the particle at $x = 0$ is at half of amplitude and is moving at upward direction. The value of δ may be.

(1) 60º (2) 300º

(3) 30º (4) 330º

109. A harmonic wave is travelling along positive x-axis on a stretched string. If wavelength of wave gets doubled, then

(1) Frequency of wave may change

(2) Wave speed may change

(3) Both frequency and speed of wave may change

(4) Only frequency will change

110. A string of length L fixed at both ends is vibrating in a resonant mode of its vibration for which particle at $x=\frac{L}{6}$ from one end is having maximum displacement. The frequency of vibration of this mode is 120 Hz. For this situation, mark out correct statements

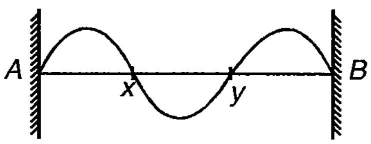
(1) The particle at will have maximum displacement

(2) The given mode is 2nd overtone

(3) The next higher overtone for which same particle at $x = \frac{L}{6}$ has maximum displacement is 6th one

(4) The next higher overtone for which same particle at $x = \frac{L}{6}$ has maximum displacement is 8th one

111. A string fixed at both ends is vibrating as shown in figure, then mark correct statements



(1) All particles in between x and y are vibrating in phase

(2) All particles in between A and x are vibrating with π phase difference with particles between x and y

(3) All particles between A and x are vibrating in phase with particles in y and B

(4) Distance between points x and y is half of wavelength

112. With regard to sound waves, mark out correct statements

(1) Phase difference between incident and reflected displacement waves from fixed end is π

(2) Phase difference between incident and reflected pressure wave from fixed end is zero

(3) Phase difference between incident and reflected pressure wave from free end is π

(4) Phase difference between incident and reflected displacement wave from free end is zero

113. A wave (harmonic) is travelling on a stretched string. The frequency of source producing wave is increased by a factor of two keeping all other parameters same then

(1) Speed is doubled

(2) Wavelength is halved

(3) Speed remains same

(4) Wavelength remains same

114. Mark correct options

(1) Waves can be transverse in liquids

(2) In some media speed of longitudnal mechanical wave is greater than speed of transverse mechanical waves

(3) Transverse waves are possible in surface of liquid

(4) Non mechanical waves are transverse is nature

115. Two points on string are being observed as a travelling wave passes them. The point are at $x_1 = 0$ and $x_2 = 1$ m, the transverse motions of two points are found to be as follows

$$y_1 = A\sin(3\pi t) \text{ and } y_2 = A\sin\left(3\pi t + \frac{\pi}{8}\right)$$

t is in seconds and y in metre. Mark correct options

(1) Frequency of wave is 3 Hz

(2) Frequency of wave is 1.5 Hz

(3) Wavelength may be 16 m

(4) Wavelength may be $\frac{16}{15}$ m

❑ ❑ ❑

SECTION - C

Linked Comprehension Type

This section contains 49 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Comprehension :

C1. According to principle of homogeneity of dimensions, two physical quantities can be added or subtracted when they have same dimensional formula. Like you can not add force and velocity as they represent two different physical quantities. On the other hand, multiplication and division is possible. As you see in various formulae, by multiplying two or more physical quantities of different dimensions (and nature), we get a new physical quantity. This principle is useful in the examination of validity of various physical relations. In addition, the mathematical functions like sine, log etc., have two properties useful for dimensional analysis. First is that the mathematical functions are dimensionless and secondly, their arguments are also dimensionless.

Choose the correct answer :

1. Which of the following is not allowed by principle of homogeneity of dimensions?
   (1) Adding speed with speed
   (2) Multiplying acceleration with time
   (3) Adding work done to torque
   (4) Subtracting force from velocity

2. There can be two physical quantities having same dimensions but different nature. Keeping into mind, the nature also, which of the following mathematical operation is meaningful?
   (1) Adding speed to velocity
   (2) Adding work to torque
   (3) Adding mass and velocity
   (4) Adding velocity to velocity

3. The acceleration of a particle moving along a straight line varies with time is $a = 3t + 5$, where acceleration is being measured in m/s^2 and time in seconds. In the above expression
   (1) The constant 5 is dimensionless constant
   (2) The constant 3 is dimensionless constant
   (3) The constant 3 has dimension m/s^2
   (4) The constant 5 has dimension m/s^2

C2. The force '*F*' acting on a particle varies with time '*t*' according to the relation $F = A\sin(\omega t)e^{\frac{-\omega t}{Ak}}$

Here A, ω and k are either dimensionless or dimensional variables where ω is angular velocity.

Choose the correct answer :

1. The dimensional formula for Ak is same as that of
   (1) Angle (2) $\frac{F}{A}$
   (3) ωt (4) All of these

2. The dimensional formula for Kt is
   (1) $[M^{-1}L^{-1}T^{3}]$ (2) $[M^0L^0T^0]$
   (3) $[M^{-1}L^{-1}T^{-2}]$ (4) $[M^0L^0T^1]$

3. Which of the following mathematical expressions is not meaningful according to principle of homogeneity of dimensions?
   (1) $F + \frac{A}{\omega t}$ (2) $Fk + \omega t$
   (3) $\frac{F}{\omega t} - \frac{1}{k}$ (4) $F + Ak$

C3. In Searle's experiment, the diameter of the wire as measured by a screw gauge is 0.050 cm. The length, measured by a scale is 110.0 cm. When a weight of 50 N (exact) is suspended from the wire, the extension is measured to be 0.125 cm by a micrometer.

Choose the correct answer :

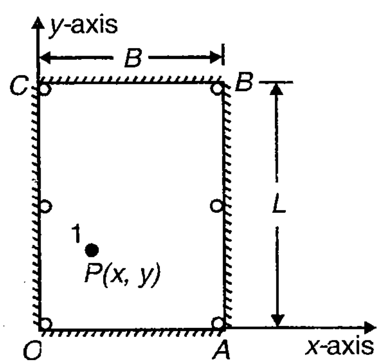
1. The percentage error in the measurement of extension by the micrometer is
   (1) Zero (2) 0.8%
   (3) 8% (4) 0.008%

2. Let R be the resolution of a particular measuring instrument in the above experiment, then select the correct alternative.
   (1) $R_{micrometer} > R_{screw\ gauge} > R_{scale}$
   (2) $R_{micrometer} < R_{screw\ gauge} < R_{scale}$
   (3) $R_{micrometer} = R_{screw\ gauge} < R_{scale}$.
   (4) $R_{micrometer} = R_{screw\ gauge} > R_{scale}$

3. The maximum error in the calculation of Young's modulus is
   (1) 1.09×10^{10} N/m^2
   (2) 0.09×10^{9} N/m^2
   (3) 0.05 N/m^2
   (4) 5 N/m^2

C4. The figure given below shows a billiard's table. One side of the table is taken along *x*-axis, whereas the other is along *y*-axis. When a billiard ball is hit, it moves in the *x–y* plane getting reflected from the edges. You can assume that the reflection of ball from an edge is like reflection of light from a plane mirror.

A billiard ball placed at point *P(x, y)* is given an initial velocity *v* making angle θ with *x*-axis (θ < 90°). There are four pockets at the four corners and two pockets in the middle of edges *AB* and *OC*. Answer the following questions



Choose the correct answer :

1. Taking the moment of projection of the ball as $t = 0$, the velocity vector of the ball after making two collisions can not be
   (1) $v\cos\theta\, i + v\sin\theta\, \hat{j}$
   (2) $-v\cos\theta\, \hat{i} - v\sin\theta\, \hat{j}$
   (3) $+v\cos\theta\hat{i} - \sin\theta\hat{j}$
   (4) All of these

2. If the ball goes into pocket 'A' after 3rd collision, the value of θ is
   (1) $\tan^{-1}\left(\dfrac{2L-y}{3B-x}\right)$ (2) $\tan^{-1}\left(\dfrac{2(L-y)}{3(B-x)}\right)$
   (3) 45° (4) $\tan^{-1}\left(\dfrac{y}{B-x)}\right)$

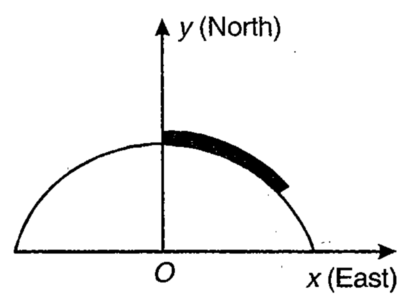
3. If the velocity of the ball after two collisions is $v\cos\theta\,\hat{i} + v\sin\theta\,\hat{j}$, then θ must be
   (1) $< \tan^{-1}\left(\dfrac{L-y}{2B-x}\right)$ (2) $> \tan^{-1}\left(\dfrac{L-y}{2B-x}\right)$
   (3) $< \tan^{-1}\left(\dfrac{L-y}{B-x}\right)$ (4) $> \tan^{-1}\left(\dfrac{L-y}{B-x}\right)$

C5. In a new system of units, let the units of force, energy and velocity be 5 N, 10 J and 100 ms^{-1} respectively. Then in this system

Choose the correct answer :

1. The unit of length is
   (1) 1 m (2) 2 m
   (3) 3 m (4) 4 m
2. The unit of mass is
   (1) 10^{-1} kg (2) 10^{-2} kg
   (3) 10^{-3} kg (4) 10^{-4} kg
3. The unit of time is
   (1) 0.1 s (2) 0.01 s
   (3) 0.2 s (4) 0.02 s

C6. Consider a chain of length ℓ with one end at the top most point of semicircle of radius *R*, lying in *x-y* plane with centre at origin.



Choose the correct answer :

1. The position vector that represents the lowermost point of the chain is
   (1) $R\left[\cos\left(\dfrac{\ell}{R}\right)\hat{i} + \sin\left(\dfrac{\ell}{R}\right)\hat{j}\right]$
   (2) $R\left[\sin\left(\dfrac{\ell}{R}\right)\hat{i} + \cos\left(\dfrac{\ell}{R}\right)\hat{j}\right]$
   (3) $R\left[\sin\left(\dfrac{\ell}{2R}\right)\hat{i} + \cos\left(\dfrac{\ell}{2R}\right)\hat{j}\right]$
   (4) $R\left[\cos\left(\dfrac{\ell}{2R}\right)\hat{i} + \sin\left(\dfrac{\ell}{2R}\right)\hat{j}\right]$

2. If the topmost part of chain reaches the initial position of the centre of chain in 1 s. The decrease in y-coordinate of the centre of the chain is

(1) $R\left[\cos\left(\frac{\ell}{R}\right)-\cos\left(\frac{\ell}{2R}\right)\right]$

(2) $R\left[\cos\left(\frac{\ell}{2R}\right)+\cos\left(\frac{\ell}{2R}\right)\right]$

(3) $R\left[\cos\left(\frac{\ell}{2R}\right)-\sin\left(\frac{\ell}{2R}\right)\right]$

(4) $R\left[-\cos\left(\frac{\ell}{R}\right)+\cos\left(\frac{\ell}{2R}\right)\right]$

3. The direction of the velocity of centre of chain just after being released is

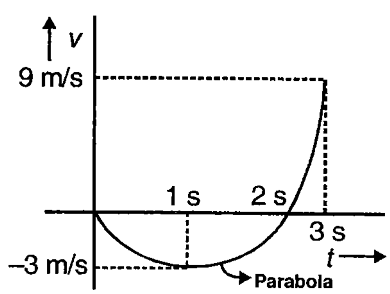
(1) $\theta=\left(\frac{\ell}{2R}\right)$ south of east

(2) $\theta=\left(\frac{\ell}{2R}\right)$ east of north

(3) $\theta=\left(\frac{\ell}{2R}\right)$ north of east

(4) $\theta=\left(\frac{\ell}{2R}\right)$ north of west

C7. A particle moves along x-axis. Its velocity time graphs is given below.



Choose the correct answer :

1. The displacement of the particle in 0 to 3 s

(1) Zero (2) 4 m
(3) 8 m (4) 12 m

2. The distance travelled by the particle in 0 to 3 s

(1) Zero (2) 4 m
(3) 8 m (4) 12 m

3. The particle changes its direction of acceleration, when

(1) $t < 1$ s (2) $t = 2$ s
(3) $t > 1$ s (4) $t \le 1$ s

C8. A particle moves along a straight line such that its velocity depends on time as $v = 4t - t^2$. For first five seconds

Choose the correct answer :

1. Average velocity of particle is

(1) $\frac{25}{3}$ m/s (2) $\frac{5}{3}$ m/s
(3) $\frac{10}{3}$ m/s (4) None of these

2. Average speed is

(1) 2 m/s (2) $\frac{25}{3}$ m/s
(3) $\frac{20}{3}$ m/s (4) $\frac{13}{5}$ m/s

3. a - v curve will be

(1) Straight line (2) Parabola
(3) Hyperbola (4) Exponential

C9. Two projectiles are projected simultaneously from the top and bottom of a vertical tower of height h at angles 45° and 60° above horizontal respectively. Both strike at the same point on ground at distance 20 m from the foot of the tower after same time.

Choose the correct answer :

1. The speed of projectile projected from the bottom is

(1) 40 m/s (2) $\frac{20}{\sqrt{3}}$ m/s
(3) $40\sqrt{3}$ m/s (4) $\frac{20}{\sqrt{\sqrt{3}}}$ m/s

2. The ratio of the speed of the projectile projected from the top and the speed of the projectile projected from the bottom of tower is

(1) $1 : \sqrt{2}$ (2) $1 : \sqrt{3}$
(3) $\sqrt{5} : 1$ (4) $\sqrt{7} : 1$

3. The time of flight of projectiles is

(1) $(3)^{\frac{1}{4}}$ (2) $2(3)^{\frac{1}{4}}$

(3) $3(3)^{\frac{1}{4}}$ (4) $4(3)^{\frac{1}{4}}$

C10. A particle in rectilinear motion is at origin at time $t = 0$. Velocity (v) of the particle is related to distance travelled (x) by the particle as

$$\underset{(\text{in m/s})}{v} = \underset{(x \text{ is in m})}{5x + 2}$$

Choose the correct answer :

1. Displacement of the particle in time t is

(1) $\frac{2}{5}(e^{5t} - 1)$ (2) $\frac{5}{2}(e^{5t} - 1)$

(3) $\frac{5}{2}\ell n(5t + 2)$ (4) None of these

2. Velocity of particle at $t = 0$ is

(1) 1 m/s (2) 0 m/s

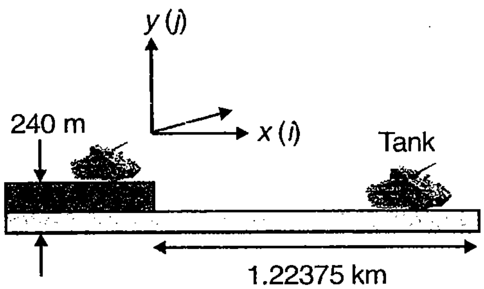
(3) 2 m/s (4) 3 m/s

3. Acceleration of particle at $t = 0$

(1) 5 m/s^2 (2) 10 m/s^2

(3) 15 m/s^2 (4) None of these

C11. An antitank gun is located on the edge of a plateau that is 240 m above a surrounding plain as shown in the figure. The gun crew sights an enemy tank stationary on the plain at a horizontal distance of 1.22375 km from the gun. At the same moment, the tank crew sees the gun and starts to move directly away from it with an acceleration of 0.5 m/s^2. The antitank gun fires a shell with a muzzle velocity (160 m/s)$\hat{i}$ + (10 m/s)$\hat{j}$.



Choose the correct answer :

1. What is the horizontal displacement of the shell in its flight?

(1) 1280 m (2) 2306.78 m

(3) 1000 m (4) 1223.75 m

2. How long should the gun crew wait before firing, if they are to hit the tank?

(1) 7 s (2) 8 s

(3) 15 s (4) 0

3. With what speed, does the shell hit the tank?

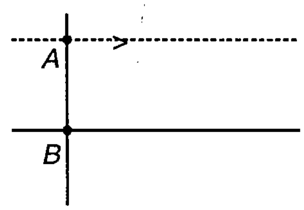
(1) Nearly 175 m/s

(2) Nearly 170 m/s

(3) Nearly 160 m/s

(4) Nearly 70 m/s

C12. Two particles A and B are situated at points (0, 0) and (0, a). The particle at A starts moving with speed u parallel to the x-axis. At the same time B also starts moving with velocity u such that it is always directed towards the particle B.



The position vector of A w.r.t. B is denoted by $\vec{r}$ and it is at angle θ from positive x-axis at any instant.

Choose the correct answer :

1. The angular velocity of A w.r.t. B at any instant is equal to

(1) $\frac{u\cos\theta}{r}$ (2) $\frac{u\sin\theta}{r}$

(3) $\frac{u(1-\cos\theta)}{r}$ (4) $\frac{u(1-\sin\theta)}{r}$

2. The rate at which the distance between the two particle is increasing with time, is equal to

(1) $u(\cos\theta - 1)$ (2) $u(1 - \cos\theta)$

(3) $u\sin\theta$ (4) $u(\sin\theta - 1)$

3. The radial distance between the two particles is related with θ according to equation

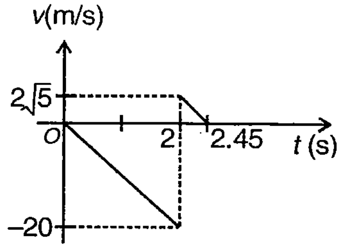
(1) $r = \frac{a}{2}\cos^2\frac{\theta}{2}$ (2) $r = \frac{a}{2}\sec^2\frac{\theta}{2}$

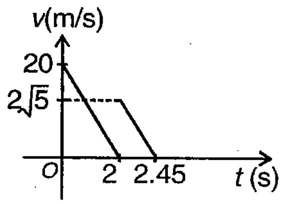
(3) $r = 2a\cos^2\frac{\theta}{2}$ (4) $r = \frac{a}{2}\text{cosec}^2\frac{\theta}{2}$

C13. A particle is dropped vertically from a height 20 m above the ground. It hits the ground and bounces up vertically to a height 10 m. Neglect subsequent motion and air resistance. Take upward direction as positive.

Choose the correct answer :

1. Velocity versus time graph is

(1)


(2)


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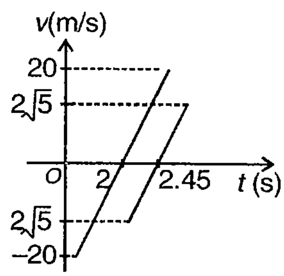

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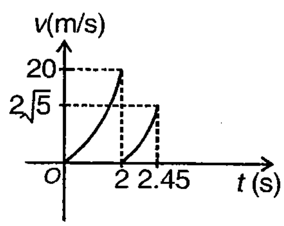
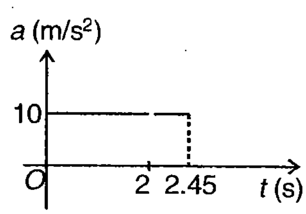
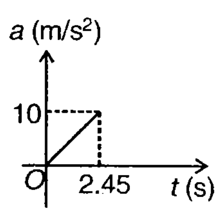
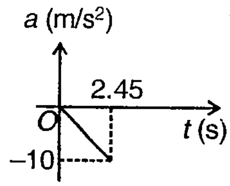


2. Acceleration versus time graph is

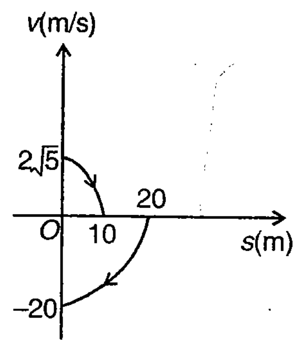
(1)


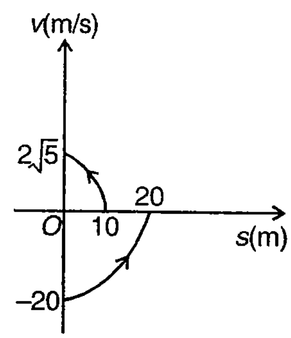
(2)


(3)

(4)


3. Velocity versus position graph is (taking origin on ground)

(1)


(2)


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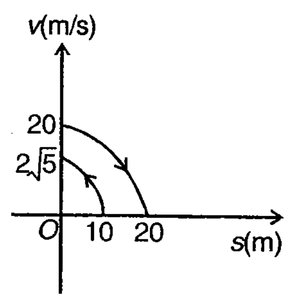
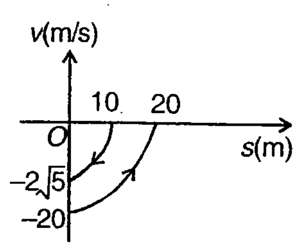
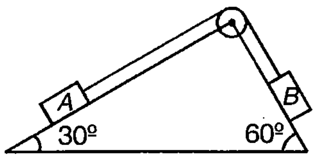


(4)


C14. Two blocks A and B of masses 10 kg and 12 kg respectively are kept on a rough wedge of inclination 30º and 60º respectively. The coefficient of friction between the block A and wedge is 0.6 while that between B and the wedge is 0.3. The blocks are connected by a light inextensible thread. The wedge is fixed with respect to ground.



Choose the correct answer :

1. The acceleration of block A is

(1) $\frac{6\sqrt{3}-5}{22}g$ up the plane

(2) $\frac{6.8-3\sqrt{3}}{22}g$ down the plane

(3) $\frac{5-3\sqrt{3}}{10}g$ down the plane

(4) Zero

2. Tension in the thread connecting A and B is (take g = 10 m/s²)

(1) 24.83 N (2) 85.92 N

(3) Zero (4) 55.79 N

3. Force of friction acting on the block A is (Take g = 10 m/s²)

(1) 35.92 N (2) 25.79 N

(3) 51.96 N (4) 54.83 N

C15. A block of mass m sits on the top of an identical block which sits on the top of a flat rough table. The coefficient of static friction between the surfaces of the blocks is μ_1 and coefficient of static friction between the block and table is μ_2.

Choose the correct answer :

1. A horizontal force F is applied to the top block only, and the force is increased until the top block starts to slide. The bottom block will slide with top block only if

(1) $\mu_1 < \frac{1}{2}\mu_2$ (2) $\frac{1}{2}\mu_2 < \mu_1 < \mu_2$

(3) $\mu_2 < \mu_1$ (4) $2\mu_2 < \mu_1$

2. Now instead, a horizontal force F is applied to the bottom block only and this force is increased until the bottom block just starts to slide. For the top block to slide with the bottom block

(1) $\frac{1}{2}\mu_2 < \mu_1 < \mu_2$ (2) $2\mu_2 < \mu_1$

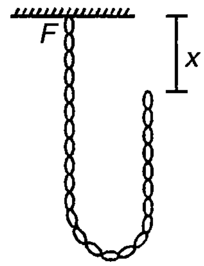
(3) $\mu_1 > 0$ (4) $\mu_2 < \mu_1$

3. If m = 5 kg; μ_1 = 0.6 and μ_2 = 0.2. Then the minimum force to be applied on the top block to induce motion in the system of blocks is (take g = 10 m/s²)

(1) 20 N (2) 17.14 N

(3) 19.61 N (4) 51.44 N

C16. The free end of the open-link chain of total length L and mass per unit length λ is released from rest at $x = 0$.



Choose the correct answer :

1. The thrust force at the lower end of non-moving part due to relative motion of other part as a function of x is

(1) $2\lambda gx$ (2) λgx

(3) $\sqrt{2}\lambda gx$ (4) Zero

2. The force on the fixed end F as a function of x is

(1) $\frac{\lambda Lg}{2}$ (2) $\frac{\lambda g}{2}(L+3x)$

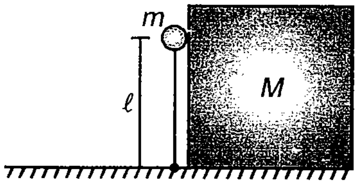
(3) $\frac{\lambda g}{2}(L+x)$ (4) $\frac{\lambda g}{2}(L+5x)$

3. The acceleration of the moving part is

(1) $\left(\frac{L+x}{L}\right)g$ (2) $\frac{g}{2}$

(3) g (4) $\left(\frac{L^2-x^2}{Lx}\right)g$

C17. A weightless rod of length ℓ with a small load of mass m at the end is hinged at point A and occupies a strictly vertical position, touching a body of mass M. A slight jerk sets the system in motion. Friction is neglected and $\ell = 0.2$ m.



Choose the correct answer :

1. At any instant before separation, the angle made by the rod with horizontal is θ. If acceleration of M is a and its velocity is v, then tangential acceleration of the small mass m is

   (1) Zero

   (2) $a_\tau = \frac{1}{\sin\theta}\left(a + \frac{v^2}{\ell}\cos\theta\right)$

   (3) $a_\tau = \frac{1}{\sin\theta}\left(a + \frac{v^2}{\ell\cos\theta}\right)$

   (4) $a_\tau = \frac{1}{\sin\theta}\left(a + \frac{v^2\cos\theta}{\ell\sin^2\theta}\right)$

2. The ratio $\frac{M}{m}$ for the two bodies (m and M) to separate at the instant $\theta = \frac{\pi}{6}$ is

   (1) 2 (2) 4

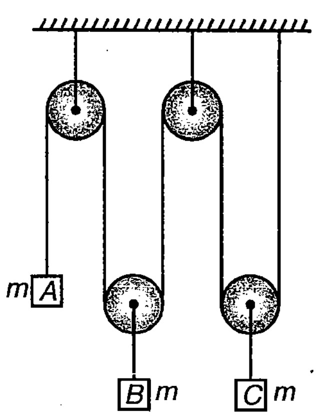
   (3) 1 (4) $\frac{1}{2}$

3. Velocity of the mass m at the moment of separation is

   (1) 2 m/s (2) 1 m/s

   (3) 0.25 m/s (4) 0.5 m/s

C18. Consider a system of three equal masses and 4 pulleys arranged as shown. The mass of each block is m



Choose the correct answer :

1. The acceleration of C is

   (1) $\frac{2g}{23}$ downwards (2) $\frac{2g}{23}$ upwards

   (3) $\frac{g}{4}$ upwards (4) $\frac{g}{9}$ upwards

2. Acceleration of B is

   (1) $\frac{2g}{9}$ (2) $\frac{g}{4}$

   (3) $\frac{7g}{9}$ (4) $\frac{g}{9}$

3. Tension in the single thread runing through all the pulleys is

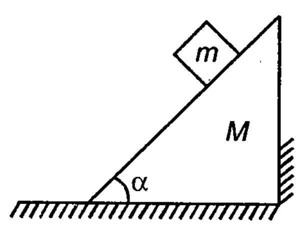
   (1) $\frac{5}{9}mg$ (2) $\frac{25}{23}mg$

   (3) $\frac{3}{4}mg$ (4) $\frac{7}{9}mg$

C19. A body with a mass m slides along the surface of a trihedral prism of mass M, whose upper plane is inclined at an angle α to the horizontal. The prism rests on a horizontal plane having a vertical wall at the rear edge of the prism to keep it at rest.

Choose the correct answer :

1. The force exerted by the base of the prism on the horizontal plane is



   (1) Mg (2) mg

   (3) $Mg + mg\sin^2\alpha$ (4) $Mg + mg\cos^2\alpha$

2. The force exerted by the wall on prism

   (1) Mg (2) mg

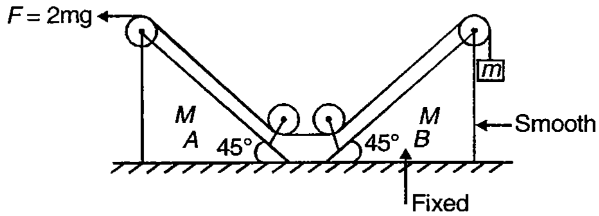
   (3) $mg\cos\alpha$ (4) $mg\sin\alpha\cos\alpha$

3. The normal reaction on the block is

   (1) mg (2) Mg

   (3) $mg\cos\alpha$ (4) $mg\sin\alpha\cos\alpha$

C20. Consider the arrangement shown in figure. Two identical wedges of same mass, one is fixed and another is movable are placed on smooth surface. All strings are massless. The pulleys are light and smooth.



Choose the correct answer :

1. Find the acceleration of wedge A

(1) Zero (2) $\frac{2m}{M}$

(3) $\frac{m}{M}$ (4) $\frac{m}{2M}$

2. Find the acceleration of hanging block

(1) g (2) $2g$

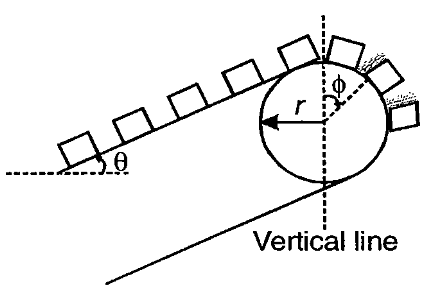
(3) $\frac{g}{3}$ (4) $\frac{g}{4}$

3. Force exerted by hinge on pulley on the wedge A is

(1) $(2\sqrt{2+\sqrt{2}})mg$ (2) $(2\sqrt{2-\sqrt{2}})mg$

(3) $(2+\sqrt{2})mg$ (4) $(2-\sqrt{2})mg$

C21. The figure given below shows an arrangement in which a conveyor belt is used to move packages of weight w each. The coefficient of friction between the packages and the belt is μ. Radius of the pulley is r. At present the arrangement lies at rest, when switched on, the conveyor belt acquires a velocity v_0 in a small time t_0 and then moves with a constant velocity thereafter.



Choose the correct answer :

1. The minimum value of time t_0 for the speeding up of the belt, if none of the packages slips on the belt is

(1) $\frac{v_0}{g(\cos\theta-\mu\sin\theta)}$

(2) $\frac{v_0}{g(\cos\theta+\mu\sin\theta)}$

(3) $\frac{v_0}{g(\sin\theta-\mu\cos\theta)}$

(4) $\frac{v_0}{g(\sin\theta)}$

2. As the packages move over the pulley and cross the vertical line

(1) They will slip on the belt before leaving contact

(2) They will leave contact before slipping on the belt

(3) They will neither slip nor leave contact with the belt

(4) They will start slipping and leave contact with the belt simultaneously

3. The value of ϕ at which the packages slip off the belt is

(1) $\cos^{-1}\left(\frac{\mu v_0^2}{rg\sqrt{1+\mu^2}}\right)+\tan^{-1}\left(\frac{1}{\mu}\right)$

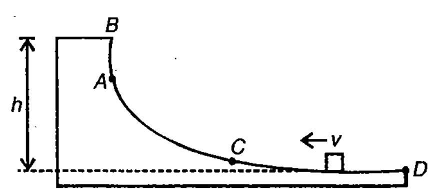
(2) $\cos^{-1}\left(\frac{\mu v_0^2}{rg\sqrt{1+\mu^2}}\right)-\tan^{-1}\left(\frac{1}{\mu}\right)$

(3) $\cos^{-1}\left(\frac{rg\sqrt{1+\mu^2}}{\mu v_0^2}\right)+\tan^{-1}(\mu)$

(4) $\cos^{-1}\left(\frac{rg\sqrt{1+\mu^2}}{\mu v_0^2}\right)-\tan^{-1}(\mu)$

C22. A small body of mass m is placed over a larger mass M whose surface is horizontal near the smaller mass and gradually curves to become vertical. The smaller mass is pushed on the longer one with a speed v and the system is left to itself

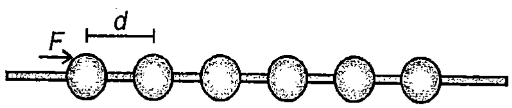
Given $M = 5$ kg
$m = 2$ kg
$v = 7$ m/s
$h = 0.7$ m
$g = 10$ m/s²



Choose the correct answer :

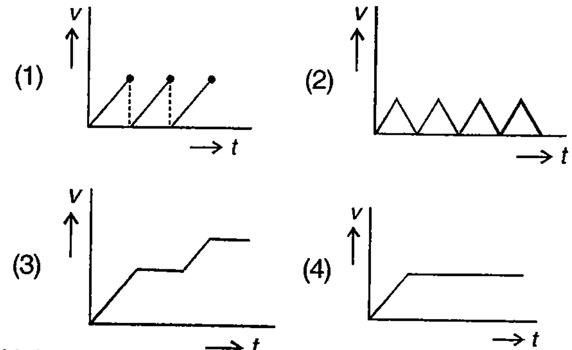
1. While the smaller mass moves on the completely vertical part i.e. AB, the speed of the larger mass
   (1) Increases with increasing height of smaller mass
   (2) Decreases with increasing height of smaller mass
   (3) First increases and when the smaller mass loses contact it becomes uniform
   (4) Remains the same
2. The speed of the smaller mass at the instant it loses contact with the larger mass is
   (1) $\sqrt{21}$ m/s (2) 2 m/s
   (3) 7 m/s (4) $\sqrt{35}$ m/s
3. The maximum height achieved by the smaller mass is
   (1) 0.7 m (2) 1.56 m
   (3) 1.75 m (4) 2 m

C23. Beads of equal mass are strung on a long horizontal wire. The beads are initially at rest but can move without friction. One of the beads (terminal) is continuously accelerated by a constant force F. The mass of each bead is m and the initial separation between consecutive beads is d

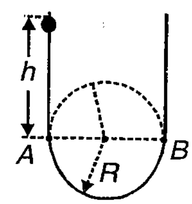


Choose the correct answer :

1. If the collision of the beads are perfectly inelastic, after a long time, the front of the shock wave acquires a constant speed. This speed is
   (1) $\sqrt{\frac{2Fd}{m}}$ (2) $\sqrt{\frac{Fd}{m}}$
   (3) $\sqrt{\frac{Fd}{2m}}$ (4) $\sqrt{\frac{Fd}{9m}}$
2. If the collision of beads is perfectly elastic then
   I. Several shock waves propagate one after the other
   II. Each bead comes to rest momentarily after collision
   III. Each bead between two successive collisions is uniformly accelerated
   IV. Average speed of first bead between two successive collisions is $\sqrt{\frac{Fd}{m}}$
   (1) I only (2) III only
   (3) I & II only (4) I, II & IV
3. The speed time graph of the first bead (under the action of F) is best represented by



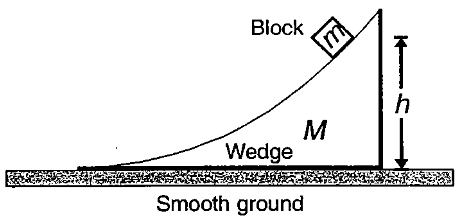
C24. A U shaped smooth wire has a smooth semi-circular bend between A and B as shown. A bead of mass m is released from a height h on one side of wire above point A and it reaches same height on other side. The speed of particle between A and B remains constant ($h >> R$).



Choose the correct answer :

1. Change in magnitude of velocity of bead between point A and B is
   (1) $\sqrt{8gh}$ (2) $\sqrt{4gh}$
   (3) $\sqrt{2gh}$ (4) Zero
2. Time taken by bead to move between points A and B is
   (1) $\frac{\pi R}{\sqrt{2gh}}$ (2) $\frac{\pi R}{2\sqrt{2gh}}$
   (3) $\frac{\pi R}{\sqrt{3gh}}$ (4) $\frac{R}{\sqrt{2gh}}$
3. The average force exterted by the bead on the part AB of the wire is
   (1) $\frac{4\,mgh}{\pi R}$ (2) $\frac{2\,mgh}{\pi R}$
   (3) $\frac{mgh}{\pi R}$ (4) $\frac{5\,mgh}{\pi R}$

C25. A block of mass m slides down a wedge of mass M as shown. The whole system is at rest, when the height of the block is h above the ground. The wedge surface is smooth and gradually flattens. There is no friction between wedge and ground.



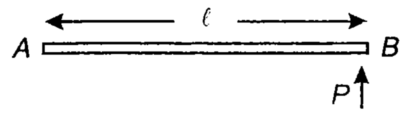
Choose the correct answer :

1. As the block slides down, which of the following quantities associated with the system remains conserved?
   (1) Total linear momentum of the system of wedge and block
   (2) Total mechanical energy of the complete system
   (3) Total kinetic energy of the system
   (4) Both linear momentum as well as mechanical energy of the system

2. If there would have been friction between wedge and block, which of the following quantities would still remain conserved?
   (1) Linear momentum of the system along horizontal direction
   (2) Linear momentum of the system along vertical direction
   (3) Linear momentum of the system along a tangent to the curved surface of the wedge
   (4) Mechanical energy of the system

3. If there is no friction any where, the speed of the wedge, as the block leaves the wedge, is
   (1) $m\sqrt{\dfrac{2gh}{(M+m)M}}$
   (2) $M\sqrt{\dfrac{2gh}{(M+m)m}}$
   (3) $(\sqrt{2gh})\dfrac{m}{M+m}$
   (4) $(\sqrt{2gh})\dfrac{M}{M+m}$

C26. A uniform rod of mass m & length ℓ is at rest on smooth horizontal surface. An impulse 'P' is applied to end B as shown



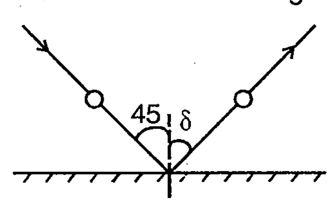
Choose the correct answer :

1. The point about which rod rotates just after impulse being applied is located at
   (1) $\dfrac{\ell}{3}$ from A (2) $\dfrac{\ell}{6}$ from A
   (3) $\dfrac{\ell}{2}$ from A (4) $\dfrac{\ell}{4}$ from A

2. Distance travelled by centre of rod, while rod rotates by 90º is
   (1) $\dfrac{\pi\ell}{4}$ (2) $\dfrac{\pi\ell}{6}$
   (3) $\dfrac{\pi\ell}{12}$ (4) $\dfrac{\pi\ell}{5}$

3. Time taken by rod to turn through right angle is
   (1) $\dfrac{2\pi m\ell}{P}$ (2) $\dfrac{2\pi P}{m\ell}$
   (3) $\dfrac{\pi P}{m\ell}$ (4) $\dfrac{\pi m\ell}{12P}$

C27. An elastic spherical ball of mass $M = 2$ kg & radius $a = 20$ cm moving with velocity $v = 4$ m/s strikes a rigid surface at an angle 45º to the normal. It skids while in contact with surface. The ratio of tangential frictional force to that of normal reaction is $\dfrac{1}{2}$. The component of velocity perpendicular to surface is reversed in direction without change in magnitude



Choose the correct answer :

1. At what possible angles ball can rebound to the normal?
   (1) $\tan^{-1} 2$, 30º (2) $\tan^{-1} 2$, zero
   (3) 30º, 45º (4) $\tan^{-1} 2$, 60º

2. Speeds with which ball can rebound from surface?

(1) $\sqrt{2},\ 2\sqrt{10}$ (2) $2\sqrt{2},\ \sqrt{2}$

(3) $2\sqrt{10},\ 2\sqrt{2}$ (4) $\sqrt{2},\ \sqrt{2}$

3. Change in angular velocity of ball after collision

(1) Zero (2) $10\sqrt{2}$

(3) $20\sqrt{2}$ (4) $25\sqrt{2}$

C28. A uniform disc and a solid sphere both of mass M and radius R are projected horizontally with velocity V_0 on a rough horizontal floor so that both start with purely sliding motion at $t = 0$. After some time, they acquire purely rolling motion.

Choose the correct answer :

1. Ratio of velocity of disc to solid sphere, when they acquire purely rolling state, is

(1) $\frac{14}{15}$ (2) $\frac{10}{21}$

(3) $\frac{2}{3}$ (4) $\frac{5}{7}$

2. Ratio of time taken by them to aquire pure rolling is

(1) $\frac{7}{6}$ (2) $\frac{6}{7}$

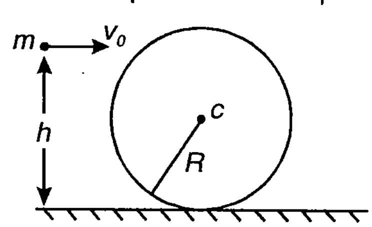
(3) $\frac{5}{7}$ (4) $\frac{7}{5}$

3. Ratio of works respective done by frictional force on the disc and sphere is

(1) $\frac{6}{7}$ (2) $\frac{5}{7}$

(3) $\frac{7}{6}$ (4) $\frac{6}{5}$

C29. The sphere shown in figure lies on a rough plane. A particle of mass m travelling at speed v_0 collides & sticks with it. The line of motion of particle is at distance h above plane. Mass of sphere is M.



Choose the correct answer :

1. Linear speed of combined system just after collision is

(1) $\frac{Mv_0}{m}$ (2) $\frac{mv_0}{M}$

(3) $\frac{mv_0}{M+m}$ (4) v_0

2. Angular speed of system about centre of sphere just after collision is (Assume $M > m$)

(1) $\frac{mv_0(h-R)}{\left(\frac{2}{5}M+m\right)R^2}$ (2) $\frac{Mv_0R}{(M+m)(R+h)^2}$

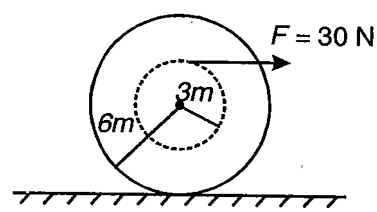
(3) $\frac{Mv_0(h-R)}{\left(\frac{2}{5}M+m\right)R^2}$ (4) $\frac{v_0}{R}$

3. Assuming that $M >> m$, find value of h such that sphere starts rolling

(1) $\frac{8R}{5}$ (2) $\frac{9R}{5}$

(3) $\frac{6R}{5}$ (4) $\frac{7R}{5}$

C30. A homogenous cylinder has mass $M = 10$ kg & radius $R = 6$ m. It is accelerated by a force of 30 N as shown in figure. Coefficient of friction is sufficient for cylinder to roll without slipping.



Choose the correct answer :

1. Coefficient of friction when μ is increased then, force of friction

(1) 0 N (2) 1 N

(3) 2 N (4) 3 N

2. Acceleration of the cylinder is

(1) 0 m/s² (2) 1 m/s²

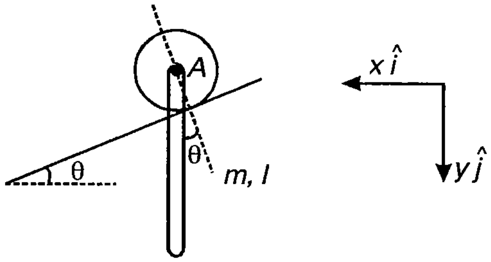
(3) 2 m/s² (4) 3 m/s²

3. Angular acceleration of the cylinder is

(1) 1 rad/s² (2) $\frac{1}{2}$ rad/s²

(3) $\frac{3}{4}$ rad/s² (4) Zero

C31. A slender rod of mass '*m*' and length *l* is released from rest in the vertical position. The rod is connected at point *A* to a small massless roller resting on the smooth incline



Let $\vec{a}_{cm}$ be the acceleration of centre of mass of the rod just after being released and $\vec{a}_A$ be the acceleration of end *A* at this moment. Take the axes as shown in figure.

Choose the correct answer :

1. A unit vector in the direction of acceleration of centre of mass will be

   (1) $\cos\theta\hat{i} + \sin\theta\hat{j}$

   (2) $-\cos\theta\hat{i} + \sin\theta\hat{j}$

   (3) $-\cos\theta\hat{i} - \sin\theta\hat{j}$

   (4) A vector other than the above three

2. The acceleration of end *A* $(\vec{a}_A)$ and the acceleration of centre of mass $(\vec{a}_{cw})$ can be related as

   (1) $\vec{a}_A = \vec{a}_{cm} + \frac{L}{2}\left|\frac{d^2\theta}{dt^2}\right|\hat{i}$

   (2) $\vec{a}_A = \vec{a}_{cm} - \left|\frac{L}{2}\frac{d^2\theta}{dt^2}\right|\hat{i}$

   (3) $\vec{a}_A = -\vec{a}_{cm} + \left|\frac{L}{2}\frac{d^2\theta}{dt^2}\right|\hat{i}$

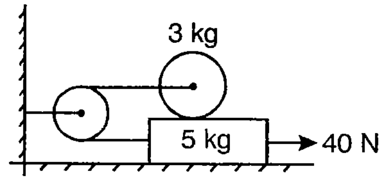
   (4) $\vec{a}_A = -\vec{a}_{cm} - \left|\frac{L}{2}\frac{d^2\theta}{dt^2}\right|\hat{i}$

3. Let α be the magnitude of initial angular acceleration of the rod and a_x, a_y be the components of acceleration of centre of mass of the rod at the instant of release, then

   (1) $\tan\theta = \frac{a_y}{a_x}$ (2) $\tan\theta = \frac{a_y}{a_x + \frac{L}{2}\alpha}$

   (3) $\tan\theta = \frac{a_x}{a_y}$ (4) $\tan\theta = \frac{a_x + \frac{L}{2}\alpha}{a_y}$

C32. In the figure shown a force of 40 N is applied on the plank of mass 5 kg. A solid sphere of mass 3 kg rolls without slipping on plank



Choose the correct answer :

1. Acceleration of plank is

   (1) $\frac{20}{13}$ m/s^2 (2) $\frac{30}{13}$ m/s^2

   (3) $\frac{40}{13}$ m/s^2 (4) $\frac{83}{20}$ m/s^2

2. Find coefficient of friction just needed to have sphere rolling on plank

   (1) 0.2 (2) 0.33

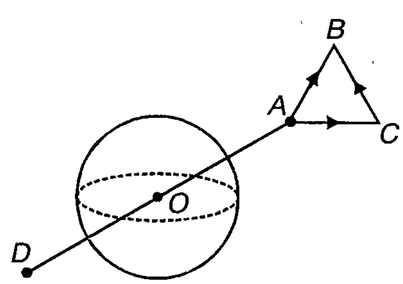
   (3) 0.1 (4) 0.55

3. Tension in string is

   (1) 25 N (2) 34.47 N

   (3) 20.72 N (4) 10 N

C33. Consider a uniform solid sphere of mass *M* and radius *R* centered at *O*. *AD* is a straight line passing through *O*, such that *OA* = *OD*. *ABC* is an equilateral triangle. A particle of mass *m* at point *A* is slowly moved to point *B*. Work done in moving the particle via straight path *AB* is w_1. Work done in moving the particle via path *A* - *C* - *B* is w_2.



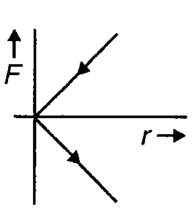
Choose the correct answer :

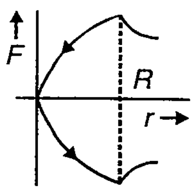
1. Gravitational potential difference between points *A* and *B* is

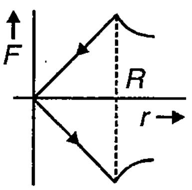
   (1) $\frac{w_1 + 2w_2}{m}$ (2) $\frac{w_1 + w_2}{2m}$

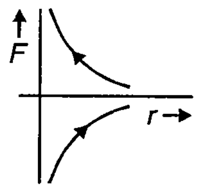
   (3) $\frac{2w_1 + w_2}{m}$ (4) $\frac{2(w_1 + w_2)}{m}$

2. The particle is now taken from A to D via straight path (assume a tunnel through the solid sphere). If the particles has been moved slowly, the best graph showing variation of force F that has to be applied with distance r from the centre is

(1) 

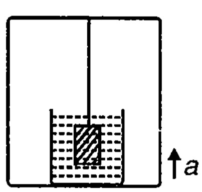
(2) 

(3) 

(4) 

3. Work done by the gravitational force if the particle is taken from A to D via any path, different from AOD
   (1) Must be positive
   (2) May be positive
   (3) Is zero
   (4) May be zero, positive or negative

C34. A cube of mass 3 kg is suspended from the ceiling of a lift and immersed in a vessel containing water as shown in the figure. If lift is moving with constant speed, tension in the string tied to the boject is 25 N. Take $g = 10$ m/s^2



Choose the correct answer :

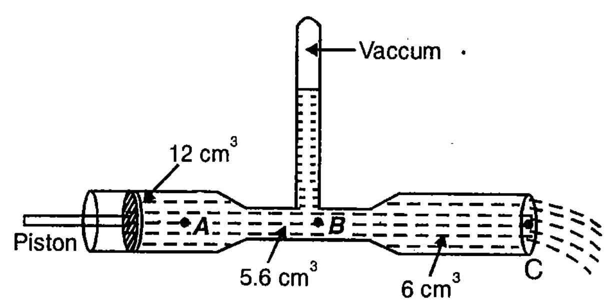
1. Length of edge of cube is approximately
   (1) 7 cm (2) 8 cm
   (3) 9 cm (4) 10 cm
2. If the lift is accelerating upward with 2 m/s^2, the tension in the string is
   (1) 20 N (2) 30 N
   (3) 25 N (4) 40 N
3. If the lift is falling freely, tension in string is
   (1) 25 N (2) 20 N
   (3) 30 N (4) Zero

C35. A cylinder has a diameter d, length l and specific gravity ($S < 1$). It displaces weight W per unit volume when immersed to certain depth in water

Choose the correct answer :

1. Centre of buoyancy is at a distance from bottom of cylinder given by
   (1) $\frac{Sl}{2}$ (2) Sl
   (3) $2Sl$ (4) $\frac{2}{3}Sl$
2. Time period of small vertical oscillations of this cylinder is
   (1) $\pi\sqrt{\frac{Sl}{g}}$ (2) $\pi\sqrt{\frac{Sl}{2g}}$
   (3) $2\pi\sqrt{\frac{Sl}{g}}$ (4) $2\pi\sqrt{\frac{2Sl}{g}}$
3. For the condition of stable equilibrium metacentre should be
   (1) At lower level than C.G
   (2) At higher level than C.G
   (3) Any where
   (4) At the level of C.D

C36. The glass tube has three different cross-sectional areas with the values indicated. The liquid used is mercury ($\rho = 1.36 \times 10^4$ kg/m^3) that flows with a speed of 8 m/s at cross-section C. It is given that $P_{atm} = 1.01 \times 10^5$ Pa and $g = 10$ m/s^2.



Choose the correct answer :

1. What is the speed of mercury at the point A?
   (1) 2 m/s (2) 4 m/s
   (3) 8 m/s (4) 12 m/s

2. The height of mercury in the monometer is
   (1) 136 mm (2) 169 mm
   (3) 272 mm (4) 366 mm
3. The magnitude of the force exerted by the mercury on the piston is
   (1) 512.4 N (2) 51.24×10^5 N
   (3) 2.72×10^3 N (4) 1024.8 N

C37. At low speeds, the resistive viscous force in a liquid can be expressed as

$R = -bv$

Here v is the velocity and b is a +ve constant dependent upon properties of medium and body.

Consider a mass m released from rest in a liquid. The only forces are R and weight mg. Neglecting buoyant force, the equation of motion can be described as

$$mg - bv = \frac{mdv}{dt} \Rightarrow \frac{dv}{dt} = g - \frac{b}{m}v$$

On soiving, $v = \frac{mg}{b}(1 - e^{-bt/m})$

When $mg = bv_T$, acceleration becomes zero. This speed is called terminal velocity.

$$v_T = \frac{mg}{b}$$

$\Rightarrow v = v_T(1 - e^{-bt/m})$

In an experimental setup, four objects were released. Following observations were made.

	I	II	III	IV
Mass(kg)	1	2	3	4
b(S.I. unit)	3.7	1.4	1.4	2.8

Choose the correct answer :

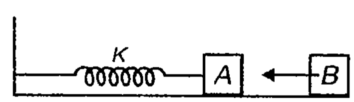
1. Which object would acquire half of their respective terminal speed in minimum time, if all were released simultaneously?
   (1) I (2) II
   (3) III (4) IV
2. Which object will have maximum terminal speed?
   (1) I (2) II
   (3) III (4) IV
3. If buoyancy force were taken into account, then value of terminal speed would have
   (1) Decreased (2) Increased
   (3) Remain same (4) Can't say

C38. A capillary tube of radius r is lowered into a liquid of surface tension T and density ρ. Given angle of contact is zero.

Choose the correct answer :

1. The work done by surface tension will be
   (1) $\frac{\pi T^2}{\rho g}$ (2) $\frac{4\pi T^2}{\rho g}$
   (3) $\frac{T^2}{\rho g}$ (4) $\frac{2T^2}{\rho g}$
2. What is the potential energy acquired by the liquid in the capillary?
   (1) $\frac{\pi T^2}{2\rho g}$ (2) $\frac{T^2}{2\rho g}$
   (3) $\frac{T^2}{\rho g}$ (4) $\frac{2\pi T^2}{\rho g}$
3. What force must be applied to detach two wetted photographic plates 9 cm × 12 cm in size from each other without shifting them. The thickness of water between the plate is 0.05 mm. Surface tension of water is 0.0073 N/m
   (1) 31.5 N (2) 16.5 N
   (3) 40.5 N (4) 20.0 N

C39. A block A of mass 1 kg connected with a spring of spring constant 10 N/m is executing SHM. The displacement time equation of block is $x = 8 + 4 \sin(100t)$. An identical block B moving towards negative x-axis with velocity 10 m/s collides elastically with block A at time $t = 0$



Choose the correct answer :

1. Displacement time equation of A after collision is
   (1) $x = 8 - 0.1 \sin(100t)$ (2) $x = 8 - 2\sin(100t)$
   (3) $x = 8 - 4\sin(100t)$ (4) $x = 8 + \sin(100t)$
2. New amplitude of oscillation of block A is
   (1) 0.1 unit (2) 0.2 unit
   (3) 0.3 unit (4) 0.4 unit

3. Velocity of block B just after collision is
   (1) 100 m/s (2) 200 m/s
   (3) 300 m/s (4) 400 m/s

C40. A particle is subjected to two SHM's. One along x-axis and other along a line making angle 60° with x-axis. The two motions are given by

$x = 3\sin(10t)$ $s = 4\sin(10t)$

Choose the correct answer :

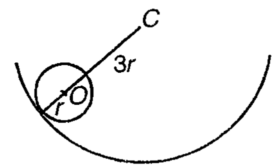
1. Amplitude of resultant motion is
   (1) 5 unit (2) $\sqrt{37}$ unit
   (3) $\sqrt{17}$ unit (4) 7 unit
2. Maximum velocity of particle is
   (1) $10\sqrt{17}$ unit (2) 50 unit
   (3) 70 unit (4) $10\sqrt{37}$ unit
3. Phase difference of resultant SHM w.r.t. $x = 3\sin 10t$ at $t = 0$ is
   (1) $\tan^{-1}\left(\frac{\sqrt{3}}{5}\right)$ (2) $\tan^{-1}\left(\frac{5}{\sqrt{3}}\right)$
   (3) $\tan^{-1}\left(\frac{2\sqrt{3}}{5}\right)$ (4) Zero

C41. A spring of spring constant 10 N/m is fixed at two ends in underformed state on a horizontal surface. A 10 gm mass is attached to the spring at distance (from one end) equal to one third length of the spring

Choose the correct answer :

1. Regarding longitudinal oscillation of the 10 gm mass equivalent force constant of arrangement
   (1) 5 N/m (2) 2.5 N/m
   (3) 45 N/m (4) 7.5 N/m
2. If the mass is displaced slightly, the time-period of small longitudinal oscillations is approximately
   (1) 0.1 s (2) 0.2 s
   (3) 0.3 s (4) 0.4 s
3. Suppose the spring is having a tensile force of 1 N when mass is in equilibrium at one third distance from one end and its total length is 9 cm. If mass is displaced slightly then the time-period of small transverse oscillations is
   (1) 4.44×10^{-1} s (2) 8.88×10^{-1} s
   (3) 4.44×10^{-2} s (4) 8.88×10^{-2} s

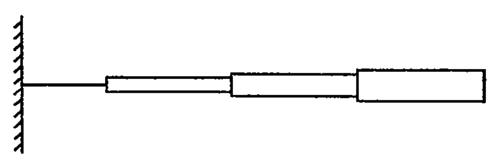
C42. A solid sphere of radius r, mass M rolls without slipping in hemispherical bowl of radius $3r$.



Choose the correct answer :

1. If angular velocity of sphere about O is ω, then angular velocity of sphere about C is
   (1) ω (2) $\frac{\omega}{2}$
   (3) Zero (4) 2ω
2. Angular frequency of sphere about C is
   (1) $\sqrt{\frac{30g}{7r}}$ (2) $\sqrt{\frac{5g}{7r}}$
   (3) $\sqrt{\frac{15g}{7r}}$ (4) $\sqrt{\frac{5g}{14r}}$
3. For small angular displacements, time period of sphere oscillating in bowl is
   (1) $2\pi\sqrt{\frac{30g}{7r}}$ (2) $2\pi\sqrt{\frac{5g}{7r}}$
   (3) $2\pi\sqrt{\frac{7r}{15g}}$ (4) $2\pi\sqrt{\frac{14r}{5g}}$

C43. Four pieces of string each of length L are joined end to end to make a long string of length 4 L. The linear mass density of strings are μ, 4 μ, 9 μ & 16 μ respectively. One end of the combined string is tied to fixed support and the string is stretched to a tension F. A transverse wave has been generated at other end having frequency f (Ignore any reflections and absorptions)



Choose the correct answer :

1. The time taken by wave to reach from source end to fixed end is
   (1) $\frac{25}{12}\frac{L}{\sqrt{\frac{F}{\mu}}}$ (2) $\frac{10L}{\sqrt{\frac{F}{\mu}}}$
   (3) $\frac{4L}{\sqrt{\frac{F}{\mu}}}$ (4) $\frac{L}{\sqrt{\frac{F}{\mu}}}$

2. Find ratio of wavelengths of waves on four strings, starting from right hand side is

(1) 12 : 6 : 4 : 3 (2) 4 : 3 : 2 : 1

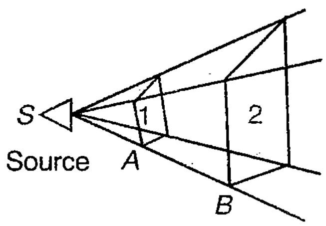
(3) 3 : 4 : 6 : 12 (4) 1 : 2 : 3 : 4

3. The rate at which energy is transferred is maximum for string having mass density

(1) μ (2) 4μ

(3) 9μ (4) 16μ

C44. In the figure shown, a source having power 12×10^{-6} W is kept at O, which is emitting sound waves in all directions. Two surfaces are labelled as 1 & 2 having areas $A_1 = 2 \times 10^3\ m^2$ and $A_2 = 4 \times 10^3\ m^2$ respectively. The distance of the source is large as compared to the area of the surfaces.



Choose the correct answer :

1. The intensities at the two surfaces are respectively

(1) $I_1 = 12 \times 10^{-6}\ W/m^2$, $I_2 = 12 \times 10^{-6}\ W/m^2$

(2) $I_1 = 6 \times 10^{-9}\ W/m^2$, $I_2 = 12 \times 10^{-9}\ W/m^2$

(3) $I_1 = 6 \times 10^{-9}\ W/m^2$, $I_2 = 3 \times 10^{-9}\ W/m^2$

(4) $I_1 = 12 \times 10^{-9}\ W/m^2$, $I_2 = 3 \times 10^{-9}\ W/m^2$

2. If two persons A & B having same physique are standing at location 1 & 2, then who will hear quieter sound

(1) Both will hear same sound

(2) A will hear quieter sound

(3) B will hear quieter sound

(4) Information is not sufficient

3. If area of ear drum of A is 2 mm^2 & that of B is 4 mm^2, then

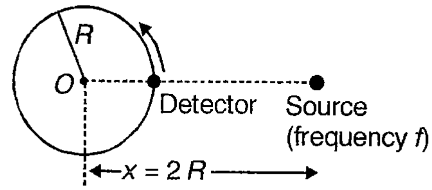
(1) A will hear quieter sound

(2) B will hear quieter sound

(3) Both hear same sound

(4) Can't say anything

C45. A source of sound & detector are shown in figure. The detector is moving along a circle with constant angular speed ω. It starts from shown location in anticlockwise direction at $t = 0$. Velocity of sound is v



Choose the correct answer :

1. What is frequency received by detector, when it rotates by an angle $\frac{\pi}{2}$

(1) f (2) $\left(\frac{v - \omega R}{v}\right) f$

(3) $\left(\frac{v - \frac{\omega R}{2}}{v}\right) f$ (4) $\left(\frac{v - \frac{\omega R \times 2}{\sqrt{5}}}{v}\right) f$

2. The time when detector will hear maximum frequency for first time is

(1) $\frac{\pi}{3\omega}$ (2) $\frac{5\pi}{3\omega}$

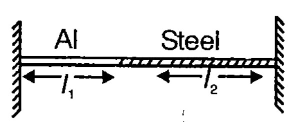
(3) $\frac{4\pi}{3\omega}$ (4) $\frac{\pi}{\omega}$

3. The time interval between maximum & minimum frequencies received by detector is

(1) $\frac{\pi}{3\omega}$ (2) $\frac{5\pi}{3\omega}$

(3) $\frac{4\pi}{3\omega}$ (4) $\frac{\pi}{\omega}$

C46. There is a composite wire of aluminium and steel having uniform cross-section (A) throughout. The composite wire is in stretched condition with tension T.



$l_1 = \frac{2}{\sqrt{3}} m$ $T = 100$ N

$l_2 = 1$ m $A = 10^{-2}$ cm^2

density of aluminium = 2.60 gm cm^{-3}

density of steel = 7.80 gm cm^{-3}

Choose the correct answer :

1. The lowest frequency of external source to strike resonance in composite wire with the junction as a node is

(1) 150 Hz (2) 170 Hz

(3) 210 Hz (4) 270 Hz

2. How many total nodes are formed on the composite string if the string is resonating in the way as described in above question?

(1) 3 (2) 5

(3) 6 (4) 8

3. If the maximum amplitude is 2 mm of steel wire, what is amplitude at a distance of $\frac{1}{12}$ m leftward from the fixed end of the steel wire?

(1) 2 mm (2) $\sqrt{2}$ mm

(3) 1 mm (4) $\frac{1}{\sqrt{2}}$ mm

C47. A person standing between a pair of tall wide cliffs claps his hands. He hears first two echos at 2 s & 3 s respectively. If speed of sound is 330 m/s, then

Choose the correct answer :

1. Separation between cliffs is

(1) 800 m (2) 825 m

(3) 850 m (4) 875 m

2. Time of third echo is

(1) 5 s (2) 4 s

(3) 6 s (4) 7 s

3. Loudest echo is

(1) 4th echo (2) 3rd echo

(3) 2nd echo (4) 10th echo

C48. A copper rod of unit length held between two rigid supports is heated to bring a temperature change of 20°C.

If $Y = 1.3 \times 10^{11}$ N/m^2, $\alpha = 1.7 \times 10^{-5}$ /°K & $\rho = 9 \times 10^3$ kg/m^3, then

Choose the correct answer :

1. Velocity of transverse wave in the rod is

(1) 40 m/s (2) 50 m/s

(3) 60 m/s (4) 70 m/s

2. Fundamental frequency of the wave is

(1) 35 Hz (2) 30 Hz

(3) 40 Hz (4) 25 Hz

3. For what minimum length, frequency of wave is 70 Hz?

(1) 1 m (2) 0.5 m

(3) 1.5 m (4) 2 m

C49. Microwave sent in space are reflected from a distant aeroplane moving towards the radar. The received frequency beats f Hz with that sent out. If wavelength sent is λ m, then

Choose the correct answer :

1. Frequency reflected by aeroplane is

(1) More than original

(2) Less than original

(3) Remains unchanged

(4) Can't say

2. Beat frequency will be, if velocity of plane is 200 m/s

(1) $\frac{200}{\lambda}$ (2) $\frac{400}{\lambda}$

(3) $\frac{100}{\lambda}$ (4) $\frac{300}{\lambda}$

3. Beat frequency, which can be sensed is

(1) > 10 Hz (2) < 10 Hz

(3) = 10 Hz (4) None of these

(IIT-JEE 2010)

49(a). A stationary source is emitting sound at a fixed frequency f_0, which is reflected by two cars approaching the source. The difference between the frequencies of sound reflected from the cars is 1.2% of f_0. What is the difference in the speeds of the cars (in km per hour) to the nearest integer? The cars are moving at constant speeds much smaller than the speed of sound which is 330 ms^{-1}.

❑ ❑ ❑

SECTION - D

Assertion - Reason Type

This section contains 128 questions. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Instructions for Assertion - Reason Type questions :

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

Choose the correct answer :

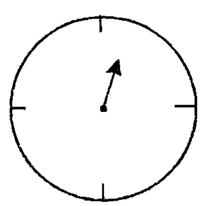
1. STATEMENT-1 : According to principle of homogeneity of dimensions, you can add torque produced by a force and work done by that force.

   and

   STATEMENT-2 : When a force acts tangentially on a wheel hinged at its centre, the torque produced by it has same numerical value as the work done by the force for a given angular displacement.

2. The figure shows a wall clock hanging on a wall. It only has hour hand.

   STATEMENT-1 : The observer reads 12 'O'clock.



   and

   STATEMENT-2 : The least count of the clock is 3 hrs.

3. STATEMENT-1 : Pressure is a vector quantity.

   and

   STATEMENT-2 : Pressure is equal to normal component of force on a surface per unit area.

4. STATEMENT-1 : When a length of 2.0 m is converted into centimeter, the result is 200 cm.

   and

   STATEMENT-2 : The numerical value of a measurement is proportional to reciprocal of the size of unit used.

5. STATEMENT-1 : Conversion within SI system are simple and convenient.

   and

   STATEMENT-2 : SI system uses decimal system.

6. STATEMENT-1 : While determining acceleration due to gravity '*g*' using a simple pendulum, the bob used in the experiment can have any possible value of mass. This will not affect the experiment.

   and

   STATEMENT-2 : The time-period is fairly independent of the mass of the bob used.

7. STATEMENT-1 : The momentum of a body has a magnitude p = mu. This result can not be written as log p = log m + log u.

   and

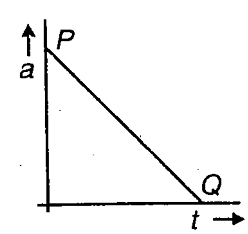
   STATEMENT-2 : The expression log p = log m + log u is dimensionally inconsistent.

8. STATEMENT-1 : When a particle is moving on a straight line, its velocity is constant.

   and

   STATEMENT-2 : The net acceleration of a moving particle may change its direction of motion or magnitude of velocity or both.

9. STATEMENT-1 : In the following graph, the initial velocity of the particle is zero at point P and maximum at point Q.



   and

   STATEMENT-2 : The acceleration of the particle is maximum at point P and zero at point Q.

10. STATEMENT-1 : If displacement is a linear function of time, its average and instantaneous velocity will be same.

and

STATEMENT-2 : If the acceleration of a moving particle is zero, the particle moves linearly.

11. STATEMENT-1 : The acceleration with negative sign only represents the direction of acceleration and it may represent retardation.

and

STATEMENT-2 : The acceleration is a vector quantity and it is called retardation only when it's direction is opposite to the velocity.

12. STATEMENT-1 : A particle is dropped from some height under gravity. Its initial velocity will be zero w.r.t. the frame from which it is released

and

STATEMENT-2 : An observer in a uniformly moving frame in horizontal direction will observe the motion of the above body as parabolic.

13. STATEMENT-1 : A stone is projected with an initial velocity $\vec{v}_0$ at some angle to the horizontal under gravity. Its location relative to origin is defined by radius vector as a function of time $\vec{r} = \vec{v}_0 t + \frac{1}{2}\vec{g}t^2$

and

STATEMENT-2 : The stone drops a distance $\left|\frac{1}{2}\vec{g}t^2\right|$ from its actual position in time 't' due to gravity.

14. STATEMENT-1 : A person can swim in still water with a velocity less than river flow. If he starts swimming perpendicularly to the river velocity observed by stationary frame, then drift of the person is minimum.

and

STATEMENT-2 : The time spent in river will be minimum, when swimmer swims in the direction perpendicular to the velocity of river.

15. STATEMENT-1 : The position velocity-curve of a particle is always a parabola.

and

STATEMENT-2 : For a constant value of $v\frac{dv}{dx}$, the position-velocity curve is parabola.

16. STATEMENT-1 : A particle is moving in such a way that normal acceleration is constant and its moduli is equal to the tangential acceleration. The path of the particle is sprial.

and

STATEMENT-2 : When velocity increases, radius of curvature decreases for constant normal acceleration.

17. STATEMENT-1 : Two particles are projected under gravity with same speed at two different angles $(45^\circ + \theta)$ & $(45 - \theta)$. Their range are same.

and

STATEMENT-2 : The angle $(45^\circ + \theta)$ and $(45 - \theta)$ are complementary angles.

18. STATEMENT-1 : A particle is projected from origin under gravity with the angle of projection $\theta = \tan^{-1}(2)$. The radius vector locating highest point is at an angle of elevation $\frac{\pi}{4}$.

and

STATEMENT-2 : The ratio of average velocity to the velocity of projection is not necessarily greater than unity for the particle projected under gravity at some angle from horizontal.

19. STATEMENT-1 : For straight line motion, the velocity and acceleration of an object are always along the same straight line.

and

STATEMENT-2 : Only the magnitude of velocity changes due to acceleration in straight line motion.

20. STATEMENT-1 : A particle is moving with uniform speed on a circle of radius R. Its acceleration varies.

and

STATEMENT-2 : The centripetal acceleration is always directed towards the centre of the circle.

21. STATEMENT-1 : A swimmer is swimming in the river for the shortest path. Its average velocity is perpendicular to the water flow.

and

STATEMENT-2 : The component of the resultant velocity of swimmer in the direction of flow should be least for shortest path.

22. STATEMENT-1 : Rolling friction is due to deformation at the point of contact.

and

STATEMENT-2 : Due to deformation, the total contact force on the wheel doesn't remain perpendicular to the surface of contact & thus has a component along horizontal.

23. STATEMENT-1 : Normal contact force offered by a horizontal surface on a block placed on it doesn't form an action-reaction pair with the weight of the block.

and

STATEMENT-2 : Contact force is electromagnetic in nature & weight is gravitational.

24. STATEMENT-1 : When a block moves on a rough horizontal surface with some speed, it eventually slows down.

and

STATEMENT-2 : Friction always opposes motion.

25. STATEMENT-1 : Due to circular motion of a particle, a force arises which acts towards the centre. This is called centripetal force.

and

STATEMENT-2 : Centripetal force is perpendicular to the velocity of particle performing circular motion.

26. Consider a block of mass m kept on a rough horizontal surface.

STATEMENT-1 : It is possible to apply a non-vertical force of however large magnitude without disturbing the equilibrium of block.

and

STATEMENT-2 : If no force is applied, force of friction is zero.

27. A system consisting of two blocks kept one over the other rests over a smooth horizontal surface. Somehow it is set in motion so that the system of blocks acquires a constant velocity. Friction coefficients between the two blocks is μ ($\mu \neq 0$)

STATEMENT-1 : Afterwards, friction between the blocks is static in nature and non zero.

and

STATEMENT-2 : The lower block is in translational equilibrium.

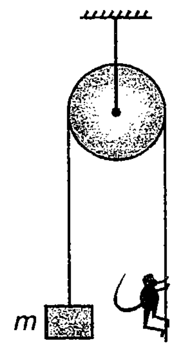
28. A block submerged in water is placed in a lift going up with an acceleration.

STATEMENT-1 : Buoyant force acting on the block due to water increases when the setup is placed in lift as compared to when it was on ground.

and

STATEMENT-2 : The pressure at the lower side in the fluid increases due to upward acceleration.

29. A block of mass m is kept in equilibrium by a massless rope held by a monkey over a pulley as shown. Now the monkey begins to climb the rope.



STATEMENT-1 : The linear momentum of the monkey, rope and block system is conserved.

and

STATEMENT-2 : Contact forces between the monkey and rope and the tension in rope are internal forces of the system.

30. STATEMENT-1 : While walking on a slippery road, one should take shorter steps.

and

STATEMENT-2 : For longer steps, the line joining the centre of gravity of man to the toe of his foot makes a larger angle to the vertical. This decreases the normal reaction and thus friction.

31. An oil tanker is moving on level horizontal road with velocity (uniform) $\vec{v}_0$. A hole opens at the bottom & oil begins to leak.

STATEMENT-1 : Thrust force due to the oil leak opposes the motion of the oil tanker.

and

STATEMENT-2 : Linear momentum of the tanker and the oil leaking out is conserved along horizontal.

32. Two trains *A* & *B* are running from west to east & east to west at equator. They move with same speed.

STATEMENT-1 : Pressure exerted by *B* on the ground will be larger than pressure exerted by *A*.

and

STATEMENT-2 : Both *A* & *B* move on circular tracks of radius equal to the earth's radius.

33. STATEMENT-1 : Kinetic Friction force opposes the relative motion of the surfaces in contact.

and

STATEMENT-2 : Friction force is generated due to relative slipping between bodies.

34. STATEMENT-1 : For motion of body, we have to apply force.

and

STATEMENT-2 : To change position of a body, velocity is necessary.

35. STATEMENT-1 : Reading of a weighing machine is not always equal to weight of the body.

and

STATEMENT-2 : Reading of weighing machine is equal to normal reaction on body by weighing machine.

36. STATEMENT-1 : Thrust force by a mass leaving or entering into system is always parallel to relative velocity.

and

STATEMENT-2 : When the mass leaving the system gains momentum, it apply force on the system in opposite direction.

37. STATEMENT-1 : Normal reaction acting on a body is always perpendicular to the surface.

and

STATEMENT-2 : Normal reaction is a component of contact force.

38. STATEMENT-1 : Static friction is not always equal to applied force.

and

STATEMENT-2 : For static friction, body must be at rest.

39. STATEMENT-1 : A body moving in uniform circular motion, is in equilibrium because speed is constant.

and

STATEMENT-2 : Net force acting on body is perpendicular to velocity in uniform circular motion.

40. STATEMENT-1 : On a circular turn without banking, centripetal force is provided by friction force.

and

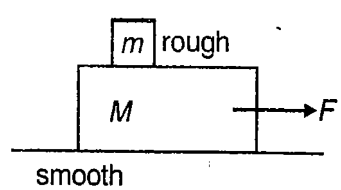
STATEMENT-2 : Friction force acting on a vehicle on circular turn without banking is balanced by other forces.

41. STATEMENT-1 : Impulsive forces act for very short duration.

and

STATEMENT-2 : Change in momentum due to an impulsive force is negligible.

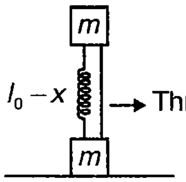
42. STATEMENT-1 : In the figure shown, upper block is always relatively at rest w.r.t. lower block, whatever be the magnitude of force.



and

STATEMENT-2 : Maximum acceleration of upper block is μg, where μ = coefficient of friction between upper & lower block.

43. In the diagram, spring is connected between two blocks & it is in compressed state.



STATEMENT-1 : Normal reaction on lower block by ground is 2 mg.

and

STATEMENT-2 : In equilibrium, net external force must be zero.

44. STATEMENT-1 : In the absence of external force, total momentum of system remains constant.

and

STATEMENT-2 : In the absence of external force acceleration of any component of a system must be zero.

45. STATEMENT-1 : The engine of a car cannot accelerate it without friction

and

STATEMENT-2 : A system cannot accelerate without external force.

46. STATEMENT-1 : A body is projected at some angle θ with horizontal. Tangential force on it during upward journey is decreasing.

and

STATEMENT-2 : Angle between instantaneous acceleration and velocity is decreasing, initially it is obtuse then becomes 90° at highest point.

47. STATEMENT-1 : Net work done by internal force in a system may be zero.

and

STATEMENT-2 : Net force on the centre of mass of the system by internal mechanism is zero.

48. STATEMENT-1 : A body is moving under the action of constant force. Its kinetic energy observed from a uniformly moving frame along any fixed direction changes.

and

STATEMENT-2 : The acceleration of a particle observed from a uniformly moving frame is independent on the frame of references.

49. STATEMENT-1 : A particle is moving on a circle of radius R with uniform speed. Its kinetic energy remains the same, but momentum changes.

and

STATEMENT-2 : Work done by centripetal force is zero. Kinetic energy and momentum are related as $K = \frac{p^2}{2m}$.

50. STATEMENT-1 : In collision between two bodies, they remain in contact with each other for a very short internal of time before they separate. During the period of restitution, the bodies try to regain their original shape.

and

STATEMENT-2 : During the period of contact, bodies exchange their momentum and energy.

51. STATEMENT-1 : The total work performed by all internal dissipative forces is always zero or a negative quantity.

and

STATEMENT-2 : The gradient of U is a vector oriented along a normal to an equipotential surface in the direction of increasing values of potential energy.

52. STATEMENT-1 : A block of mass 'M' is placed on a moving railroad car moving with velocity 'v'. The kinetic energy of the block is $\frac{1}{2}Mv^2$ in all frames.

and

STATEMENT-2 : The kinetic energy of a system or body is different in different frames.

53. STATEMENT-1 : If the work done by forces other than conservative forces is zero, then mechanical energy is conserved.

and

STATEMENT-2 : The work done by non-conservative forces is always negative.

54. STATEMENT-1 : Two blocks of masses m_1 and m_2 are attached with a string (ideal) and the string passes over an ideal pulley. The total mechanical energy of the system is conserved but individual mechanical energy of the block will not be conserved.

and

STATEMENT-2 : The net work done by tension is zero.

55. STATEMENT-1 : A man is moving slowly on a road its mechanical energy will be constant.

    and

    STATEMENT-2 : Net work done by gravity will be zero.

56. STATEMENT-1 : A disc of radius R and mass *'m'* is at rest on a horizontal surface. Its potential energy will be zero.

    and

    STATEMENT-2 : The change in potential energy of a system is defined by the change in configuration of the system.

57. STATEMENT-1 : The normal force on a body by the floor is not a conservative force.

    and

    STATEMENT-2 : The normal forces does no work at all. Hence it will not store energy in the system.

58. STATEMENT-1 : A disc is rotating in *x-y* plane about centre of mass with angular velocity ω. Its kinetic energy with respect to a man moving along *x*-axis with velocity v is $\frac{1}{2}I_{c.m}\omega^2$

    and

    STATEMENT-2 : The kinetic energy depends on reference frame.

59. STATEMENT-1 : A disc is in pure rolling on a flat horizontal surface. Its kinetic energy with respect to a man moving parallel with the velocity $V_{c.m.}$ is $\frac{1}{2}I_{c.m}\omega^2$.

    and

    STATEMENT-2 : With respect to moving man parallel to the disc, the disc is in pure rotation.

60. STATEMENT-1 : When we slightly disturb the position of a body and the position of centre of mass does not change, the potential energy of the system remains constant.

    and

    STATEMENT-2 : In the case of neutral equilibrium, the position of centre of mass does not change with the change in position of object.

61. STATEMENT-1 : When a body remains at rest on a floor, It is in static equilibrium.

    and

    STATEMENT-2 : In static equilibrium, the linear momentum and angular moment of the body will be zero.

62. STATEMENT-1 : A block of mass M is moving with constant velocity on smooth horizontal floor. The average power in time t is zero.

    and

    STATEMENT-2 : The mechanical energy of the block is constant.

63. STATEMENT-1 : Coefficient of restitution can be greater than 1.

    and

    STATEMENT-2 : While dealing with systems having some form of internal energy stored, it is possible to achieve greater velocity of separation than velocity of approach.

64. STATEMENT-1 : Impulse of an impulsive force can only be measured by measuring the change in momentum of the object on which the force is applied.

    and

    STATEMENT-2 : Impulsive force is a force of variable and large magnitude.

65. STATEMENT-1 : For a system of particles, total energy of the system can change even if net force acting on the system is zero.

    and

    STATEMENT-2 : If net force on a system of particles is zero, total momentum can not change.

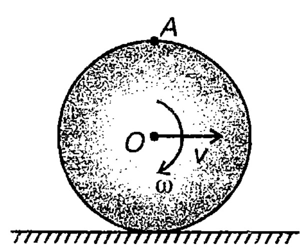
66. STATEMENT-1 : In a perfectly elastic collision in one-dimension, the relative velocity of approach before collision & relative velocity of separation after collision are same.

    and

    STATEMENT-2 : Impulse of deformation = Impulse of restitution for elastic collision.

67. A solid sphere rolls purely on a level horizontal surface. The linear velocity of the centre is v.

    STATEMENT-1 : The radius of curvature of particle at point A in ground frame and the frame attached with the centre of sphere O is numerically same.



    and

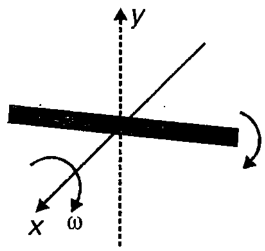
    STATEMENT-2 : The frame attached with O is moving with a constant velocity w.r.t. ground frame & hence is inertial (considering ground frame as inertial frame)

68. STATEMENT-1 : Moment of Inertia for any rigid body about Z axis is $I_z = I_x + I_y$ (perpendicular axis theorem).

and

STATEMENT-2 : Perpendicular axis theorem is valid for only planar rigid bodies.

69. STATEMENT-1 : For given figure, moment of Inertia of rod about y-axis first increases and then decreases while the rod is rotating with constant angular velocity.



and

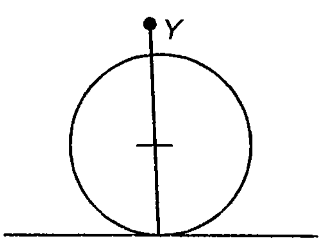
STATEMENT-2 : The mass distribution about axis is changing with time.

70. STATEMENT-1 : Angular velocity is characteristic of a rigid body as a whole.

and

STATEMENT-2 : Angular velocity may be different for different particles of rigid body about axis of rotation.

71. STATEMENT-1 : Consider a purely rolling rigid body as shown in figure. As one moves from O to Y, net velocity of particles on line OY increases.



and

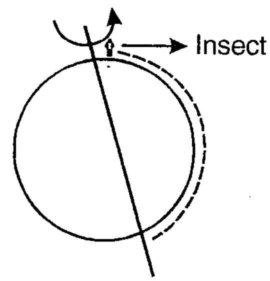
STATEMENT-2 : As we move from O to Y, angular velocity of particles decrease.

72. STATEMENT-1 : In pure rolling motion, net work done by friction is zero.

and

STATEMENT-2 : Sum of translational work done by friction and rotational work done by friction is zero.

73. STATEMENT-1 : A solid sphere is rotating about an axis shown in figure. An insect follows the path indicated. The angular momentum will remain constant for system.



and

STATEMENT-2 : The moment of inertia changes, in this event.

74. STATEMENT-1 : For a system of particles under central force field, total angular momentum is conserved about the centre.

and

STATEMENT-2 : Torque acting on such a system is zero about the centre.

75. STATEMENT-1 : If net force on a rigid body is zero, then linear velocity of centre of mass is constant.

and

STATEMENT-2 : Angular momentum about an axis passing through centre of mass may be varying.

76. STATEMENT-1 : A ball is rolling on a rough horizontal surface. It gradually slows down & stops.

and

STATEMENT-2 : Force of rolling friction decreases linear velocity.

77. STATEMENT-1 : During translatory motion, Angular momentum is meaningless.

and

STATEMENT-2 : A particle in linear motion can have angular momentum except, when particle's line of motion contains the reference point.

78. STATEMENT-1 : Change in rotational kinetic energy of a rigid body is equal to net work done by external torque on the rotating body.

and

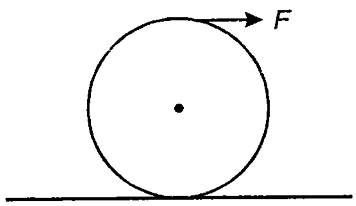
STATEMENT-2 : According to work energy theorem, net work done by conservative force is equal to change in kinetic energy.

79. STATEMENT-1 : Suppose our planet suddenly shrinks in size still remaining perfectly spherical, then duration of day will decrease.

and

STATEMENT-2 : Duration of year will remain unchanged.

80. STATEMENT-1 : A ring is rolling without slipping on rough surface as shown in figure. The force of friction necessary for ring to purely roll is in forward direction.



and

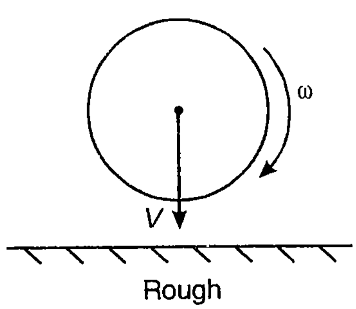
STATEMENT-2 : Force of friction is zero when external force acts at top of ring.

81. STATEMENT-1 : A smooth sphere *A* is moving on a frictionless horizontal plane with angular speed ω & centre of mass with velocity *v*. It collides with another identical sphere at rest. Neglect friction every where. The angular velocity of *A* does not change after collision.

and

STATEMENT-2 : Angular velocity of second sphere is half of angular velocity of first sphere.

82. STATEMENT-1 : A ball rotating with angular velocity ω strikes a rough horizontal surface as shown in figure. Then path of ball after collision is parabolic towards right.



and

STATEMENT-2 : A force of friction will act towards right during collision.

83. STATEMENT-1 : Velocity acquired by a rolling body depends on inclination of plane on which it rolls down without slipping.

and

STATEMENT-2 : Velocity depends upon height of descent of body.

84. STATEMENT-1 : A cylinder rolls up an incline plane, reaches some height and then rolls down. The direction of friction force acting on cylinder is up the incline, while ascending as well as descending.

and

STATEMENT-2 : Direction of force of friction is in accordance with sense of angular acceleration.

85. STATEMENT-1 : Time of descent of a purely rolling body does not depend on inclination.

and

STATEMENT-2 : More is the inclination, less is time of descent.

86. STATEMENT-1 : According to Kepler's second law, the radius vector to a planet from the sun sweeps out equal areas in equal intervals of time.

and

STATEMENT-2 : The angular momentum of the planet about the sun is constant.

87. STATEMENT-1 : The force of attraction due to a hollow spherical shell of uniform density, on a point mass situated inside it is zero.

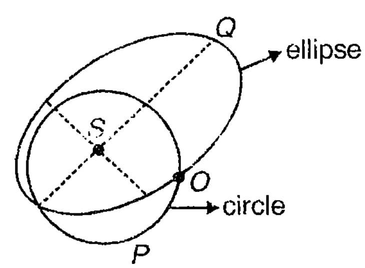
and

STATEMENT-2 : The gravitation field due to the shell inside the shell will be zero.

88. STATEMENT-1 : A planet may orbit around a star either in orbit *P* or orbit *Q*. The speed of a planet at *O* is same for both orbits.

and

STATEMENT-2 : The radius vector of point *O* from the sun is same for both orbit *P* and *Q*.



89. STATEMENT-1 : The angular momentum under a central force is constant.

and

STATEMENT-2 : A force directed towards a fixed point following inverse square law is conservative.

(IIT-JEE 2009)

89a. Under the influence of the Coulomb field of charge $+Q$, a charge $-q$ is moving around it in an elliptical orbit. Find out the correct statement(s)

(1) The angular momentum of the charge $-q$ is constant

(2) The linear momentum of the charge $-q$ is constant

(3) The angular velocity of the charge $-q$ is constant

(4) The linear speed of the charge $-q$ is constant

90. STATEMENT-1 : A satellite moves round the earth in a circular orbit under the action of gravity. A person in the satellite experience a zero gravity field in the satellite.

and

STATEMENT-2 : The contact force by the surface on the person is zero.

(IIT-JEE 2008)

90(a). STATEMENT-1 : An astronaut in an orbiting space station above the Earth experiences weightlessness.

and

STATEMENT-2 : An object moving around the Earth under the influence of Earth's gravitational force is in a state of 'free-fall'.

(1) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is a correct explanation for STATEMENT-1

(2) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is NOT a correct explanation for STATEMENT-1

(3) STATEMENT-1 is True, STATEMENT-2 is False

(4) STATEMENT-1 is False, STATEMENT-2 is True

91. STATEMENT-1 : If we reduce the volume of a spherical body but mass of the body remains constant, then escape velocity on its surface increases.

and

STATEMENT-2 : If the escape velocity tends to the speed of light, then any body thrown with the velocity of light or less will return back to the planet.

92. STATEMENT-1 : The force between two masses may be represented by

$$F = \frac{G_\infty m_1 m_2}{r^2}\left[1+\left(1+\frac{r}{\lambda}\right)\alpha e^{-r/\lambda}\right].$$

and

STATEMENT-2 : For $r >> 200$ m

$$F = G_\infty \frac{m_1 m_2}{r^2}$$

For $r << 200$ m

$$F = \frac{G_\infty m_1 m_2 (1+\alpha)}{r^2}$$

The value of G for small distances is about 1% less than the value of G for large distance.

93. STATEMENT-1 : The viscosity of a liquid increases with rise of temperature.

and

STATEMENT-2 : Viscosity of liquid is the property of the liquid by virtue of which it opposes the relative motion between its layers.

94. STATEMENT-1 : If a barometer is accelerated upwards, the level of mercury in the tube of barometer will decrease.

and

STATEMENT-2 : The effective value of acceleration due to gravity will increase, so up-thrust will increase.

95. STATEMENT-1 : Two row boats moving parallel to each other and nearby, are attracted towards each other.

and

STATEMENT-2 : Increase of velocity of fluid flow decreases the pressure between them.

96. STATEMENT-1 : The density of water is maximum at 4°C.

and

STATEMENT-2 : The volume of water decreases while heating from 0°C to 4°C.

97. STATEMENT-1 : A solid sphere and a hollow sphere of same material are floating in a liquid. Radius of both the spheres are same. Percentage of volume immersed of both the spheres will be same.

and

STATEMENT-2 : Upthrust acts due to volume of liquid displaced. It has nothing to do whether the body is solid or hollow.

98. STATEMENT-1 : Amplitude of damped oscillation decreases with time.

    and

    STATEMENT-2 : Amplitude of damped oscillation always decreases exponentially.

99. STATEMENT-1 : In SHM, total mechanical energy can be negative also.

    and

    STATEMENT-2 : Potential energy is always negative.

100. STATEMENT-1 : If a pendulum clock is taken to mountain top, it gains time.

    and

    STATEMENT-2 : Value of acceleration due to gravity is less at heights.

101. STATEMENT-1 : If amplitude of SHM is doubled, the time period remains same.

    and

    STATEMENT-2 : Amplitude & periodicity are two independent characteristics of SHM.

102. STATEMENT-1 : SHM is not an example of uniformly accelerated motion.

    and

    STATEMENT-2 : Non-uniform velocity cannot give uniform acceleration.

103. STATEMENT-1 : Oscillatory motions are necessarily periodic motions, but all periodic motions are not oscillatory.

    and

    STATEMENT-2 : Simple pendulum is an example of oscillatory motion.

104. STATEMENT-1 : When a simple pendulum is made to oscillate on surface of moon, its time period is more as compared to earth.

    and

    STATEMENT-2 : Gravity is smaller at moon than at earth.

105. STATEMENT-1 : Tension in the string of a simple pendulum remains same, irrespective of position of bob in oscillation.

    and

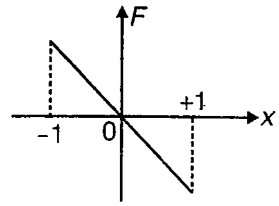
    STATEMENT-2 : Tension is maximum at mean position of oscillating bob.

106. STATEMENT-1 : Two SHM's along x & y axes with angular frequency ratio $\omega_1 : \omega_2 = 1 : 2$ with same amplitude result in curved path on superposition.

    and

    STATEMENT-2 : x & y displacements are related as $y \propto x^2$ in this case.

107. STATEMENT-1 : Curve between force acting on a particle & displacement is given. This graph represents a particle that executes SHM.



    and

    STATEMENT-2 : The force $F \propto x$ and is always directed towards origin.

108. STATEMENT-1 : If a man with a wrist watch on his hand falls from top of tower, his watch gives correct time during fall.

    and

    STATEMENT-2 : The working of a wrist watch depends on spring-action & it has nothing to do with gravity.

109. STATEMENT-1 : The bob of simple pendulum is a hollow ball full of water. If a fine hole is made at bottom of ball, then time period will no more remain constant.

    and

    STATEMENT-2 : The time period of simple pendulum does not depend upon mass of the bob.

110. STATEMENT-1 : The frequency of oscillations of a simple pendulum mounted in cabin that is falling freely under gravity, is zero.

    and

    STATEMENT-2 : During free fall, net acceleration of bob is zero.

111. STATEMENT-1 : During SHM, $\vec{a}\cdot\vec{v} < 0$ where $\vec{a}$ is acceleration and $\vec{v}$ is velocity of particle.

    and

    STATEMENT-2 : Acceleration is always towards mean position.

112. STATEMENT-1 : A particle executes SHM with frequency f. The frequency with which total mechanical energy of particle oscillates is $2f$.

    and

    STATEMENT-2 : Both kinetic as well as potential energy of particle in SHM oscillate with a frequency $2f$.

113. STATEMENT-1 : A tunnel is dug along any chord in earth. The particle dropped in the Tunnel will execute SHM.

and

STATEMENT-2 : Time period of oscillation of particle in all tunnels will be same.

114. STATEMENT-1 : A particle moves on x-axis according to equation $x = 2 + 6 \sin(\pi t)$. Motion is not SHM.

and

STATEMENT-2 : The acceleration is not proportional to displacement from origin.

115. STATEMENT-1 : Sound waves can be transverse in nature.

and

STATEMENT-2 : In solids, nature of sound waves depend on mode of excitation.

116. STATEMENT-1 : Wave on string can be longitudinal in nature.

and

STATEMENT-2 : The string can't be compressed or rarefied.

117. STATEMENT-1 : If two people talk simultaneously and each creates an intensity level of 60 dB at a point P, then total intensity level at point P is 120 dB.

and

STATEMENT-2 : Sound level is defined on non-linear scale.

118. STATEMENT-1 : Quality of sound produced by an open pipe is better than closed pipe.

and

STATEMENT-2 : An open pipe produces all harmonics but a closed pipe does not.

119. STATEMENT-1 : The fundamental frequency of an open organ pipe increases as temperature is increased.

and

STATEMENT-2 : As temperature increases, the velocity of sound increases rapidly.

120. STATEMENT-1 : When two vibrating tuning forks having frequency 220 Hz and 440 Hz are held near each other, beats connot be heard.

and

STATEMENT-2 : Principle of super position is valid only if frequencies of oscillations are equal.

121. STATEMENT-1 : The frequencies of incident, reflected and refracted beam of monochromatic light incident from one medium to other medium are same.

and

STATEMENT-2 : The incident, reflected and refracted rays are coplanar.

122. STATEMENT-1 : Compression and rarefaction involve change in density and pressure.

and

STATEMENT-2 : When particles are compressed, density of medium increases and when rarefied density of medium decreases.

123. STATEMENT-1 : For a travelling wave $y = 0.2 \sin 2\pi(10t - 5x)$, speed of wave is 2 units.

and

STATEMENT-2 : Wavelength of the wave is 5 units.

124. STATEMENT-1 : As a wave travels from denser to rarer medium, wavelength of a wave may increase or decrease.

and

STATEMENT-2 : The frequency remains unchanged by a change in medium.

125. STATEMENT-1 : Wave velocity and particle velocity for transverse wave are mutually perpendicular to each other.

and

STATEMENT-2 : The wave velocity and particle velocity have a constant ratio of their magnitudes.

126. STATEMENT-1 : Interference of waves is based on energy conservation.

and

STATEMENT-2 : For observing interference between two waves, the amplitude of two wave must be nearly equal.

127. STATEMENT-1 : For sound passing in gas, the compressibility of gas at a point oscillates in time.

and

STATEMENT-2 : The position of small layers of gas oscillates in time.

128. STATEMENT-1 : When a sound source moves towards observer, then frequency of sound increases.

and

STATEMENT-2 : Wavelength of sound in medium towards observer is decreased.

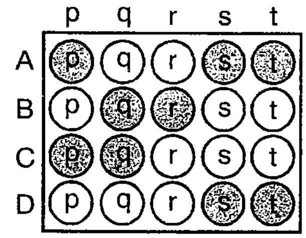
❑ ❑ ❑

SECTION - E

Matrix-Match Type

This section contains 60 questions. Each question contains statements given in two columns which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **One OR More** statement(s) in **Column II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example :

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.



1. In the following columns, the **Column II** is a list of pair of physical quantities and **Column I** contains list of relation between them. Match the entries in **Column I** to all the entries in **Column II.**

Column I	Column II
(A) Same dimensional formula	(p) Specific latent heat & gravitational potential
(B) Different dimensional formula	(q) Work and torque
(C) Dimensionless quantities	(r) Momentum per unit area and pressure
(D) Physical quantities with (–1) dimension in length	(s) Reynold's number and coefficient of friction
	(t) Energy density and Young's modulus

2. Taking force, length and time to be fundamental quantities, relate quantities in **Column I** and dimensions in **Column II**. Match the entries in **Column I** with all the entries if **Column II**. More than one match are possible

Column I	Column II
(A) Density	(p) FL
(B) Pressure	(q) FT
(C) Momentum	(r) FL^{-2}
(D) Energy	(s) $FL^{-4}T^2$

3. A new system of units is chosen in which speed of light c (= 3×10^8 m/s) Planck's constant h (= 6.6×10^{-34} J-s) and gravitational constant G (= 6.67×10^{-11} N m^2 kg^{-2}) are regarded as fundamental quantities. **Column II** contains a list of some physical quantities or expressions and **Column I** lists some dimensional formula. Match the entries in **Column I** with all the entries in **Column II.**

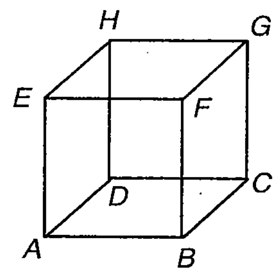
Column I	Column II
(A) $\sqrt{\dfrac{ch}{G}}$	(p) Mass
(B) $\sqrt{\dfrac{Gh}{c^5}}$	(q) Time

(C) $\frac{c^5}{G}$ (r) Torque

(D) $\sqrt{\frac{c^5 h}{G}}$ (s) $\frac{\text{Planck's constant}}{\text{Time}}$

(t) $(\text{Current})^2 \times \text{Resistance} \times \text{Time}$

4. Match the entries in Column-I and Column-II considering the cube (of side a) shown below



Column I	Column II
(A) $\overline{AC}+\overline{BE}+\overline{GB}$	(p) Is a null vector
(B) $\overline{AD}+\overline{EF}$	(q) Is a vector with magnitude $a\sqrt{3}$
(C) $\overline{AD}+\overline{CD}+\overline{HD}$	(r) Is a vector with magnitude $a\sqrt{2}$
(D) $\overline{AC}+\overline{GF}+\overline{FE}$	(s) $\overline{EH}-\overline{GH}$
	(t) $\overline{EH}+\overline{FH}+\overline{HG}$

5. Match the entries in **Column I** to all the entries in **Column II**.

Column I	Column II
(A) Impulse	(p) Electron-volt
(B) Energy	(q) kWh
(C) Electric flux	(r) volt × metre
(D) Coefficient of viscosity	(s) N.s
	(t) pascal × second

6. Match the entries in **Column I** to all the entries in **Column II**.

Column I	Column II
(A) $[ML^{-1}T^{-1}]$	(p) Planck's constant
(B) $[MT^{-2}]$	(q) Torque × time
(C) $[ML^2T^{-1}]$	(r) Surface Tension
(D) $[M^0LT^{-2}]$	(s) Coefficient of viscosity
	(t) Gravitational field intensity

7. A particle is moving in circular path of radius r. Match the entries in Column-I with all possible entries in Column-II

Column I		Column II
(A) If the particle is moving with constant speed	(p)	$\vec{v}\cdot\vec{r}=0$
(B) If the particle is moving with increasing speed	(q)	$\vec{v}\cdot\vec{a}=0$
(C) If the particle is moving with decreasing speed	(r)	$\vec{v}\cdot\vec{a}>0$
(D) If speed of the particle is given by $v = 5 - 2t$ then at any instant t	(s)	$\vec{r}\cdot\vec{a}<0$
	(t)	$\vec{v}\cdot\vec{a}<0$

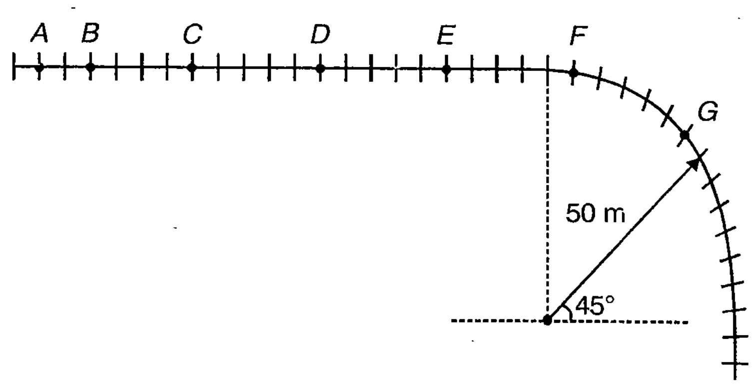
8. Match the entries in **Column I** to all the entries in **Column II**.

Column I		Column II
(A) Dot product of force and velocity	(p)	Power
(B) Cross product of force and position vector	(q)	Angular momentum
(C) Dot product of force and displacement	(r)	Work
(D) Cross product of momentum and position vector	(s)	Torque
	(t)	(+2) Dimensions in length

9. **Column-I** gives some situations match their situation with entries in **Column-II**

Column I		Column II
(A) Uniform circular motion	(p)	Variable acceleration
(B) Parabolic path with constant speed	(q)	Variable velocity
(C) Particle moving along x-axis such that $x = 5t^2$	(r)	Acceleration of constant magnitude
(D) Oblique projectile near the surface of the earth	(s)	Variable centripetal acceleration
	(t)	Constant acceleration

10. The figure below illustrates a stretch of a horizontal road. The markers (┼┼) indicate distance along the road separated by 10 m. At A a car enters the stretch of road. It accelerates uniformly up to point C, and then continues moving at constant speed. The dots show the position of the car at one second intervals.



Match the entries in **Column I** with all the entries if **Column II. More than one match is possible.**

Column I	**Column II (in SI units)**
(A) The speed of car at point B	(p) Zero
(B) The acceleration of car at point D	(q) 50
(C) The speed of car at point E	(r) 30
(D) The acceleration of car at point G	(s) 20

11. A particle is projected with a velocity $u_x\hat{i} + u_y\hat{j}$ at an angle θ above the horizontal.

Column I	**Column II**
(A) Time of flight depends on	(p) u_x for fixed θ
(B) Range depends on	(q) u_y for fixed θ
(C) The ratio of maximum height and time of flight depends on	(r) θ for fixed value of u_x
(D) Speed at highest point depends on	(s) θ for fixed value of u_y
	(t) u_x for fixed value of u_y

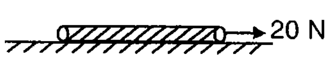
12. **Column I** contains some entries and **Column II** contains some related entries. Match the entries in **Column-I** with all possible entries in **Cclumn-II**

Column I	**Column II**
(A) Particle moving on a straight line path with constant velocity	(p) Magnitude of net force is nonzero constant
(B) Particle moving on a straight line path with constant acceleration	(q) Direction of net force is fixed
(C) Particle moving in a circle with constant speed	(r) Magnitude of net force is variable
(D) Particle moving along parabola with constant speed	(s) Direction of net force changes with time
	(t) Magnitude of net force is zero.

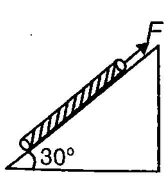
13. **Column I** contain some questions and **Column II** contains some answers. Match the correct answer of question.

Column I | **Column II**

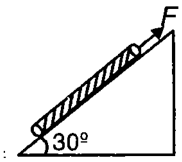
(A) A rope of mass 2 kg on a rough horizontal surface is pulled by a horizontal force of 20 N, $\mu_{SL} = 0.5$ — (p) Tension at the mid point of rope is 10 N



(B) A rope of mass 2 kg pulled with constant speed up an incline of inclination 30º and coefficient of friction $\frac{1}{\sqrt{3}}$ — (q) Acceleration of rope is 5 m/s^2



(C) A rope of mass 1.0 kg pulled by a constant force of 10 N upon incline of inclination 30º and coefficient of friction $\frac{1}{\sqrt{3}}$



(r) Force of friction acting is 5 N

(D) A rope of mass 2 kg pulled vertically by a force 20 N

(s) Resultant force on the rope is zero

(t) Force of friction acting is 10 N

14. The entries in **Column II** show some arrangements of two or more blocks connected by means of light, inextensible ropes and smooth pulleys. The tension in the string AB is $T = \eta mg$ **Column I** lists some values of η. Match appropriately neglect friction.

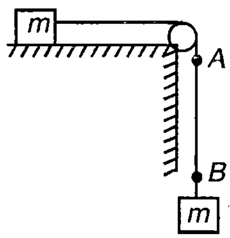
Column I

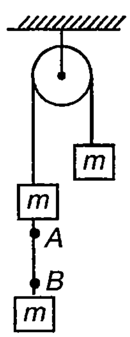
(A) $\eta = \frac{1}{2}$

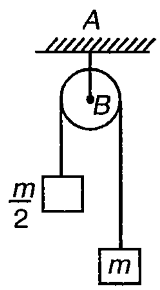
(B) $\eta = \frac{4}{3}$

(C) $\eta = \frac{8}{3}$

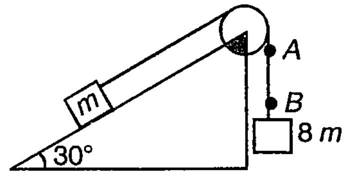
Column II

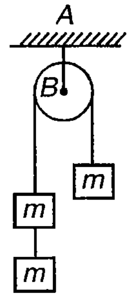
(p) 

(q) 

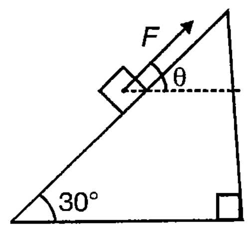
(r) 

(D) $\eta = \frac{2}{3}$

(s) 

(t) 

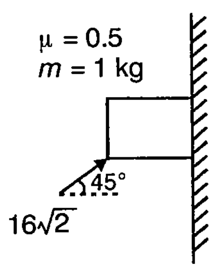
15. A block of 10 kg is pulled by a force F on rough inclined surface with coefficient of friction $\mu = 0.8$. Match the entries in **Column-I** and **Column-II**.



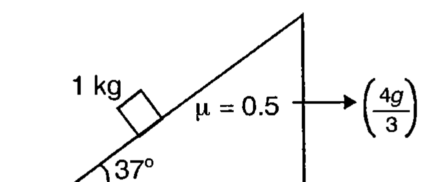
Column I	**Column II**
(A) $F = 30$ N, $\theta = 30°$	(p) Body is at rest
(B) $F = 30$ N, $\theta = 0°$	(q) Body is accelerated
(C) $F = 30$ N, $\theta = -90°$	(r) $N = 86$ N
(D) $F = 50$ N, $\theta = 30°$	(s) $N = 101$ N
	(t) Force of friction is zero

16. Match appropriately **Column-I** and **Column-II**

Column I **Column II**

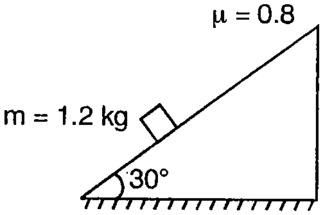
(A) 

(p) Force of friction is static

(B) 

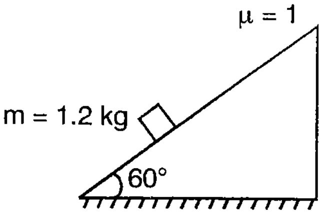
Block is moved horizontal with constant acceleration $\left(\frac{4g}{3}\right)$

(q) Force of friction is zero

(C) 

Fixed wedge

(r) Force of friction is kinetic

(D) 

Fixed wedge

(s) Net force on the block is zero

(t) Net force on the block is 10 N

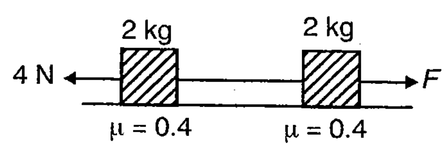
17. Consider a system of particles. If U, K and p denote the total potential energy, kinetic energy and linear momentum of the system, then match the Column appropriately (i and f stand for initial and final respectively)

Column I	**Column II**
(A) $U_f - U_i$	(p) Is zero when no forces are acting
(B) $K_f - K_i$	(q) Is zero when no force is doing work
(C) $(U_f + K_f) - (U_i + K_i)$	(r) Is zero when only conservative forces are doing work
(D) $p_f - p_i$	(s) Is zero when work done by conservative forces is zero
	(t) Is zero when there are no external forces and no non-conservative forces

18. A bob pendulum (mass m) is suspended vertically with the help of an inextensible string of length ℓ. It is projected horizontally so that the bob moves in a vertical circle of radius r.

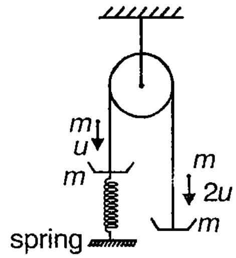
Column I	**Column II**
(A) Velocity at highest point depends on	(p) m
(B) Tension at highest point depends on	(q) u
(C) Difference of tension at highest point and lowest point depends on	(r) g
(D) Minimum possible value of u	(s) ℓ
	(t) None of m, u, g and ℓ

19. Two similar blocks are connected by a string. A force of 4 N is applied on left block as shown in diagram. T represents tension in string, f_1 represents force of friction on left block and f_2 represents force of friction on right block. Now a force whose magnitude is increasing continuously is applied on right block. Now match the **Column I** and **Column II**.



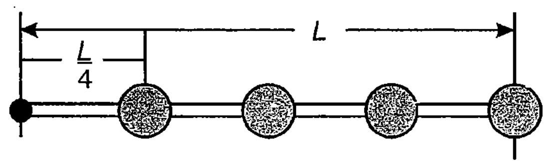
Column-I	**Column-II**
(A) $F = 0$ N	(p) $f_1 = 4$
(B) $F = 4$ N	(q) $f_2 = 0$
(C) $F = 8$ N	(r) $T = 0$
(D) $F = 12$ N	(s) $f_2 = 4$
	(t) $f_1 = 0$

20. Two pans of same mass are connected by string. Two balls of same mass moving with speed u and $2u$ collide with the pan and stick with pan after collision. Now match the **Column-I** and **Column-II.**



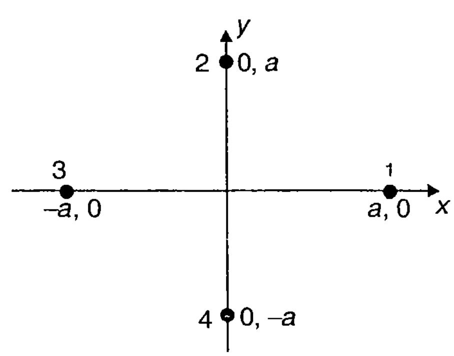
Column-I	**Column-II**
(A) For left pan	(p) Impulse by normal reaction
(B) For right pan	(q) Impulse by tension
(C) For left ball	(r) Impulse by spring
(D) For right ball	(s) Impulse by weight
	(t) Impulse by friction between balls and pans

21. A rod of length L connects four particles, each of mass M and the particles are placed at equal distances from each other as shown. The rod is fixed and the entire system rotates about this end. The system is initially at rest and goes to an angular velocity of $\frac{3 \text{ rad}}{s}$ in 5 seconds.



Column I	**Column II**
(A) Power developed	(p) $15\frac{ML^2}{8}$
(B) Moment of inertia about fixed point	(q) $135\frac{ML^2}{16}$
(C) Total work done	(r) $27\frac{ML^2}{16}$
(D) Angular acceleration	(s) $\frac{3}{5}$
	(t) Scalar quantity

22. The following figure shows a system of four particles having same mass. **Column I** lists the path followed by the particles and **Column II** lists the resulting path of centre of mass. Match appropriately



Column I	Column II
(A) 1 moves along x-axis, others at rest	(p) Remains stationary
(B) 1 and 2 move with constant velocity, others do not move	(q) Circle
(C) 1 moves along x-axis, 2 moves along y-axis other do not move	(r) Parabola
(D) 1 and 3 move along x-axis 2 and 4 move along y-axis	(s) Straight line

23. In a region of space, the potential energy of an object varies only along the direction of x as $U = -U_0 \sin kx$. (k = +ve) Here U_0 is a positive constant. An object is released in the region, the entries in **Column-I** lists the x-coordinates where the object is released. Match appropriately

Column I	Column II
(A) $x = 0$	(p) Potential energy is decreasing
(B) $x = \frac{\pi}{2k}$	(q) Stable equilibrium
(C) $x = \frac{3\pi}{2k}$	(r) Unstable equilibrium
(D) $x = (4n-3)\frac{\pi}{k}$	(s) Magnitude of force is increasing
Here n = 1, 2, 3...	(t) Force is maximum

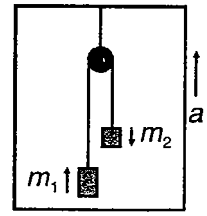
24. A car is climbing up a steep hill (60 degrees) and traverse a distance of 5 km in 30 minutes at constant speed. Assuming that the car slides 50% of the distance (coefficient of friction is 0.5 and mass of car is 800 kg). Match them appropriately

Column I	Column II
(A) Distance travelled under friction	(p) –98000
(B) Work done by friction	(q) 43747.2
(C) Work done by car	(r) 2500
(D) Power developed by car	(s) 24.304
	(t) Zero

25. A meter stick of mass 1 kg is held vertically with one end on the floor and is then allowed to fall. Take ground as datum. Match them appropriately

Column I	Column II
(A) Initial mechanical energy	(p) 5.425
(B) (Angular velocity)^2	(q) 29.429
(C) Linear velocity	(r) 4.9
(D) Moment of inertia	(s) 0.333
	(t) Zero

26. A pulley system is attached to an elevator as shown in figure. The elevator starts to move up with an acceleration a.



Column I	**Column II**
(A) Acceleration of m_1 in elevator frame	(p) $\dfrac{\frac{1}{2}(m_2 - m_1)(g+a)t^2}{(m_1+m_2)} + \dfrac{1}{2}at^2$
(B) Acceleration of m_1 in ground frame	(q) $\dfrac{1}{2}\left[\dfrac{m_2 - m_1}{(m_1+m_2)}(g+a)\right]t^2$
(C) Distance covered of m_1 in elevator frame	(r) $\left(\dfrac{m_2 - m_1}{m_1+m_2}\right)(g+a)+a$
(D) Distance covered of m_1 in ground frame	(s) $\dfrac{(m_2 - m_1)}{(m_1+m_2)}(g+a)$
	(t) Zero

27. **Column I** contain some questions and **Column II** contains some answers. Match the correct answer of question.

Column I	**Column II**
(A) Collision of two light nuclei to form a heavier nucleus	(p) Elastic collision
(B) Speeding bullet getting embedded in a wooden plank placed on smooth table	(q) Inelastic collision
(C) Collision of neutron with heavy unstable nucleus	(r) Nuclear fission
(D) Collision in which there is no loss of external kinetic energy	(s) Nuclear fussion
	(t) Linear momentum of system is conserved

28. Two carts on an air track are pushed towards each other, cart A moves in (+)ve x-direction and B in the (–)ve x-direction. Carts bounce off each other.

Column I

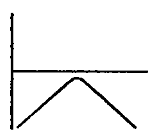
(A) Variation of momentum of cart A

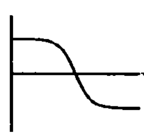
(B) Variation of position of cart A

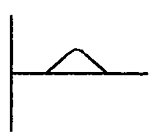
(C) Variation of force on cart B

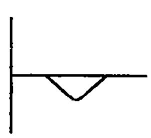
(D) Variation of force on cart A

Column II

(p) 

(q) 

(r) 

(s) 

(t) Is such that it increases and then decreases in magnitude

29. A solid spherical ball of mass M and radius R rolls without slipping down a surface inclined to horizontal at an angle 45°. Considering that ball is uniform solid sphere and that ball and surface are perfectly rigid. Match **Column I** and **Column II**

Column I	**Column II**
(A) Reaction force	(p) $\frac{Mg}{7}\frac{\sqrt{53}}{2}$
(B) Friction force	(q) $\frac{Mg}{\sqrt{2}}$
(C) Contact force	(r) $\frac{5}{7\sqrt{2}}$ Mg
(D) Net force	(s) $\frac{\sqrt{2}}{7}$ Mg
	(t) Electromagnetic

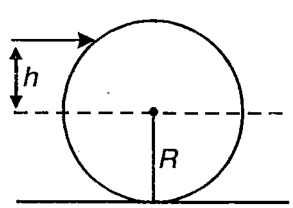
30. A solid sphere, hollow sphere, solid cylinder, hollow cylinder and ring each of mass M and radius R are simultaneously released from top of incline and roll without slipping down the incline then match **Column I** & **Column II**.

Column I	**Column II**
(A) Time taken to reach bottom is maximum for	(p) Solid sphere
(B) Angular acceleration maximum for	(q) Hollow cylinder
(C) Kinetic energy at bottom is same for	(r) Hollow sphere
(D) Rotational knetic energy is maximum for	(s) Ring
	(t) Solid cylinder

31. A ring, disc, solid sphere, hollow sphere and hollow cylinder all of mass M and radius R are kept on rough horizontal surface after giving its centre a horizontal speed V_0 then

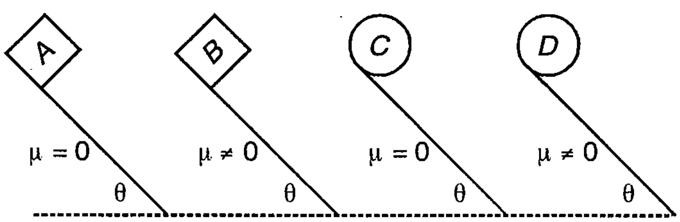
Column I	**Column II**
(A) Maximum time is taken to attain pure rolling	(p) Solid sphere
(B) Minimum time is taken to attain pure rolling	(q) Ring
(C) Minimum velocity of body at time of pure rolling	(r) Disc
(D) Minimum velocity of body at time of pure rolling	(s) Hollow sphere
	(t) Hollow cylinder

32. A uniform disc kept on a horizontal surface is stuck by cue at height h above central line.



Column I	**Column II**
(A) $h = \frac{R}{2}$	(p) Friction acts towards left
(B) $h > \frac{R}{2}$	(q) Friction force is zero
(C) $h < \frac{R}{2}$	(r) Friction acts towards right
(D) $h = 0$	(s) Work done against friction is zero after pure rolling begins
	(t) Contact force is inclined to the left of vertical

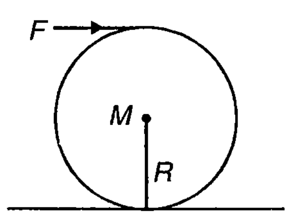
33. Four objects travel the same distance down four inclines all tilted at the same angle. Objects A and B are blocks that slide, while objects C and D are round and D rolls without slipping. Inclines A and C have no friction, inclines B and D have some friction



In moving from the top to the bottom, match the entries in **Column I** with all the entries in **Column II. More than one match is possible.**

Column I	**Column II**
(A) Biggest change in total kinetic energy	(p) A
(B) Smallest change in total kinetic energy	(q) B
(C) Biggest change in linear kinetic energy	(r) C
(D) Smallest change in linear kinetic energy	(s) D

34. Suppose a force F is applied at topmost point of rigid bodies of radius R and mass M



Column I	**Column II**
(A) Force of friction will be zero for	(p) Solid sphere
(B) Force of friction will be forward for	(q) Disc
(C) Force of friction will be backward for	(r) Ring
(D) Work done against friction is zero for	(s) No uniform round body
	(t) Hollow cylinder

35. Match the following

Column I	Column II
(A) Solid sphere is rolling without slipping. The ratio of rotational kinetic energy to translational *KE*	(p) $\frac{5}{7}$
(B) When ring and disc both roll on inclined plane, ratio of their times to reach bottom	(q) $\frac{2}{5}$
(C) A solid sphere rolls without slipping. Ratio of friction force to net force	(r) $\frac{2}{\sqrt{3}}$
(D) Ratio of translational KE to total KE for a hollow sphere rolling on an inclined plane	(s) 0.67
	(t) < 1

36. Consider the motion of a planet around sun in an elliptical orbit

Column I	Column II
(A) Mechanical energy of sun and planet system	(p) Remains constant during the orbit
(B) Kinetic energy of planet	(q) Is same after one complete revolution
(C) Angular velocity of planet about sun	(r) Changes continuously during the orbit
(D) Momentum of planet	(s) Changes continuously but becomes same after one come revolution
	(t) Always remains zero

37. Match the entries in **Column I** to all the entries in **Column II**.

Column I	Column II
(A) Escape velocity from surface of a planet	(p) $\sqrt{Rg}$
(B) Gravitational potential at the surface of planet	(q) $-\frac{GM}{R}$
(C) Gravitational potential at centre of planet	(r) $-\frac{3GM}{2R}$
(D) Orbital velocity of a body near the surface of a planet	(s) $\sqrt{2Rg}$
	(t) Is different for different planets

38. Match the entries in **Column I** to all the entries in **Column II**.

Column I	Column II
(A) Time period of infinite length pendulum	(p) mgh for small value of h
(B) Gravitational potential at a point P inside the shell at a distance r from the centre R is the radius of sphere	(q) $\frac{-GM}{R}$
(C) Kepler's law	(r) $2\pi\sqrt{\frac{R}{g}}$
(D) Work done against gravity	(s) Conservation of angular momentum
	(t) $\frac{mgh}{1+\frac{h}{R}}$ for large value of h

39. Match appropriately

Column I	Column II
(A) Kinetic energy of a body projected from surface of earth with speed more than escape speed, at large distance from surface of earth ___________	(p) Must be zero
(B) Gravitational potential energy of a bound system ____________ (Assuming reference level at infinity)	(q) May be zero
(C) Change in potential energy of a point mass if left free to itself, with time________	(r) Positive
(D) Change in areal velocity of earth as it moves from apogee towards perigee_____	(s) Negative
	(t) Cannot be zero

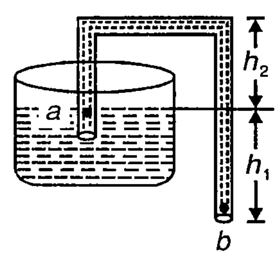
40. An ice block is floating in a liquid of specific gravity ρ. When ice melts, the level of fluid

Column I	Column II
(A) Rises up	(p) $\rho = 1$
(B) Falls down	(q) $\rho > 1$
(C) Remain unchanged	(r) $\rho < 1$
(D) Fraction of volume of ice block in water is	(s) 9/10
	(t) $\rho \neq 1$

41. A pitot tube is a L shaped device to determine the velocity of flow of liquid at a required point in a stream. If nose of Pitot tube is

Column I	Column II
(A) Perpendicular to the direction of flow	(p) Level of water in vertical limb will rise
(B) Faces down stream	(q) Level of water in vertical limb will fall
(C) Faces up stream	(r) Level of water in vertical limb will be same
(D) In still liquid	(s) Level of water in the tube is same as level outside the level of water is decided by using
	(t) Bernoulli's theorem

42. A syphon transfers liquid from high level to low level as shown in figure. If ρ is density of liquid, P_0 is atmospheric pressure, v_a is velocity at point a and v_b is velocity at point b, then

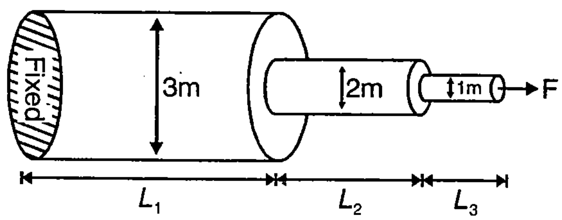


Column I	Column II
(A) $(h_1+h_2)-\dfrac{P_0}{\rho g}$	(p) $= 1$
(B) $v_a - v_b$	(q) < 0
(C) h_1	(r) > 0
(D) $P_a - P_b$	(s) $= 0$
	(t) Must be ≤ 1

43. In the table shown below, **Column II** shows the possible outcomes to the water level of a swimming pool where a person standing on a boat in it does any one of the actions shown in **Column I**. Match the outcomes

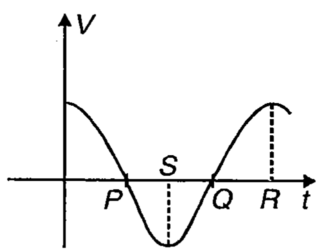
Column I	**Column II**
(A) He throws a 20 kg anchor from the boat into water, the anchor settles at the bottom	(p) It goes down
(B) He throws a 20 kg iron anchor from the boat into water, which remains hung from the boat, without touching bottom	(q) It goes up
(C) He throws out a 20 kg log of wood from the boat	(r) It remains the same
(D) He emplies 20 kg of water from the boat into the pool	(s) The level can either go up or down
	(t) The outcome cannot be predicted

44. Three wires of lengths L_1, L_2, L_3 and Youngs moduli Y_1, Y_2 and Y_3 respectively are pulled by a force F as shown in figure. The extensions produced in wires are ΔL_1, ΔL_2, ΔL_3. Match the Column-I with Column-II.



Column-I	**Column-II**
(A) If $9L_2 = 4L_1$ and $\Delta L_1 = \Delta L_2$, then	(p) $Y_2 = Y_1$
(B) If $L_2 < 4L_3$ and $\Delta L_2 = \Delta L_3$, then	(q) $Y_2 > Y_1$
(C) If $\Delta L_1 = \Delta L_2$ and $L_1 = L_2$, then	(r) $Y_2 < Y_3$
(D) If $L_2 = L_3$ and $\Delta L_2 = \Delta L_3$, then	(s) $4Y_2 = Y_3$
	(t) Possible relation is $3Y_1 = 2Y_2 = 1Y_3$

45. Velocity-time graph of particle in SHM is shown in figure. Match the following



Column I	**Column II**
(A) At P	(p) Particle is at $x = -A$
(B) At Q	(q) Acceleration of particle is maximum
(C) At R	(r) Displacement of particle is zero
(D) At S	(s) Acceleration of particle is zero
	(t) Phase is an odd multiple of π

46. Match the following

Column I	Column II
(A) Time period changes as system is taken on moon	(p) Simple pendulum
(B) Time period does not change as system is taken on moon	(q) Physical pendulum
(C) Time period depends on inertia of system	(r) Torsional pendulum
(D) Time period depends on length of system	(s) Spring-mass system
	(t) Conical pendulum

47. Match the following

Column I	Column II
(A) Motion of particle $\vec{r} = (\hat{i} + 2\hat{j})A\cos\omega t$	(p) Straight line
(B) Motion of particle $\vec{r} = A(\hat{i}\sin\omega t + \hat{j}\cos\omega t)$	(q) Ellipse
(C) Motion of particle $\vec{r} = \frac{A}{2}\sin\omega t\,\hat{i} + A\cos\omega t\,\hat{j}$	(r) Periodic
(D) Motion of particle $r = A^2\sin^2\omega t$	(s) Circle
	(t) Simple harmonic

48. $\vec{a}$, $\vec{v}$ and $\vec{r}$ are acceleration, velocity and displacement respectively for particle executing SHM then

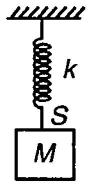
Column I	Column II
(A) $\vec{v}\cdot\vec{r}$	(p) May be positive
(B) $\vec{a}\cdot\vec{r}$	(q) Must be positive
(C) $\vec{a}\times\vec{r}$	(r) May be negative
(D) $\vec{v}\times\vec{a}$	(s) Must be non-positive
	(t) Must be non-negative

49. Match the following

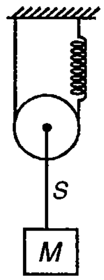
Column I	Column II
(A) Periodic motion	(p) 50% of total energy
(B) Simple harmonic motion	(q) Repeats after regular time interval
(C) Average PE of cycle	(r) Acceleration $a \propto -y$, where y is displacement
(D) Damping force	(s) Depends on velocity
	(t) Force is necessary

50. In the following four situations given in **Column I** mass M of 1 kg is hanging in a state of equilibrium. The spring has a stiffness 100 N/m in each case. The string is light, inextensible and there is no friction anywhere. **Column II** lists the possible speed that can be given to block in vertical direction so that the string(s) does not become slack during subsequent motion. Match them appropriately

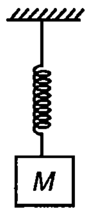
Column I | **Column II**

(A) 

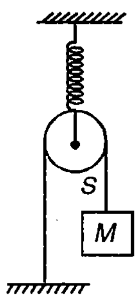
(p) 0.5 m/s

(B) 

(q) 1 m/s

(C) 

(r) 0.25 m/s

(D) 

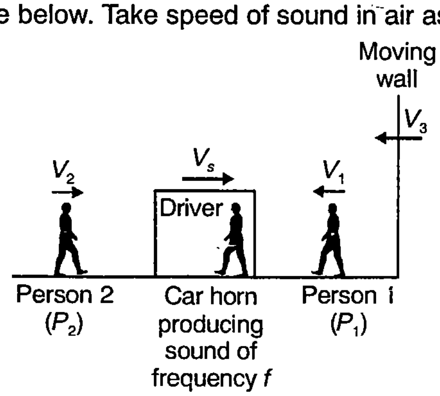
(s) 2 m/s^{-1}

(t) 1.5 m/s

51. In $y = A \sin \omega t + A \sin\left(\omega t + \dfrac{2\pi}{3}\right)$

Column I	**Column II**
(A) Maximum acceleration	(p) $A\omega^2$
(B) Amplitude	(q) A
(C) Initial phase	(r) $\dfrac{\pi}{3}$
(D) Maximum velocity	(s) $A\omega$
	(t) Dimensions are non-zero in length or time or both

52. Consider situation shown in figure below. Take speed of sound in air as V.

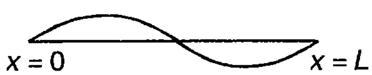


For direct wave, match entries from **Column I** & **Column II**

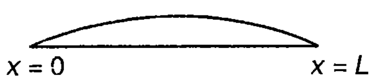
Column I	**Column II**
(A) Wavelength as received by P_1 & wall	(p) $\frac{V}{f}$
(B) Wavelength as received by driver	(q) $\frac{V-V_s}{f}$
(C) Wavelength as received by P_2	(r) $\frac{V+V_s}{f}$
(D) Frequency as received by wall	(s) $\frac{V+V_3}{V-V_s}\times f$
	(t) Different from natural due to motion of car only

53. **Column I** shows different set of standing waves in a string of length L whose ends are either fixed or free. Entries in **Column II** shows possible equations for them, where symbols have usual meanings

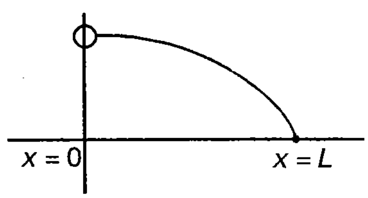
Column I / **Column II**

(A) 

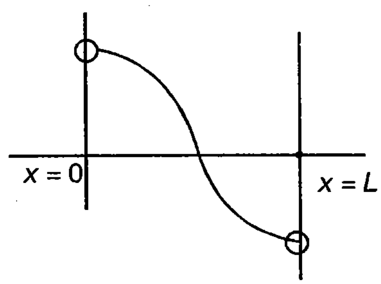
(p) $y = A\sin\frac{\pi x}{L}\cos\omega t$

(B) 

(q) $y = A\sin\frac{2\pi x}{L}\cos\omega t$

(C) 

(r) $y = A\cos\frac{\pi x}{2L}\cos\omega t$

(D) 

(s) $y = A\cos\frac{\pi x}{L}\cos\omega t$

here n = 1, 2, 3...

(t) $y = A\sin\frac{\pi x}{L}\sin\omega t$

54. For harmonic wave y = (2 cm) sin ($3t-4x$) where y & x in cm, t in second, match the following :

Column I	**Column II**
(A) Particle at $x = 0$ at $t = 0$ is	(p) Moving downwards
(B) Particle at $x = \frac{\pi}{8}$ cm at $t = 0$ is	(q) Moving upwards
(C) Particle at $x = 0$ at $t = \frac{\pi}{3}$ s is	(r) Accelerated upwards
(D) Particle at $x = \frac{\pi}{8}$ cm at $t = \frac{\pi}{3}$ s is	(s) Accelerated downwards
	(t) At rest

55. For transverse wave on string

Column I	Column II
(A) If amplitude increases	(p) Maximum instantaneous power increases
(B) If frequency increases	(q) Average power increases
(C) If amplitude decreases	(r) Maximum instantaneous power decreases
(D) If frequency decreases	(s) Average power decreases
	(t) Wavelength changes if speed is constant

56. Two strings are joined as shown in figure

μ_1 and μ_2 are mass per unit length

Column I	Column II
(A) Wave speed is	(p) Same on both strings
(B) Wavelength is	(q) Different on both strings
(C) Frequency is	(r) More on 1st string
(D) Power assuming same amplitude is	(s) Less on 1st string
	(t) Same only if $\mu_1 = \mu_2$

57. Suppose wave pulse has been created at free end of taut string by moving the hand up and down once. The string is attached at its other end to a distant wall.

Column I	Column II
(A) Moving hand more quickly up and down once by same amount	(p) Amplitude changes
(B) Moving hand more quickly up and down once by more amount in same time	(q) Width of pulse changes
(C) Moving hand at same speed up and down once by more amount	(r) Wave speed changes
(D) Moving hand more quickly up and down once by less amount	(s) Maximum particle speed changes
	(t) Average power changes

58. A wave is transmitted from denser to rarer medium then match following

Column I	Column II
(A) Frequency of wave	(p) Will increase for sound wave
(B) Speed of wave	(q) Will decrease for sound wave
(C) Wavelength of wave	(r) Remains unchanged for sound wave or light wave
(D) Amplitude of wave	(s) Will increase for light wave
	(t) Will decrease for light wave

59. In closed organ pipe

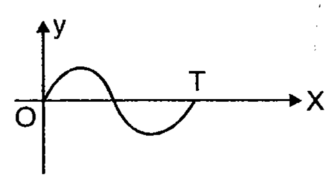
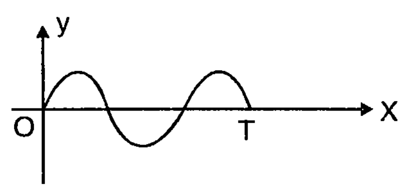
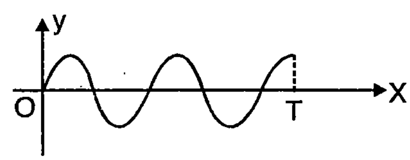
Column I	**Column II**
(A) Third overtone frequency is x times fundamental frequency then x is	(p) 3
(B) Number of nodes in second overtone	(q) 4
(C) Number of antinodes in second overtone	(r) 5
(D) n^{th} harmonic does not exists, where n is	(s) 7
	(t) 6

60. Three travelling sinusoidal waves are on a string. Equation of waves are

y_1 = A sin (3x ñ 6t)

y_2 = A sin (4x ñ 8t)

y_3 = A sin (6x ñ 12t)

Column I	**Column II**
(A) Speed of each wave	(p) 
(B) y_1 is represented by	(q) 
(C) y_2 is represented by	(r) 
(D) y_3 is represented by	(s) 2 m/s
	(t) Depends on tension and linear mass density of each string

❑ ❑ ❑

SECTION - F

Subjective Type Questions

This section contains 60 subjective questions.

Solve the followings :

1. A screw gauge with pitch 1 mm and 100 divisions on circular scale is used to measure the thickness of a glass-slab. When there is no object between the studs and the faces of the screw gauge touch each other, the 40th division of circular scale coincides with the reference line. Now, the glass place is held between the studs and reading of linear scale is found to be 5 and that of circular scale is 26. What is the thickness of the glass plate? It is given that zero of linear scale is not visible when the faces touch each other.

2. Using dimensional analysis, form a dimension less quantity or expression using angular velocity (ω) gravitational constant (G), radius of earth (R) and density (ρ).

3. Let $\vec{A}$ be a constant vector of magnitude A and $\vec{P}$ be a vector $\perp$ to $\vec{A}$ such that $\frac{d\vec{P}}{dt} = \vec{A} \times \vec{P}$. Show that the vector $\vec{P}$ revolves in a plane perpendicular to vector $\vec{A}$. Find its angular velocity.

4. If $\vec{A} \times \vec{B} = \vec{C} + \vec{D}$, then show that the component of $\vec{C}$ along $\vec{A}$ is equal and opposite to component of $\vec{D}$ along $\vec{A}$.

5. A particle moves in xñy plane along the curve $y = x^3 \tilde{n} 9x^2$. Write possible unit vector in the direction of motion, when the particle is at any point P (x, y).

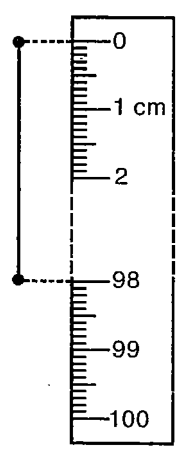
6. The unknown resistance in a meter bridge is given by $x = \left(\frac{\ell}{100 \tilde{n} \ell}\right)R$ where ℓ is the distance of null point from one end. Find the value of ℓ for which error in determination of x is minimum.

7. Following figure shows an experimental set up to determine acceleration due to gravity. Following measurements were taken.

   (i) ℓ = 98.0 cm

   (ii) Time for 50 oscillations is 98 s.

   If the least count of the stop watch is 1 s, what is the calculated value of acceleration due to gravity in this experiment.



8. A length S is divided into n equal parts, at the end of each of which, the acceleration of a moving point is increased by f/n. Find the velocity of the point after describing the distance s given that the particle started from rest with acceleration 'f'.

9. For $\frac{1}{m}$ of the distance between two stations, a train is uniformly accelerated for $\frac{1}{n}$ of the distance then it is uniformly retarded. It starts from rest at one station and comes to rest at the other. Find the ratio of its greatest velocity to its average velocity.

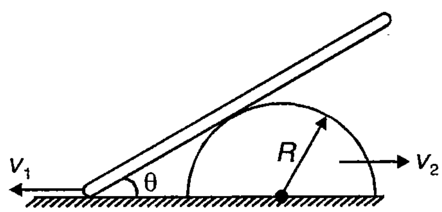
10. A train accelerates between two stations A and B. Its acceleration is given by the relation $a = \alpha - \beta x$. Find
    (a) Maximum velocity of the train
    (b) The distance between two stations
    (c) The distance from station A where its velocity becomes maximum

11. A particle projected horizontally from a tower of height h strikes an inclined plane of inclination θ with the horizontal. After striking it returns to the tower with the same speed at which it was projected. Find
    (a) Velocity of projection
    (b) When it will return back to the tower
    (c) Horizontal and vertical displacement before it strikes the inclined plane

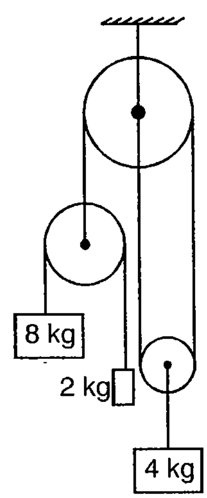
12. A battle ship A slights another ship B distant a km. steering in a direction at right angles to AB with a speed of v km/hr. A alters her course so as to pass in front of B and to come to a nearest distance c km from B. If the new course makes an angle α with AB, prove that A's speed is $\frac{v\cos\beta}{\sin(\alpha-\beta)}$ km/hr, where $\sin\beta = \frac{c}{a}$.

13. A point mass starts moving in a straight line with a constant acceleration a. At a time t, after the beginning of motion, the acceleration changes sign, remaining the same in magnitude. Determine the time from the beginning of motion in which the point mass returns to the initial position.

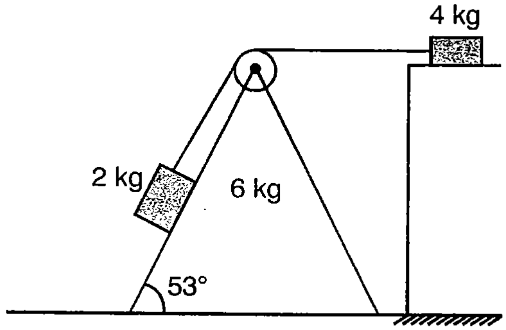
14. Consider the situation as shown in figure, a hemisphere and a supported rod. The hemisphere is moving in right direction with a uniform velocity v_2 and the end of rod which is in contact with ground is moving in left direction with a velocity v_1. Find the rate at which angle θ is changing in terms of v_1, v_2, R and θ.



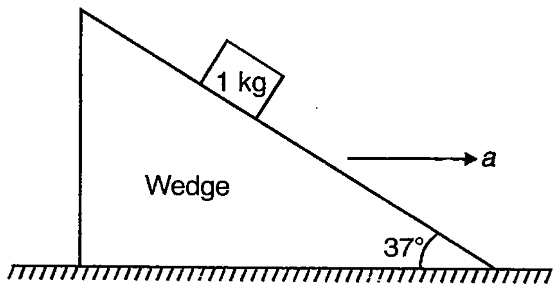
15. Determine the $\vec{a}$ of the blocks in the system shown in figure assuming that pulleys and strings are ideal. (g = 10 m/s²)



16. Assuming all surfaces to be smooth, find acceleration of wedge and block of mass 4 kg.



17. The block of mass 1 kg is placed on a smooth wedge of inclination 37° which gets a horizontal acceleration '*a*' to the right. Find acceleration of block 1 kg w.r.t. wedge, when



(a) $a = \frac{3g}{5}$

(b) $a = \frac{g}{4}$

(c) $a = \frac{3g}{4}$

18. A weightless inextensible string is wound around a cylinder of mass '*m*'. With what minimum force and at what angle α to the horizontal should the string be pulled for the rotating cylinder to remain in place? The coefficient of friction between the cylinder and the floor is μ.

19. A block of mass *m* is kept on a rough inclined surface making an angle θ with horizontal. If the block starts from rest and covers a distance of *l* meter in first *t* second of its motion, calculate the coefficient of kinetic friction.

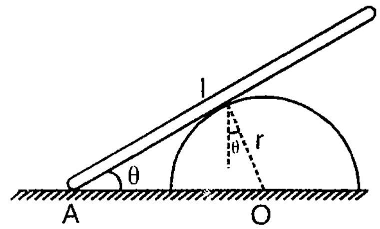
20. A block of mass 2 kg slides down an inclined plane which makes an angle of 30° with the horizontal. The coefficient of friction between the block and the surface is $\frac{\sqrt{3}}{2}$

(i) What force must be applied to the block so that the block moves down the plane without acceleration?

(ii) What force should be applied to the block so that it can move up without any acceleration?

(iii) Calculate the ratio of the powers needed in the above two cases, if the block moves with the same speed in both the cases.

21. A uniform bar of length ël í rests with one end on a horizontal floor and the other on a half-cylinder of radius r. The coefficient of friction on the ground and on the cylinder are both equal to μ. Find



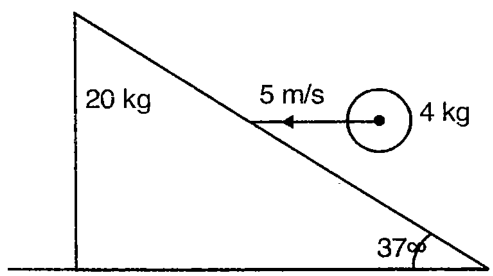
(i) The minimum coefficient of friction μ in terms of r, l and θ.

(ii) If radius of the half-cylinder $r = \frac{l}{2}$ and $\theta = 30$∞, what will be the value of ëμí?

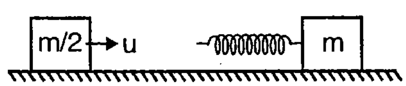
22. Four balls of equal radii form a pyramid supported by a smooth horizontal plane surface. The three balls (lower) are held together by an encircling string. If the weight of each ball is 100 N, determine the tensile force in the string.

23. A small mass falls vertically and strikes an inclined plane of inclination 30ƒ. After impact velocity of ball becomes horizontal. Consider the inclined plane to be fixed, find the coefficient of restitution.

24. A ball of mass 4 kg elastically collides with 20 kg block kept over a smooth surface. Find impulse imparted by wedge to ball.

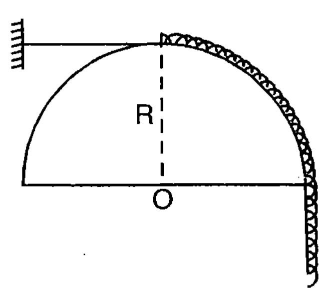


25. A block of mass m is connected to a spring of spring constant k. The other end of the spring is free. A block of mass $\frac{M}{2}$ moving with speed u is moving towards this arrangement (see figure). Find the compression in the spring when the speed of $\frac{m}{2}$ has become nu(n < 1).



26. A bullet of mass m moving with a speed u hits and paneterates a thickness x in to a wooden block of mass M before coming to rest in it. If the wooden block is free to move on a smooth surfaces, find the average force experienced by the bullet.

27. A chain of length πR is held at rest on a fixed, smooth hemisphere of radius R as shown. The thread is cut. Find the speed of the chain, when it leaves the hemisphere.

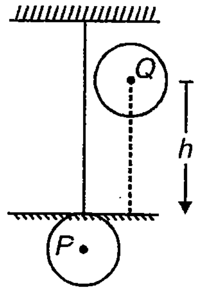


28. A pendulum bob of mass m is suspended at rest. A constant horizontal force $F = mg$ start acting on it. Find

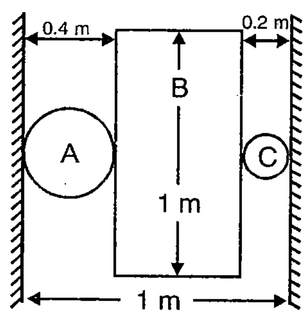
    (a) The maximum angular deflection of the string.

    (b) The maximum possible tension in the string.

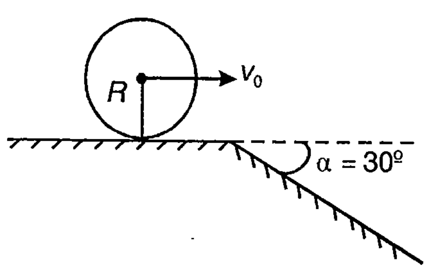
29. A ball P is hanging from an inextensible cord BC. An identical ball Q is released from rest when it is just touching the cord. If there is no loss of energy due to collision, determine the maximum height to which P moves after collision. The ball Q fall through a height h before collision.



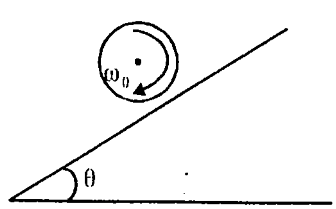
30. Three cylinders A, B and C are held between vertical walls at separation of 1m (See in figure). The length of cylinder B is 1 m and mass 2.5 kg while masses and diameter of A and C are 2 kg and 0.4 m and 1 kg and 0.2 m respectively. The system is in a vertical plane & is released from rest. The cylinders A and C roll without slipping along vertical wall and cylinder B. Find acceleration of cylinder B (g = 10 m/s²)



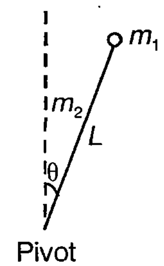
31. A uniform cylinder of radius R = 15 cm rolls over a horizontal plane changing into an inclined plane forming an angle α = 30° with the horizontal. Find the maximum value of velocity v_0 which still permits the cylinder to roll on to the inclined plane section without a jump. The sliding is assumed to be absent.



32. A sphere of mass m and radius R initially rotating about its centroidal axis with ω_0 is gently placed on rough inclined plane with its axis horizontal as shown in figure. The angle of inclination of plane is θ. Find the time after which sphere starts pure rolling.



33. A uniform rod of length L and mass m_2 is pivoted at one end as shown. To its other end is fastened a uniform disk of mass m_1 and radius r. Find angular acceleration of system just after it is released from the position shown.



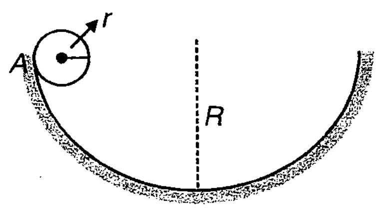
34. A rod of length 1 m and mass 4 kg can rotate freely in a vertical plane around its end A. The rod is initially held in horizontal position and then released. At the instant, when the rod makes an angle 45º with the vertical, calculate

(a) Its angular acceleration

(b) Its angular velocity

35. Starting from rest, a sphere rolls down a 30º incline. What is minimum value of coefficient of static friction if there is to be no slipping

36. A small sphere of radius r is released from point A as shown in large hermispherical bowl of radius R. Sphere purely rolls. Find



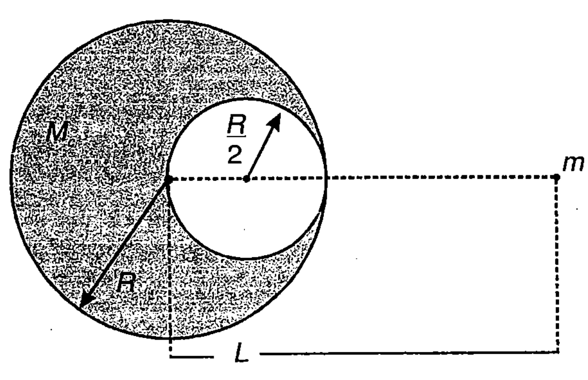
(a) Fraction of translation and rotational energy when sphere reaches bottom of bowl

(b) Normal force on sphere when it is at bottom of sphere

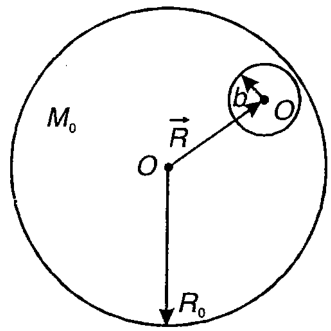
37. A particle of mass m was transferred from the centre of the base of a uniform hemisphere of mass M and radius R to infinity. What work was performed in the process by the gravitational force exerted on the particle by the hemisphere?

38. Two particles of massès m_1 and m_2 separated a distance L from each other are released from their initial rest state. What will their velocity be, when the distance between them is l ?

39. Calculate the gravitational pull exerted upon a mass m due to a sphere of radius R in which a cavity of radius $\frac{R}{2}$ was made as shown in figure.



40. Consider a sphere of radius R_0 and mass M_0. Inside it is a spherical cavity of radius b. The distance between the two centres is R (as shown in figure). Calculate the gravitational force acting on a mass m inside the cavity.



41. Show that for a planet of mass m moving in an elliptical orbit of semi-major axis 'O' with sun (mass M) at its focus, the total mechanical energy is $\frac{-GMm}{2a}$

42. A stationary container of negligible mass is filled with water to a height h_1. A small hole is punched at the bottom. If the tank be placed on smooth floor, then find the velocity acquired when the tank becomes empty upto a height h_2.

43. An aerometer floats in water which wets its walls completely. The diameter of the vertical cylindrical tube of the aerometer d = 9 mm. How much will the depth of submergence of the aerometer change, if several drops of alcohol are poured onto the surface of water? (Surface tension of water = 0.073 N/m, surface tension of alcohol = 0.02 N/m)

44. A rectangular gate 3 m × 1 m stands vertical with water on side of it, hinged at the middle. Find the force required to be applied at the bottom to keep the gate in equilibrium.

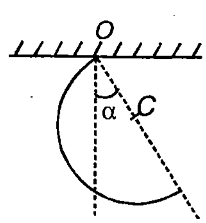
45. A cube floating in mercury contained in a beaker has one-third of its volume submerged in mercury. Water is poured into the beaker till the cube is completely covered. What fraction of the volume of the cube is now submerged in mercury? The relative density of mercury = 13.6.

46. A horizontal tube of length 0.25 m and of uniform cross-section is open at one end and has a small hole at the other end. The tube is filled with a liquid and then rotated at an angular speed of 4 rad/s about the vertical axis passing through the open end. Find the velocity of flow of the liquid from the hole at the instant when 0.15 m of liquid column is left in the pipe. Neglect the viscosity of the liquid.

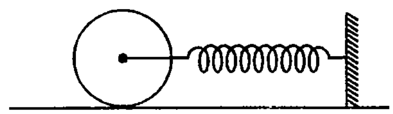
47. A semicircular ring is pivoted at O. Mass of ring is M and radius is R

(a) Find value of α for equilibrium position

(b) If it is slightly displaced from its equilibrium position, find frequency of oscillation.



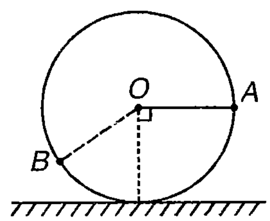
48. A solid sphere, a solid cylinder and a ring are attached to massless spring of spring constant k one-by-one. All bodies roll without slipping. Find ratio of their time periods.



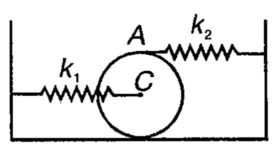
49. The angular frequency of particle executing SHM is ω rad/s. There is a point A at distance x_0 from mean position O. When particle passes A along OA it has speed v_0. Find the time in which it returns to A again.

50. Two blocks A(3kg) and B(6kg) resting on a smooth horizontal surface are connected by a spring of stiffness 120 N/m. Initially spring is undeformed. A is imparted a velocity of 4 m/s along line of spring away from B. Find displacement of A t seconds later.

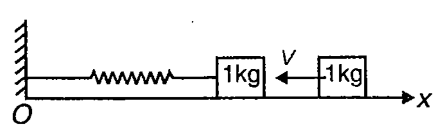
51. A disc of mass M = 4 kg, radius R = 1 m is attached with two blocks A and B of masses 1 kg and 2 kg respectively on the rim and is resting on a smooth horizontal surface with its plane vertical as shown in figure. Find angular frequency of small oscillations of arrangement.



52. A solid sphere of mass 2 kg is kept in equilibrium on horizontal surface. Two unstretched springs of force constant k_1 = 10 N/m and k_2 = 20 N/m are attached to sphere as shown in figure. Find time period of oscillation. The sphere rolls without sliding.



53. One end of an ideal spring is fixed to wall at origin O and axis of spring is parallel to x-axis. A block of mass 1 kg is attached to free end of spring which performs SHM. Equation of position of block in coordinate system shown in figure is $x = 10 + 3\sin(10t)$, where t is in seconds and x in cm. Calculate force constant of spring. Another identical block moving towards origin with velocity 60 cm/s collides elastically with block performing SHM at $t = 0$. Calculate new amplitude of oscillation and equation of motion of block performing SHM.



54. A harmonic wave is travelling in stationary medium as $y = A\sin(\omega t - kx)$. Find equation of this wave w.r.t. frame which is moving along –ve x-axis with constant speed v w.r.t. stationary medium. Find speed of wave in moving frame.

55. For an organ pipe, three successive resonances are observed at 425, 595 and 765 Hz. Taking speed of sound to be 340 m/s, find length of pipe in metre.

56. Atomic weight of iodine is 127 gm/mole. A standing wave, in iodine vapour at 400 K, produces nodes 9.57 cm apart with frequency 1000 Hz. What is atomicity of iodine vapour?

57. A plane undamped harmonic wave propagates in a medium. Find mean space density of total energy, if at any point in space, density of energy is W_0 at $t = t_0 + \frac{T}{6}$ where t_0 is time when amplitude is maximum and T is time period of oscillation.

58. Loudness of sound from an isotropic point source at distance of 10 m is 20 dB. What is the distance at which it is not heard.

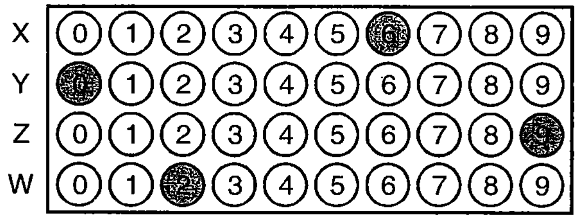
59. A source of sound with frequency 1000 Hz and a receiver are located at the same point. At the moment $t = 0$, the source and receiver start receding from each other with acceleration 3.0 m/s^2 and 2.0 m/s^2. Find the oscillation frequency registered by the receiver at $t = 9$s from the start.

60. In a resonance tube experiment, to determine the speed of sound in air, a pipe of diameter 5 cm is used. The air column in pipe resonates with a tuning fork of frequency 480 Hz. When the minimum length of air column is 16 cm. Find the speed of sound in air.

❑ ❑ ❑

SECTION - G
Integer Answer Type

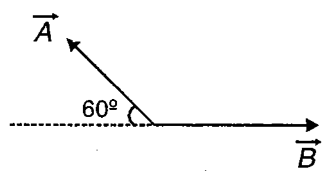
This section contains 51 questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W(say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following :



1. Angle between two vectors $(\hat{i}+\hat{j}+\hat{k})$ and $(\hat{i}+\hat{j})$ is θ. Find the value of $2\sec^2\theta$.

2. If in certain system of units, unit of mass is 2 times the unit of mass in SI system, unit of length is 2 times the unit of length in SI system and unit of time is 4 times the unit of time in SI system. Find the numeral value associated with 1 joule work in this system of unit.

3. If resultant of the following two vectors is perpendicular to the vector $\vec{A}$, then find the magnitude of the resultant. Magnitude of $\vec{A}$ is $2\sqrt{3}$.



4. $\vec{a}_1$ and $\vec{a}_2$ are two non co-linear unit vector. Given that $|\vec{a}_1+\vec{a}_2|=\sqrt{3}$. If $(\vec{a}_1-\vec{a}_2).(2\vec{a}_1+\vec{a}_2)=\frac{1}{n}$. Find *n*.

5. What is the maximum value *y*, if

$$y=4\sin\omega t+8\sin\left(\omega t+\frac{2\pi}{3}\right)+4\sin\left(\omega t-\frac{2\pi}{3}\right)?$$

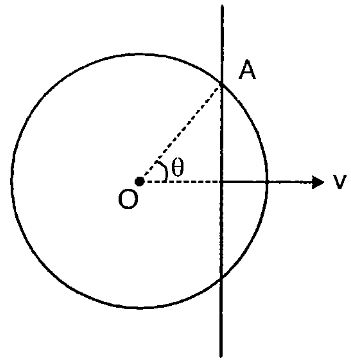
6. A particle moves along a straight line according to the law $S^2 = at^2 + bt + c$. The acceleration of the particle varies as $S^{-\alpha}$. Find α.

7. A stone *A* is dropped from rest from a height $h = 8.1$ m above the ground. *A* second stone *B* is simultaneously thrown vertically up with velocity *v*. Find the value of *v* which would enable the stone *B* to meet the stone *A* midway between their initial position. (Take $g = 10$ m/s^2) (in m/s)

8. A ball is projected from ground with speed $10\sqrt{3}$ m/s at angle 60º from the horizontal. After how much time (in s) its velocity makes angle 60º with the vertical (Take $g = 10$ m/s^2)?

9. Two particles *A* and *B* are at (0, –*a*) and (0, 0). At a certain instant *'B'* starts moving with constant velocity $u\hat{i}$. At the same instant *A* starts moving with the same speed such that its velocity is always directed toward *B*. The distance between the two particles, at the instant when velocity of *A* is at angle 60º with the *x*-axis, is $\frac{2a}{x}$. Find the value of *x*.

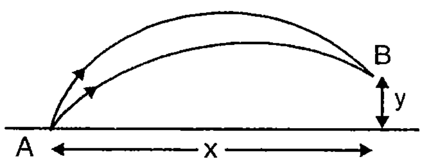
10. Figure shows a ring of radius 2 m and a rod of length l. The rod is moving with velocity 4 m/s perpendicular to its length. Find the angular speed (in rad/s) of point of intersection 'A' w.r.t. O at the instant when θ = 30ƒ.



11. Two balls are projected from a point in two mutually perpendicular vertical planes. Speed of projection of both the balls is 400 m/s. Angle of projection with horizontal is 53ƒ for both the balls. After how much time (in s) their velocities will be at angle 60ƒ from each other? (Take g = 10 m/s^2)

12. Acceleration (a) of a particle moving along x axis is given by "a = 8 ñ 4x". Velocity of the particle at x = 0 is zero. Find the speed of the particle at x = 2.

13. A boy throws a ball with a speed $20(\sqrt{3}+1)$ m/s at angle 60ƒ from horizontal. If he throws another ball with the same speed at an angle 30ƒ, determine the time interval between the two throws so the balls collide in mid air at B. (Take g = 10 m/s^2)

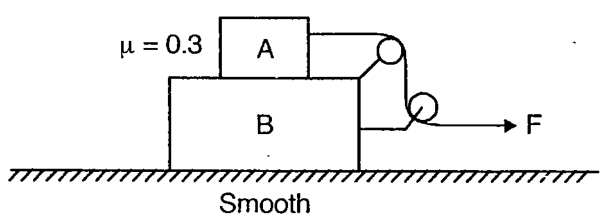


14. A stone is projected from the point on the ground in such a direction so on to hit a bird on the top of a telegraph post of height h and then attain maximum height 2h above the ground. If at the instant of projection bird were to fly away horizontally with uniform speed $v = 2(\sqrt{2}-1)$ m/s. Find the horizontal velocity of the stone if the stone still hits the bird while descending

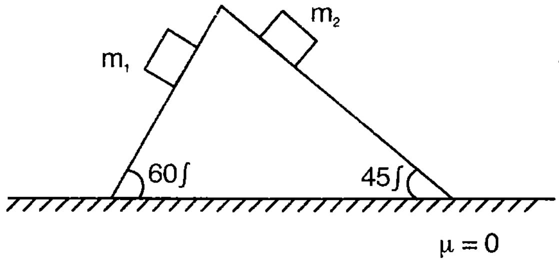
15. A particle is moving in a plane according to the law x = at^2, y = bt^3 where a = 2 m/s^2 and b = 1 m/s^3. Radius of curvature of path of the particle at t = 1 s is found to be $\frac{n^3}{12}$. Find n.

16. A car goes on horizontal circular road of radius R = 1 m, the speed increasing at a rate $\frac{dv}{dt}$ = 3 m/s^2. The friction coefficient between road and tyre is $\mu = \frac{1}{\sqrt{10}}$. Find the speed at which car will skid.

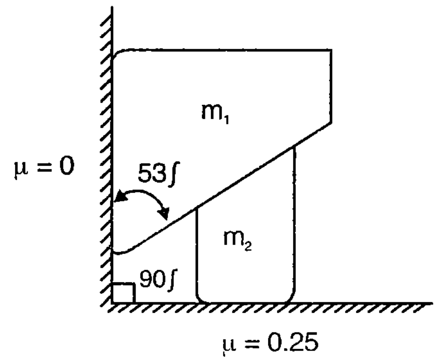
17.. Consider the following arrangement of two blocks A and B. Coefficient of friction between the two blocks A and B is 0.3. There is no friction between the block B and ground. Pulleys and string are light. Find the maximum value of F (in N) for which there is no slipping between the two blocks (m_A = 1 kg and m_B = 3 kg).



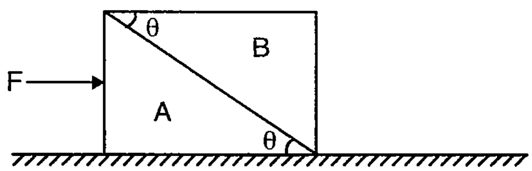
18. Figure shows a wedge on smooth horizontal ground. Two blocks of masses m_1 and m_2 are released from rest on the smooth and inclined surfaces of the wedge. If the acceleration of the wedge is zero then find the value of $\left(\frac{4m_2^2}{m_1^2}\right)$.



19. Consider the arrangement shown in the figure. The mass m_2 is 12 kg. Friction coefficient between m_2 and ground is 0.25. All other contact surfaces are frictionless. Find the maximum value of m_1 (in kg) for which the system remains in equilibrium.



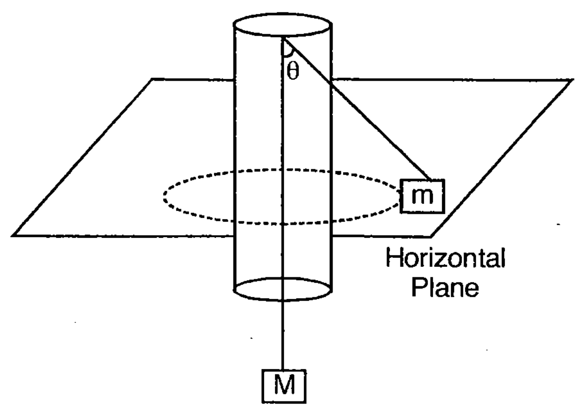
20. A wedge 'A' is resting on another wedge 'B' as shown in the figure. Both wedges have same mass $\left(\frac{21}{88}\right)$kg. The angle θ is 37°. The coefficient of friction between the two wedges is $\frac{1}{6}$. Find the maximum value of F (in N) for which there is no sliding between wedges.



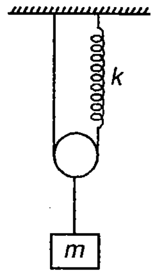
Smooth ground

21. An object takes $\sqrt{2}$ times as much time to slide down a 45° rough incline as it takes to slide down a smooth 45° incline. Find the inverse of coefficient of kinetic friction between object and incline

22. A large mass M = 20 kg and a small mass m = 2 kg are at the two ends of the string that passes through a smooth tube as shown in figure. The mass m moves around in a circular path, which lies in horizontal plane. The length of the string from the mass m to the top of the tube is l = 10 cm and θ is the angle this length makes with vertical. What should be the number of revolution per second of mass m so that m remain stationary $(\sqrt{10} = \pi)$?



23. The block shown in figure is released from rest with the spring initially unstretched. The spring constant is 500 N/m and mass of the block is 1 kg. Find the maximum extension in spring (in cm)



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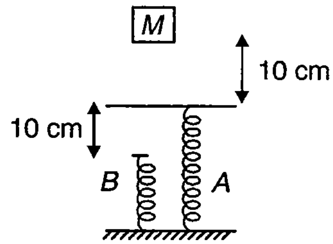
24. A block of mass 2 kg is released from rest on a spring A of spring constant 100 N/m as shown in the figure. The block compresses the spring B through a distance 10 cm. The spring constant of spring B is $x \times 10^2$ N/m. Find the value of x.



4

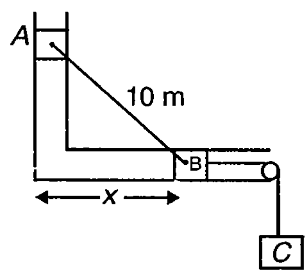
25. A particle experiences a force which is proportional to distance from origin and always directed towards origin. Work done by the force during displacement of the particles from (3, 4) to (3, 0) is 8 J. Find the constant of proportionality (in S.I. unit). [Co-ordinates are in metre]

26. In following expression E is energy, x is distance, T is temperature and k is Boltzman's constant. The dimensional formula of β is $M^aL^bT^c$. What is the value of $(a + b - c)$?

$$E = \frac{\alpha x^2}{\beta} e^{\frac{-kT}{\alpha x}}.$$

27. What is the value of $\frac{2500}{3}$ J energy in a system of unit where km, kg and minute are taken as fundamental unit?

28. Two bodies A and B connected by a light rigid bar 10 m long move in two frictionless guider as shown in figure. B starts from rest when it is vertically below A. If the velocity of B is found to be 138 β cm/s when x = 6 m Find β. Assume $m_A = m_B$ = 200 kg and m_C = 100 kg (use g = 9.8 m/s^2)



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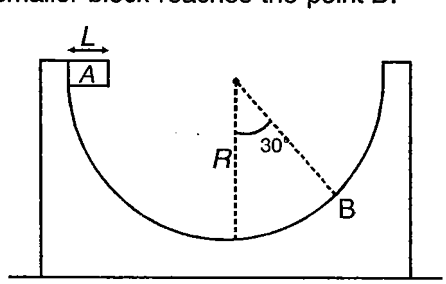
29. A cubical block of mass m and edge L (= 1 m) is released from the point A on a smooth block with semicircular track of radius R (= 10.5 m). The larger block has a mass 4 m. Find the linear distance (in m) travelled by larger block during the time the smaller block reaches the point B.

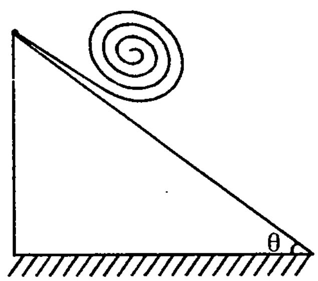


Smooth

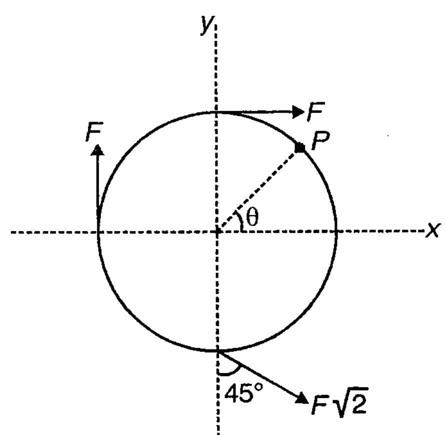
30. A body is projected vertically upwards from the ground with a speed of 20 m/s. After 1 s the body explodes into two parts in the ratio 1 : 3. After explosion the larger mass starts moving horizontally. If the maximum height reached by smaller mass is 19x in m then find the value of x. (Take g = 10 m/s^2)

31. 50 uniform rods each of mass 117 g are kept at x = 20 cm, 40 cm, 60 cm, ... parallel to the y - axis. The moment of inertia of the system approximately is 25x kg - m^2 about y - axis. Find the value of x.

32. A length L of flexible tape is tightly wound. it is then allowed to unwind as it rolls down a large incline that makes an angle θ with the horizontal, the upper end of the tape being fixed. Find the time taken by the tape to unwind completely. (in seconds) $\left(\text{use} \frac{L}{g \sin\theta} = 3\right)$



33. Three forces are acting on a ring placed in the x - y plane as shown. Taking P as the point of application of resultant force the value of θ is $\frac{\pi}{x}$. Find the value of x.

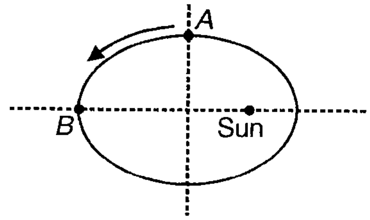


34. A satellite is orbiting around earth in a circular orbit of radius 44,800 km. Taking radius of the earth R = 6400 km, the surface area of the earth covered with this satellite is found to be $\frac{66xR^2}{49}$. Find the value of x.

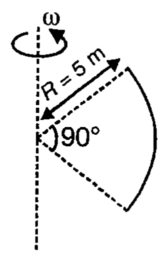
35. Two uniform solid spheres of equal radii R, but mass M and 4M have a centre to centre separation 6R. The two spheres are held fixed. A projectile of mass m is projected from the surface of the sphere of mass M directly towards the centre of the second sphere. Find the minimum speed v of the projectile so that it reaches the surface of second sphere. Neglect gravitational affect of all other masses. use $\left(\frac{GM}{R} = \frac{125}{3} \text{ SI unit}\right)$

36. A high jumper can jump height h on earth. With the same effort, if he is able to jump 24 m high on a planet whose density is one third and radius one fourth of earth. Find h.

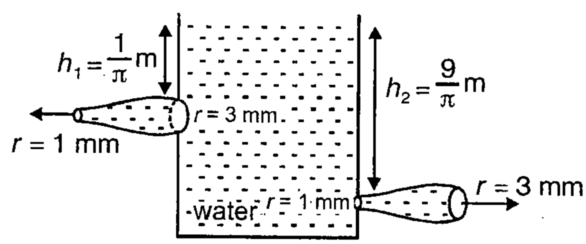
37. A planet is revolving around the sun in an elliptical orbit having eccentricity $e\left(=\frac{\pi}{4}\right)$. If the time period of revolution is 16 months then find the time taken by the planet in going from A to B in months.



38. A quarter ring made of a metal wire of breaking stress 2×10^9 N/m^2 and density 500 kg/m^3 is rotating with a constant angular velocity about the axis shown in the figure. If the value of ω at which the ring ruptures is $100x$ rad/s, then find the value of x.



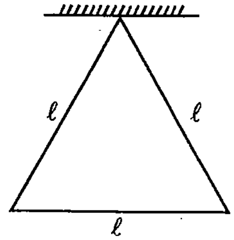
39. Water is filled in a large tank containing two small openings shown in figure. If the resultant horizontal force experienced by the vessel is $\frac{x}{5}$N then find the value of x.



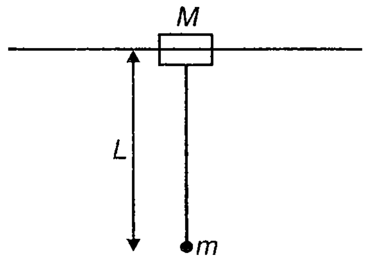
40. A tube having its two limbs bent at right angles to each other is held with one end dipping in a stream and opposite to the direction of the flow. If the speed of the stream is 10 m/s find the height to which the water rises in the vertical limb of the tube

41. If a number of little drops of water, all of same radius r and at same temperature coalesce to form a single drop of radius R. Find the rise in temperature of water. Given that J is the mechanical equivalent of heat, σ is the surface tension of water and $\frac{\sigma}{J}\left(\frac{1}{r}-\frac{1}{R}\right)=\frac{5}{3}$ kelvin

42. Three identical rods each of mass m and length $\ell(=6\sqrt{3}\,\text{m})$ are connected to form an equilateral triangle. This system is displaced slightly in its plane and released. Find the time period (in s) of small oscillations (take $g = \pi^2$)



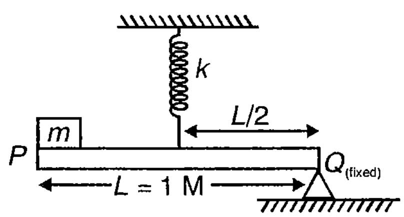
43. In the arrangement shown the block of mass M (= 8 kg) can slide freely on the horizontal rail. A simple pendulum of length L (= 5 m) having a bob of mass m(= 2 kg) is suspended from the load. Taking $g = \pi^2$, find the time period (in s) of small oscillations of the pendulum.



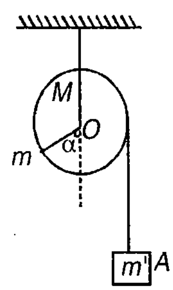
44. A point mass m is suspended at the end of a wire of negligible mass and of length L and cross section A. If y be the Young's modulus for the wire, find the time period of oscillations for the simple harmonic motion along the vertical line. (Take $\frac{Ay}{mL} = \pi^2$) (in seconds)

45. A block of mass 5 kg executes SHM under the restoring force of a spring on a smooth horizontal surface. The amplitude and the time period of the motion are 0.1 m and π s respectively. Find the maximum force exerted by spring on the block. (in Newton)

46. A rod PQ of mass M = 3 kg is attached as shown to a spring of spring constant $k = 8\pi^2$ N/m as shown. End Q of the rod is fixed. A small block of mass m = 1 kg is placed on the rod at its free end P. If end P is moved down, through a small distance x and released determine the period of vibration



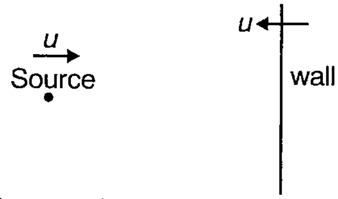
47. A uniform cylindrical pulley of mass M and radius R can freely rotate about the horizontal axis O. The free end of a thread tightly wound on the pulley carries a dead weight A. At certain angle α it counter balances a point mass m fixed at the rim of the pulley. If the frequency of small oscillation of the arrangement is found to be 5α seconds. Find α. Use $\frac{MR + 2mR(1+\sin\alpha)}{2m} = g\pi^2 \cot\alpha$ and $\pi^2 = 10$



48. A vertical cylinder of radius R contains a quantity of ideal gas and fitted with a piston of mass m that is free to move. The piston and the walls of the cylinder are made of a perfect thermal insulator. The outside pressure is P_0. In equilibrium the piston sits at a height h above the bottom of the cylinder. The piston is pulled up by a small distance and released. Find the time period of small oscillation of piston. (Use $\gamma = \frac{C_p}{C_v}$ and $[P_0(\pi R^2) + mg]\frac{\gamma}{mh} = \pi^2$)

49. The equation of resultant displacement of a point produced by two simple harmonic oscillations in the same direction is $y = a\cos(50\,\pi t)\cos(0.2\,\pi t)$. Find the period (in s) with which the two constituent oscillations beat.

50. A source of sound and a wall are moving towards each other with equal speed u. The speed of sound in the medium is $10u$. If the wavelength received by the wall is 11 units then find the wavelength reflected by the wall.



51. Two wires 1 and 2 same length and same density of radii r and $2r$ are welded together end to end. The combination is used on sonometer wire and is kept under tension T. The welded point is midway between the two bridges. What would be the ratio of number of loops $\frac{n_2}{n_1}$ formed in the wires such that joint is a node when stationary vibrations are set up in the wire?

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SECTION - H
Multiple True-False Type Questions

Identify the correct combination of true and false of the given three statements.

1. STATEMENT-1 : If velocity and acceleration of a particle are in same direction then speed of the particle increases.

   STATEMENT-2 : If velocity and acceleration of a particle are always perpendicular to each other the speed decreases.

   STATEMENT-3 : If acceleration of a particle is negative the speed of the particle decreases.

   (1) T T F (2) T T T (3) T F F (4) F T T

2. STATEMENT-1 : Cross product of any two unit vectors is also a unit vector.

   STATEMENT-2 : If a body is in equilibrium under the action of three forces then the forces must be concurrent.

   STATEMENT-3 : If resultant of four forces is zero, the forces must be coplanar.

   (1) F T F (2) T F T (3) T T F (4) F F F

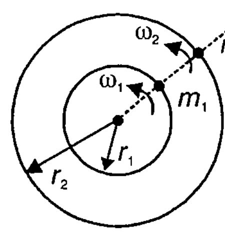
3. STATEMENT-1 : Pseudoforce acting on an object depends on acceleration of the object w.r.t. an inertial frame.

   STATEMENT-2 : Force always exist in pair called action force and reaction force.

   STATEMENT-3 : In uniform circular motion force acting on a particle is constant.

   (1) T F T (2) F F F (3) T T T (4) F T F

4. Two point objects of masses m_1 and m_2 are moving in concentric circular paths of radii r_1 and r_2 respectively. Their angular speeds are ω_1 and ω_2 respectively.



   STATEMENT-1 : Centrifugal force on m_1 w.r.t. m_2 is $m_1\omega_2^2r_2$.

   STATEMENT-2 : Centrifugal foce on m_2 w.r.t. m_1 is $m_2\omega_2r_2$.

   STATEMENT-3 : Net force on m_2 w.r.t. m_1 is constant in magnitude.

   (1) T F T (2) T F F (3) T T T (4) F T T

5. STATEMENT-1 : Force, momentum and time cannot be taken as fundamental quantities to define the unit of energy.

   STATEMENT-2 : Gravitational constant is a dimensionless quantity.

   STATEMENT-3 : Angular momentum and Planck's constant have same dimensional formula

   (1) F F T (2) T F T (3) F T F (4) F F F

6. STATEMENT-1 : "There are 20 students in a class". In underlined figure number of significant figure is infinite.

   STATEMENT-2 : Zero error is a systematic error.

   STATEMENT-3 : Consider that density is calculated from measured values of mass and volume.

   The percentage error in the density will be more than the error in the percentage error in mass and volume.

   (1) F F F (2) F F T (3) T T T (4) T F T

7. STATEMENT-1 : Work done by a constant force on a particle during its displacement from one point to other does not depend on the path followed.

STATEMENT-2 : Work done by a force depends on the frame of reference.

STATEMENT-3 : Change in potential energy is always equal to work done by the external force.

(1) T T F (2) T T T (3) T F F (4) F T T

8. STATEMENT-1 : Work is a scalar quantity so it does not depend on direction of the force involved.

STATEMENT-2 : At the point of stable equilibrium $\frac{d^2U}{dx^2}$ must be positive. (Here U is potential energy)

STATEMENT-3 : At the point of equilibrium $\frac{dU}{dx}$ must be zero.

(1) T T F (2) F F T (3) T T T (4) F T T

9. STATEMENT-1 : Vector sum of the moment of masses of different particles of the system is zero about the centre of mass.

STATEMENT-2 : When a bomb kept at rest explodes then the total energy of the system increases.

STATEMENT-3 : When a bullet is fired at a steel plate then the average force acting on the plate will be larger if the bullet bounces off as compared to the case when it sticks to the plate.

(1) T T T (2) T T F (3) T F T (4) F F T

10. STATEMENT-1 : A gun gives greater kick when fired with the butt held loosely against the shoulder than when held tightly.

STATEMENT-2 : Area enclosed between force-time graph and force axis is equal to the impulse.

STATEMENT-3 : A car is accelerated due to the internal force of the engine.

(1) T F T (2) T F F (3) T T F (4) F F T

11. STATEMENT-1 : Moment of inertia is neither a scalar nor a vector quantity.

STATEMENT-2 : When a block slides with a constant speed on a rough inclined plane, the normal force does not pass through the centre of the block.

STATEMENT-3 : If a ring and a hollow sphere of different mass and radius are released from the topmost point of a rough inclined plane simultaneously the ring reaches the bottom first.

(1) T T T (2) T T F (3) T F T (4) F T T

12. STATEMENT-1 : When a body moves with constant velocity along a straight line parallel to coordinate axis its angular momentum about any fixed point remains constant.

STATEMENT-2 : Friction force acting on the rear wheels of a bicycle is always directed along the velocity of the bicycle.

STATEMENT-3 : When a rigid body rotates with a variable angular velocity about a vertical axis passing through its centre of mass the resultant force acting on any particle of the body away from the axis is horizontal and skew with the axis.

(1) T F F (2) T F T (3) F F T (4) F F F

13. STATEMENT-1 : Two satellites are revolving around the earth in circular orbits of equal radii. Their time period will be same as measured by a person standing on surface of earth.

STATEMENT-2 : Gravitational potential is always negative with usual reference level.

STATEMENT-3 : Gravitational force acting between two bodies depends upon the medium.

(1) T T T (2) F T F (3) T F F (4) T T F

14. STATEMENT-1 : Change in gravitational potential energy of a system depends upon the reference level.

STATEMENT-2 : Any satellite revolving at a distance of nearly 36,000 km from earth centre is a geostationary satellite.

STATEMENT-3 : The value of g at a height of nearly 20 km from north pole is same as that at the equator.

(1) T F T (2) F F T (3) T F F (4) F F F

15. STATEMENT-1 : If a wire breaks after crossing the limit of elasticity then its material is called ductile.

STATEMENT-2 : Radius of sphere of molecular activity is equal to the molecular range.

STATEMENT-3 : The surface of water in a silver vessel is perfectly horizontal.

(1) F T F (2) T F F (3) F T T (4) T F T

16. STATEMENT-1 : When an air bubble rises from the bottom of a lake to its surface, the excess pressure inside the bubble decreases.

STATEMENT-2 : Viscosity of liquids decreases with rise in temperature but that of gases increases with rise in temperature.

STATEMENT-3 : Centre of buoyancy is the centre of mass of displaced fluid.

(1) T T T (2) F T F (3) T F F (4) F T T

17. STATEMENT-1 : A pendulum clock runs fast in a lift accelerating upwards.

STATEMENT-2 : In simple harmonic motion the scalar product of acceleration and displacement is always negative.

STATEMENT-3 : Time period of a physical pendulum depends upon the angular amplitude.

(1) T F F (2) T T F (3) T F T (4) F T T

18. STATEMENT-1 : A body executes oscillatory motion if its equilibrium position is stable.

STATEMENT-2 : If a spring is cut into two parts in the ratio 2 : 3 then the force constant of each part will be more than the force constant of the spring initially.

STATEMENT-3 : Time period of a simple pendulum whose length is equal to the radius of earth is 2 hour.

(1) T T F (2) F T T (3) T F T (4) F F T

19. STATEMENT-1 : When two identical pulse inverted in shape travelling in opposite direction meet, the total energy of the pulses is purely kinetic.

    STATEMENT-2 : A person who has inhaled helium has a remarkably low pitch.

    STATEMENT-3 : The frequency of whistle heard by the guard of a train moving on a circular path with constant speed is equal to the natural frequency of the whistle.

    (1) T F F (2) T F T (3) F T T (4) T F F

20. STATEMENT-1 : Principle of superposition is valid for displacement, velocity and kinetic energy of medium particles.

    STATEMENT-2 : Quinck's tube is used to find the speed of sound and is based on the phenomenon of interference.

    STATEMENT-3 : Speed of sound in air increases nearly by 0.61 m/s for each 1°C rise in temperature.

    (1) T T T (2) T F T (3) F T T (4) F F T

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Heat

UNIT 2

This Unit Includes

Kinetic Theory of Gases, Thermodynamics, Heat Transfer

SECTION - A

Straight Objective Type

This section contains 96 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. Select the incorrect statement from following statements

   (1) $W = \int PdV$ for a reversible process only

   (2) $W \neq \int PdV$ for an irreversible process

   (3) $W \neq \int PdV$ for free expansion

   (4) If $dV = 0$ then work done must be zero

2. If we increase temperature of a gas sample, which of the following is true?

   (1) K.E. of gas sample decreases

   (2) Average speed remains constant

   (3) Average momentum remains constant

   (4) P.E. of gas sample increases

3. The change in momentum of a molecule moving with momentum p colliding wall of the container can not be

   (1) $p/2$ (2) $2p$

   (3) $3p$ (4) p

4. The ratio of average translational K.E to rotational K.E. of a linear polyatomic molecule at temperature T is

   (1) 3 (2) 5

   (3) $\frac{3}{2}$ (4) $\frac{7}{5}$

5. An ideal gas mixture filled inside a balloon expands according to relation $PV^{\frac{1}{3}}$ = constant. The temperature of the gas inside the balloon is

   (1) Increasing (2) Constant

   (3) Decreasing (4) Cannot be said

6. P-V diagram of a monoatomic gas is a straight line passing through origin. The molar heat capacity of the gas in the process will be

   (1) $\frac{3R}{2}$ (2) $\frac{R}{2}$

   (3) $2R$ (4) $3R$

7. The velocities of three molecules are $3v$, $4v$ and $12v$ respectively. Their rms speed will be

   (1) 13 v

   (2) 17 v

   (3) 7.5 v

   (4) Cannot say temperature is not given

8. A closed and big compartment containing gas is moving with some acceleration in horizontal direction, neglect effect of gravity. Then the pressure in the compartment is

   (1) Same everywhere

   (2) Lower in the front side

   (3) Lower in the rear side

   (4) Lower in the upper side

9. For a gas, molar specific heat in a process is greater than C_V, which of the following relation is possible?

(1) $P^2V^{\frac{1}{3}} = C$

(2) $PV^2 = C$

(3) $PV^3 = C$

(4) $P^2V^3 = C$

10. Which of the following supports energy conservation? {where terms have usual meaning}

(1) $C_P - C_V = R$ (2) $\frac{C_P}{C_V} = \gamma$

(3) $PV = nRT$ (4) $U = nC_VT$

(IIT-JEE 2009)

10(a) C_v and C_p denote the molar specific heat capacities of a gas at constant volume and constant pressure, respectively. Then

(1) $C_p - C_v$ is larger for a diatomic ideal gas than for a monoatomic ideal gas

(2) $C_p + C_v$ is larger for a diatomic ideal gas than for a monoatomic ideal gas

(3) $\frac{C_p}{C_v}$ is larger for a diatomic ideal gas than for a monoatomic ideal gas

(4) $C_p \cdot C_v$ is larger for a diatomic ideal gas than for a monoatomic ideal gas

11. A sample of a gas is kept in a closed container and temperature is increased. Which of the following is true?

(1) Pressure is increased because momentum transferred per collision to wall is increased

(2) Pressure is decreased

(3) Pressure is increased because frequency of collision is decreased

(4) Both (1) & (3) are correct

12. There is an open container. Temperature of gas in container is varying. Internal energy of gas sample in container is

(1) Variable (2) Decreasing

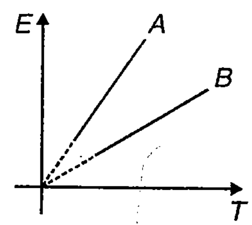
(3) Constant (4) Increasing

13. At what temperature the effective speed of gaseous H_2 molecules is equal to that of oxygen molecules at 320 K?

(1) 20 K (2) 50 K

(3) 40 K (4) 30 K

14. There are two samples A and B, which contains two different gases. Each sample has one mole of a gas. Graph between internal energy (E) and temperature (T) as shown in figure, then



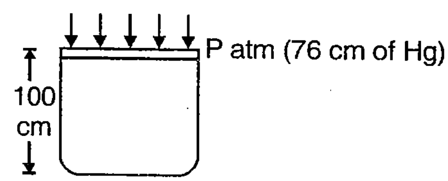
(1) A contains He, B contains O_2

(2) B contains N_2, A contains O_2

(3) A contains CO_2, B contains He

(4) A contains He, B contains CO_2

15. A vertical cylinder of height 100 cm contains air at room temperature and its top is closed by a light and frictionless piston at atmospheric pressure (76 cm of mercury column). If mercury is slowly poured on the piston, due to extra weight air is compressed. Find the maximum height of Hg column which can be put on the piston



(1) 76 (2) 24

(3) 38 (4) 12

16. Which of the following is correct according to Maxwell's distribution of speeds?

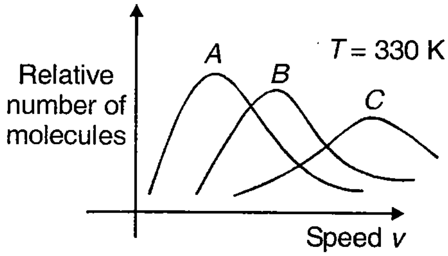
(1) At most probable speed K.E. of a molecule is maximum

(2) $v_{rms} > v_{mp} > v_{av}$

(3) No. of molecules having most probable speed is higher than number of molecules moving with rms speed

(4) Average velocity is non zero

17. Maxwell distribution function is shown in figure from different gases, which of the following is correct matching?

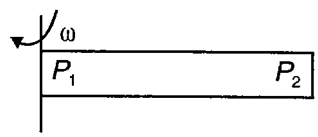


(1) $A \rightarrow$ Ne, $B \rightarrow O_2$, $C \rightarrow$ He
(2) $A \rightarrow$ Ne, $B \rightarrow$ He, $C \rightarrow O_2$
(3) $A \rightarrow O_2$, $B \rightarrow$ He, $C \rightarrow$ Ne
(4) $A \rightarrow O_2$, $B \rightarrow$ Ne, $C \rightarrow$ He

18. At the top of mountain, a thermometer reads 280 K and a barometer reads 70 cm of Hg. At the bottom of mountain, they read 300 K and 76 cm of Hg. Find the ratio of densities of air at the top and that at the bottom

(1) 0.80 (2) 0.89
(3) 0.99 (4) 0.97

19. A horizontal tube of length ℓ closed at both ends contains He gas. The tube is rotated at a constant angular velocity ω about a vertical axis passing through an end. Assuming temperature is uniform and constant, which of the following is correct?



(1) $P_1 > P_2$ (2) $P_2 > P_1$
(3) $P_1 > P_2$ (4) Cannot say

20. The pressure of an ideal diatomic gas can be represented as $P = \frac{2E}{3V}$, here V is volume and E is

(1) Rotational kinetic energy
(2) Translational kinetic energy
(3) Vibrational kinetic energy
(4) Total kinetic energy

21. In a gas sample, consider a collision between two gas molecules simultaneously, which of the following is correct?

(1) Total K.E. of gas molecules increases
(2) Total K.E. of gas molecules decreases
(3) Total momentum decreases
(4) K.E of first molecule may increase and K.E. of second molecule may decrease

22. A 20 cm long test tube (cylindrical) is inverted and pushed vertically down into water. When the closed end is at water surface, how high has the water risen inside the tube? [$P_{atom} = 10^5$ N/m^2]

(1) 0.38 cm (2) 10 cm
(3) 20 cm (4) 15 cm

23. At constant pressure modulus of elasticity is

(1) P (2) γP
(3) Zero (4) $\frac{1}{T}$

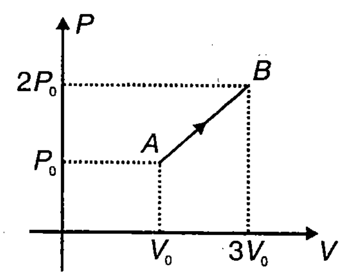
24. One mole of an ideal monoatomic gas at temperature T is heated at constant pressure till the volume is doubled and then it is allowed to expand at constant temperature till the pressure is halved. Calculate the heat supplied to the gas

(1) $(5 + 2\,\ell n\, 2)\, RT$ (2) $(2 + 2\,\ell n\, 2)\, RT$
(3) $(2.5 + 2\,\ell n\, 2)\, RT$ (4) $(2.5 + \ell n\, 2)\, RT$

25. A glass container encloses gas at a pressure 4×10^5 Pa and 300 K temperature. The container walls can bear a maximum pressure of 8×10^5 Pa. It the temperature of container is gradually increases find temperature at which container will break

(1) 600 K (2) 150 K
(3) 1200 K (4) 375 K

26. One mole of a monoatomic ideal gas undergoes process AB in given P-V diagram then average specific heat for this process is



(1) $\frac{21R}{10}$ (2) $\frac{18R}{10}$
(3) $\frac{9R}{10}$ (4) $\frac{13R}{10}$

27. Ideal monoatomic gas is taken through process such that $dQ = 3dU$. The molar heat capacity for process is

(1) 3 R (2) 4.5 R
(3) 4 R (4) 2 R

28. One mole of an ideal gas (monoatomic) at temperature T_0 expands slowly according to law $P^2 = cT$ (c is constant). If final temperature is $2T_0$. heat supplied to gas is

(1) $2RT_0$ (2) $\frac{3}{2}RT_0$

(3) RT_0 (4) $\frac{RT_0}{2}$

29. The minimum attainable pressure of one mole of an ideal gas will be, if during its expansion, its temperature and volume are related as $T = T_0 + \alpha V^2$ where T_0 and α are positive constant

(1) $R\sqrt{\frac{T_0\alpha}{2}}$ (2) $\frac{R}{2}\sqrt{T_0\alpha}$

(3) $2R\sqrt{T_0\alpha}$ (4) $R\sqrt{2T_0\alpha}$

30. Relation between U, P and V for ideal gas is $U = 2 + 2PV$ then gas is

(1) Monoatomic

(2) Diatomic

(3) Polyatomic

(4) Mixture of mono and diatomic

31. One mole of ideal gas goes through process $P = \frac{2V^2}{1+V^2}$ then change in temperature of gas when volume changes from $V = 1\ m^3$ to $2\ m^3$ is

(1) $-\frac{4}{5R}$K (2) $\frac{11}{5R}$K

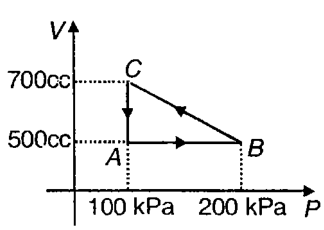
(3) $\frac{-5}{2R}$K (4) 2K

32. During adiabatic process pressure P and density ρ equation is

(1) $P\rho^{\gamma}$ = constant (2) $P\rho^{-\gamma}$ = constant

(3) $P^{\gamma}\rho^{\gamma+1}$ = constant (4) $P^{\frac{1}{\gamma}}\rho^{\gamma}$ =constant

33. A gas is taken through cyclic process ABCA is shown in figure. If 2.4 cal. of heat is given in the process, what is the value of mechanical equivalent of heat?



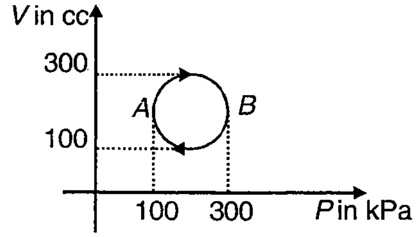
(1) 4.17 J/cal

(2) 4.4 J/cal

(3) 4.1 J/cal

(4) None of these

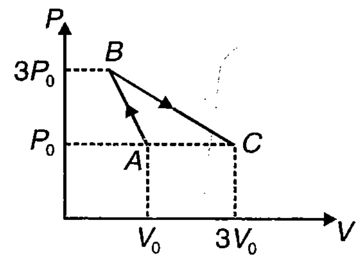
34. Calculate heat absorbed during process ABA given in figure



(1) 3.14 J (2) 314 J

(3) 31.4 J (4) None of these

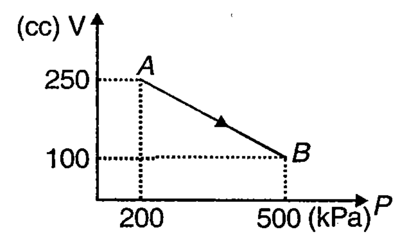
35. P-V diagram of ideal gas is as shown in figure. Work done by the gas in the process ABC is



(1) $2P_0V_0$ (2) $4P_0V_0$

(3) P_0V_0 (4) $3P_0V_0$

36. A monoatomic gas is taken along path AB as shown. Calculate change in internal energy of system



(1) 279.8 J (2) 341 J

(3) 241 J (4) Zero

37. A gas is compressed adiabatically till its pressure becomes 27 times its initial pressure. Calculate final temperature if initial temperature is 27ºC and the value of γ is $\frac{3}{2}$

(1) 300 K (2) 600 K

(3) 900 K (4) 1200 K

38. Calculate γ for oxygen from following data. Speed of sound in oxygen at 0ºC is 315 m/s, molecular weight of oxygen is 32 g/mol and gas constant R = 8.3 J/mol K

(1) 1.2 (2) 1.3

(3) 1.4 (4) 1.5

39. Standing wave of frequency 5 kHz are produced in tube filled with oxygen at 300 K. The separation between consecutive nodes is 3.3 cm. Calculate C_v for gas

(1) 18.2 J/mol K (2) 15.6 J/mol K

(3) 24.3 J/mol K (4) 20.7 J/mol K

40. C_p for above problem is

(1) 29 J/mol K (2) 32 J/mol K

(3) 25 J/mol K (4) 22 J/mol K

41. Find equation of polytropic process for which heat capacity is $C = \frac{7}{2}R$ for a monoatomic gas

(1) PV = constant (2) PV^2 = constant

(3) P^2V = constant (4) None of these

42. Molar heat capacity of gas whose molar heat capacity at constant volume is C_v for process $P = 2e^{2V}$

(1) $C_v + \frac{R}{1+2V}$ (2) $C_v + \frac{R}{2V}$

(3) $C_v + \frac{R}{V}$ (4) None of these

43. One mole of ideal gas undergoes process $T = 300 + 2V$ then amount of work done by gas when volume increases from 2 m^3 to 4 m^3

(1) 300R ln 2 + 4R (2) 2 + 2 ln 2

(3) 300R ln 2 (4) None of these

44. One mole of ideal gas whose adiabatic exponent $\gamma = \frac{4}{3}$ undergoes process $P = 200 + \frac{1}{V}$ then change in internal energy of gas when volume changes from 2 m^3 to 4 m^3 is

(1) 400 J (2) 800 J

(3) 1200 J (4) None of these

45. An ideal gas is taken through a process in which the process equation is given as $P = kV^{\alpha}$, where k and α are positive constants. The value of α for which, in this process molar heat capacity becomes zero is

(1) $\alpha = -\frac{\gamma}{2}$ (2) $\alpha = \frac{\gamma}{2}$

(3) $\alpha = -\gamma$ (4) $\alpha = \gamma$

46. An ideal gas with adiabatic exponent $\gamma = \frac{4}{3}$ undergoes a process in which internal energy is releated to volume as $U = V^2$ then molar heat capacity of the gas

(1) 3 R (2) 3.5 R

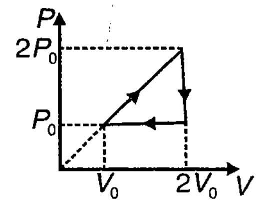
(3) 4 R (4) None of these

47. What amount of heat is to be transferred to nitrogen in isobaric heating process for that gas to perform work ΔW = 2J?

(1) 3 J (2) 5 J

(3) 9 J (4) 7 J

48. An ideal gas with adiabatic exponent γ = 2 goes through a cycle as shown in figure. Find efficiency of cycle



(1) $\frac{1}{9}$ (2) $\frac{1}{8}$

(3) $\frac{1}{6}$ (4) $\frac{1}{5}$

49. The volume of one mole of ideal gas with adiabatic exponent $\gamma = \frac{4}{3}$ is varied according to law $V = \frac{1}{T}$. Find amount of heat obtained by gas in this process if gas temperature is increased by 100 K.

(1) 100 R (2) 200 R

(3) 300 R (4) 400 R

50. Two Carnot engines 1 and 2 connected in series deliver equal work. If 1 receives energy at 900 K and B rejects energy at 400 K. The temperature for rejection in 1 is

(1) 650 K (2) 700 K

(3) 800 K (4) 500 K

51. Average degree of freedom per molecule of gas is 6. If 25 J of work is done by gas at constant pressure. Find heat absorbed or evolved by gas.

(1) 50 J (2) 500 J

(3) 100 J (4) 150 J

52. In given process for ideal gas $dW = 0$ and $dQ > 0$ then for gas
    (1) Volume remains constant
    (2) Volume will increase
    (3) Temperature will increase
    (4) Both (1) & (3) correct

53. In polytropic process PV^n = constant
    (1) If $n = 1$ isothermal process
    (2) If $n = \infty$ isocaloric process
    (3) If $n = 0$ isobaric process
    (4) All of these

54. A Carnot engine is made to work first between 200 K and 100 K and then between 400 K and 200 K. The ratio of efficiencies $\frac{\eta_2}{\eta_1}$ in two cases is
    (1) 1 : 15 (2) 1 : 1
    (3) 1 : 2 (4) 1.73 : 1

55. If in refrigerator, the lower temperature coils of evaporator are –23ºC and compressed gas in condenser has a temperature of 77ºC. The coefficient of performance is
    (1) 70 (2) 20
    (3) 23 (4) 2.5

56. In a process PT = constant if molar heat capacity of gas is $C = 37.35$ J/mol K then number of degree of freedom of molecules in gas is
    (1) $f = 10$ (2) $f = 5$
    (3) $f = 6$ (4) $f = 7$

57. What work will be done when 3 moles of an ideal gas are compressed to half the initial volume at constant temperature of 300 K?
    (1) –5188 J (2) 5000 J
    (3) 5188 J (4) – 5000 J

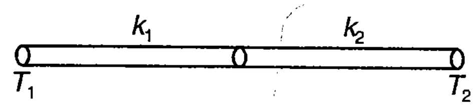
58. Molar heat capacity of gas is directly related to
    (1) Temperature
    (2) Heat energy
    (3) Molecular configuration
    (4) Mass

59. If a system undergoes an adiabatic change from state 1 to state 2, the work done by the gas is
    (1) $U_1 - U_2$ (2) $U_2 - U_1$
    (3) $C_v(T_2 - T_1)$ (4) $\frac{f}{2}(P_2V_2 - P_1V_1)$

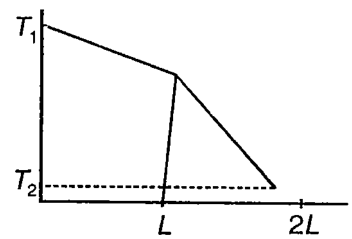
60. The temperature of gas contained in closed vessel increases by 1ºC when pressure of gas is increased by 1%. The initial temperature of gas is
    (1) 100 K (2) 100ºC
    (3) 250 K (4) 250ºC

61. It is known that temperature in a room is +20°C when out-door temperature is –20°C and when room is at +10°C outdoor temperature is –40°C. Determine the temperature T of radiator heating the room
    (1) 40°C (2) 50°C
    (3) 60°C (4) 70°C

62. Two rods of same length and same area of cross section are joined. Temperature of two ends are as shown in figure



As we move along the rod, temperature are as shown in following



    (1) $K_1 > K_2$ (2) $K_1 = K_2$
    (3) $K_1 < K_2$ (4) None of these

63. Estimate temperature T_e of earth, assuming it is in radiative equilibrium with sun (Assume radius of sun $R_s = 7 \times 10^8$ m) temperature of solar surface $T_s = 6000$ K, earth sun distance $d = 1.5 \times 10^{11}$ m
    (1) 290 K (2) 300 K
    (3) 310 K (4) 1000 K

64. A 100 W electric light bulb has filament which is 0.6 m long and has diameter of 8×10^{-5} m. Estimate working temperature of filament, if its total emissivity e is 0.7
    (1) 1900 K (2) 2018 K
    (3) 2800 K (4) 2946 K

65. The first law of thermodynamics tells us that
    (1) $\oint dQ \neq \oint dW$
    (2) $dU = dQ + dW$
    (3) $(dQ - dW)$ is an exact differential
    (4) $\int dQ = Q$

66. A polytropic process PV^n = constant represents an isochoric process if
(1) $n = 0$ (2) $n = 1$
(3) $n = \gamma$ (4) $n = \infty$

67. Select correct statement from following statements
(1) Heat is a property of the system
(2) dQ is an exact differential
(3) Mixing of non-identical gases is a rigid insulated container is an example of constant internal energy process
(4) Sudden magnetisation produces cooling effect

68. Two spheres of emissive power 0.6 and 0.8 and radii 2 cm and 4 cm are heated to 27°C and 127°C and placed in room of temperature 0 K. The ratio of heat radiated per second is
(1) 0.059 (2) 0.044
(3) 0.079 (4) 0.831

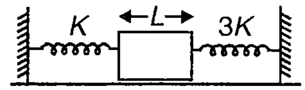
69. A spherical black body with radius of 12 cm radiates 450 W power at 500 K. If radius were halved and temperature doubled, the power radiated in watt would be
(1) 225 (2) 450
(3) 900 (4) 1800

(IIT-JEE 2010)

69(a). Two spherical bodies A (radius 6 cm) and B (radius 18 cm) are at temperatures T_1 and T_2, respectively. The maximum intensity in the emission spectrum of A is at 500 nm and in that of B is at 1500 nm. Considering them to be black bodies, what will be the ratio of the rate of total energy radiated by A to that of B?

70. A metal rod A of 25 cm length expands by 0.05 cm when its temperature is raised from 0ºC to 100ºC. Another rod B of a different metal of length 40 cm expands by 0.04 cm for the same rise in temperature. A third rod C of 50 cm length is made up of pieces of rods A and B placed end to end expands by 0.03 cm on heating from 0 to 50ºC. The length of rod A in third rod is
(1) 30 cm (2) 40 cm
(3) 10 cm (4) 50 cm

71. The system shown consist of two springs. If the temperature of the rod is increased by ΔT. The coefficient of linear expansion of the material of rod is α. If thermal stress in rod is zero, compression in left spring is



(1) $\dfrac{L\alpha\Delta T}{4}$ (2) $\dfrac{3L\alpha\Delta T}{4}$
(3) $\dfrac{L\alpha\Delta T}{3}$ (4) Zero

72. A sinker of weight w_0 has an apparent weight w_1 when placed in a liquid at a temperature T_1 and w_2 when weighed in the same liquid at a temperature T_2. The coefficient of cubical expansion of the material of the sinker is β. If the coefficient of volume expansion of the liquid is α. Equation giving correct relationship between w_1, w_2, w_0, β, T_1, T_2 and γ is
(1) $\dfrac{w_0+w_1}{w_0+w_2} = \dfrac{1+\gamma(T_2-T_1)}{1+\beta(T_2-T_1)}$
(2) $\dfrac{w_0-w_2}{w_0-w_1} = \dfrac{1+\gamma(T_2-T_1)}{1+\beta(T_2-T_1)}$
(3) $\dfrac{w_0+w_2}{w_0+w_1} = \dfrac{1+\gamma(T_2-T_1)}{1+\beta(T_2-T_1)}$
(4) $\dfrac{w_0-w_1}{w_0-w_2} = \dfrac{1+\gamma(T_2-T_1)}{1+\beta(T_2-T_1)}$

73. A wooden cylinder of 50 kg is floating in water. A weight of 2 kg is to be placed on it to just make it submerge when the temperature is 10°C. How much less weight is to be placed when temperature increases to 30°C?
(Given $\gamma_{water} = 10^{-4}$/°C, γ_{wood} is negligible.)
(1) 104 g (2) 58 g
(3) 208 g (4) 54 g

74. A liquid in thermally insulated vessel receives heat at constant rate 30 W from electrical heater. The temperature of the liquid becomes constant at 50°C. The temperature of surrounding is 20°C. After the heater is switched off the liquid cools from 40°C to 39.9°C in 10 s. The heat capacity of the liquid is
(1) 2000 J/°C (2) 1000 J/°C
(3) 500 J/°C (4) 4000 J/°C

75. Three identical adiabatic container have helium, ozone and oxygen gases at the same pressure and temperature. They are allowed to expand to same final volume
(1) The final temperature of the gas in each container is same
(2) The final temperature of helium is maximum
(3) The final temperature of oxygen is maximum
(4) The final temperature of ozone is maximum

76. A gas performs Q work when it expand at constant pressure. During this process heat absorbed by the gas is 4Q. The average number of degrees of freedom for the gas is

(1) 5 (2) 6

(3) 4 (4) 3.5

77. Three identical rods of same material are joined to form an equilateral triangle. The temperature of ends A and B are maintained constant at $T\sqrt{3}$ and T. The ratio of $\frac{T_C}{T_B}$ is

(1) $\frac{1+\sqrt{3}}{2}$ (2) $\frac{1ñ\sqrt{3}}{2}$

(3) $\frac{1+\sqrt{2}}{2}$ (4) $\frac{1ñ\sqrt{2}}{2}$

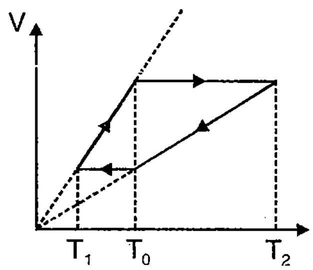
78. The work done by the one mole gas in the cyclic process shown in graph is W. Then

(1) $T_0 = \frac{T_1+T_2}{2}$

(2) $T_0 = \frac{W}{2R} + \frac{T_1+T_2}{2}$

(3) $T_0 = \frac{W}{2R}$

(4) $T_0 = \frac{W}{2R} + \frac{T_1-T_2}{2}$



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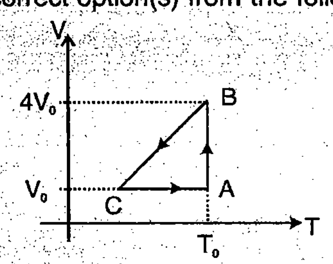
78(a). One mole of an ideal gas in initial state A undergoes a cyclic process ABCA as shown in the figure. Its pressure at A is P_0. Choose the correct option(s) from the following :



(1) Internal energies at A and B are the same

(2) Work done by the gas in process AB is P_0V_0 ln 4

(3) Pressure at C is $\frac{P_0}{4}$

(4) Temperature at C is $\frac{T_0}{4}$

79. Two spherical black bodies of radii r_1 and r_2 and with surface temperatures T_1 and T_2 respectively radiate same power, then $\frac{r_1}{r_2}$ is

(1) $\left(\frac{T_1}{T_2}\right)^2$ (2) $\left(\frac{T_2}{T_1}\right)^2$

(3) $\left(\frac{T_1}{T_2}\right)^4$ (4) $\left(\frac{T_2}{T_1}\right)^4$

(IIT-JEE 2010)

79(a). Two spherical bodies A (radius 6 cm) and B (radius 18 cm) are at temperatures T_1 and T_2, respectively. The maximum intensity in the emission spectrum of A is at 500 nm and in that of B is at 1500 nm. Considering them to be black bodies, what will be the ratio of the rate of total energy radiated by A to that of B?

80. A body cools from 50∞C to 40∞C in 5 minute. Surrounding temperature is 20∞C. Then what will be its temperature 5 minutes after reaching 40∞C?

(1) 35∞C (2) $\frac{100}{3}$°C

(3) 32∞C (4) 30∞C

81. One end of a metal rod is kept in steam chamber. In steady state the temperature gradient

(1) May be variable (2) Must be constant

(3) Must be variable (4) None of these

82. Two metallic spheres P and Q are of same surface finish and same density. Weight of P is twice that of Q. Both spheres are heated to same temperature and are left in room to cool by radiation. The ratio of initial rate of cooling of P to that of Q is

(1) $1:\sqrt{2}$ (2) $\sqrt{2}:1$

(3) $1:2^{\frac{1}{3}}$ (4) $2^{\frac{2}{3}}:1$

83. A planet having surface temperature T has solar constant S. An angle θ is subtended by the sun at planet then

(1) $S \propto T^2$ (2) $S \propto T$

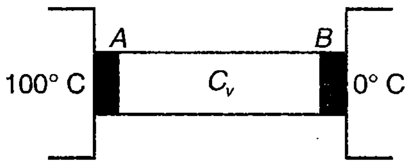
(3) $S \propto \theta$∞ (4) $S \propto \theta^2$

84. The temperature of a point in space is given by $T = x^2 + y^2$ ñ 2^2. A mosquito located at (1, 1, 0) desires to fly in such a direction that it will get heat as soon as possible then unit vector in direction the mosquito should fly is

(1) $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ (2) $\frac{i+\hat{j}-\hat{k}}{\sqrt{3}}$

(3) $\frac{i-\hat{j}}{\sqrt{2}}$ (4) $-\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

85. Figure shows a lagged copper bar AB whose ends are pressed against metal tanks at 100°C and 0°C, but are separated from them by layers of dirt. The length of the bar is 10 cm and the dirt layer are 0.1 mm thick. The conductive of dirt is 0.001 times that of copper. The temperature difference of copper bar is



(1) 50°C
(2) 20°C
(3) 33.4°C
(4) 60°C

86. 2 moles of an ideal diatomic gas is expanded according to relation P^2T = constant from its initial state (P_0, V_0) to the final state, due to which temperature becomes double the initial temperature. Heat supplied to the gas is

(1) $4P_0V_0$ (2) $2P_0V_0$

(3) P_0V_0 (4) $\frac{P_0V_0}{2}$

87. The quantity of heat which crosses unit area of metal plate during conduction depends upon

(1) Density of metal
(2) Temperature gradient
(3) Temperature to which metal is heated
(4) Area of metal plate

88. If K and σ are thermal and electrical conductivities of metal at T then

(1) $\frac{K}{\sigma T}$ = constant (2) $\frac{K}{\sigma}$ = constant

(3) $\frac{K}{T}$ = constant (4) $\frac{\sigma}{KT}$ = constant

89. A polished metal with rough black spot on it is heated to about 1400 K and quickly taken to dark room. Which one of the following statements is true?

(1) Spot will appear brighter than plate
(2) Spot will appear darker than plate
(3) Spot and plate will be equally bright
(4) Spot and plate will not be visible in dark

90. Fraunhoffer lines in spectrum of sun are explained by

(1) Wien's law (2) Planck's law
(3) Newton's law (4) Kirchhoff's laws

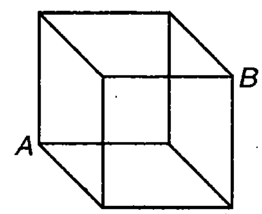
91. Planck's hypothesis about black body radiation is relation between

(1) Frequency and velocity
(2) Energy and amplitude
(3) Frequency and energy
(4) Colour and frequency

92. Newton's law of cooling is used in laboratory for determining

(1) Specific heat of gas (2) Specific heat of liquids
(3) Latent heat of gas (4) Latent heat of liquids

93. All parameters of rods forming cube are equal and thermal conductivity of each rod is k. Then find equivalent thermal resistance between A and B if resistance of each rod is R



(1) $\frac{6R}{5}$

(2) $\frac{5R}{6}$

(3) $\frac{3R}{2}$

(4) $\frac{2R}{3}$

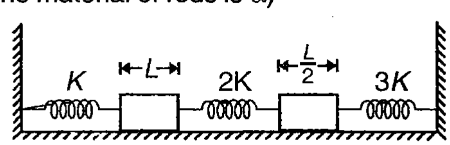
94. Two thin blankets are better than one thick blanket in controlling effect of cold air since

(1) Perforation in thick blanket will be bigger
(2) Perforation in thin blanket will be smaller
(3) Air between thin blankets stops heat transfer
(4) Thin blanket absorb more energy

95. Temperature at which person can feel metal rod and wooden block to be equally hot is

(1) His body temperature
(2) Twice has body temperature
(3) Four times equal to body temperature
(4) Temperature equal to their ratio of specific heat capacities

96. The system shown consists of 3 springs and two rods. If the temperature of the rods is increased by ΔT, the energy stored in the spring having spring constant K will be (there is no friction the springs are initially relaxed. The coefficient of linear expansion of the material of rods is α)



(1) $\frac{27}{242}KL^2\alpha^2\Delta T^2$ (2) $\frac{81}{484}KL^2\alpha^2\Delta T^2$

(3) $\frac{81}{242}KL^2\alpha^2\Delta T^2$ (4) $\frac{81}{121}KL^2\alpha^2\Delta T^2$

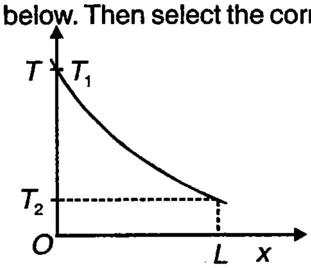
SECTION - B

Multiple Choice Questions

This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **MORE THAN ONE** is correct.

Choose the correct answers :

1. The two ends of a long bar maintained at different temperatures. The graph of temperature against distance of the bar when it has attained steady state is shown below. Then select the correct alternative



(1) The cross-section area of the bar may increase as the distance from the hot end increases

(2) The cross-section area of the bar may decreases as the distance from the hot end increases

(3) The conductivity of the rod may be increasing as the distance from hot end increases

(4) The conductivity of the bar may decrease as the distance from hot end increases

2. Internal energy of ideal diatomic gas at 300 K is 100 J. In this 100 J

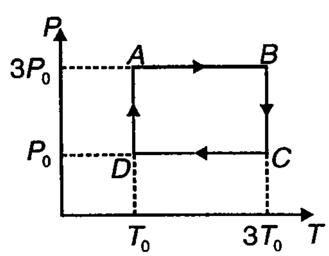
(1) Potential energy = 0

(2) Rotational kinetic energy = 40 J and translational kinetic energy = 60 J

(3) Molar specific heat of gas at constant volume = 20.8 J/mole.kelvin

(4) Molar specific heat of gas at constant pressure = 29.1 J/mole.kelvin

3. An ideal monoatomic gas goes under cyclic process shown in following curve



(1) For AB $\frac{\Delta U}{W}$ is $\frac{3}{2}$

(2) For BC $Q = W$

(3) For complete cycles $W > 0$

(4) For complete cycle $Q > 0$

4. An ideal gas in a cylinder expands according to the relation PV^n = constant. For the process if

(1) $n > 1$ then internal energy increases

(2) $n > 1$ then internal energy decreases

(3) $n = 0$ then internal energy increases

(4) $n = \gamma$ then internal energy remain constant

5. C_p is always greater than C_v for gas. Which of following statements provides partly or wholly the reason for this ?

(1) $dW = 0$ at constant volume

(2) For work being positive at constant pressure

(3) dU is process dependent

(4) Molar heat capacity C satisfies $C_v \le C \le C_p$

6. Five moles of Ne at 2 atm and 27ºC is adiabatically compressed to $\frac{1}{8}$ times of its initial volume [$\gamma = 1.67$, $C_v = 0.148$ cal/g, $M = 20.18$ gm/mole]

(1) Pressure will change to 6 atm

(2) Temperature will become 1200 K

(3) Work done by gas is zero

(4) Work done by gas is nonzero

7. The temperature T is measured by a constant volume gas thermometer

(1) T is independent of the gas used at high pressure

(2) T is independent of the gas used at low pressure

(3) The ideal gas scale agree with the absolute scale of temperature

(4) The ideal gas scale does not agree with the absolute scale

8. The energy radiated by a perfect black body

(1) Depend on its specific heat

(2) Depend on its surface area

(3) Depends on temperature of surroundings

(4) Independent of temperature of surroundings

9. The rates of fall of temperature of two perfectly black solid spheres of same radii but of different materials are equal at a certain temperature
   (1) Their heat capacities are equal
   (2) Their heat capacities are proportional to their density
   (3) Their specific heat capacities are proportional to their densities
   (4) Their specific heat capacities are inversely proportional to their densities

10. For 1 mole of monoatomic gas process is $T = V^2$ and temperature changes from 100 K to 400 K then
    (1) Change in internal energy = 450 J
    (2) Work done by the gas is 150 R
    (3) Heat supplied to the gas is 600 R
    (4) Gas obeys law $PV^{-1} = R$

11. Rate of cooling of a body by radiation depends on
    (1) Area of the body
    (2) Mass of the body
    (3) Specific heat
    (4) Temperature of the body and the surrounding

12. Which of the following have no units and dimension?
    (1) Emissive power   (2) Absorptive power
    (3) Emissivity   (4) Wien's constant

13. Energy radiated by a body depends on
    (1) Area of body
    (2) Nature of surface
    (3) Temperature of surrounding
    (4) Temperature of body

14. Maximum spectral radiancy of a black body is corresponding to λ wavelength. If temperature is now changed so that maximum spectral radiancy now corresponds to $\frac{3\lambda}{4}$ then
    (1) New temperature is $\frac{4}{3}$ times the old temperature
    (2) The maximum spectral radiancy increases by factor $\frac{1024}{243}$
    (3) Power radiated by body changes by factor $\frac{256}{81}$
    (4) Power radiated by body changes by factor $\frac{81}{256}$

$1 \times \frac{3}{4} \times \frac{25}{3}\lambda \times 800$ 157

15. Two spheres *A* and *B* have same radius but heat capacity of *A* is greater than that of *B*. The surfaces of both are painted black. They are heated to same temperature and allowed to cool then initially
    (1) *A* cools faster than *B*
    (2) Both *A* and *B* cool at the same rate
    (3) Energy radiated in unit time from unit area is same for both the spheres
    (4) *B* cools faster than *A*

16. A black body is at temperature of 2880 K. The energy of radiation emitted by this object between wavelength 4990 Å and 5000 Å is U_1 between 9990 Å and 10000 Å is U_2 and between 14990 Å and 15000 Å is U_3. The Wien's constant is $b = 2.88 \times 10^{-3}$ mK then
    (1) $U_2 > U_1$ (2) $U_2 > U_3$
    (3) $U_1 = U_3 < U_2$ (4) U_2 is maximum

17. In which of the processes medium is required for transmission of heat?
    (1) Conduction   (2) Convection
    (3) Radiation   (4) All of these

18. According to Kirchhoff's law
    (1) Bad absorber is bad emitter
    (2) Bad absorber is good reflector
    (3) Bad reflector is good emitter
    (4) Bad emitter is good absorber

19. If solid sphere and hollow sphere are of same material and radius then at same temperature
    (1) Both will emit equal amount of radiation per second initially
    (2) Both will absorb equal amount of radiation per second initially
    (3) Initial rate of cooling is same for both
    (4) At any instant their temperatures will be equal

20. A monoatomic gas undergoes a process given by $adU + b.dW = 0$, Now if
    (1) If $a = 0$, $b \neq 0$, the process is isochoric
    (2) $b = 0$, then the process is isothermal
    (3) $\frac{a}{b} = 1$, then the process is adiabatic
    (4) $\frac{a}{b} = -\frac{2}{3}$, then the process is isobaric

$R/2 + 3R/2$ $2R$ $1 \times 2R \times 300$

SECTION - C

Linked Comprehension Type

This section contains 11 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Comprehensions

C1. A certain amount of ice is heated at a constant rate for 14 minutes. For the first 4 minutes the temperature rises uniformly with time. Then it remains constant for 8 minutes and again the temperature rises at uniform rate for the last 2 minute.

Choose the correct answer :

1. What is the initial temperature of ice?

(1) $-40°C$ (2) $-80°C$

(3) $0°C$ (4) $-20°C$

2. The temperature at the end of 14 minutes is

(1) 120°C (2) 40°C

(3) 20°C (4) 100°C

3. If the mass of ice is 6 gm then the rate at which constant power is supplied

(1) 1 W (2) 2 W

(3) 4 W (4) 0.5 W

C2. An ideal gas whose adiabatic exponent is γ is expanded under an polytropic process such that the amount of heat transferred to the gas is equal to decrease in the internal energy then

Choose the correct answer :

1. Molar heat capacity of the gas is

(1) $\frac{-R}{\gamma-1}$ (2) $\frac{-R}{\gamma}$

(3) $\frac{R}{\gamma-2}$ (4) None of these

2. Equation of the polytropic process in T and V is

(1) $T^{\gamma}V$ = constant (2) $TV^{\frac{\gamma-1}{2}}$ = constant

(3) TV^{γ} = constant (4) None of these

3. Work done by the one mole of gas when final temperature is twice of initial temperature T_0 is

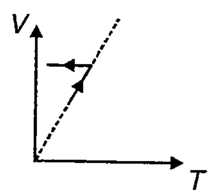
(1) $\frac{2RT_0}{\gamma-1}\left(1-2^{\frac{1-\gamma}{2}}\right)$ (2) $\frac{RT_0}{\gamma-1}\left(1-2^{\frac{1-\gamma}{2}}\right)$

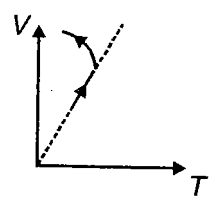
(3) $\frac{2RT_0}{\gamma-1}$ (4) None of these

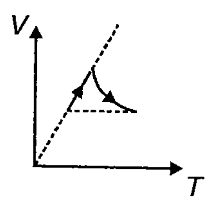
C3. One mole of a monoatomic gas at a temperature 300 K occupy a volume of 10 litres. The gas is first expanded at constant pressure until the volume has doubled, and then adiabatically until the temperature returns to its initial value.

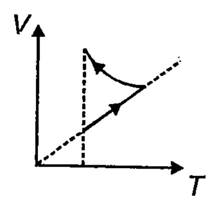
Choose the correct answer :

1. Which of the following V - T curves represent above process correctly?

(1)


(2)


(3)


(4)


2. What is the total work done by the gas?

(1) 750 R (2) –50 R

(3) 50 R (4) 300 R

3. If the gas is now taken to its initial state through an isothermal process then the net heat supplied to the system is

(1) $750\,R - 100\,R\ln 2$ (2) $(50 + 500\ln 2)\,R$

(3) $750\,R - 500\,R\ln 2$ (4) $300\,R + 500\,R\ln 2$

C4. n moles of H_2 gas undergoes a process PV^2 = constant. Initially the pressure and the volume were P_1 and V_1 and at end of the process rms speed of gas molecule is double compared to its initial rms speed then

Choose the correct answer :

1. For the given system in given process T-V curve is

   (1) Parabolic (2) Hyperbolic

   (3) Straight line (4) Elliptical

2. Heat supplied to the gas during the process

   (1) $4\ P_1V_1$ (2) $4.5\ P_1V_1$

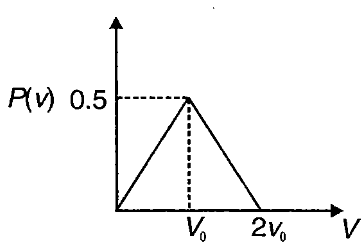
   (3) $5\ P_1V_1$ (4) $6\ P_1V_1$

3. The change in internal energy during the process is

   (1) $7\ P_1V_1$ (2) $7.5\ P_1V_1$

   (3) $8\ P_1V_1$ (4) $8.5\ P_1V_1$

C5. A hypothetical sample of N gas particles has the speed distribution shown in figure.



Here v is the molecular speed, P(v) is a probability distribution function, defined as follows. The Pdv is a fraction of molecules whose speed lies in the range v to $(v + dv)$.

Choose the correct answer :

1. Total area under the curve is equal to

   (1) Total number of molecules

   (2) Unity

   (3) RMS speed

   (4) Probability to have most probable speed

2. The number of molecules having speed between v_0 and $2v_0$

   (1) $\frac{N}{4}$ (2) $\frac{3N}{4}$

   (3) $\frac{N}{2}$ (4) $\frac{Nv_0}{2}$

3. The ratio of most probable speed to the average speed of molecules is

   (1) 1 (2) $\frac{1}{2}$

   (3) 2 (4) $\frac{1}{3}$

C6. One mole of an ideal monoatomic gas undergoes process $T = V^2$ and temperature of gas changes from 300 K to 1200 K then

1. Work done by the gas is

   (1) 400 R (2) 450 R

   (3) 900 R (4) 600 R

2. Heat supplied to the gas is

   (1) 1200 R (2) 1800 R

   (3) 900 R (4) 750 R

3. ΔU for this process is

   (1) 750 R (2) 650 R

   (3) 250 R (4) 1350 R

C7. A metal block of heat capacity 80 J/°C being heated electrically is placed in a room at 20°C. The heater is switched off when temperature of the block reaches 30°C. The temperature of block rises at rate 2°C/s just after heater was switched on and falls at the rate 0.2°C/s when switch off. (Assume Newton's law of cooling holds). Neglect radiation during heating

Choose the correct answer :

1. Find power of heater

   (1) 120 W (2) 140 W

   (3) 160 W (4) 200 W

2. Find power radiated by block just after heater is switched off

   (1) 12 W (2) 14 W

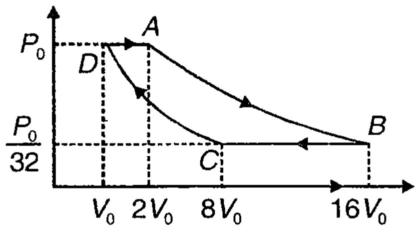
   (3) 16 W (4) 20 W

3. Find power radiated by block when its temperature is 25°C

   (1) 16 W (2) 8 W

   (3) 24 W (4) 4 W

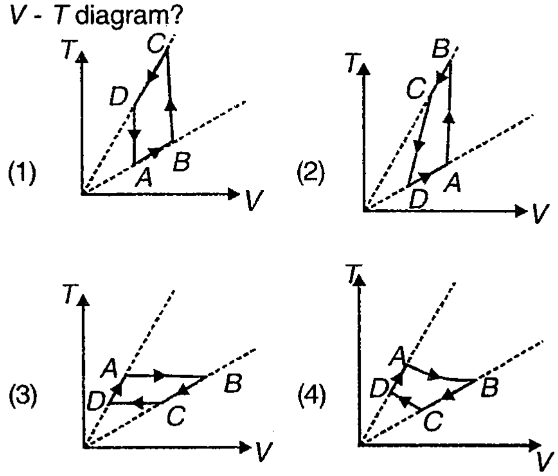
C8. Two moles of an ideal gas goes under the process shown in figure. AB and CD are reversible adiabatic process.



Choose the correct answer :

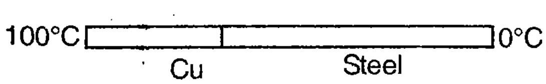
1. The gas under the process is
   (1) Monoatomic
   (2) Diatomic
   (3) Non linear polyatomic
   (4) Mixture of monoatomic and non-linear polyatomic

2. Which of the following shows above process on V - T diagram?



3. The efficiency of the cycle is
   (1) $\frac{1}{4}$ (2) $\frac{1}{2}$
   (3) $\frac{3}{4}$ (4) $\frac{3}{5}$

C9. A bar of length 75 cm of copper joined end to end with 125 cm steel bar of same cross-section radius 1 cm as shown



Thermal Conductivity
$K_{Cu} = 9.2 \times 10^{-2}$ kcal/m-s °C
$K_{st} = 1.1 \times 10^{-2}$ kcal/m-s °C

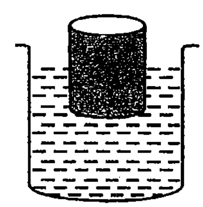
Choose the correct answer :

1. Heat transmitted per unit time is
   (1) 0.258 cal/s (2) 0.34 cal/s
   (3) 0.428 cal/s (4) None of these

2. Temperature of junction is
   (1) 72° C (2) 80.2° C
   (3) 93.3° C (4) None of these

3. Equivalent thermal conductivity of system
   (1) 1.4×10^{-2} units (2) 1.64×10^{-2} units
   (3) 1.32×10^{-4} units (4) None of these

C10. A solid cylinder of height 10 cm is floating in a liquid. The coefficient of linear expansion of the solid is α and the coefficient of cubical expansion of the liquid is γ. Initially the cylinder is half submerged.



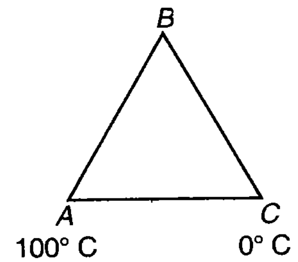
Choose the correct answer :

1. If we take the liquid whose coefficient of cubical expansion is negligible then on heating the whole system
   (1) Force of buoyancy increase
   (2) Force of buoyancy decreases
   (3) Force of buoyancy remains same
   (4) The fraction of immerse portion of the cylinder remains same.

2. The temperature of the whole system is increased by the same amount. The height of immersed portion will remain same if
   (1) $2\alpha = \gamma$ (2) $3\alpha = \gamma$
   (3) $3\alpha = 2\gamma$ (4) $2\alpha = 3\gamma$

3. The temperature of the whole system is increase by the same amount. The height of the portion of the cylinder remaining outside the liquid remains constant if
   (1) $2\alpha = \gamma$ (2) $3\alpha = \gamma$
   (3) $4\alpha = \gamma$ (4) $3\alpha = 2\gamma$

C11. Three rods of equal length of same material are joined as shown in the figure. Area of cross-sections rods *AB, BC* and *AC* are *S*, 2*S* and *S* respectively



Choose the correct answer :

1. Ratio of thermal resistance of *BC* to *AC*

(1) 1 : 1
(2) 1 : 2
(3) 3 : 1
(4) None of these

2. Temperature of the junction *B*

(1) 56° C
(2) 33.33° C
(3) 78.2° C
(4) None of these

3. The heat current in *AB* is

(1) $\frac{1}{3}$rd of heat current in *AC*
(2) $\frac{2}{3}$rd of heat current in *AC*
(3) $\frac{1}{2}$nd of heat current in *BC*
(4) None of these

❑ ❑ ❑

SECTION - D

Assertion - Reason Type

This section contains 33 questions. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Instructions for Assertion - Reason Type questions :

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

Choose the correct answer :

1. STATEMENT-1 : Real gas approaches ideal gas behaviour at low pressures and high temperatures.

   and

   STATEMENT-2 : At low pressure, density of gas is very low.

2. STATEMENT-1 : All molecules in a gas move with the same speed.

   and

   STATEMENT-2 : Average velocity of molecules of a gas sample is zero.

3. STATEMENT-1 : Total energy of a gas sample is equally distributed in all possible energy modes.

   and

   STATEMENT-2 : The average energy of one molecule corresponding to each degree of freedom is $\frac{1}{2}kT$.

4. STATEMENT-1 : If we compress a gas sample in an adiabatic container, pressure increases.

   and

   STATEMENT-2 : Frequency of collisions of atoms increases.

5. STATEMENT-1 : Internal energy of a gas ($U = nC_VT$) is due to random motion of the gas molecules.

   and

   STATEMENT-2 : A container is moving with speed v. It is suddenly stopped by a force, temperature of the gas in container increases.

6. STATEMENT-1 : Internal energy of an ideal gas sample is total kinetic energy of the gas.

   and

   STATEMENT-2 : There is no interaction force between gas molecules hence potential energy is not defined.

7. STATEMENT-1 : The adiabatic exponent $\left(\gamma = \frac{C_p}{C_v}\right)$ of a diatomic gas is less than that of a monoatomic gas .

   and

   STATEMENT-2 : The molecules of diatomic gas has more degrees of freedom.

8. STATEMENT-1 : If an ideal gas expands in vacuum in an insulated chamber, ΔQ, ΔU and ΔW all are zero.

   and

   STATEMENT-2 : Temperature of gas remains constant.

9. STATEMENT-1 : In process, if initial volume is equal to final volume. work done by gas is zero.

   and

   STATEMENT-2 : In an isochoric process, work done is zero

10. STATEMENT-1 : All processes in which pressure and volume are proportional take place at constant temperature.

    and

    STATEMENT-2 : Work done in thermodynamical process is path dependent.

11. STATEMENT-1 : If temperature of an ideal gas is constant, then change in its internal energy is zero.

    and

    STATEMENT-2 : For a cyclic path the change in internal energy is equal to the work done by the gas.

12. STATEMENT-1 : Within a broad pressure range the thermal conductivity is independent of the pressure of gas.

    and

    STATEMENT-2 : A dependence becomes noticeable if the mean free path of the molecules becomes comparable to the distance between the walls across which heat is transferred.

13. STATEMENT-1 : Efficiency of a Carnot engine with sink at 0 K is 100%.

    and

    STATEMENT-2 : Keeping sink at ice point and source at 100°*C* will bring 100% efficiency.

14. STATEMENT-1 : For process ΔQ = 100 J and W = 120 J then temperature of gas in process should increase.

    and

    STATEMENT-2 : Work done by gas is greater than heat supplied hence $\Delta U < 0$.

15. STATEMENT-1 : A refrigerator transfers heat from lower temprature to higher temperature.

    and

    STATEMENT-2 : Heat cannot be transferred from lower temperature to higher temperature without doing any external work.

16. STATEMENT-1 : Q heat is given to melt ice cube and magnitude of work done by ice on surrounding is W. Then $\Delta U = Q - W$.

    and

    STATEMENT-2 : First law of thermodynamics is applicable in this situation.

17. STATEMENT-1 : Work is a state function in any thermodynamical process.

    and

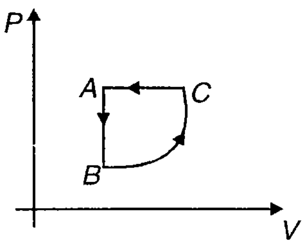
    STATEMENT-2 : Internal energy is state function.

18. STATEMENT-1 : Internal energy of a system must increases with increase in temperature.

    and

    STATEMENT-2 : Kinetic energy of gas increases with increase in temperature.

19. STATEMENT-1 : If a gas undergoes a process shown below then the heat is taken from the gas.



    and

    STATEMENT-2 : For above process work done by the gas is negative and the change in internal energy is zero.

20. STATEMENT-1 : Woollen clothes keep body warm in winter.

    and

    STATEMENT-2 : Air, which is bad conductor of heat is trapped in wollen clothes.

21. STATEMENT-1 : When ice melts the change in internal energy is greater than the heat added.

    and

    STATEMENT-2 : Coefficient of cubical expansion of ice is negative during melting process.

22. STATEMENT-1 : Emissive power of body is dimensionless quantity.

    and

    STATEMENT-2 : Absorptive power is a dimensionless quantity.

23. STATEMENT-1 : Stainless steel cooking pans are preferred with extra copper bottom.

    and

    STATEMENT-2 : Thermal conductivity of copper is more than steel. So the heating is uniform at the bottom.

24. STATEMENT-1 : It is hotter at some distance over top of fire than it is on sides.

    and

    STATEMENT-2 : Convection takes heat upwards.

25. STATEMENT-1 : If a, r and t are absorptive, reflective and transmitting powers of body then $a + r + t = 1$.

    and

    STATEMENT-2 : For $t \to 1$ the body will be diathermanous.

26. STATEMENT-1 : Desert areas have exceptionally large day night temperature variation.

    and

    STATEMENT-2 : The specific heat of sand is small.

27. STATEMENT-1 : During melting of slab of ice at 273 K at atmospheric pressure, positive work is done by ice water system on atmosphere.

    and

    STATEMENT-2 : Internal energy of ice water increases, when ice melts.

28. STATEMENT-1 : For steady state during heat conduction across a rod of uniform cross-section temperature gradient is same for all points.

    and

    STATEMENT-2 : Thermal current decreases as we move across rod from higher temperature to lower temperature.

29. STATEMENT-1 : Thermal current is same at all points in conductor during steady state.

    and

    STATEMENT-2 : Thermal current is proportional to cross sectional area of conductor for a given temperature difference across conductor.

30. STATEMENT-1 : Body can never be cooled to a temperature less than surrounding during radiation.

    and

    STATEMENT-2 : Newton's law of cooling is special case of Stefan's law.

31. STATEMENT-1 : In distribution of energy in spectrum of black body, at given temperature energy is not distributed uniformly among different wavelengths.

    and

    STATEMENT-2 : For all wavelengths increase in temperature causes a decrease in intensity.

32. STATEMENT-1 : Heat is transferred most rapidly during radiation.

    and

    STATEMENT-2 : Transfer of heat take place with the speed of light during radiation.

33. STATEMENT-1 : A cold block of metal feels colder than a block of wood at the same temperature. But a hot metal feels hotter than a block of wood at the same temperature.

    and

    STATEMENT-2 : According to Kirchhoff's law good emitters are good absorbers.

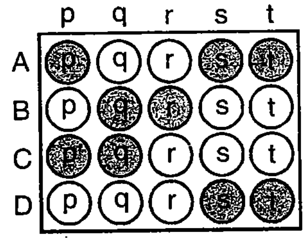
❑ ❑ ❑

SECTION - E

Matrix-Match Type

This section contains 13 questions. Each question contains statements given in two columns which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **One OR More** statement(s) in **Column II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example :

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.



1. A gas sample is enclosed in a closed container, temperature of gas is continuously increasing. Match the correct options in column-II corresponding to column-I.

Column I	Column II
(A) Internal energy of gas	(p) Increases
(B) Average momentum of gas molecules	(q) Decreases
(C) Number of molecules moving with most probable speed	(r) Zero
(D) $\frac{v_{avg}}{v_{rms}}$	(s) Remains constant
	(t) Depends on temperature and is independent of other variables

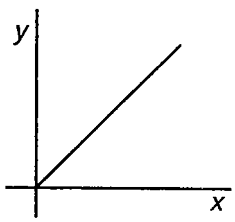
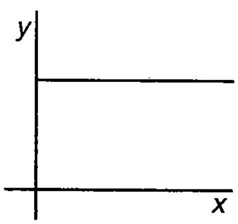
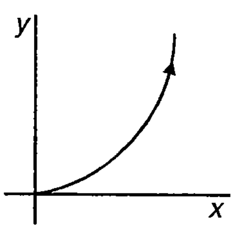
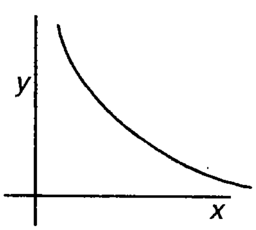
2. Match the following

Column I	Column II
(A) Diatomic molecule	(p) Ratio of translational and rotational energy is $\frac{3}{2}$
(B) Hollow sphere in pure rolling motion	(q) Fast and isolated
(C) Adiabatic process	(r) Maximum conversion of heat into work
(D) Isothermal process	(s) Work done by friction is zero
	(t) Ratio of translational and rotational kinetic energy is $\frac{5}{2}$

3. A gas is kept in container which has moving piston. Volume of container is decreased by piston but temperature is constant. Match the column-I and column-II.

Column I	**Column II**
(A) Ratio of $\frac{P}{\rho}$	(p) Increases
(B) Ratio of $\frac{v_{sound}}{v_{mp}}$	(q) Decreases
(C) Frequency of collision of molecules	(r) Remains constant
(D) Momentum transferred to wall per collision	(s) Depends upon atomicity of gas
	(t) Depends as upon adiabatic exponent of gas

4. Match the following

Column I	**Column II**
(A) 	(p) $y = v_{rms}^2$, $x = \rho$(density) provided pressure is constant
(B) 	(q) $y = v_{rms}^2$, $x = T$(temperature)
(C) 	(r) $x = v_{rms}$, y = temperature
(D) 	(s) y = number of molecules moving in particular direction, x = temperature
	(t) y = pressure and x = volume of gas in a thermodynamic process

5. Match the following

Column I	Column II
(A) Cyclic process	(p) $\Delta U < 0$
(B) Isobaric process	(q) $\Delta Q = \Delta W$
(C) Isochoric process	(r) $\Delta W = nR\Delta T$
(D) Adiabatic expansion	(s) $\Delta Q = \Delta U$
	(t) Nothing can be said about the sign of work done with surity

6. Match the following

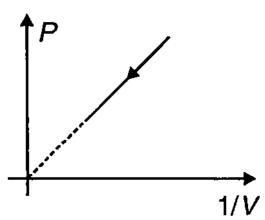
Column I	Column II
(A) Diatomic Molecule	(p) $U = n\frac{f}{2}RT$
(B) (f degree of freedom)	(q) Work done is more than work done by gas in isothermal expansion
(C) Adiabatic process	(r) $C_p = 3.5\ R$
(D) Isobaric expansion	(s) Sudden process or process in isolated system
	(t) All the thermodynamic variables change simultaneously

7. Match the following

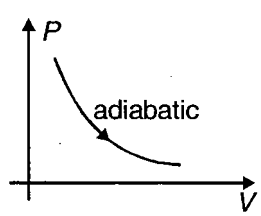
Column I	Column II
(A) Adiabatic process	(p) Change in entropy is zero
(B) Isothermal process	(q) Cooling on expansion
(C) Critical temperature	(r) Bursting of an air filled tube
(D) Quasi-static process	(s) Coexistence of liquid and gas is not possible
	(t) All types of equilibrium

8. Figure below shows different processes for given amount of ideal gas.

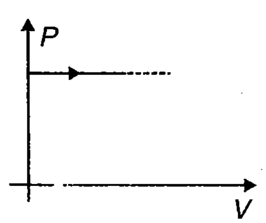
(i)



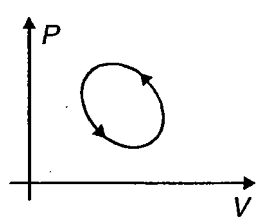
(ii)



(iii)



(iv)



Column I	Column II
(A) In figure (i)	(p) $\Delta Q > 0$
(B) In figure (ii)	(q) $\Delta W < 0$
(C) In figure (iii)	(r) $\Delta Q < 0$
(D) In figure (iv)	(s) $\Delta W > 0$
	(t) Density of gas decreases continuously

9. Referring to figure in above problem

Column I	Column II
(A) In figure (i)	(p) $\Delta U \neq 0$
(B) In figure (ii)	(q) $\Delta U = 0$
(C) In figure (iii)	(r) $\Delta S \neq 0$
(D) In figure (iv)	(s) $\Delta S > 0$
	(t) Density temperature graph will be a curve (not a straight line)

10. Match the following

Column I	Column II
(A) Planck's law	(p) Electromagnetic waves
(B) Rayleigh-Jean's law	(q) $E_\lambda = \dfrac{8\pi hc}{\lambda^5 [e^{h\nu/kT} - 1]}$
(C) Wein's law	(r) $E_\lambda = \dfrac{8\pi kT}{\lambda^4}$
(D) Heat waves	(s) $E_\lambda = 8\pi\, hc\, \lambda^{-5}\, e^{-\frac{hc}{\lambda^2 T}}$
	(t) Temperature of stars

11. Explanations of phenomenas in column-II is explained by laws given in column-I.

Column I	Column II
(A) Why days are hot and nights cold in deserts	(p) Wein's displacement law
(B) Why blackened platinum wire when heated gradually appears red and then blue	(q) Planck's law
(C) Change in wavelength corresponding to maximum intensity with temperature in distribution of energy in black body spectrum	(r) Kirchhoff's law
(D) Determination of some stars being hotter than others	(s) Stefan's law
	(t) Wavelength shift

12. Match the following

Column I	Column II
(A) Cyclic process	(p) Black body
(B) Bad reflector	(q) 273.15 K
(C) Wein's law	(r) Net work done during a cycle can be greater than zero
(D) Absolute zero temperature	(s) Total change in internal energy is zero
	(t) Shift in wavelength

13. Match the following

Column I	Column II
(A) Heat current is directly proportional to cross section area	(p) Conduction
(B) For small temperature difference heat current is directly proportional to temperature difference	(q) Convection
(C) Transfer of heat due to difference in density	(r) Radiation
(D) Fastest heat transfer	(s) Kirchhoff's law
	(t) Newton's law of cooling

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SECTION - F

Subjective Type Questions

This section contains 14 subjective questions.

Solve the followings :

1. At 127°C and 5×10^{-3} atm pressure the density of gas is 6.2×10^{-3} kg/m^3

   (a) Find V_{rms} for the gas molecules.

   (b) Find molecular weight of the gas and identify it.

2. An air column is closed in a tube sealed at one end by a Hg column having length 8 cm. When the tube is placed with its open end downward the height of air column is 20 cm. If the tube is turned so that its open end is the top, the height of air column is 16 cm. Find the atmospheric pressure.

3. A vertical cylinder closed from both ends is equipped with an easily moving conducting piston dividing the volume into two parts each containing one mole of air. In equilibrium at T_0 = 300 K. The volume of upper part is 4 times of volume of lower part. At what temperature ratio of volumes be equal to 3 times?

4. Two identical glass bulbs are connected by a narrow tube and are filled with a gas at 27°C and 1 atm pressure. One of the bulbs is placed in melting ice and other is placed in a water bath at 82°C. What is the new pressure inside the bulbs neglect volume of connecting tube?

5. A vessel of volume V_0 contains an ideal gas at pressure (P_0) and temperature (T). Gas is continuously pumped out of this vessel at a constant volume rate $\frac{dV}{dt} = \alpha$, keeping temperature constant.

   (a) Find pressure of the gas in container as a function of time.

   (b) The time taken before $\frac{1}{3}$rd of original gas is pumped out.

6. Find minimum attainable pressure of ideal gas in process $T = T_0 + \alpha V^2$.

7. Find maximum attainable temperature of ideal gas in process $P = P_0 - \alpha V^2$ for one moles gas.

8. In an adiabatic expansion of air, volume increases by 5% what is percentage change in pressure?

9. An Ideal gas has molar heat capacity C_V at constant volume, find molar heat capacity for the process $T = T_0 e^{\alpha V}$

10. One mole of gas with heat capacity C_p at constant pressure goes through process $T = T_0 + \alpha V$. What is the heat capacity of gas?

11. For a solid cylinder of length L_0, area A conductivity varies with temperature T as $k = k_0(1 + \alpha T)$. If one end is at $2T_0$ and other at T_0, find rate of heat flow.

12. A pond of water at 0°C is covered with layer of ice 4 cm thick if air temperature is −10°C (constant), how long it takes for ice thickness to increase to 8 cm? K_{ice} = 2 W/m°C, L_f = 80 cal/gm, ρ_{ice} = 900 kg/m^3.

13. A cubical rigid container of edge length 10 cm with thickness of wall t = 4 mm, $K = 8.31 \times 10^{-3}$ W/m-k has helium gas at 800 K. If temperature of surrounding is 300 K, then find the time when pressure becomes half of initial pressure.

14. Water of volume 2 litre in container is heated with coil of 1 kW at 27°C. The lid of container is open and energy dissipates at rate 160 J/s. In how much time, temperature will rise from 27°C to 77°C?

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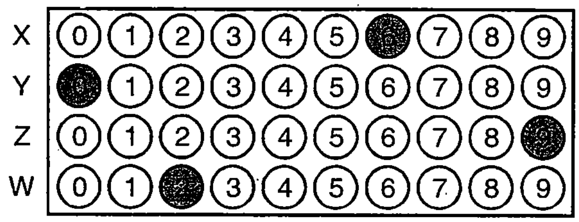
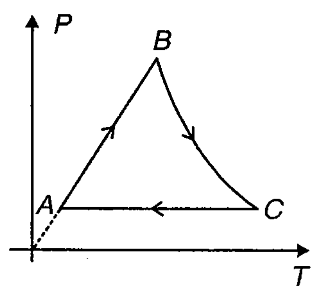
SECTION - G

Integer Answer Type

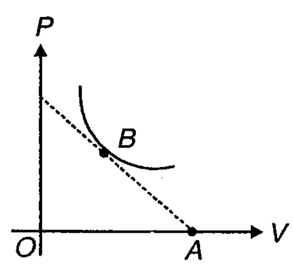
This section contains 7 questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W(say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following :



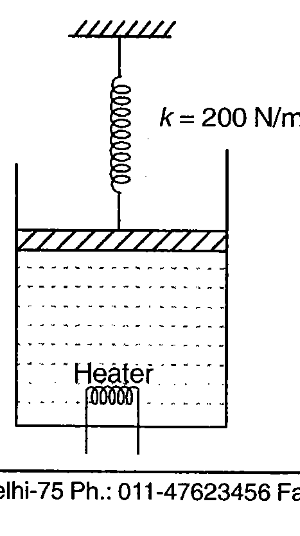
1. A monoatomic gas initially in state $A(P_0, V_0)$ is taken through a cyclic process $ABCA$ as shown in the figure. The pressure of point B is twice of that of A. The curve BC is a rectangular hyperbola. If the net work done by the gas is xP_0V_0, then find the value of x.



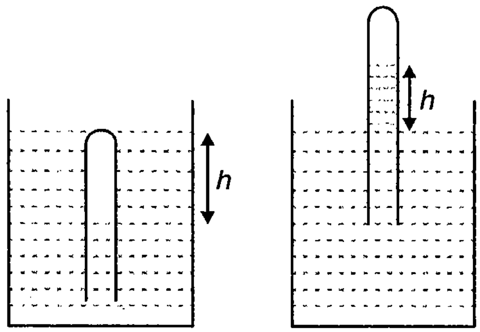
2. For an unknown gas undergoing adiabatic process the variation of pressure with volume is shown in the figure. The co-ordinates of point B is given by $\left(\frac{1}{2}\text{ units}, \frac{1}{2}\text{units}\right)$ and the angle OBA is $\frac{\pi}{2}$. AB is a tangent drawn at point B as shown in the figure. The adiabatic exponent of gas is



3. A diatomic gas is enclosed in a cylinder piston arrangement. The piston having mass m = 1 kg is attached to a light spring having spring constant k = 200 N/m. The area of cross section of cylinder is 1 cm^2. Initially the spring is relaxed. Now the heater starts supplying heat very slowly. Calculate the work done (in J) by the gas when the piston moves through a distance x = 10 cm from the position shown. [Take g = 10 m/s^2]

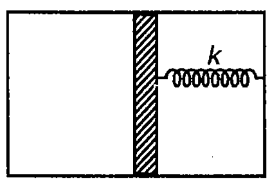


4. A glass tube, which is closed at one end is completely dipped with open end downward in a vessel containing unknown liquid ($\rho = 5 \times 10^3$ kg/m^3) so that the length of the air column is $h = 100$ cm. Now the tube is raised upwards until the height of free surface of liquid inside the tube above the level of liquid in the vessel becomes $h = 100$ cm. Find the length of air column (in m) trapped between tube and liquid.



5. A standing wave with a frequency of 1000 Hz in a column of mixture of unknown gasses at 27°C produces mode that are 0.1 m apart. Find the value of γ for the mixture. (Use $R = 8.3$ J/mole and molar mass of mixture 124.5 g/mol)

6. A thermally insulated vessel is divided into two parts by a heat insulating massless piston which can move in the vessel without friction. The left part of vessel contains 1 mole of an ideal monoatomic gas and right part is empty. The piston is connected to the right wall of vessel through a spring whose length in free state is equal to the length of the vessel. Heat capacity of the system is found to be nR. Find n. Heat capacities of the vessel piston and spring are negligible.



7. Temperature at the bottom of a lake is 100 x kelvin. An air bubble starts rising from the bottom of a lake. Its radius is $(5.168)^{1/3}$ mm at the bottom and 2 mm at the surface. The depth of the lake is 4.664 m and the temperature at the surface is 320 K. Find x. (Given atmospheric pressure = 76 cm of mercury. $g = 9.8$ m/s^2, specific gravity of mercury = 13.6)

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SECTION - H

Multiple True-False Type Questions

Identify the correct combination of true and false of the given three statements.

1. STATEMENT-1 : If in a process gas is compressed then $C_P - C_V = -R$.

   STATEMENT-2 : The expansion formula is valid for very small change in temperature.

   STATEMENT-3 : The isothermal and adiabatic curves can intersect each other, only at one point.

   (1) T T F (2) F F F (3) T T T (4) T F T

2. STATEMENT-1 : When temperature of a system is constant, then its change in internal energy must be zero.

   STATEMENT-2 : In free expansion of gas Q, ΔU and W all are zero.

   STATEMENT-3 : If a gas follows the equation $P \propto \frac{1}{\sqrt{V}}$ then the Bulk modulus of elasticity of gas is $\frac{P}{2}$, where P is the pressure of gas

   (1) F T T (2) T F F (3) F T F (4) T T T

3. STATEMENT-1 : The graph between fraction of molecules and their thermal speed is symmetrical about $V = V_{\text{most probable}}$.

   STATEMENT-2 : On increasing temperature of gas contained in an open container, the mean free path of gas molecules decreases.

   STATEMENT-3 : If in a process ΔV (change in gas volume) is zero then work done by gas may be zero.

   (1) F T T (2) T F F (3) F T F (4) F F T

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Electromagnetism

UNIT 3

This Unit Includes

Electrostatics, Current Electricity, Magnetic Effect of Current and Magnetism, Electromagnetic Induction, Alternating Current

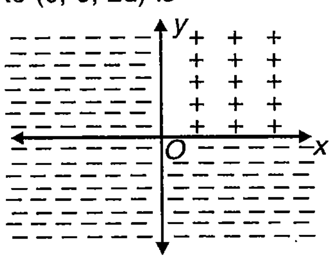
SECTION - A

Straight Objective Type

This section contains 193 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. If charge is distributed uniformly in xy plane with charge density $+\sigma$ in first quadrant and $-\sigma$ in remaining three quadrants, then work done by electric field in moving a point charge q from $(0, 0, d)$ to $(0, 0, 2d)$ is



(1) $\frac{-\sigma q}{4\varepsilon_0}d$ (2) $\frac{\sigma q}{4\varepsilon_0}d$

(3) $\frac{-\sigma}{2\varepsilon_0}qd$ (4) $\frac{\sigma q}{\varepsilon_0}d$

2. A metal sphere is placed in a uniform electric field $E_0\hat{i}$, then

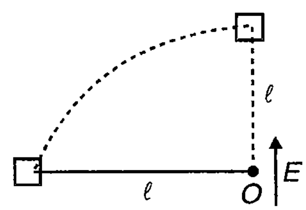
(1) $\frac{\partial V}{\partial x}$ is uniform both inside and out side the sphere

(2) $\frac{\partial V}{\partial x}$ is uniform outside but non-uniform inside the sphere

(3) $\frac{\partial V}{\partial x}$ is uniform inside but non-uniform outside the sphere

(4) $\frac{\partial V}{\partial x}$ in non-uniform both inside and outside the sphere

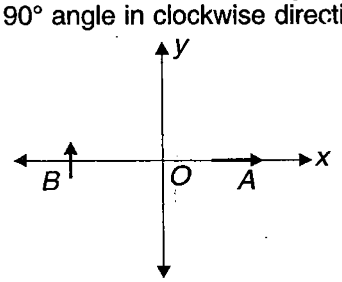
3. A block of mass m and charge q is connected to a point O with help of an inextensible string. The system is on a horizontal table. An electric field is switched on in direction perpendicular to string. What will be tension in string when it become parallel to electric field?



(1) $\frac{qE}{2}$ (2) $3qE$

(3) $\frac{qE}{\ell}$ (4) $\frac{3qE}{5}$

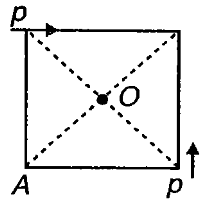
4. Two dipoles of dipole moments p each are placed on points A $(a, 0)$ and B $(-a, 0)$ as shown in figure. How much work is done in rotating both the dipoles through 90° angle in clockwise direction?



(1) pE (2) $\frac{kp^2}{r^4}$

(3) Zero (4) $\frac{-2kp^2}{r^4}$

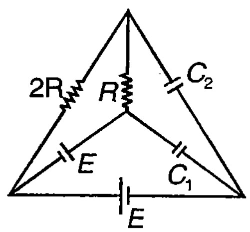
5. Two short dipoles of dipole moment p are placed at two corners of a square as shown in the figure. What is the ratio of magnitudes of electric field at two points O & A?



(1) 2 (2) $2\sqrt{2}$

(3) 1 (4) $\sqrt{2}$

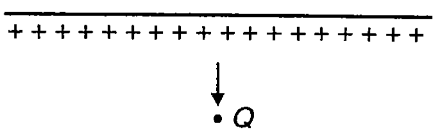
6. If energy stored in the capacitors C_1 and C_2 are same, then what is the value of $\frac{C_1}{C_2}$?



(1) $\frac{36}{25}$ (2) $\frac{1}{36}$

(3) $\frac{4}{9}$ (4) $\frac{9}{4}$

7. An electric dipole and a point charge are placed near an infinite large insulating sheet of uniform charge density σ, then



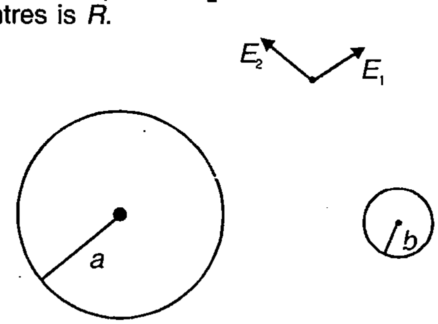
(1) Dipole moves towards point charge

(2) Dipole moves towards sheet

(3) Dipole rotates clockwise

(4) Dipole rotates anti-clockwise

8. Two conducting spheres of Radii a and b have charges Q_1 and Q_2. Distance between their centres is R.

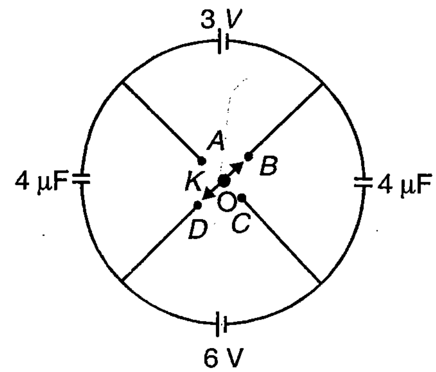


If $\vec{E}_1$ and $\vec{E}_2$ are electric field vectors due to two spheres at any point, then what is value of $\varepsilon_0 \int_{\text{All space}} \vec{E}_1 \cdot \vec{E}_2 \, dV$?

(1) $\frac{KQ_1 Q_2}{R}$ (2) $\frac{KQ_1^2}{a} + \frac{KQ_2^2}{b}$

(3) $\frac{K Q_1 Q_2}{ab}$ (4) $\frac{2KQ_1 Q_2}{R}$

9. In figure, there is a four way key at the middle. If key is thrown from situation BD to AD, then how much charge will flow through point O?



(1) 24 μC (2) 36 μC

(3) 72 μC (4) 12 μC

10. A point charge q is placed at $\left(0,\ 0,\ \frac{-a}{2}\right)$ inside a conducting shell of radius a and center (0, 0, 0). What is flux linked to hemispherical surface?

$x^2 + y^2 + z^2 = 4a^2$ & $z > 0$

(1) $\frac{q}{2\,\varepsilon_0}$ (2) $\frac{q}{\varepsilon_0}$

(3) Less than $\frac{q}{2\,\varepsilon_0}$ (4) Zero

11. Two pith balls having charge $3q$ and $2q$ are placed at distance of 'a' from each other. For what value of charge transferred from 1st ball to 2nd ball, force between balls becomes maximum?

(1) $\frac{q}{2}$ (2) $\frac{5q}{2}$

(3) $7q$ (4) q

12. Two concentric spherical shells of radii a & 1.2 a have charges + Q and –2 Q respectively. At what distance from centres potential will be same as that of centre?

(1) 2 a (2) 1.5 a

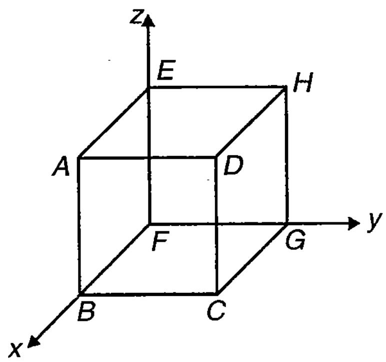
(3) 2.5 a (4) 3 a

13. An electric dipole is made up of two particles having charges $+1\mu C$, mass 1 kg and other with charge $-1\mu C$ and mass 1 kg separated by distance 1 m. It is in equilibrium in a uniform electric field of 20×10^3 V/m. If the dipole is deflected through angle 2°, time taken by it to come again in equilibrium is

(1) $2.5\ \pi s$ (2) 2.5 s

(3) $5\ \pi s$ (4) $4\ \pi$

14. Electric field in a region is given by $\vec{E} = -4x\hat{i} + 6y\hat{j}$, find the charge enclosed in cube of side 1 m oriented as shown in figure



(1) $2\varepsilon_0$ (2) Zero

(3) ε_0 (4) $6\varepsilon_0$

15. The potential decreases uniformly from V_1 to V_2 along x-axis in a co-ordinate system as one moves from $(-a, 0)$ to $(+a, 0)$. The field at origin is

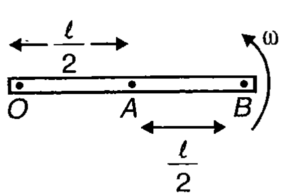
(1) Must be $\dfrac{V_1 - V_2}{2a}$

(2) Cannot be less than $\dfrac{V_1 - V_2}{2a}$

(3) Must be smaller than $\dfrac{V_1 - V_2}{2a}$

(4) Must be greater than $\dfrac{V_1 - V_2}{2a}$

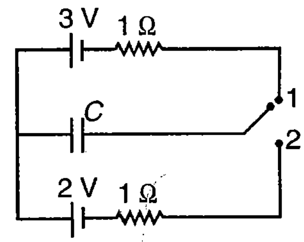
16. A conducting rod of length l rotates about its one end with angular velocity ω. Potential difference between A and B is (M & e = mass and charge of electron)



(1) $\dfrac{M\omega^2\ell^2}{e}$ (2) $\dfrac{3M\omega^2\ell^2}{4e}$

(3) $\dfrac{3}{8}\dfrac{M\omega^2\ell^2}{e}$ (4) Zero

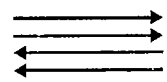
17. The key K is connected in turn to each of the contacts over short identical time intervals so that change in charge on the capacitor over each connection is small. The final charge q_0 on the capacitor is



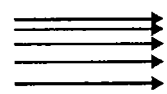
(1) 2.5 C (2) 5 C

(3) 4 C (4) $\dfrac{C}{2}$

18. Which of following lines represent electric field?

(1) 

(2) 

(3) 

(4) None of these

19. Surface charge densities of two concentric spheres of radii, R_1 and R_2 are $+\sigma_1$ and $-\sigma_2$ Suppose E_1 is field at distance r (such that $R_1 < r < R_2$). Now if two spheres are connected by a thin wire, field at same point is E_2, where $\left|\dfrac{E_2}{E_1}\right|$ is

(1) $\dfrac{R_1}{R_1 + R_2}$

(2) $\dfrac{R_2}{R_1 + R_2}$

(3) Zero

(4) Infinite

20. A proton and a deutron initially at rest are accelerated with same uniform electric field for time t.

(1) Both particles will have same momentum

(2) Both particles will have same K.E.

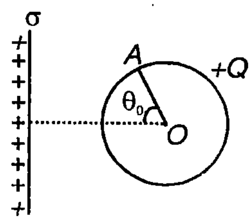
(3) Both particles will have same speed

(4) Both particles will cover same distance

21. Potential at a point x is 5 V and at a point y is -5 V. A proton is moving towards x from y, then
   (1) It must have K.E. more than 10 eV to reach x from y
   (2) Work done by $\vec{E}$ in motion from x to y is -10 eV
   (3) Work done by $\vec{E}$ in motion from y to x is 0
   (4) K.E. at y is more than K.E. at x, if particle is released at x

22. A conducting sphere of radius R and charge Q is placed near a uniformly charged non-conducting infinitely large thin plate having surface charge density σ. Then potential at point A on sphere due to charge on sphere

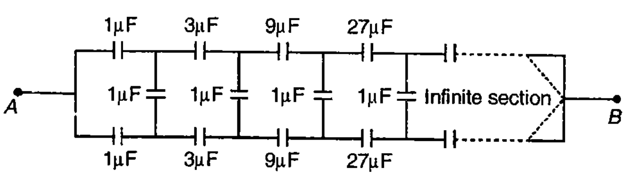
$\left(\text{Here } k = \dfrac{1}{4\pi\varepsilon_0}, \theta_0 = \dfrac{\pi}{3}\right)$



   (1) $k\dfrac{Q}{R} - \dfrac{\sigma}{4\varepsilon_0}R$ (2) $\dfrac{kQ}{R}$
   (3) $k\dfrac{Q}{R} - \dfrac{\sigma R}{\varepsilon_0}$ (4) None of these

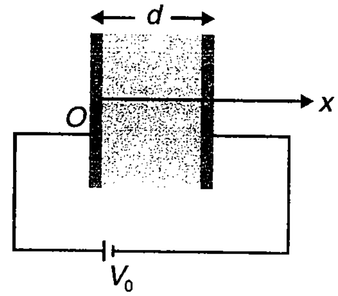
23. If electric field between plates of a parallel plate capacitor is 2 N/C and charge on two plates are 10 C and 3 C, then force on one of the plates is
   (1) 20 N (2) 13 N
   (3) $\dfrac{60}{7}$ N (4) $\dfrac{7}{2}$ N

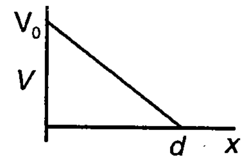
24. What is equivalent capacitance of circuit between points A and B?

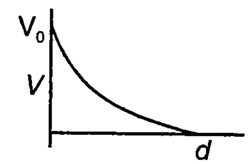


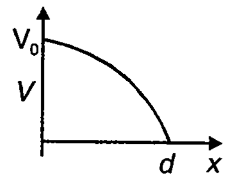
   (1) $\dfrac{2}{3}$ μF (2) $\dfrac{4}{3}$ μF
   (3) Infinite (4) $(1+\sqrt{3})$ μF

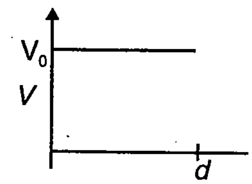
25. The gap between plates of a parallel plate capacitor is filled with an isotropic dielectric whose dielectric constant varies linearly in a direction perpendicular to the plates. Potential difference between plates is V. Correct variation of potential with x is



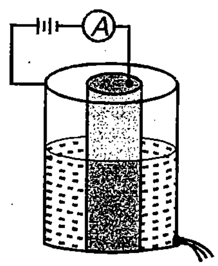
(1) 

(2) 

(3) 

(4) 

26. Two long cylindrical metal tubes stand on insulating floor. A dielectric oil is filled between plates. Two tubes are maintained with potential difference V. A small hole is opened at bottom then



   (1) Reading of ammeter decreases
   (2) Capacitance of system increases
   (3) Current in circuit is dependent on area of hole
   (4) Current in circuit is inversely proportional to dielectric constant

27. A circular ring of radius R with uniformly distributed positive charge Q on its circumference is located in xy plane with its centre at origin O. A particle of mass m and charge q is at origin. It is slightly disturbed towards $+z$-axis. Kinetic energy when it reaches at $z = R\sqrt{3}$
   (1) $\dfrac{KqQ}{2R}$ (2) $\dfrac{KqQ}{R}$
   (3) $\dfrac{KqQ}{\sqrt{3}R}$ (4) $\dfrac{KqQ}{4R}$

28. In a regular polygon with 11 sides each corner is at a distance a from centre. Identical charges are placed at 10 corners. At the centre the intensity is E and the potential is V. The ratio of $\frac{V}{E}$ has magnitude

(1) $11a$
(2) $\frac{10}{a}$
(3) $\frac{10}{11}a$
(4) $10a$

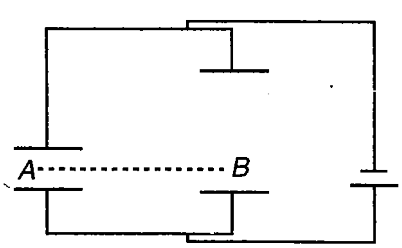
29. In a uniform electric field the potential of origin is V and $\frac{V}{2}$ at each of the points $(a, 0, 0)$, $(0, b, 0)$, $(0, 0, c)$. The potential at (a, b, c) will be

(1) $\frac{V}{2}$
(2) $\frac{-3V}{2}$
(3) $-\frac{V}{2}$
(4) $-V$

30. Consider a triangular surface whose vertices are three points having co-ordinate A (2a, 0, 0), B (0, a, 0), C (0, 0, a). If there is a uniform electric field $E_0\hat{i} + 2E_0\hat{j} + 3E_0\hat{k}$ then flux linked to triangular surface ABC is

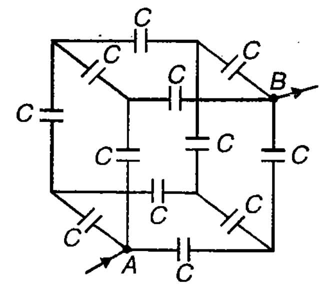
(1) $\frac{7E_0a^2}{2}$
(2) $3E_0a^2$
(3) $\frac{11E_0a^2}{2}$
(4) Zero

31. Two parallel plate capacitors with same area but different distances between plates are connected as shown in figure



(1) E_B is more that E_A
(2) Potential at A is more than potential at B
(3) Work done by external agent in moving e^- from A to B is negative
(4) $E_A = E_B$

32. Effective capacitance between A and B will be

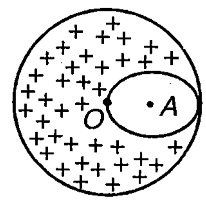


(1) $\frac{4}{3}C$
(2) $\frac{12}{7}C$
(3) $\frac{6}{5}C$
(4) C

33. Three infinitely long charged thin wires are placed along x, y, z axes. Their line charge densities are λ_1, λ_2 and λ_3 respectively. Then

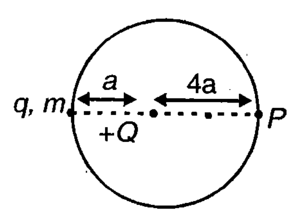
(1) E_x at point $(a, a, 0)$ is independent to λ_2
(2) E_z at point (a, a, a) is proportional to $\sqrt{\lambda_1^2 + \lambda_2^2}$
(3) E at point $(a, a, 0)$ is proportional to $\sqrt{\lambda_1^2 + \lambda_2^2}$
(4) Work done to move a charge from $(a, a, 0)$ to (a, a, a) is dependent on λ_1 and λ_2

34. A solid sphere having uniform charge density ρ and radius R is shown in figure. A spherical cavity of radius $\frac{R}{2}$ is hollowed out. What is potential of O? (Assuming potential at infinity to be zero)



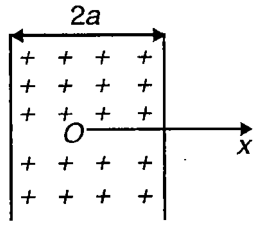
(1) $\frac{11R^2\rho}{24\varepsilon_0}$
(2) $\frac{5}{12}\frac{R^2\rho}{\varepsilon_0}$
(3) $\frac{7\rho R^2}{12\varepsilon_0}$
(4) $\frac{3}{2}\frac{R^2\rho}{\varepsilon_0}$

35. The diagram shows a small bead carrying charge q. The bead can freely move on smooth fixed ring placed on a smooth horizontal plane. Potential due to $+Q$ at P is V. If bead is given a very small velocity tangential from Q. Velocity of bead when it reaches at P.

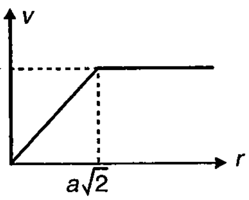


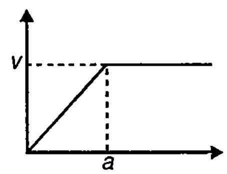
(1) $\sqrt{\frac{6qV}{m}}$
(2) $\sqrt{\frac{qV}{m}}$
(3) $\sqrt{\frac{3qV}{m}}$
(4) Zero

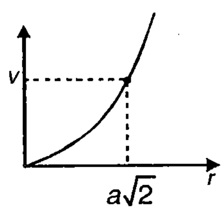
36. An infinite non conducting wall in yz plane having thickness $2a$ in the x direction carries uniform positive charge, of volume density ρ_0

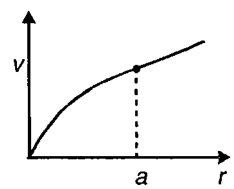


Which of the following represents variation of potential along line $x = y$, $z = 0$ with r where r is distance from origin?

(1) 

(2) 

(3) 

(4) 

37. An electric charge is given to an insulated metal plate which is parallel and close to similar earthed plate. Separation between plates is increased (using non conducting handle). Which of the following is/are correct?

A. Work must be done to separate the plate

B. Charge flows on to earthed plate

(1) A only

(2) B only

(3) Both (1) & (2)

(4) None of these

38. Three charges each of value Q are placed at points A $(-K, 0)$, O $(0, 0)$ and B $(0, K)$. If force on point charge at A is $a\hat{i} + b\hat{j}$ then force on point charge at B is

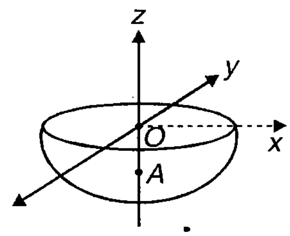
(1) $-a\hat{i} - b\hat{j}$

(2) $b\hat{i} + a\hat{j}$

(3) $-b\hat{i} - a\hat{j}$

(4) $-a\hat{j} + b\hat{i}$

39. Consider a uniformly charged hemispherical shell of radius R. If field at point A $(-z_0, 0, 0)$ is $\vec{E}$ then field at point $(z_0, 0, 0)$ is $[z_0 < R]$



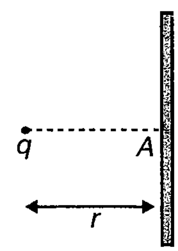
(1) $-\vec{E}$

(2) $-\vec{E} + \dfrac{KQ}{z_0}\hat{k}$

(3) $+\vec{E}$

(4) $+\vec{E} - \dfrac{KQ}{z_0}\hat{k}$

40. A point charge is placed in front of an infinitely large metal plate. Potential of point A is



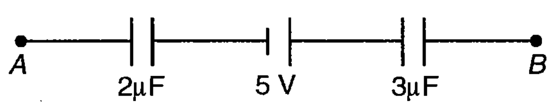
(1) $\dfrac{Kq}{r}$

(2) Zero

(3) $\dfrac{-Kq}{r}$

(4) Infinite

41. A circuit has a section AB as shown in the figure. If the potential difference between two points AB is 10 V (A at higher potential) then potential difference across 2μF capacitor is



(1) 9 V

(2) 7 V

(3) 12 V

(4) None of these

42. Two charges Q and $2Q$ are placed at $(a, 0)$ and $(-a, 0)$. Field at origin is E. Now Q charge is moved along x-axis away from origin. Then

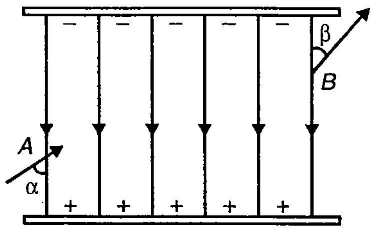
(1) Field at mid point of two charges increases

(2) Field at mid point of two charge decreases

(3) Field at origin decreases

(4) Field at origin remains same

43. A charged particle enters at point A and comes out from B. Its velocity makes angle α & β with electric field at these two points. Ratio of kinetic energy of changed particle at these two points will be



(1) $\dfrac{\sin^2\alpha}{\sin^2\beta}$

(2) $\dfrac{\sin^2\beta}{\sin^2\alpha}$

(3) $\dfrac{\cos^2\alpha}{\cos^2\beta}$

(4) $\dfrac{\cos^2\beta}{\cos^2\alpha}$

44. Electric field at point P (2, 3, 4) due to charge 1 nano coulomb which is placed at (1, 2, 3) is $\vec{E}.x$ component of electric field at point P is

(1) $\dfrac{2}{9\sqrt{3}}$ N/C (2) $\dfrac{2}{\sqrt{3}}$ N/C

(3) $\dfrac{8}{\sqrt{3}}$ N/C (4) $\sqrt{3}$ N/C

45. Which of the following expressions will have unit $\dfrac{J}{m^3}$?

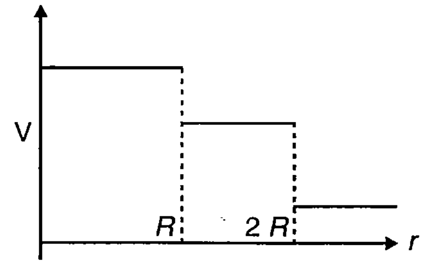
(1) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{e^2}{r}$

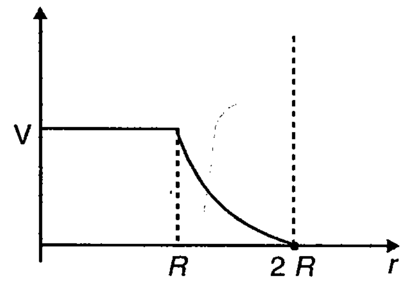
(2) $\dfrac{1}{2}CV^2$

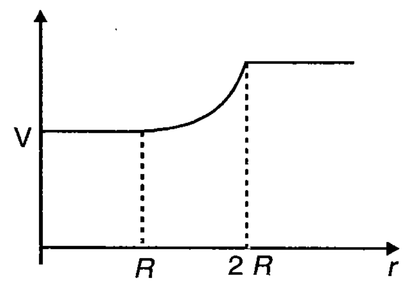
(3) $\dfrac{\sigma^2}{2\varepsilon_0}$

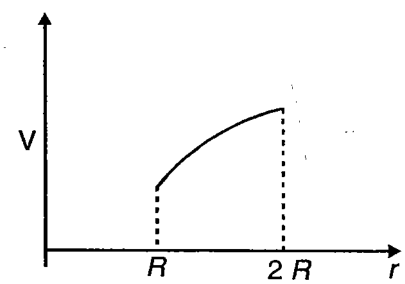
(4) $\dfrac{\lambda^2}{2\pi\varepsilon_0 r}$

46. Two concentric spherical shells of radii R & $2R$ have charges $+Q$ & $-Q$. Which of the following may represent correct variation of potential with distance r from origin?

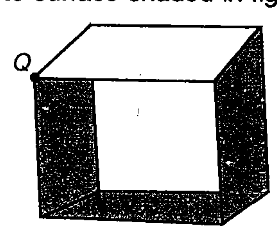
(1)


(2)


(3)


(4)


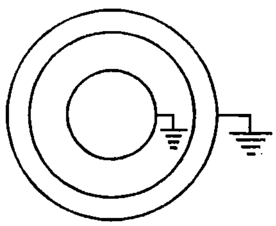
47. If a point charge is placed at vertex of cube then flux linked to surface shaded in figure



(1) $\dfrac{q}{8\varepsilon_0}$ (2) $\dfrac{q}{3\varepsilon_0}$

(3) $\dfrac{q}{12\varepsilon_0}$ (4) Zero

48. Three concentric conducting spherical shells have radii R, $2R$, $3R$ and charges Q_1, Q_2 and Q_3 respectively. Inner most and outer most shells are earthed as shown in the figure. Select incorrect option



(1) $Q_1 + Q_3 = -Q_2$ (2) $\frac{Q_1}{Q_2} = \frac{-1}{4}$

(3) $\frac{Q_3}{Q_1} = 3$ (4) $\frac{Q_2}{Q_3} = -3$

(IIT-JEE 2009)

48(a) Three concentric metallic spherical shells of radii R, $2R$, $3R$, are given charges Q_1, Q_2, Q_3, respectively. It is found that the surface charge densities on the outer surfaces of the shells are equal. Then, the ratio of the charges given to the shells, $Q_1 : Q_2 : Q_3$, is

(1) 1 : 2 : 3 (2) 1 : 3 : 5

(3) 1 : 4 : 9 (4) 1 : 8 : 18

49. A parallel plate capacitor C carries a charge Q. The distance between the plates is doubled by application of force, the work done by force is

(1) Zero (2) $\frac{Q^2}{2C}$

(3) $\frac{Q^2}{C}$ (4) $\frac{Q^2}{4C}$

50. Two concentric shells are having radii R and 2R, charges q_1 and q_2 and potentials 3 V and V respectively. Now outer shell is earthed,

(1) Potential difference between shell increases

(2) Potential difference between shell decreases

(3) Potential of inner sphere will become 2 V

(4) Potential of common centre will become 2.5 V

51. Consider a solid insulating sphere of radius R with charge density varying as $\rho = \rho_0 r^2$ (ρ_0 is a constant and r is measured from center). Consider two points A and B at distances x and y respectively ($x < R$, $y > R$) from the centre. If magnitudes of electric fields at points A and B are equal, then

(1) $x^2y = R^3$ (2) $x^3y^2 = R^5$

(3) $x^2y^3 = R^5$ (4) $\frac{x^4}{y} = R^5$

(IIT-JEE 2009)

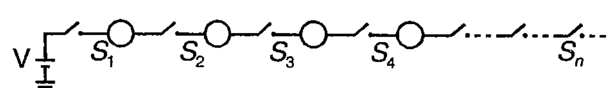
51(a) A solid sphere of radius R has a charge Q distributed in its volume with a charge density $\rho = kr^a$, where k and a are constants and r is the distance from its centre. If the electric field at $r = \frac{R}{2}$ is $\frac{1}{8}$ times that at $r = R$, find the value of a.

52. The potential in space varies according to the relation $V = 3x + 4y + 5z$. There is a wall parallel to yz plane at x = −5 m. A ball having charge 2 C is released from origin. If collision of ball and wall is elastic then time after which x-coordinate of particle became x = +15 m (Mass of the ball 3 kg)

(1) $\sqrt{15}$ s (2) 5 s

(3) $\sqrt{10}$ s (4) Never

53. All spheres are identical and initially uncharged, S_1 is closed at $t = 0$ leaving all others switches open. After sufficiently long time S_1 is opened and S_2 is closed. The process is done till S_{n-1} is opened and S_n is closed. Net loss of energy of system if it is made of infinite number of spheres



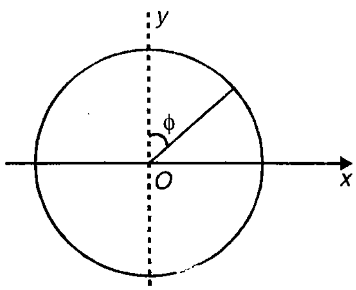
(1) $\frac{5}{6} 4\pi \varepsilon_0 RV^2$

(2) $\frac{1}{2} 4\pi \varepsilon_0 RV^2$

(3) $\frac{2}{3} 4\pi \varepsilon_0 RV^2$

(4) Zero

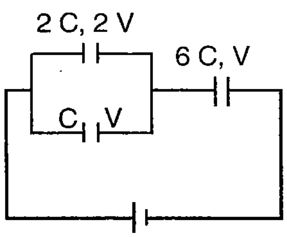
54. A thin non-conducting ring of radius a has a linear charge density $\lambda = \lambda_0 \sin\phi$. A uniform electric field $E_0\hat{i} + E_0\hat{j}$ is present there. Net torque acting on ring is



(1) $E_0\sqrt{2}\,\pi a^2\lambda_0$ (2) $E_0\pi a^2\lambda_0$

(3) $2\,E_0\pi a^2\lambda_0$ (4) Zero

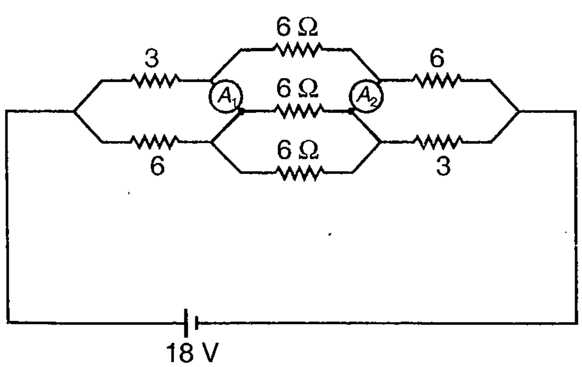
55. Diagram shows three capacitors with capacitance and breakdown voltage mentioned. What should be maximum value of the external emf of source such that no capacitor breaks down?



(1) V (2) 2 V

(3) 1.5 V (4) 4 V

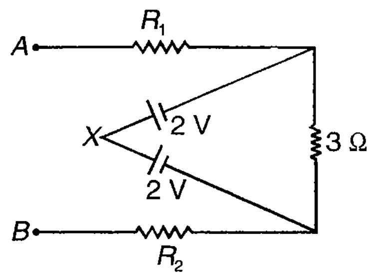
56. Find reading of ammeters A_1 and A_2 for the circuit shown



(1) 1 A, 1 A (2) 1 A, Zero

(3) Zero, 1 A (4) Zero, zero

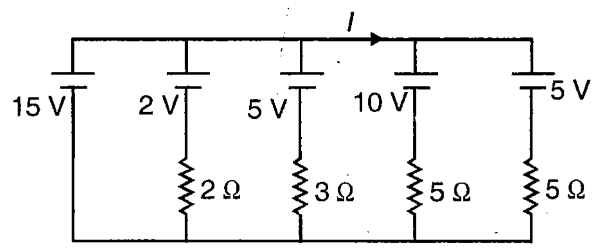
57. If equivalent resistance between points A and X is 5 Ω and equivalent resistance between A and B is 10 Ω then R_2 is



(1) 2 Ω (2) 5 Ω

(3) 3 Ω (4) 10 Ω

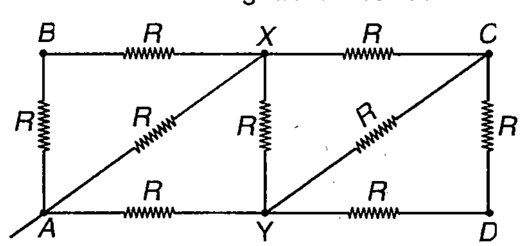
58. Current shown in figure is



(1) 7 A (2) 2 A

(3) 5 A (4) 3 A

59. Which of the following is/are incorrect?



(1) $R_{AC} = \frac{9}{11}R$ (2) $R_{XY} = \frac{5}{11}R$

(3) $R_{AB} = \frac{34}{21}R$ (4) $R_{BD} = \frac{15}{11}R$

60. Which of the following is a correct statement about current carrying conductor?

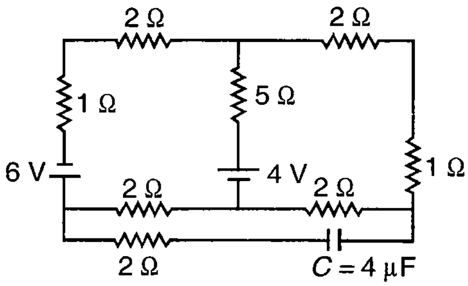
(1) On increasing temperature average velocity of free electron decreases

(2) On increasing temperature average speed of free electron decreases

(3) On increasing P.D. average kinetic energy of electron increases

(4) On increasing P.D. average kinetic energy of electron decreases (Neglect heating effect of electric current)

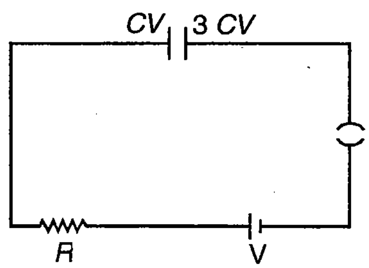
61. Find charge on capacitor in steady state in given circuit



(1) 9.6 μC (2) 7.2 μC

(3) 4.8 μC (4) 2.4 μC

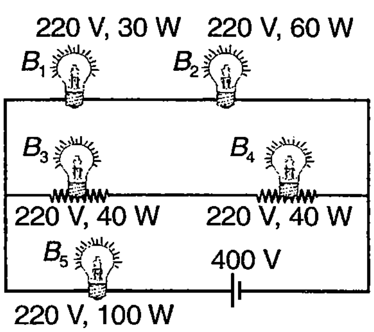
62. Plates of a parallel plate capacitor C have charges CV and $3\ CV$ on its plates. If switch is closed at $t = 0$. Then initial rate at which heat energy is produced in resistane R is



(1) $\frac{V^2}{R}$ (2) $\frac{4V^2}{R}$

(3) $\frac{9V^2}{R}$ (4) $\frac{16V^2}{R}$

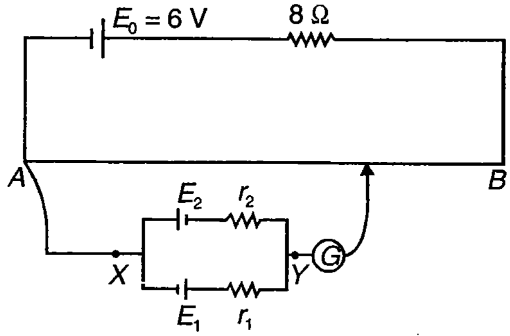
63. There is arrangement of five bulb as shown in figure. Which glow brightest?



(1) B_1 (2) B_3, B_4

(3) B_5 (4) B_1,B_2,B_3,B_4,B_5

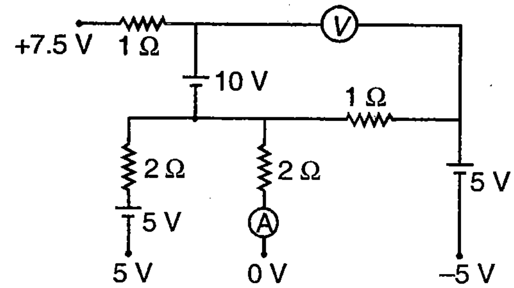
64. A battery of emf $E_0 = 6$ V is connected across a 2 m long uniform wire having resistance $\frac{4\ \Omega}{m}$. The cells of small emf $E_1 = 2$ V and $E_2 = 3$ V having internal resistance 2 Ω & 1 Ω respectively are connected as shown in the figure. The null point will be obtained at



(1) $\frac{1}{5\text{ m}}$ (2) 0.25 m

(3) 0.50 m (4) None of these

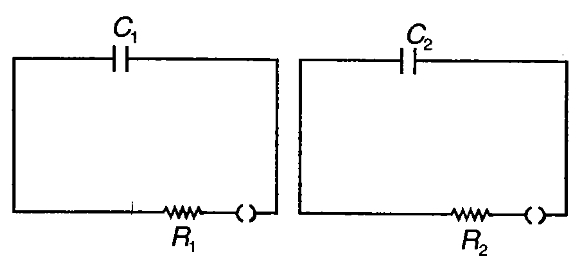
65. Potential of certain points in circuit are maintained as marked. What is reading of voltmeter (If ammeter reads zero) ?

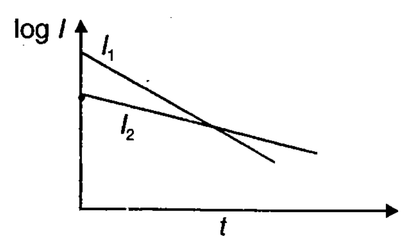


(1) 10 V (2) 2.5 V

(3) 5 V (4) 20 V

66. Two capacitors of capacitance C_1 and C_2 are charged to a potential difference V and connected in series with resistance R_1 and R_2. At $t = 0$ both keys are closed. Graph of current I_1 & I_2 in two circuits are as shown here. Which of the following must be incorrect?

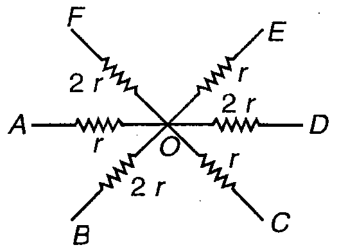




(1) $R_1 > R_2$ (2) $R_1 < R_2$

(3) $C_1 > C_2$ (4) $C_1 < C_2$

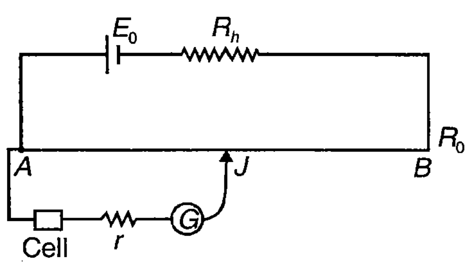
67. The terminal network shown in the figure consists of 6 resistors. The points A, C and E all are at potential 20 V while points B, D and F are at potential –10 volt then potential of junction O will be



(1) Zero (2) 10 V

(3) 15 V (4) –5 V

68. In a potentiometer circuit, emf of driving battery is E_0 and resistance of potentiometer wire is R_0. No null point is obtained between A & B. Which of the folllowing is not a possible reason for this?



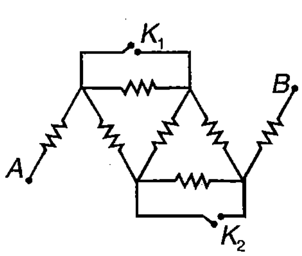
(1) $r > R_0$

(2) $R >> R_0$

(3) Emf of cell >> E_0

(4) Negative terminal of cell is connected to point A

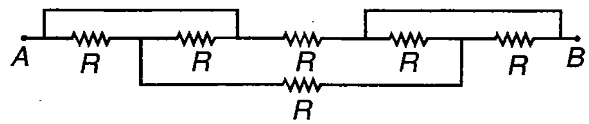
69. All wires have same resistance and equivalent resistance between A and B is R_0. Now keys are closed, then the equivalent resistance will become



(1) $\frac{7R_0}{3}$ (2) $\frac{7R_0}{9}$

(3) $7R_0$ (4) $\frac{R_0}{3}$

70. Find equivalent resistance between A & B in the following circuit



(1) $\frac{3R}{2}$ (2) $\frac{2R}{3}$

(3) $2R$ (4) $3R$

71. Two wires are of same length and same area of cross-section. If first wire has resistivity ρ_1 and temperature coefficient of resistance α_1 but second wire has resistivity ρ_2 and temperature coefficient of resistance α_2. Their series equivalent resistance is independent of small temperature changes. Then

(1) $\alpha_1 + \alpha_2 = 0$ (2) $\rho_1\alpha_1 = \rho_2\alpha_2$

(3) $\rho_1\alpha_1 + \rho_2\alpha_2 = 0$ (4) $\rho_1\alpha_2 + \rho_2\alpha_1 = 0$

72. Rate of dissipation of joule heat in resistance per unit volume is (E is electric field, ρ resistivity)

(1) $\frac{E}{\rho}$ (2) $\frac{E^2}{\rho}$

(3) $E^2\sigma$ (4) None of these

73. A galvanometer has a resistance of 20 Ω and reads full scale when 0.1 V is applied across it. To convert it into voltmeter of 10 V range, the galvanometer should have a resistance of

(1) 1980 Ω in series

(2) 2080 in series

(3) 980 Ω in series

(4) 1980 in parallel

74. A metal wire has coefficient of linear expression α_1 and temperature coefficient of resistivity α_2. Apparent temperature coefficient of resistance will be

(1) α_2 (2) $\alpha_2 - \alpha_1$

(3) $\alpha_2 + \alpha_1$ (4) $\alpha_2 - 2\alpha_1$

75. If following meters are prepared with the help of identical galvanometers, in which of the following cases resistance of the device will be largest?

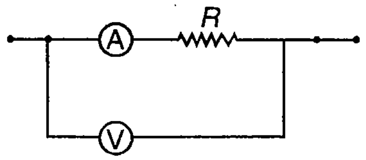
(1) An ammeter of range 10 A

(2) A voltmeter of range 5 V

(3) An ammeter of range 5 A

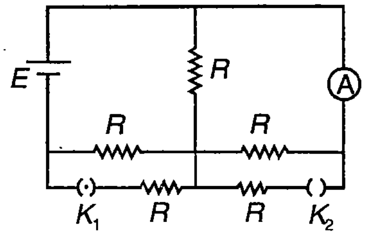
(4) A voltmeter of range 10 V

76. In circuit shown, the readings of ammeter and voltmeter are 2*A* and 5 V respectively. The meters are not ideal, then *R* is



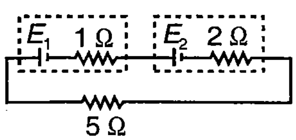
(1) 2.5 Ω (2) Less than 2.5 Ω
(3) More than 2.5 Ω (4) More than 5 Ω

77. In the circuit shown the ammeter A reads a current of I_1 amp. If key K_1 is opened and K_2 is closed, ammeter reads I_2, then



(1) $I_1 > I_2$
(2) $I_1 < I_2$
(3) $I_1 = I_2$
(4) Depend on the value of *R*

78. What should be the value of $\frac{E_1}{E_2}$ so that current flowing through 5 Ω resistor could be increased by short-circuiting the battery of emf E_2?



(1) $\frac{E_1}{E_2} < 3$ (2) $\frac{E_1}{E_2} > 3$
(3) $\frac{E_1}{E_2} > 2$ (4) $E_1 = E_2$

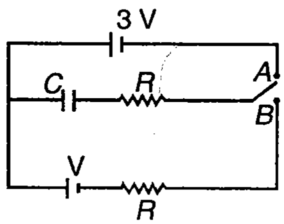
79. The charge flowing through a resistance *R* varies with time according to $q = a - bt^2$. The heat produced in one second is

(1) $\frac{a^3R}{6b}$ (2) $\frac{4b^2R}{3}$
(3) $\frac{a^2R}{3b}$ (4) $\frac{b^2R}{2}$

80. A constant potential difference *V* is applied to a conductor of length *l* and radius r. If wire is streched so that length of wire becomes doubled then drift speed is

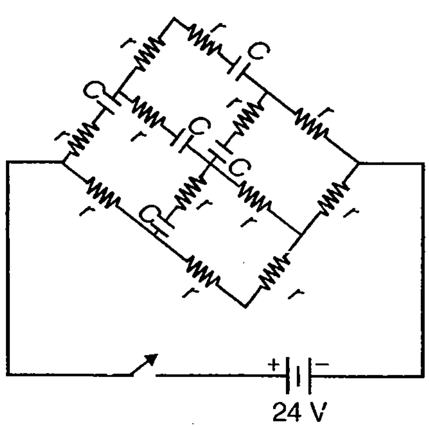
(1) Halved
(2) Unchanged
(3) Doubled
(4) Quadrupled

81. A capacitor is initially connected to a battery of EMF 3 V. At *t* = 0, switch is thrown to *B* state. Now charge on capacitor at any instant is given by



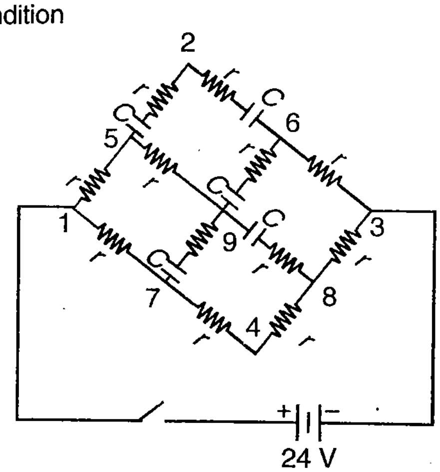
(1) $q = C\left(V + 2V\,e^{-t/RC}\right)$
(2) $q = C\left(V - 2V\,e^{-t/RC}\right)$
(3) $q = C\left(V + 2V\,e^{-t/2RC}\right)$
(4) $q = C\left(V + 2V\,e^{-2t/RC}\right)$

82. In the circuit shown $r = 4\,\Omega$ and $C = 2\,\mu F$. The current coming out of the battery just after the switch is closed.



(1) 6 A (2) 8 A
(3) 2 A (4) 4 A

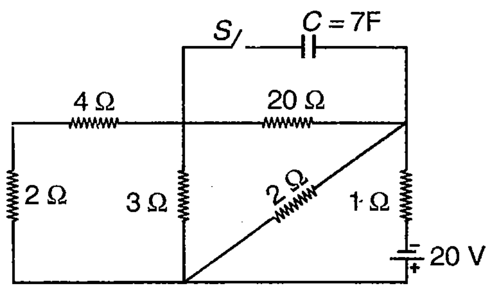
83. In the circuit shown $r = 4\ \Omega$ and $C = 2\mu F$ find charge on each capacitor in the steady state condition



(1) 6 μC (2) 12 μC

(3) 3 μC (4) 9 μC

84. At $t = 0$ switch S is closed. Current through switch as a function of time t is



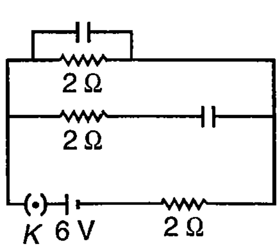
(1) $i(t) = 5e^{-(0.125\,t)}$ A

(2) $i(t) = 4e^{-(0.125\,t)}$ A

(3) $i(t) = 2e^{-(0.75\,t)}$ A

(4) $i(t) = 4e^{-(0.75\,t)}$ A

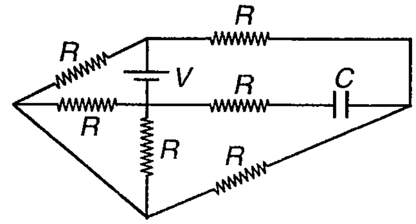
85. In following circuit, key is closed at time $t = 0$ then what will be current through battery at that time?



(1) 3 A (2) 1.5 A

(3) 2 A (4) 6 A

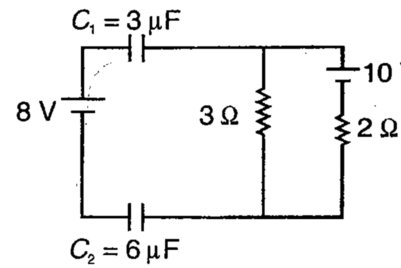
86. Time constant of C-R circuit will be



(1) $\frac{11}{7}CR$ (2) $\frac{3}{2}CR$

(3) CR (4) $\frac{11}{10}CR$

87. In the circuit shown in figure, find the steady state charge on capacitor C_1



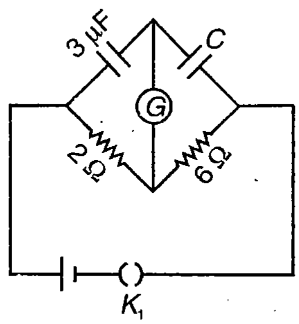
(1) 2 μC

(2) 3 μC

(3) 4 μC

(4) Zero

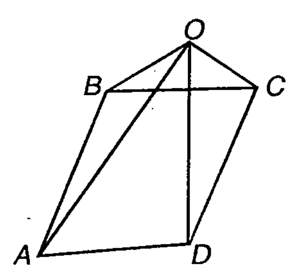
88. If key K_1 is closed in circuit shown in figure and galvanometer doesn't give deflection at any time, then value of C is



(1) 3 μF (2) 9 μF

(3) 4 μF (4) 1 μF

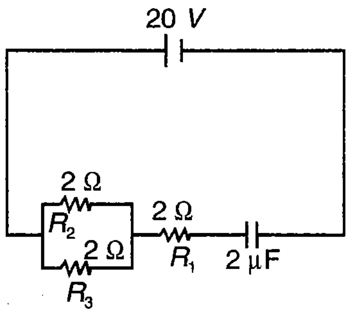
89. Eight identical resistances r each are connected as shown. If equivalent resistance between AD is R_1 and that between AC is R_2 then $\frac{R_1}{R_2}$ =



(1) 4 : 5 (2) 2 : 3

(3) 3 : 5 (4) 1 : 3

90. The circuit shown in figure is closed at $t = 0$. Calculate the total amount of heat generated in R_2 during the time capacitor gets fully charged



(1) $\frac{200}{3}\mu J$ (2) $\frac{400}{3}\mu J$

(3) $\frac{800}{3}\mu J$ (4) $400\ \mu J$

91. A capacitor is charged up to V volts. The space between two plates of capacitor is filled with dielectric medium of constant K and conductivity σ. The time after which charge on capacitor becomes $\frac{1}{e}$ times its initial charge is

(1) $\frac{K\varepsilon_0}{\sigma}$ (2) $\frac{\varepsilon_0}{K\sigma}$

(3) $\frac{2K\sigma}{\sigma}$ (4) $\frac{K\varepsilon_0 A}{\sigma d^2}$

92. Current in a coil decreases down to zero from I_0 uniformly during a time interval t_0. If amount of heat generated in time $t = 0$ to $t = \frac{t_0}{2}$ is H_1 and heat generated in time $t = \frac{t_0}{2}$ to $t = t_0$ is H_2 then $\frac{H_1}{H_2}$ is

(1) 5 : 1 (2) 7 : 1

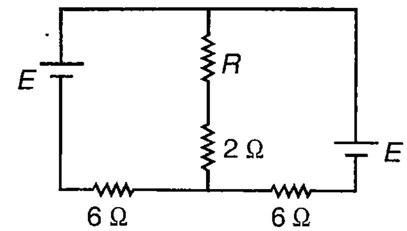
(3) 3 : 1 (4) 1 : 1

93. An ammeter and a voltmeter are connected in series to a battery. When a certain resistance is connected in parallel to voltmeter reading of voltmeter becomes half while reading of ammeter becomes double. What is the ratio of voltmeter resistance and ammeter resistance?

(1) $\frac{1}{3}$ (2) $\frac{3}{2}$

(3) $\frac{2}{1}$ (4) $\frac{3}{1}$

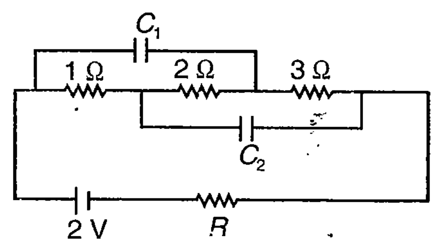
94. In the circuit shown in figure the emf of each battery is E. At what value of R thermal power generated in it will be minimum?



(1) $\frac{6}{5}\Omega$ (2) $\frac{5}{6}\Omega$

(3) 5 Ω (4) 14 Ω

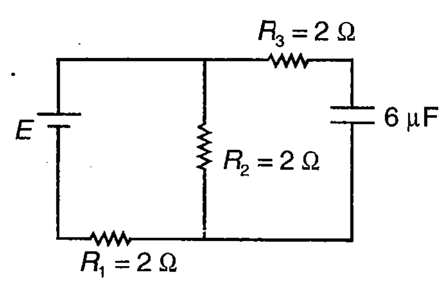
95. In the shown network charges in capacitors are same then $\frac{C_1}{C_2}$ is



(1) $\frac{5}{3}$ (2) 1 : 1

(3) 1 : 3 (4) 1 : 5

96. In the circuit shown in figure if battery is ideal, then time after which current in R_3 becomes $\frac{1}{e}$ time of maximum current through it is



(1) 18 μs (2) 12 μs

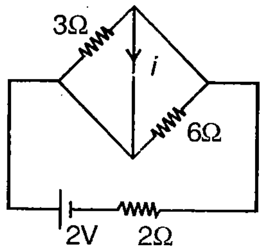
(3) 6 μs (4) 2 μs

97. Two resistances with temperature coefficients of resistance α_1 and α_2 have resistance R_1 and R_2. These two are connected in parallel. Its equivalent resistance does not change with small change in temperature then

(1) $\alpha_1 R_1 = \alpha_2 R_2$ (2) $\alpha_1 R_1 + \alpha_2 R_2 = 0$

(3) $\alpha_1 R_2 + \alpha_2 R_1 = 0$ (4) $\alpha_1 R_2 = \alpha_2 R_1$

98. Current i as shown in the circuit will be



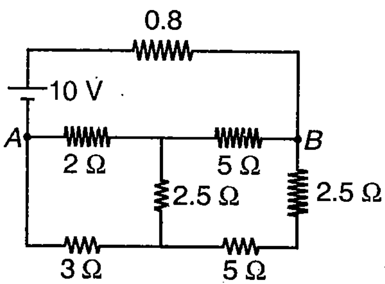
(1) 0.5 A

(2) 1 A

(3) Zero

(4) 0.25 A

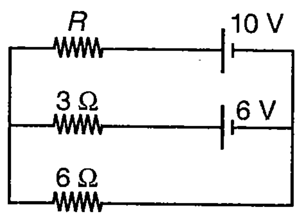
99. What is potential difference between A and B?



(1) 8.4 V (2) 2.4 V

(3) 4.2 V (4) 7.2 V

100. In the circuit shown in figure, the internal resistances of the sources are negligible. What is maximum power that can be generated in resistance R?



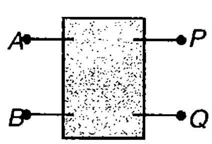
(1) 4 W

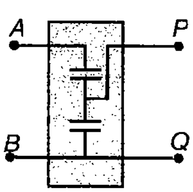
(2) 4.5 W

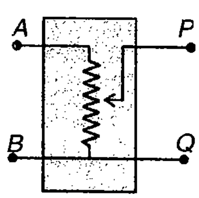
(3) 2 W

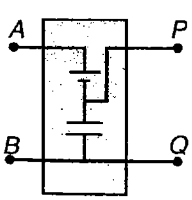
(4) 2.5 W

101. If an ideal battery of 10 V is connected across A and B, potential difference measured by voltmeter between P and Q is 4 V. But if same battery is connected across P and Q, potential difference between A and B is 10 V. Correct circuit in box is



(1) 

(2) 

(3) 

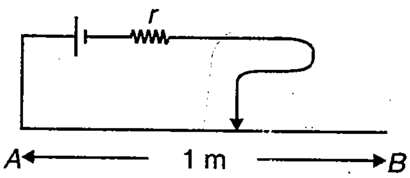
(4) All of these

102. Two circuits contain battery A and battery B respectively and each circuit is having an external resistance R. The maximum currents are same while maximum power output in first circuit is double that in second. If E_1 and E_2 are emfs and r_1 and r_2 are internal resistances of batteries respectively, then

(1) $r_1 = r_2$ (2) $E_1 = E_2$

(3) $E_1 = 2E_2$ (4) $r_1 = 2r_2$

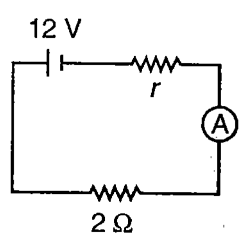
103. In following circuit, resistance of potentiometer wire is 10 Ω. Power consumption in potentiometer wire is same when jocky is placed at 10 cm from end A or end B. Internal resistance of cell(r) is



(1) 5 Ω (2) 6 Ω

(3) 2 Ω (4) 3 Ω

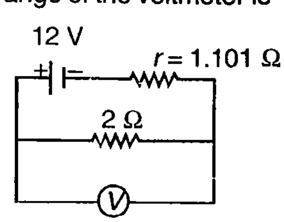
104. A galvanometer (coil resistance 99 Ω) is converted into an ammeter using a shunt of 1 Ω and connected as shown in figure. The ammeter reads 3A. The value of internal resistance (r) of the cell is



(1) 2.52 Ω (2) 2.02 Ω

(3) 1.01 Ω (4) 1.51 Ω

105. A galvanometer (coil resistance 99 Ω) is converted into a voltmeter by connecting a resistance of 101 Ω in series. This voltmeter is connected as shown in figure. Its reading is found to be $\frac{4}{5}$ of the full scale reading. The approximate range of the voltmeter is



(1) 10 V

(2) 15 V

(3) 20 V

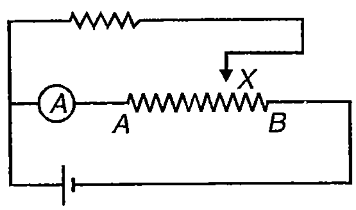
(4) 5 V

106. A constant voltage is applied to a metal wire. The current passing through the wire heats the wire to a certain temperature. If half of the wire is cooled by pouring cold water, then
(1) Temperature of other half increases
(2) Temperature of other half decreases
(3) Temperature of other half remain same
(4) Current through other half decreases

107. Each of three resistors having a resistance R can dissipate maximum power P. What is maximum power the circuit comprising of three resistors can dissipate?
(1) 3 P (2) 2 P
(3) 1.5 P (4) 2.5 P

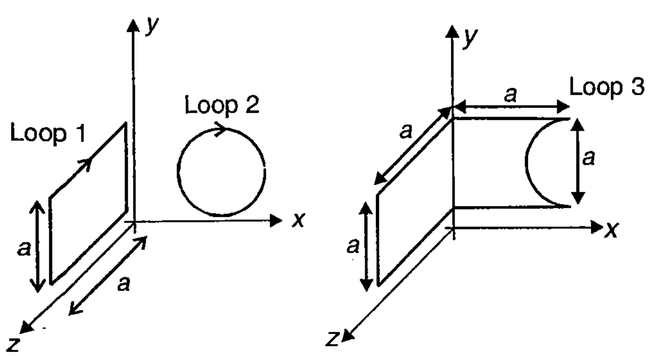
108. A bulb is marked (50 W, 100 V). It represents
(1) Current flowing through it
(2) Potential difference across it
(3) Resistance of filament
(4) Minimum current for glow of bulb

109. In circuit shown in figure. Terminal X is brought from point A to B. Then reading of ammeter



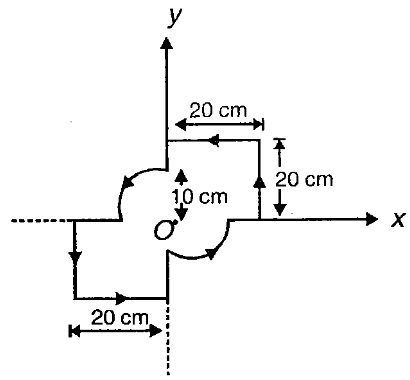
(1) Increases
(2) Decreases
(3) First increases then decreases
(4) First decreases then increases

110. Loops 1, 2, 3 carry same current. Torque on loop 1 is τ and on loop 2 is zero. Torque on loop 3 is



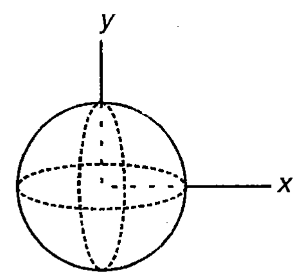
(1) τ (2) $\tau\left(1+\frac{\pi}{2}\right)$
(3) $\tau\left(1-\frac{\pi}{2}\right)$ (4) Zero

111. A current $i = 5$ A flows through a thin wire as shown in figure, the magnetic field produced by the current at point O in the figure is



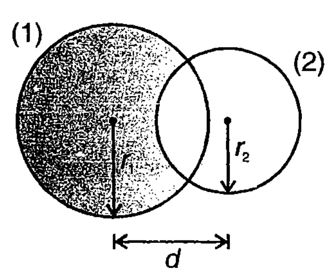
(1) 22.78 μT (2) 72.82 μT
(3) 17.87 μT (4) 34.47 μT

112. Three rings each having equal radius R, are placed mutually perpendicular to each other and each having its centre at the origin of co-ordinate system. If current I is flowing through each ring then the magnitude of the magnetic field at the common centre is



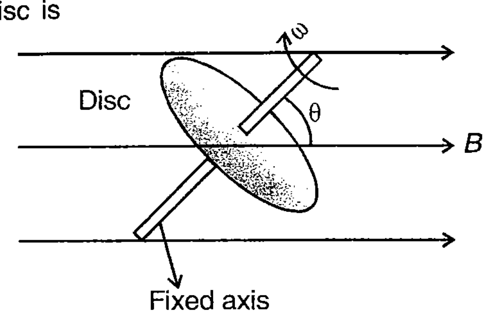
(1) $\frac{3\mu_0 I}{2R}$ (2) $\frac{\sqrt{3}\mu_0 I}{2R}$
(3) Zero (4) $(\sqrt{3}-1)\frac{\mu_0 I}{2R}$

113. Circular regions (1) and (2) have current densities J and $-J$ respectively, such that their region of intersection carries no current. Magnetic field in their region of intersection is



(1) Uniform, proportional to $(r_1 + r_2) - d$
(2) Uniform, proportional to d
(3) Non-uniform
(4) Zero

114. A disc (of radius r) carrying positive charge q is rotating with angular speed ω in a uniform magnetic field B about a fixed axis (as shown in figure), such that angle made by axis of disc with magnetic field is θ. Torque applied by axis on the disc is



(1) $\dfrac{q\omega r^2 B\sin\theta}{2}$, clockwise

(2) $\dfrac{q\omega r^2 B\sin\theta}{4}$, anticlockwise

(3) $\dfrac{q\omega r^2 B\sin\theta}{2}$, anticlockwise

(4) $\dfrac{q\omega r^2 B\sin\theta}{4}$, clockwise

115. Which of the following is incorrect?

(1) When $\vec{E}$ is parallel to $\vec{B}$, a charged particle in motion may move in a straight path with acceleration related to $\vec{E}$ as $\vec{a} = k\vec{E}$, where k is positive constant

(2) When $\vec{E}$ is parallel to $\vec{B}$ a charged particle in motion may move on a helix with increasing pitch

(3) When $\vec{E}$ is perpendicular to $\vec{B}$ a charged particle in motion may move on a straight path with acceleration related to $\vec{E}$ as $\vec{a} = -k\vec{E}$, where k is positive

(4) When $\vec{E}$ is perpendicular to $\vec{B}$, a charged particle in motion may move on a cycloid

116. A current carrying ring is bent along its diameter such that its one half has magnetic moment $\vec{M}_1$ and other half has magnetic moment $\vec{M}_2$, then which of the following is incorrect?

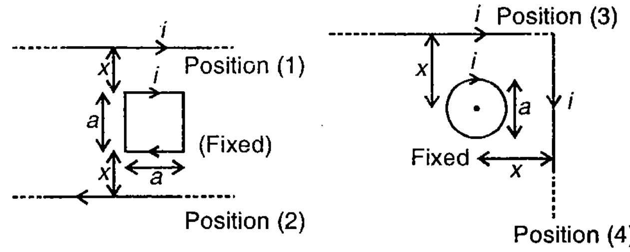
(1) $|\vec{M}_1| = |\vec{M}_2|$

(2) $\vec{M}_1 \cdot (\vec{M}_1 \times \vec{M}_2) = \vec{0}$

(3) $\vec{M}_1 \times [(\vec{M}_1 \cdot \vec{M}_2)\vec{M}_2]$ may be zero

(4) $\vec{M}_1 \cdot \vec{M}_2$ can never be zero

117. Consider the diagrams shown. Work done in transferring wire from position (1) to position (2) is W_1. Work done in transferring the wire from position (3) to position (4) is W_2 then



(1) $\dfrac{W_1}{W_2} > 1$

(2) $\dfrac{W_2}{W_1} < 1$

(3) $W_1 - W_2 = 0$

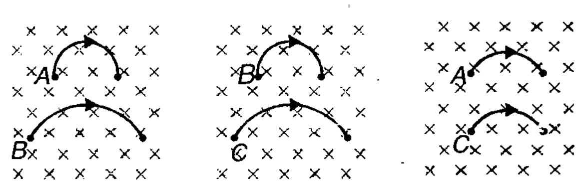
(4) W_1 is positive, W_2 is zero

118. An infinite cylinder of radius r with surface charge density σ is rotated about its central axis with angular speed ω. What is the magnetic field at any point inside the cylinder?

(1) $\mu_0\sigma\omega r^2$ (2) $\dfrac{\mu_0\omega r}{\sigma}$

(3) $\mu_0\sigma\omega r$ (4) $\mu_0\sigma\omega^2 r$

119. Trajectories of three particles A, B and C projected perpendicular to a uniform transverse magnetic field in three different cases are shown in figure.



Case I (Speed of particles is same) | Case II (Kinetic energy is same) | Case III (Momentum is same)

A, B and C can be

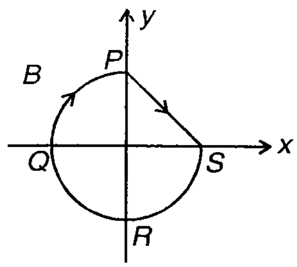
(1) $^{1}_{1}H$, $^{4}_{2}He$ and $^{2}_{1}H$

(2) $^{1}_{1}H$, $^{2}_{1}H$ and $^{4}_{2}He$

(3) $^{2}_{1}H$, $^{4}_{2}He$ and $^{1}_{1}H$

(4) $^{4}_{2}He$, $^{1}_{1}H$ and $^{2}_{1}H$

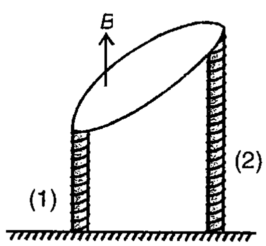
120. A current carrying loop is placed in a uniform magnetic field pointing in negative z direction. Branch $PQRS$ is a three quarter circle, while branch PS is straight. If force on branch PS is F, force on branch PQR is



(1) $\sqrt{2}F$ (2) $\frac{F}{\sqrt{2}}$

(3) $\frac{\pi F}{\sqrt{2}}$ (4) $\sqrt{2}\pi F$

121. A current carrying horizontal coil (as shown in the figure) is tied at its two sides with vertical rods (of different lengths) in a space with vertical magnetic field. If the coil is in the equilibrium, which of the following statements is correct?



(1) When viewed from top, current in the coil is clockwise

(2) Stress in rod (1) must be compressive

(3) Stress in rod (2) must be tensile

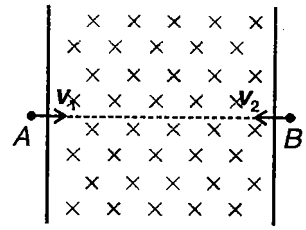
(4) Stress in rod (1) is compressive if stress in rod (2) is tensile

122. A vertical wire of length ℓ has its both ends fixed. Space around the wire has a horizontal magnetic field of strength B. If current i is passed through the wire such that its mid-point is deflected by amount x, tension in the wire is

(1) $\frac{Bi\ell^2}{x}$ (2) $\frac{Bi\ell^2}{4x}$

(3) $\frac{Bix^2}{\ell}$ (4) $\frac{Bix^2}{4\ell}$

123. Two particles A and B of same mass and having charges of same magnitude but of opposite nature are thrown into a region of magnetic field (as shown) with speeds v_1 and v_2 ($v_1 > v_2$). At the time particle A escapes out of the magnetic field, angular momentum of particle B w.r.t. particle A is proportional to (Assume both the particles escape the region after traversing half circle)



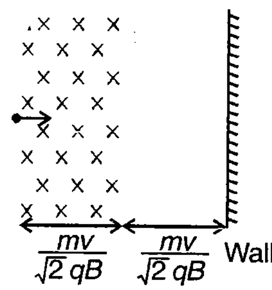
(1) $v_1 + v_2$

(2) $v_1 - v_2$

(3) $v_1^2 - v_2^2$

(4) $v_1^2 + v_2^2$

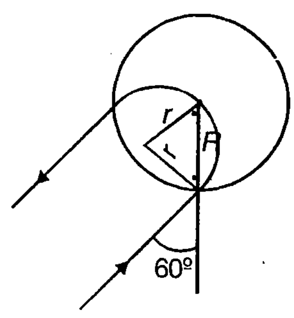
124. A particle of mass m and charge q enters a region of magnetic field (as shown) with speed v. There is a region in which the magnetic field is absent, as shown. The particle after entering the region collides elastically with a rigid wall. Time after which the velocity of particle becomes antiparallel to its initial velocity is



(1) $\frac{m}{2qB}(\pi+4)$ (2) $\frac{m}{qB}(\pi+2)$

(3) $\frac{m}{4qB}(\pi+2)$ (4) $\frac{m}{4qB}(2\pi+3)$

125. A uniform magnetic field of intensity xT is applied in a circular region of radius 0.1 m, directed into the plane of paper. A charged particle of mass 5×10^{-5} kg and charge $q = 5 \times 10^{-4}$C enters the field with velocity $\frac{1}{\sqrt{3}}$ m/s making an angle 60º with a radial line of circular region and passes through centre of applied field. The intensity of magnetic field is



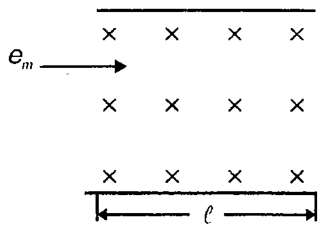
(1) $\frac{1}{\sqrt{3}}$ T

(2) $\sqrt{3}$ T

(3) 1 T

(4) 2 T

126. An electron moves straight inside a charged parallel plate capacitor of uniform surface charge density σ. The space between the plates is filled with constant magnetic field induction B. The velocity of electron is



(1) Zero (2) $\dfrac{\sigma}{2\varepsilon_0 B}$

(3) $\dfrac{2\sigma}{\varepsilon_0 B}$ (4) $\dfrac{\sigma}{\varepsilon_0 B}$

127. A jumper of mass m and length ℓ is placed on two parabolic rails in x-y plane. Shape of the rails can be described by

Rail 1 : $y = x^2$ (and $z = 0$)

Rail 2 : $y = x^2$ (and $z = \ell$)

If x is horizontal and y is vertical direction and magnetic field in the space is $B_0\hat{j}$, the jumper can remain in equilibrium when y coordinate of its ends is (i = current in jumper)

(1) $\dfrac{iB_0\ell}{2mg}$ (2) $\dfrac{iB_0\ell}{mg}$

(3) $\left(\dfrac{iB_0\ell}{mg}\right)^2$ (4) $\left(\dfrac{iB_0\ell}{2mg}\right)^2$

128. A conducting loop is placed in a magnetic field of strength B perpendicular to its plane. Radius of the loop is r, current in the loop is i and linear mass density of the wire of loop is m. Speed of any transverse wave in the loop will be

(1) $\sqrt{\dfrac{Bir}{m}}$ (2) $\sqrt{\dfrac{Bir}{2m}}$

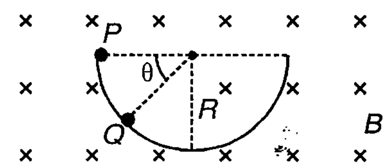
(3) $\sqrt{\dfrac{2Bir}{m}}$ (4) $2\sqrt{\dfrac{Bir}{m}}$

129. At a place on earth, horizontal component of earth's magnetic field is B_1 and vertical component of earth's magnetic field is B_2. If a magnetic needle is kept vertical, in a plane making angle α with the horizontal component of magnetic field, then time period of oscillation of needle when slightly disturbed is proportional to

(1) $\dfrac{1}{\sqrt{B_1 \cos\alpha}}$ (2) $\dfrac{1}{\sqrt{B_2}}$

(3) $\dfrac{1}{\sqrt{(B_1\cos\alpha)^2 + B_2^2}}$ (4) Infinite

130. A charged sphere of mass m and charge $-q$ starts sliding along the surface of a smooth hemispherical bowl, at position P. The region has a transverse uniform magnetic field B.Normal force by the surface of bowl on the sphere at position Q is



(1) $mg\sin\theta + qB\sqrt{2gR\sin\theta}$

(2) $3mg\sin\theta + qB\sqrt{2gR\sin\theta}$

(3) $mg\sin\theta - qB\sqrt{2gR\sin\theta}$

(4) $3mg\sin\theta - qB\sqrt{2gR\sin\theta}$

131. Magnetic made at the centroid of an n-sided regular polygon made of a conducting wire, of side x and carrying current i, is

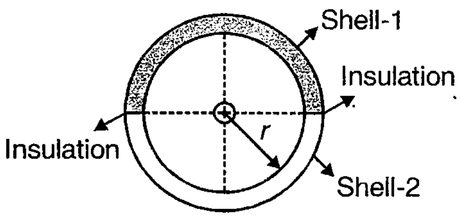
(1) $\dfrac{\mu_0 ni}{2x}$

(2) $\dfrac{\mu_0 ni}{\pi x}\tan\left(\dfrac{\pi}{n}\right).\sin\left(\dfrac{\pi}{n}\right)$

(3) $\dfrac{\mu_0 ni}{\pi x}\tan\left(\dfrac{\pi}{n}\right).\text{cosec}\left(\dfrac{\pi}{n}\right)$

(4) $\dfrac{\mu_0 ni}{\pi x}\cot\left(\dfrac{\pi}{n}\right).\sin\left(\dfrac{\pi}{n}\right)$

132. The figure shows two infinite semi-cylindrical shells: shell-1 and shell-2. Shell-1 carries current i_1 in inward direction normal to the plane of paper, while shell-2 carries same current i_1, in opposite direction. A long straight conductor lying along the common axis of the shells is carrying current i_2 in direction same as that of current in shell-1. Force per unit length on the wire is



(1) Zero (2) $\frac{\mu_0 i_1 i_2}{2\pi r}$

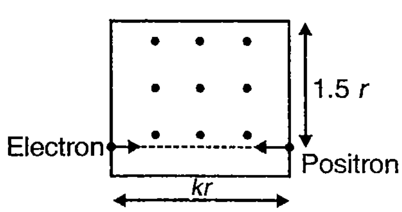
(3) $\frac{2\mu_0 i_1 i_2}{\pi r}$ (4) $\frac{2\mu_0 i_1 i_2}{\pi^2 r}$

133. A charged particle is released inside rough horizontal circular tube of small width with velocity $v = \frac{2Bqr}{m}$ at $t = 0$, there exist a uniform magnetic field perpendicular plane of circular tube, from $t = 0$ to $t \to \infty$. Work done by friction will be

(1) Zero (2) $-2\frac{B^2q^2r^2}{m}$

(3) $-\frac{3}{2}\frac{B^2q^2r^2}{m}$ (4) $+\frac{1}{2}\frac{B^2q^2r^2}{m}$

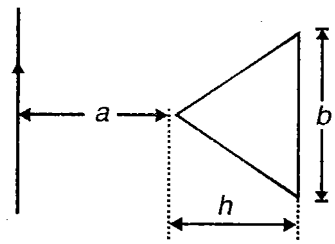
134. An electron and a positron are projected in a transverse magnetic field (of strength B) with speed v each. If width of magnetic field region is kr (where k is a constant, r is radius of revolution of each of the particles). Time spent by each of the particles in magnetic field is one-fourth of the time period of revolution of particles for k equal to (Assume elastic collision, if particles collide)



(1) 1 (2) $\sqrt{2}$

(3) $\frac{1}{\sqrt{2}}$ (4) 2

135. A very long straight conductor and an isosceles triangular conductor lie in a plane and separated from each other as shown in figure. The coefficient of mutual induction is



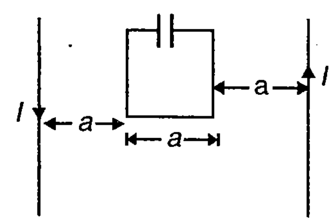
(1) $\frac{\mu_0 h}{2\pi b}\left[h - a\ln\frac{a+h}{h}\right]$

(2) $\frac{\mu_0 h}{2\pi b}\left[h - a\ln\left|\frac{a+h}{a}\right|\right]$

(3) $\frac{\mu_0 b}{2\pi h}\left[h - a\ln\left(\frac{a+h}{h}\right)\right]$

(4) $\frac{\mu_0 b}{2\pi h}\left[h - a\ln\left|\frac{a+h}{a}\right|\right]$

136. A square loop of side a with a capacitor of capacitance C is placed between two current carrying long parallel wires as shown. The value of I in the wires is given by $I = I_0 \sin\omega t$. The value of maximum current in the square loop is



(1) $\mu_0 \pi C I_0 a\omega^2 \ln 2$ (2) $\frac{\mu_0}{\pi} C I_0 a\omega^2 \ln 2$

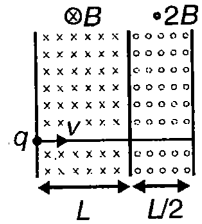
(3) $\mu_0 \pi C I_0 a\omega^2 \ln a$ (4) $\frac{\mu_0}{\pi} C I_0 a\omega^2 \ln a$

137. A particle of specific charge (charge/mass) α start moving from origin under action of an electric field $\vec{E} = E_0\hat{i}$ and magnetic field $\vec{B} = B_0\hat{k}$. Its velocity at $(x_0, y_0, 0)$ is $4\hat{i} + 3\hat{j}$. The value of x_0 is

(1) $\frac{13\alpha E_0}{2B_0}$ (2) $\frac{16\alpha B_0}{E_0}$

(3) $\frac{25}{2\alpha E_0}$ (4) $\frac{5\alpha}{2B_0}$

138. A particle of charge $+q$ and mass m moves inside magnetic field as shown in figure. (Neglect gravity) total time spent in magnetic field will be



where $L = \dfrac{mv}{2Bq}$

(1) $\dfrac{\pi m}{4Bq}$ (2) $\dfrac{2\pi m}{Bq}$

(3) $\dfrac{\pi m}{6Bq}$ (4) $\dfrac{\pi m}{Bq}$

139. A particle of charge q and mass m starts moving from origin under action of a magnetic field $\vec{B} = B_0\hat{j}$ and electric field $\vec{E} = E_0\hat{j}$ with a velocity $\vec{v} = v_0\hat{i}$. Work done by the lorentz force till particle crosses $y-z$ plane normally for the first time, does not depend on

(1) m (2) q

(3) B (4) E

140. In a certain region of space, electric and magnetic fields are crossed

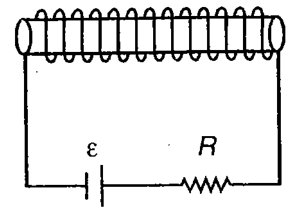
(1) A charged particle moves undeflected in the region only if $\vec{v}$ is perpendicular to both $\vec{E}$ and $\vec{B}$

(2) A charged particle must move undeflected in the region, if $\vec{v}$ is perpendicular to both $\vec{E}$ and $\vec{B}$

(3) A positron moves undeflected if its velocity is $\vec{v}$, for an electron to move undeflected its velocity must be $-\vec{v}$

(4) A charged particle may move undeflected even if it is not moving with $\vec{v}$ perpendicular to $\vec{B}$

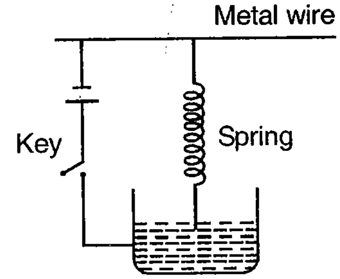
141. An iron core solenoid of length l and cross-section area A having N turns on it is connected to a battery through a resistance as shown in the figure. At instant $t = 0$, the iron rod of permeability μ from the core is abraptly removed. Current in the circuit just after removal of the rod is



(1) $\dfrac{\varepsilon}{R}$ (2) $\dfrac{\mu\varepsilon}{R}$

(3) Zero (4) $\dfrac{\varepsilon}{\mu R}$

142. In the arrangement shown here, one end of the spring just touches the surface of mercury contained in a metallic vessel. If the key is pressed on



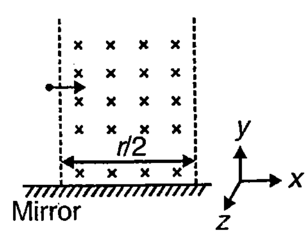
(1) The spring stretches, attaining equilibrium

(2) The spring compresses, attaining equilibrium

(3) The spring neither stretches nor compresses

(4) The spring oscillates vertically

143. Consider the figure shown. A proton enters a uniform magnetic field region with velocity $\vec{v} = 6\hat{i}$ m/s. Thickness of magnetic field region is $\dfrac{r}{2}$, where r is radius of rotation of the proton in the magnetic field. A large plane mirror in x-z plane is moving with constant velocity $3\hat{i} - 2\hat{j}$ m/s. Velocity of the image of proton in mirror when the proton comes out of the field is



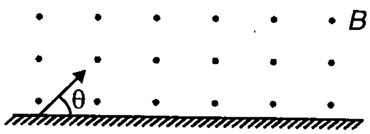
(1) $3\sqrt{3}\,\hat{i} - 5\hat{j}$ m/s

(2) $3\sqrt{3}\,\hat{i} - 7\hat{j}$ m/s

(3) $(3+3\sqrt{3}\,\hat{i}) - 5\hat{j}$ m/s

(4) $(3+3\sqrt{3}\,\hat{i}) - 7\hat{j}$ m/s

144. A particle of mass m and charge $-q$ is projected at angle $\theta = \frac{1}{20}$ radians with a horizontal smooth surface. Magnetic field in the region is uniform and transverse, of strength B. Time after which vertical velocity of the particle ceases to exist, if the coefficient of restitution for each collision the particle makes with the horizontal surface is 0.5, is (neglect gravity)



Horizontal surface

(1) $\frac{m}{5qB}$ (2) $\frac{m}{qB}$

(3) $\frac{m}{20qB}$ (4) Infinite

145. A particle (mass m and charge q) is at rest at origin. An electric field $\vec{E} = 10\hat{k}$ units and magnetic field $\vec{B} = -8\hat{i} + 6\hat{j}$ units is switched on in the region. Speed of the particle as function of its z-coordinate is

(1) $\sqrt{\frac{10qz}{m}}$ (2) $\sqrt{\frac{20qz}{m}}$

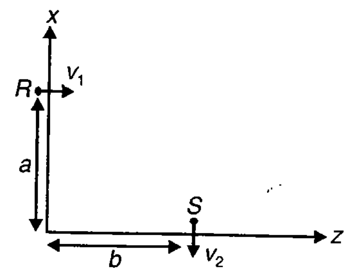
(3) $\sqrt{\frac{30qz}{m}}$ (4) $\sqrt{\frac{40qz}{m}}$

146. Force on a particle (of charge q and mass m) is $qvB\left(-\frac{1}{2}\hat{j} + \frac{\sqrt{3}}{2}\hat{k}\right)$ when projected along x-axis with speed v. (B here denotes magnitude of magnetic field in the region). Unit vector in the direction of $\vec{B}$ is

(1) $\frac{\sqrt{3}}{2}\hat{i} + \hat{k}$ (2) $\frac{\sqrt{3}}{2}\hat{j} + \frac{\hat{k}}{2}$

(3) $-\frac{\sqrt{3}}{2}\hat{i} + \hat{k}$ (4) $-\sqrt{3}\,\hat{j} + \frac{\hat{k}}{2}$

147. A charged particle (of charge q and mass m) is projected with velocity $v_1\,\hat{k}$ at a point R as shown. Electric and magnetic fields in the region are $E_0\hat{k}$ and $B_0\hat{j}$ respectively. Velocity at another point S in the region is $-v_2\,\hat{i}$ (as shown). Choose the correct alternative



(1) $2E_0b = m(v_1^2 - v_2^2)$

(2) $2E_0a = m(v_2^2 - v_1^2)$

(3) $2E_0b = m(v_2^2 - v_1^2)$

(4) $2E_0a = m(v_1^2 - v_2^2)$

148. A large metal sheet placed at $z = 0$ in x-y plane carries current per unit width equal to λ in positive y-direction along its surface such that it produces magnetic field B. A charged particle (of mass m and charge q) at (2, 3, 5) is projected with velocity $2\hat{i} + 3\hat{j} + 5\hat{k}$ units. Coordinates of the particle when for the first time velocity of the particle is again the same are (x_0, y_0, z_0) then

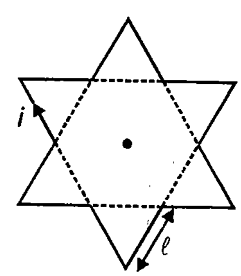
(1) $x_0 = 2 + \frac{4\pi m}{qB}$ units

(2) $y_0 = 2 + \frac{2\pi m}{qB}$ units

(3) $z_0 = \frac{4\pi m}{qB}$ units

(4) $x_0 = y_0 = z_0 = 2 + \frac{4\pi m}{qB}$ units

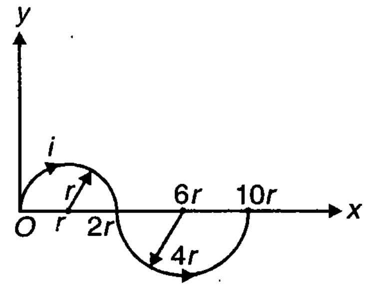
149. A star shaped loop (with ℓ = length of each section) carries current i. Magnetic field at the centroid of the loop is



(1) $\frac{3\mu_0 i}{\pi\ell}$ (2) $\frac{3\mu_0 i}{2\pi\ell}$

(3) $(3-\sqrt{3})\frac{\mu_0 i}{\pi\ell}$ (4) $(3+\sqrt{3})\frac{\mu_0 i}{\pi\ell}$

150. A conducting loop carrying current i, shown in the figure, is constrained to rotate about x-axis. At the instant shown, a magnetic field $\vec{B} = a\hat{i} + b\hat{j} + c\hat{k}$ is suddenly switched on. Magnetic moment of the loop and direction of initial angular acceleration of the loop respectively are (a, b, c are positive)



(1) $-\frac{3}{2}\pi r^2\hat{k}, \hat{i}$ (2) $-\frac{15}{2}\pi r^2\hat{k}, -\hat{i}$

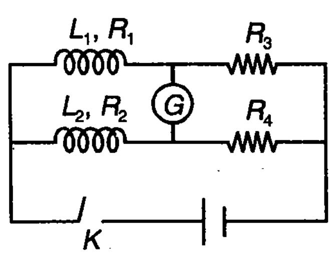
(3) $\frac{3}{2}\pi r^2\hat{k}, -\hat{i}$ (4) $\frac{15}{2}\pi r^2\hat{k}, -\hat{i}$

151. A particle of charge Q and mass m moves in circular path of radius R in uniform magnetic field B. The same particle now moves with same speed in a circle of radius R in the space between cylindrical electrodes of, cylindrical capacitor. Radius of inner electrode is $\frac{R}{2}$ and that of outer is $\frac{3R}{2}$. The potential difference between electrodes must be

(1) $\frac{QBR\ln(3)}{m}$ (2) $\frac{QB^2R^2\ln(3)}{2m}$

(3) $\frac{QB^2R^2\ln(3)}{m}$ (4) $\frac{QB^2R^2\ln(3)}{4m}$

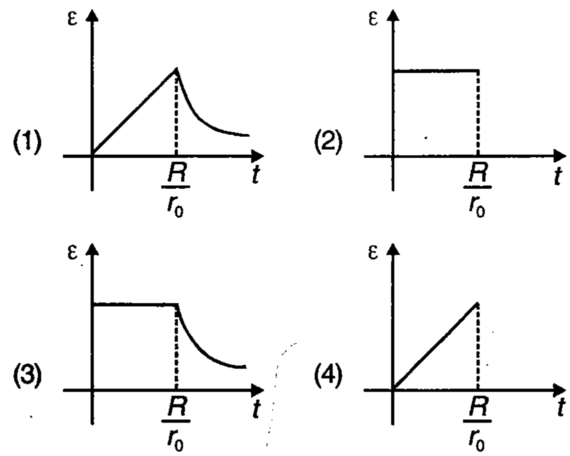
152. After the key k is closed, galvanometer in the shown arrangement shows zero deflection at all the times if (R_1 and R_2 are resistances of inductors L_1 and L_2)



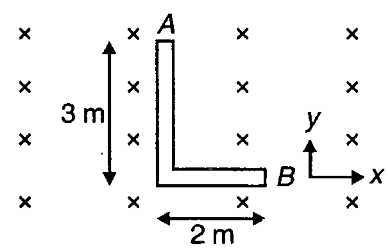
(1) $\frac{L_1}{L_2} = \frac{R_1}{R_2} = \frac{R_3}{R_4}$ (2) $\frac{L_1}{L_2} = \frac{R_3}{R_4} = \frac{R_2}{R_1}$

(3) $L_1R_2 = L_2R_1$ (4) $L_1R_4 = L_2R_3$

153. A conducting loop of radius R is placed in a uniform cylindrical, transverse magnetic field region of strength B. Radius of the loop is increasing with time as $r = r_0t$. Induced emf in the loop varies with time as (centre of the loop coincides with axis of magnetic field region)



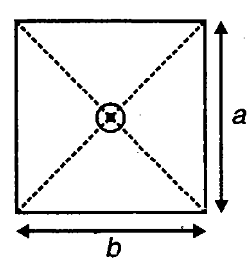
154. An L-shaped conductor rod is moving in transverse magnetic field as shown in the figure. Potential difference between ends of the rod is maximum if the rod is moving with velocity



(1) $4\hat{i} - 6\hat{j}$ m/s (2) $-4\hat{i} + 6\hat{j}$ m/s

(3) $3\hat{i} + 2\hat{j}$ m/s (4) $\sqrt{13}\,\hat{i}$ m/s

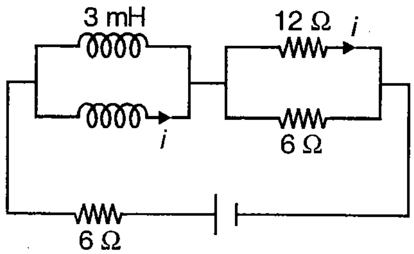
155. A rectangular coil has a long straight wire passing through its centroid perpendicular to its plane as shown. If current through the wire varies as $i = i_0\sin\omega t$, induced current in the coil will be (Given R = Resistance of the coil)



(1) $\frac{i_0\sin\omega t}{R}$ (2) $\frac{\pi a\sin\omega t}{bR}$

(3) $\frac{\pi a\cos\omega t}{bR}$ (4) Zero

156. The circuit shown here is in its steady state. Time constant of the circuit is



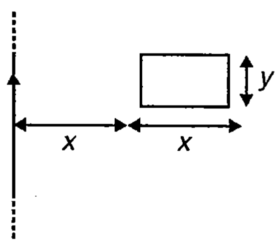
(1) 0.1 ms

(2) 0.2 ms

(3) 0.3 ms

(4) Information is insufficient of determine time constant

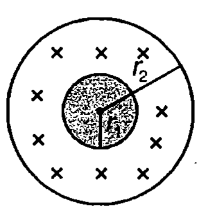
157. Consider a system of coplanar infinite straight wire and a rectangular loop of resistance *ln* as shown in the figure. If current in the wire changes from *i* to 2*i*, charge flowing through the rectangular loop is



(1) $\frac{\mu_0 yi\ln 2}{4\pi}$ (2) $\frac{\mu_0 yi\ln 4}{4\pi}$

(3) $\frac{\mu_0 yi\ln 8}{4\pi}$ (4) $\frac{\mu_0 yi\ln 10}{4\pi}$

158. Consider cylindrical region of the magnetic field shown in the figure. Region I and II have fields directed perpendicularly outward and inward respectively. Fields are varying with time as



Region I : $B = 3B_0t$

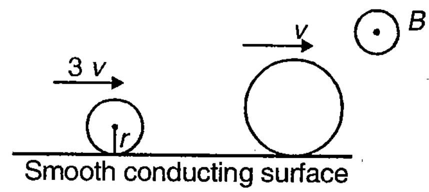
Region II : $B = B_0t$

$\frac{r_1}{r_2}$ such that there is no net induced electric field in the region outside the magnetic field is

(1) 0.5 (2) 0.6

(3) 0.8 (4) 0.2

159. Two conducting rings are moving on a smooth conducting horizontal surface as shown. There is a transverse uniform magnetic field of strength *B* in the region. Potential difference between highest points of the rings is zero in this case. Had the rings been moving in opposite direction with same speeds, potential difference between the highest points would be



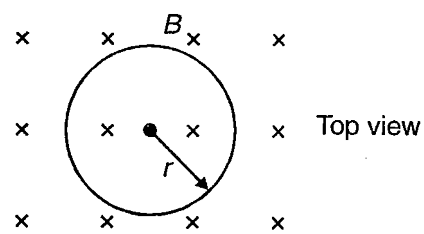
(1) 3 *Brv*

(2) 6 *Brv*

(3) 12 *Brv*

(4) Zero, as the surface on which rings are moving is conducting and hence are equipotential

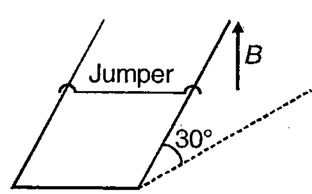
160. A non conducting ring (of mass *m*, radius *r*, having charge *Q*) is placed on a rough horizontal surface (in a cylindrical region with transverse magnetic field). The field is increasing with time at the rate *R* and coefficient of friction between the surface and the ring is μ. For ring to remain in equilibrium μ should be greater than



(1) $\frac{Qr^2R^2}{2mg}$ (2) $\frac{QrR}{2mg}$

(3) $\frac{Qr^2R}{2mg}$ (4) $\frac{QrR^2}{2mg}$

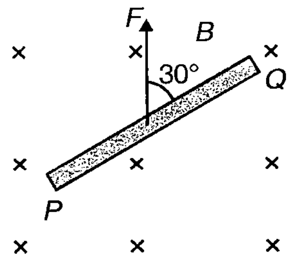
161. Consider a pair of smooth metallic rails joined at one of the ends. Rails are parallel and are inclined at 30° with horizontal. A jumper of mass *m*, length ℓ and resistance *R* slides down the rails with constant speed *v*. Magnetic field in the region is vertical. Strength of magnetic field is



(1) $\sqrt{\frac{mgR}{3v\ell^2}}$ (2) $\sqrt{\frac{2mgR}{3v\ell^2}}$

(3) $\sqrt{\frac{3mgR}{v\ell^2}}$ (4) $\sqrt{\frac{\sqrt{3}mgR}{v\ell^2}}$

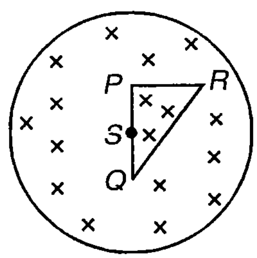
162. A conducting rod of mass m and length ℓ is placed on a smooth horizontal surface in a region where transverse uniform magnetic field B exists in the region. At $t = 0$, a constant force F starts acting on the rod at its mid point as shown. Potential difference between ends of the rod, $V_P - V_Q$ at any time t is



(1) $\frac{BF\ell t}{2m}$ (2) $\frac{BF\ell t}{4m}$

(3) $\frac{5BF\ell t}{8m}$ (4) $\frac{7BF\ell t}{8m}$

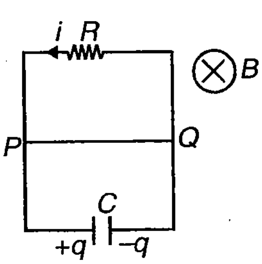
163. Consider a region of cylindrical magnetic field, changing with time at the rate x. A triangular conducting loop PQR is placed in the field such that mid point of side PQ coincides with axis of the magnetic field region. $PQ = 2\ell$, $PR = 2\ell$. E.m.f. induced in the sides PQ, QR, PR of the loop are



(1) $x\ell^2, 0, x\ell^2$ (2) $0, \frac{x\ell^2}{2}, \frac{3x\ell^2}{2}$

(3) $0, x\ell^2, x\ell^2$ (4) $0, \frac{3}{2}x\ell^2, \frac{x\ell^2}{2}$

164. A conducting wire PQ of length ℓ, mass m and resistance r is sliding down a smooth, vertical, thick pair of rails (as shown) with constant speed. Choose the correct alternative, if the circuit is in steady state



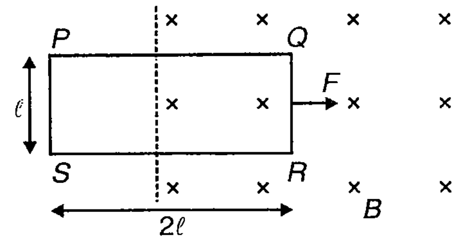
(1) $i = \frac{mg}{B\ell}, q = +\frac{mgCR}{B\ell}$

(2) $i = -\frac{mg}{B\ell}, q = \frac{mgCR}{B\ell}$

(3) $i = -\frac{mg}{B\ell}, q = \text{zero}$

(4) $i = \text{zero}, q = -\frac{mgCR}{B\ell}$

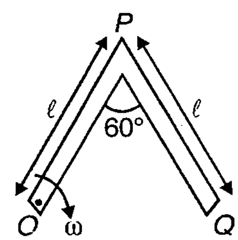
165. A rectangular loop $PQRS$, is being pulled with constant speed into a uniform transverse magnetic field by a force F (as shown). E.m.f. induced in side PS and potential difference between points P and S respectively are (Resistance of the loop = r)



(1) Zero, $\frac{Fr}{B\ell}$ (2) Zero, Zero

(3) Zero, $\frac{Fr}{6B\ell}$ (4) $\frac{Fr}{6B\ell}, \frac{Fr}{6B\ell}$

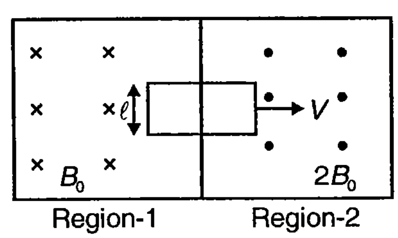
166. A rod OPQ is rotating with angular speed ω about point O. A uniform magnetic field B exists perpendicular to the plane of the rod. Potential difference between points P and Q on the rod is



(1) $\frac{B\omega\ell^2}{2}$ (2) $B\omega\ell^2$

(3) Zero (4) $\frac{B\omega\ell^2}{8}$

167. A conducting loop is being pulled with speed v from region I of magnetic field to region II. If resistance of the loop is R, current induced in the loop at the instant shown is



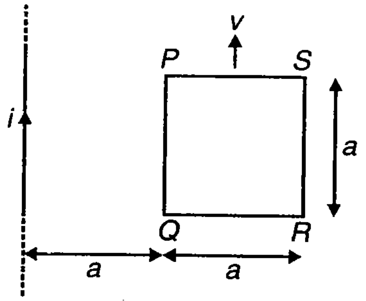
(1) $\frac{B_0\ell v}{R}$, clockwise

(2) $\frac{B_0\ell v}{R}$, anticlockwise

(3) $\frac{3B_0\ell v}{R}$, clockwise

(4) $\frac{3B_0\ell v}{R}$, anticlockwise

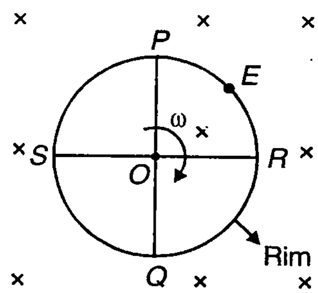
168. A square conducting loop $PQRS$ of side a is moving parallel to a long straight current carrying conductor as shown. E.m.f. induced in the loop and potential difference between points P and R respectively are



(1) Zero, $\frac{\mu_0 iv}{2\pi}\ln 2$ (2) Zero, zero

(3) $\frac{\mu_0 iv}{4\pi}\ln 2$, zero (4) Zero, $\frac{\mu_0 iv}{4\pi}\ln 2$

169. A wheel of diameter d is rotating about its axis passing through O with angular speed ω. A transverse magnetic field exists in the region. Choose the correct alternative



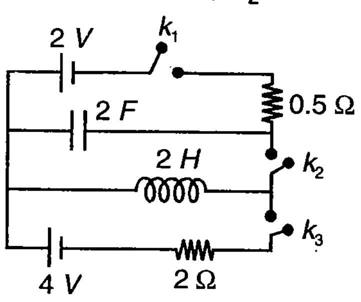
(1) Centre of wheel O is at higher potential compared to any point E on the rim

(2) Potential difference between end Q of one of the spokes and R (end of another spoke) is non-zero

(3) Potential difference between O and R is $\frac{B\omega d^2}{2}$

(4) Potential difference between O and E is $\frac{B\omega d^2}{8}$

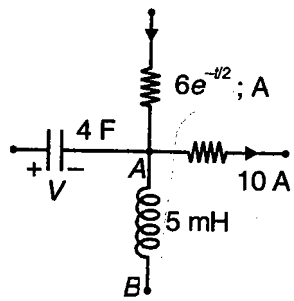
170. For the circuit shown here keys k_1 and k_3 are closed for 1 second. Key k_2 is closed at the instant k_1 and k_3 are opened. Maximum charge on the capacitor after key k_2 is closed is



(1) $4\left(1-\frac{1}{e}\right)C$ (2) $4\sqrt{2}\left(1-\frac{1}{e}\right)C$

(3) $8\left(1-\frac{1}{e}\right)C$ (4) Zero

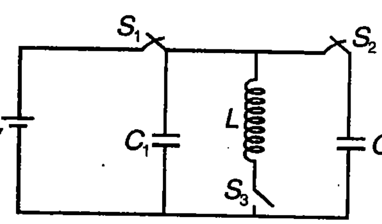
171. Potential difference across the capacitor is varying as $V = e^{-\frac{t}{2}}$ volt. Potential difference between points A and B, $V_A - V_B$ equals



(1) $5e^{-t/2}$ mV (2) $-5e^{-t/2}$ mV

(3) $10e^{-t/2}$ mV (4) $-10e^{-t/2}$ mV

172. In figure S_1 and S_2 is closed for long time. If at $t = 0$, S_1 is opened and S_3 is closed. Then maximum current and angular frequency of oscillation respectively



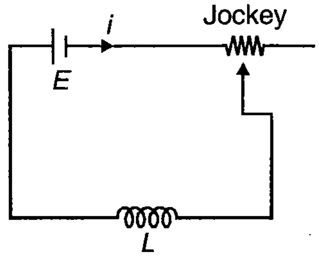
(1) $I_{max} = \left(\sqrt{\frac{C_1+C_2}{L}}\right)V,\ \omega = \frac{1}{\sqrt{L(C_1+C_2)}}$

(2) $I_{max} = \sqrt{\frac{1}{L}\left(\frac{C_1C_2}{C_1+C_2}\right)}\ V,\ \omega = \frac{1}{\sqrt{L\left(\frac{C_1C_2}{C_1+C_2}\right)}}$

(3) $I_{max} = \sqrt{\frac{C_1C_2}{L(C_1+C_2)}}.V,\ \omega = \frac{1}{\sqrt{L(C_1+C_2)}}$

(4) $I_{max} = \sqrt{\frac{(C_1+C_2)}{L}}.V,\ \omega = \frac{1}{\sqrt{L\left(\frac{C_1C_2}{C_1+C_2}\right)}}$

173. In the shown figure, jockey is being moved towards left such that resistance of the circuit at the instant shown is r. Choose the correct alternative



(1) Current i in the circuit is equal to $\frac{E}{r}$

(2) Current i in the circuit is more than $\frac{E}{r}$

(3) Current i in the circuit is less than $\frac{E}{r}$

(4) Current may be more or less than $\frac{E}{r}$ depending on whether of induced e.m.f. in the circuit is zero or non-zero in this case

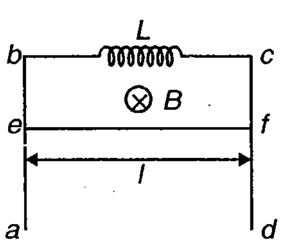
174. Mutual inductance of a system of two thin coaxial conducting loops of radius r each, their centres separated by distance d ($d >> r$) is

(1) $\mu_0 \pi r^4 d^3$ (2) $\frac{\mu_0 \pi r^4}{2d^3}$

(3) $\frac{\mu_0 \pi r^4}{d^3}$ (4) $\frac{\mu_0 \pi r^4 d^3}{4}$

175. A conducting frame $ABCD$ is kept on vertical plane. A conducting rod of mass m and length l can slide smoothly on it remaining always horizontal. The resistance of loop is negligible and inductance is constant value L. The rod is left from rest and allowed to fall under gravity and inductor has no initial current. A magnetic field B is present through out the loop pointing inward.

Choose the correct alternatives



(1) Conducting rod executes SHM with time period $T = 2\pi\frac{\sqrt{mL}}{Bl}$

(2) Maxjmum current through inductor will be, $\frac{2mg}{Bl}$

(3) Amplitude of oscillation of wire, $\frac{mgL}{B^2l^2}$

(4) All of these

176. Which of these is not correct regarding eddy currents?

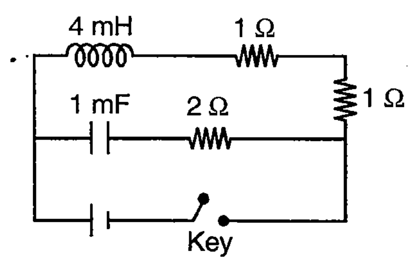
(1) Eddy currents result due to motion of a metallic plate in magnetic field

(2) Eddy currents are minimised in transformer by using laminated core with metal laminations separated by some insulating material

(3) In induction furnace, eddy currents in metal to be melted raise temperature of the metal, melting it

(4) Eddy currents are named so, as they propagate similar to swirling eddies in water

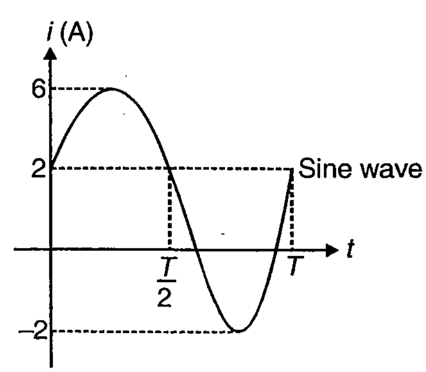
177. Key for the circuit shown is closed at time $t = 0$. Currents through the inductor and the capacitor are equal at time t (in ms) equal to



(1) ln 2 (2) ln 4

(3) ln 8 (4) $\ln\left(\frac{1}{2}\right)$

178. The current 'i' through a wire varies with time t as shown in the figure. The effective (rms) value of the current is



(1) 6 A

(2) $2\sqrt{3}$ A

(3) $2+2\sqrt{2}$ A

(4) 3 A

179. An alternative voltage $V = 300\sqrt{2}\sin(100t)$ is connected to a 1 μF capacitor through an a.c. ammeter. The reading of the ammeter will be

(1) 10 mA

(2) 30 mA

(3) $30\sqrt{2}$ mA

(4) $20\sqrt{2}$ mA

180. A resistance of 300 Ω is connected in series with a pure inductor having inductance $\left(\frac{1}{\pi}\right)H$. If an a.c. source having frequency 200 Hz is applied across the combination, then the phase angle between the voltage and the current is

(1) $> \frac{\pi}{4}$ (2) $< \frac{\pi}{4}$

(3) $= \frac{\pi}{4}$ (4) Between $\frac{\pi}{6}$ and $\frac{\pi}{4}$

181. In a circuit with 220 V, 50 Hz a.c. supply, the elements are a resistor 12 Ω a capacitor of reactance 14 Ω and an inductor of reactance 30 Ω. The ratio of time average of power and the apparent power in the circuit is

(1) $\frac{4}{3}$ (2) $\frac{5}{3}$

(3) $\frac{3}{5}$ (4) $\frac{2}{3}$

182. Two circuit elements in series connection have current and total voltage $i = 4\cos(2000t)$ A and $V = 200\sin(2000t + 37°)$ V. Two elements will be

(1) $R = 30\ \Omega$, $X_C = 40\ \Omega$

(2) $R = 40\ \Omega$, $X_C = 30\ \Omega$

(3) $R = 30\ \Omega$, $X_L = 40\ \Omega$

(4) $R = 40\ \Omega$, $X_L = 30\ \Omega$

183. When an alternating e.m.f. $E = E_0 \sin(100t)$ is connected across an inductor (L), the peak current is i_0. On replacing the inductor by a capacitor (C), the r.m.s. current becomes 4 times. The possible values of L and C are

(1) 50 H and 2 μF

(2) 100 H and 4 μF

(3) 50 H and 4 μF

(4) 100 H and 8 μF

184. In an experiment to determine inductance of a coil, it is first connected to a 200 volt d.c. supply and a current of 2A is observed. Now an alternating supply of 400 volt, 50 Hz is connected, again a current of 2A is observed. The inductance is

(1) 1 H (2) 1.10 H

(3) 0.55 H (4) 0.275 H

185. In an a.c. circuit, V and I are given by $V = 100 \sin(100t)$ volts and $I = 100 \sin(100t + \frac{\pi}{3})$ milliampere. The resistance in the circuit is

(1) 500 Ω (2) 0.5 Ω

(3) 500 mΩ (4) 500 μΩ

186. The electric current in a circuit is given by $i = i_0\left(\frac{t}{k}\right)$. The mean square current for the time interval $t = 0$ to $t = k$ is

(1) $\frac{i_0}{\sqrt{3}}$ (2) $\frac{i_0^2}{3}$

(3) $\sqrt{3}\, i_0$ (4) $3i_0^2$

187. An AC source of frequency f is fed across a resistor R and a capacitor C in series. The current flowing in the circuit is I. If now the frequency of source is changed to $\frac{f}{3}$, without any change in magnitude of voltage, the current in the circuit is found to halved. The ratio of reactance to resistance at the original frequency f will be

(1) $\frac{3}{\sqrt{5}}$ (2) $\frac{\sqrt{3}}{5}$

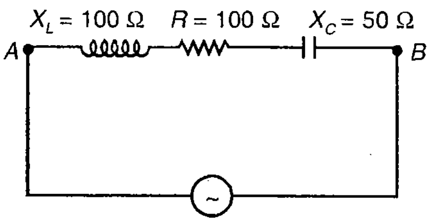
(3) $\sqrt{\frac{5}{3}}$ (4) $\sqrt{\frac{3}{5}}$

188. What should be the value of inductance that must be connected in series with a capacitor of 5 μF and a resistor of 10 Ω across an alternating voltage of 50 Hz, so that the power factor of the circuit becomes unity?

(1) $\left(\frac{200}{\pi^2}\right)$H (2) $\left(\frac{20}{\pi^2}\right)$H

(3) $(200\pi^2)$H (4) $(20\pi^2)$H

189. In the series LCR circuit shown below the peak value of current is $\sqrt{2}$ A. The current at the given instant is 1A. The potential difference $|V_A - V_B|$ at this instant is



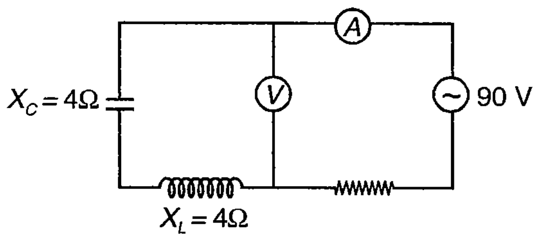
(1) 150 V

(2) 250 V

(3) $50\sqrt{5}$ V

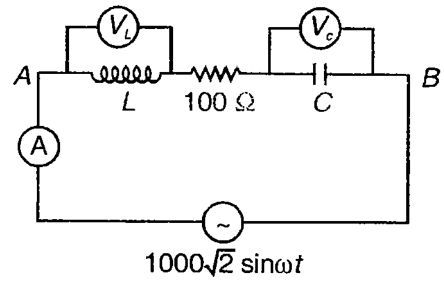
(4) Zero

190. In this figure, reading of voltmeter V is



(1) Zero
(2) 90 V
(3) 10 V
(4) 45 V

191. In the circuit shown, the reading of ammeter is 10 A and that of $V_C = 200$ V. The reading of V_L is



(1) 200 V (2) $200\sqrt{2}$ V

(3) $(-1200 + 1000\sqrt{2})$ V (4) Zero

192. In a choke coil with inductance L and a very low resistance R, the power loss for an input voltage of frequency 'ω' is proportional to

(1) $\dfrac{R}{\omega L}$ (2) $\dfrac{\omega L}{R}$

(3) $\dfrac{R}{\omega^2 L^2}$ (4) $\dfrac{\omega^2 L^2}{R}$

193. The phase difference between current and voltage, when the frequency of applied e.m.f. is $\omega_0 + \dfrac{R}{2L}$ (ω_0 is resonance frequency) in a series LCR circuit is

(1) $\dfrac{\pi}{2}$ (2) $\dfrac{\pi}{4}$

(3) $\dfrac{\pi}{6}$ (4) Zero

❑ ❑ ❑

SECTION - B

Multiple Choice Questions

This section contains 48 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **MORE THAN ONE** is correct.

Choose the correct answer :

1. Which of the following motions is/are possible for a charged particle moving under influence of electric field?

 (1) Straight line (2) Circular

 (3) Helical (4) None of these

2. Two charges Q_1 and Q_2 placed at (0, 0, 0) and (a, 0, 0) are such that x-component of field is zero at $\left(\frac{a}{2}, a, 0\right)$. y component of field will be zero at

 (1) $\left(\frac{a}{2}, 0, 0\right)$ (2) $(2a, 0, 0)$

 (3) $\left(\frac{a}{2}, 0, a\right)$ (4) $(-2a, 0, 0)$

3. Electric field at any point $P(x, y, z)$ in space is given by $\vec{E} = -E_0 x\hat{i}$, where E_0 is a positive constant and all physical quantities are given in S.I. units. Select the correct statements out of the following statements

 (1) Potential at points on y-axis must be zero

 (2) Potential difference between any two points along z-axis must be zero

 (3) Potential changes linearly with positive along x-axis

 (4) A cubical volume of edge 1 m with one of the edges along x-axis, placed in this electric field encloses a charge of $(-E_0\varepsilon_0)$ coulomb

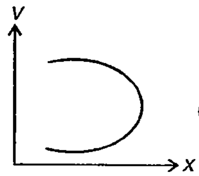
4. An equipotential surface is plane and cuts xy plane in line $3y = 4x$, then electric field vector at point $(3k, 4k)$ may be

 (1) $3\hat{i} + 4\hat{j}$ (2) $-4\hat{i} + 3\hat{j} + 5\hat{k}$

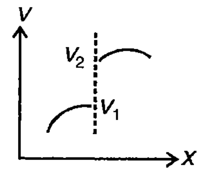
 (3) $4\hat{j} + 3\hat{k} + 4\hat{k}$ (4) $8\hat{i} - 6\hat{j} + 16\hat{k}$

5. Which potential versus distance graph is not possible

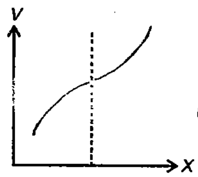
 (1)



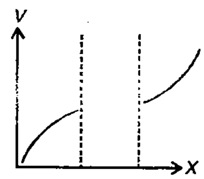
 (2)



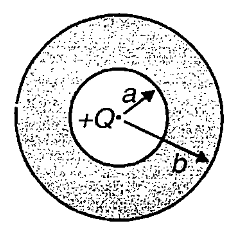
 (3)



 (4)



6. A charge + Q is placed at the centre of an isolated metallic shell of inner radius a and outer radius b as shown in the figure. Find out the correct statements out of the following statements



 (1) Electric field at the outer surface of the metallic sphere is $\frac{Q}{4\pi\varepsilon_0 b^2}$

 (2) Electric field at the inner surface of the metallic sphere is $\frac{Q}{4\pi\varepsilon_0 a^2}$

 (3) If inner surface of the metallic sphere is earthed, charge on inner surface is zero

 (4) If outer surface of the metallic sphere is earthed, charge on outer surface is zero

7. "In reference to Q. 25 on page 154 under section A, which of the following statements are incorrect?

 (1) Electric field between the plates will be uniform

 (2) Volume charge density at any point in dielectric will be nonzero

(3) Electric lines of force will be parallel lines between plates

(4) Electric Flux linked to any Gaussian surface taken between plates will be zero

8. A closed conductor of irregular shape is given some charge. Which of the following statements are incorrect?

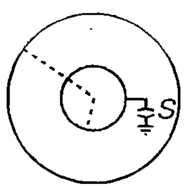
(1) Charge will appear on inner and outer surface

(2) All points on its surface will have same charge density

(3) Electric field inside it is non-zero

(4) Potential of conductor will change if its shape is changed

9. Two thin conducting shells of radii R and $2R$ are shown in figure. The outer shell carries a charge $+Q$ and inner shell is neutral.



(1) With switch open potential of inner sphere is same as that of point at distance $\frac{3R}{2}$ from centre

(2) When switch S is closed, potential of inner sphere becomes zero

(3) With switch S closed charge on inner sphere is $-\frac{Q}{2}$

(4) By closing switch capacitance of system decreases

10. Separation between the plates of a parallel plate capacitor is increased by keeping it connected to the cell. Find out the incorrect statements out of the following statements

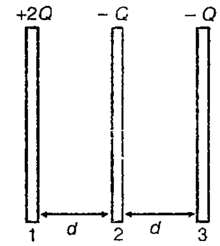
(1) Charge on the capacitor decreases

(2) Electric field inside the capacitor increases

(3) Energy stored in capacitor decreases

(4) Work done by external agent gets stored in electric field inside capacitor

11. Three identical square plates each of surface area A are arranged as shown in the figure. Plates 1, 2, and 3 are given charges $+2Q$, $-Q$ and $-Q$ respectively. Find out the correct options



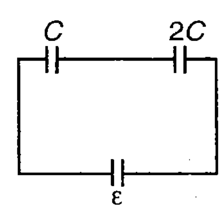
(1) Charges on the two faces of the middle plate are $-\frac{Q}{2}$ and $-\frac{Q}{2}$, If plates 1 and 3 are connected through a conducting wire

(2) Charge on the two faces of the middle plate are $-2Q$ and $+Q$

(3) Energy of the system is $\left(\frac{5}{2}\frac{Q^2d}{\varepsilon_0 A}\right)$

(4) Energy of the system is $\left(\frac{3}{2}\frac{Q^2d}{\varepsilon_0 A}\right)$

12. Two capacitors are fully charged as shown in the figure. Then cell is taken out and the two capacitors are connected together such that plates of opposite polarity are connected together. Choose the correct statements



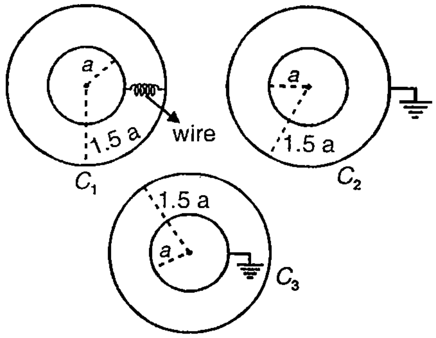
(1) Charge on capacitor of capacitance C is $\left(\frac{4C\varepsilon}{9}\right)$

(2) Charge on capacitor of capacitance $2C$ is $\left(\frac{8C\varepsilon}{9}\right)$

(3) Charge on capacitor of capacitance $2C$ is zero

(4) Energy loss in the process of charge distribution is $\left(\frac{C\varepsilon^2}{3}\right)$

13. Capacitances of following combinations of spheres are C_1, C_2 & C_3



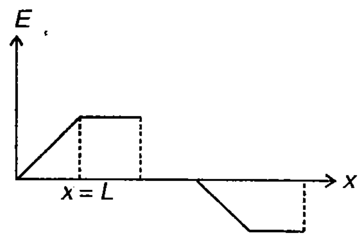
(1) $C_2 > C_1$

(2) $C_1 > C_3$

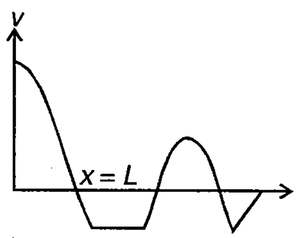
(3) $C_1 > C_2$

(4) $C_3 > C_2$

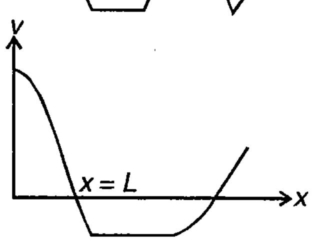
14. The diagram shows E versus X graph. If the point $X = L$ is at zero potential then which of the following most appropriately represent the V versus X graph? (Do not calculate the exact values of the potential. Only choose the correct shape.)



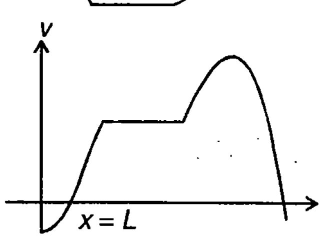
(1)



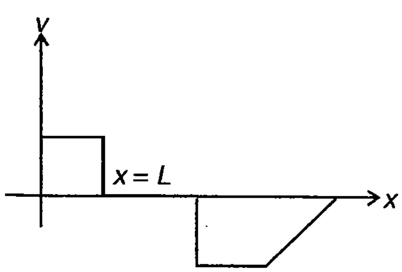
(2)



(3)



(4)



15. A non conducting ring of mass m and radius R is placed on rough surface. Two point charge $+q$ and $-q$ are fixed at highest point & lowest point of metal ring. At time $t = 0$ uniform electric field E_0 in horizontal direction and parallel to plane of ring is switched on. Ring starts rolling for

(1) $\mu = \dfrac{2qE}{mg}$

(2) $\mu = \dfrac{3qE}{mg}$

(3) $\mu = \dfrac{qE}{mg}$

(4) $\mu > \dfrac{1.5qE}{mg}$

16. A constant voltage is applied to n groups of resistors in series where each group has m identical resistors in parallel. If one resistor burns out in first group, then

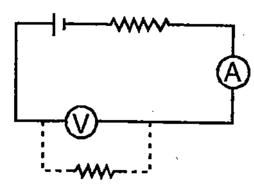
(1) Percentage increase of current in each resistor of first group is $\dfrac{(n-1)\times 100}{nm-n+1}$

(2) Percentage decrease of current in each resistor of the second group is $\dfrac{100}{nm-h+1}$

(3) Percentage decrease of current in each resistor of the second group is $\dfrac{(n-1)\times 100}{nm-n+1}$

(4) Percentage increase of current in each resistor of first group is $\dfrac{100}{nm-n+1}$

17. Reading of voltmeter and ammeter in following circuit are V and I respectively. If a resistance is joined in parallel with voltmeter, the incorrect statement is



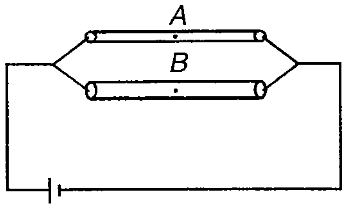
(1) Both V & I decreases

(2) Both V & I increases

(3) V increases but I decreases

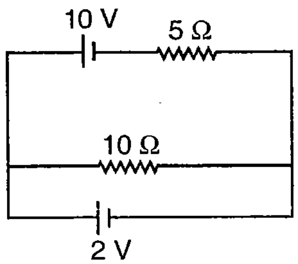
(4) I increases but V decreases

18. Two wires of same length and same material but different areas of cross-section are connected parallel to each other. Now if some potential difference is applied across the two, then select the incorrect option



(1) $E_A = E_B$ (2) $(V_d)_A = (V_d)_B$
(3) $J_A > J_B$ (4) $\sigma_A = \sigma_B$

19. In the given circuit, choose the correct options

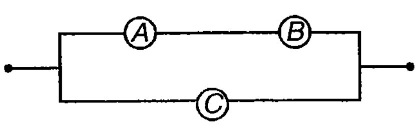


(1) 10 Ω resistor is short circuited
(2) Current through 10 Ω resistor is 0.2 A
(3) Cell of emf 2 V is consuming power of 2.8 watt
(4) Cell of emf 2 V is supplying power of 2.8 watt

20. To get maximum current through a resistance of 2.5 Ω, one can use m rows of cells, each row having n cells. The internal resistance of each cell is 0.5 Ω. What are values of n and m if the total number of cells is 45?

(1) $m = 9$ (2) $m = 3$
(3) $n = 15$ (4) $m = 15$

21. Rating of bulbs A and B is 220 V, 200 W each and rating of bulb C is 220 V, 100 W. Choose the correct options out of the following

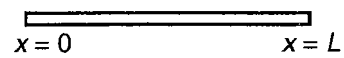


(1) All the three bulbs shine equally brightly
(2) Bulb C shines more brightly than each of the two bulbs A and B
(3) If supply voltage is increased, bulb C gets fused first
(4) Power consumption in two bulbs A and B taken together is equal to power consumption in C.

22. The wire shown in figure has a uniform cross-section A. Resistivity of the material of wire is given by

$$\rho = \rho_0\left(\frac{L}{L+x}\right)$$

A potential difference V is applied across the wire. Choose the correct options



(1) Resistance of wire is $\frac{\rho_0 L}{A}\cdot\ln(2)$
(2) Current density is variable inside the wire
(3) Electric field at $x = 0$ is $\frac{V}{(\ln 2)\cdot L}$
(4) Electric field at $x = L$ is $\frac{V}{(\ln 2)\cdot L}$

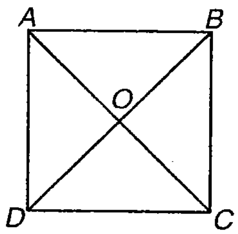
23. Which option(s) is correct ?
(1) When there is no current in a conductor free electron moves in a straight line between collisions
(2) When current flows in a conductor, then the average speed in random motion of an electron for large time interval is zero
(3) If applied potential is increased random motion of electrons also increases.
(4) In the absence of current, average of velocities of the free electron at any instant is zero

24. A voltmeter and an ammeter are connected in series to an ideal cell. The reading of voltmeter is V and ammeter reading is I, then
(1) We can calculate resistance of voltmeter
(2) We cannot calculate ammeter resistance
(3) We cannot calculate emf of cell
(4) We can calculate ammeter resistance

25. In a series LCR circuit, when an alternating voltage of peak value 500 V and angular frequency 100 rad/s is applied, the peak voltage drops across L, C and R could be respectively
(1) 200 V, 300 V, 0
(2) 800 V, 500 V, 400 V
(3) 600 V, 200 V, 300 V
(4) 1200 V, 1600 V, 300 V

26. In which case average power dissipated is not zero?
(1) Either capacitor or inductor only
(2) A combination of R and C only
(3) A combination of R and L only
(4) Any combination of R, L or C

27. In the shown network of resistive wire current enters at O and leaves out at A. Resistances $R_{OA} = R_{OB} = R_{OC} = R_{OD} = R_{AB} = R_{BC} = R_{CD} = R_{DA} = R$. Choose the correct options



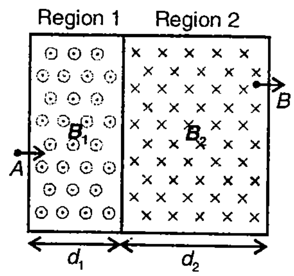
(1) Equivalent resistance between O and A is $\frac{7R}{15}$
(2) Equivalent resistance between O and A is $\frac{7R}{8}$
(3) Potential of points A and C are same
(4) Potential of points B and D are same

28. The current through a conducting body depends on applied voltage as
$V = 4i^2$
Choose the correct options
(1) This is an ohmic conductor
(2) This is a non-ohmic conductor
(3) Power consumption is $P = Vi$
(4) Power consumption is $P = 4i^4$

29. In an a.c. circuit containing resistance only
(1) Average power dissipated in a time interval equal to half the time period may be zero
(2) The r.m.s. value of current is never zero for any finite interval
(3) The average value of current in a time interval equal to half the time period may not be zero
(4) Average power dissipated in a time interval equal to half the time period is never zero

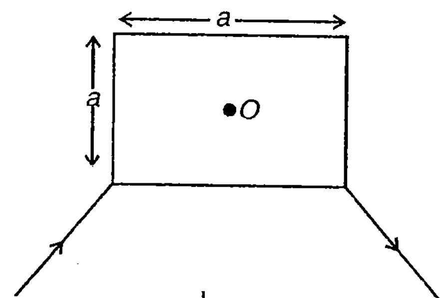
30. A moving positively charged particle is spotted at point (5 cm, 0, 0) at a given instant. At the same instant magnetic field produced by it at origin is detected to be $\vec{B} = B_0\hat{j}$; where B_0 is a positive constant. The possible velocities of the charged particle are
(1) $\vec{v} = 5\hat{i} + 4\hat{j}$; m/s
(2) $\vec{v} = 2\hat{i} - 4\hat{k}$; m/s
(3) $\vec{v} = -\hat{i} - 3\hat{k}$; m/s
(4) $\vec{v} = -2\hat{j} - 2\hat{k}$; m/s

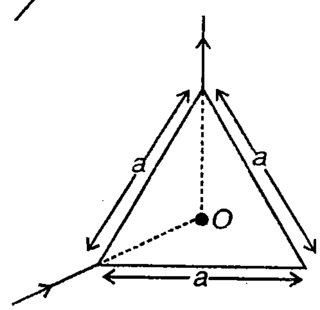
31. Consider the figure shown. A charged particle enters magnetic field at A and emerges out of magnetic field at B moving parallel to its direction of motion at A. If r_1 and r_2 are the radii of rotation of particle in region 1 and region 2 respectively,

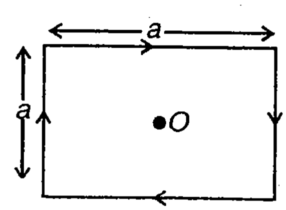


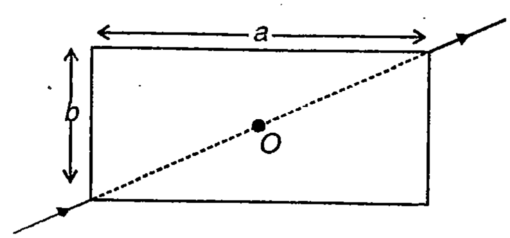
(1) $\frac{r_1}{r_2} = \frac{d_2}{d_1}$
(2) $\frac{r_1}{r_2} = \frac{d_1}{d_2}$
(3) $\frac{r_1}{r_2} = \frac{B_2}{B_1}$
(4) $\frac{r_1}{r_2} = \frac{B_1}{B_2}$

32. In which case, magnetic field at the centre of the loop is zero if loop is made of uniform resistance wire

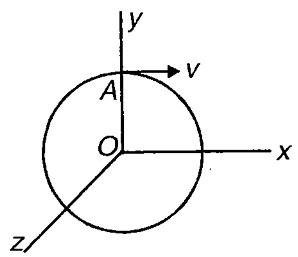
(1)


(2)


(3)


(4)


33. A particle of charge q and mass m is revolving in a circular path in a uniform magnetic field as shown in figure. At the instant when it is at point A, another particle of charge q and mass m moving along z-axis collides with it and sticks to it. Choose the correct option(s)



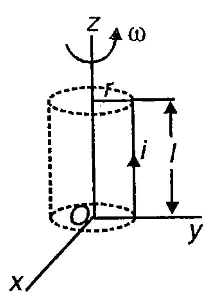
(1) Subsequent path of the combined mass is a straight line

(2) Subsequent path of the combined mass is a helix of uniform pitch

(3) Subsequent path of the combined mass is a helix of same radius as the radius of circular path before collision

(4) Subsequent path of the combined mass is a helix of different radius as compared to the radius of the circular path

34. A wire of length l and carrying current i is rotating about z-axis as shown in the figure. At the cylindrical surface, traced by rotating conductor, magnetic field is radially inward and has a magnitude B. Select the correct options



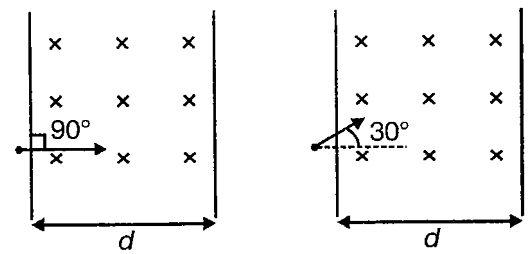
(1) Torque experienced by the wire due to magnetic field is, $\vec{\tau} = Bilr\ \hat{k}$

(2) Torque experienced by the wire due to magnetic field is $\vec{\tau} = -Bilr\ \hat{k}$

(3) Power supplied by external agent to rotate the wire with constant angular speed ω is, $P = +\ Bilr\ \omega$

(4) Power supplied by external agent to rotate the wire with constant angular speed ω is $P = -\ Bilr\ \omega$

35. A charged particle enters a transverse uniform magnetic field region in two different manners (as shown in the figures). Maximum speed for which the particle does not cross the magnetic field region onto the other side is v, when it enters in manner 1. The maximum speed if it enters the field in manner 2 is



Manner 1 Manner 2

(1) v

(2) $15v$

(3) $\frac{2}{3}v$

(4) $2v$

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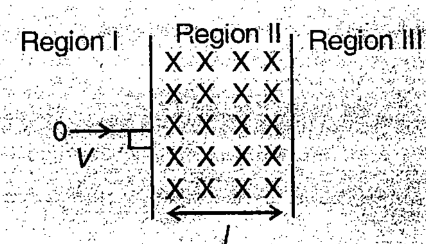
35(a). A particle of mass m and charge q, moving with velocity V enters Region II normal to the boundary as shown in the figure. Region II has a uniform magnetic field B perpendicular to the plane of the paper. The length of the Region II is l. Choose the correct choice(s).



(1) The particle enters Region III only if its velocity $V > \frac{qlB}{m}$

(2) The particle enters Region III only if its velocity $V < \frac{qlB}{m}$

(3) Path length of the particle in Region II is maximum when velocity $V = \frac{qlB}{m}$

(4) Time spend in Region II is same for any velocity V as long as the particle returns to Region I

36. In a region, electric field and magnetic field are reported to be

$$\vec{E} = E_0 x \hat{i}$$

$$\vec{B} = B_0 x \hat{i}$$

Choose the correct options

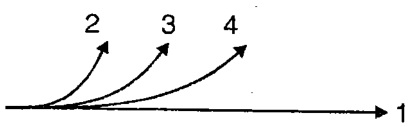
(1) Such an $\vec{E}$ is possible

(2) Such an $\vec{E}$ is not possible

(3) Such a $\vec{B}$ is possible

(4) Such a $\vec{B}$ is not possible

37. Neutron, positron, H^+, He^+, O^{2+}, Li^+ all having same kinetic energy when enter a region of transverse magnetic field follow different trajectories as shown in the figure. Choose the correct alternative



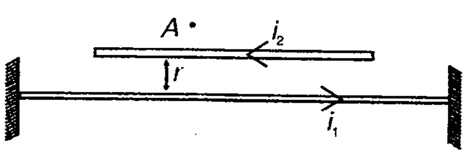
(1) Both He^+ and O^{2+} follow trajectory 3

(2) Li^+ follows trajectory 4

(3) Neutron follows trajectory 1 and H^+ follows trajectory 2

(4) Magnetic field in the region is directed perpendicular outwards to the plane of paper

38. Two long current carrying wires, one fixed another free, are in a vertical plane one above another. Select the correct options



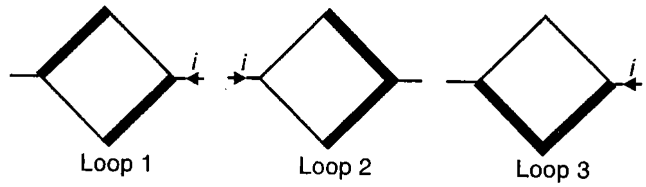
(1) If $r = \frac{\mu_0 i_1 i_2}{2\pi mg}$; where m is mass per unit length of upper wire, then upper wire will be in equilibrium

(2) If a charge is projected vertically upwards from A, then it will be deflected towards wire carrying current i_2

(3) If a charge in projected vertically upwards then it will be deflected towards wire carrying current i_1

(4) When i_1 and i_2 are in mutually opposite directions and upper wire is displaced slightly from equilibrium, it starts making simple harmonic motion

39. Consider three different square loops made of aluminium wires. Relative thicknesses of the wires used to construct the loops are shown in the figure. Magnetic field



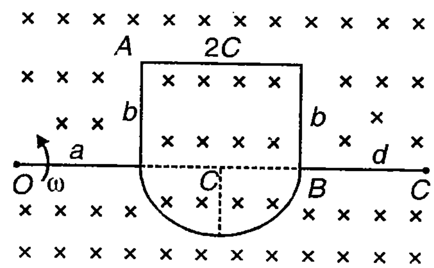
(1) At the centre of only loop 1 is zero

(2) At the centre of loops 1 and 2 is zero

(3) At the centre of all loops is zero

(4) At the centre of loop 3 is directed up

40. A frame is rotating about hinge at O in a uniform transverse magnetic field as shown in the figure. Dimensions of various sections of the rod are shown. Some points are marked on the rod C Choose the correct alternative.



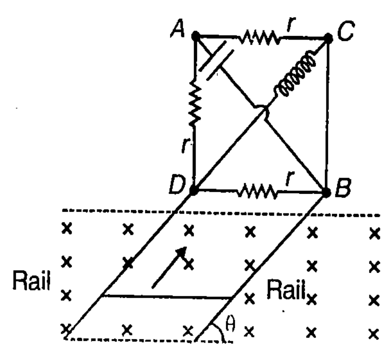
(1) Potential difference between O and A can never be zero

(2) Potential difference between A and C may be zero

(3) Potential difference between O and C does not depend on b

(4) Potential difference between A and B does not depend on a

41. The arrangement shown which is confined in a vertical plane has two rails inclined at angle θ with horizontal. A horizontal rod of length ℓ moves on the rails with constant speed v, in the region with transverse field B. Choose the correct alternative(s). The rod starts moving at time $t = 0$



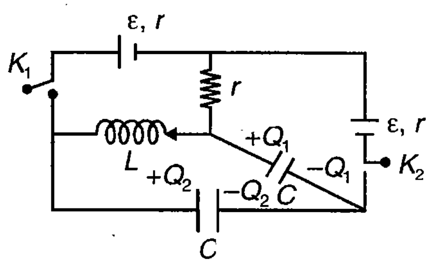
(1) At $t = 0$, current in the circuit is $\dfrac{Blv\sin\theta}{2r}$

(2) At $t = \infty$, current in the circuit is $\dfrac{Blv\sin\theta}{r}$

(3) At any time t (except at $t = 0$) point A is at higher potential than point B

(4) At any time t (except at $t = 0$) point D is at lower potential than C

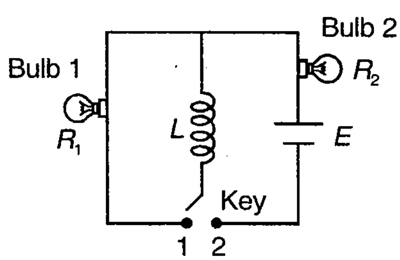
42. Keys K_1 and K_2 are simultaneously closed at $t = 0$. At any time t current through K_1 is 'i' and current in inductor is increasing at the rate x. Current in the resistor is zero. Choose the correct alternatives



(1) $E - ir = Lx$ (2) $E + ir = \dfrac{Lx}{2}$

(3) $Q_2 = 2Q_1$ (4) $\dfrac{Q_1}{C} = Lx$

43. Key is in position 2 for time t. Thereafter, it is in position 1. Resistances of the bulb and inductance of inductor are marked in the figure choose the correct alternative



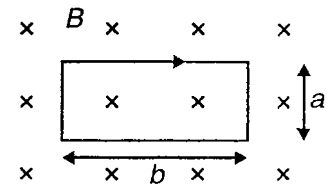
(1) Bulb 2 dies as soon as key is switched into position 1

(2) Time in which brightness of bulb 1 becomes half its maximum brightness does not depend on t

(3) If $t = \infty$, total heat produced in bulb 1 is $\dfrac{LE^2}{2R_2^{\,2}}$

(4) Ratio of maximum power consumption of bulbs depends on time

44. A rectangular loop made of flexible conducting wire carrying clockwise current is placed in uniform magnetic field as shown. Choose the correct alternative



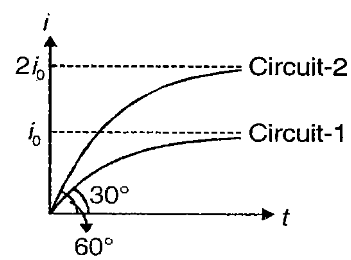
(1) The loop develops induced anti clockwise current for a short time

(2) The loop finally has area equal to $\dfrac{(a+b)^2}{4}$

(3) Induced charge flown through the loop is $\dfrac{B}{R}\left[\dfrac{(a+b)^2 - ab}{\pi}\right]$, where R is resistance of the loop

(4) Centre of mass of the loop does not change its position

45. Growth of current in two different L-R circuits are depicted by the i-t graphs shown. Angle subtended by the curves with time axis at time $t = 0$ are also shown in the graph τ_1 and τ_2 are time constants for the circuits 1 and 2 respectively. Choose the correct alternative



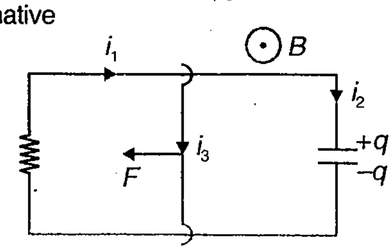
(1) $\dfrac{\tau_1}{\tau_2} = \dfrac{2}{3}$

(2) $\dfrac{\tau_1}{\tau_2} = \dfrac{3}{2}$

(3) Initial rate of charing of capacitor for circuit-2 is 3 times that of circuit-1

(4) Initial rate of change of current for circuit-2 is 3 times that of circuit-1

46. Consider two horizontal parallel rails connected by a movable conducting connector. Terminals of the rails are connected by a resistor and a capacitor. A uniform magnetic field perpendicular to the plane of horizontal rails exists in the region. At any general instant, currents in various branches and charge on the capacitor are shown. Initially the connector is moving towards right. A constant force starts acting on the rod towards left. Assuming the rails to be long enough, choose the correct alternative



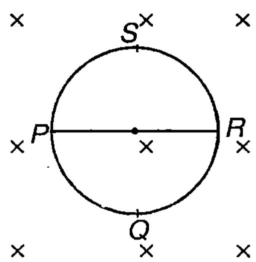
(1) Initially i_1 is in same direction to as shown, i_2 is in opposite direction to as shown, q is negative

(2) At the instant direction of motion of rod reverses, $i_1 = 0$, $q = 0$, $i_2 \neq 0$

(3) After a long time, $i_2 = 0$, i_1 is constant and is in opposite direction to as shown

(4) i_3 is in opposite direction to as that shown finally and equals i_2

47. The radius of the circular loop is 'a'. Magnetic field is increasing at the constant rate α(Magnetic field is confined to a cylindrical region and axis of magnetic field coincides with the axis of the loop). Resistance per unit length of the wire of loop is ρ



The choose the correct options

(1) Current in the loop $PQRS$ is $\frac{a\alpha}{2\rho}$ anticlockwise

(2) Current in the loop $PQRS$ in $\frac{a\alpha}{\rho}$ clockwise

(3) Current in the wire PR is zero

(4) Current in the wire PR is $\frac{\pi a\alpha}{2\rho}$

48. Choose the correct statement

(1) A short magnet is moved along axis of a metallic loop. The loop repels the magnet if the magnet is approaching the loop and attracts it if the magnet is moving away from the loop

(2) If ends of coil in a moving coil galvanometer are connected together, suddenly stops oscillating if it was oscillating

(3) An e.m.f. is induced in a conducting loop when it is placed in a non-uniform magnetic field

(4) A bar magnet released from rest along a long vertical copper tube moves with almost constant speed after some time

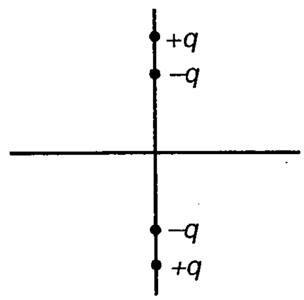
❑ ❑ ❑

SECTION - C

Linked Comprehension Type

This section contains 25 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

C1. Two rods of length l and $2l$ are placed in xy plane such that their mid-points are at origin and they are free to rotate in xy plane about z-axis. Two $+q$ charges are fixed at two ends of bigger rod and two $-q$ charges are fixed at two ends of smaller rod.



Choose the correct answer :

1. What is electric dipole moment of system?

(1) $3q\frac{l}{2}$ (2) $5q\frac{l}{2}$

(3) ql (4) Zero

2. Electric field at point $(a, 0, 0)$ is E. Now if $a >> l$ then

(1) $E \propto \frac{1}{a^2}$ (2) $E \propto \frac{1}{a^3}$

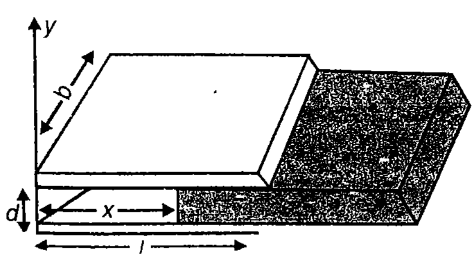
(3) $E \propto \frac{1}{a^4}$ (4) $E \propto \frac{1}{a^5}$

3. Work done to rotate smaller rod through 180° about z-axis

(1) 0 (2) $\frac{3kg^2}{3e}$

(3) $\frac{3kg^2}{2e}$ (4) $\frac{-2kg^2}{2e}$

C2. Consider a slab of dielectric material partially inserted between the plates of a parallel plate capacitor. If charge on capacitor is Q. (Dielectric constant of material is K)



Choose the correct answer :

1. Dielectric slab is attracted into capacitor due to

(1) Uniform field between plates

(2) Field outside plates

(3) Fringing field outside

(4) Uniform field outside plates

2. Energy stored in capacitor at instant when slab has travelled $(l - x)$ distance

(1) $\frac{Q^2}{2\varepsilon_0 d}$ (2) $\frac{Q^2 d}{2\varepsilon_0[Kl + x(1-K)]\cdot b}$

(3) $\frac{Q^2}{2\,\varepsilon_0 db}$ (4) $\frac{Q^2 d}{2Kxd\,\varepsilon_0}$

3. Magnitude of force acting on dielectric is

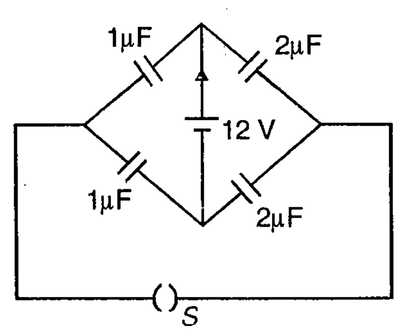
(1) Constant

(2) Increasing

(3) Decreasing

(4) First increasing then decreasing

C3. When current comes out from positive terminal of battery, energy is supplied by the battery to external circuit. In this process e^- inside cell moves from higher potential to lower potential. Work against the field (inside the cell) is done at the cost of chemical potential energy. Net energy output from battery is also called work done by battery. If ΔQ charge flows through battery then work done by battery is equal to $\Delta Q(V)$ Where V is potential difference between two electrodes.



Energy stored in capacitors is U_1 when S is open. If S is closed the charge passed through S is Q. Now total energy stored in capacitors is U_2.

Choose the correct answer :

1. What is the value of $(U_1 - U_2)$?

(1) Zero (2) –20 kJ
(3) + 30 kJ (4) +20 kJ

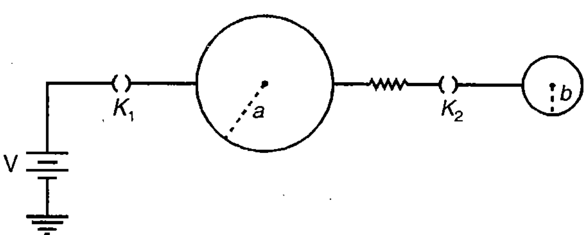
2. What is value of work done by battery?

(1) Zero (2) 10 μJ
(3) 40 μJ (4) 20 μJ

3. Thermal energy produced in circuit

(1) 10 μJ (2) Zero
(3) 50 μJ (4) 100 μJ

C4. Consider situation shown in figure in which two isolated conducting spheres are connected. Initially K_2 is open and K_1 is closed. Charge on sphere of radius a is Q. Now K_1 is opened and K_2 is closed. Now charge on sphere of radius b is q



Choose the correct answer :

1. Terminal potential of battery is equal to

(1) $\frac{KQ}{a}$ (2) $\frac{K\gamma}{b}$
(3) $K\gamma\left(\frac{1}{a}+\frac{1}{b}\right)$ (4) Both (1) & (3)

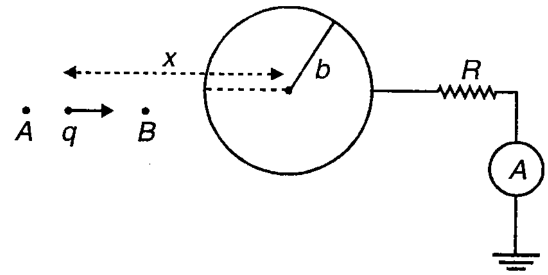
2. If now K_2 is again opened and K_1 is closed and this process is repeated infinite number of times then maximum charge on smaller sphere is

(1) Infinite
(2) $\frac{Qq}{Q-q}$
(3) Q
(4) Depend to on ratio $\frac{a}{b}$

3. Maximum energy that can be withdrawn from battery

(1) VQ (2) $V(Q+q)$
(3) $V\frac{Q^2}{(Q-q)}$ (4) Vq

C5. A charge q is moving towards the centre of an earthed conducting sphere of radius b with uniform velocity v. Distance of two points A and B from centre of sphere are $3a$ & $2a$. Conducting sphere is earthed with an ammeter and resistance in series (as shown)



Let at any instant point charge is at x distance from center. Ignore induction effects.

Choose the correct answer :

1. Net charge on surface of conductor at this instant

(1) $+q$
(2) $-q$
(3) $-q\frac{x}{b}$
(4) $-q\frac{b}{x}$

2. Reading of ammeter at this instant

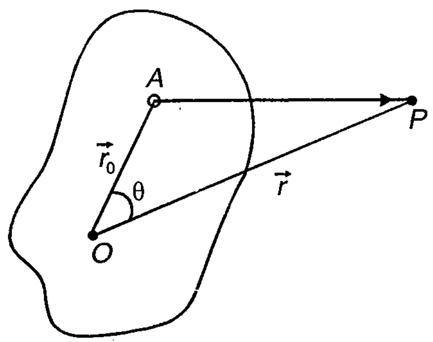
(1) $q\frac{xV}{b^2}$
(2) $q\frac{V}{b}$
(3) $\frac{qbv}{x^2}$
(4) Zero

3. Heat energy produced in resistance till point charge moves from A to B

(1) $\frac{19\,q^2b^2vR}{648\,a^3}$
(2) $\frac{2\,q^2b^2vR}{5\,a^3}$
(3) Zero
(4) $\frac{5}{72}\,\frac{q^2b^2vR}{a^3}$

C6. Consider an arbitrary localized charge distribution.

O is the origin and $O\vec{A}$ is position of small volume element dt. ρ is volume charge density at this point. Potential due to this at point P will be



$$dV = \frac{K\rho dt}{AP}$$

or $V = \int \frac{K\rho dt}{AP}$

Where

$$AP^2 = OA^2 + OP^2 - 2\ OA\ OP \cos\theta$$

$$AP^2 = r^2 + r_0^2 - 2r\, r_0 \cos\theta$$

$$AP = r\sqrt{1 + x}$$

Where

$$x = \frac{r_0}{r}\left(\frac{r_0}{r} - 2\cos\theta\right)$$

Now using binomial theorem

$$\frac{1}{AP} = \frac{1}{r}(1+x)^{-1/2}$$

Or $\frac{1}{AP} =$

$$\frac{1}{r}\times\left(1+\frac{r_0}{r}\cos\theta+\left(\frac{r_0}{r}\right)^2\left(\frac{3}{2}\cos^2\theta-\frac{1}{2}\right) + \left(\frac{r_0}{r}\right)^3\left(\frac{5}{2}\cos\theta-\frac{3}{2}\cos\theta\right)+......\right)$$

So potential At P

$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{1}{r}\int\rho dt + \frac{1}{r^2}\int r_0 \cos\theta\ \rho dt\ ....\right]$$

This is called multiple expansion of V in powers of $\frac{1}{r}$

(i) First term in the expansion is the monopole term. In this term $\int \rho dt$ is net charge of system. Due to this term V is proportional to $\frac{1}{r}$

(ii) Second term in expansion is equivalent dipole moment of system. Due to this term potential is inversely proportional to r^2.

$$V_{dip} = \frac{1}{4\pi\varepsilon_0}\frac{1}{r^2}\int r_0 \cos\theta\, \rho dt$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{\hat{r}}{r^2}\int \vec{r}_0\, \rho dt$$

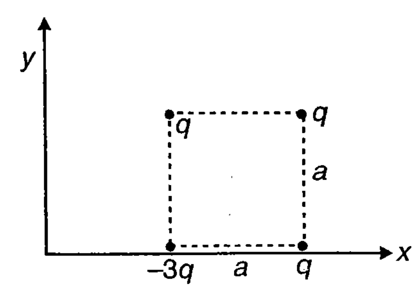
The integral $\int \vec{r}_0\, \rho dt$ is called dipole moment. If net charge is zero then dipole moment of charge distribution is independent of point of reference.

Choose the correct answer :

1. A uniformly charged sphere has charge Q and radius R. Then dipole moment of sphere about its centre is
   (1) Proportional to $\frac{1}{R}$
   (2) Proportional to $\frac{1}{R^2}$
   (3) Proportional to R
   (4) Zero

2. Dipole moment of a point charge q placed at (a, b) with respect to origin
   (1) Zero (2) $q\sqrt{a^2 + 1b^2}$
   (3) $q(a + b)$ (4) Cannot be calculated

3. Dipole moment of given configuration about origin



   (1) $q\,a\sqrt{2}\ (i + \hat{j})$
   (2) $2q\,a\,(i - j)$
   (3) $2q\,a(i + j)$
   (4) Zero

C7. We know that similar charges repel each other. Hence charge on any part of surface is repelled by charge on its remaining parts. The surface charge thus experiences a pressure. This pressure is given by

$$P = \frac{\sigma^2}{2\varepsilon_0}$$

Or $P = \frac{1}{2}\varepsilon_0 E^2$

Choose the correct answer :

1. If two plates of parallel plate capacitor with plate area A are given charge Q and $3Q$ respectively then force between plates is

(1) $\frac{3Q^2}{2A\varepsilon_0}$ (2) $\frac{2Q^2}{A\varepsilon_0}$

(3) $\frac{Q^2}{A\varepsilon_0}$ (4) $\frac{9Q^2}{2A\varepsilon_0}$

2. A metal sphere of radius R carries a total charge Q. What is force of repulsion between the two hemispheres formed by great circle of sphere

(1) $\frac{KQ^2}{8R^2}$ (2) $\frac{KQ^2}{4R^2}$

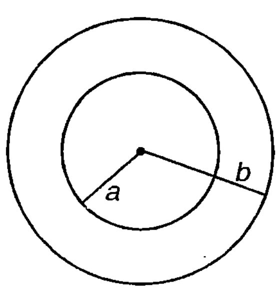
(3) $\frac{KQ^2}{R^2}$ (4) Zero

3. Electrostatic pressure can also be written as

(1) $\frac{1}{2}\varepsilon_0 E^2$ (2) $\frac{2}{3}\varepsilon_0 E^2$

(3) $\varepsilon_0 E^2$ (4) $\frac{3}{2}\varepsilon_0 E^2$

C8. A spherical capacitor consists of a spherical shell of radius b. This is concentric with a smaller conducting sphere of radius a.



Choose the correct answer :

1. If charge given to inner sphere is q then what should be charge on outer sphere so that potential energy of system is minimum?

(1) q (2) $-q$

(3) $\frac{-q}{a}b$ (4) $-q\frac{a}{b}$

2. If charge given to inner sphere is $+Q$ then energy of system is U_1. Now if $-Q$ charge is given to outer sphere also, energy of system is U_2. What will be potential energy of system if $-Q$ charge is given to outer sphere only (*i.e.* charge on inner sphere is zero).

(1) $U_1 - U_2$ (2) $U_2 - U_1$

(3) $U_1 + U_2$ (4) U_2

3. If charge on outer sphere is Q and inner sphere is earthed then which of the following is a correct statement

(1) Field outside $(r > b)$ is zero

(2) Charge on inner sphere is zero

(3) Field at point between two sphere is zero

(4) None of these

C9. In a experiment current flowing through a cell and potential difference across it's terminal are measured. Following observation table is prepared

S. No.	V (volts)	I (Ampere)
1.	1.2	0.04
2.	0.8	0.12
3.	0.4	0.20

Choose the correct answer :

1. What is emf of cell used in experiment?

(1) 1.5 V (2) 1.4 V

(3) 2 V (4) 2.5 V

2. What is the maximum current that can be withdraw from cell?

(1) 0.25 A (2) 0.28 A

(3) 0.3 A (4) 0.35 A

3. What is the maximum useful power that can be withdrawn from cell?

(1) 50 mW (2) 98 mW

(3) 9.8 mW (4) 49 mW

C10. When a conductor does not have a current through it, it's conduction electrons move randomly. Average velocity of all free electrons in this case is zero. Now when potential difference is applied electrons tend to drift with drift speed V_d in the direction opposite to field. Drift speed in house-hold wiring is approximately 10^{-4} m/s

Expression for drift velocity is given by

$$\vec{V_d} = \frac{-e\vec{E}}{m}\tau$$

Current flowing through a conductor is given by

$I = A.n.e.V_d$

Choose the correct answer :

1. A wire is carrying 2 A current from left to right. Drift speed of electron in conductor is 1 mm/s. A person is moving towards right with 1 mm/s velocity parallel to conductor. Average velocity of electron with respect to this person

(1) 1 mm/s (2) Zero

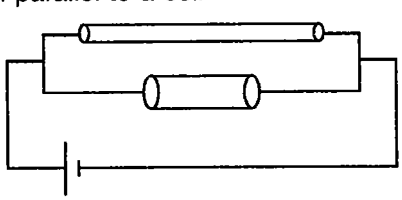
(3) 2 mm/s (4) Can't be said

2. Current through above conductor with respect to moving person

(1) 2 A (2) Zero

(3) 1 A (4) Can't be said

3. Two wires of length ℓ, 2ℓ and area of cross-section A, $2A$ respectively are connected in parallel to a cell

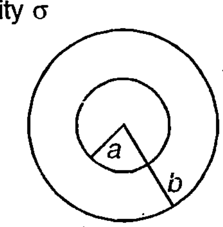


What is the ratio of current density in two wire?

(1) 1 : 2 (2) 2 : 1

(3) 1 : 1 (4) 1 : 4

C11. Two concentric metallic spherical shells of radii a & b are separated by weakly conducting medium of conductivity σ



If they are maintained at a potential difference V, current flows radially outward from inner sphere to outer sphere.

Choose the correct answer :

1. What is resistance between the shells?

(1) $\frac{1}{4\pi\sigma}\left(\frac{1}{a}-\frac{1}{b}\right)$ (2) $\frac{1}{4\pi\sigma}\frac{(a-b)}{ab}$

(3) $\frac{1}{2\pi\sigma}\left(\frac{1}{b-a}\right)$ (4) $\frac{1}{4\pi\sigma}\left(\frac{a+b}{ab}\right)$

2. If there is a sphere of radius R in a weakly conducting medium of conductivity σ, charge on sphere is Q, total current through surface of sphere is

(1) $\frac{Q\sigma}{\varepsilon_0}$ (2) $\frac{2Q\sigma}{\varepsilon_0}$

(3) $\frac{Q\sigma}{2\varepsilon_0}$ (4) $k\,Q\,\sigma$

3. Two identical metal balls are in a weakly conducting medium of conductivity σ at large separation. We connect a battery between the two objects to charge them upto potential difference v_0. If we disconnect the battery, the charge will leak. Now potential difference between balls at any time is given by

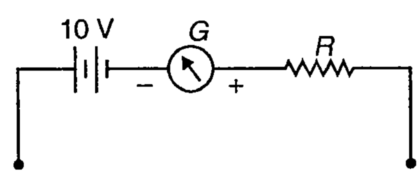
$v = v_0\, e^{-t/\tau}$

Where τ is equal to

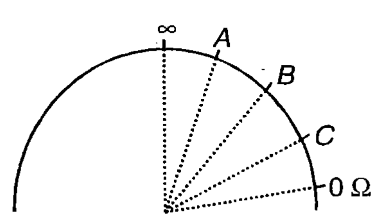
(1) $\frac{\varepsilon_0}{\sigma}$ (2) $\frac{4\pi\varepsilon_0}{\sigma}$

(3) $\frac{2\pi\varepsilon_0}{\sigma}$ (4) $\frac{\pi\varepsilon_0}{\sigma}$

C12. An ohm meter measures the resistance placed between its leads. This resistance reading is indicated by galvanometer which operates on current. The ohm meter has an internal source of voltage to create the necessary current to operate the galvanometer and also has appropriate resistor to allow just right amount of current through galvanometer. A simple ohm meter is shown here.



When there is an infinite resistance, there is zero current through galvanometer and it points in middle. If the test leads of this meter are directly shorted (zero resistance) galvanometer will give full deflection.



Galvanometer specification

Resistance of galvanometer = 100 Ω

Full scale current = 0.5 mA

Total number of division = 40

Choose the correct answer :

1. What is the value of resistance required in series with battery and galvanometer?

(1) 20 kΩ (2) 19.9 kΩ

(3) 19 kΩ (4) 9 kΩ

2. If an unknown resistance is placed between two leads and needle deflects upto *B*, then resistance is equal to

(1) 20 kΩ (2) 10 kΩ

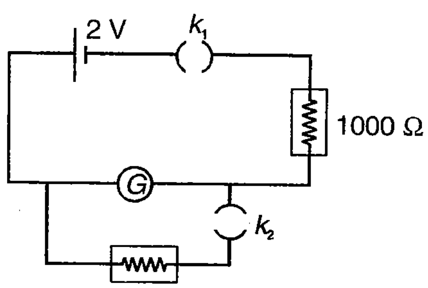
(3) 5 kΩ (4) 25 kΩ

3. If 5 Ω is measured with help of ohm meter, the needle lies between

(1) ∞ & *A* (2) *A* & *B*

(3) *B* & *C* (4) *C* & zero

C13. To convert a galvanometer into a voltmeter, we need to calculate its internal resistance and figure of merit. The electrical arrangement shown can be used for this purpose



Shunt resistance

When k_1 is closed and k_2 is open, galvanometer needle is deflected by 20 divisions which is also full scale deflection. When k_2 is also closed and 100 Ω is taken from shunt resistance, deflection shown by the galvanometer is halved.

Choose the correct answer :

1. Resistance of the galvanometer is approximately

(1) 100 Ω (2) 99 Ω

(3) 111 Ω (4) 121 Ω

2. Figure of merit (inverse of current sensitivity of the galvanometer) is

(1) 9×10^{-5} A/div (2) 9×10^{-4} A/div

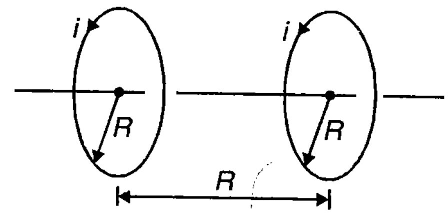
(3) 9×10^{-3} A/div (4) 9×10^{-2} A/div

3. If the galvanometer is to be converted into a voltmeter of range 4.5 V, resistance required to be connected to the galvanometer is

(1) 2400 Ω (2) 2389 Ω

(3) 2401 Ω (4) 2379 Ω

C14. Consider an arrangement of two circular coils each (of radius *R* each) perpendicular to a common axis. Both the coils carry a steady current *i* in the same direction, as shown in the figure. Centres of the coils are separated by distance *R*.



Choose the correct answer :

1. Magnetic field on the axis of the coils at a distance *y* from the center of one of the coils on the line joining centres of the coils is

(1) $\dfrac{\mu_0 i R^2}{2}\left[\dfrac{1}{(R^2+y^2)^{3/2}} - \dfrac{1}{(R^2+y^2-2Ry)^{3/2}}\right]$

(2) $\dfrac{\mu_0 i R^2}{2}\left[\dfrac{1}{(R^2+y^2)^{3/2}} + \dfrac{1}{(R^2+y^2-2Ry)^{3/2}}\right]$

(3) $\dfrac{\mu_0 i R^2}{2}\left[\dfrac{1}{(R^2+y^2)^{3/2}} + \dfrac{1}{(2R^2+y^2-2Ry)^{3/2}}\right]$

(4) $\dfrac{\mu_0 i R^2}{2}\left[\dfrac{1}{(R^2+y^2)^{3/2}} - \dfrac{1}{(2R^2+y^2-2Ry)^{3/2}}\right]$

2. Which of the following is correct for the point mid way between the two coils?

(1) $\dfrac{dB}{dy} = 0, \dfrac{d^2B}{dy^2} > 0$

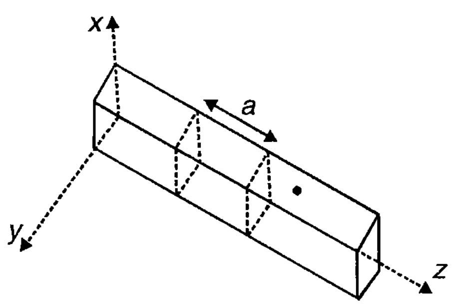
(2) $\dfrac{dB}{dy} = 0, \dfrac{d^2B}{dy^2} = 0$

(3) $\dfrac{dB}{dy} < 0, \dfrac{d^2B}{dy^2} = 0$

(4) $\dfrac{dB}{dy} = 0, \dfrac{d^2B}{dy^2} < 0$

3. Choose the correct alternative
   (1) Magnetic field in the region midway between the coils is zero
   (2) Magnetic field near the centers of both coils is tending to be very small
   (3) Magnetic field in the region midway between the coils is uniform
   (4) Magnetic field near the centers of the coils is uniform

C15. Liquid metal (as liquid sodium) may be used in nuclear reactors to extract out heat from the core of the nuclear reactor. Metal in molten state is circulated through pipes in reactor by pump that uses the force on a moving charge in magnetic field. Such a pump is called electromagnetic pump. Consider a horizontal insulated tube of rectangular cross-section (as shown in the figure) with liquid sodium filled in it, placed along z-axis. If a current of current density $\vec{J}$ is maintained through the metal and a uniform magnetic field $\vec{B}$ is applied in the region (such that $\vec{J}$ and $\vec{B}$ are in x-y plane and $\vec{J} \perp \vec{B}$) liquid starts flowing through the tube. This explains the working of electromagnetic pump.



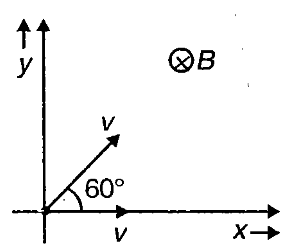
Choose the correct answer :

1. Choose the incorrect alternative
   (1) Magnetic forces acting on conducting fluids is the principle of working of electromagnetic pumps
   (2) Some nuclear reactors use molten sodium as conducting fluid to cool reactor core
   (3) As magnetic forces do no work, fluid flows unaccelerated through the pipe in the arrangement of electromagnetic pump
   (4) If the liquid is prevented from flowing in the tube, an increase in pressure takes place in the fluid

2. For which of the following values of current density (J) and magnetic field ($\vec{B}$), liquid in the tube shown in the diagram flows along positive z-axis? (Here J_0, B_0, B_1, B_2 are positive constants)
   (1) $J = J_0\hat{i}$, $\vec{B} = B_0\hat{i}$
   (2) $J = J_0\hat{i}$, $\vec{B} = B_0\hat{k}$
   (3) $J = J_0\hat{i}$, $\vec{B} = B_1\hat{i} + B_2\hat{j}$
   (4) $J = J_0\hat{i}$, $\vec{B} = B_1\hat{i} - B_2\hat{j}$

3. Shown in the figure are two sections of the tube, separated by distance a. Current density corresponding to the current flowing through the fluid is $J\hat{j}$ and magnetic field in the region is $B\hat{i}$. If the liquid is prevented from flowing, pressure difference between the liquid at the two sections is
   (1) $\frac{JB}{a}$ (2) JBa
   (3) $\frac{Ba}{J}$ (4) $\frac{a}{JB}$

C16. Two identical charged particles (of mass m and having charge q) are simultaneously projected from origin (as shown) with equal speeds v, in a region of transverse magnetic field.



Choose the correct answer :

1. If $\vec{r_1}$ and $\vec{r_2}$ are the position vectors of the particles at time $t = \frac{\pi m}{qB}$ then $\vec{r_1} \cdot \vec{r_2}$ equals
   (1) $\left(\frac{mv}{qB}\right)^2$ (2) $\frac{1}{2}\left(\frac{mv}{qB}\right)^2$
   (3) $2\left(\frac{mv}{qB}\right)^2$ (4) $4\left(\frac{mv}{qB}\right)^2$

2. Magnitude of relative speeds of the particles after they are projected

   (1) Increases

   (2) Decreases

   (3) Remains constant

   (4) First increases, then decreases

3. Magnitude of relative angular momentum of the particles after they are projected

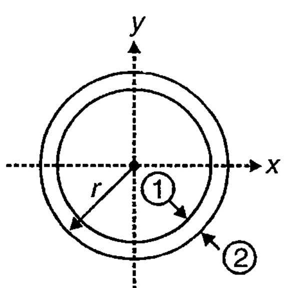
   (1) Increases

   (2) Decreases

   (3) Remains constant

   (4) First increases, then decreases

C17. A particle (of mass m and carrying charge $+q$) is constrained to move in a smooth circular slot of radius r, in x-y plane (as shown in the figure). The space is gravity free and the particle is initially at rest at $(0, r)$. Inner and outer surfaces of the slot are marked 1 and 2 respectively, in the figure. Let N_1 and N_2 represent normal reaction by surfaces 1 and 2 respectively on the particle.



Choose the correct answer :

1. If a uniform magnetic field of strength B is applied along –ve z-direction and particle is imparted velocity $v = \frac{qBr}{m}$ in positive x-direction

   (1) $N_1 = 0, N_2 = 0$

   (2) $N_1 = \frac{qvB}{2}, N_2 = \frac{qvB}{2}$

   (3) $N_1 = qvB, N_2 = 0$

   (4) $N_1 = 0, N_2 = 2qvB$

2. If a uniform magnetic field of strength B is applied in $+z$ direction, and the particle is imparted velocity $v = \frac{qBr}{2m}$ in +ve x-direction

   (1) $N_1 = 0, N_2 = \frac{qvB}{2}$

   (2) $N_1 = \frac{qvB}{2}, N_2 = \frac{qvB}{2}$

   (3) $N_1 = qvB, N_2 = 0$

   (4) $N_1 = 0, N_2 = 2qvB$

3. A uniform magnetic field of strength B is applied in $-z$ direction and a uniform electric field of strength E is applied in negative x-direction, simultaneously. As the particle reaches $(-r, 0)$, $N_1 > N_2$ if

   (1) $E < \frac{2qB^2r}{9m}$ (2) $E > \frac{2qB^2r}{9m}$

   (3) $E < \frac{q^2B^2r}{m}$ (4) $E > \frac{q^2B^2r}{m}$

C18. Consider two parallel electron beams moving in same direction. Cross sectional area of each beam is A, v is speed of electrons in the beam, n is electron concentration in the either beam, r is distance between the two beams, e is electronic charge. Cross-sectional dimension of each beam is small compared to r.

Choose the correct answer :

1. Electric force acting on an element, of length ℓ, chosen in any of the beams is

   (1) $\frac{e^2n^2A^2\ell}{\pi\varepsilon_0 r}$ (2) $\frac{e^2n^2A^2\ell^2}{2\pi\varepsilon_0 r}$

   (3) $\frac{e^2n^2A^2\ell^2}{\pi\varepsilon_0 r}$ (4) $\frac{e^2n^2A^2\ell}{2\pi\varepsilon_0 r}$

2. Magnetic force acting on an element, of length ℓ, chosen in any of the beams is

   (1) $\frac{\mu_0 e^2n^2v^2A\ell}{2\pi r}$ (2) $\frac{\mu_0 e^2n^2v^2A^2\ell}{2\pi r}$

   (3) $\frac{\mu_0 e^2n^2v^2A^2\ell^2}{2\pi r}$ (4) $\frac{\mu_0 e^2n^2v^2A\ell}{4\pi r}$

3. Ratio of magnetic force to electric force, acting on an element of length ℓ in any of the beams is

(1) $\frac{v^2}{c^2}$ (2) $\frac{c^2}{v^2}$

(3) $\frac{2c}{v}$ (4) $\frac{c}{2v}$

C19. **Particle acceleration :** A cyclotron is used to accelerate charged particles to very high speeds. An alternating potential difference increases speed of the charged particle and a magnetic field in transverse direction rotates the particle on a circular path. When the energy of ions in a cyclotron exceeds 20 MeV, relativistic effects dominate. Moving ion no longer remains in phase with applied potential difference. Accelerators with variable frequency of the applied potential difference solve this problem.

A betatron, another particle accelerator, accelerates electron to high energy exploiting electromagnetic induction. Electrons in a vacuum chamber are moved in circular orbits, by a magnetic field perpendicular to the orbital plane. Magnetic field is gradually increased to induce an electric field around the orbit.

Choose the correct answer :

1. Choose the incorrect alternative

(1) A cyclotron is not suitable to accelerate charged particles to very high energies (more than 20 MeV)

(2) In cyclotron, electric and magnetic fields are crossed

(3) Betatron is based on the principle of electromagnetic induction

(4) In betatron, a variable frequency of the applied potential difference keeps electron moving on circular path

2. As magnetic field in a betatron arrangement is changed, induced electric field is such that it will

(1) Speed up an electron rotating in the field

(2) Speed up a positron rotating in the field

(3) May speed up or speed down a positron rotating in the field

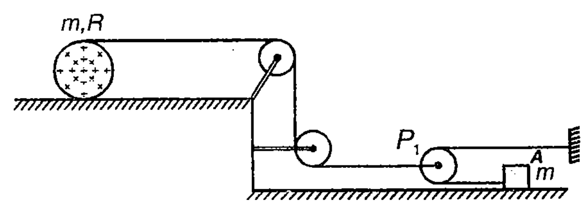
(4) Make a positron gradually stop down

3. Consider an electron, being accelerated by a betatron, rotating in a circle at an instant. Average magnetic field over the area enclosed by the orbit is x. Magnetic field at the circumference of the circle is y. For the radius of orbit of electron to remain unchanged, x and y are related as (Magnetic field is switched on at time $t = 0$ and electron starts from rest)

(1) $x = y$ (2) $x = 2y$

(3) $2x = y$ (4) $x^2 = y$

C20. A solid non-conducting disc of mass m and radius R has total charge Q is uniformly distributed on its surface. A light thin string is wound around the disc is connected to the light pulley P_1 as shown in figure. A block of same mass rest on smooth surface. Now uniform magnetic field given by $B = B_0t$ perpendicular into the plane of paper is switched on. The surface on which disc lies is sufficiently rough to ensure pure rolling. Then



Choose the correct answer

1. Tension in string wound around the disc is

(1) $\frac{4QB_0R}{35}$ (2) $\frac{QB_0R}{35}$

(3) $\frac{4QB_0R}{70}$ (4) $\frac{QB_0R}{20}$

2. Angular acceleration of disc is

(1) $\frac{QB_0}{m}$ (2) $\frac{4QB_0}{35m}$

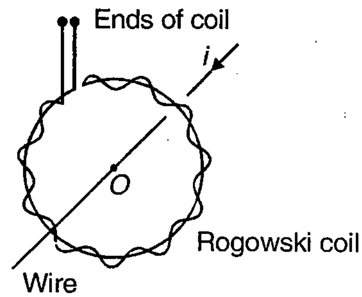
(3) $\frac{QB_0}{70m}$ (4) $\frac{2QB_0}{35m}$

3. Acceleration of block

(1) $\frac{2QB_0R}{35m}$ (2) $\frac{20QB_0R}{7\ m}$

(3) $\frac{4QB_0R}{41\ m}$ (4) $\frac{4QB_0R}{35\ m}$

C21. **Rogowski coil :** The coil shown in the figure, called Rogowski coil, is used in electrical measurements. The coil consists of a toroidal conductor wrapped around a circular return cord. The coil can be used to measure amplitude of alternating current or value of direct current in a wire. The coil is simply clipped around the wire. Measured value of emf across the ends of the coil gives value of current amplitude, in case a.c. is flowing through the wire. To measure direct current, ends of the coil are connected to ballistic galvanometer. Current in the wire is switched off and amount of charge crossing the loop is measured by the ballistic galvanometer. This value of charge is used to calculate value of direct current in the wire.



Choose the correct answer :

1. Number of turns per unit length of the coil, area of each loop in the coil, current flowing through the wire are n, S and $i_0 \sin\omega t$ respectively. Maximum e.m.f. induced in the coil is

(1) $nS\mu_0 i_0\omega$ (2) $\frac{nS\mu_0 i_0\omega}{2}$

(3) $nS\mu_0 i_0^2\omega$ (4) $\frac{nS\mu_0 i_0^2\omega}{2}$

2. Number of turns per unit length of the coil, area of each loop in the coil, resistance of the coil, are n, S and R respectively. Current flowing through the wire crossing the plane of the coil is i. A ballistic galvanometer is connected across the ends of the coil and the current is switched off, charge that flows through the coil is measured to be Q. The correct relation is

(1) $\frac{\mu_0 nSi}{QR} = 1$ (2) $\frac{\mu_0 nSi}{QR} = 2$

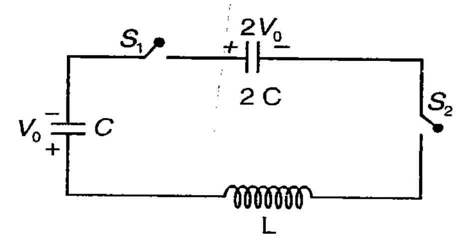
(3) $\frac{\mu_0 nSi}{QR} = \frac{1}{2}$ (4) $\frac{\mu_0 nSi}{Q^2R} = 1$

3. Consider two current carrying wires carrying currents i_1 and i_2 in opposite directions. Both the wires are perpendicular to the plane of the coil. Wire carrying currents i_1 and i_2 are respectively at a distance 0.5 r and 1.5 r from the centre of the coil. Reading of ballistic galvanometer depends on

(1) i_1 (2) $i_1 - i_2$

(3) $\frac{i_1}{2}$ (4) $\frac{i_1 - i_2}{2}$

C22. Two capacitors of capacitance C and $2C$ are charged to potential difference V_0 and $2V_0$ respectively and connected to an inductor of inductance L as shown in figure. Now the switches S_1 and S_2 are closed at $t = 0$ s.



Choose the correct answer

1. Potential difference across capacitor of capacitance C when current in the circuit is maximum

(1) V_0 (2) $2V_0$

(3) $\frac{3}{2}V_0$ (4) $\frac{4}{3}V_0$

2. Charge on capacitor of capacitance $2C$ when current in the circuit is maximum

(1) $\frac{8}{3}CV_0$ (2) $4CV_0$

(3) $3CV_0$ (4) $2CV_0$

3. Maximum current in the inductor is

(1) $V_0\sqrt{\frac{C}{L}}$ (2) $V_0\sqrt{\frac{2C}{L}}$

(3) $V_0\sqrt{\frac{L}{C}}$ (4) $V_0\sqrt{\frac{6C}{L}}$

C23. An alternating current whose instantaneous value is given as $i = 5\sin\left(1000t - \frac{\pi}{6}\right)$ flows through a series combination of a coil and a resistor. The resistor has a resistance of 90 Ω. The total voltage across the combination leads current by $\frac{\pi}{4}$ and inductance of the coil is 0.1 H.

Choose the correct answer :

1. The voltage drop across the resistor is given as

(1) $450\sin 1000t$

(2) $450\sin\left(1000t-\frac{\pi}{6}\right)$

(3) $450\sqrt{2}\sin(1000t)$

(4) $450\sqrt{2}\sin\left(1000t-\frac{\pi}{6}\right)$

2. The resistance of the coil is

(1) 10 Ω (2) 20 Ω

(3) 30 Ω (4) Zero

3. The voltage drop across the coil is

(1) 500 V (2) 550 V

(3) $50\sqrt{101}$ V (4) $50\sqrt{202}$ V

C24. When a device X is connected across 220 V, $\frac{50}{\pi}$Hz alternating supply, the voltage leads current by $\frac{\pi}{3}$. When a device Y is connected across the same supply, the current leads voltage by $\frac{\pi}{6}$. Now both the devices are connected in series across the same supply.

Choose the correct answer :

1. The device X can be

(1) An inductor

(2) A capacitor

(3) A resistor

(4) A series combination of inductor and resistor

2. Let the two devices have same resistance. The voltage across the series combination is V and current is i. Select the current alternative

(1) V and i are in phase

(2) V leads i by $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$

(3) i leads V by $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$

(4) V leads i by $\frac{\pi}{6}$

3. The device Y cannot be

(1) A pure inductor

(2) A pure capacitor

(3) A combination of L, C and R

(4) Both (1) & (2)

C25. An ac generator with an adjustable frequency is connected to an inductor L, capacitor C (= 5.50 μF) and a variable resistor R. When R is 100 Ω, the amplitude of the current produced in the circuit by the ac generator is half of its maximum possible value. This situation occurs at two different frequencies of generator viz 1.30 kHz and 1.50 kHz.

Choose the correct answer :

1. The inductance L of the circuit is

(1) 2.35 mH

(2) 4.70 mH

(3) 1.175 mH

(4) 9.40 mH

2. The phase difference between voltage and current in the above mentioned situation is

(1) $\frac{\pi}{4}$ (2) $\frac{\pi}{6}$

(3) $\frac{\pi}{3}$ (4) $\frac{\pi}{2}$

3. The resonance frequency for the circuit is

(1) 1.30 Hz

(2) 1.50 Hz

(3) $\sqrt{1.30\times1.50}$ Hz

(4) $\frac{(1.30+1.50)}{2}$ Hz

❑ ❑ ❑

SECTION - D

Assertion - Reason Type

This section contains 74 questions. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Instructions for Assertion - Reason Type questions :

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

1. STATEMENT-1 : When two charged spherical shells are connected to each other, loss of electrostatic potential energy may take place.

   and

   STATEMENT-2 : Energy density is given by $\frac{1}{2}\varepsilon_0 E^2$ and E will decrease at all points during sharing of charges.

2. STATEMENT-1 : Two spheres A and B are having charges Q and zero. It is impossible to transfer whole charge of A to B.

   and

   STATEMENT-2 : Transfer of charge cannot take place by itself from lower potential to higher potential.

3. STATEMENT-1 : If a dielectric is placed in external field then field inside dielectric will be less than applied field.

   and

   STATEMENT-2 : Electric field will induce dipole moment opposite to field direction.

4. STATEMENT-1 : Acceleration of charged particle in non-uniform electric field does not depend on velocity of charged particle.

   and

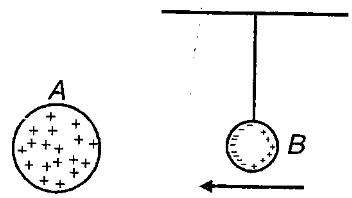
   STATEMENT-2 : Charge is an invariant quantity, that is, amount of charge on particle does not depend on frame of reference.

5. STATEMENT-1 : Electric field does not remain continuous when we cross a surface charge.

   and

   STATEMENT-2 : Then normal component of E field changes by amount $\frac{\sigma}{\varepsilon_0}$ at any boundary.

6. STATEMENT-1 : An uncharged dielectric sphere B in radial field of a positive charge A moves towards sphere A.



   and

   STATEMENT-2 : As ball B goes closer to ball A, potential energy decreases.

7. STATEMENT-1 : Potential at the surface of a solid metallic sphere may be non-zero, even if net charge on the surface is zero.

   and

   STATEMENT-2 : If potential at the centre of a solid metallic sphere is non-zero, potential at the surface of the sphere is non-zero.

8. STATEMENT-1 : Potential energy of a system of point charges may be zero.

   and

   STATEMENT-2 : Potential energy of individual point charges in a system of point charges may be zero.

9. STATEMENT-1 : Capacitance of a system of two conductors at finite separation, separated by some insulating medium, depends on geometry of the conductors and properties of insulating medium separating the conductors.

   and

   STATEMENT-2 : Capacitance of a capacitor does not depend on charge stored by the capacitor

10. STATEMENT-1 : Capacitance of a parallel plate capacitor increases if a metallic ball is introduced in between the plates of the capacitor.

and

STATEMENT-2 : For same charge stored by the plates of capacitor, electrostatic potential energy of the system is more if a metallic ball is introduced in between plates of the capacitor.

11. STATEMENT-1 : A test charge can be brought from infinity to a point in electric field due to dipole such that no work has to be done by external force on it for any part of its displacement.

and

STATEMENT-2 : Potential at any point on equatorial line of dipole is zero.

12. STATEMENT-1 : Electric field intensity at a point in space can be determined if electric potential at the point is known.

and

STATEMENT-2 : If electric potential at a distance r from a point charge is V, magnitude of electric field intensity at the point is $\frac{|V|}{r}$

13. STATEMENT-1 : A high-voltage dc power line (11,000 V w.r.t. ground) falls on a car, such that entire body of car is at 11,000 V with respect to the ground. Occupants of the car are safe while they are sitting in the car, but get fatal shock as they step out of the car.

and

STATEMENT-2 : Electric field inside metal is zero.

14. STATEMENT-1 : A metallic sphere is to be charged by bringing in positive charge, a little at a time, until total charge on the sphere is Q. Total work required for the process is proportional to Q^2.

and

STATEMENT-2 : Energy of isolated metallic sphere $= \frac{Q^2}{8\pi\varepsilon_0 R}$

15. STATEMENT-1 : Capacitance of a capacitor having liquid dielectric may decrease if temperature of the dielectric is increased.

and

STATEMENT-2 : For liquid dielectrics having polar molecules dielectric constant decreases with rise in temperature.

16. STATEMENT-1 : In electronics it is customary to define the potential of ground (thinking of earth as a large conductor).

and

STATEMENT-2 : Total charge on earth is zero.

17. STATEMENT-1 : Electrostatic energy for a system of charges does not obey the principle of superposition.

and

STATEMENT-2 : Electrostatic potential energy density is proportional to square of magnitude of electric field intensity.

18. STATEMENT-1 : No work may be required to separate a charged mercury drop into two smaller drops.

and

STATEMENT-2 : Surface energy of drop increases at the expense of electric potential energy.

19. STATEMENT-1 : Motion of a charged particle in non-uniform electric field can be helical.

and

STATEMENT-2 : Electric field due to a long uniform line charge distribution is cylindrically symmetric.

20. STATEMENT-1 : A charged particle may not move along electrostatic field lines, even if it starts from rest.

and

STATEMENT-2 : Charge is always associated with mass.

21. STATEMENT-1 : Energy stored in a charged Leclanche cell does not leak to surroundings.

and

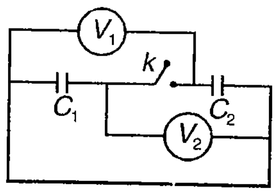
STATEMENT-2 : Electric field at any point near electrode of cell (outside cell) is zero.

22. STATEMENT-1 : When a soap bubble is charged excess pressure inside decreases.

and

STATEMENT-2 : Surface tension of soap solution decreases.

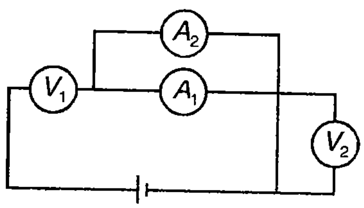
23. STATEMENT-1 : Consider the circuit shown. Capacitor marked C_1, is uncharged. Capacitor marked C_2 is charged. Voltmeter marked V_1 is ideal, while the voltmeter marked V_2 is not ideal. As the key k is closed both voltmeters give the same reading.



and

STATEMENT-2 : Both the voltmeters are in parallel, after the key k is closed.

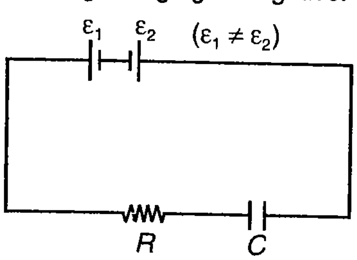
24. STATEMENT-1 : Consider an arrangement of voltmeters (identical) and ammeters (identical) connected to a battery as shown. The instruments are not ideal. The cell is ideal. Resistance of voltmeter can be determined using the circuit, even if the battery is unknown.



and

STATEMENT-2 : If potential difference across any branch in a circuit is known and current through the branch is known, resistance of the branch can be determined using Ohm's law.

25. STATEMENT-1 : A capacitor is charged using the arrangement shown here. Work done by one of the batteries during charging is negative.



and

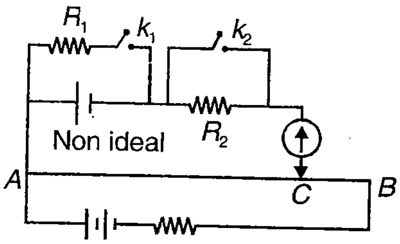
STATEMENT-2 : The battery of lower emf also gets charged as the capacitor is being charged.

26. STATEMENT-1 : It is possible that energy stored by a capacitor may decrease after it is connected to a battery.

and

STATEMENT-2 : During redistribution of charge on a capacitor, heat is generated in the connecting wires.

27. STATEMENT-1 : Consider the arrangement of potentiometer shown. Null point is obtained at point C, with keys k_1 open and k_2 closed. If the key k_1 is closed and k_2 is open, the null point will shift from C towards end A.



and

STATEMENT-2 : As key k_2 is opened resistance R_2 which was shorted, is no more shorted.

28. STATEMENT-1 : In free electron model of conduction in metals, resistivity of metals is proportional to $\sqrt{T}$, where T is the temperature in Kelvins.

and

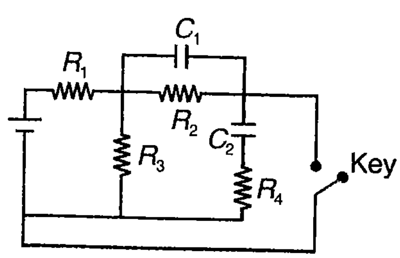
STATEMENT-2 : In free electron model of conduction in metals, electron (assumed to be existing as free electron cloud) have speed proportional to $\sqrt{T}$.

29. STATEMENT-1 : Using a potentiometer circuit, only emf of cells with emf less than emf of the driver cell might be measured.

and

STATEMENT-2 : Potential difference between the ends of a potentiometer wire cannot be greater than emf of the driver cell. A null point will not be obtained if the cell to be known has emf greater than the driver cell.

30. STATEMENT-1 : Charge stored (in steady state) by capacitor C_2 does not depend on C_1 if the key is open, but it depends on C_1 if the key is closed.



and

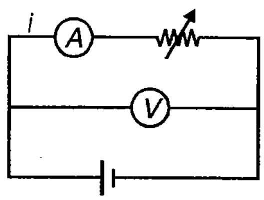
STATEMENT-2 : Only if the key is closed, part of energy supplied by battery into the circuit, is taken up by capacitor C_1.

31. STATEMENT-1 : An electrical bulb starts glowing instantly as it is switched on.

    and

    STATEMENT-2 : Drift speed of electrons in a metallic wire is very large for metallic conductors.

32. STATEMENT-1 : In the arrangement shown, meters are ideal. Internal conductance of the cell can be measured by varying the load resistance and taking readings of ammeter and voltmeter.



    and

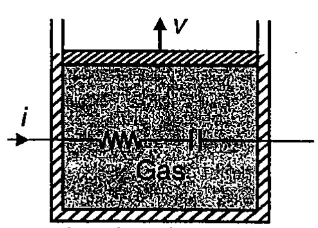
    STATEMENT-2 : If a graph is plotted between reading of voltmeter (V) and reading of ammeter (A), it is a straight line. Conductance of the battery will be ratio of y-intercept of the graph to the x-intercept.

33. STATEMENT-1 : Temperature coefficient of resistance is negative for p-type semiconductors, while it is positive for conductors.

    and

    STATEMENT-2 : Effective charge carriers in conductors are negatively charged, whereas in p-type semiconductors they are positively charged.

34. STATEMENT-1 : For the gas to remain at constant temperature in the arrangement shown, the piston (massless and frictionless) is moved with variable speed v. It is sure that $\frac{dv}{dt}$ is negative.



Insulated vessel

    and

    STATEMENT-2 : As the gas expands, pressure of gas reduces and speed of the piston is reduced.

35. STATEMENT-1 : For a cylindrical conductor AB of uniform cross-section, the resistivity of material of wire increases linearly from end A to end B. Magnitude of electric field intensity also increases from end A to end B, whatever may be the direction of current flow in the wire.

    and

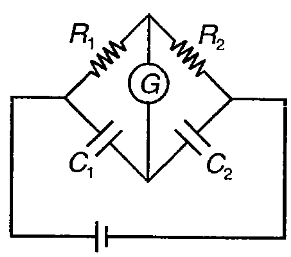
    STATEMENT-2 : For a current carrying wire of uniform cross-section, electric field at any section of wire is proportional to local resistivity of the wire.

36. STATEMENT-1 : Change in charge on any of the plates of the capacitors is x in time interval t. Change in charge on the plate of the capacitor in next time interval t will be lesser than x, irrespective of whether the capacitor is being charged or discharged.

    and

    STATEMENT-2 : In both charging and discharging RC circuits, current in the circuit decreases with time.

37. STATEMENT-1 : Deflection of the galvanometer needle shown in the circuit may or may not be zero.



    and

    STATEMENT-2 : No current passes through the galvanometer branch in the circuit if $R_1C_1 = R_2C_2$.

38. STATEMENT-1 : A high tension supply, say 11 kV, must have a very high internal resistance.

    and

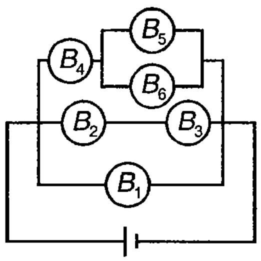
    STATEMENT-2 : If a high tension supply is accidentally shorted, current drawn will exceed safety limits, if internal resistance is not large.

39. STATEMENT-1 : Two bulbs rated to operate at voltage V are connected in series across the voltage V. The bulb with lower power rating glows more brightly.

    and

    STATEMENT-2 : Voltage drop across the bulb with lesser power rating in the arrangement is lesser than V.

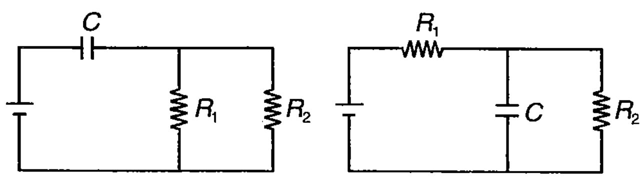
40. STATEMENT-1 : Six identical bulbs are arranged in a circuit as shown. Bulb marked B_4 glows brighter than bulb marked B_3.



and

STATEMENT-2 : Current through bulb marked B_4 is more than the current through the bulb marked B_3.

41. STATEMENT-1 : Time constants of the circuits shown in the figure are same.



and

STATEMENT-2 : Instantaneous current through the capacitor branch is same at any instant for both the circuits, if batteries are inserted in the circuits at $t = 0$.

42. STATEMENT-1 : A beam of electrons (being emitted from an electron gun) is accelerated by a uniform electric field, such that area of cross-section of the beam is constant. As beam moves away from the gun, the current increases as speed of the electrons increases.

and

STATEMENT-2 : Current is related to speed of electrons (v) as $i = neAv$, n = number density of electrons, e = electronic charge, A = Area of cross-section of beam, v = Speed of electrons.

43. STATEMENT-1 : Consider an arrangement of three parallel wires, so that in cross-sectional view they are at corners of an equilateral triangle. There is no way to arrange currents in the wires, so that all the three wires attract each other.

and

STATEMENT-2 : Net force on a wire may be zero due to symmetry of the arrangement.

44. STATEMENT-1 : When a current is passed through a vertical spring coil made up of conducting material its elastic potential energy must increase.

and

STATEMENT-2 : When a current is passed through a spring coil made up of conducting material it tends to contract.

45. STATEMENT-1 : Magnetic field at the centre of a current carrying loop is greater than that at any other point in the plane of the loop.

and

STATEMENT-2 : Magnetic field lines have greatest density in the plane of a current carrying loop near the centre of the loop.

46. STATEMENT-1 : A charged particle may or may not accelerate in a region containing both electric and magnetic field.

and

STATEMENT-2 : Force due to magnetic field on a charge may or may not be zero depending on its direction of motion.

47. STATEMENT-1 : Magnetic moment of a given current carrying flexible loop does not depend on its shape.

and

STATEMENT-2 : Magnetic moment is $\vec{M} = I\vec{A}$ for a loop carrying current I and having area vector $\vec{A}$.

48. STATEMENT-1 : Consider a current carrying loop (placed in a region of uniform magnetic field) in the position of stable equilibrium. If the loop is rotated from this position by angle θ ($\theta < 45°$) then loop oscillates simple harmonically.

and

STATEMENT-2 : When a current carrying loop is rotated from its stable equilibrium position by angle θ($\theta < 45°$) a restoring torque (towards the initial position) acts on the loop.

49. STATEMENT-1 : $\oint \vec{B}.\vec{d\ell}$ for a closed Amperian loop of any shape is zero, if no net charge is crossing the loop.

and

STATEMENT-2 : $\oint \vec{B}.\vec{d\ell} = \mu_0 i$, where i is the current crossing the Amperian loop, according to Ampere's circuital law.

50. STATEMENT-1 : An electron is moving parallel to a long current carrying wire at an instant. If the electron is seen from a system, moving with same velocity as electron's, force on the electron is zero.

and

STATEMENT-2 : Magnetic force on electron is zero, as it is stationary with respect to system moving with same velocity as the electron.

51. STATEMENT-1 : A wire carrying no current, when placed in a magnetic field experiences no force.

and

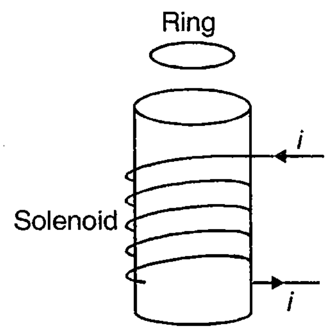
STATEMENT-2 : An electron in the wire does not experience any magnetic force.

52. STATEMENT-1 : It does not take energy to set up a magnetic field in a region.

and

STATEMENT-2 : Magnetic field does not do any work.

53. STATEMENT-1 : If a solenoid is wound around an iron core, a metal ring is placed on the top and current through the solenoid is switched on, then the ring may jump several feet in the air.

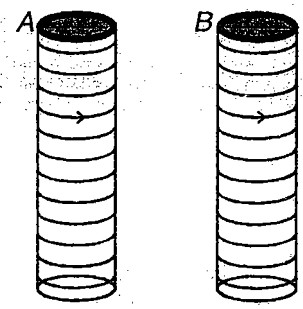


and

STATEMENT-2 : Sudden change of flux through the ring leads to induced current in the opposite direction (to as in the solenoid), leading to repulsion between the solenoid and the ring.

(IIT-JEE 2009)

53(a) Two metallic rings A and B, identical in shape and size but having different resistivities ρ_A and ρ_B, are kept on top of two identical solenoids as shown in the figure. When current I is switched on in both the solenoids in identical manner, the rings A and B jump to heights h_A and h_B, respectively, with $h_A > h_B$. The possible relation(s) between their resistivities and their masses m_A and m_B is(are)



(1) $\rho_A > \rho_B$ and $m_A = m_B$

(2) $\rho_A < \rho_B$ and $m_A = m_B$

(3) $\rho_A > \rho_B$ and $m_A > m_B$

(4) $\rho_A < \rho_B$ and $m_A < m_B$

54. STATEMENT-1 : A time varying magnetic field can be used to speed up a charged particle.

and

STATEMENT-2 : A time varying magnetic field produces an electric field, due to which charged particle may have tangential acceleration.

55. STATEMENT-1 : A charged particle entering a region of uniform magnetic field from a field free region cannot complete a closed path.

and

STATEMENT-2 : Angle of entrance equals angle of emergence for the charged particle if the particle returns to the same side of the region.

56. STATEMENT-1 : Pairs of conductors carrying current into and out of the power supply components of electronic equipments are sometimes twisted together.

and

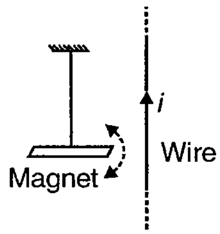
STATEMENT-2 : Pairs of wires, twisted together, carrying current in equal and opposite directions oppose each others magnetic effects.

57. STATEMENT-1 : Coil of a ballistic galvanometer is wound on a non-metallic frame.

and

STATEMENT-2 : The moving system in a ballistic galvanometer should have least possible electrical resistance.

58. STATEMENT-1 : A short bar magnet placed horizontally in magnetic meridian is suspended by a vertical string. A straight conducting wire is also placed in the magnetic meridian. The magnet oscillates, if disturbed, with certain time period. If current i starts flowing in wire, the time period of oscillation may increase or decrease depending upon the direction of current in the wire.



and

STATEMENT-2 : Time period of oscillation of magnet depends on the magnetic field at the location of the magnet.

59. STATEMENT-1 : When an iron or toaster is unplugged, a spark may be seen, while when they are plugged in no spark is seen.

and

STATEMENT-2 : Electromagnetic induction tries to keep the current going in the circuit even if it has to jump the gap in the circuit.

60. STATEMENT-1 : A short cylindrical bar magnet is dropped down a vertical aluminium pipe of slightly larger diameter and of length several meters. It takes several seconds to emerge at the bottom, whereas an unmagnetized iron takes a fraction of a second.

and

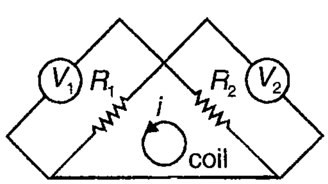
STATEMENT-2 : Eddy currents are generated in aluminium pipe which dampen the motion of bar magnet.

61. STATEMENT-1 : Inductance plays same role in the electrical circuits as mass plays in the mechanical circuits.

and

STATEMENT-2 : Greater the value of inductance, harder it is to change the current in the circuit.

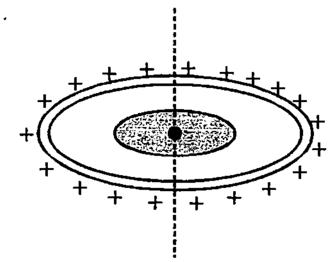
62. STATEMENT-1 : Consider the arrangement shown. The coil is carrying variable current i. Readings of the voltmeters V_1 and V_2 may be different.



and

STATEMENT-2 : Induced electric field is non-conservative in nature.

63. STATEMENT-1 : A horizontal rim of a wheel is free to rotate about a vertical axis. A line charge is glued onto the rim of the wheel. The shaded central region has a uniform magnetic field pointing in vertical direction. If the field is switched off, the wheel starts rotating with certain angular speed which does not depend on how fast or slow the field is switched off.



and

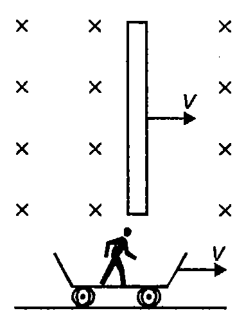
STATEMENT-2 : Induced electric field due to a time varying magnetic field does not depend on time taken to change magnetic field.

64. STATEMENT-1 : A sheet of copper is placed between the poles of an electromagnet, so that the magnetic field is perpendicular to the sheet. Force is required only if the sheet has to be pulled out with increasing speed.

and

STATEMENT-2 : Force required to pull out a copper sheet out of magnetic field increases with speed with which the sheet is pulled out.

65. STATEMENT-1 : A conductor is moving through a uniform transverse magnetic field as shown. In a reference frame, moving with same velocity as the conductor, the conductor is at rest and hence no e.m.f. is induced in the rod.



Reference frame

and

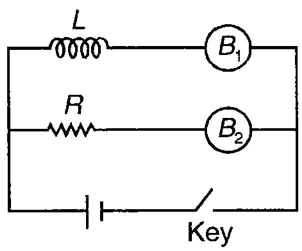
STATEMENT-2 : In a reference frame, if an electron is at rest, magnetic force experienced by the electron is zero.

66. STATEMENT-1 : In small sized transformers, oxides of iron called ferrites are used as core.

and

STATEMENT-2 : Ferrites are ferromagnetic materials having high resistivity and hence they minimize eddy current losses.

67. STATEMENT-1 : Initially there is no current in the circuit. Key is closed at time $t = 0$. Bulb B_1 glows gradually, while bulb B_2 glows instantly. At time t, the key is switched off. Bulb B_1 dies gradually, while bulb B_2 dies instantly.



and

STATEMENT-2 : Inductor opposes any change in magnetic flux and hence change in current through it.

68. STATEMENT-1 : Induced e.m.f. in an inductor may be non-zero, even if the current through it is zero.

and

STATEMENT-2 : For alternating sinusoidal current, passing through an inductor, voltage across inductor and current are completely out of phase.

69. STATEMENT-1 : Two air-filled inductors (assumed non-ideal) may have different time constants, even if they have identical geometrical construction.

and

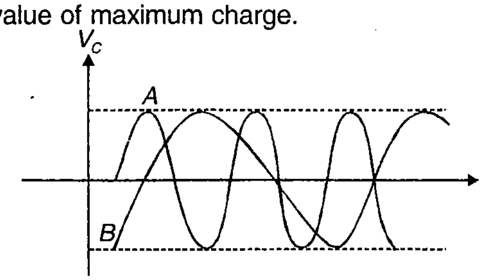
STATEMENT-2 : Two air-filled inductors having identical geometrical construction may have different self inductances, if made up of wires of different radii.

70. STATEMENT-1 : Equivalent inductance of two inductors in series may be greater or lesser than sum of the individual inductances of the inductors.

and

STATEMENT-2 : Non-ideal inductors have some resistance associated with them and so potential difference across an inductor may be greater or lesser than $L\frac{di}{dt}$ (where L is inductance of the inductor and $\frac{di}{dt}$ is associated rate of change of current through the inductor).

71. The following graph shows the variation of capacitor voltage V_C for two LC circuits A and B. The two circuits contain identical capacitors and same value of maximum charge.

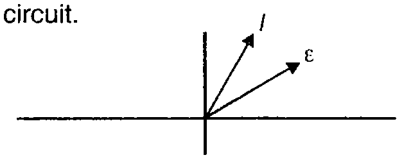


STATEMENT-1 : The circuit A has a greater inductance than circuit B.

and

STATEMENT-2 : The frequency of oscillations of charge in $f = \frac{1}{2\pi\sqrt{LC}}$. So lesser frequency means higher inductance for same capacitance.

72. The following figure shows the phasor for a series LCR circuit.



STATEMENT-1 : In the given circuit, the driving angular frequency is greater than resonant angular frequency.

and

STATEMENT-2 : At resonant angular frequency, current and e.m.f. are in phase with each other.

73. In a series LCR circuit, the voltage leads current.

STATEMENT-1 : To increase the energy transferred to the resistive load, either the capacitance or the inductor should be decreased.

and

STATEMENT-2 : When voltage leads current, X_L is greater then X_C. To increase power transferred, current should be increased which is possible by decreasing the difference between X_L and X_C.

74. A resistive load is connected to an alternating e.m.f. device. The resistance of load is greater than the device.

STATEMENT-1 : To increase the power transmitted to the resistive load, a step-up transformer is connected between them.

and

STATEMENT-2 : The power transmitted is maximum when load resistance is equal to resistance of source. This can be achieved by a step up transformer which will decrease the apparent resistance of load.

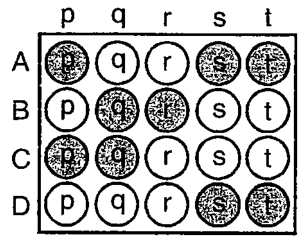
❑ ❑ ❑

SECTION - E

Matrix-Match Type

This section contains 31 questions. Each question contains statements given in two columns which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **One OR More** statement(s) in **Column II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example :

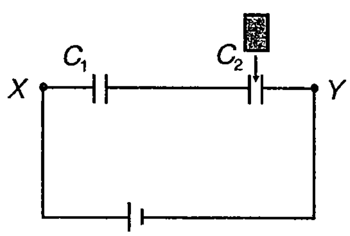
If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.



1. A dipole is placed at point A at a large distance r from centre O of earthed metal sphere whose radius is R ($R < r$). Angle of dipole moment is θ_1 with radius vector OA. Now dipole is rotated from $\theta = \theta_1$ to $\theta = \theta_2$.

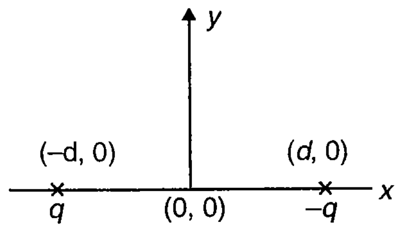
Column I	Column II
(A) $\theta_1 = 0$ to $\theta_2 = 90°$	(p) Electrons flow from earth to sphere
(B) $\theta_1 = 180°$ to $\theta_2 = 0°$	(q) Electrons flow from sphere to ground
(C) $\theta_1 = 60°$ to $\theta_2 = 120°$	(r) There is no flow of net charge from sphere to ground
(D) $\theta_1 = 90°$ to $\theta_2 = -90°$	(s) Work done in process is zero
	(t) Work done in the process is non-zero

2. Two identical capacitors are connected in series. Now a dielectric of dielectric constant K is introduced to fill gap between plates of second capacitor by introducing a dielectric slab.



Column I	Column II
(A) Electric field between plates of first capacitor	(p) Increases
(B) Force between plates of second capacitor	(q) Decreases
(C) Potential difference between points X and Y	(r) Constant if $C_1 = C_2$
(D) Ratio of energy stored in first capacitor and second capacitor	(s) Constant if $C_1 = kC_2$
	(t) Unpredictable

3. Two point charges q and $-q$ are placed on x-axis at $(-d, 0)$ and $(d, 0)$ respectively as shown in figure. Match the proper entries from column-II to column-I.



Column I	Column II
(A) Consider plane $a^2 \le y^2 + z^2 \le b^2$ $(a >> d)$	(p) $\vec{E}$ is directed along + x-axis
(B) Consider plane $a^2 \le x^2 + y^2 \le b^2$ $(a >> d)$	(q) $\vec{E}$ is directed along – x-axis
(C) Along line $x = 0$	(r) V is zero
(D) Along line $y = 0$	(s) Flux is $\frac{qd}{\varepsilon_0}\left(\frac{1}{a}-\frac{1}{b}\right)$
	(t) Flux is zero

4. A dipole of dipole moment p_0 is placed at origin. Direction of dipole moment is towards positive x-axis. Assuming potential energy of dipole to be zero when $\vec{p} \perp \vec{E}$, match the columns

Column I	Column II
(A) Energy of a dipole $p\hat{i}$ will be zero if it is placed at	(p) $(a, 0, a\sqrt{2})$
(B) Torque on a dipole $p\hat{j}$ will be maximum if it is placed at	(q) $(a, a\sqrt{2}, 0)$
(C) y component of electric field is zero at	(r) $(a, 0, 0)$
(D) Torque on a dipole $p\hat{i}$ will be zero at	(s) $(0, 0, a)$
	(t) $(0, a, 0)$

5. I vs t curves for two series R-C circuits are given, in figure (a) and figure (b). The capacitors are initially uncharged and battery is connected at $t = 0$. Figure (a) corresponds to RC circuit with resistance and capacitance R and C respectively. Figure (b) corresponds to RC circuit with resistance and capacitance R' and C' respectively. Column I gives various relations and column II gives possible values of R' and C'. Match respectively.

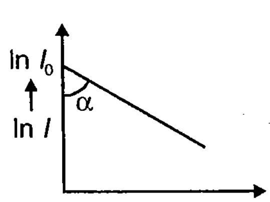


Figure (a)

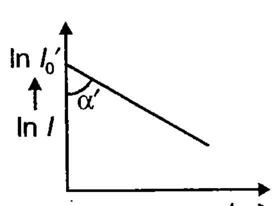


Figure (b)

Column I	Column II
(A) $\alpha' > \alpha$	(p) $C' = C, R' = 2R$
(B) $\alpha' < \alpha$	(q) $C' = 2C, R' = R$
(C) $I'_0 > I_0$	(r) $C' = \frac{C}{4}, R' = 2R$
(D) $I'_0 < I_0$	(s) $C' = 4C, R' = \frac{R}{2}$
	(t) $C' = \frac{C}{8}, R' = 2R$

6. An R-C series circuit is charged in two ways. In first case, it is connected to the terminals of a cell of emf $2E$. In second case, it is connected to the terminals of a cell of emf E. After getting fully charged with E, it is connected to cell of emf $2E$ and charged till saturation. In second case as compared to first case

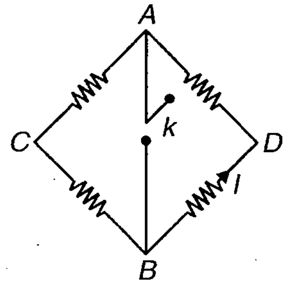
Column-I	Column-II
(A) Saturation charge on capacitor	(p) Increases if the cells are ideal
(B) Maximum energy stored in capacitor	(q) Decreases if the cells are ideal
(C) Energy supplied by cell(s)	(r) Remains same if the cells are ideal
(D) Heat generated in resistor	(s) Does not change if the cells are non-ideal
	(t) Increases if the cells are ideal

7. Column I enlists some cases of capacitors and column II enlists nature of energy density. Match column I with column II

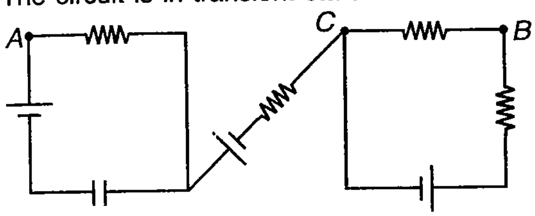
Column-I	Column-II
(A) Energy density between plates of a parallel plate capacitor	(p) Zero
(B) Energy density between the shells of a spherical capacitor when inner sphere is given a charge $-q$ and outer shell is earthed.	(q) Non-zero
(C) Energy density between the shells of a spherical capacitor when outer shell is given a charge $+q$ and inner shell is earthed.	(r) Uniform
(D) Energy density outside the outer shell in the arrangement described in part (C) above	(s) Non-uniform
	(t) Non-negative

8. Column I gives some electrical circuits, with points A and B indicated in the circuit. Column II gives possible values of potential difference between the points $V_A - V_B$ and $V_B - V_C$. Match appropriately.

Column I	Column II
(A) Current I in branch BD does not change, even if key k is closed	(p) $V_A - V_B = 0$

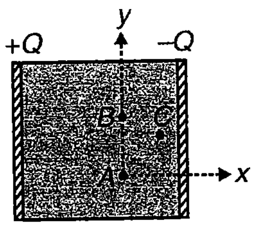


(B) The circuit is in transient state



(q) $V_A - V_B$ = Positive

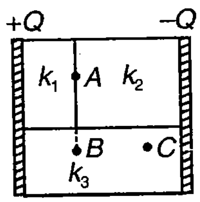
(C) Dielectric constant of dielectric is varying with y



(capacitor with dielectric)

(r) $V_A - V_B$ = Negative

(D) Space between capacitor plates is filled with three dielectric slabs of different dielectric constants ($k_1 \neq k_2 \neq k_3$)



(s) $V_B - V_C = 0$

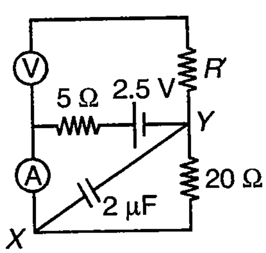
(t) $V_B - V_C$ = Positive

9. Column I gives some electrical circuits in steady state. Column II gives some statements regarding the circuits. Match appropriately.

Column I

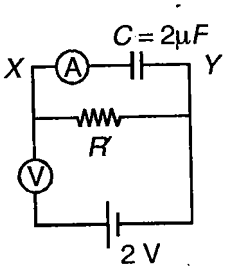
Column II

(A)

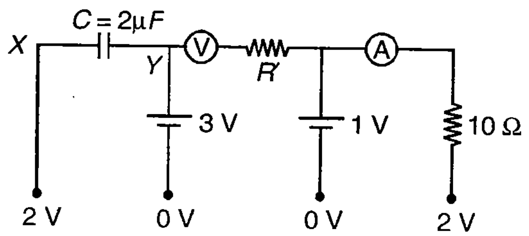


(p) Reading of voltmeter is 2 V

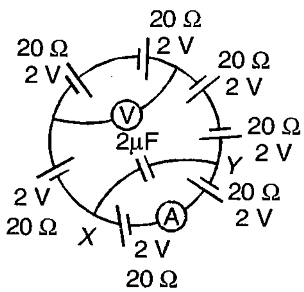
(B)



(q) Reading of ammeter is 0.1 A

(C) 

(r) Current through R' is zero

(D) 

(s) Charge on capacitor is 2 μC

(t) Point marked Y is at lower potential relative to point marked X

10. In column I, some physical quantities are given for a current carrying conductor. These quantities depend on the parameters given in column II. Match appropriately.

Column I

(A) Electrical conductivity

(B) Thermal energy generated in a unit volume of conductor

(C) Current density in a current carrying wire

(D) Current through a conductor for a given potential difference

Column II

(p) Length of conductor

(q) Electric field in conductor

(r) Temperature of conductor

(s) Nature of conductor

(t) Area of conductor

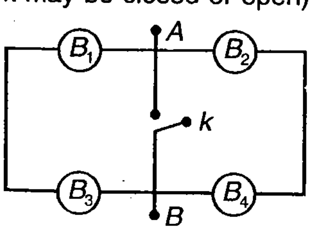
11. Column I gives some incomplete statements with a parameter x. Column II gives some statements which can complete the statements given in column I. Match statements in column I to all the statements in column II which can possibly complete the statements in column I.

Column I

(A) Two identical fuses rated (in Ampere) at x, when combined together may act as a fuse of rating ______________.

(B) Two identical non-ideal cells of emf x each, when combined together may act as a cell of e.m.f. ______________.

(C) Four identical bulbs (each of power x) are arranged as shown in the diagram. Equivalent power of the combination between points A and B may be ______________ (Given that key k may be closed or open)



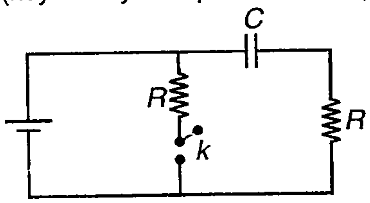
Column II

(p) $0.5x$

(q) x

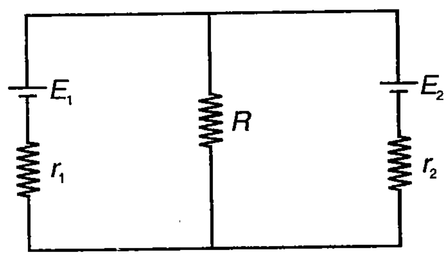
(r) $2x$

(D) Time constant of the circuit shown (key k may be open or closed). $x = RC$ (s) $4x$



(t) $8x$

12. Consider the circuit shown. Entries in column I are some relations for quantities involved in the circuit. Match these relations with the entries in column II.

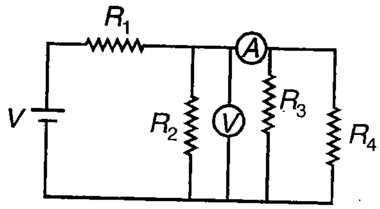


Column I	**Column II**
(A) If current through E_2 is zero	(p) $E_1 > E_2$
(B) Necessary condition for maximum power in R	(q) $E_1 < E_2$
(C) Terminal pd of cell 1 is equal to Terminal pd of cell 2	(r) $E_1 = E_2$
(D) If current through E_1 is zero	(s) Dependent of r_1
	(t) Independent of r_2

13. A cell of e.m.f. E and internal resistance r is connected across a variable load resistance R. Match the statements given in column I to conditions gives in column II.

Column I	**Column II**
(A) Thermal power generated in the load resistance is less than $\frac{E^2}{4r}$	(p) $R = r$
(B) Potential difference across load is more than $\frac{E}{2}$	(q) $R = 0$
(C) Thermal power generated in the cell is $\frac{E^2}{r}$	(r) $r = \frac{R}{4}$
(D) Work done by battery is positive	(s) $r = \frac{3R}{2}$
	(t) $r = \frac{R}{2}$

14. Column I enlists some changes in circuit and column II enlists their effects on ammeter and voltmeter readings. Match column I with column II suitably

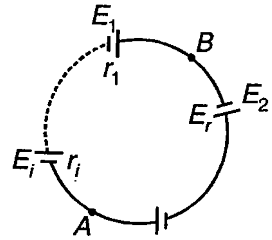


$R_1 = R_2 = R_3 = R_4 = R$

Voltmeter and ammeter are ideal.

Column-I	**Column-II**
(A) R_1 replaced by a conducting wire	(p) Voltmeter reading increases
(B) R_2 taken out	(q) Voltmeter reading decreases
(C) R_3 taken out	(r) Ammeter reading increases
(D) R_4 taken out	(s) Ammeter reading decreases
	(t) Readings of both ammeter and voltmeter do not change

15. n cells are connected in a closed loop. Emf of the cells are 1 V, 2 V, 3 V, ..., n V, here n is even. Internal resistance of the cells are 0.5 Ω, 1.0 Ω, 1.5 Ω, 2 Ω ...... $\frac{n}{2}$Ω



Based on above facts, match column I with column II.

Column-I	**Column-II**
(A) Zero	(p) Current through each cell
(B) Equal	(q) Terminal voltage of each cell
(C) Unequal	(r) Potential difference between any two points A and B on the circuit
(D) Non-zero	(s) Power supplied by each cell
	(t) Current through each cell if alternate cells are connected with reverse polarity

16. Column-I gives electric and magnetic fields in different regions of space. Column-II gives possible paths of a charged particle in these regions. Match appropriately.

Column I	Column II
(A) $\vec{E}=0,\ \vec{B}=B_0\hat{k}$	(p) Straight line
(B) $\vec{E}=E_0\hat{k}, \vec{B}=0$	(q) Circle
(C) $\vec{E}=E_0\hat{k}, \vec{B}=-B_0\hat{k}$	(r) Parabola
(D) $\vec{E}=-E_0\hat{k}, \vec{B}=-B_0\hat{k}$	(s) Helix of increasing pitch
	(t) Helix of decreasing pitch

17. Column I gives some incomplete statements. Column II gives completing statements. Match appropriately, so as to complete the incomplete statements in Column I.

Column I	Column II
(A) A conductor carrying current distributed uniformly over its cross-section, has magnetic field varying __________ distance from its axis, for an inside point	(p) Linearly with
(B) A thin walled tube carrying current has magnetic field varying __________ distance from its axis, for an outside point	(q) Inversely with
(C) Orbital magnetic moment of an electron moving in a circular orbit making r revolutions per second varies __________ r	(r) As second power of
(D) Magnetic field at an axial point distant x (x >> radius of loop) for a current carrying loop varies __________ x	(s) As n^{th} power of ($n \neq 1, -1, 2$)
	(t) Inversely as third power of

18. Column I gives some current distributions and a point P in the space around these current distributions. Column II gives some expressions of magnetic field strength. Match Column I to corresponding field strengths at point P given in Column II.

Column I	Column II
(A) A conducting loop shaped as regular hexagon of side x, carrying current i. P is the centroid of hexagon	(p) $\dfrac{3\mu_0 i}{32\pi x}$
(B) A cylinder of inner radius x and outer radius $3x$, carrying current i. Point P is at a distance $2x$ from the axis of the cylinder	(q) $\dfrac{\sqrt{3}\mu_0 i}{\pi x}$
(C) Two coaxial cylinders of radii x and $2x$, each carrying current i, but in opposite directions. Inner cylinder is solid, outer is hollow. P is a point at distance $1.5x$ from the axis of the cylinders	(r) $\geq \dfrac{\mu_0 i}{2x}$

(D) Magnetic field at the centre of an n-sided regular polygon, of circum circle of radius x, carrying current i, $n \to \infty$. P is centroid of the polygon

(s) $\frac{\mu_0 i}{3\pi x}$

(t) $< \frac{\mu_0}{4\pi} \frac{I}{x}$

19. Column I gives various current distributions. Column II gives graphs and some statements regarding variation of magnetic field B due to these current distributions, with respect to parameter x given in column I. Match appropriately.

Column I

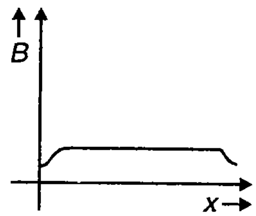
(A) A straight long conductor of uniform cross section carrying current. x = Perpendicular distance of any point in space from the wire

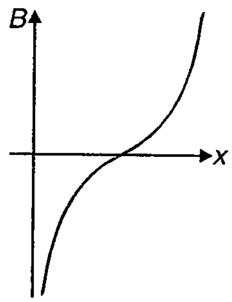
(B) Two parallel beams of electrons and protons carrying currents of same current densities and cross section, at fixed separation r. x = Distance of a point in the plane of the beams, from any of the beams

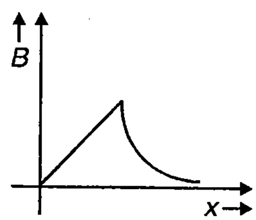
(C) A thin hollow cylindrical pipe carrying current. x = Distance of any point from axis of the pipe

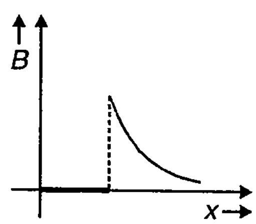
(D) A long solenoid carrying current. x = Distance of any point from one of the ends of the solenoid

Column II

(p) 

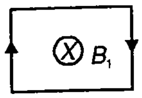
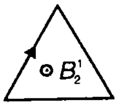
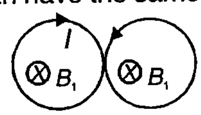
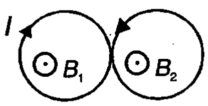
(q) 

(r) 

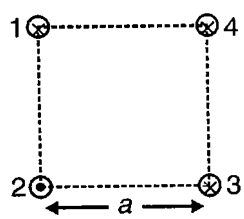
(s) 

(t) B is non-uniform

20. Column-I shows different current carrying loops, each of them carrying current-I. All the loops have been placed either in uniform magnetic field. B_1 or non uniform magnetic field B_2. The term F, τ, and μ represent the force acting on the loop. Torque acting on loop and magnetic dipole moment of loop respectively. Match the **Column-I** with **Column-II**

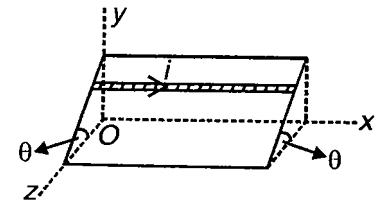
Column I	Column II
(A) 	(p) $F \neq 0$
(B) 	(q) $F = 0$
(C) Both have the same area 	(r) $\mu = 0$
(D) Both have the same area 	(s) $\mu \neq 0$
	(t) $\tau = 0$

21. Four long wires carrying equal currents (i) are passing through the corners of a square as shown in figure. Column I enlists force per unit length experienced by different wires and column II their values and direction. Match **Column I** with **Column II.**



Column-I	Column-II
(A) Wire - 1	(p) $\frac{\mu_0 i^2}{4\pi a}(\hat{i}+3\hat{j})$
(B) Wire - 2	(q) $\frac{\mu_0 i^2}{4\pi a}(-\hat{i}-\hat{j})$
(C) Wire - 3	(r) $\frac{\mu_0 i^2}{4\pi a}(3\hat{i}+\hat{j})$
(D) Wire - 4	(s) $\frac{3\mu_0 i^2}{4\pi a}(-\hat{i}-\hat{j})$
	(t) Along the diagonal of the square

22. A current carrying rod is on a rough inclined plane as shown in figure. Angle of inclination (θ) is greater than angle of repose. Column I describes various directions of applied magnetic field and column II enlists their effects on the rod. Match column I with column II suitably



Column-I

(A) $\vec{B} = B_0\hat{j}$

(B) $\vec{B} = -B_0\hat{j}$

(C) $\vec{B} = B_0\hat{k}$

(D) $\vec{B} = -B_0\hat{k}$

Column-II

(p) Rod may remain in equilibrium

(q) Rod cannot remain in equilibrium

(r) Frictional force on the rod is up along the incline

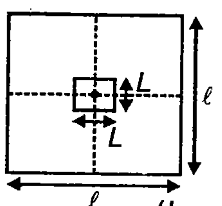
(s) Frictional force on the rod is down along the incline

(t) Rod may remain in rotational equilibrium

23. Column I and Column II show/describe different arrangements of conductors. Match the arrangements in Column I to all the arrangements in Column II having same dependence of mutual inductance on the parameter ℓ.

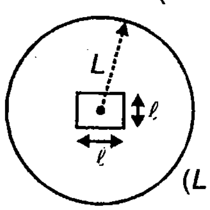
Column I

(A)



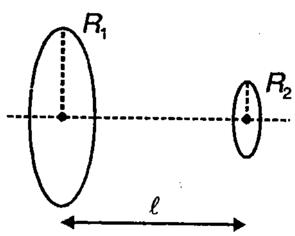
$(L << \ell)$

(B)



$(L >> \ell)$

(C)

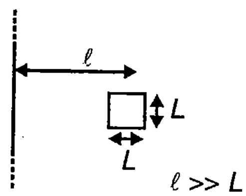


($\ell >> R_1$ and R_2)
Loops are coaxial

(D) An infinite planar sheet (which can carry current along its plane) and a small loop with its plane parallel to plane of infinite sheet, at a distance ℓ from the infinite sheet

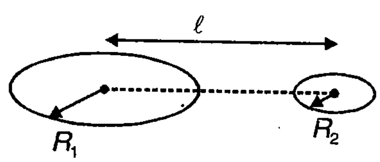
Column II

(p)



$\ell >> L$
Infinite straight wire

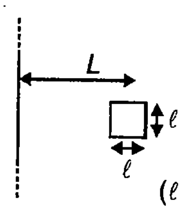
(q)



($\ell >> R_1$ and R_2)
Loops are coplanar

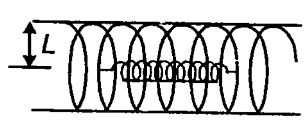
(r) An infinite planar sheet (which can carry current along its plane) and a small loop with its plane perpendicular to the plane of sheet, at a distance ℓ from the sheet

(s)



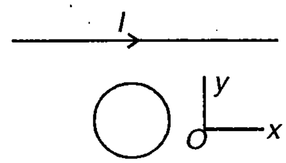
$(\ell << L)$
Infinite straight wire

(t)



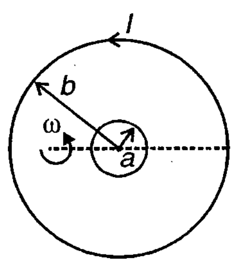
L = radius of bigger solenoid
ℓ = radius of smaller solenoid

24. A long current carrying wire and a circular conducting loop are lying in x-y plane as shown in figure. Column I enlists the directions of velocity of the loop and column II enlists their effect on loop. Match column I with column II suitably



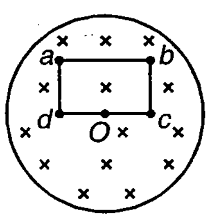
Column-I	Column-II
(A) $\vec{v} = +v_0\hat{i}$	(p) Induced emf is zero
(B) $\vec{v} = -v_0\hat{i}$	(q) Induced emf is non-zero
(C) $\vec{v} = +v_0\hat{j}$	(r) Induced current is clockwise
(D) $\vec{v} = -v_0\hat{j}$	(s) Induced current is anti-clockwise
	(t) Induced current is zero

25. At the centre of a large current carrying coil, a small coil of resistance R is placed as shown in figure. Small coil is being rotated at a constant angular speed ω about its diameter. θ is the angle between the planes of the two coils. **Column-I** has some quantities which depend on different parameter shown in **Column-II.** Match the **Column-I** with **Column-II.**



Column-I	Column-II
(A) Current in smaller loop	(p) I
(B) Mutual inductance of two coil	(q) a
(C) Torque on smaller loop	(r) b
(D) Self inductance of small coil	(s) ω
	(t) θ

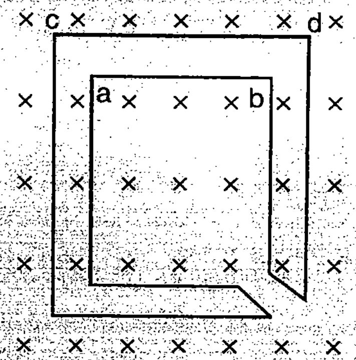
26. Consider a uniform transverse magnetic field confined to a cylindrical region (with axis passing through O) as shown in the figure. Also shown is an imaginary rectangular loop $abcd$, with mid point of its side cd at O. Magnetic field in the region is increasing at a constant rate.Match the entries in Column I to the all possible entries in Column II.



Column I	Column II
(A) Potential difference between points a and c, $V_a - V_c$	(p) Zero
(B) Work done in carrying charge q from point c to a	(q) Positive
(C) Component of electrostatic field at point a along side ad, assuming direction from a towards d to be positive	(r) Negative
(D) Component of induced electric field at point c along cb, assuming direction from c towards b to be positive	(s) Not defined
	(t) May have non-zero value

(IIT-JEE 2009)

26(a) The figure shows certain wire segments joined together to form a coplanar loop. The loop is placed in a perpendicular magnetic field in the direction going into the plane of the figure. The magnitude of the field increases with time. I_1 and I_2 are the currents in the segments **ab** and **cd**. Then



(1) $I_1 > I_2$

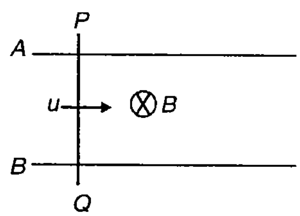
(2) $I_1 < I_2$

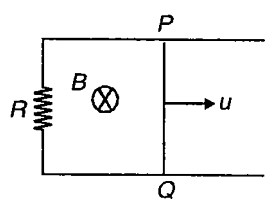
(3) I_1 is in the direction ba and I_2 is in the direction **cd**

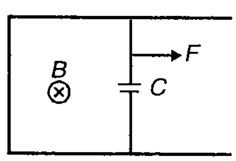
(4) I_1 is the direction ab and I_2 is in the direction **dc**

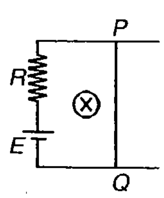
27. The whole motion is in smooth horizontal plane. The parallel bars are infinitely large and vertical uniform magnetic field exist

Column I	**Column II**
(A) Conducing rod PQ is projected with velocity u	(p) Uniform motion
(B) Conducing rod PQ is projected with velocity u	(q) Uniformly accelerated motion
(C) Conducting rod is pulled with constant force F	(r) Non uniformly accelerated motion
(D) Conducting rod PQ is released from rest	(s) Velocity of rod after long time is non zero constant
	(t) Motion is SHM

(A) 

(B) 

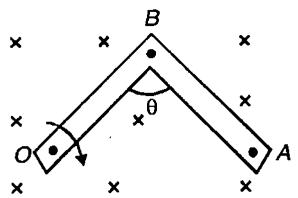
(C) 

(D) 

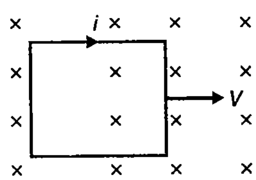
28. Column I gives some incomplete statements. Column II gives some completing statements. Match appropriately.

Column I | **Column II**

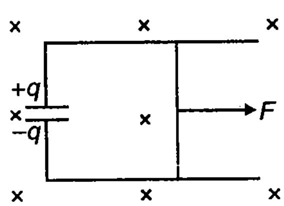
(A) A rod rotates in a uniform transverse magnetic field as shown, about hinge at O. Potential difference between points A and B



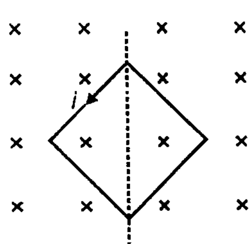
(B) A conducting loop is moved in a region of transverse magnetic field, downward the plane of paper, as shown. Value of induced current i ____________



(C) If a constant force F is acting on the wire, rate of change of charge q stored by the capacitor, $\frac{dq}{dt}$ ____________



(D) A square loop is rotated about diagonal in a region of uniform magnetic field as shown. Value of i at an instant ____________



(p) May be zero

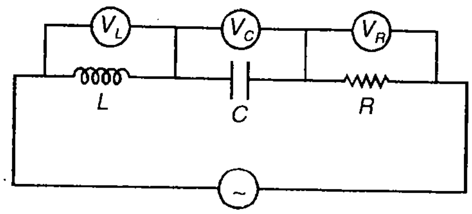
(q) Must be zero

(r) Is/may be non-negative

(s) Is/may be non-positive

(t) May have non-zero value

29. In an LCR series circuit connected to an ac source, the supply voltage is $V = V_0 \sin\left(100\pi t + \frac{\pi}{6}\right)$. $V_L = 40$ V, $V_R = 40$ V, $Z = 5\ \Omega$ and $R = 4\ \Omega$.



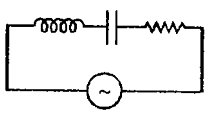
Column I	Column II
(A) Peak current (in A)	(p) $10\sqrt{2}$
(B) V_0 (in volts)	(q) $50\sqrt{2}$
(C) Effective value of applied voltage (in volts)	(r) 50
(D) X_C (in Ω)	(s) 1
	(t) $2\sqrt{2}\omega$, where ω is resonance frequency of the LCR circuit

30. In a series LCR circuit, the e.m.f. leads current. Now the driving frequency is decreased slightly.

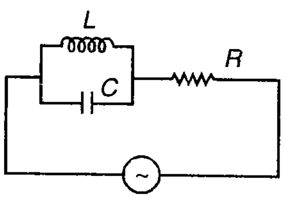
Column I	Column II
(A) Current amplitude	(p) Increases
(B) Phase constant	(q) Decreases
(C) Power developed in resistor	(r) Remains same
(D) Impedance	(s) May increase or decrease
	(t) Becomes maximum if resonance is achieved

31. Let X_L, X_C be the inductive reactance and capacitive reactance and R be the resistance in each of the circuits given in Column-I. Let V_L, V_C and V_R be the r.m.s. voltage drop in each case and i be the r.m.s. current from mains. and I_1 is the r.m.s current passing through R The supply voltage is 10 V. $X_L = 10\ \Omega$, $X_C = 10\ \Omega$ and $R = 10\ \Omega$. Match the entries in **Column-I** to all the entries in **Column-II.**

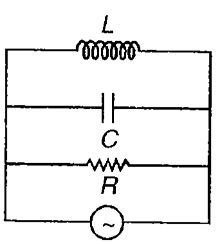
Column I **Column II**

(A) 

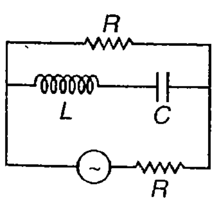
(p) $i = 1$ A

(B) 

(q) $i = 0$

(C) 

(r) $V_L = 10$ V

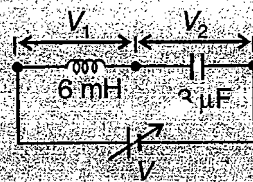
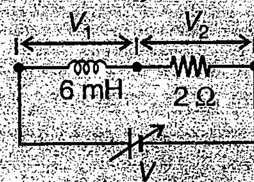
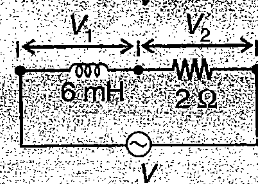
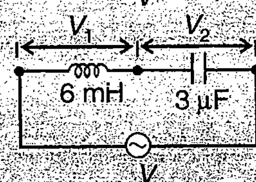
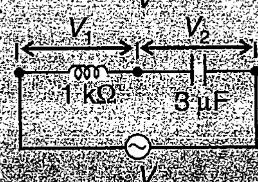
(D) 

(s) $V_C = 10$ V

(t) $I_1 = 1A$

(IIT-JEE 2010)

31(a) You are given many resistances, capacitors and inductors. These are connected to a variable DC voltage source (the first two circuits) or an AC voltage source of 50 Hz frequency (the next three circuits) in different ways as shown in **Column II**. When a current I (steady state for DC or rms for AC) flows through the circuit, the corresponding voltage V_1 and V_2. (indicated in circuits) are related as shown in **Column I**. Match the two

Column I	**Column II**
(A) $I \neq 0$, V_1 is proportional to I	(p) 
(B) $I \neq 0$, $V_2 > V_1$	(q) 
(C) $V_1 = 0$, $V_2 = V$	(r) 
(D) $I \neq 0$, V_2 is proportional to I	(s) 
	(t) 

❑ ❑ ❑

SECTION - F

Subjective Type Questions

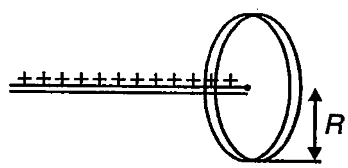
This section contains 26 subjective questions.

Solve the followings :

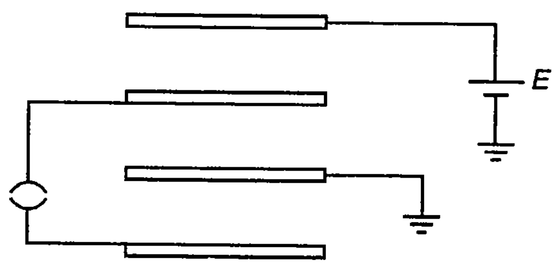
1. A electric dipole of dipole moment p is placed at origin such that dipole moment is parallel to z-axis. Calculate flux linked with following surface

   $x^2 + y^2 + z^2 = a^2$ & $z > 0$

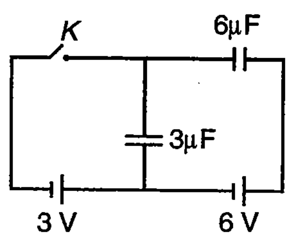
2. A ring of insullating material is situated at one end of a semi-infinite long line of charge. If λ is charge per unit length for ring as well as line-charge and R is radius of ring. Plane of ring is perpendicular to line charge. Find tension in ring.



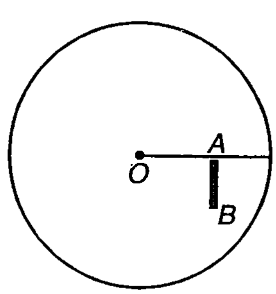
3. Four conducting plates each of area A are placed parallel to each other. Distance between two adjacent plates is d. Find charge flown through key when it is closed.



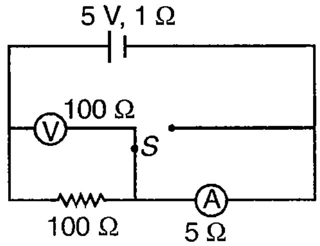
4. Calculate heat produced in circuit when key is closed.



5. A rod AB of length a and mass m is positively charged with charge Q. It is pivoted at end and is hanging freely in uniformly charged (ρ charge per unit volume) spherical region. Centre of spherically charged region is O which is at a distance a from point of suspension of rod. Find the initial torque on the rod about O.



6. (a) Find the reading of ammeter and voltmeter for situation shown in figure



(b) What will be reading if switch is turned other side?

7. A metal cylinder of radius a is surrounded by a thin co-axial metal cylinder of radius *b*. The space between them is filled up with a poorly conducting medium of resistivity ρ. Find resistance per unit length between two cylinders. (Assume that cylinders are very long incomparison to their radii).

8. An ammeter and a voltmeter are connected in series with a battery of emf $E = 10$ V. When a certain resistance is connected in parallel with voltmeter, then reading of voltmeter becomes half, whereas the reading of ammeter becomes double. Find voltmeter reading after connection of resistance.

9. If H_1 & H_2 are amounts of total heat generated in a resistance R due to charge Q passing through it when current i through it changes in following ways

   (a) Decreases down to zero uniformly during a time interval T.

   (b) Decreases down to zero becoming $\frac{1}{e}$ times of its value after every time T.

   Find $\frac{H_1}{H_2}$

10. A battery has an open circuit potential difference of 10 V between its terminals. When two loads 9 Ω and 4 Ω are connected one-by-one across the battery, the power in load resistance is same. How much heat will be generated in one second in load if a load of 5 Ω is connected across battery?

11. A charged particle of mass m and charge q is projected on a rough horizontal X-Y plane, both electric and magnetic fields are acting in the region and given by $\vec{E} = -E_0\hat{k}$ and $\vec{B} = -B_0\hat{k}$ respectively. The particle enters into the field at $(a_0, 0, 0)$ with velocity $\vec{V} = V_0\hat{j}$. The particle starts moving into a circular path on the plane. If coefficient of friction between the particle and the plane is μ, then calculate the

    (i) Time when the particle will come to rest

    (ii) Time when the particle will hit the centre

    (iii) Path travelled by the particle when it comes to rest

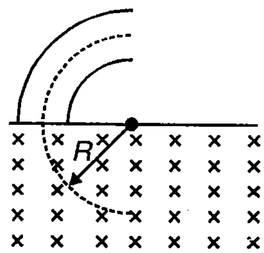
12. A particle of mass 1×10^{-26} kg and charge $+1.6 \times 10^{-19}$ C travelling with a velocity 1.28×10^6 ms^{-1} in the $+x$ direction enters a region in which a uniform electric field E and a uniform magnetic field of induction B are present such that $E_x = E_y = 0$, $E_z = -102.4$ kVm^{-1} and $B_x = B_z = 0$, $B_y = 8 \times 10^{-2}$ Wb/m^2. The particle enters this region at the origin at time $t = 0$. Determine the location (x, y and z coordinates) of the particle at $t = 5 \times 10^{-6}$ s. If the electric field is switched off at this instant (with the magnetic field still present), what will be the position of the particle at $t = 7.5 \times 10^{-6}$ s?

13. A charged particle carrying charge $q = 10$ μC moves with velocity $V_1 = 10^6$ m/s at angle 45° with x-axis in the xy plane and experiences a force $F_1 = 5\sqrt{2}$ mN along the negative z-axis. When the same particle moves with velocity $v_2 = 10^6$ m/s along the z-axis it experiences a force F_2 in y direction. Find

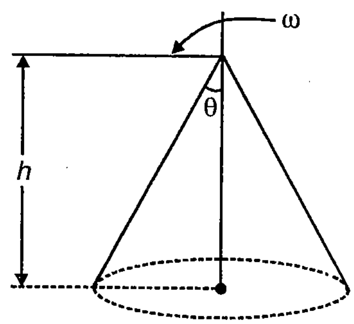
    (i) Magnitude and direction of the magnetic field

    (ii) The magnitude of the force F_2

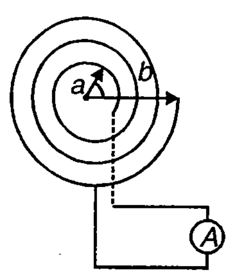
14. A charged particle (charge q, mass m) moves between the plates of a cylindrical capacitor (inner radius = a, outer radius = b) and gets into a uniform transverse magnetic field B. In the capacitor, the particle moves along the arc of a circle, in the magnetic field, along a semi-circle of radius R. A potential difference V is maintained between the plates of the capacitor. Find the speed of the particle and the ratio $\frac{q}{m}$.



15. Q charge is uniformly distributed over the surface of a right circular cone of semi-vertical angle θ and height h. The cone is uniformly rotated about its axis at angular velocity ω. Calculate the associated magnetic dipole moment.



16. A plane spiral coil is made of conducting wire of resistance R and has N turns. The inside and outside radii are a and b respectively. The coil is kept in a magnetic field which varies with time from $t = 0$ to $t = T$ according to law $B = B_0 \sin 2\pi t$ and is directed perpendicular to the plane of the coil. If the inner and outer ends of the coil are joined with an ammeter. Find the



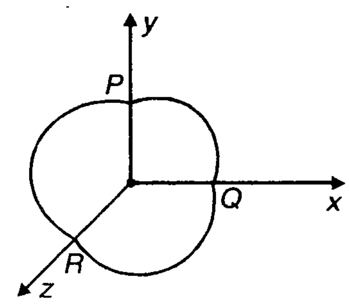
(i) Maximum e.m.f. induced in the coil

(ii) Instants when the ammeter reading will be maximum

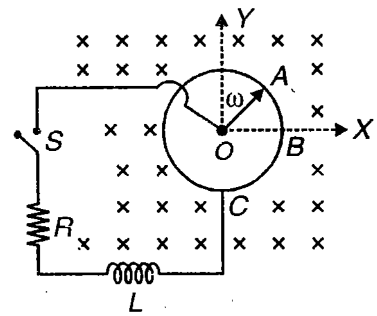
(iii) Maximum current

(iv) Value of t when the current reverses its sign for the first time

17. Three identical wires are bent into circular arcs each of radius r such that each arc subtends an angle $\theta = 120°$ at its centre of curvature. These arcs are connected with each other to form a closed mesh such that one of them lies in x-y plane, one in y-z plane and the other in z-x plane as shown in figure. In the region of space a uniform magnetic field of induction $\vec{B} = B_0(\hat{i} + \hat{j})$ exists, whose magnitude increases at a constant rate $\frac{dB}{dt} = \alpha$. Calculate magnitude of emf induced in the mesh and mark direction of flow of induced current in the mesh shown in figure.



18. A conducting rod OA of mass m and length l is kept rotating in a vertical plane about a fixed horizontal axis passing through O. The free end A is arranged to slide on a fixed conducting ring without any friction. A uniform and constant magnetic field B perpendicular to the plane of rotation is applied. The point O and the point C (on the ring) are connected by a series combination of a resistor R and an inductor L through a switch S. The angular frequency of the rod is ω. Initially the switch is opened. Neglect any other resistance.



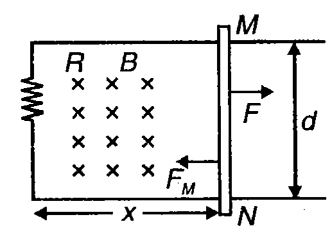
(i) Find the e.m.f. induced across the length of the rod

(ii) The switch is closed at time $t = 0$

(a) Obtain an expression for the current in the resistor as a function of time.

(b) In the steady state find the torque needed to maintain the constant angular speed of the rod. The rod was initially along the positive X-axis.

19. Two long parallel horizontal rails, a distance d apart, each having a resistance λ per unit length, are joined at one end by a resistance R. A perfectly conducting rod MN of mass m is free to slide along the rails without friction. There is a uniform magnetic field of induction B normal to the plane of the paper and directed into it. A variable force F is applied such that a constant current, I, flows through R.



(i) Find the magnetic force F_M on the rod, and the induced e.m.f. as a function of the distance, x.

(ii) Find the velocity of the rod, and the applied force F as a function of the distance x of the rod from R.

(iii) What fraction of the work done by F is converted into heat?

20. A 3.00 μF capacitor is connected across an ac source whose voltage amplitude is kept constant at 50.0 V but whose frequency can be varied. Find the current amplitude when the angular frequency is

(i) 100 rad/s

(ii) 1000 rad/s

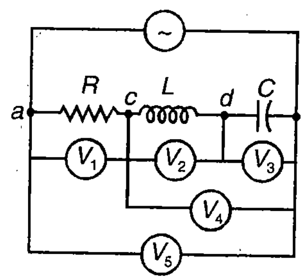
(iii) 10000 rad/s

21. In an *L-R* circuit the source has a voltage amplitude of 50.0 V and an angular frequency of 1000 rad/s. $R = 200\ \Omega$; $L = 0.900$ H.
    (i) What is the impedance of the circuit?
    (ii) What is the current amplitude?
    (iii) What are the voltage amplitudes across the resistor and across the inductor?
    (iv) What is the phase angle φ of the source voltage with respect to the current? Does the source voltage lag or lead the current?

22. A 200 Ω resistor is in series with a 0.100 H inductor and a 0.500 μF capacitor. Compute the impedance of the circuit and draw phasor diagram
    (i) At a frequency of 500 Hz
    (ii) At a frequency of 1000 Hz.

    Compute, in each case, the phase angle of the source voltage with respect to the current, and state whether the source voltage lags or leads the current.

23. An *LCR* circuit consist of a resistor $R = 200\ \Omega$, capacitor $C = 2.00\ \mu$F, and inductor $L = 0.900$ H attached to an a.c. source of amplitude 150 V.



    (i) At what angular frequency is the circuit in resonance?
    (ii) What is the reading of each (ideal) voltmeter in the figure when the source frequency equals the resonance frequency?
    (iii) What is the rms current at resonance?

24. A transformer connected to a 120-V (rms) ac line is to supply 6.00 V (rms) to a low voltage lighting system for a model railroad village. The total equivalent resistance of the system is 8.00 Ω.
    (i) What should be the ratio of the primary to secondary turns of the transformer?
    (ii) What rms current must the secondary supply?
    (iii) What average power is delivered to the load?
    (iv) What resistance connected directly across the 120 V line would draw the same power as the transformer? Show that this is equal to 8.00 Ω times the square of the ratio of primary to secondary turns.

25. In an *L-R-C* series circuit the phase angle is 40°, with the source voltage leading the current. The reactance of the capacitor is $X_C = 400\ \Omega$, and the resistance is $R = 200\ \Omega$. The average power delivered by the source is 150 W. Find
    (i) The reactance of the inductor
    (ii) The rms current
    (iii) The rms voltage of the source

26. A 100 Ω resistor, a 0.100 μF capacitor and a 0.300 H inductor are connected in series to a voltage source with amplitude 240 V.
    (i) What is the resonance angular frequency?
    (ii) What is the maximum current in the resistor at resonance?
    (iii) What is the maximum voltage across the capacitor at resonance?
    (iv) What is the maximum voltage across the inductor at resonance?
    (v) What is the maximum energy stored in the capacitor at resonance and in the inductor?

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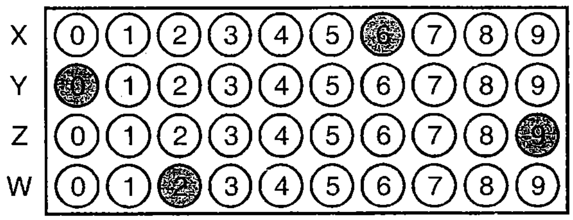
SECTION - G

Integer Answer Type

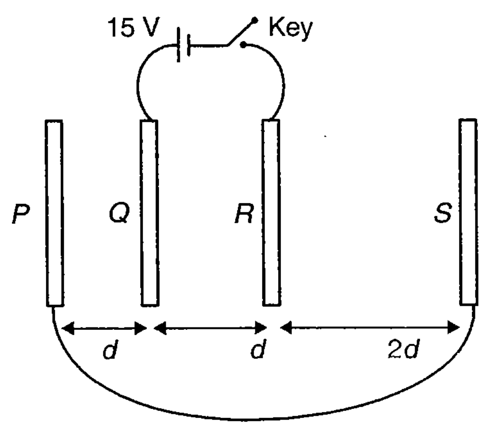
This section contains 23 questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W(say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following :



1. At $t = 0$, a positive point charge of mass m is projected towards another positive point of mass m at rest in free space. At the instant of minimum separation kinetic energy of the system of two charges becomes $\frac{1}{n}$ times the initial kinetic energy of the system, what is the value of n?

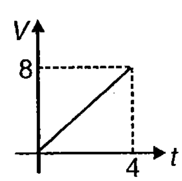
2. Capacitor-1 of capacitance 3 μF is charged to 10 V and charging battery is then removed. Capacitor-2 of capacitance 6 μF is charged to 3 V and charging battery is then removed. Now the two capacitors are connected in parallel with each other. The possible values of common potential across the capacitors are V_1 and V_2. What is the value of $|V_1 - V_2|$ in volt?

3. Consider a system of four identical uncharged infinite metal plates marked P, Q, R and S arranged as shown. The key is now closed. What is the potential difference (in volt) between plates Q and S in steady state?

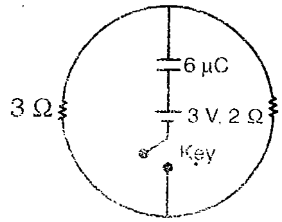


4. When a dielectric slab of thickness $\frac{d}{2}$ is inserted between the plates of a parallel plate capacitor (with d as the separation between the plates) Capacitance of a capacitor become $\frac{4}{3}$ times of the original value. Find the dielectric constant of the slab

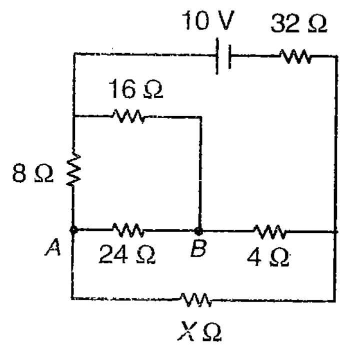
5. Voltage Vs time graph of a circuit element capacitor is shown in the figure. If $C = 2$F, then find the current in A



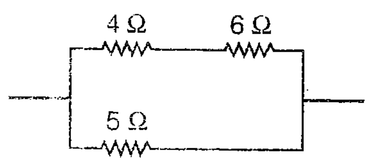
6. Consider the circuit shown. The capacitor is initially uncharged and the key is open, the key is closed at $t = 0$. What is heat dissipated (in μJ) in the resistor of resistance 3 Ω between $t = 0$ and $t = \infty$?



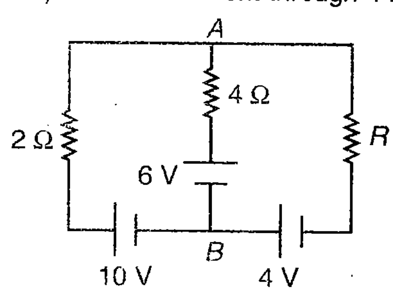
7. Consider the electrical circuit shown. Resistance of one of the resistor is unknown and is, therefore, marked X Ω. For what integral value of X current in 24 Ω resistor flows from B to A?



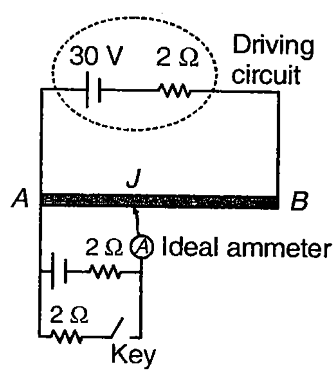
8. The heat generated in 5 Ω resistor due to current flowing through it is 10 cal/second. Heat generated in 4 Ω resistor in cal/s is



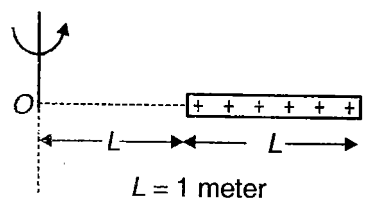
9. In the given circuit the value of R (in Ω) for which current through 4 Ω resistor is zero.



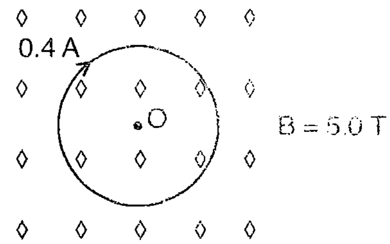
10. Consider the potentiometer circuit shown. Potentiometer wire AB is 100 cm long and has electrical resistance of 1 Ω between its ends. With key opened the balancing length AJ equals 40 cm. Now, the key is closed and jockey J is touched at the wire such that AJ equals 20 cm. What is the reading (in A) of the ammeter?



11. A thin rod is being rotated about point O in horizontal plane. The rod carries uniformly distributed charge over it having linear charge density $\frac{2}{\pi}$ coulomb/metre. The rod is rotating with constant angular velocity 2π rad/s. If magnetic field strength at O is $\frac{\mu_0 X}{4\pi}\log_e 2$ tesla, then find out the value of x.



12. A uniform ring of radius 1 metre carries current 0.4 A. The ring is being rotated about centre O in horizontal plane with constant angular velocity $\sqrt{\pi}$ rad/s. A uniform magnetic field of magnitude 5.0 Tesla has been applied transverse to the plane of ring. The linear mass density of ring is $\frac{1}{\pi}$ kg/m. Find the tension developed (in N) in the ring.



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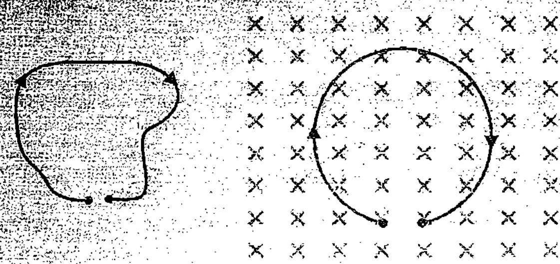
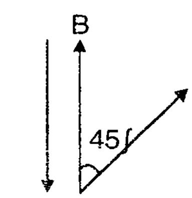
12(a). A thin flexible wire of length L is connected to two adjacent fixed points and carries a current I in the clockwise direction, as shown in the figure. When the system is put in a uniform magnetic field of strength B going into the plane of the paper, the wire takes the shape of a circle. The tension in the wire is



(1) IBL (2) $\frac{IBL}{\pi}$ (3) $\frac{IBL}{2\pi}$ (4) $\frac{IBL}{4\pi}$

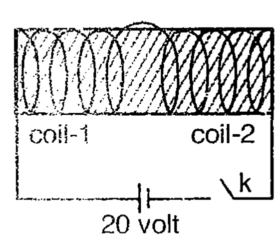
13. In a region of space, both electric field and magnetic field have been applied simultaneously in opposite direction to each other. A particle of mass 6 mg having charge 1 μC enters the region with speed $10\sqrt{2}$ m/s making an angle 45ƒ with magnetic field B as shown in figure. After entering the region the particle moves on a contracting helix with time period 2 second. The magnitude of electric field is 12 N/C. Find out the 2nd pitch (in m) of the helix.



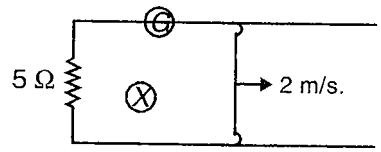
14. A current carrying ring has moment of inertia 400 ◊ $10^{ñ2}$ kg about an axis passing through it centre and perpendicular to its plane. The centre of the ring is at origin. The ring has magnetic moment $\vec{M} = 3\hat{i} - 4\hat{j}$ A-m^2. A magnetic field $\vec{B} = 4\hat{i} + 3\hat{j}$ T is switched on at t = 0. The angular velocity of the ring (rad/second) is

15. A rigid circular loop of radius 3.5 m and mass 11 kg lies in x-y plane on a smooth horizontal plane. A current flows through it. The magnetic field is $\vec{B} = 5\hat{i} + 8\hat{k}$(T) at this plane. The value of current so that one edge of the loop is lifted from the table is x ampere then find x (take g = 10 m/s^2)

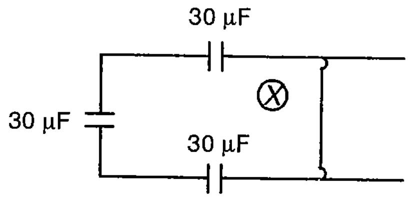
16. The diagram here shows two inductors having self inductance 5 mH each, have been wound on the same core. The mutual inductance between the two coils is also equal to 5 mH. At t = 0, key k is closed. The resistance of the each coil is 5 Ω. If final magnetic energy stored in the inductors is X ◊ $10^{ñ2}$ joule, then find out the value of X.



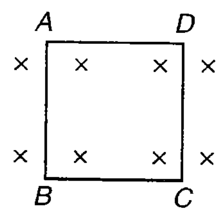
17. The diagram shows two rail rods lying in horizontal plane and connected by a resistance of 5 Ω. A uniform transverse inward magnetic field 2.0 tesla has been applied inside the plane. A slider starts moving at $t = 0$, with constant velocity 2 m/s. At $t = 5$ s, the current in circuit is 1A and self inductance of loop is 5 H. The rail rods are separated by a distance of 50 cm. Find out the total charge flown through the galvanometer in time interval of $t = 0$ to $t = 5$ s.



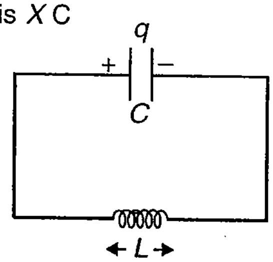
18. Consider the diagram. The two conducting rail rods are separated by a distance 20 cm. The rail rods are connected with three capacitors, each have the same capacitance 30 μF. A slider is moving on rail rod with velocity $v = (2t + 1)$ m/s where t is time in second. A uniform transverse inward magnetic field 1.5 tesla has been applied into the plane of rod and slider. Find out the charge on any of the capacitor in micro coulomb at $t = 1$s.



19. A square coil $ABCD$ of side 2 m is placed in a magnetic field $B = 2t^2$(T). The induced electric field (in V/m) in DC wire at $t = 2$ second is

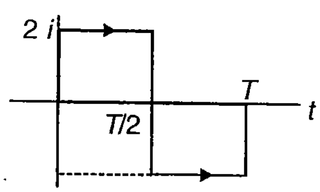


20. $C = 1$F; $L = 11$H charge in the capacitor is 4 C at $t = 0$ and it is decreasing at the rate of $\sqrt{3}$ C/second. The maximum charge on the capacitor is X C



21. An inductor coil, a capacitor and an A.C. source $v = 24\sqrt{2}\cos\omega t$ are connected in series. Now the frequency of source is varied, and a maximum rms current 12 A is obtained. Suppose this inductor coil is connected to battery of emf 12 volt and internal resistance 1 Ω. If self inductance of inductor is 1 H, then find out the final energy in Joule stored in the inductor.

22. The average current for the $A.C.$ whose i-t current graph is given is



23. The R.M.S. current (in A) for the above problem is

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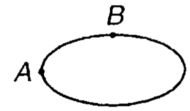
SECTION - H

Multiple True-False Type Questions

Identify the correct combination of true and false of the given three statements.

1. Consider the following statements for the shown charged ellipsoidal conductor in electrostatic condition



STATEMENT-1 : Charge density at point A on the surface of conductor is greater than that at point B.

STATEMENT-2 : Electrostatic potential at point A is greater than that at B.

STATEMENT-3 : Electrostatic field just near point A outside the conductor is greater than field just near point B outside the conductor.

(1) T T T (2) T F F (3) F F T (4) T F T

2. Consider the following statements

STATEMENT-1 : Electrostatic potential inside a charged metallic body is zero.

STATEMENT-2 : Electrostatic pressure experience by a charged metallic body is proportional to σ, where σ = local surface charge density.

STATEMENT-3 : Potential gradient along a charged metallic surface is zero.

(1) T F F (2) F F T (3) T F T (4) F T T

3. A wire is connected across a cell through a switch. The switch is now closed. As the current flows through the wire, it gradually gets heated up. Consider the following statements

STATEMENT-1 : Relaxation time of the electrons gradually decreases.

STATEMENT-2 : Drift speed of electrons gradually increases.

STATEMENT-3 : Current in the wire gradually increases

(1) T F F (2) T T F (3) T T T (4) F T F

4. Consider the following statements in context of RC charging circuit (with capacitor initially uncharged).

STATEMENT-1 : Time constant of the circuit is the time in which charge on capacitor becomes $\frac{1}{e}$ times the maximum charge on capacitor.

STATEMENT-2 : Considering that charging begins at $t = 0$, slope of ln I versus t graph does not depend on value of resistance.

STATEMENT-3 : Considering that charging begins at $t = 0$, slope of ln (q) versus t graph does not depend on value of capacitance.

(1) F T F (2) F F F (3) T T F (4) F F T

5. STATEMENT-1 : A solenoid tends to contract when a current passes through it.

STATEMENT-2 : When a magnetic dipole is placed in a non-uniform magnetic field, only a torque may act on the dipole.

STATEMENT-3 : Weber and volt second, both have the same dimensions.

(1) T F T (2) F F T (3) T T F (4) F T F

6. STATEMENT-1 : The path of a charged particle moving in a uniform steady magnetic field cannot be a parabola.

   STATEMENT-2 : Magnetic lines start from the N-pole and terminate on the S-pole.

   STATEMENT-3 : A long narrow solenoid carrying a steady current is equivalent to a bar magnet, because both produce the same magnetic field pattern

   (1) T F T (2) F F T (3) T T F (4) F T F

7. STATEMENT-1 : Induction brakes work on the principle of eddy current.

   STATEMENT-2 : At resonance frequency current is completely cut off in Parallel LCR circuit.

   STATEMENT-3 : A spark occurs some time when an electric iron is switched off. The sparking is due to self induced emf in the circuit.

   (1) T T T (2) F F F (3) F T F (4) T F F

8. STATEMENT-1 : An inductor cannot have zero resistance.

   STATEMENT-2 : The core of transformer is laminated as rusting of the core may be prevented

   STATEMENT-3 : In step-up transformer $N_S > N_P$ & $E_S > E_P$

   (1) T F T (2) F T T (3) F F F (4) T T T

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Optics and Modern Physics

UNIT 4

This Unit Includes

Optics, Modern Physics

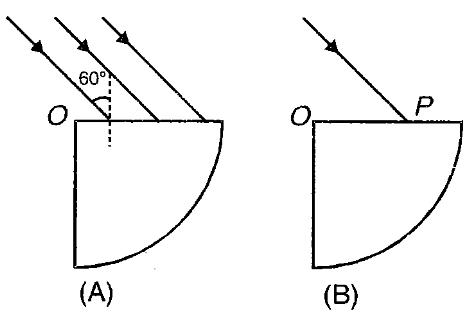
SECTION - A

Straight Objective Type

This section contains 116 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. A parallel beam of light falls on a quarter cylinder of radius R, as shown in figure (A). Refractive index of the material of the cylinder is $\sqrt{3}$. Maximum value of OP, as shown in figure (B), so that rays don't suffer T.I.R at the curved surface is (consider refractive index of surrounding medium equal to 1)



(1) $\frac{R}{3}$

(2) $\frac{2R}{3}$

(3) $\frac{R}{2}$

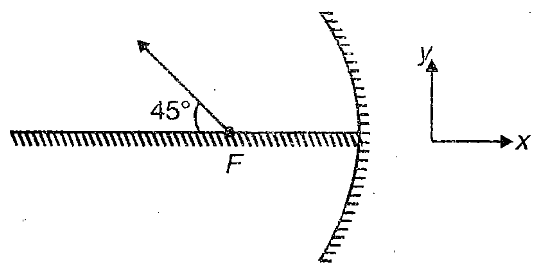
(4) $\frac{3R}{4}$

2. A hemisphere (made of material of refractive index $\sqrt{3}$) of radius r is placed on a horizontal surface with its base touching the surface. A vertical beam of cross sectional radius $\frac{\sqrt{3}}{2}r$ is incident symmetrically on its curved surface. Radius of the spot of light formed on the horizontal surface is

(1) $\frac{r}{2}$ (2) $\frac{r}{3}$

(3) $\frac{r}{\sqrt{2}}$ (4) $\frac{r}{\sqrt{3}}$

3. A particle is projected on a horizontal (x-z) plane, at an angle 45° with horizontal, as shown. The particle is projected from focus F of a concave mirror of curvature R, with speed $v = \sqrt{gR}$. Velocity of image of the particle as it is just about to strike the horizontal plane is



(1) $\frac{v}{4\sqrt{2}}\hat{i} - \frac{v}{4\sqrt{2}}\hat{j}$ (2) $\frac{v}{2\sqrt{2}}\hat{i} + \frac{v}{4\sqrt{2}}\hat{j}$

(3) $\frac{v}{4\sqrt{2}}\hat{i} - \frac{v}{2\sqrt{2}}\hat{j}$ (4) $\frac{-v}{2\sqrt{2}}\hat{i} + \frac{v}{4\sqrt{2}}\hat{j}$

4. Consider a rod of length 4 cm placed along the optical axis of a concave mirror. Image of the rod is 6 cm long, is real and just touches the rod. Focal length of the concave mirror is

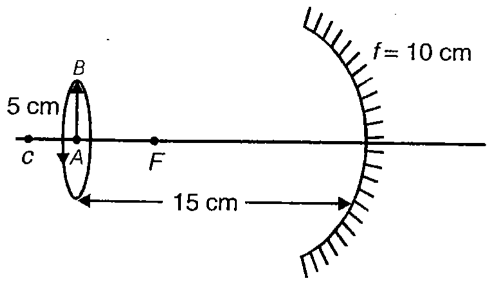
(1) 8 cm

(2) 12 cm

(3) 16 cm

(4) 24 cm

5. A small rod AB of length 5 cm is rotating about principal axis. It is at the distance 15 cm from mirror, then radius of path followed by end B of the rod is

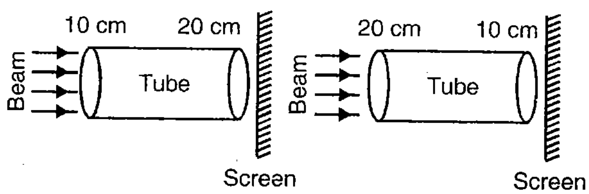


(1) 10 cm (2) 15 cm
(3) 20 cm (4) 5 cm

6. When an object is at distance x_1 and x_2 from the poles of a concave mirror, images of same magnification are formed. The magnitude of focal length of the mirror is

(1) $\left|\frac{x_1+x_2}{2}\right|$ (2) $\left|\frac{x_1-x_2}{2}\right|$
(3) $|x_1 - x_2|$ (4) $|x_1 + x_2|$

7. A tube of length 30 cm has its inner lateral surface blackened. Two lenses of focal lengths 10 cm and 20 cm are fixed at the ends of the tube



Arrangement (1) Arrangement (2)

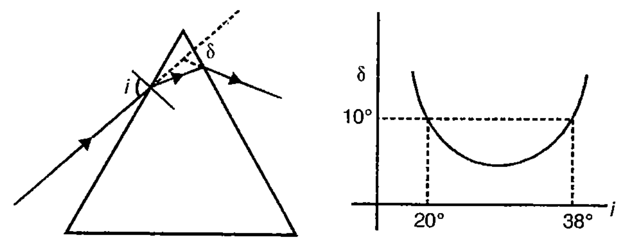
For same beam, intensities of spots on screen are I_1 and I_2 for arrangement(1) and arrangement(2) respectively. $\frac{I_1}{I_2}$ equals

(1) 1 (2) 16
(3) $\frac{1}{16}$ (4) 0.25

8. Principal axis of a thin lens is the x-axis. The coordinates of a point object and its image are (–20 cm, 2 cm) and (25 cm, –1 cm). Lens is located at

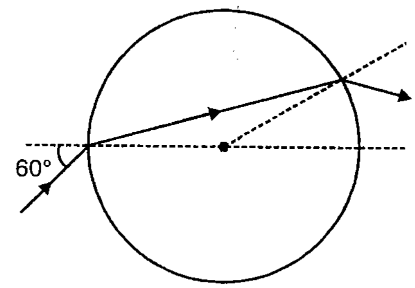
(1) $x = +10$ cm
(2) $x = -2.5$ cm
(3) $x = 2$ cm
(4) $x = -3$ cm

9. A ray is incident on prism at an angle i with normal. When it comes out of prism its angular deviation is δ. Graph between δ and i is given. Prism angle is



(1) 68° (2) 60°
(3) 48° (4) 29°

10. A ray is incident at an angle 60° on a sphere which is made of material having refractive index = $\sqrt{3}$, find angle by which the emergent ray is deviated



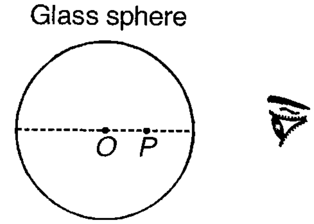
(1) 30° (2) 15°
(3) 45° (4) 60°

11. What is the minimum value of refractive index for a 60°, 30°, 90° prism so that rays entering any one of the faces do not emerge from opposite face?

(1) $n = 1.414$ (2) $n = 2$
(3) $n = 1.33$ (4) $n = 1.6$

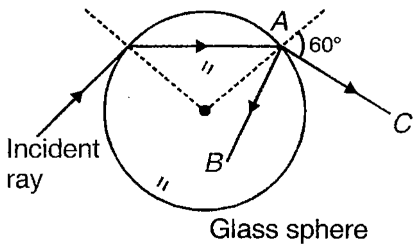
12. In the figure shown, O is the centre of the glass sphere. Spot P in the sphere when viewed almost normally appears

Glass sphere



(1) At point O
(2) Towards left of point O
(3) Towards right of point O, shifted towards the observer
(4) Towards right of point O, shifted away from the observer

13. Consider the figure shown. Reflected ray *AB* and refracted ray *AC* are perpendicular. Refractive index of the material of the sphere is



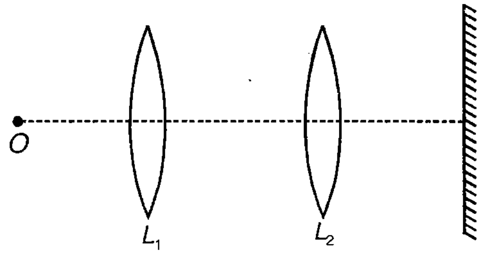
(1) $\sqrt{1.5}$

(2) $\sqrt{2}$

(3) $\sqrt{3}$

(4) $\sqrt{2.5}$

14. Position of object *O* and screen is fixed and lens is moved. At two positions of lens we get clear image. First position is at 30 cm from object and second position is at 50 cm from object. Find focal length of lens.



(1) $\frac{25}{4}$ (2) $\frac{75}{4}$

(3) $\frac{45}{4}$ (4) $\frac{65}{4}$

15. Two plane mirrors are inclined at an acute angle such that a ray incident on a mirror undergoes a total deviation of 210° after two reflections

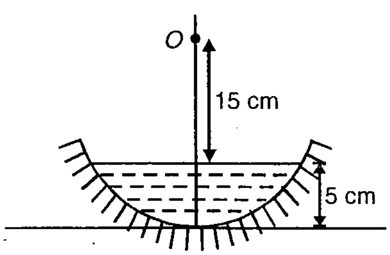
(1) The angle between mirrors is 60°

(2) The number of images formed by this system will be 5

(3) All images and object will lie on a circle

(4) All images and object will lie on an ellipse

16. In the diagram, an object is placed at distance 20 cm from pole. In this condition object and image coincide. Radius of curvature of mirror is 25 cm. Refractive index of liquid is



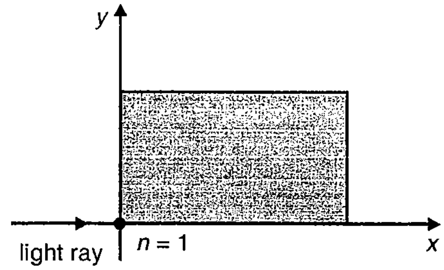
(1) $\frac{4}{3}$

(2) $\frac{3}{2}$

(3) $\frac{9}{8}$

(4) 1.2

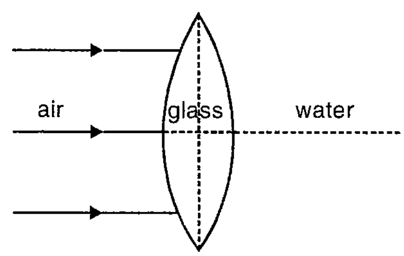
17. A long rectangular slab of transparent medium is placed on a horizontal table with its length parallel to *x*-axis and width parallel to the *y*-axis as shown in diagram. A ray of light travelling in air makes a grazing incidence on the slab. The refractive index *N* of medium varies as $N = 2x$. The path of light ray is given by



(1) $y = 2\log_e x$ (2) $y = 0$

(3) $y = 2x^2$ (4) $x^2 = 2y$

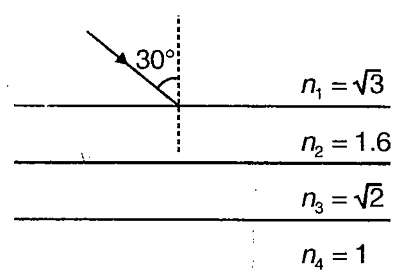
18. A thin equiconvex lens made of glass ($n = \frac{3}{2}$) is placed in such a way, that one surface is in contact with water ($n = \frac{4}{3}$) and another surface is in contact with air. Find focal length of setup if the rays are incident as shown. Radius of curvature (R = 30 cm)



(1) 60 cm (2) 120 cm

(3) 30 cm (4) 100 cm

19. Angle made by light ray with the normal in medium of refractive index $\sqrt{2}$ is



(1) $\sin^{-1}\sqrt{\frac{3}{8}}$ (2) $\sin^{-1}\sqrt{\frac{3}{4}}$

(3) $\sin^{-1}\sqrt{\frac{3}{6}}$ (4) $\sin^{-1}\sqrt{\frac{3}{10}}$

(IIT-JEE 2008)

19(a). A light beam is traveling from Region I to Region IV (Refer Figure). The refractive index in Regions I, II, III and IV are n_0, $\frac{n_0}{2}$, $\frac{n_0}{6}$ and $\frac{n_0}{8}$, respectively. The angle of incidence θ for which the beam just misses entering Region IV is

Figure :

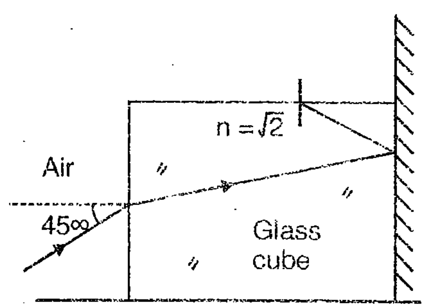
Region I	Region II	Region III	Region IV
n_0 θ	$\frac{n_0}{2}$	$\frac{n_0}{6}$	$\frac{n_0}{8}$

0 0.2 m 0.6 m

(1) $\sin^{-1}\left(\frac{3}{4}\right)$ (2) $\sin^{-1}\left(\frac{1}{8}\right)$

(3) $\sin^{-1}\left(\frac{1}{4}\right)$ (4) $\sin^{-1}\left(\frac{1}{3}\right)$

20. Right face of a glass cube is silvered as shown. A ray of light is incident on left face of the cube as shown. Find the deviation of the ray when it comes out of the glass cube

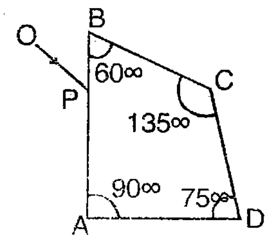


(1) 0∞ (2) 90∞

(3) 180∞ (4) 270∞.

(IIT-JEE 2010)

20(a). A ray OP of monochromatic light is incident on the face AB of prism ABCD near vertex B at an incident angle of 60∞ (see figure). If the refractive index of the material of the prism is $\sqrt{3}$, which of the following is/are correct?



(1) The ray gets totally internally reflected at face CD

(2) The ray comes out through face AD

(3) The angle between the incident ray and the emergent ray is 90∞

(4) The angle between the incident ray and the emergent ray is 120∞

21. The deviation angle in a prism of refracting angle 60∞ and refractive index 1.5

(1) Is 37∞

(2) Is 58∞

(3) Is 49∞

(4) Lies between 37∞ and 58∞

(IIT-JEE 2008)

21(a). Two beams of red and violet colours are made to pass separately through a prism (angle of the prism is 60∞). In the position of minimum deviation, the angle of refraction will be

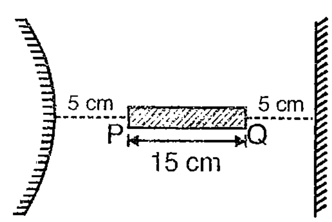
(1) 30∞ for both the colours

(2) Greater for the violet colour

(3) Greater for the red colour

(4) Equal but not 30∞ for both the colours

22. Image in convex mirror, of the image of rod PQ in the plane mirror, is (radius of curvature of mirror is 60 cm)



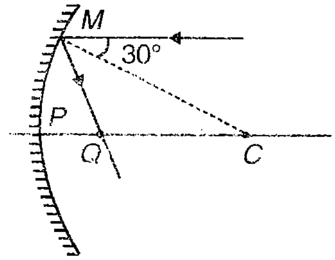
(1) Virtual, erect and 6 cm long

(2) Real, inverted and 3 cm long

(3) Virtual, erect and 3 cm long

(4) Real, inverted and 6 cm long

23. A ray parallel to principal axis is incident at 30° from normal on concave mirror having radius of curvature R. The point on principal axis where rays are focussed is Q such that PQ is



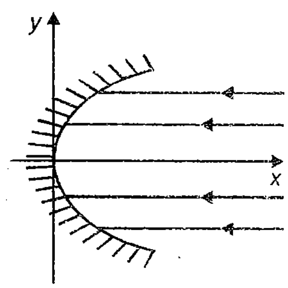
(1) $\frac{R}{2}$

(2) $\frac{R}{\sqrt{3}}$

(3) $\frac{\sqrt{2}R-R}{\sqrt{2}}$

(4) $R\left(1-\frac{1}{\sqrt{3}}\right)$

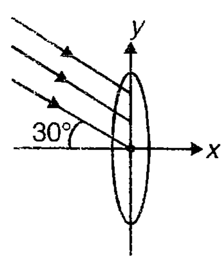
24. A mirror of parabolic shape is shown. The equation of mirror surface is $y^2 = 8x$. Rays parallel to principal axis are focussed at



(1) (2, 0) (2) (0, 2)

(3) (4, 0) (4) (6, 0)

25. Parallel rays are focussed by the convex lens (lens is placed along y-axis) of focal length 20 cm at the point



(1) (20, 0)

(2) (20, –20)

(3) (20, –10)

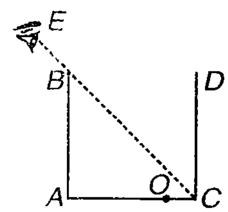
(4) $\left(20, -\frac{20}{\sqrt{3}}\right)$

26. An object is placed in front of an equiconvex lens with refractive index 1.5 and radius of curvature 30 cm. Surface which is away from object is polished. Find the distance of object from lens so that object and image coincide

(1) 10 cm (2) 20 cm

(3) 15 cm (4) 40 cm

27. A cubical vessel with non-transparent walls is so located that the eye E of an observer can not see its bottom but can see all of the wall CD. The height upto which water should be filled in the vessel for the observer to see ... shown will be (OC = 10 cm, μ of water $\frac{4}{3}$)



(1) 25 cm

(2) 26.7 cm

(3) 29 cm

(4) 30 cm

28. The limiting angle of incidence of a ray that can be transmitted by an equilateral prism of refractive index $n = \sqrt{\frac{7}{3}}$ is

(1) $\frac{\pi}{6}$ (2) $\frac{\pi}{3}$

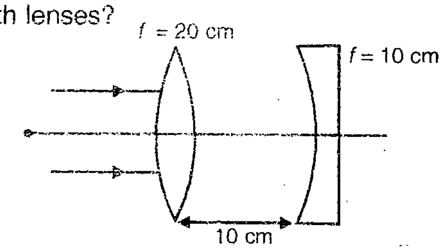
(3) $\frac{\pi}{4}$ (4) $\frac{\pi}{5}$

29. Consider a glass sphere of radius r with centre at origin. For a point object placed at (0, a, 0) image is formed at (0, $-b$, 0). $a > r$, $b > r$. Now the sphere is cut into two, along the plane $x = 0$ and for the hemisphere $y > 0$, plane surface is silvered. The other hemisphere is removed. New image of the object is formed at

(1) (0, a, 0) (2) (0, $a-r$, 0)

(3) (0, $b-r$, 0) (4) (0, b, 0)

30. Parallel rays are focussed on a pair of lenses. Where will rays be focussed after refraction from both lenses?



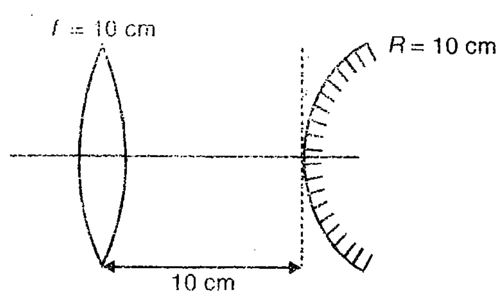
(1) At 40 cm from first lens

(2) At ∞ from first lens

(3) At 10 cm from first lens

(4) At 20 cm from first lens

31. Image of an object (kept at very large distance) formed by the shown pair of convex lens and convex mirror is



(1) Upright (2) At 20 cm from lens

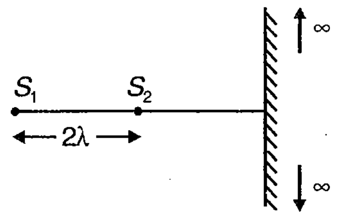
(3) At pole of mirror (4) Inverted

32. A plane mirror is moving with $-2\hat{i}+3\hat{j}+\hat{k}$ m/s in *x-z* plane. Velocity of image of a point object moving with velocity $\hat{i}+2\hat{j}-5\hat{k}$ m/s is (assume that object is located on front side of the mirror)

    (1) $-2\hat{i}+4\hat{j}-\hat{k}$ m/s (2) $\hat{i}+4\hat{j}-5\hat{k}$ m/s

    (3) $2\hat{i}-3\hat{j}+\hat{k}$ m/s (4) $-\hat{i}+5\hat{j}-4\hat{k}$ m/s

33. There are two sources kept at distances 2λ. A large screen is perpendicular to line joining the sources. Number of maximas on the screen in this case is (λ = wavelength of light)



    (1) 1 (2) 3

    (3) 5 (4) 7

34. In a Young's double slit experiment, the slits are d distance apart and are illuminated by red light. Whole system is immersed in liquid of index $\frac{6}{5}$. Which of the following is incorrect?

    (1) Fringe width changes

    (2) Position of all maxima remains same

    (3) At central maxima path different is still zero

    (4) Optical path travelled by a ray decreases

35. In a Young's double slit experiment intensities of sources are $4I$ and $9I$. What is the ratio of maximum and minimum intensities?

    (1) 25 : 1 (2) 5 : 1

    (3) 2 : 3 (4) 4 : 9

36. In a YDSE apparatus, d = 2 mm, λ = 600 nm, D = 1 m. The slits individually produce same intensity on the screen. Find the position of point where intensity is $\frac{3}{4}$ times of the maximum intensity on screen

    (1) 0.01 mm

    (2) 13×10^{-4} mm

    (3) 0.05 mm

    (4) 1.5×10^{-4} mm

37. A thin transparent sheet is placed in front of one slits in YDSE experiment. The fringe width will

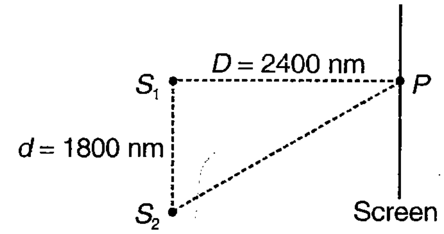
    (1) Increase

    (2) Decrease

    (3) Remain same

    (4) May increase or may decrease

38. White light is used for double slit interference, for how many wavelengths, we get maximum at point P shown here on the screen?



    (1) 1 (2) 2

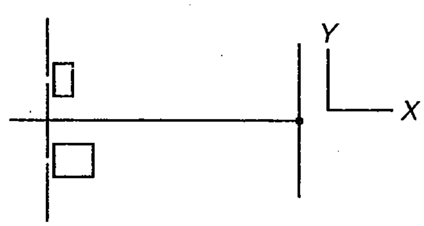
    (3) 3 (4) 7

39. Optical path for yellow light is same if it passes through 4 cm of glass or 6 cm of water. If the refractive index of water is $\frac{4}{3}$, what is the refractive index of glass?

    (1) 2 (2) 1.5

    (3) $\frac{16}{9}$ (4) $\frac{3}{4}$

40. In YSDE, both slits are covered by transparent slab. Upper slit is covered by slab of R.I. 1.5 and thickness t and lower is covered by R.I. $\frac{4}{3}$ and thickness $2t$, then central maxima



    (1) Shifts in +ve y axis direction

    (2) Shifts in –ve y axis direction

    (3) Remains at same position

    (4) May shift in upward or downward depending upon wavelength of light

41. Wavelength of red colour in air is 400 nm. If red colour rays pass normally through a glass slab of refractive index $\frac{3}{2}$, then number of waves in glass slab of thickness 80 μm is

(1) 300 (2) 200

(3) 600 (4) 400

42. Which of the following properties supports transverse wave nature of light?

(1) Refraction (2) Interference

(3) Reflection (4) Polarisation

43. A Young's double slit is performed with two independent sources of same frequencies

(1) We get clear pattern

(2) We get well defined dark and bright fringes

(3) Pattern is not clear because phase difference is not constant for two independent sources

(4) None of these

44. The minimum thickness of film which will strongly reflect the light of λ = 300 nm, the R.I of material of film is 1.25

(1) 120 nm (2) 100 nm

(3) 110 nm (4) 90 nm

45. In Lloyd's mirror experiment, we generate one source by reflection because we need two sources

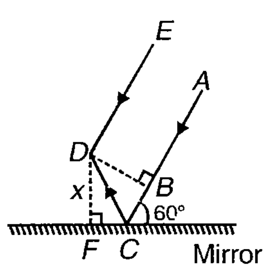
(1) Producing light of same intensities

(2) Producing light of same wavelength

(3) Coherent in nature

(4) Incoherent in nature

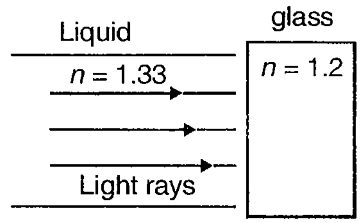
46. For the two parallel rays *AB* and *DE* shown here, *BD* is the wavefront. For what value of wavelength of rays destructive interference takes place between ray *DE* and reflected ray *CD* ?



(1) $\sqrt{3}\,x$ (2) $\sqrt{2}\,x$

(3) x (4) $2x$

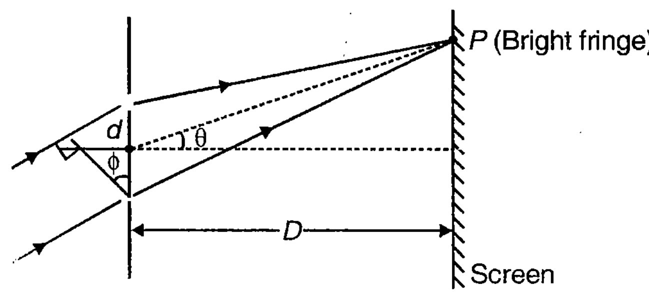
47. When light rays reflect from the liquid glass interface shown here, there is a phase difference of α between incident and reflected wave, then α is equal to



(1) 0 (2) π

(3) $\frac{\pi}{2}$ (4) $\frac{\pi}{3}$

48. For maxima (bright fringe) at point *P*, relation between given quantities is



(1) $|d\sin\phi - d\sin\theta| = \text{odd}\left(\frac{\lambda}{2}\right)$

(2) $|d\sin\phi - d\sin\theta| = n\lambda$

(3) $|d\sin\phi - d\sin\theta| = \text{odd}\left(\frac{\lambda}{4}\right)$

(4) None of these

49. Consider the three waves represented by

$$y_1 = 3\sin(kx - \omega t)$$

$$y_2 = 3\sin\left(kx - \omega t + \frac{2\pi}{3}\right)$$

$$y_3 = 3\sin\left(kx - \omega t + \frac{4\pi}{3}\right)$$

What is the amplitude of resultant of waves at $x = 0$?

(1) 0 (2) 9

(3) 6 (4) 1

50. In YDSE, how many maximas can be obtained on a screen including central maxima in both sides of the central fringe if λ = 3000Å, d = 5000Å?

(1) 2 (2) 5

(3) 3 (4) 1

(IIT-JEE 2008)

50(a). In a Young's double slit experiment, the separation between the two slits is d and the wavelength of the light is λ. The intensity of light falling on slit 1 is four times the intensity of light falling on slit 2. Choose the correct choice(s).

(1) If $d = \lambda$, the screen will contain only one maximum

(2) If $\lambda < d < 2\lambda$, at least one more maximum (besides the central maximum) will be observed on the screen

(3) If the intensity of light falling on slit 1 is reduced so that it becomes equal to that of slit 2, the intensities of the observed dark and bright fringes will increase

(4) If the intensity of light falling on slit 2 is increased so that it becomes equal to that of slit 1, the intensities of the observed dark and bright fringes will increase

51. Two beams of light having intensities I and $4I$ interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\frac{\pi}{2}$ at point A and π at point B. Then the difference between the resultant intensities at A and B is

(1) $2I$ (2) $4I$

(3) $5I$ (4) $7I$

52. In a YDSE bichromatic light of wavelengths 400 nm and 560 nm are used. The distance between the slits is 0.1 mm and the distance between the plane of the slits and the screen is 1 m. The minimum distance between two successive regions of complete darkness is

(1) 4 mm (2) 5.6 mm

(3) 14 mm (4) 28 mm

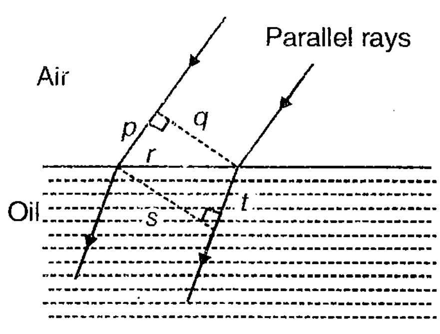
53. In the diagram shown, various lengths have been indicated. Refractive index of the oil w.r.t. air is

(1) $\frac{q}{s}$

(2) $\frac{p}{r}$

(3) $\frac{s}{q}$

(4) $\frac{p}{s}$



54. Threshold wavelength for photoelectric emission in tungsten is 230 nm. The wavelength of light that must be used in order for electrons with maximum energy of 1.5 eV to be ejected is

(1) 120 nm (2) 130 nm

(3) 180 nm (4) 200 nm

55. Consider the following statements

(i) Bound electrons can absorb whole energy of incident photon

(ii) Isolated free electrons can't absorb whole energy of photon

(iii) Classical mechanics permits massless particles to carry energy and momentum

(iv) Energy and momentum of electrons are related as $E = pc$

The incorrect statements are

(1) (ii) and (iii) (2) (iii) and (iv)

(3) All of these (4) None of these

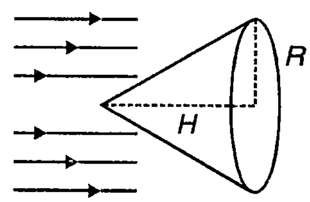
56. The radiation force experienced by body exposed to radiation of intensity I(as shown in figure), assuming surface of body to be perfectly absorbing, is

(1) $\frac{\pi R^2 I}{c}$

(2) $\frac{2\pi R^2 I}{c}$

(3) $\frac{4\pi R^2 I}{c}$

(4) None of these



57. A metal ball is illuminated by UV radiation of wavelength 200 nm. The work function of metal is 2 eV. The electric potential acquired as a result of photoelectric effect is

(1) 4.2 V (2) 3.2 V

(3) 1.2 V (4) Data insufficient

58. The surface of metal with work function ϕ is illuminated by electromagnetic radiation whose electric field component is $E = a(1 + \cos\omega t)\cos\omega_0 t$. Then maximum kinetic energy of photoelectron liberated from surface is

(1) $\frac{h}{2\pi}\omega - \phi$ (2) $\frac{h\omega_0}{2\pi} - \phi$

(3) $\frac{h(\omega+\omega_0)}{2\pi} - \phi$ (4) $\frac{h(\omega-\omega_0)}{2\pi} - \phi$

59. Photoelectric effect is observed from a surface for frequency's 3×10^{14} Hz and 2×10^{14} Hz for incident radiation. If maximum kinetic energies are in ratio 2 : 1 then threshold frequency is

(1) 10^{14} Hz (2) $\frac{3}{2}\times10^{14}$ Hz

(3) $\frac{4}{3}\times10^{14}$ Hz (4) None of these

60. Maximum kinetic energy of photoelectron is E and its wavelength of incident light is $\frac{\lambda}{2}$. If energy becomes double when wavelength becomes $\frac{\lambda}{3}$, then work function of metal is

(1) $\frac{3hc}{\lambda}$ (2) $\frac{hc}{3\lambda}$

(3) $\frac{hc}{\lambda}$ (4) $\frac{hc}{2\lambda}$

61. Light quanta with an energy 4.9 eV eject photo electrons from metal with work function 4.5 eV. The maximum impulse transmitted to the surface of the metal when each electrons flies out is

(1) 1.34×10^{-25} kg-m/s (2) 3.45×10^{-25} kg-m/s

(3) 1.43×10^{-25} kg-m/s (4) 5.43×10^{-25} kg-m/s

62. A moving hydrogen atom absorbs a photon of wavelength 122 nm and comes to rest. Then speed of moving hydrogen was

(1) 3.25 m/s (2) 6.5 m/s

(3) 1.75 m/s (4) None of these

63. Which of the following statements are incorrect about photoelectric effect?

(1) Photoelectric effect supports quantum nature of radiation

(2) Maximum kinetic energy of photoelectric effect is proportional to frequency of incident radiation

(3) The phenomena of photoelectric effect is almost instantaneous

(4) Saturation photocurrent is proportional to intensity of radiation

64. When a monochromatic point source of light is at distance of 0.2 m from a photoelectric cell, the cut off voltage and saturation current are respectively 0.6 V and 18 mA. If same source is placed 0.6 m away from photoelectric cell then

(1) Stopping potential will be 0.2 volt

(2) Stopping potential will be 0.6 volt

(3) Saturation current will be 6 mA

(4) Saturation current will be 4 mA

65. An X-ray tube is operated 20 kV. The shortest wavelength emitted is

(1) 0.89 Å (2) 0.75 Å

(3) 0.62 Å (4) None of these

66. Atomic number of element which has k_α X-ray line of wavelength 1.785 Å is

(1) 27 (2) 26

(3) 25 (4) None of these

67. Efficiency of an X-ray tube with molybednum ($Z = 42$) as the target and operating at 100 kV is

(1) 0.59% (2) 0.89%

(3) 0.69% (4) None of these

68. X-ray are produced in coolidge tube at given accelerating voltage. The wavelength of continuous X-rays has values from

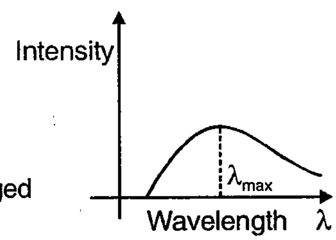
(1) Zero

(2) λ_{min} to infinity and $\lambda_{min} > 0$

(3) λ_{min} to λ_{max} and $0 < \lambda_{min} < \lambda_{max} < \infty$

(4) Zero to λ_{max} and $\lambda_{max} < \infty$

69. λ_{max} is wavelength at which intensity of continuous X-ray radiation is maximum as shown in figure. As operating tube voltage is increased λ_{max}



(1) Increases

(2) Decreases

(3) Remains unchanged

(4) Can't say

70. If frequency of k_α X-ray emitted from the element with atomic number 31 is f, then frequency of k_α X-ray emitted from the element with atomic number 51 would be (Assuming screening constant for k_α X-rays is 1)

(1) $\frac{5}{3}f$ (2) $\frac{51}{31}f$

(3) $\frac{9}{25}f$ (4) $\frac{25}{9}f$

71. According to Moseleys law ratio of slopes of graph between $\sqrt{f}$ and Z for k_β and k_α is

(1) $\sqrt{\frac{32}{27}}$ (2) $\sqrt{\frac{27}{32}}$

(3) $\sqrt{\frac{33}{22}}$ (4) $\sqrt{\frac{22}{33}}$

72. An X-ray tube is operating at 100 kV and 10 mA. Assuming 0.2% of energy is converted into X-ray, the rate at which target is heated is

(1) 432.6 cal/s

(2) 238.75 cal/s

(3) 329.7 cal/s

(4) None of these

73. Which of the following is incorrect regarding constants a and b appearing in Moseley's law?

(1) a and b are independent of target material

(2) a and b depend on series

(3) a for K_α X-rays is $\sqrt{\frac{3Rc}{4}}$

(4) a is different for different series but is same for every member of particular series

74. In X-ray tube, anode should be made of material

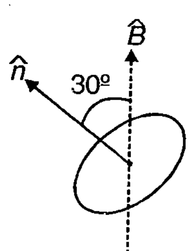
(1) High atomic number and low thermal conductivity

(2) High atomic number and high thermal conductivity

(3) Low atomic number and low thermal conductivity

(4) Low atomic number and high thermal conductivity

75. An electron in the ground state of hydrogen atom is revolving in anti-clock wise direction in the circular orbit of radius R as shown in figure and this atom is placed in a uniform magnetic induction B, such that the plane normal of the electron orbit makes an angle 30º with the magnetic induction. The torque experienced by the orbiting electron is



(1) $\frac{8ehB}{\pi m}$ (2) $\frac{ehB}{4\pi m}$

(3) $\frac{4ehB}{\pi m}$ (4) $\frac{ehB}{8\pi m}$

76. Which state of triply ionised (Be^{3+}) has same orbital radius as that of ground state of hydrogen?

(1) $n = 1$ (2) $n = 2$

(3) $n = 3$ (4) None of these

77. If 9.5 eV of energy is supplied to H atom the number of spectral lines emitted is equal to

(1) 0 (2) 1

(3) 2 (4) 3

78. A hydrogen atom in a state having a binding energy of 0.85 eV makes a transition to a state with excitation energy 10.2 eV. The energy of photon emitted is

(1) 2.55 eV (2) 3.42 eV

(3) 5.25 eV (4) 7.53 eV

79. At an instant, two electrons are moving with same speed v: one in region of uniform electric field and other in uniform magnetic field. After some time if de Broglie wavelength of two electrons respectively are λ_1 and λ_2 then

(1) $\lambda_1 = \lambda_2$ (2) $\lambda_1 > \lambda_2$

(3) $\lambda_1 < \lambda_2$ (4) None of these

80. Find binding energy of an electron in ground state of hydrogen like atom in whose spectrum the third of corresponding Balmer series is 108.5 nm

(1) 54.4 eV

(2) 13.6 eV

(3) 112.4 eV

(4) None of these

81. The emission spectrum of H atom consist of

(1) Balmer series only

(2) Lyman series only

(3) Paschen series only

(4) All the series

82. An electron in hydrogen atom makes transition from n_1 to n_2 state. The time period of revolution of electron in initial state is 8 times than in final state then possible values of n_1 and n_2 are

(1) $n_1 = 4$ to $n_2 = 2$

(2) $n_1 = 8$ to $n_2 = 2$

(3) $n_1 = 8$ to $n_2 = 1$

(4) $n_1 = 6$ to $n_2 = 4$

83. If the short series limit of the Balmer series for hydrogen is 3644 Å. The approximate atomic number of the element which give X-ray wavelength down to 1 Å is

(1) $z = 31$ (2) $z = 16$

(3) $z = 8$ (4) $z = 13$

84. An excited hydrogen atom emits photon of wavelength λ in returning to ground state. The quantum number n of excited state is given by (R = Rydberg constant)

(1) $\frac{\sqrt{\lambda R(\lambda R-1)}}{2}$ (2) $\sqrt{\frac{\lambda R}{\lambda R-1}}$

(3) $\sqrt{\frac{(\lambda R-1)}{\lambda R}}$ (4) $\frac{1}{\sqrt{\lambda R(\lambda R-1)}}$

85. If shortest wavelength of Lyman series of hydrogen atom is x, the wavelength of first member of Balmer series of hydrogen atom is

(1) $\frac{9x}{5}$ (2) $\frac{36}{5}x$

(3) $\frac{5x}{9}$ (4) $\frac{5x}{36}$

86. In certain electronic transition from quantum level n to ground state in atomic hydrogen in one or more steps no line belonging to Brackett series is observed. The wave numbers which may be observed in Balmer series is

(1) $\frac{8R}{9}, \frac{5R}{36}$ (2) $\frac{3R}{16}, \frac{8R}{9}$

(3) $\frac{5R}{36}, \frac{3R}{16}$ (4) $\frac{3R}{4}, \frac{3R}{16}$

87. When electron and its antiparticle (positron) revolve around their centre of mass, the system so formed is called positronium ion. In which part of electromagnetic spectrum does positronium ion radiate when it deexcites from its first excited state to ground state

(1) Ultraviolet

(2) Visible

(3) Infra-red

(4) Insufficient information

88. An electron with kinetic energy 9 eV is incident on hydrogen atom in its ground state, the collision

(1) Must be elastic

(2) May be partially elastic

(3) Must be completely inelastic

(4) May be completely inelastic

89. An excited free hydrogen at rest undergoes transition from $n = 3$ to $n = 1$ emitting photon of wavelength λ then

(1) $\lambda < 103$ nm (2) $\lambda > 103$ nm

(3) $\lambda = 103$ nm (4) None of these

90. In above question of photon is emitted opposite to direction of motion of wavelength λ of photon is

(1) $\lambda < 103$ nm (2) $\lambda > 103$ nm

(3) $\lambda = 103$ nm (4) None of these

91. Which of the following is incorrect regarding α particles?

(1) Streak of doubly ionised helium atom

(2) Ionisation power is more than of β rays

(3) Penetration power is less compared to γ rays

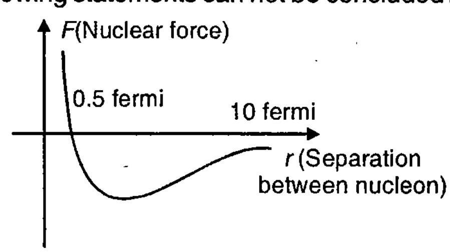
(4) Speed is more than β rays

92. A container is filled with radioactive substance for which half life is 2 days. A week later, when container is opened it contains 5 grams of substance. Approximately how many grams of substance were initially placed in container?

(1) 40 (2) 60

(3) 80 (4) 100

93. The dependence of nuclear force on distance between nucleons is not known precisely but approximate variation is shown graphically. From graph which of following statements can not be concluded?



(1) Nuclear force is repulsive for separation less than 0.5 fermi

(2) Nuclear force is attractive for separation less than 0.5 fermi

(3) Nuclear force is attractive for separation more than 0.5 fermi

(4) Nuclear force is negligible when separation between nucleon is more than 10 fermi

94. What is probability that a nucleus decays in time t? (Given that decay constant is λ)

(1) $e^{-\lambda t}$ (2) $1 - e^{-\lambda t}$

(3) $e^{\lambda t}$ (4) $1 - e^{\lambda t}$

95. The fraction f_1 of radioactive sample decays in one mean life and fraction f_2 decays in one half life then the correct relation is

(1) $f_1 > f_2$

(2) $f_1 < f_2$

(3) $f_1 = f_2$

(4) May be (1), (2) or (3) depending on values of mean life and half life

96. There are two radioactive nuclei A and B. A is α emitter while B is beta emitter. Their disintegration constants are in ratio of 1 : x. What should be ratio of number of nuclei of A and B at any time t so that probabilities of getting number of α and β particles are same at that instant?

(1) $x : 1$ (2) $1 : x$

(3) $e : 1$ (4) $1 : e$

97. A sample of radioactive material has mass m, decay constant λ and molar mass M. Avogadro constant is N_A. The initial activity of sample is

(1) λM (2) $\frac{\lambda m}{M}$

(3) $\frac{\lambda m N_A}{M}$ (4) $mN_A e^{-\lambda t}$

98. In above question the activity of substance after t s is

(1) $\left(\frac{mN_A}{M}\right)e^{\lambda t}$ (2) $\left(\frac{mN_A}{M}\right)e^{-\lambda t}$

(3) $\left(\frac{mN_A}{M\lambda}\right)e^{-\lambda t}$ (4) $\frac{m}{\lambda}(1 - e^{-\lambda t})$

99. For Uranium nucleus how does it mass vary with volume?

(1) $m \propto V$ (2) $m \propto \frac{1}{\sqrt{2}}$

(3) $m \propto \frac{1}{V}$ (4) $m \propto V^2$

100. The activity of sample of radioactive material is A_1 at time t_1 and A_2 at time t_2 ($t_2 > t_1$). Its mean life is T then

(1) $A_1 t_1 = A_2 t_2$ (2) $\frac{A_1 - A_2}{t_2 - t_1} = \text{constant}$

(3) $A_2 = A_1 e^{\frac{(t_1 - t_2)}{T}}$ (4) $A_2 = A_1 e^{\left(t_1/t_2/T\right)}$

101. Which of the following processes represents γ decay?

(1) ${}^AX_Z + \gamma \rightarrow {}^AX_{Z-1} + a + b$

(2) ${}^AX_Z + {}^1n_0 \rightarrow {}^{A-3}X_{Z-2} + c$

(3) ${}^AX_Z \rightarrow {}^AX_Z + f$

(4) ${}^AX_Z + {}_{-1}e^0 \rightarrow {}^AX_{Z-1} + g$

102. Two radioactive materials X_1 and X_2 have decay constant 11λ and λ respectively. If initially they have same number of nuclei, then ratio of number of nuclei of X_1 to X_2 will be $\frac{1}{e^2}$ after a time

(1) $\frac{1}{5\lambda}$ (2) $\frac{1}{11\lambda}$

(3) $\frac{1}{10\lambda}$ (4) $\frac{1}{9\lambda}$

103. A star initially has 10^{44} duetrons. It produces energy via process given by

${}_1H^2 + {}_1H^2 \rightarrow {}_1H^1$ and ${}_1H^2 + {}_1H^3 \rightarrow {}_1He^4 + {}_1n^1$

The mass of nuclei are as follows

$m(H^2) = 2.014$ amu $m_p = 1.007$ amu

$m_n = 1.008$ amu $m(He^4) = 4.001$ amu

If the average power radiated by star is 10^{20} W the deutron supply of star is exhausted in time of order of

(1) 10^8 s (2) 10^{10} s

(3) 10^{12} s (4) 10^{14} s

104. Which of the following particles may show unstable behaviour?

(1) Electron (2) Neutron

(3) Proton (4) Alpha particle

105. A neutrino is

(1) Has no charge and has no spin

(2) Has no charge but has spin

(3) Charged like an electron but has spin

(4) Uncharged but has mass nearly that of proton

106. Radon 220 decays to Bismuth 212 by the following series of decay

${}_{86}Rn^{220} \rightarrow {}_{84}Po^{216} + {}_2He^4$; $T_{1/2} = 55$ s

${}_{84}Po^{216} \rightarrow {}_{82}Pb^{212} + {}_2He^4$; $T_{1/2} = 0.016$ s

${}_{82}Pb^{212} \rightarrow {}_{83}Bi^{212} + {}_{-1}e^0$; $T_{1/2} = 10.6$ hrs

If certain mass of radon is allowed to decay in certain container, after five minutes element with greatest and least mass will respectively be

(1) Radon, bismuth (2) Polonium, lead

(3) Lead, bismuth (4) Bismuth, lead

107. Pick nuclear fusion reaction from the following

(1) ${}_{6}C^{13} + {}_{1}H^{1} \rightarrow {}_{6}C^{14} + 4.3$ MeV

(2) ${}_{6}C^{12} + {}_{1}H^{1} \rightarrow {}_{7}C^{13} + 2$ MeV

(3) ${}_{7}N^{14} + {}_{1}H^{1} \rightarrow {}_{7}O^{15} + 7.3$ MeV

(4) ${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{54}Xe^{140} + {}_{88}Sr^{94} + 2\,{}_{0}n^{1} + 200\text{ MeV}$

108. Consider fission reaction : ${}_{92}U^{236} \rightarrow X^{117} + Y^{117} + 2\,{}_{0}n^{1}$. Two nuclei of same mass number 117 are formed along with two neutrons. The binding energy per nucleon of X is 8.5 MeV, whereas that of U^{236} is 7.6 MeV the total energy liberated will be about

(1) 2 MeV (2) 20 MeV

(3) 195.4 MeV (4) 2000 MeV

109. Consider screening effect of electrons in helium atom which consists of two electrons orbiting round the nucleus and estimate the effective atomic number of helium atom in ground state. The ionisation potential for helium atom in its ground state is measured experimentally to be 24.46 V

(1) 1.3 (2) 1.4

(3) 1.5 (4) 1.7

110. In Bohr's model of hydrogen atom let R, V and E represent radius of orbit, speed of electron and total energy of electron respectively. Which of following quantities is proportional to quantum number n?

(1) $\frac{VR}{E}$ (2) RE

(3) $\frac{V}{E}$ (4) $\frac{R}{E}$

111. A uniform magnetic field B exists in a region. An electron projected perpendicular to field goes in a circle. Assuming Bohr's quantization rule for angular momentum is valid, then minimum possible speed of electron is

(1) $\sqrt{\frac{heB}{2m^2}}$ (2) $\sqrt{\frac{heB}{\pi m^2}}$

(3) $\sqrt{\frac{heB}{2\pi m^2}}$ (4) $\sqrt{\frac{he}{\pi B m^2}}$

112. X-ray can be made harder by

(1) Increasing potential difference between Cathode and Anode

(2) Decreasing potential difference between Cathode and Anode

(3) Increasing current through filament

(4) Decreasing current through filament

113. If λ_{min} is minimum wavelength produced in X-ray tube and $\lambda_{k\alpha}$ is wavelength of k_α line. As operating tube voltage is increased

(1) $(\lambda_{k\alpha} - \lambda_{min})$ increases

(2) $(\lambda_{k\alpha} - \lambda_{min})$ decreases

(3) $\lambda_{k\alpha}$ increases

(4) $\lambda_{k\alpha}$ decreases

114. Electrons with energy 80 keV are incident on tungsten target of X-ray tube. K shell electrons of tungsten have –72.5 keV energy. X-rays emitted by the tube contain

(1) A continuous X-ray spectrum with minimum wavelength 0.155 Å

(2) Only a continuous X-ray spectrum with all wavelength

(3) Characteristic X-ray spectrum of tungsten

(4) Both (1) & (3)

115. Work function of Al is 4.2 eV. If two photons each of energy 3.5 eV strike an electron of aluminium, then emission of electron

(1) Will be possible

(2) Depends on smoothness of surface

(3) Will not be possible

(4) None of these

116. In photoemissive cell with exciting wavelength λ the fastest electron has speed v. If the exciting wavelength is changed to $\frac{3\lambda}{4}$, the speed of fastest emitted electron will be

(1) $v\left(\frac{3}{4}\right)^{1/2}$

(2) $v\left(\frac{4}{3}\right)^{1/2}$

(3) Less than $v\left(\frac{4}{3}\right)^{1/2}$

(4) Greater than $v\left(\frac{4}{3}\right)^{1/2}$

❑ ❑ ❑

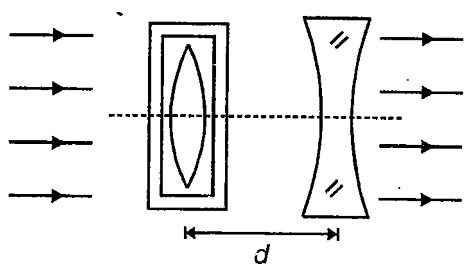
SECTION - B

Multiple Choice Questions

This section contains 44 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **MORE THAN ONE** is correct.

Choose the correct answers :

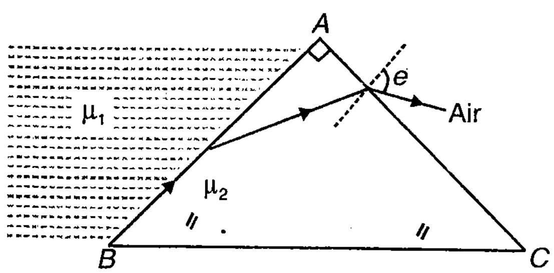
1. Consider the figure shown. A system consists of a coaxial glass slab (with convex lens of focal length f_1 inside it) and a concave lens (of focal length f_2) separated by distance d. A parallel beam of light is incident on the glass slab and correspondingly a parallel beam of light emerges out of the concave lens. Choose the possibly correct alternatives in this situation



(1) $d > f_1$ (2) $d < f_1$

(3) $d > f_1 - f_2$ (4) $d < f_2$

2. A ray of light is incident grazingly on face AB of a right angled prism as shown. It emerges out of face AC, as shown, e = Angle of emergence. Refractive indices of different media have been shown in the diagram. Choose the correct alternatives



(1) $\mu_1^2 + \sin^2 e = \mu_2^2$

(2) $\mu_2^2 + \sin^2 e = \mu_1^2$

(3) $\mu_1^2 + \cos^2 e = \mu_2^2$

(4) If the ray just fails to emerge out of the face AC of the prism, for $\mu_2 = \sqrt{3}$, angle of refraction at face AB is $\sin^{-1}\sqrt{\frac{2}{3}}$

3. For a real object, magnification produced by a mirror is +2.5. Choose the correct statements regarding the mirror

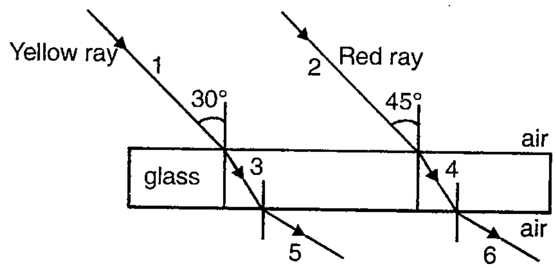
(1) Mirror must be a convex mirror

(2) Mirror can be a concave or a convex mirror

(3) Mirror cannot be a plane mirror

(4) Mirror must be concave mirror, with object between pole and focus

4. Rays of different colours are passing through a slab as shown. Which of the following is/are incorrect?



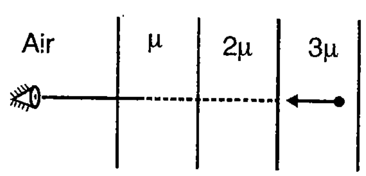
(1) Ray 1 and ray 2 are parallel

(2) Ray 5 and ray 6 are parallel

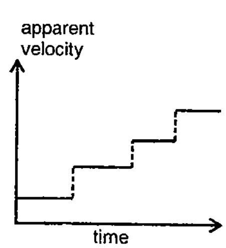
(3) Ray 1 and ray 5 are parallel

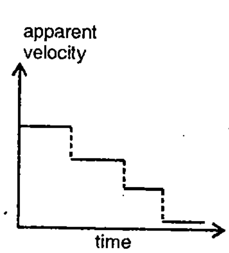
(4) Ray 3 and ray 1 must be parallel

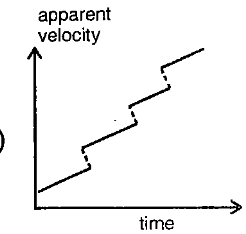
5. A particle is moving with a real velocity v m/s along a straight line shown. An observer at the end of the same line is viewing the particle which of the following graphs are not representing the velocity of the particle as seen by the observer?

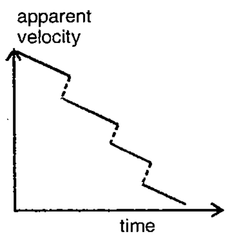


All the medium boundaries are in the state of rest

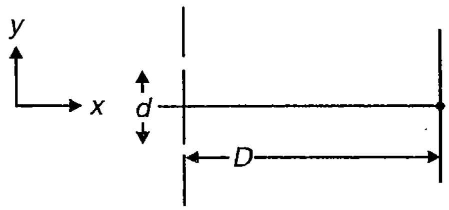
(1)


(2)


(3) 

(4) 

6. If screen is shifted in x direction away from source, then which of the following is incorrect?



(1) Central maxima is shifted along y-axis

(2) Position of all maximas except the central maxima change

(3) Fringe width remains constant

(4) Angular width changes due to shifting

7. Which of the following is correct?

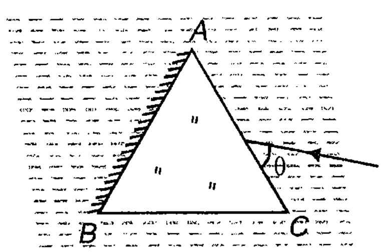
(1) For point source intensity $I = \frac{\text{constant}}{r^2}$.(r is the distance from point source)

(2) For line source intensity $I = \frac{\text{constant}}{r}$

(3) For plane wave front intensity I = constant r

(4) For cylindrical wave front intensity $I = \frac{\text{constant}}{r}$

8. An equilateral prism ABC (polished at its surface AB) is surrounded by a liquid of refractive index μ. A ray is incident on its face AC as shown. Refractive index of the material of the prism is $\frac{3}{2}$. Choose the correct statement(s)



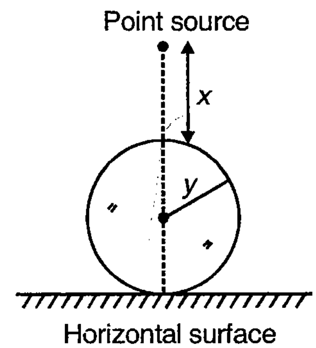
(1) θ for which the ray retraces back its path is $\sin^{-1}\left(\frac{3\sqrt{3}}{4\mu}\right)$

(2) θ for which the ray retraces back its path is $\cos^{-1}\left(\frac{3\sqrt{3}}{4\mu}\right)$

(3) For $\theta = 45°$ and $\mu = \frac{3}{2\sqrt{2}}$, deviation of the ray finally emerging out of the prism is 150°

(4) For $\theta = 45°$ and $\mu = \frac{3}{2\sqrt{2}}$, deviation of the ray finally emerging out of the prism is 0°

9. A point source of light is placed directly above an opaque sphere of radius y placed on a horizontal surface



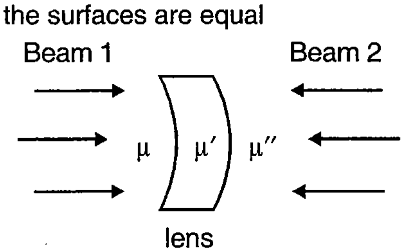
(1) For $x = \frac{2y}{3}$, radius of shadow formed on horizontal surface is $2y$

(2) For $x = y$, radius of the shadow formed on horizontal surface is $\sqrt{3}y$

(3) For $x = \frac{2y}{3}$ and for surrounding medium having refractive index $\sqrt{3}$, radius of shadow formed on horizontal surface is $2y$

(4) For $x = y$ and for surrounding medium having refractive index $\sqrt{3}$, radius of the shadow formed on horizontal surface is $\sqrt{2}\,y$

10. The lens (thin) shown here is surrounded by different media on both sides. Radii of curvature of both the surfaces are equal



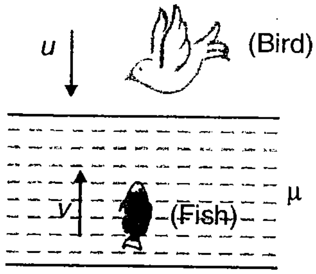
(1) Focal length of the lens is independent of μ' for both the beams

(2) If the lens is converging for beam 1 it will also be converging for beam 2

(3) If $\mu > \mu''$, lens is converging for beam 2

(4) If $\mu \le \mu''$, lens is converging for beam 1

11. Consider the figure shown. A fish is moving up towards the surface of the lake with speed v. A bird is diving towards the lake surface to catch the upcoming fish with speed u. Refractive index of water = μ. Choose the correct alternatives



(1) Speed of the bird as observed by the fish is $\mu.u + v$

(2) Speed of the fish as observed by the bird is $\frac{v}{\mu} + u$

(3) Speed of the bird as observed by the fish may be equal to the actual speed (w.r.t. ground) of the bird

(4) Speed of the fish as observed by the bird may be equal to the actual speed (w.r.t. ground) of the fish

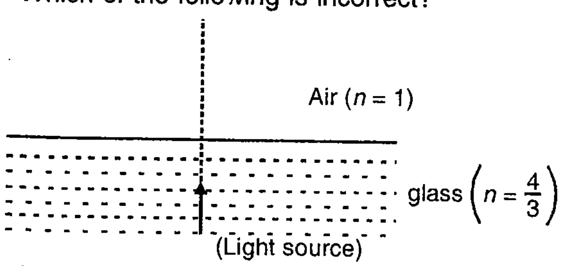
(IIT-JEE 2009)

11(a). A ball is dropped from a height of 20 m above the surface of water in a lake. The refractive index of water is 4/3. A fish inside the lake, in the line of fall of the ball, is looking at the ball. At an instant, when the ball is 12.8 m above the water surface, the fish sees the speed of ball as [Take g = 10 m/s^2.]

(1) 9 m/s (2) 12 m/s

(3) 16 m/s (4) 21.33 m/s

12. A light source is submerged inside water. It is moving in upward direction due to buoyancy force. Which of the following is incorrect?



(1) Percentage of light transfering from water to air is increasing

(2) Percentage of light transfering from water to air is constant

(3) Base area of light cone is increasing

(4) Base area of light cone is decreasing

(IIT-JEE 2010)

12(a). A large glass slab (μ = 5/3) of thickness 8 cm is placed over a point source of light on a plane surface. It is seen that light emerges out of the top surface of the slab from a circular area of radius R cm. What is the value of R?

13. Which of the following statements is incorrect?

(1) Size of image on retina of eyes only depends upon size of object

(2) Minimum deviation produced by a prism is independent of angle of prism

(3) Only real images are formed by a concave mirror

(4) Convex mirror always forms real image

14. Which of the following is incorrect?

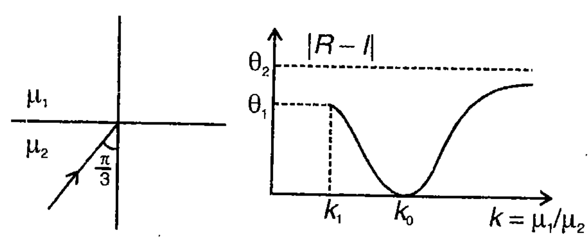
(1) A soap bubble when viewed in white light shows colours due to scattering

(2) Prism generates spectrum of colour due to interference

(3) A soap bubble when viewed in white light shows colours due to interference

(4) Main cause behind generation of rainbow is total internal reflection

15. The figure shows a ray incident at angle $i = \frac{\pi}{3}$. The plot drawn shows the variation of $k = \frac{\mu_1}{\mu_2}$ and $|r - i|$, where r is angle of refraction. Using the graph, find the correct options. (The angle of incident is maintained constant at $\frac{\pi}{3}$)



(1) $\theta_1 = 30°$ (2) $\theta_2 = 60°$

(3) $k_1 = \frac{\sqrt{3}}{2}$ (4) $k_0 = 1$

16. Consider a Young's double slit arrangement with slit separation d, distance between slits and screen equal to D and intensity of each slit equals to I. If wavelength of light used is λ, then (Angular position θ of any point on the screen is measured w.r.t. center point between the slits)

(1) Intensity at a point with angular position $\theta = \frac{\lambda}{4d}$, is $2I$

(2) If the screen is shifted away from the slits, angular position of first maxima remains unchanged

(3) If a glass slab is placed in front of one of the slits and the incident wavefront on the slits is planar, it may happen that the central maxima is symmetrically located on the screen

(4) If the arrangement is immersed in an oil of refractive index μ, fringe width becomes $\frac{1}{\mu}$ times

17. Which of these are correct regarding interference due to thin films in different physical situations?

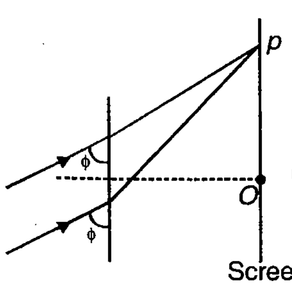
(1) An oil film produces destructive interference for reflected light for a minimum thickness $\frac{\lambda}{2}$ (λ = wavelength of light in air, rays are normally incident)

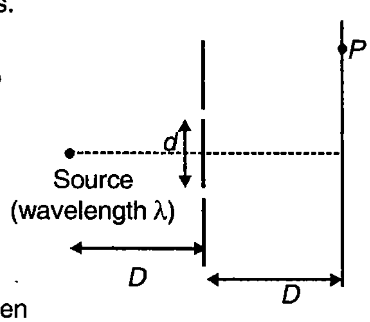
(2) An oil film produces destructive interference for reflected light for a minimum thickness $\frac{\lambda}{2}$ (λ = wavelength of light in oil, rays are normally incident)

(3) An oil film of thickness $\frac{\lambda}{\sqrt{3}}$ may show destructive interference for transmitted light (λ = wavelength of light in oil, rays are normally incident)

(4) An oil film of thickness $\frac{\lambda}{\sqrt{3}}$ may show destructive interference for transmitted light (λ = wavelength of light in air, rays are normally incident)

18. For YDSE apparatus shown in figure, choose the correct statements.





(1) If source performs SHM then point P is n^{th} order maxima will also perform SHM with same frequency.

(2) If $d = 20.7\lambda$ then number of maxima and minima are 41 & 42 respectively

(3) If $d = 20.2\,\lambda$ then number of maxima and minima will be 41 & 40 respectively

(4) For all maxima, geometrical path difference must be zero

19. A scientist is trying to eject electrons from a metal by shining a light on it. The electrons are bound inside by an energy of 4.2 eV. Which of the following wavelenths are not useful

(1) 640 nm (2) 420 nm

(3) 350 nm (4) 250 nm

20. When a monochromatic light source is at 0.2 m from photoelectric cell, the cut off voltage and saturation current are 0.6 V and 18 mA respectively. If same source is placed 0.6 m away from photoelectric cell then

(1) Stopping potential will be 0.2 V

(2) Stopping potential will be 0.6 V

(3) Saturation current will be 6 mA

(4) Saturation current will be 2 mA

21. The threshold wavelength for photoelectric emission from material is 5200 Å. Photo electrons will be emitted when this material is illuminated with monochromatic radiation from a

(1) 50 W infrared lamp

(2) 20 W infrared lamp

(3) 50 W UV lamp

(4) 20 W UV lamp

22. Choose the correct statements regarding distribution of intensity w.r.t. wave length on increasing the acceleration voltage in a collidge tube set up.

(1) λ_{min} decreases

(2) Intensity corresponding to each λ changes

(3) Characteristic part of the spectrum does not change

(4) Tube current does not change

23. If electron of hydrogen atom is replaced by another particle of same charge but of double mass then

(1) Bohr radius increases

(2) Ionisation energy of atom will be doubled

(3) Speed of new particle in given state will be lesser than electron's speed in same orbit

(4) Gap between energy levels will now be doubled

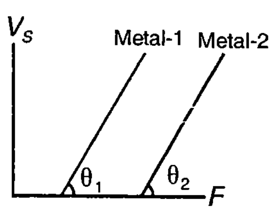
24. Which of following is not correct regarding nuclear forces?
    (1) Charge dependent
    (2) Nuclear forces are generated due to exchange of π meason
    (3) Obey principle of superposition
    (4) Total force between P - P < N - N = P - N

25. A photon beam is incident on a mirror and reflected back. Choose the correct option.
    (1) Reflected beam has lesser energy than incident beam
    (2) Lost energy is due to absorption of photons by mirror
    (3) Lost energy is due to energy loss in each photon
    (4) Reflected beam has high energy than incident beam due to energy gain in reflection

26. How many transition pair are possible in hydrogen atom which give the same frequency of radiations.
    (1) 1 (2) 2
    (3) 3 (4) 4

27. A photon moves vertically up in a region with gravitational field g downwards. Frequency of photon at an instant is ν. After it has moved up by height h
    (1) Its speed decreases
    (2) Its energy decreases
    (3) Its frequency is $\nu\left(1-\frac{gh}{c^2}\right)$
    (4) Its frequency is $\nu e^{-\frac{gh}{c^2}}$

28. The given graph is showing variation of stopping potential (V_s) with frequency (f) of the incident photons for two different metals. Choose the correct statements



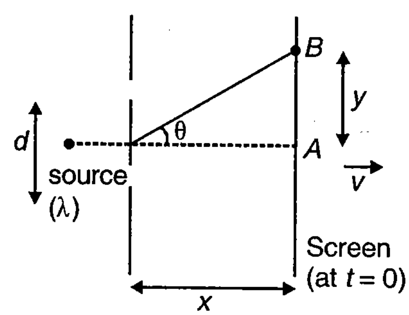
    (1) $\theta_1 = \theta_2$
    (2) If metal-1 is gold, metal-2 may be cesium
    (3) Work function of metal-1 is greater than work function of metal-2
    (4) Slope of the graph $= \frac{h}{e}$

29. In a YDSE arrangement, white light is used to illuminate the slits. At a point on the screen directly in front of the slits, which of these wavelengths is missing?
    (λ = wavelength of light used, d = distance between the slits, D = separation between the slits and the screen, $d << D$)
    (1) $\frac{d^2}{D}$ (2) $\frac{d^2}{3D}$
    (3) $\frac{d^2}{4D}$ (4) $\frac{d^2}{5D}$

30. A quantum particle in a box is in the lowest energy state. If the size of box is increased, the wavelength and energy of the particle change as
    (1) Wavelength increases
    (2) Energy decreases
    (3) Wavelength decreases
    (4) Energy increases

31. An electron in an H like atom is in excited state. It has total energy of –3.4 eV. Then
    (1) K.E. of electron is 3.4 eV
    (2) K.E. of electron is 6.8 eV
    (3) de Broglie wavelength of electron is 6.6 Å
    (4) P.E. of electron is 6.8 eV

32. In the YDSE arrangement shown here, the screen starts moving towards right at t = 0, as shown. Position of any point B on the screen can be specified by y or by angle θ as shown. Choose the correct statement(s)



    (1) At any point on the screen (for a given y) fringe order decreases with time
    (2) At any point on the screen (for a given θ) fringe order remains constant
    (3) At any point B on the screen (for a given y), at t = 0, 3rd order minima was positioned. After some time, 3rd order maxima may be positioned at that point
    (4) Point (for a given y), where 3rd order maxima is positioned at t = 0, 2nd order minima is positioned at time $t = \frac{x}{v}$

33. Considering Bohr's model to be valid for unielectron systems, choose the correct statement(s)
   (1) Angular momentum of an electron in second excited state in He^+ ion is equal to angular momentum of an electron in orbit with $n = 3$ in a Be^{3+} ion
   (2) When electron in fourth excited state in B^{4+} jumps to ground state, speed acquired by the boron ion is $\frac{24hR}{m}$. (m = mass of boron ion)
   (3) When electrons in a He^+ ion jumps from $n = 4$ to $n = 2$, radiations with wavelength in UV region are emitted
   (4) Maximum number of spectral lines emitted when an electron in Li^{2+} jumps from $n = 5$ to $n = 2$ is 6

34. Work function of a metal X equals ionisation energy of Li^{2+} ion in second excited state. Work function of another metal Y equals ionisation energy of He^+ ion with electron in $n = 4$. Now a photon of energy x falls on both the metals such that maximum kinetic energy of photoelectron emitted from metal X is half that of photoelectron emitted from metal Y. Choose the correct statement

   (E = Potential energy of electron in ground state of hydrogen atom)
   (1) $x = -3.5$ E
   (2) $x = -7$E
   (3) As x increases, difference in maximum kinetic energy of photo electrons increases
   (4) As x increases, difference in maximum kinetic energy of photo electrons remains constant

35. Consider a hypothetical atom with single electron. In this atom, when an electron de-excites from energy level $n = x$ to $n = 2$, wavelength(λ) of the radiation emitted is given by $\lambda = \frac{Ax^2}{x^2 - 4}$ (where A is a constant). Choose the correct alternatives
   (1) Least energetic photon emitted during such a transition will have wavelength 1.8 A
   (2) Most energetic photon emitted in such a transition will have wavelength A
   (3) Ionisation potential of the atom in its ground state is $\frac{hc}{1.8\text{ eA}}$
   (4) Ionisation potential of the atom in its first excited state is $\frac{hc}{\text{eA}}$

36. The energy, magnitude of linear momentum and orbital radius of an electron in hydrogen atom corresponding to quantum number n, are E, P and r respectively. Then according to Bohr's theory of hydrogen atom
   (1) $EPr \propto \frac{1}{n}$
   (2) $\frac{P}{E} \propto n$
   (3) $E \propto \frac{1}{n^2}$
   (4) $Pr \propto n$

37. Suppose potential energy between electron and proton at distance r is given by $-\frac{ke^2}{3r^3}$. Application of Bohr's theory of hydrogen atom in this case shows that
   (1) Energy in n^{th} orbit is proportional to n^6
   (2) Energy is proportional to m^{-3} (m : mass of electron)
   (3) Energy in n^{th} orbit is proportional to n^{-2}
   (4) Energy is proportional to m^3 (m : mass of electron)

38. The wavelength of k_α X-rays for lead isotopes Pb^{208}, Pb^{206}, Pb^{204} are λ_1, λ_2 and λ_3 respectively then
   (1) $\lambda_1 = \lambda_2 = \lambda_3$
   (2) $\lambda_1 > \lambda_2 > \lambda_3$
   (3) $\lambda_2 > \lambda_1 > \lambda_3$
   (4) $\lambda_2 = \sqrt{\lambda_1 \lambda_3}$

39. For a proton and an α-particle, λ_1 and λ_2 represent de-Broglie wavelengths respectively
   (1) If they have same moment a , $\lambda_1 = \lambda_2$
   (2) If they have same kinetic energies, $\lambda_1 = 2\lambda_2$
   (3) If they are accelerated through same potential difference, $\lambda_1 = 2\sqrt{2}\lambda_2$
   (4) λ_1 can never be lesser than λ_2

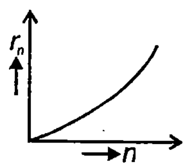
40. Let m_p be mass of proton, m_n be mass of neutron, M_1 mass of $^{20}_{10}Ne$ and M_2 mass of $^{40}_{20}Ca$ nucleus, then
   (1) $M_2 > 2M_1$
   (2) $M_2 = 2M_1$
   (3) $M_2 < 2M_1$
   (4) $M_1 < 2(m_n + m_p)$

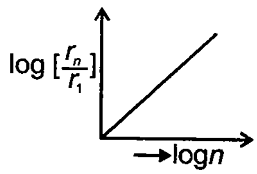
41. Which of the following transitions of He^+ ion will give rise to spectral line which has same wavelength as some spectral line in hydrogen atom?

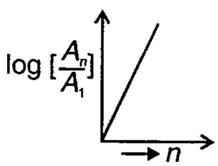
(1) $n = 4$ to $n = 2$ (2) $n = 6$ to $n = 5$

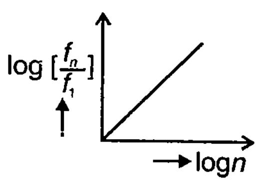
(3) $n = 6$ to $n = 3$ (4) $n = 8$ to $n = 4$

42. If, in a hydrogen atom, radius of n^{th} Bohr orbit is r_n, frequency of revolution of electron in nth orbit is f_n and area enclosed by n^{th} orbit is A_n, then which of the following graphs are correct?

(1) 

(2) 

(3) 

(4) 

43. a, b, c represent speed, angular momentum and radius of an electron in n^{th} orbit of a hydrogen atom. Choose the correct alternatives

(1) $\frac{b^2}{c}$ = constant (2) $\frac{b}{ac}$ = constant

(3) a^2c = constant (4) $\frac{c^2}{ab}$ = constant

44. Choose the correct alternative

(1) K_α wavelength emitted by an atom of atomic number $Z = 21$ is λ, then K_α wavelength emitted by an atom of atomic number $Z = 31$ is $\frac{4\lambda}{9}$

(2) Half life of a radioactive substance is 5 years. Probability that a nucleus decays in 10 years is $\frac{3}{4}$

(3) Mass number of a nucleus is always greater than its atomic number

(4) Gamma rays are emitted due to nuclear de-excitation

❑ ❑ ❑

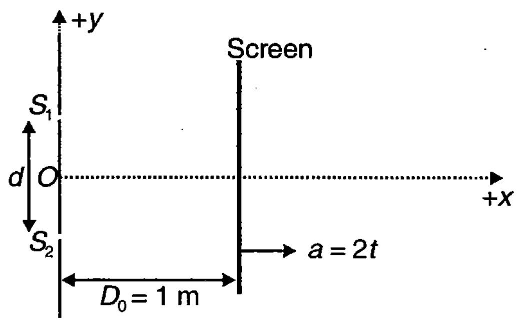
SECTION - C

Linked Comprehension Type

This section contains 16 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Comprehension

C1. A light of wavelength $\lambda = 1000$ Å is incident on the slit S_1 and S_2 separated by distance $d = 1$ mm. A horizontal screen S is accelerated from rest with an acceleration $a = 2t$, where t time in second along +ve x-axis from given position as shown in figure is initial separation between plane of slits and screen is $D_0 = 1$ m. Taking origin at O (mid point of S_1 and S_2) +ve x-axis and $+y$ axis as shown.



Choose the correct answer

1. Velocity of central maxima in vector form at $t = 3$ s is

   (1) 3 m/s (2) 6 m/s

   (3) 9 m/s (4) 12 m/s

2. Velocity of n^{th} maxima in vector form at $t = 2$ s is

   (1) $t^2\hat{i} \pm \frac{n\lambda}{d}t^2\hat{j}$ (2) $\pm\frac{n\lambda}{d}t^2\hat{j}$

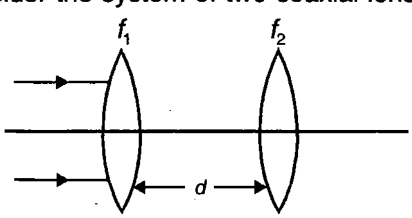
   (3) $t\hat{i} + \frac{n\lambda}{d}t\hat{j}$ (4) $t^2\hat{i} + 0\hat{j}$

3. Relative acceleration of second maxima with respect to first minima on the other side of central maxima is

   (1) $\frac{5\lambda}{d}\hat{j}$ (2) $\frac{5\lambda}{d}t\hat{j}$

   (3) $\frac{5}{2}\frac{\lambda}{d}t\hat{j}$ (4) $\frac{7\lambda}{d}t\hat{j}$

C2. Consider the system of two coaxial lenses shown



Choose the correct answer :

1. If $d = f_1 + f_2$, effective focal length of system

   (1) ∞ (2) $\frac{f_1 f_2}{f_1 + f_2}$

   (3) $\frac{f_1 f_2}{f_1 + f_2 + d}$ (4) $f_1 - f_2$

2. If $f_1 > f_2$ and $d = f_1 + f_2$

   (1) Intensity of rays increases after 2nd refraction

   (2) Intensity of rays decreases after 2nd refraction

   (3) Intensity of rays remains same after 2nd refraction

   (4) Aperture of beam increases after 2nd refraction

3. The combination behaves like

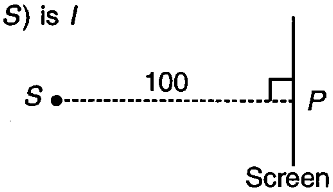
   (1) Convex lens

   (2) Plane glass slab

   (3) Concave lens

   (4) Plane mirror

C3. A point source of light S is placed in front of a large screen, at a distance of 100 unit from the screen, as shown. Intensity at a point P on the screen (point P is the point on screen closest to source S) is I



Choose the correct answer :

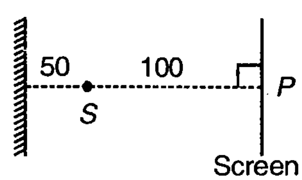
1. A large mirror is now placed at a distance of 50 unit from the source S, towards the left of source S (as shown). New intensity of light at P is

   (1) I only

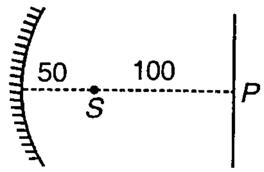
   (2) 1.25 I

   (3) 1.5 I

   (4) 2I

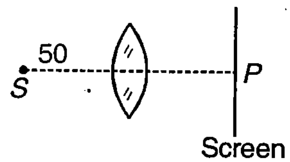


2. A concave mirror of radius of curvature 100 unit is placed at a distance 50 unit towards left of S, as shown. New intensity of light at P is



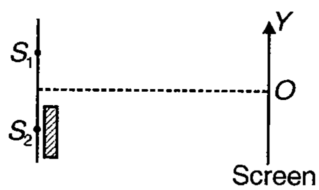
(1) I
(2) $3I$
(3) $5I$
(4) $7I$

3. A convex lens (of focal length 50 unit) is placed at a distance of 50 unit from the source S, as shown. New intensity at point P on the screen is



(1) I
(2) $2I$
(3) $4I$
(4) $5I$

C4. The Young's double slit experiment is done in a medium of refractive index 4/3. A light of 600 nm wavelength is falling on the slits having 0.45 mm separation. The lower slit S_2 is covered by thin glass sheet of thickness 10.4 μm and refractive index 1.5. The interference pattern is observed on a screen placed 1.5 m from the slits



Choose the correct answer :

1. Find the position of the central maximum (bright fringe with zero path difference) on the Y-axis

(1) 4.33 mm (2) 4.33 cm
(3) 4.33 m (4) 4.9 m

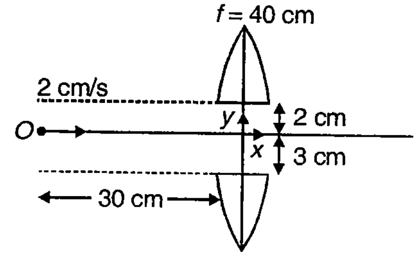
2. Find the light intensity at point O in terms of to the maximum fringe intensity(I_{max})

(1) 0.5 I_{max} (2) 0.75 I_{max}
(3) 4 I_{max} (4) 2 I_{max}

3. Now if 600 nm light is replaced by light of wavelength range 400 to 700 nm, find the wavelengths of the light that form maxima exactly at point O. [All wavelengths in this problem are for the given medium of refractive index 4/3. Ignore dispersion]

(1) 200 nm to 300 nm
(2) 400 nm to 600 nm
(3) 650 nm to 433.34 nm
(4) 750 nm to 800 nm

C5. Consider the diagram shown here



An object O is approaching two halves of a lens placed according to diagram.

Choose the correct answer :

1. At the instant shown, x coordinate of images

(1) –120 cm (2) –30 cm
(3) –40 cm (4) +120 cm

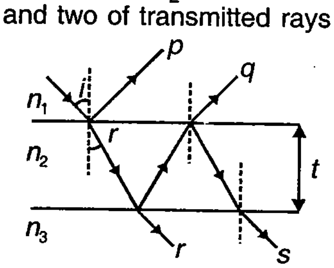
2. y coordinates of images formed by lower and upper half respectively are

(1) –6 cm, 9 cm (2) –8 cm, –12 cm
(3) 8 cm, –12 cm (4) –8 cm, +12 cm

3. Component of relative velocity of images parallel to the x axis is

(1) Zero (2) 1 cm/s
(3) 2 cm/s (4) 3 cm/s

C6. A ray of light is incident on thin film of thickness t and refractive index n_2. Two of reflected rays are shown, and two of transmitted rays are shown in figure.



Choose the correct answer :

1. Assume that rays p and q undergo a phase change because of difference in refractive indices. Which of these is correct?

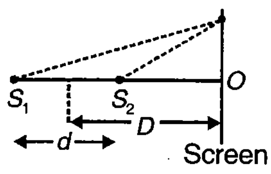
(1) $n_3 > n_2 > n_1$ (2) $n_1 > n_2 > n_3$
(3) $n_2 > n_3 > n_1$ (4) $n_3 > n_1 > n_2$

2. If $n_1 = 1$, for constructive interference of reflected rays p and q (λ = wavelength of incident rays both p and q undergo phase change because of difference in refractive indices) [where n = 0, 1, 2, 3, ...]

(1) $2n_2t\cos r = n\lambda$
(2) $2n_2t\cos r = (2n-1)\frac{\lambda}{2}$
(3) $n_2t\cos r = n\lambda$
(4) $n_2t\cos r = (2n-1)\frac{\lambda}{2}$

3. Considering assumption in problem 1, for constructive interference of transmitted rays r and s,
   (1) $2n_2t\cos r = n\lambda$
   (2) $2n_2t\cos r = (2n-1)\frac{\lambda}{2}$
   (3) $n_2t\cos r = n\lambda$
   (4) $n_2t\cos r = (2n-1)\frac{\lambda}{2}$

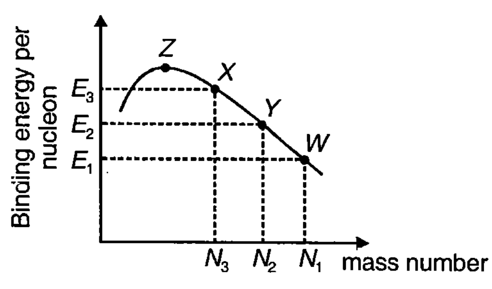
C7. In the figure shown, a screen is placed normal to the line joining the two point sources S_1 and S_2. Take d = 20 μm, λ = 2000 Å and D = 40 cm. Assume that the screen is infinite. Power of each source = 20 watt.



Choose the correct answer :

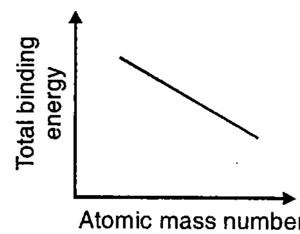
1. Find radius of first bright ring on the screen
   (1) 0.33 cm (2) 0.99 cm
   (3) 0.44 cm (4) 0.55 cm
2. If I represents intensity at a point on the screen, $\int IdA$ for screen is (where dA is the area of small element on screen)
   (1) 0 watts (2) 40 watts
   (3) 20 watts (4) 10 watts
3. Number of maximas on screen above point O are
   (1) 98 (2) 100
   (3) 97 (4) 99

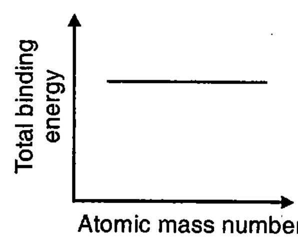
C8. Consider nuclear fission reaction $W \rightarrow X + Y$. Using graph given, answer the following questions.

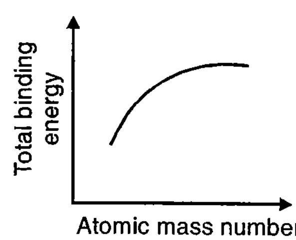


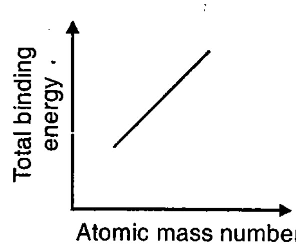
Choose the correct answer :

1. What is Q value of reaction?
   (1) $E_1N_1 - (E_2N_2 + E_3N_3)$
   (2) $E_2N_2 + E_3N_3 - E_1N_1$
   (3) $E_2N_2 + E_1N_1 - E_3N_3$
   (4) $E_1N_1 + E_3N_3 - E_2N_2$
2. If M_W is mass of W, M_X is mass of X and M_Y is mass of Y nucleus, choose correct alternative
   (1) $\frac{M_W}{N_1} > \frac{M_Y}{N_2} > \frac{M_X}{N_3}$
   (2) $\frac{M_W}{N_1} < \frac{M_Y}{N_2} < \frac{M_X}{N_3}$
   (3) $\frac{M_W}{N_1} < \frac{M_Y}{N_2} > \frac{M_X}{N_3}$
   (4) $\frac{M_W}{N_1} > \frac{M_Y}{N_2} < \frac{M_X}{N_3}$
3. Which of the following graphs might represent relationship between atomic mass number (*i.e.*, atomic weight) and total binding energy of nucleus, for nuclei heavier than Z?

(1) 

(2) 

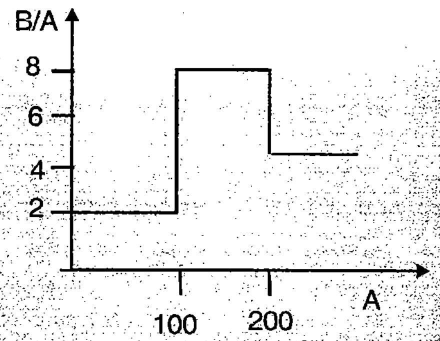
(3) 

(4) 

(IIT-JEE 2008)

8(a). Assume that the nuclear binding energy per nucleon (B/A) versus mass number (A) is as shown in the figure. Use this plot to choose the correct choice(s) given below.

Figure :



(1) Fusion of two nuclei with mass numbers lying in the range of $1 < A < 50$ will release energy

(2) Fusion of two nuclei with mass numbers lying in the range of $51 < A < 100$ will release energy

(3) Fission of a nucleus lying in the mass range of $100 < A < 200$ will release energy when broken into two equal fragments

(4) Fission of a nucleus lying in the mass range of $200 < A < 260$ will release energy when broken into two equal fragments

C9. A radioactive nucleus X decays to nucleus Y which further decays to a stable nucleus Z as given below:

$$X \xrightarrow{\lambda_X = 0.1\text{sec}^{-1}} Y \xrightarrow{\lambda_Y = \frac{1}{30}\text{sec}^{-1}} Z \text{ (stable).}$$

Initially the sample contains nuclei of X only and its population is $N_0 = 10^{20}$. Further the population of Y as function of time is given by

$$N_Y(t) = \frac{N_0 \lambda_X}{\lambda_X - \lambda_Y}\left(e^{-\lambda_Y t} - e^{-\lambda_X t}\right)$$

Choose the correct answer :

1. If N_X, N_Y and N_Z represent population of X, Y and Z respectively at any instant of time t then

(1) $\frac{dN_Y}{dt} = \frac{N_Y}{30}$

(2) $\frac{dN_Y}{dt} = 0.1N_X - \frac{N_Y}{30}$

(3) $\frac{dN_Y}{dt} = -\frac{N_Y}{30}$

(4) $\frac{dN_Y}{dt} = 0.1N_Y + \frac{N_Y}{30}$

2. The time at which population of Y is maximum is

(1) ln 3

(2) ln 5

(3) 15 ln 3

(4) 5 ln 3

3. Population of X at instant when N_Y is maximum is

(1) $\frac{10^{20}\sqrt{3}}{9}$

(2) $\frac{10^{20}}{\sqrt{3}}$

(3) $10^{20}\sqrt{3}$

(4) None of these

C10. Consider an imaginary atom consisting of hypothetical subatomic particles. The charge on first particle is $+e$ and its mass is 15 m_e. The charge on other particle is $-e$ and its mass is 10 m_e. Taking motion of nucleus into account and assuming Bohr's atomic model is valid,

Choose the correct answer :

1. Ionisation energy of atom is

(1) 81.6 eV

(2) 13.6 eV

(3) 54.4 eV

(4) None of these

2. First Bohr's radius is

(1) 0.53 Å

(2) 0.088 Å

(3) 0.43 Å

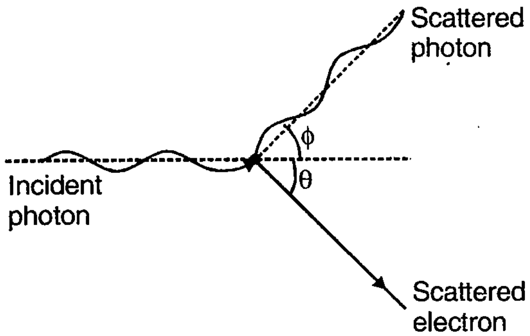
(4) None of these

3. Ratio of Rydberg constant for this atom and that for hydrogen atom is

(1) 4 (2) 6

(3) 8 (4) 10

C11. The scattering of photon by an electron is called comptom effect. Energy and momentum are conserved in such an event and as a result the scattered photon has lesser energy (longer wavelength) than incident photon.



Applying conservation of energy and momentum we get

$\lambda' - \lambda = \frac{h}{m_0 c}(1-\cos\phi)$ where λ is wavelength of incident photon, λ' is wavelength of scattered photon, m_0 is rest mass of electron. Now, consider scattering of X rays of photon 10 pm.

Choose the correct answer :

1. The wavelength of X rays scattered through 45° is

(1) 10.7 pm (2) 10.4 pm

(3) 11.3 pm (4) None of these

2. The maximum wavelength present in scattered X rays is

(1) 11.3 pm (2) 12.4 pm

(3) 114.9 pm (4) 14.86 pm

3. The maximum kinetic energy of recoil electrons is

(1) 24.2 keV (2) 36.4 keV

(3) 40.5 keV (4) None of these

C12. An electron is orbiting in circular orbit of radius r under influence of constant transverse magnetic field B. Assuming that Bohr's postulate regarding the quantisation of angular momentum holds good for this electron (h plancks constant, e is charge on electron and m is mass of electron)

Choose the correct answer :

1. Radius of nth orbit of electron will be

(1) $\sqrt{\frac{2nh}{\pi Be}}$ (2) $\sqrt{\frac{nh}{2\pi Be}}$

(3) $\sqrt{\frac{neh}{2\pi Be}}$ (4) $\sqrt{\frac{2\pi eh}{\pi B}}$

2. Kinetic energy of electron in nth orbit will be

(1) $\frac{nhBe}{4\pi m}$ (2) $\frac{nhBe}{2\pi m}$

(3) $\frac{nhB}{2\pi em}$ (4) $\frac{nhB}{4\pi em}$

3. The potential energy of interaction between magnetic moment of orbital current due to electron moving in its nth orbit and magnetic field may be

(1) $\frac{nhB}{2\pi me}$ (2) $-\frac{nhBe}{4\pi m}$

(3) $-\frac{nhB}{2\pi me}$ (4) $-\frac{nhBe}{2\pi m}$

C13. Work function of metal X is equal to 3.4 eV. Work function of metal Y is equal to ionization energy of He^+ ion in second orbit. Photons of same energy E are incident on both X and Y. Maximum kinetic energy of photoelectrons emitted from X is twice that of photoelectrons emitted from Y.

Choose the correct answer :

1. Work function of metal Y is

(1) –3.4 eV (2) 3.4 eV

(3) –13.6 eV (4) 13.6 eV

2. Value of E (in eV) is

(1) 20.8 (2) 32.2

(3) 24.6 (4) 23.8

3. The difference in maximum kinetic energy of photoelectrons from X and from Y

(1) Increases with increase in E

(2) Decreases with increase in E

(3) First increases then decreases with increase in E

(4) Remains constant

C14. A gas of hydrogen like ions is prepared in such a way that the ions are only in the ground state and the first excited state. A light of wavelength 1216Å is absorbed by the ions. The ions are lifted to higher excited state and emit radius of 6 wavelengths some higher and some lower then the wavelength absorbed.

Choose the correct answer

1. Find the nuclear charge on the ions

(1) 1 (2) 2

(3) 4 (4) 14

2. The principal quantum number of all excited state is

(1) 1,2,3,4 (2) 2,3,4,5

(3) 1,2,3 (4) 1,2

3. The maximum and minimum wavelength is

(1) 4700 Å, 542 Å (2) 7400 Å, 245 Å

(3) 4700 Å, 245 Å (4) 5670 Å, 245 Å

C15. A μ meson particle moves in circular orbit around a very heavy nucleus (of infinite mass) and of charge $+3e$. Assuming Bohr's model is applicable to this system then

1. Expression for radius of nth Bohr orbit is

(1) $\dfrac{0.53n^2}{(108Z)}$ Å (2) $\dfrac{0.53n^2}{(208Z)}$ Å

(3) $\dfrac{0.32n^2}{(108Z)}$ Å (4) None of these

2. Find n for which radius of orbit is approximately same as that of 1st Bohr orbit for hydrogen atom

(1) $n = 15$ (2) $n = 20$

(3) $n = 25$ (4) $n = 22$

3. Find wavelength of radiation emitted when μ meson jumps from 3rd orbit to 1st orbit (μ – meson is particle with charge of e^- and mass 208 times that of e^-)

(1) 0.548 Å (2) 0.36 Å

(3) 0.25 Å (4) None of these

C16. The mass absorption coefficient for aluminium X rays having $\lambda = 0.32$ Å is 0.6 cm^2/g. If density of aluminium is 2.7 g/cc find

1. Linear absorption coefficient of Al

(1) 1.2 cm^{-1} (2) 1.4 cm^{-1}

(3) 0.8 cm^{-1} (4) 1.62 cm^{-1}

2. Half value thickness is

(1) 0.428 cm (2) 0.32 cm

(3) 0.28 cm (4) 0.128 cm

3. Thickness of aluminium needed to cut down intensity of beam to $\dfrac{1}{20}$ of initial value

(1) 1.45 cm

(2) 1.6 cm

(3) 1.85 cm

(4) None of these

❑ ❑ ❑

SECTION - D

Assertion - Reason Type

This section contains 47 questions. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Instructions for Assertion - Reason Type questions :

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

Choose the correct answer :

1. STATEMENT-1 : A spherical lens with equal radii of curvature will not show dispersion.

   and

   STATEMENT-2 : Dispersion is shown by two refracting surfaces inclined at some angle to each other.

2. STATEMENT-1 : If a ray travels from one medium to another medium, there is no effect on colour of the ray.

   and

   STATEMENT-2 : In refraction there is change in wavelength.

3. STATEMENT-1 : All the images produced by a pair of plane mirrors inclined at an angle θ and object are at same distance from a particular point.

   and

   STATEMENT-2 : All images produced by a pair of plane mirrors and object lie on an ellipse.

4. STATEMENT-1 : A biconvex lens in air can be used to decrease intensity of light on a screen placed in front of the lens.

   and

   STATEMENT-2 : A biconvex lens may behave as diverging lens.

5. STATEMENT-1 : All rays parallel to principal axis are focussed at same point after reflection.

   and

   STATEMENT-2 : Focal length is different for paraxial and marginal rays.

6. STATEMENT-1 : We can use concave mirror for rear view mirror in a car.

   and

   STATEMENT-2 : If object is close, image by a concave mirror can be virtual.

7. STATEMENT-1 : Negative sign of magnification by an optical element suggests that image is inverted w.r.t. object.

   and

   STATEMENT-2 : Magnitude of magnification, if greater than 1, suggests that image formed is magnified.

8. STATEMENT-1 : For astronomical telescope, aperture of objective is large so that resolution limit is low.

   and

   STATEMENT-2 : Aperture of objective is large so that telescope can collect more light energy to get brighter image.

9. STATEMENT-1 : For achromatic combination of two lenses nature of lenses must be opposite i.e., one converging and another one diverging.

   and

   STATEMENT-2 : Relation between dispersive powers and focal lengths is $\frac{\omega_1}{f_1}+\frac{\omega_2}{f_2}=0$ to remove chromatic defect, for two lenses in contact.

10. STATEMENT-1 : A convex lens may behave as a diverging lens.

    and

    STATEMENT-2 : A convex lens may show spherical aberration.

11. STATEMENT-1 : If position of object and screen is fixed, we always get two positions of converging lens for clear image.

    and

    STATEMENT-2 : For converging lens minimum distance between a real object and its real image is $4f$.

12. STATEMENT-1 : If we introduce a slab of thickness 't' and refractive index 'n' in path of converging rays, rays are shifted by $t\left(1-\frac{1}{n}\right)$ towards slab.

    and

    STATEMENT-2 : Shifting of image due to slab is always in the direction of propogation of incident rays.

13. STATEMENT-1 : For white light, focal length of mirror is different for different colours.

    and

    STATEMENT-2 : Focal length of mirror is $\frac{R}{2}$ for paraxial rays. (R = Radius of curvature)

14. STATEMENT-1 : Interference is an example of superposition of waves.

    and

    STATEMENT-2 : Young's double slit experiment supports transverse nature of light waves.

15. STATEMENT-1 : A wave is travelling parallel to unit vector $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$, then all particles in xy plane are oscillating in same phase.

    and

    STATEMENT-2 : Wave front is always perpendicular to direction of wave propagation.

16. STATEMENT-1 : Two coherent sources are placed at very small distance $x = 3\lambda$, sources are placed on diameter, equidistant from the centre of a circle. All maximas at surface of circle are equispaced.

    and

    STATEMENT-2 : Number of maximas on the circle are 12.

17. STATEMENT-1 : Wave front due to a source placed at infinity is planar.

    and

    STATEMENT-2 : Rays due to source placed at infinity are parallel.

18. STATEMENT-1 : In YDSE, we get dark and bright fringes, that are equally spaced irrespective of any condition.

    and

    STATEMENT-2 : In YDSE, energy of waves is redistributed.

19. STATEMENT-1 : A point source is placed at intersection of x, y and z axis, position of wavefront may be given by $x^2 + y^2 + z^2 = kt^2$, where t represents time

    and

    STATEMENT-2 : Wavefront due to a point source is cylindrical.

20. STATEMENT-1 : In YDSE, for a beam of parallel rays, path difference before slits must be zero.

    and

    STATEMENT-2 : At the position of central maximum, geometrical path difference may or may not be zero.

21. STATEMENT-1 : Three sources of intensities I, $4I$ and $9I$ produce maximum intensity $36I$.

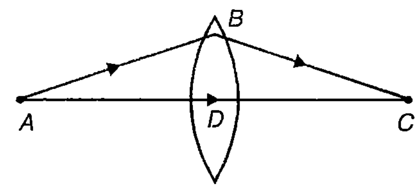
    and

    STATEMENT-2 : Three sources of intensities I, $4I$ and $9I$ produce minimum intensity $16I$.

22. STATEMENT-1 : A surface on which wave disturbance is in same phase at all points is called wavefront.

    and

    STATEMENT-2 : The direction of wave propagation is perpendicular to wavefront.

23. 

    STATEMENT-1 : Geometrical paths of rays ABC and ADC are different.

    and

    STATEMENT-2 : Optical paths for rays ABC and ADC are equal.

24. STATEMENT-1 : Electron capture occurs more often than positron emission in heavy elements.

    and

    STATEMENT-2 : Heavy elements exhibit radioactivity.

25. STATEMENT-1 : Ionisation energy of atomic hydrogen is greater than atomic deuterium.

    and

    STATEMENT-2 : Ionisation energy is proportional to reduced mass.

26. STATEMENT-1 : For pair production energy of γ rays is greater than 1.02 MeV.

    and

    STATEMENT-2 : In pair production energy is converted into mass.

27. STATEMENT-1 : Free neutron is not stable.

    and

    STATEMENT-2 : A neutron outside nucleus decays into a proton, an electron and an anti-neutrino.

28. STATEMENT-1 : Nuclear energy is due to difference in sum of masses of component nucleons and the nucleus.

    and

    STATEMENT-2 : Mass of nucleus is more than the sum of masses of component nucleons.

29. STATEMENT-1 : Classical physics is not able to explain photoelectric effect.

    and

    STATEMENT-2 : Maximum kinetic energy of photoelectrons emitted should increase with increasing intensity of incident light, according to classical physics.

30. STATEMENT-1 : In radioactive disintegration an electron is emitted by nucleus.

and

STATEMENT-2 : Electrons are also present inside the nucleus.

31. STATEMENT-1 : An isolated proton cannot β-decay to a neutron.

and

STATEMENT-2 : Q-value of the reaction is positive.

32. STATEMENT-1 : Heavy water is preferred to ordinary water in reactors to slow down neutrons.

and

STATEMENT-2 : Deuterium in D_2O does not form stable nuclei on absorbing neutron but protons in H_2O form.

33. STATEMENT-1 : Balmer series lies in visible region of electromagnetic spectrum.

and

STATEMENT-2 : Wavelength of lines in Balmer series is given by $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$ and $n = 3, 4$ .....

34. STATEMENT-1 : Half life of certain radioactive element is 10 days. After 200 days fraction left undecayed will be 50%.

and

STATEMENT-2 : $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

35. STATEMENT-1 : Nucleus density is almost same for all nuclei.

and

STATEMENT-2 : Size of nucleus $\propto A^{1/3}$.

(A = Mass number)

36. STATEMENT-1 : X-rays travel with speed of light.

and

STATEMENT-2 : X-rays are electromagnetic waves.

37. STATEMENT-1 : Isobars are elements having same mass number but different atomic number.

and

STATEMENT-2 : Neutrons and protons are present inside nucleus.

38. STATEMENT-1 : UV rays are dangerous to human beings.

and

STATEMENT-2 : UV rays are absorbed by ozone layer.

39. STATEMENT-1 : Charge on α particle is $+2e$ and its mass is 4 amu.

and

STATEMENT-2 : β rays move with velocity of light.

40. STATEMENT-1 : Nuclear forces are non central.

and

STATEMENT-2 : Nuclear forces donot act necessarily along line joining centres of nucleons.

41. STATEMENT-1 : CO_2 laser are much more efficient than other lasers.

and

STATEMENT-2 : The vibrational rotational levels of the lowest electronic state are involved in the CO_2 laser transition.

42. STATEMENT-1 : Out of nuclei ${}_3X^7$ and ${}_3Y^4$ former is more stable.

and

STATEMENT-2 : Size of ${}_3X^7$ is larger than that of ${}_3Y^4$.

43. STATEMENT-1 : The unit of decay constant is s^{-1}.

and

STATEMENT-2 : It represents rate of disintegration.

44. STATEMENT-1 : 1 amu is equivalent to energy of 931 MeV.

and

STATEMENT-2 : Energy is released during nuclear fission.

45. STATEMENT-1 : A certain radioactive substance has half life period of 30 days. Its disintegration constant is 0.0231 day^{-1}.

and

STATEMENT-2 : Decay constant varies inversely as half life.

46. STATEMENT-1 : The ionising power of β particles is less compared to α particles but their penetrating power is more.

and

STATEMENT-2 : The mass of β particle is less than mass of α particle.

47. STATEMENT-1 : If electrons in an atom were stationary they would fall into nucleus.

and

STATEMENT-2 : Electrostatic force of attraction acts between negative electrons and positive nucleus.

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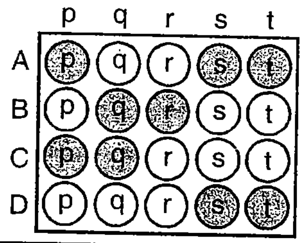
SECTION - E

Matrix-Match Type

This section contains 21 questions. Each question contains statements given in two columns which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **One OR More** statement(s) in **Column II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example :

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.



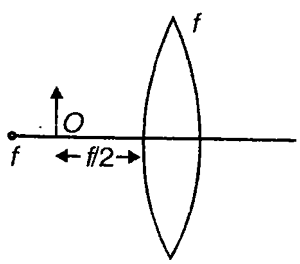
1. In **Column-I** types of sources of light and example of sources in **Column-II** are given

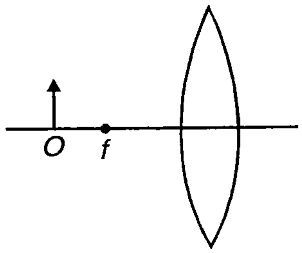
Column I	**Column II**
(A) Incandescent source of light	(p) Radium coated plate
(B) Gas discharge source of light	(q) Burning candle
(C) Luminescent source of light	(r) Neon bulb
(D) Natural source of light	(s) Sun
	(t) Sodium vapour lamp.

2. For an object placed in front of a mirror, magnification (m) is given in **column I. Column II** gives the possible nature of the mirror or that of image. Match appropriately

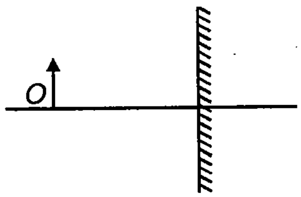
Column I	**Column II**
(A) $m = \frac{1}{4}$	(p) Concave mirror
(B) $m = -1$	(q) Convex mirror
(C) $m = 2$	(r) Plane mirror
(D) $m = 1$	(s) Real
	(t) Virtual

3. Match the following. Column II gives nature of image formed in various cases given in **Column I.**

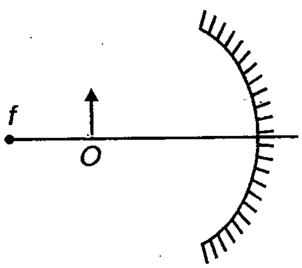
Column I	**Column II**
(A) 	(p) Real

(B) 

(q) Inverted

(C) 

(r) Virtual

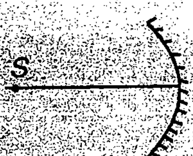
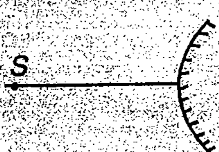
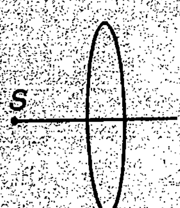
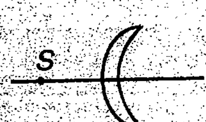
(D) 

(s) Upright

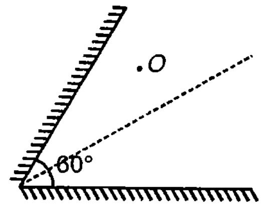
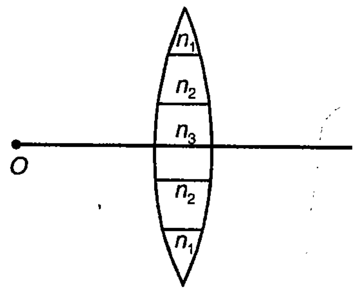
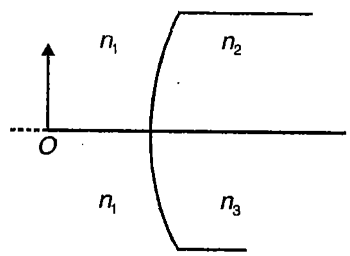
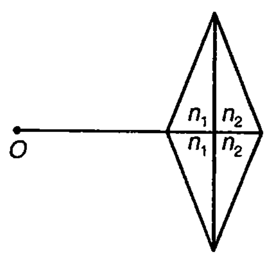
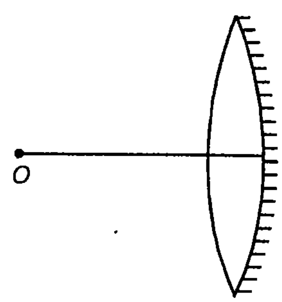
(t) Magnified

(IIT-JEE 2008)

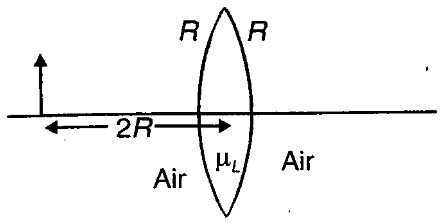
3(a). An optical component and an object S placed along its optic axis are given in Column I. The distance between the object and the component can be varied. The properties of images are given in Column II. Match all the properties of images from Column II with the appropriate components given in Column I. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I	Column II
(A) 	(p) Real image
(B) 	(q) Virtual image
(C) 	(r) Magnified image
(D) 	(s) Image at infinity

4. Match the following, **Column-I** gives number of images formed, **Column-II** shows an arrangement and an objects

Column I	Column II
(A) Number of images = 3	(p) 
(B) Number of images = 5	(q) 
(C) Number of images = 2	(r) 
(D) Number of images = 1	(s) 
	(t) 

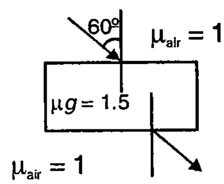
5. Match the following



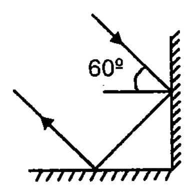
Column I	Column II
(A) μ_L is equal to 3	(p) Real image
(B) Lens is made plano convex (μ_2 = 2)	(q) Virtual image
(C) If μ_L = 1.5 and right side is silvered	(r) Magnified image
(D) Radius is doubled of initial value and μ_L is equal to 2	(s) Diminished image
	(t) Image is of same size

6. Angle of deviation is given in **Column-I** and ray diagram for angle of deviation in **Column-Ii**

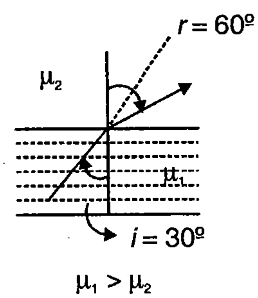
(A) 60º

(p)


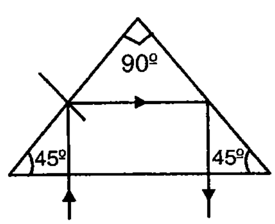
(B) 0º

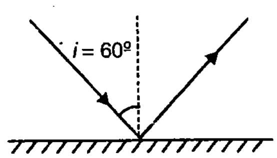
(q)


(C) 180º

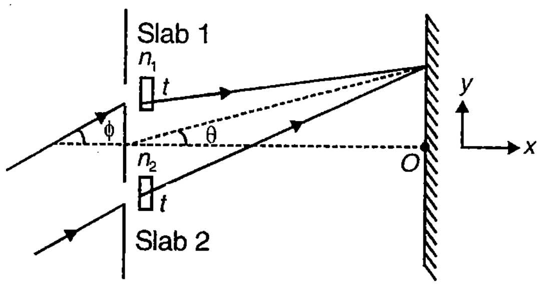
(r)


(D) 30º

(s)


(t)


7. Young's double slit experimental arrangement is shown in the diagram. 'θ' represents angular position of point on the screen. Also, note that two slabs made up of material of refractive indices n_1 and n_2 and each of thickness $t = 0.02$ mm are placed in front of the slits.



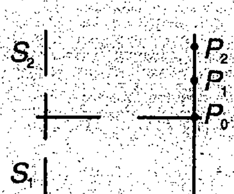
Match the following. Column I lists values of different parameters shown in diagram. Column II lists various possibilities.

Column I	Column II
(A) Central maxima must be above point O	(p) If $\phi = 30°$ and $n_1 = n_2$
(B) Central maxima must be below point O	(q) If $\phi = 30°$ and $n_1 > n_2$
(C) Central maxima must be at origin O	(r) If $\phi = 30°$ and $n_1 = 1.3$, $n_2 = 1.5$
(D) Central maxima may be below point O	(s) If $\phi = 0°$ and $n_1 = n_2$
	(t) If $\phi = 0°$ and $n_1 < n_2$

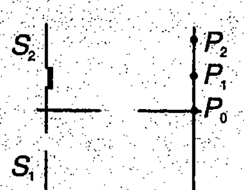
(IIT-JEE 2009)

7(a) **Column I** shows four situations of standard Young's double slit arrangement with the screen placed far away from the slits S_1 and S_2. In each of these cases $S_1P_0 = S_2P_0$, $S_1P_1 - S_2P_1 = \lambda/4$ and $S_1P_2 - S_2P_2 = \lambda/3$, where λ is the wavelength of the light used. In the cases B, C and D, a transparent sheet of refractive index μ and thickness t is pasted on slit S_2. The thicknesses of the sheets are different in different cases. The phase difference between the light waves reaching a point P on the screen from the two slits is denoted by $\delta(P)$ and the intensity by $I(P)$. Match each situation given in **Column I** with the statement(s) in **Column II** valid for that situation.

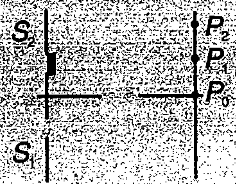
Column I **Column II**

(A) 

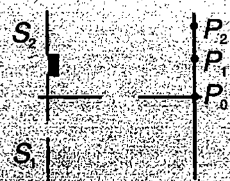
(p) $\delta(P_0) = 0$

(B) $(\mu - 1)t = \lambda/4$ 

(q) $\delta(P_1) = 0$

(C) $(\mu - 1)t = \lambda/2$ 

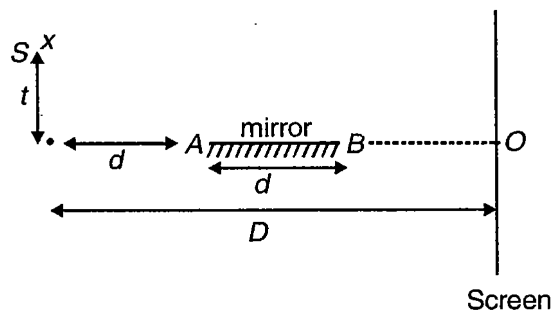
(r) $I(P_1) = 0$

(D) $(\mu - 1)t = 3\lambda/4$ 

(s) $I(P_0) > I(P_1)$

(t) $I(P_2) > I(P_1)$

8. S is source of monochromatic light and *AB* is plane mirror placed before screen as shown in arrangement. Consider the image of *S* in mirror. Light from S bears constant phase difference of π with reflected light from mirror *AB*.

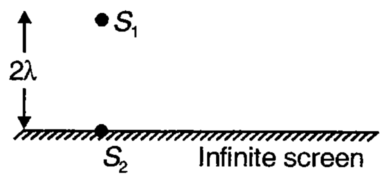


Column I	Column II
(A) Minimum height above *O* at which fringe is formed	(p) $\dfrac{t^2}{\lambda d}$
(B) Maximum height above *O* at which fringe is formed	(q) $\dfrac{(D-2d)t}{2d}$
(C) Total number of fringes formed on screen	(r) $\dfrac{(D-d)t}{d}$
(D) Fringe width	(s) $\dfrac{(D+d)t}{d}$
	(t) $\dfrac{\lambda D}{2t}$

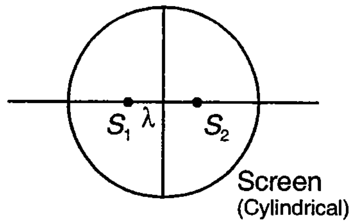
9. Match the following. S_1 and S_2 in column I represent coherent point sources, S represents a point source. λ = wavelength of light emitted by the sources.

Column I

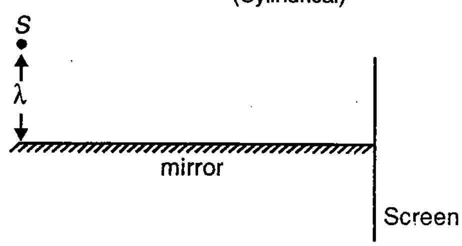
(A)



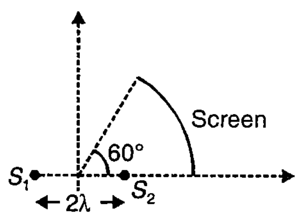
(B)



(C)



(D)



Column II

(p) Number of maximas = 2

(q) Number of minimas = 2

(r) Number of maximas = 4

(s) Number of minimas = 4

(t) Only hyperbolic fringes

10. Match the following.

Column I	Column II
(A) Interference	(p) Supports wave nature
(B) Polarisation	(q) Supports particle nature
(C) Scattering	(r) Depends upon wavelength
(D) Dispersion	(s) Light of different wavelengths are deviated by different amounts
	(t) Setting sun and rising sun appears red

11. Match the following.

Column I	Column II
(A) Radiation pressure	(p) Particle nature of radiation
(B) Threshold wavelength	(q) Stopping potential
(C) Maximum kinetic energy of photoelectron	(r) Maximum wavelength of incident photons for photoelectric effect
(D) Quantisation of angular momentum of electron	(s) de Broglie hypothesis
	(t) Principal quantum number

12. Match the following.

Column I	Column II
(A) Photoelectric effect	(p) Ionisation
(B) Saturation photo current	(q) Usually veryless
(C) Photon efficiency	(r) Intensity of radiation
(D) Work function	(s) Quantum nature of light
	(t) Threshold frequency

13. Match the following.

Column I	Column II
(A) Characteristic X-rays	(p) X-ray tube voltage
(B) Continuous X-rays	(q) Knock out of e^-
(C) Cut off wave length	(r) Bremsstrahlung radiation
(D) X-ray production	(s) Moseley's law
	(t) Duane Hunt law

14. Match the following.

Column I	Column II
(A) Atomic excitation	(p) Stationary orbit
(B) Lyman series	(q) Absorption spectrum
(C) Rydberg constant	(r) Inelastic collision
(D) Bohr's atomic model	(s) Depends on mass of electron
	(t) Line spectrum

15. Match the following.

Column I	Column II
(A) Hydrogen bomb	(p) Fission
(B) Atom bomb	(q) Fusion
(C) Stellar energy	(r) Critical mass
(D) Nuclear reactor	(s) Controlled chain reaction
	(t) High temperature and pressure

16. Match the following.

Column I	Column II
(A) α decay	(p) Neutrino
(B) β decay	(q) Tunnel effect
(C) γ decay	(r) Atomic number of parent nucleus decreases by 1
(D) K-electron capture	(s) No change in atomic number
	(t) Atomic number of parent nucleus decreases by 2

17. Match the following.

Column I	Column II
(A) Isobars	(p) Saturation
(B) Isotones	(q) Same mass number
(C) Isotopes	(r) Different chemical properties
(D) Nuclear force	(s) Same atomic number
	(t) Non-central

18. Different types of forces in **Column-I** and properties of these forces in **Column-II**

Column I	Column II
(A) Nuclear force	(p) Short range
(B) Gravitational force	(q) Central
(C) Weak force	(r) Conservative
(D) Electromagnetic force	(s) Long range
	(t) β-decay

19. Consider Bohr's model to be valid for a hydrogen like atom with atomic number Z. Match quantities given in **Column-I** to those given in **Column II.**

Column I	Column II
(A) $\frac{Z^3}{n^5}$	(p) Angular speed
(B) $\frac{Z^2}{n^2}$	(q) Magnetic field at the centre due to revolution of electron
(C) $\frac{Z^2}{n^3}$	(r) Potential energy of an electron in n^{th} orbit
(D) $\frac{Z}{n}$	(s) Speed of an electron in n^{th} orbit
	(t) Frequency of revolution of electron

20. For a given Bohr's atom with increase in principal quantum number

Column I	Column II
(A) Radius of orbit	(p) Must increase
(B) K.E. of electron	(q) Must decrease
(C) Ratio of magnetic moment to angular moment of electron	(r) Constant
(D) deBroglie wavelength	(s) Changes
	(t) May increase or decrease

21. Match the following.

Column I		Column II	
(A)	Photoelectric effect	(p)	Moseley
(B)	X ray	(q)	Roentgen
(C)	Behaviour of characteristic X ray	(r)	Einstein
(D)	Radioactivity	(s)	Rutherford
		(t)	Heinrich Hertz

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SECTION - F

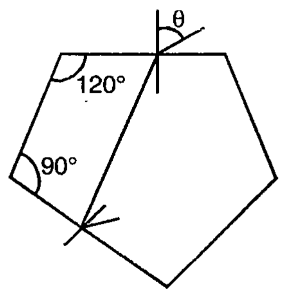
Subjective Type Questions

This section contains 18 subjective questions.

Solve the followings :

1. A balloon is rising up along the principal axis of a concave mirror of $R = 20$ cm. A ball is dropped from balloon at height of 15 m from the mirror, when balloon has velocity 30 m/s. Find the speed of image of ball formed by concave mirror after 4 s. ($g = 10$ m/s^2)

2. A ray of light entering into diamond ($n = 2$) from air is being internally reflected at the bottom as shown. Find maximum value of θ.



3. A converging bundle of light rays in the shape of a cone with vertex angle 60° falls on a circular diaphragm of 20 cm diameter. A lens of focal power $8D$ is fixed in the diaphragm. What will be the new angle of cone?

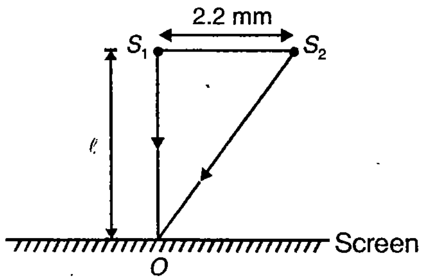
4. A ray of light moving along $-3\hat{i}-4\hat{j}$ undergoes refraction at an interface of two media which is the $y-z$ plane. The refractive index for $x < 0$ is 2 while for $x > 0$ is $\sqrt{\frac{5}{2}}$. Find the unit vector along which refracted ray moves.

5. A concave mirror is of hemispherical shape with radius $R = 40$ cm. A thin layer of unknown transparent liquid is poured into the mirror. The mirror-liquid forms a real image and another real image is formed by mirror alone. One of them coincides with object and other is at a distance 20 cm from the object in a direction away from mirror. Find possible values of refractive index of the liquid.

6. One of the slits in a Young's double slit experiment is wider than the other, so that amplitudes of light reaching the central point of the screen from one slit alone, is twice that from the other slit alone. Find the expression for resultant intensity I_0 in direction θ on the screen (Distance between the slits is $2d$).

7. A thin glass plate of thickness t and refractive index μ is inserted between one of slits and screen in a Young's experiment. If the intensity of light at central point O is I_0 for $t = 0$, find the condition for maximum/minimum intensity at O as a function of thickness t of the glass plate.

8. Two coherent light sources emit light of wavelength 550 nm which produce an interference pattern on a screen (as shown in figure). The sources are 2.2 mm apart and 2.2 m from the screen. Determine whether the interference at the point O is constructive or destructive. Calculate the fringe width.



9. Two similar rectangular pieces of glass are in contact along one edge while the opposite edges are separated by a thin piece of tin foil. When examined in sodium light of wavelength 5.89×10^{-5} cm reflected perpendicularly from the air film 40 bright interference fringes are observed. What is the thickness of the foil if its edge just coincides with the centre of first interference band?

10. A photon of frequency f is emitted from surface of star of mass M and radius R. Find gravitational shift of frequency $\frac{\Delta f}{f}$ of photon at large distance.

11. The wavelength of certain line in X-ray spectrum for tungsten $Z = 74$ is 200 Å. What would be wavelength of same line for platinum $Z = 78$ and $a = 1$?

12. A muon is unstable elementary particle whose mass is 207 m_e and whose charge is either $+e$ or $-e$. A negative muon can be captured by a nucleus to form muonic atom. A proton captures a muon. Find radius of first Bohr orbit of this atom and ionisation energy of atom.

13. Consider an excited H atom in state n moving with velocity $v(v < c)$. It emits photon in direction of its motion and changes its state to lower state m. Find frequency of emitted radiation in terms of frequency f_0 emitted if atom were at rest.

14. Find number of α decays that occur in 1 g sample of thorium 232 in one year, if disintegration constant λ of thorium 232 is 1.58×10^{-18} s^{-1}.

15. Radium-226 decays to radon-222 with half life of 1620 yrs. Radon decays to Po^{218} with half life of 3.83 days. Starting with initial pure sample of Ra^{226}. Find number of Radon half lives that have elapsed when radon reaches 90% of its equilibrium concentration.

16. Bi^{212} decays to Th^{208} by α emission in 34% of disintegration and to Ra^{212} by β emission in 66% of disintegration. If total value of half lives of period is 60.5 minutes, find decay constants for α and β and total emission.

17. A piece of ancient wooden boat shows activity of C^{14} of 3.9 disintegrations per minute per gm of carbon. Estimate the age of boat if half life of C^{14} is 5568 yrs. Assume activity of fresh C^{14} is 15.6 gm/min.

18. Calculate energy released by fission of 2 gm of $_{92}U^{235}$ in kWh. Given that energy released per fission is 200 MeV.

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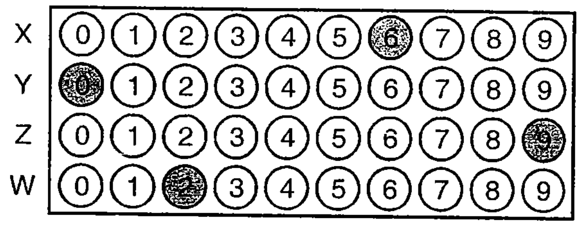
SECTION - G

Integer Answer Type

This section contains 17 questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W(say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following :



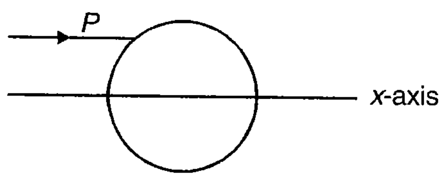
1. When a monochromatic point source of light is at a distance of 0.2 m from a photoelectric cell, the cut off voltage and the saturation current are respectively 0.6 V and 18 mA. If the same source is placed 0.6 m away from the photoelectric cell, then find the value of saturation current (in mA)

2. What is the ratio of de-Broglie wavelength of proton to that of α-particle being subjected to the same transverse magnetic field, so that the radii of their paths are equal to each other?

3. The shortest wavelength of the Brackett series of a hydrogen like atom (atomic number = Z) is the same as the shortest wavelength of the Balmer series of hydrogen atom. Find the value of Z.

4. When a metallic surface is illuminated with monochromatic light of wavelength λ, stopping potential for photoelectric current is 3 V_0. When same metallic surface is illuminated with a light of wavelength 2λ, the stopping potential is V_0. If the threshold wavelength for the surface is $n\lambda$, find the value of n.

5. A sphere of glass is placed symmetrically on x-axis. A ray parallel to x-axis is incident on the sphere at point P and emerges on x-axis. If angle of refraction at P is 30º for the refractive index of the glass is $\sqrt{x}$. Then find x



6. The magnification of an object placed in front of a convex lens is +2. The focal length of the lens is 2 m. Find the distance (in m) by which object has to be moved to obtain a magnification of –2

7. A convex lens of focal length 9 cm be placed between two point sources S_1 and S_2 which are 24 cm apart so that image of both the sources formed at the same place. Find the distance (in cm) between the lens and source

8. An equiconvex lens of glass $\left({}_a\mu_g = \frac{3}{2}\right)$, with each of its surfaces having the radius of curvature 20 cm, is placed with air in the object space and water in the image space. Find the ratio of its focal length with reference to its face placed in air.

9. A plano-convex lens of glass $\left({}_a\mu_g = \frac{3}{2}\right)$ has the maximum thickness of 3 cm. When seen normally through the spherical face of lens, the greatest thickness appears to be $\frac{5}{2}$ cm. Calculate the radius of curvature of spherical face of lens (in cm).

10. A convex lens A of focal length 14 cm and a concave lens B of focal length 5 cm are kept along the same axis with a distance d between them. If a parallel beam of light falling on A leaves B as a parallel beam, find the value of d (in cm).

11. A point source is kept on the principle axis of a convex lens of focal length f, at a distance $4f$ from it. Behind the lens, there is a concave mirror of focal length f. There are two positions of mirror, such that final image coincides with the point source. If the ratio of the distance between lens and mirror for the two cases is $\frac{1}{2}n$, then find the value of n.

12. A point source emits waves equally in all directions in a non-absorbing medium. Two points P and Q are at a distance of 5 meter and 25 meter respectively from the source. Find the ratio of the amplitudes of the waves at P and Q.

13. Two thin lenses, when in contact, produce a combination of power +10 dioptre. When they are 0.25 m apart, the power reduces to +6 dioptre. Find the ratio of powers of high power lens to low power lens.

14. The recoil speed (in m/s) in integer is when hydrogen atom emits a photon during the transition from $n = 5$ to $n = 1$ is

15. E, P and r are the energy, linear momentum and orbital radius of an electron in a hydrogen atom corresponding to the quantum number 'n' then EPr is proportional to n^{-x} then, find x

16. In a coolidge tube the potential difference across the tube is 20 kV and 10 mA current flows through the voltage supply. Only 0.5% of the energy carried by the electron striking the target in converted into X-ray. Then the X-ray beam carries a power of x W. Find x

17. In a sample of radioactive material, the fraction of the initial number of active nuclei will remain undisintegrated after half of a half life of the same is $\frac{1}{\sqrt{x}}$.

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SECTION - H

Multiple True-False Type Questions

Identify the correct combination of true and false of the given three statements.

1. STATEMENT-1 : Photons cannot be deflected by electric or magnetic fields.

   STATEMENT-2 : The phenomena like photo-electric effect, compton effect etc. can be explained by wave theory of light.

   STATEMENT-3 : The mass of photon is given by $m = \frac{h}{c\lambda}$.

   (1) T F T (2) T T T (3) F T T (4) T F F

2. STATEMENT-1 : The β-particle is the electron ejected from the orbits of an atom.

   STATEMENT-2 : In all radioactive transformations either an α or a β-particle (never both or more than one of each kind) is emitted by the atom.

   STATEMENT-3 : When a radioactive element decays through the emission of a γ-ray neither atomic number nor the mass number changes.

   (1) T T T (2) F T T (3) T F T (4) F T F

3. STATEMENT-1 : The deviation of a ray of light produced by a prism is same for all wavelengths

   STATEMENT-2 : If for a given prism, the angle of incidence *i* of a ray of light in changed from 0º to 90º, then the angle of deviation produced first increases and then decreases.

   STATEMENT-3 : The brighter images are formed by the total reflecting prisms than images formed by a good silvered plane mirror.

   (1) F T F (2) F T T (3) F F T (4) T T F

4. STATEMENT-1 : Doppler effect in light is symmetrical but this effect in sound is asymmetrical.

   STATEMENT-2 : Change in wavelength $\Delta\lambda$ for light coming from a star is negative for star moving away from the earth.

   STATEMENT-3 : In case of radar moving with velocity V fractional change in wavelength $\frac{\Delta\lambda}{\lambda} = 2\frac{V}{c}$, where c is the velocity of light.

   (1) T T T (2) T F T (3) F F F (4) F T T

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Miscellaneous Questions

UNIT 5

This Unit Includes

Questions involving concepts of two or more than two chapters.

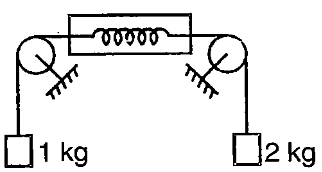
SECTION - A

Straight Objective Type

This section 210 contains multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

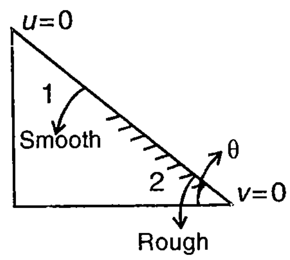
1. If the system is released from rest, then the reading of spring balance is



(1) $\frac{g}{3}$ (2) $\frac{2g}{3}$

(3) g (4) $\frac{4g}{3}$

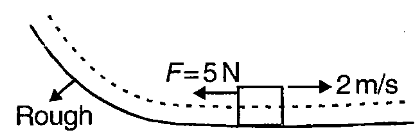
2. The ratio of lengths of smooth and rough part of an inclined plane is 1 : 2. A particle starts moving from top and again comes to rest at the bottom point then the co-efficient of friction of rough surface is



(1) $\frac{3}{2}\tan\theta$ (2) $\frac{2}{3}\tan\theta$

(3) $3\tan\theta$ (4) $\frac{1}{3}\tan\theta$

3. A block is moving as shown in figure. The direction of friction force at the instant shown is



(1) Towards right

(2) Towards left

(3) May be in any direction

(4) Not determinate as friction is absent

4. The velocity of a particle moving along x-axis varies with its distance from origin as $v = k\sqrt{x}$. Assuming that the particle starts from origin, the position of the particle at any instant t is given by

(1) $x = kt$ (2) $x = k^2t$

(3) $\frac{k^2t^2}{4}$ (4) $\frac{k^2t^2}{2}$

5. A space shuttle is in a circular orbit around earth. The pilot of the shuttle fires a small rocket in forward direction. After firing, the space shuttle

(1) Keeps on moving in the same circular orbit

(2) Changes its orbit to another circular orbit of smaller radius

(3) Changes its orbit to elliptical

(4) Changes its orbit to another circular orbit of larger radius

6. At a given place where acceleration due to gravity is 10 m/s^2 a sphere of lead of density d (kg/m^3) is gently released in a column of liquid ρ (kg/m^3). If $d > \rho$, the sphere will

   (1) Fall vertically with an acceleration 10 m/s^2

   (2) Fall vertically with no acceleration

   (3) Fall vertically with an acceleration $10\left(\frac{d-\rho}{d}\right)$

   (4) Fall vertically with an acceleration $g\left(\frac{\rho}{d}\right)$

7. The value of $\frac{L}{m} = 2.2 \times 10^{15}\,\text{m}^2/\text{s}$, where L is angular momentum of earth about the sun and m is mass of Earth. The are enclosed by Earth's orbit is approximately

   (1) 6.94×10^{22} m^2 (2) 3.47×10^{22} m^2

   (3) 34.7×10^{22} m^2 (4) 69.4×10^{22} m^2

8. On heating one end of a rod, the temperature of whole rod will be uniform when

   (1) $K < 1$ (2) $K = 0$

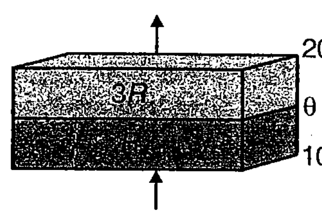
   (3) $K = 100$ (4) $K = \infty$

9. The temperature at which a black body of unit area loses its energy at the rate of 1 joule/second is

   (1) – 65°C (2) 65°C

   (3) 65 K (4) None of these

10. In the following figure, two insulating sheets with thermal resistance R and $2R$ are shown. The temperature of the interface θ is



   (1) 20°C (2) 60°C

   (3) 75°C (4) 80°C

11. A wire of area of cross-section 10^{-6} m^2 is stretched to increase its length by 0.1%. The tension produced is 1000 N. The Young's modulus of wire is

   (1) 10^{17} N/m^2 (2) 10^{12} N/m^2

   (3) 10^{10} N/m^2 (4) 10^9 N/m^2

12. A soap bubble of radius R is blown from a soap solution. After heating the solution, a second bubble of radius $2R$ is blown. The work required to blow the second bubble in comparison to that required for the first bubble is

   (1) Double

   (2) Slightly less than double

   (3) Slightly less than four times

   (4) Slightly more than four times

13. The pressure of a medium is changed from 1.01×10^5 N/m^2 to 1.11×10^5 N/m^2 and change in volume is 5% keeping temperature constant. The bulk modulus of the medium is

   (1) 204.8×10^5 Pa (2) 2.0×10^5 Pa

   (3) 2.45×10^5 Pa (4) 3.05×10^5 Pa

14. A closed container, containing a gas is moving with some acceleration in horizontal direction. Neglecting effect of gravity, the pressure in the compartment is

   (1) Same every where (2) Lower in front side

   (3) Lower in rear side (4) Lower in upper side

15. The open mouth of cylindrical vessel of radius r is in the form of an ellipse of semi-major axis R. It is possible to fill the vessel completely with a liquid

   (1) By giving it a horizontal acceleration $a = \left(\frac{R^2 - r^2}{r^2}\right)^{\frac{1}{2}} g$

   (2) By giving it a horizontal acceleration $a = \left(\frac{r^2}{R^2 - r^2}\right)^{\frac{1}{2}} g$

   (3) By giving it a vertical acceleration $a = g$

   (4) While keeping the vessel at rest

16. Two particles execute simple harmonic motions, represented by the equations $y_1 = 5\sin\left(3\pi t + \frac{\pi}{4}\right)$ and $y_2 = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$. Their respective amplitudes are in the ratio

   (1) 1 : 1 (2) 1 : 2

   (3) 2 : 1 (4) 1 : 5

17. When an open tube is dipped vertically in water with $\frac{1}{3}$rd of its length the tube inside the water, the fundamental frequency is f. The fundamental frequency of the tube is

(1) $\frac{4f}{3}$ (2) $\frac{2f}{3}$

(3) $\frac{f}{3}$ (4) f

18. The extension in a string, obeying Hookeís law, is x. The speed of a transverse wave in the stretched string is v. If the extension in the string is increased to 1.5x, the speed of sound will be

(1) $> \sqrt{1.5}\,v$ (2) $< \sqrt{1.5}\,v$

(3) $\sqrt{1.5}\,v$ (4) v

19. The equation of wave in a string fixed at both end is $y = 2\sin\pi t \cdot \cos\pi x$. The phase difference between oscillations of two points located at x = 0.4 m and x = 0.6 m is

(1) 0 (2) $\frac{\pi}{10}$

(3) $\frac{\pi}{5}$ (4) π

20. An open container having liquid in it is in free falling condition. Then,

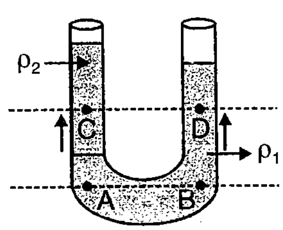
(1) Pressure everywhere in the liquid is same and is equal to the atmospheric pressure

(2) Pressure everywhere in the liquid is zero

(3) Pressure increases vertically in the liquid

(4) Pressure decreases vertically in the liquid

21. An open U tube contains two immiscible liquids of densities ρ_1 and $\rho_2(\rho_1 > \rho_2)$ as shown in figure. If P_A, P_B, P_C and P_D refer to the pressure at points A, B, C and D respectively then



(1) $P_A = P_B > P_C > P_D$

(2) $P_A = P_B > P_D > P_C$

(3) $P_A = P_B > P_C = P_D$

(4) It is not possible to predict the correct relation between P_A, P_B, P_C and P_D with given information

22. Three particles move in a straight line with initial velocities v_1, v_2 and $v_3(v_1 < v_2 < v_3)$ each with constant retardation 'a' such that motion continues for more than one second before velocity of each particle becomes zero. If s_1, s_2 and s_3 respectively be the distances travelled in the last one second before velocity becomes zero, then

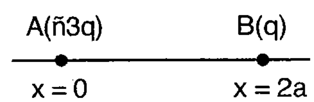
(1) $s_1 = \frac{v_1^2}{2a}$, $s_2 = \frac{v_2^2}{2a}$, $s_3 = \frac{v_3^2}{2a}$

(2) $s_1 > s_2 > s_3$

(3) $s_1 = s_2 = s_3$

(4) $s_1 < s_2 < s_3$

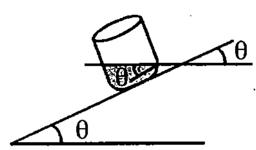
23. Two point like charge particles A & B are fixed on x-axis at the position shown. A third charged particle with a charge Q is to placed on x-axis such that it does not experience any force due to electric field. The position x of this particle satisfies

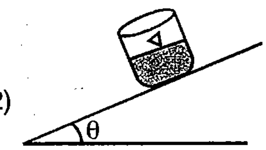


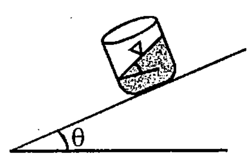
(1) 0 < x < a (2) x > 2a

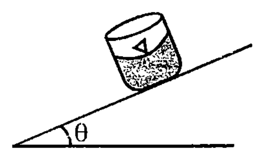
(3) a < x < 2a (4) x < 0

24. An open container containing a liquid is fixed to the inclined plane, then which of the following will correctly represent the free surface of the liquid?

(1)


(2)


(3)


(4)


25. As the accelerating potential used in a coolidge tube to produce X-rays is increased, the cut-off wavelength

(1) Increases

(2) Decreases

(3) First increases, then decreases

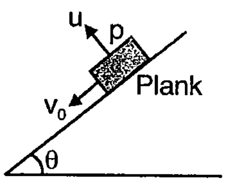
(4) Remain unchanged

26. If the angle of projection of a particle from the horizontal is doubled keeping the speed of projection same, the particle strikes the same target on the ground, then the ratio of time of flight in the two cases will be

(1) 1 : 1 (2) 1 : 2

(3) $2:\sqrt{3}$ (4) $1:\sqrt{3}$

27. A plank is released on a smooth inclined plane. When it gains velocity v_0 down the plane then a particle is projected from point 'p' of the plank with velocity u (with respect to plank) and perpendicular to the inclined plane. The particle will



(1) Strike the plank at a point behind the point p

(2) Strike the plank at a point ahead of point p

(3) Strike the plank at the point p itself

(4) Strike the plank at a point whose position will depend on inclination θ of the plane and velocity v_0

28. A black body is at a temperature of 2880 K. The energy of radiation emitted by this object with wavelength between 499 nm & 500 nm is u_1, between 999 nm with 1000 nm is u_2 and between 1499 nm and 1500 nm is u_3. The weins constant is b = 0.28 cm K. The correct alternative is

(1) $u_1 = 0$

(2) $u_3 = 0$

(3) $u_1 > u_2$

(4) $u_2 > u_1$

29. A particle P moves between A and B with a constant velocity v. Another particle Q starts at A from rest, accelerates uniformly to 2v and then, retards uniformly come to rest at B. If t_1 and t_2 be the times taken by the particles P and Q respectively for the journey, then

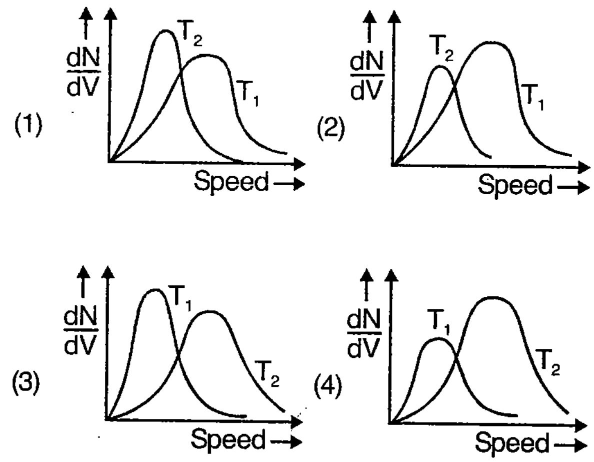
(1) $t_1 = t_2$

(2) $t_1 = 2t_2$

(3) $t_1 = \frac{t_2}{2}$

(4) $t_1 = 4t_2$

30. Choose the correct Maxwell speed distribution curves drawn at two different temperature T_1 and $T_2 (T_2 > T_1)$



31. A particle is moving in a plane with velocity $\vec{v}$. Which of the following is possible?

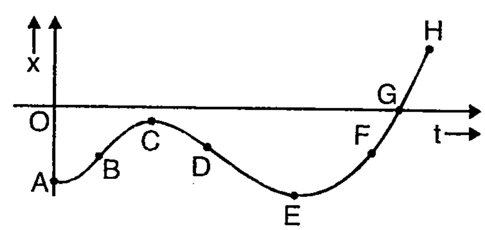
(1) $\frac{d|\vec{v}|}{dt} = 0, \frac{d\vec{v}}{dt} \neq 0$ and path is straight line

(2) $\frac{d|\vec{v}|}{dt} \neq 0$ and $\frac{d\vec{v}}{dt} = 0$

(3) $\frac{d|\vec{v}|}{dt} \neq 0$ and $\left(\frac{d\vec{v}}{dt}\right).\vec{v} = 0$

(4) $\frac{d|\vec{v}|}{dt} = 0, \frac{d\vec{v}}{dt} \neq 0$

32. A particle is moving along x-axis such that its x-coordinate depends upon time 't' as shown in figure below. In which interval the x-coordinate, velocity as well as acceleration are non-zero and negative?



(1) CD and EF

(2) DE only

(3) CD only

(4) EF only

33. N molecules, each of mass m of gas A and 2 N molecules, each of mass 2 m of gas B are contained in the same vessel which is maintained at a temperature T. The mean square of the velocity of molecules of B type is denoted by V^2 and the mean square of the x-component of the velocity of A type is denoted by W^2, then $\left(\frac{W^2}{V^2}\right)$ is

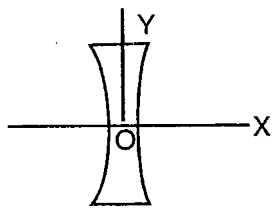
(1) 2

(2) 1

(3) $\frac{1}{3}$

(4) $\frac{2}{3}$

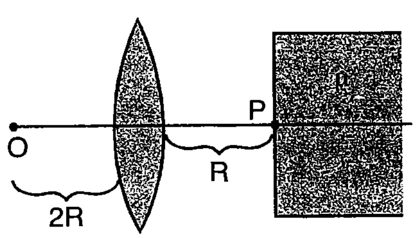
34. There is a concave lens of focal length 'f'. A ray is incident on the lens given by y = b. The equation of the refracted ray will be



(1) $y = \frac{bx}{f} + b$ (2) $y = -\frac{bx}{f} + b$

(3) $y = \frac{bx}{f} - b$ (4) $y = \frac{fx}{b} + b$

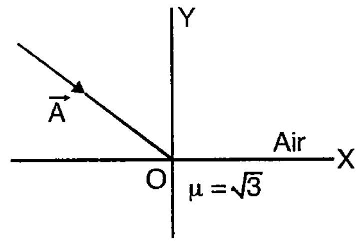
35. There is an equiconvex lens of curvature R and refractive index 1.5 kept before a plane refracting surface of index μ. An object O is placed at a distance 2 R from the lens as shown in figure. The distance of the final image from the lens will be



(1) $2\mu R$ (2) $(\mu + 1)R$

(3) $(2\mu - 1)R$ (4) $(2\mu + 1)\frac{R}{2}$

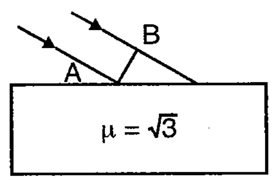
36. A ray is incident on a plane refracting surface as shown in the figure. The incident ray vector is $\vec{A} = (2\sqrt{3})\hat{i} - 2\hat{j}$. If the refractive index of the medium is $\sqrt{3}$, the angle of refraction will be



(1) 45° (2) 30°

(3) 15° (4) 60°

37. A beam of width 'd' is incident on plane refracting surface of a liquid having index $\sqrt{3}$ at an angle 60° with the normal. The width of the beam inside the liquid will be



(1) d (2) $\sqrt{3}d$

(3) $\frac{d}{\sqrt{3}}$ (4) $\frac{2d}{\sqrt{3}}$

38. A planoconvex lens ($\mu = 1.5$) and a planoconcave lens ($\mu = 1.2$) are placed in contact forming a combination of focal length F_0. Now the lenses are placed with a mutual separation R, (R = curvature of the curved surfaces) the focal length of the combination will become

(1) $\frac{5F_0}{4}$ (2) $\frac{3F_0}{4}$

(3) $\frac{7F_0}{6}$ (4) $\frac{2F_0}{3}$

39. A planoconvex lens of width a and diameter 2b has refractive index n_0, if a << b, the focal length of the lens in air should be

(1) $\frac{b^2}{a(n_0 - 1)}$ (2) $\frac{b^2}{a(n_0 + 1)}$

(3) $\frac{b^2}{2a(n_0 - 1)}$ (4) $\frac{b^2}{a(n_0)}$

40. A particle is moving towards a lens along its axis from a point far away with a constant speed v_0. The velocity of the real image at this instant is given as

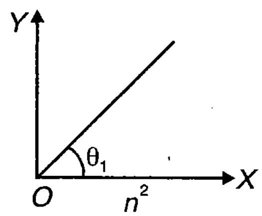
(1) $v_i = v_0$ towards the lens

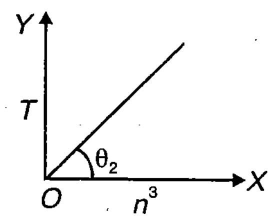
(2) $v_i > v_0$, away from the lens

(3) $v_i < v_0$ away from the lens

(4) $v_i = v_0$, away from the lens

41. Plots of orbital radius (r) *vs* square of the principal quantum number (n^2) and time period (T) v_s cube of the principal quantum number (n^3) are given. The velocity of the electron in a hydrogen atom in ground state will be





(1) $\dfrac{2\pi\theta_1}{\tan\theta_2}$ (2) $\dfrac{2\pi\tan\theta_1}{\tan\theta_2}$

(3) $\dfrac{2\pi\sin\theta_1}{\cos\theta_2}$ (4) $\dfrac{2\pi\tan\theta_2}{\tan\theta_1}$

42. A particle of mass 'm' is moving on a circular path under potential $U = A + B\log(r)$. If Bohr's quantum condition holds, here the minimum permissible value of the radius should be

(1) $\dfrac{h}{2\pi B}$

(2) $\dfrac{h}{2\pi mB}$

(3) $\dfrac{h}{2\pi\sqrt{mB}}$

(4) $\dfrac{h}{\pi\sqrt{2mB}}$

43. A particle of mass m starts to move with acceleration $a = A\cos t$. The de Broglie wavelength associated with this particle at time $t = \left(\dfrac{\pi}{2}\right)$ s will be

(1) $\dfrac{h}{mA}$ (2) $\dfrac{2h}{mA}$

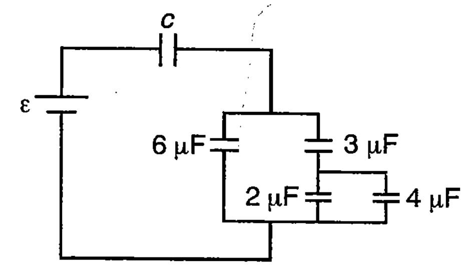
(3) $\sqrt{\dfrac{h}{mA}}$ (4) Infinite

44. Radiation of wavelength $\dfrac{\lambda_0}{3}$ (λ_0 being the threshold wavelength) is incident on a photosensitive sphere of radius R. The charge developed on the sphere when electrons cease to be emitted will be

(1) $\dfrac{4\pi\varepsilon_0 Rhc}{e\lambda_0}$ (2) $\dfrac{6\pi\varepsilon_0 Rhc}{e\lambda_0}$

(3) $\dfrac{8\pi\varepsilon_0 Rch}{e\lambda_0}$ (4) $\dfrac{12\pi\varepsilon_0 Rhc}{e\lambda_0}$

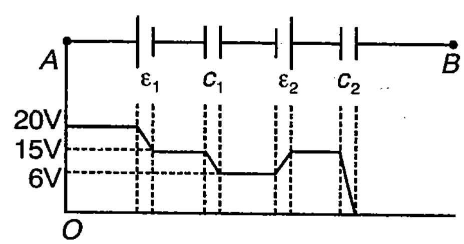
45. Consider the circuit shown in figure. If the charge on 4 μF capacitor is 12 μC, then charge on 6 μF capacitor will be



(1) 9 μC (2) 18 μC

(3) 36 μC (4) 54 μC

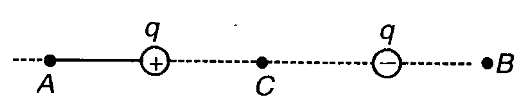
46. The variation of potential across the batteries (ε_1 and ε_2) and capacitors of capacitances c_1 and c_2 for the given circuit is as shown in figure. The ratio $\dfrac{c_1}{c_2}$ will be



(1) $\dfrac{5}{2}$ (2) $\dfrac{3}{5}$

(3) $\dfrac{5}{3}$ (4) $\dfrac{1}{1}$

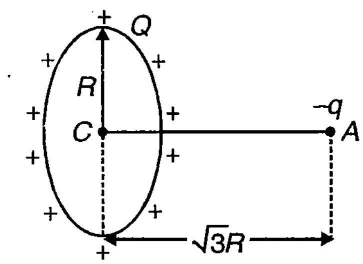
47. Out of the three points A, B and C in the region of a electric dipole, the electric field may be zero at the point



(1) A (2) B

(3) C (4) Nowhere shown

48. A ring of radius R having uniformly distributed charge $+Q$ is fixed in the region as shown. If a negative charge $-q$ is released at the point A, then the kinetic energy of the negative charge when it reaches at the centre C of the ring will be



(1) $\frac{1}{4\pi\varepsilon_0}\left(\frac{Qq}{2R}\right)$

(2) $\frac{1}{4\pi\varepsilon_0}\left(\frac{Qq}{R}\right)$

(3) $\frac{1}{4\pi\varepsilon_0}\left(\frac{2Qq}{R}\right)$

(4) $\frac{1}{4\pi\varepsilon_0}\left(\frac{Qq}{\sqrt{3}R}\right)$

49. An electric field given by $\vec{E} = E_0\hat{i} + E_0\hat{j}$ exists in the region. The work done by an external agent in moving a charge $+q_0$ slowly from $A(a, 0, a)$ to $B(2a, a, 0)$ will be

(1) q_0Ea (2) $-q_0Ea$

(3) $-2q_0E_0a$ (4) $\sqrt{2}q_0Ea$

50. The force on an electric dipole having dipole moment $\vec{P} = P_0\hat{i}$ placed in an electric field $\vec{E} = \alpha x\hat{i}$, where α is a positive constant, will be

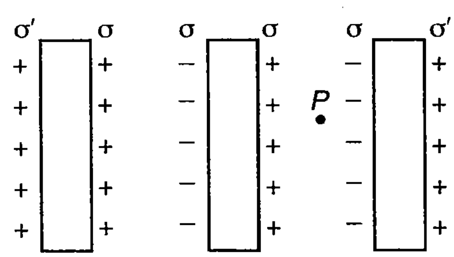
(1) $P_0\alpha$ in the positive x-direction

(2) $P_0\alpha$ in the negative x-direction

(3) $P_0\alpha$ in the positive y-direction

(4) Zero

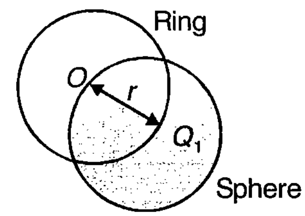
51. Three parallel large conducting plates having charge distribution as shown in figure are placed in a region. The electric field at point P will be



(1) $\frac{\sigma}{\varepsilon_0}$ (2) $\frac{\sigma}{2\varepsilon_0}$

(3) $\frac{\sigma'}{\varepsilon_0}$ (4) $\frac{\sigma'}{2\varepsilon_0}$

52. A charge Q is distributed uniformly on a ring of radius r. A sphere of radius r is constructed with its centre at the periphery of the ring as shown in figure. The electric flux through the surface of sphere will be



(1) $\frac{Q}{\varepsilon_0}$ (2) $\frac{Q}{2\varepsilon_0}$

(3) $\frac{2Q}{3\varepsilon_0}$ (4) $\frac{Q}{3\varepsilon_0}$

53. A large plane charge sheet having surface charge density $\sigma = 2 \times 10^{-6}$ C/m^2 lies in x-y plane. The flux of electric field through a circular area of radius 1 cm lying completely in the region where x, y, z are all positive and with its normal making an angle of 60° with the z-axis will be

(1) 35 N-m^2/C (2) 17.5 N-m^2/C

(3) 30.3 N-m^2/C (4) 7.5 N-m^2/C

54. The electric field in a region is radially outward

given $E = \begin{Bmatrix} 0, & r < R \\ \frac{k}{r^2}, & r > R \end{Bmatrix}$

where, r is the distance from origin. The charge enclosed by a spherical surface having radius R and passing through origin will be

(1) $4\pi\varepsilon_0 k$ (2) $\frac{4\pi\varepsilon_0 k}{3}$

(3) $\frac{2\pi\varepsilon_0 k}{3}$ (4) $\pi\varepsilon_0 k$

55. Super heated water is

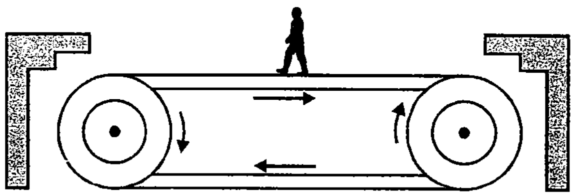
(1) Water in liquid phase at a temperature above the boiling point of water at a given pressure

(2) Water in liquid phase at a temperature slightly less than the boiling point of water at a given pressure

(3) Water in vapour form at a temperature below its boiling point at a given pressure

(4) Water in vapour form at a temperature above the boiling point of water at a given pressure

56. The figure shows a man of mass 80 kg standing stationary with respect to a horizontal conveyor belt that is accelerating. If the coefficient of static friction between the man's shoes and the belt is 0.2. The maximum acceleration of the belt up to which man continue to be stationary relative to the belt, will be



(1) 2 m/s^2

(2) 4 m/s^2

(3) 1 m/s^2

(4) 0.2 m/s^2

57. A body constrained to move along the z-axis of a coordinate system is subjected to a constant force $\vec{F}(N) = -\hat{i}+2\hat{j}+3\hat{k}$ where $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along x, y and z axes respectively. The work done by this force in moving the body by a distance 4 m along a z-axis is

(1) 8 joule

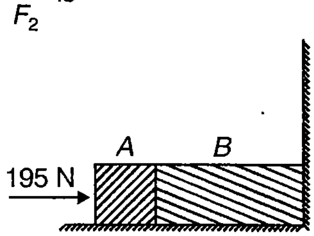
(2) 12 joule

(3) 6 joule

(4) Zero

58. Two blocks A and B of masses 5 kg and 10 kg is contact with each other rest on a table against a rigid partition as shown in figure. The coefficient of friction between the blocks and the table is $\mu_s = \mu_k = 0.10$. A force of 195 N is applied horizontally at A. If F_1 be the contact force between the blocks A and B, when partition is in place. F_2 is the contact force between A and B when partition is removed.

The ratio $\frac{F_1}{F_2}$ is



(1) $\frac{3}{2}$ (2) $\frac{2}{3}$

(3) 1 : 1 (4) 1 : 3

59. Two particles each of mass m carrying charge $+q$ and $-q$ respectively are attached at the opposite ends of a non-conducting massless spring of natural length $2a$. The system is placed on a smooth horizontal surface and is released from rest from position when spring is at its natural length. Subsequently, it is found that the maximum compression in the spring from the natural length is a. The spring constant will be equal to

(1) $\frac{q^2}{8\pi\varepsilon_0 a^3}$ (2) $\frac{q^2}{2\pi\varepsilon_0 a^3}$

(3) $\frac{q^2}{4\pi\varepsilon_0 a^3}$ (4) $\frac{q^2}{\pi\varepsilon_0 a^3}$

60. A non conducting rod of mass m and length L carries uniform distribution of charge such that its linear charge density is λ. The rod is placed on a smooth horizontal surface and uniform horizontal electric field E is switched on. If the tension at mid point of rod is T, then

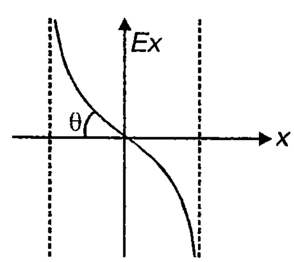
(1) $T > \frac{\lambda L}{2}$

(2) $\frac{\lambda L}{2} < T < \lambda L$

(3) $T = \frac{\lambda L}{2}$

(4) $T = 0$

61. The variation of x component of electric field with x-coordinate in a region is given by the adjacent graph. A small electric dipole having dipole moment $P_0\hat{i}$ is placed at origin, then net force on dipole is



(1) $P_0 \tan\theta$ in the positive x-direction

(2) $P_0 \tan\theta$ in the negative x-direction

(3) Zero

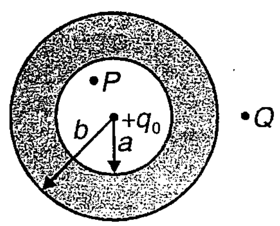
(4) $P_0 \tan\theta$ in the positive y-direction

62. The bob of a simple pendulum of length ℓ has mass m and it carries some positive charge. The same amount of positive charge is fixed at point of suspension such that when the bob is at lowest position in the rest condition, the tension in the string is 2 mg. The minimum horizontal velocity that should be given to the bob at the lowest position, such that it completes the vertical circle is

(1) $\sqrt{3gl}$ (2) $\sqrt{2gl}$

(3) $\sqrt{4gl}$ (4) $\sqrt{5gl}$

63. A conducting spherical shell of inner radius a and outer radius b is having charge q_0 at the centre. There are two points P and Q at the location as shown in figure. If the charge q_0 is shifted to point P then choose the correct statement



(1) Distribution of induced charge will change on inner surface, the distribution of charge on outer surface will not change but the electric field at point Q will change

(2) Distribution of induced charge will change on the inner surface, the distribution of charge on outer surface as well as electric field at point Q will not change

(3) Distribution of charge on inner and outer surfaces as well as electric field at point Q will change

(4) Distribution of charge on inner and outer surfaces both will change and electric field at point Q remains unchanged

64. A gas has molar heat capacity C = 3.5R for a process in which PT = constant. The number of degrees of freedom of molecules in the gas will be

(1) 3 (2) 4

(3) 5 (4) 6

65. An irregular shaped body of mass m, density σ is falling with a terminal speed v in a viscous medium of density ρ and viscosity η. The viscous drag force acting on the body has a magnitude

(1) mg (2) $mg\left(1-\frac{\rho}{\sigma}\right)$

(3) $6\pi\eta rv$ (4) $mg\left(1+\frac{\rho}{\sigma}\right)$

66. The number of significant figures in the quantity 0.069000 m^3 is

(1) 2 (2) 3

(3) 5 (4) 4

67. The average translational kinetic energy of O_2 (Molar mass 32) molecules at a particular temperature is 0.048 eV. The translational kinetic energy of N_2 (Molar mass 28) molecules in eV at same temperature is

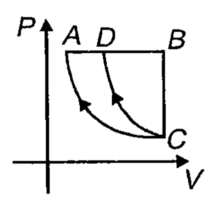
(1) 0.0015

(2) 0.003

(3) 0.048

(4) 0.768

68. A cyclic process $ABCA$ is performed on an ideal gas in which gas expanded isobarically from A to B, then it is cooled isochorically from B to C and finally it is compressed isothermally from C to A. The net heat +20 joule is absorbed in this cyclic process. Similarly in process $BCDB$ heat absorbed is +5 joule. For a cyclic process $ADCA$ performed on the same ideal gas,



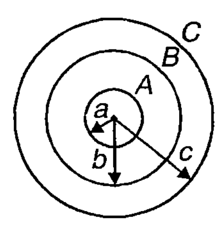
(1) +15 joule net heat is absorbed

(2) +15 joule net heat is rejected

(3) +25 joule net heat is absorbed

(4) +25 joule net heat is rejected

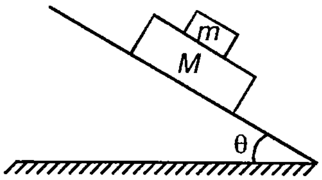
69. Three conducting concentric spherical shells A, B and C having total charges $+Q$, $-2Q$ and $+Q$ respectively are placed as shown in figure (b = 2a, c = 3a). The potential at the centre will be



(1) $+\frac{Q}{5\pi\varepsilon_0 a}$ (2) $-\frac{Q}{12\pi\varepsilon_0 a}$

(3) $\frac{Q}{12\pi\varepsilon_0 a}$ (4) Zero

70. A block of mass m is placed over a plank of mass $M(M > m)$ which rests on a smooth inclined plane as shown in figure. If the coefficient of friction between the plank and the block is μ and the system is released from rest, then the frictional force applied by the plank on the block



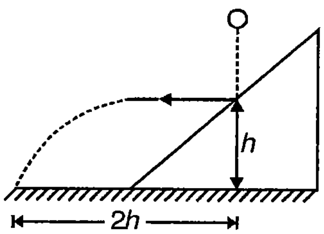
(1) Is up the inclined plane

(2) Is down the inclined plane

(3) Is zero

(4) Will depend on the value of M

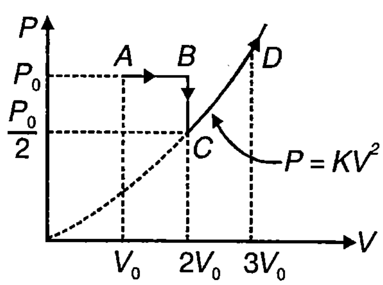
71. A ball of mass m when dropped from certain height as shown in figure strikes a wedge of mass M kept on a smooth horizontal surface and move horizontally just after impact. If the ball strikes the horizontal surface at a distance $2h$ from its initial line of fall, then the velocity of wedge just after the impact will be



(1) $\sqrt{2gh}$ (2) $\frac{M}{m}\sqrt{2gh}$

(3) $\frac{m}{M}\sqrt{2gh}$ (4) $\frac{m}{M}\sqrt{gh}$

72. A Process $ABCD$ has been performed on an ideal gas as shown in figure. The process CD is defined by $P = KV^2$ where K is a positive constant. If the temperature at A is T_0 then the temperature at D will be



(1) $\frac{8}{27}T_0$ (2) $\frac{27}{8}T_0$

(3) $\frac{9}{8}T_0$ (4) $\frac{8}{9}T_0$

73. A point charge $+q$ is fixed at point A on the circumference of a fixed smooth non-conducting circular wire of radius R in a gravity free space. A small ring of mass m and charge $+q$ which can slide freely on the wire track is given tangential velocity at point B which is diametrically opposite to A. If the distance of closest approach between the fixed charge and the ring is R, then force applied by the wire track on the ring just after the release will be $\left[F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{R^2}\right]$

(1) $\frac{3F}{4}$ (2) $\frac{F}{4}$

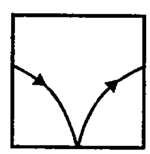
(3) $\frac{5F}{4}$ (4) F

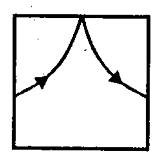
74. An infinitely long rod lies along the axis of a concave mirror of focal length f. The near end of the rod is at a distance $u > f$ from the mirror. Its image will have a length

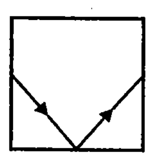
(1) $\frac{uf}{u-f}$ (2) $\frac{uf}{u+f}$

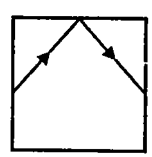
(3) $\frac{f^2}{u+f}$ (4) $\frac{f^2}{u-f}$

75. A cubic container is filled with a liquid whose refractive index increases linearly from top to bottom. Which of the following represents the path of a ray of light inside the liquid?

(1) 

(2) 

(3) 

(4) 

76. A metal surface is illuminated with light of certain frequency, which of the following factors affect the fact that "emission of electrons will take place"?

(1) Intensity of light

(2) Time of exposure

(3) Area of the surface

(4) Material of the surface

77. The x-z plane separates two media A and B of refractive indices $\mu_1 = 1.5$ and $\mu_2 = 2$. A ray of light travels from A to B. Its direction in the two media are given by unit vectors $\vec{u_1} = a\hat{i} + b\hat{j}$, $\vec{u_2} = c\hat{i} + d\hat{j}$. Then

(1) $\frac{a}{c} = \frac{4}{3}$ (2) $\frac{a}{c} = \frac{3}{4}$

(3) $\frac{b}{d} = \frac{4}{3}$ (4) $\frac{b}{d} = \frac{3}{4}$

78. Select the correct statement regarding radioactive disintegration?

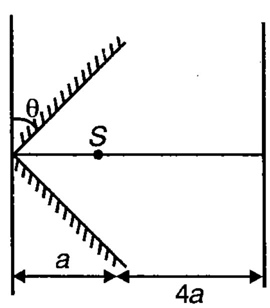
(1) In α-decay the various α-particles are emitted with same energy

(2) In β-decay, the various β-particle are emitted with same energy

(3) In γ-decay, there is no change in configuration of a nucleus

(4) All the above are correct statements

79. There are two plane mirrors. They are mutually inclined. S is a source emitting light of wavelength λ. The reflected beams interfere and fringe pattern is obtained on the screen. If θ is very small, the fringe width will be



(1) $\frac{\lambda}{\theta}$

(2) $\frac{3\lambda}{2\theta}$

(3) $\frac{2\lambda}{3\theta}$

(4) None of these

80. When a certain metallic surface is illuminated with monochromatic light of wavelength λ, the stopping potential for photoelectric current is $3V_0$. When the same surface is illuminated with light of wavelength 2λ the stopping potential is v_0. The threshold wavelength for this surface for photoelectric effect is

(1) 6λ (2) $\frac{4\lambda}{3}$

(3) 4λ (4) 8λ

81. A photon with energy $\left(\frac{5hcR}{4}\right)$ is incident on a hydrogen atom in ground state and this is absorbed by the electron. This electron enters a magnetic field of induction B perpendicular to its direction. The radius of the circular path on which the electron will move is

(1) $\frac{1}{eB}\sqrt{\frac{2Rhcm}{5}}$ (2) $\frac{1}{eB}\sqrt{\frac{Rhcm}{2}}$

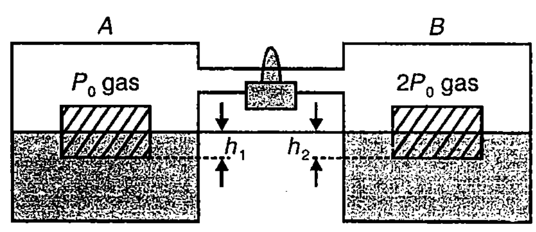
(3) $\frac{1}{eB}\sqrt{\frac{2Rhcm}{3}}$ (4) None of these

82. An electron is accelerated through a potential difference v_0. 1% of its kinetic energy converts into on X-ray photon which falls on a photosensitive plate. The maximum kinetic energy of the photoelectron is observed to be four times the work function. The de Broglie wavelength associated with the photoelectrons should be

(1) $\sqrt{\frac{h^2}{2mv_0e}}$ (2) $5\sqrt{\frac{h^2}{2mv_0e}}$

(3) $5\sqrt{5}\sqrt{\frac{h^2}{2mv_0e}}$ (4) $5\sqrt{2}\sqrt{\frac{h}{2mv_0e}}$

83. Two containers A and B each contain some liquid and an ideal gas at pressure P_0 and $2P_0$ respectively. With the valve connecting the two containers closed, two ice blocks are floating in the container in the position shown in figure. Now if valve is opened, then what will be the effect on h_1 and h_2?



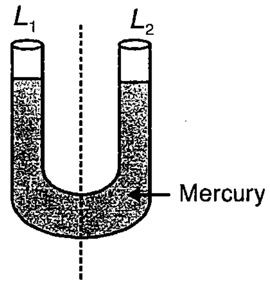
(1) h_1 as well as h_2 both will decrease

(2) h_1 will decrease whereas h_2 will increase

(3) h_1 will increase but h_2 will decrease

(4) h_1 and h_2 both will remain unchanged

84. An U-tube containing mercury has two limbs L_1 and L_2 of cross-sectional area $2A$ and A respectively. Now a 20 cm column of a liquid of specific gravity $S = 3.4$ is poured in limb L_1. Then the difference in final levels of liquids in two limbs, will be come



(1) 15 cm (2) 5 cm

(3) 20 cm (4) 10 cm

85. An uniform rod of length L, cross-sectional area A and Young's modulus Y has negligible self weight. One end of the rod is hinged and a particle of mass m is attached to the other end The system is released from rest from the horizontal position. The extension in the length of the rod when the particle is at the lowest point is

(1) $\frac{mgL}{YA}$ (2) $\frac{2mgL}{YA}$

(3) $\frac{3mgL}{YA}$ (4) $\frac{4mgL}{YA}$

86. A solid cylinder rolls down a rough inclined plane without slipping. As it goes down, the force of friction

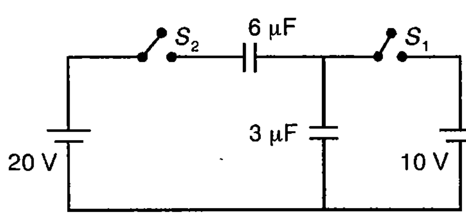
(1) Decreases its mechanical energy

(2) Decreases its translational kinetic energy

(3) Decreases its rotational kinetic energy

(4) Decreases its potential energy

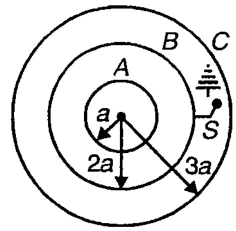
87. In the given circuit switch S_1 is closed and when steady state is reached switch S_2 is also closed. The charge on 6 μF capacitor will be



(1) 20 μC (2) 40 μC

(3) 60 μC (4) 120 μC

88. Three conducting concentric spherical shells A, B and C having radii a, $2a$ and $3a$ respectively are placed as shown. Initially A and C carry some positive charge where as shell B is uncharged. Now switch S is closed. The potential difference $(V_A - V_B)$ between shells A and B will



(1) Increase

(2) Decrease

(3) Remains unchanged

(4) Increase or decrease depending upon actual amount of charges on A and C

89. A thick, non-conducting sheet of large surface area and thickness d contains uniform charge distribution of density ρ. If the potential of the surface is v_0 then the potential at a point P inside the plate at a distance x from the central plane will be

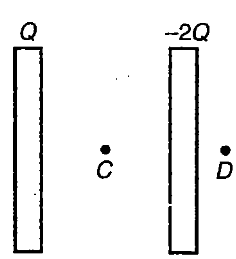
(1) $v = v_0 + \frac{\rho}{2\varepsilon_0}\left(\frac{d^2}{4} - x^2\right)$

(2) $v = v_0 - \frac{\rho}{2\varepsilon_0}\left(\frac{d^2}{4} - x^2\right)$

(3) $v = v_0 + \frac{\rho}{2\varepsilon_0}x^2$

(4) $v = v_0 - \frac{\rho}{2\varepsilon_0}x^2$

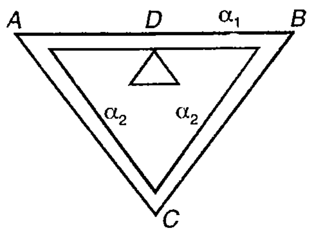
90. Two large, parallel conducting plates having charge $+Q$ and $-2Q$ respectively are placed in the region as shown in figure. The ratio of intensities of electric field at point C and D, $\frac{E_C}{E_D}$ will be



(1) 3 : 1 (2) 1 : 3

(3) 1 : 1 (4) 2 : 1

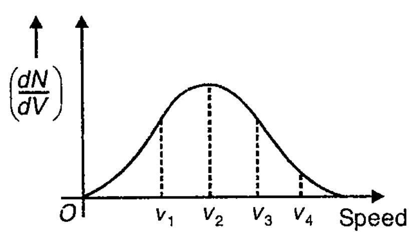
91. Three rods of equal length are joined to form an equilateral triangle ABC. D is the mid point of AB. The coefficient of linear expansion is α_1 for AB and α_2 for AC and BC. If the distance DC remains constant for small changes in temperature then



(1) $\alpha_1 = \alpha_2$ (2) $\alpha_1 = 2\alpha_2$

(3) $\alpha_1 = 4\alpha_2$ (4) $\alpha_1 = \frac{1}{2}\alpha_2$

92. For the given Maxwell's speed distribution curve if v_p = most probable speed, v_{rms} = r.m.s. speed and v_m = mean speed, then



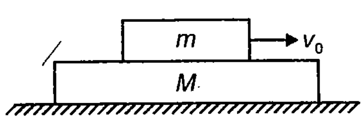
(1) $v_1 = v_{rms}$, $v_2 = v_p$ and $v_3 = v_m$

(2) $v_2 = v_p$, $v_3 = v_m$ and $v_4 = v_{rms}$

(3) $v_2 = v_p$, $v_3 = v_{rms}$ and $v_4 = v_m$

(4) $v_3 = v_p$, $v_4 = v_{rms}$ and $v_2 = v_m$

93. A sufficiently long plank of mass M is resting on a smooth horizontal plane. A small block of mass m which is placed over the plank is given a velocity v_0 relative to the plank. If the coefficient of friction between the block and the plank is m then the loss of kinetic energy of the block until the relative slipping between the block and plank ceases will be



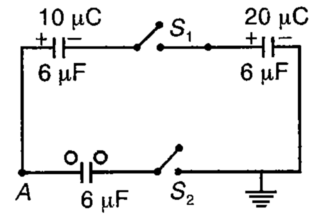
(1) Proportional to μ

(2) Proportional to $\frac{1}{\mu}$

(3) Proportional to μ^2

(4) Independent of μ

94. In the given circuit when S_1 and S_2 are closed the potential of point A will be



(1) $\frac{5}{3}$ V (2) $\frac{10}{3}$ V

(3) 5 V (4) 0

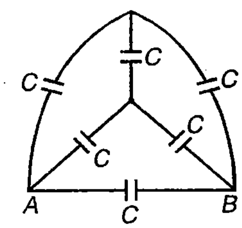
95. For the given circuit, the equivalent capacitance between points A and B is

(1) $\frac{C}{2}$

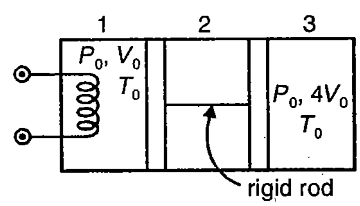
(2) C

(3) $2C$

(4) $\frac{3C}{2}$



96. An adiabatic cylindrical vessel is divided into three compartments by two adiabatic pistons connected by a rigid rod. Compartments 1 and 3 each contain the same ideal gas ($\gamma = 1.5$) at initial pressure, volume and temperatures as shown in figure. Now the gas in compartment 1 is slowly heated until its volume becomes $4V_0$. The final temperature of the gas contained in compartment 3 will be



(1) T_0 (2) $2T_0$

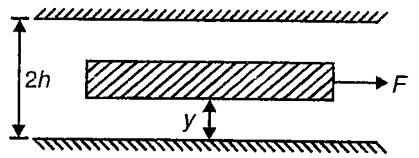
(3) $\frac{T_0}{2}$ (4) $8T_0$

97. Water at 0°C kept in a container with an open top is placed in a large evacuated chamber. If the specific latent heat of vaporization of water at 0°C is η times the specific latent heat of freezing of water at 0°C, then the fraction of water that will ultimately freeze is

(1) $\frac{1}{\eta}$ (2) $\frac{\eta}{\eta+1}$

(3) $\frac{\eta-1}{\eta}$ (4) $\frac{\eta-1}{\eta+1}$

98. A thin plate is floating in a highly viscous liquid of viscosity η contained between two infinite stationary parallel plates. The thin plate is acted upon by a constant horizontal force F as shown in figure. For the terminal velocity achieved by the rod to be maximum, the value of y will be



(1) $\frac{h}{2}$ (2) $\frac{h}{3}$

(3) $\frac{h}{4}$ (4) h

99. An ideal gas is kept in a long cylindrical vessel fitted with a frictionless piston of cross-sectional area 10 cm^2 and weight 1 kg. The length of the gas column in the vessel is 20 cm. The atmospheric pressure is 100 kPa. The vessel is now taken into a spaceship revolving round the earth as a satellite. The air pressure in the spaceship is maintained at 100 kPa. The length of the gas column in the cylinder will be

(1) 11 cm (2) 22 cm

(3) 33 cm (4) 5.5 cm

100. Two samples A and B of the same gas have equal volumes and pressures. The gas in sample A is expanded isothermally to double its volume and the gas in B is expanded adiabatically to double its volume. If the work done by the gas is the same for the two cases, then γ (specific heat) satisfies the equation

(1) $1 - 2^{1-\gamma} = (\gamma - 1)\ \ln 2$

(2) $1 - 2^{\gamma - 1} = (1 - \gamma)\ \ln 2$

(3) $2^{\gamma - 1} = \ln 2$

(4) $1 - 2^{1-\gamma} = \gamma \ln 2$

101. A vessel containing one mole of a monoatomic ideal gas (molecular weight = 20 gm/mol) is moving on a floor at a speed of 50 m/s. The vessel is stopped suddenly. Assuming that the mechanical energy lost has gone into the internal energy of the gas, the rise in its temperature will

(1) 1 K (2) 2 K

(3) 3 K (4) 4 K

102. In a double slit experiment, the slits are separated by a distance d and the screen is at a distance D from the slits. If a maxima is formed just opposite to each slit, then what is the order of the fringe so formed?

(1) $\frac{d^2}{2\lambda D}$ (2) $\frac{2d^2}{\lambda D}$

(3) $\frac{d^2}{\lambda D}$ (4) $\frac{d^2}{4\lambda D}$

103. A prism of refractive index n and angle A is placed in minimum deviation position. If the angle of minimum deviation is equal to the angle A, then the value of A is

(1) $\sin^{-1}\left(\frac{n}{2}\right)$ (2) $2\cos^{-1}\left(\sqrt{\frac{n}{2}}\right)$

(3) $2\sin^{-1}\sqrt{\frac{1-n^2}{2}}$ (4) $2\cos^{-1}\left(\frac{n}{2}\right)$

104. Light of wavelength λ in air enters a medium of refractive index μ. Two points in this medium, lying along the path of this light are at a distance x apart. The phase difference between these points is

(1) $\mu\frac{2\pi}{\lambda}x$ (2) $\frac{1}{\mu}\frac{2\pi}{\lambda}x$

(3) $(\mu-1)\frac{2\pi}{\lambda}x$ (4) $\frac{1}{(\mu-1)}\frac{2\pi}{\lambda}x$

105. An electron with kinetic energy E (eV) collides with a hydrogen atom in the ground state. The collision will be elastic

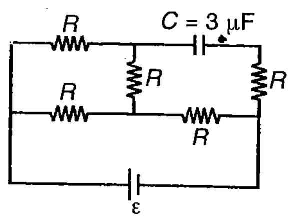
(1) For all values of E

(2) For E < 10.2 eV

(3) For E < 13.6 eV

(4) Only for E < 3.4 eV

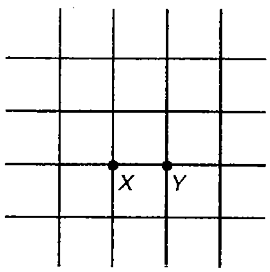
106. In the given circuit, the potential difference across the capacitor is 12 V. Each resistance is of 3 Ω. The cell is ideal. The emf of the cell is



(1) 15 V (2) 9 V

(3) 12 V (4) 24 V

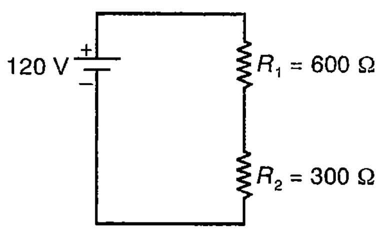
107. There is an infinite wire grid with square cells as shown in the figure. Resistance of each side of the square is r. The resistance between point X and Y is



(1) $2r$ (2) $\frac{3}{4}r$

(3) $\frac{r}{2}$ (4) $\frac{r^2}{XY}$

108. A voltmeter of resistance 600 Ω when connected in turn across resistance R_1 and R_2 reads v_1 and v_2 respectively, given by



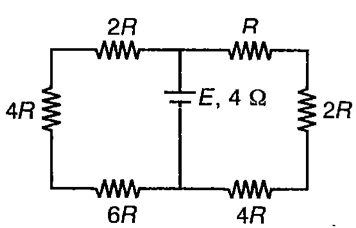
(1) 30 V, 60 V

(2) 60 V, 30 V

(3) 45 V, 75 V

(4) 30 V, 30 V

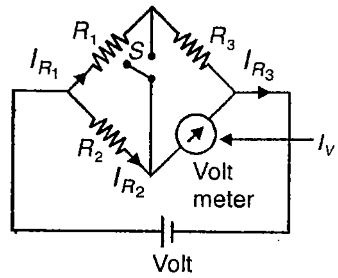
109. A battery of internal resistance 4 Ω is connected to the network of the resistance as shown. If maximum power can be delivered to the network, the magnitude of resistance (in Ω) should be



(1) $\frac{19}{21}$ Ω (2) $\frac{84}{19}$ Ω

(3) 12 Ω (4) 7 Ω

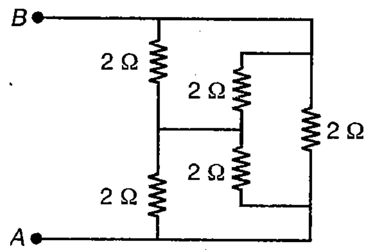
110. In the given circuit $R_1 \neq R_2$, the reading of the voltmeter is same, irrespective of the fact that switch S open or close, then which of the following is correct?



(1) $I_{R_2} = I_V$ (2) $I_{R_1} = I_{R_2}$

(3) $I_{R_3} = I_V$ (4) None of these

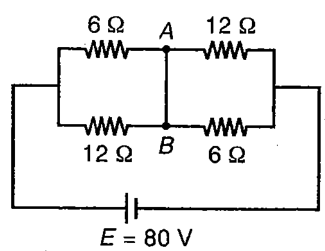
111. Find the equivalent resistance between A and B for the given circuit



(1) 2 Ω (2) 4 Ω

(3) 1 Ω (4) None of these

112. In the circuit as shown a wire is connected between points A and B. How much current will flow through the wire?



(1) 5 A (2) $\frac{10}{3}$ A

(3) $\frac{20}{3}$ A (4) $\frac{5}{3}$ A

113. A point object is placed on the axis of layered lens as shown in figure is made of two different transparent materials. The number of images that will be formed is

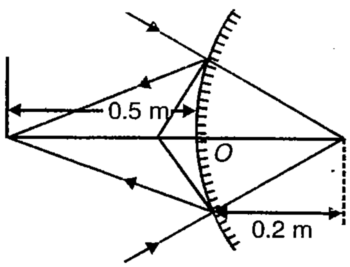
(1) One image

(2) Two image

(3) Three image

(4) No image

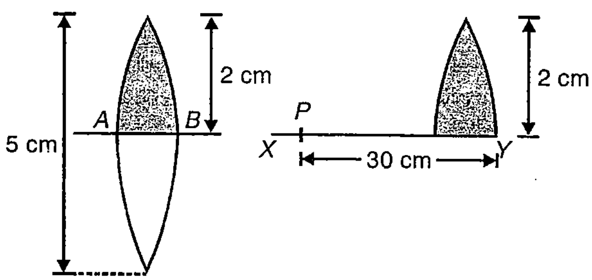
114. A beam of convergent light converges to a point 0.5 m in front of the mirror after reflection at convex mirror. But in the absence of the mirror the beam converges to a point 0.2 m behind the mirror. The radius of curvature of the mirror is



(1) 20 cm   (2) 50 cm

(3) 66.67 cm   (4) 28.57 cm

115. A convergent lens of focal length 20 cm and diameter 5 cm is cut along the line AB. The part of the lens shown shaded in the diagram is now used to form an image of a point P placed 30 cm away from it on the line XY, which is perpendicular to the plane of the lens? The image of P will be formed at a point



(1) 0.5 cm above XY

(2) 1 cm below XY

(3) On XY

(4) 1.5 cm below XY

116. A circuit is made up of a resistance 1 Ω and inductance 0.01 H. An alternating emf of 200 V, 50 Hz is connected in the circuit. The phase difference between the current and emf in the circuit is

(1) $\tan^{-1}(\pi)$ (2) $\tan^{-1}\left(\frac{\pi}{2}\right)$

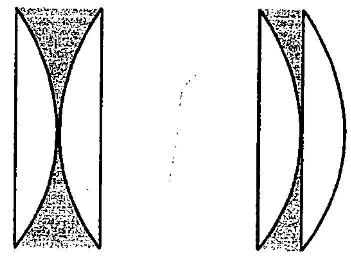
(3) $\tan^{-1}\left(\frac{\pi}{4}\right)$ (4) $\tan^{-1}\left(\frac{\pi}{3}\right)$

117. The angular momentum of an electron in the hydrogen atom in an orbit, in which its potential energy is –6.8 eV is

(1) $\frac{h}{2\pi}$ (2) $\frac{3h}{2\pi}$

(3) $\frac{2h}{\pi}$ (4) $\frac{h}{\pi}$

118. A liquid of refractive index 1.33 is placed between two identical plano-convex lenses with refractive index 1.50. Two possible arrangement P and Q are shown. The system is



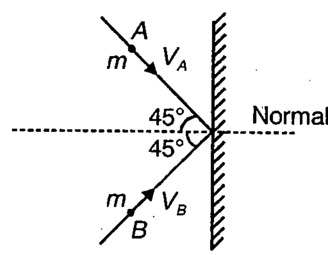
(1) Divergent in P, convergent in Q

(2) Convergent in P, divergent in Q

(3) Convergent in both

(4) Divergent in both

119. Two bodies A and B are moving towards a plane mirror with speeds V_A and V_B respectively as shown in the figure. The speed of image of A with respect to the body B is



(1) $V_A + V_B$ (2) $|V_A - V_B|$

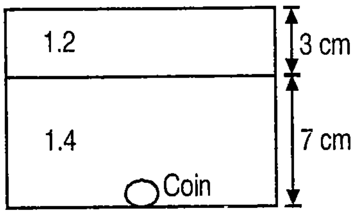
(3) $\sqrt{V_A^2 + V_B^2}$ (4) $\sqrt{V_A^2 - V_B^2}$

120. A parallel beam of light passes parallel to the principal axis and falls on one face of a thin equi-convex lens of focal length f and after two internal reflections from the second face forms a real image. If the refractive index of material of lens is 1.5, the distance of image for the lens is

(1) $\frac{f}{7}$ (2) $\frac{f}{2}$

(3) $7f$ (4) None of these

121. There is a coin placed at the bottom of a beaker which contains two immiscible liquids of refractive index 1.2 and 1.4 as shown in the figure. The depth of the coin below the surface as observed from above is



(1) 1.6 cm (2) 7.5 cm

(3) 8 cm (4) None of these

122. The dispersive power of two lenses are 0.01 and 0.02. If focal length of one lens is +10 cm, then what should be the nature and focal length of the second lens, so that they form an achromatic combination?

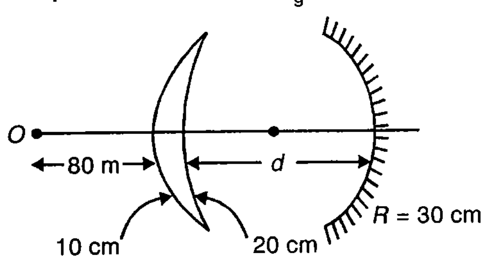
(1) Diverging lens having focal length 20 cm

(2) Converging lens having focal length 20 cm

(3) Diverging lens having focal length 10 cm

(4) Converging lens having focal length 10 cm

123. If the final image after two refractions through the lens and one reflection from the mirror is formed at same point O, then d is (μ_g = 1.5)



(1) 100 cm (2) 110 cm

(3) 90 cm (4) 80 cm

124. A cubic block is floating in a liquid with half of its volume immersed in the liquid. When the whole system accelerated upward with a net acceleration of $\frac{g}{3}$. The fraction of volume immersed in the liquid will become/remain

(1) $\frac{1}{2}$ (2) $\frac{3}{8}$

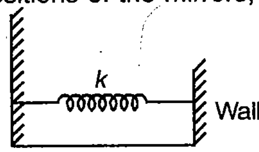
(3) $\frac{2}{3}$ (4) $\frac{3}{4}$

125. A particle executes S.H.M. in front of a concave mirror of radius 1 m about the centre of curvature, along the axis with very small amplitude a. The amplitude of oscillations of the image is

(1) a (2) $2a$

(3) $\frac{a}{2}$ (4) None of these

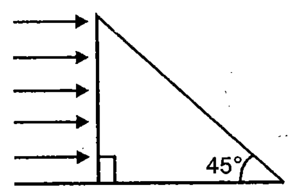
126. A plane mirror having a mass m is tied to free end of a massless spring of spring constant k. The other end of the spring is attached to a wall. The spring with the mirror held vertically to the floor can slide along it smoothly. When the spring is at its natural length, the mirror is found to be moving at a speed v. The separation between the images of a man standing before the mirror, for the two extreme positions of the mirrors, is



(1) $v\sqrt{\frac{m}{k}}$ (2) $\frac{v}{2}\sqrt{\frac{m}{k}}$

(3) $2v\sqrt{\frac{m}{k}}$ (4) $4v\sqrt{\frac{m}{k}}$

127. A beam of light consisting of red, greed and blue colours is incident on a right angled prism. The refractive indices of the material of prism for the red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. The prism will



(1) Separate part of red colour from the green and blue colours

(2) Separate part of the blue colour from red and green colours

(3) Separate all the three colours from one another

(4) Not separate even partially any colour from the other two colours

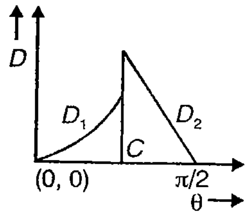
128. A particle moves towards a concave mirror of focal length 30 cm along its axis with a constant speed of 4 cm/s. What is the speed of its image when the particle is at 90 cm from the mirror?

(1) 2 cm/s (2) 8 cm/s

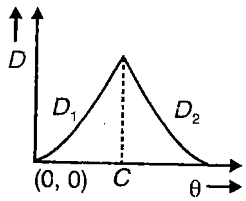
(3) 1 cm/s (4) 4 cm/s

129. A ray of light travels from a medium of refractive index M into air. If the angle of incidence at the plane surface of separation is θ and the corresponding angle of deviation is D, the variation D with θ is shown correctly by the figure

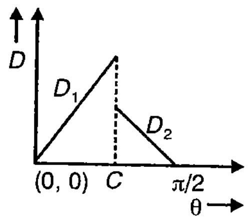
(1)



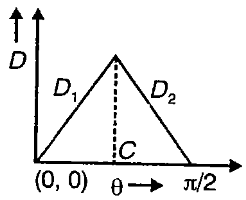
(2)



(3)



(4)



130. In Young's double slit experiment, the separation between two coherent sources S_1 and S_2 is d and the distance between the source and screen is D. In the interference pattern it is found that exactly in front of one slit there occurs a minimum. The possible wavelength used in experiments are

(1) $\lambda = \frac{d^2}{D}, \frac{d^2}{3D}, \frac{d^2}{5D}\ldots$

(2) $\lambda = \frac{d^2}{D}, \frac{d^2}{5D}, \frac{d^2}{9D}\ldots$

(3) $\lambda = \frac{d^2}{D}, \frac{d^2}{2D}, \frac{d^2}{3D}\ldots$

(4) $\lambda = \frac{d^2}{3D}, \frac{d^2}{7D}, \frac{d^2}{11D}\ldots$

131. When an object is at a distances u_1 and u_2 from the optical centre of a lens, a real and virtual image are formed respectively, with the same magnification. The focal length of the lens is

(1) $(u_1 + u_2)$ (2) $u_1 + \frac{u_2}{2}$

(3) $\frac{u_1+u_2}{2}$ (4) $\frac{u_1-u_2}{2}$

132. Let S_1 and S_2 be the two slits in Young's double slit experiment. If central maxima is observed at P and angle $\angle S_1PS_2 = \theta$, then the fringe width for the light of wavelength λ will be

(1) $\frac{\lambda}{\theta}$ (2) $\lambda\theta$

(3) $\frac{2\lambda}{\theta}$ (4) $\frac{\lambda}{2\theta}$

133. A lens of refractive index μ is put in a liquid of refractive index μ. If the focal length of the lens in air is f, its focal length in liquid will be

(1) $-\frac{f\mu'(\mu-1)}{\mu'-\mu}$ (2) $\frac{f(\mu'-\mu)}{\mu'(\mu-1)}$

(3) $\frac{\mu'(\mu-1)}{f(\mu'-\mu)}$ (4) $\frac{f\mu'\mu}{(\mu-\mu')}$

134. In a two slit experiment with white light, a white fringe is observed on a screen kept behind the slits. When the screen is moved away by 0.05 m, then central white fringe

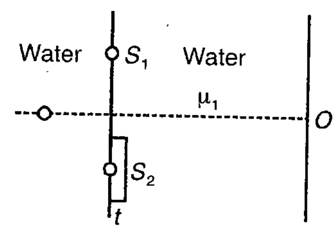
(1) Does not move at all

(2) Get displaced from its earlier position

(3) Becomes coloured

(4) Disappears

135. A Young's double slit experiment is conducted in water (μ_1) as shown in the figure. A glass plate of thickness t and refractive index μ_2 is placed in the path of S_2. Find the magnitude of the optical path difference at O



(1) $\left|\left(\frac{\mu_2}{\mu_1}-1\right)t\right|$ (2) $\left|\left(\frac{\mu_1}{\mu_2}-1\right)t\right|$

(3) $|(\mu_2 - \mu_1)t|$ (4) $|(\mu_2 - 1)t|$

136. A converging lens of a transparent material in air will behave as

(1) Converging lens in water

(2) Diverging lens in water

(3) Neither converging nor diverging in water

(4) Converging, diverging or neither in water

137. In Young's double slit experiment we get 60 fringes in the field of view of monochromatic light of wavelength 4000 Å. If we use monochromatic light of wavelength 6000 Å then the number of fringes obtained in the same field of view is

(1) 60 (2) 90

(3) 40 (4) 150

138. There are n number of radioactive nuclei in a sample. If from the sample n number of β particles are emitted in every two seconds, then the half life of the nuclei is

(1) $\frac{n'}{2}$ (2) $0.693\times\left(\frac{2n}{n'}\right)$

(3) $0.693\times\ln\left(\frac{2n}{n'}\right)$ (4) $0.693\times\left(\frac{n}{n'}\right)$

139. The activity of a radioactive sample decreases to one tenth of the original activity A_0 in a period of one year. After 9 more years its activity would be

(1) $\frac{A_0}{100}$ (2) $\frac{A_0}{90}$

(3) $\frac{A_0}{10^{10}}$ (4) None of these

140. Binding energy per nucleon for C^{12} is 7.68 MeV and for C^{13} is 7.74 MeV. The energy required to remove a neutron from C^{13} is

(1) 5.49 MeV (2) 8.46 MeV

(3) 9.45 MeV (4) 5.59 MeV

141. A radioactive nuclide A_1 with decay constant λ_1 transform into a radioactive nuclide A_2 with decay constant λ_2. Assuming that at the initial moment the preparation contained only the nuclide A_1 then the time interval after which the activity of the nuclide A_2 reach its maximum value is

(1) $\frac{\ln(\lambda_2/\lambda_1)}{\lambda_2-\lambda_1}$ (2) $\frac{\ln(\lambda_1/\lambda_2)}{\lambda_1-\lambda_2}$

(3) $\ln(\lambda_2-\lambda_1)$ (4) $e^{-(\lambda_1-\lambda_2)}$

142. A radioactive isotope X has a half life of 10 s. There are 1000 isotopes which are falling from rest from a height of 500 m. When it is at a height of 100 m from the reference plane, find the activity of the sample

(1) 50 (2) 39

(3) 29 (4) 100

143. In the nuclear reaction given by ${}_2He^4 + {}_7N^{14} \rightarrow {}_1H^1 + X$, then the nucleus X is

(1) Nitrogen of mass 16 (2) Nitrogen of mass 17

(3) Oxygen of mass 16 (4) Oxygen of mass 17

144. If 10% of a radioactive material decays in 5 days, then the amount of the original material left after 20 days is approximately

(1) 60% (2) 65%

(3) 70% (4) 75%

145 The de Broglie wavelength of the thermal neutron at 927°C is λ. Its wavelength at 327°C will be

(1) $\frac{\lambda}{2}$ (2) $\frac{\lambda}{\sqrt{2}}$

(3) $\lambda\sqrt{2}$ (4) 2λ

146. The electron in H-atom makes a transition from $n_1 \rightarrow n_2$ where n_1 and n_2 are the principal quantum number of the states. Assume Bohr's model to be valid. The time period of the electron in initial state is 27 times that in final state. Find the possible value of n_1 and n_2 if only just first 10 states are in the visible range of instrument

(1) 3, 9 (2) 39, 13

(3) 56, 14 (4) 2, 10

147. A small mirror of mass m is suspended by a light thread of length L. The angle through which the thread will be deflected when a short pulse of laser of energy E falls normally on the mirror is

(1) $\theta = \frac{2E}{mc\sqrt{2g\ell}}$ (2) $\frac{mc\sqrt{g\ell}}{2E}$

(3) $\frac{mc\sqrt{2g\ell}}{2E}$ (4) $\frac{2E}{mc\sqrt{g\ell}}$

148. If E_1, E_2 and E_3 represent respectively the K.E of an electron, an alpha particle and a proton each having same de Broglie wavelength, then

(1) $E_1 > E_3 > E_2$ (2) $E_2 > E_3 > E_1$

(3) $E_1 > E_2 > E_3$ (4) $E_1 = E_2 = E_3$

149. Radius of the second Bohr orbit of a singly ionised helium atom is

(1) 0.53 Å (2) 1.06 Å

(3) 0.265 Å (4) 0.132 Å

150. A beam of electrons accelerated by a large potential difference V is made to strike a metal target to produce X-rays. For which of the following values of V, the resulting X-rays have the lowest minimum wavelength?

(1) 10 kV (2) 20 kV

(3) 30 kV (4) 40 kV

151. The ionisation energy of the ionised sodium atom Na^{+10} is

(1) 13.6 eV (2) 13.6×11 eV

(3) $\left(\frac{13.6}{11}\right)$ eV (4) $13.6 \times (11^2)$ eV

152. If radiation $K\alpha$ for M_0 ($Z = 42$) has a wavelength of 0.71 Å, find the wavelength of the corresponding radiation of Cu ($Z = 29$)

(1) 1 Å

(2) 2 Å

(3) 1.52 Å

(4) 1.25 Å

153. Three measurements 3.6 m, 3.7 m and 3.2 m are made in an experiment. The result with correct number of significant figures is

(1) 3.6 m (2) 3.56 m

(3) 3.5 m (4) 3 m

154. The dimension of the quantity $\frac{h}{x}$ where x has dimension of length and h represents Planck's constant is identicle to dimension of

(1) Mass

(2) $\frac{E}{c}$, $E \equiv$ energy and c is velocity of light

(3) Time

(4) None of these

155. The dimensional formula of $\frac{h\nu}{c}$, where h is Planck's constant, ν is frequency, c is velocity of light, is

(1) $[ML^2T^{-2}]$ (2) $[MLT^{-1}]$

(3) $[ML^{-1}T^{-1}]$ (4) $[M^1L^0T^0]$

156. An experiment measures quantity a, b, c and x is calculated, from $x = \frac{ab}{c^3}$. If the maximum percentage error in a, b and c are 1%, 1% and 2% respectively, the maximum percentage error in x will be

(1) 8% (2) –4%

(3) 4% (4) None of these

157. The dimension of $\frac{L}{C}$ is equivalent to that of

($L \rightarrow$ inductance, $C \rightarrow$ capacitance)

(1) ω^2, $\omega \equiv$ angular frequency

(2) T^2, $T \equiv$ time period

(3) R^2, $R \equiv$ Resistance

(4) Angle

158. An opaque sphere of radius R is placed on a table. A point source is fixed above the sphere at a height $3R$ from the surface of the table along the diameter of the sphere. The radius of the shadow of the sphere cast on the table will be

(1) R (2) $2R$

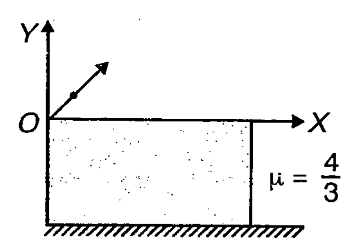
(3) $\sqrt{3}R$ (4) $\frac{\sqrt{3}R}{2}$

159. A ring of radius R is floating on the surface of a liquid of refractive index $\mu = \sqrt{3}$. A point source of light is placed on the axis of the ring at a depth $\sqrt{3}R$. The radius of the shadow of the ring on the ceiling at a height $5R$ from the surface of the liquid will be

(1) $5\sqrt{3}R$ (2) $(1+5\sqrt{3})R$

(3) $(1+\sqrt{3})R$ (4) $(10\sqrt{3}R)$

160. The bottom of water tank is lined with a plane mirror. A particle is projected from the origin O under gravity. The equation of the trajectory is $y = a(x - x^2)$. The depth of the tank is $4a$ and this is completely filled. The maximum separation between the particle and its image viewed from outside water will be



(1) $\frac{4a}{3}$ (2) $\frac{13a}{3}$

(3) $\frac{5a}{4}$ (4) $\frac{13a}{2}$

161. In an experiment on photoelectric effect, the wavelength of the incident radiation is λ. The wavelength of the incident radiation is reduced to $\frac{1}{3}$rd of the initial value and the maximum kinetic energy of the photoelectron is observed to be n times the previous value. The threshold wavelength for the metal plate is

(1) $\left(\frac{n-1}{n-3}\right)\lambda$ (2) $\left(\frac{n}{n-3}\right)\lambda$

(3) $\frac{(n+1)\lambda}{(n-3)}$ (4) $\frac{\lambda}{n}$

162. An electron is moving on a circular path around a stationary neutron under gravitational interaction. Masses of the neutron and electron are M and m respectively. If Bohr's quantum condition holds here the minimum permissible de Broglie wavelength associated with the electron will be

(1) $\frac{h^2}{2\pi GMm}$ (2) $\frac{h^2}{2\pi GMm^2}$

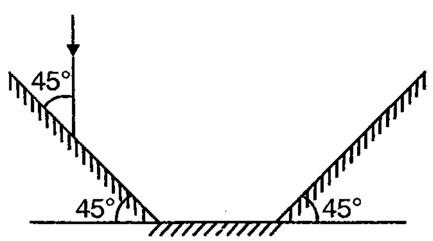
(3) $\frac{h^2}{2\pi GM^2m}$ (4) $\frac{h^2}{4\pi GM^2m}$

163. Consider a hypothetical annihilation of a stationary electron with a stationary position, what is wavelength of resulting radiation?

(1) $\frac{h}{m_0c}$ (2) $\frac{2h}{m_0c}$

(3) $\frac{h}{2m_0c}$ (4) $\frac{m_0}{hc}$

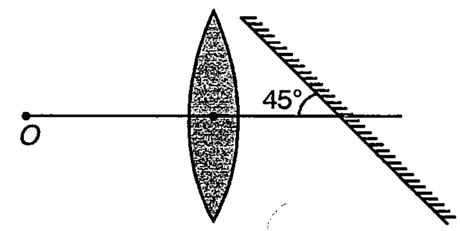
164. There is a set of three plane mirrors as shown in figure. A ray incident on the first mirror at an angle 45° with the mirror surface. The deviation suffered by the ray when it finally exits will be



(1) $\frac{\pi}{3}$ (2) $\frac{\pi}{6}$

(3) $\frac{\pi}{2}$ (4) π

165. A convex lens of focal length $\frac{a}{2}$ and a plane mirror are arranged as shown in the figure. The plane mirror is inclined at an angle 45° with the axis and the distance between the lens and mirror is equal to the focal length of the lens. A point source O is placed at a distance a from the lens at its axis. The distance between the source and the image formed after reflection from the mirror will be



(1) $\frac{a}{2}$ (2) $\frac{\sqrt{5}a}{2}$

(3) $\frac{\sqrt{10}a}{2}$ (4) $\frac{\sqrt{2}a}{5}$

166. A radioactive sample is undergoing alpha decay. At any time t_1 its activity is A and at a later time t_2 the activity is $\frac{A}{3}$. The average life time for the sample should be

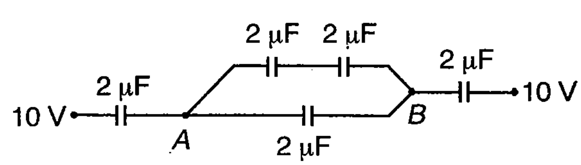
(1) $\log 2(t_2 - t_1)$

(2) $\frac{t_2 - t_1}{\log(3)}$

(3) $\frac{t_2 - t_1}{\log(5)}$

(4) $\log 3\left(\frac{t_2 + t_1}{2}\right)$

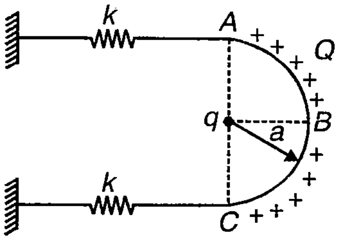
167. In given circuit, equivalent capacitance across A and B is



(1) 2 μF (2) 3 μF

(3) 4 μF (4) 5 μF

168. In the given figure, ABC is a non-conducting semicircular wire of radius a carrying total charge Q uniformly distributed and a point charge q is at its centre. Ends of wire are attached to springs each having spring constant k as shown in the figure. In the given position, system is in equilibrium. Now the point charge q is removed. The amplitude of resulting S.H.M will be



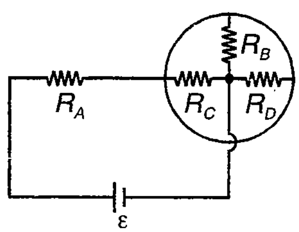
(1) $\frac{qQ}{4\pi^2\varepsilon_0 a^2 k}$

(2) $\frac{qQ}{4\pi\varepsilon_0 a^2 k}$

(3) $\frac{2qQ}{4\pi^2\varepsilon_0 a^2 k}$

(4) $\frac{qQ}{\pi^2\varepsilon_0 a^2 k}$

169. In the given circuit $R_B = 6\ \Omega$, $R_C = 3\ \Omega$, $R_D = 1\ \Omega$. The ratio of current through resistors A, B, C and D will be in the ratio



(1) 3 : 2 : 1 : 6 (2) 6 : 3 : 2 : 1

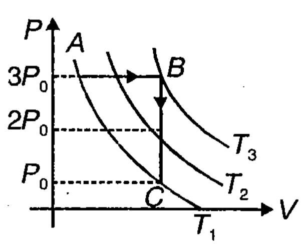
(3) 1 : 2 : 3 : 6 (4) 6 : 1 : 2 : 3

170. The ratio of velocity of sound in gaseous mixture containing 4 gm of He and 32 gm of O_2 and root mean square speed of oxygen molecules at same temperature will be

(1) $\sqrt{2}:1$ (2) $2\sqrt{2}:1$

(3) $\sqrt{2}:\sqrt{3}$ (4) 2 : 1

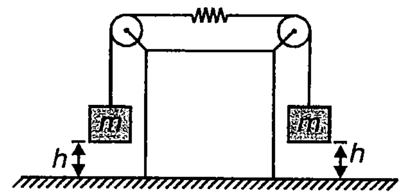
171. Three isotherm are drawn for $\frac{2}{R}$ moles of an ideal gas ($\gamma = 1.5$) at temperatures T_1, T_2 and T_3 where T_1 = 150 K as shown in figure. For the process ABC net heat absorbed is



(1) 200 J (2) 300 J

(3) 400 J (4) 600 J

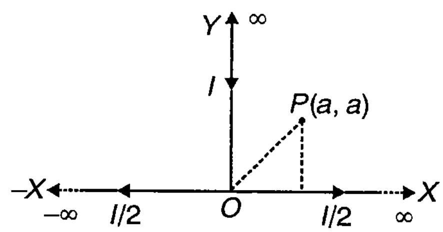
172. In the adjacent figure, spring is massless and surface of pulleys is smooth. At position shown in figure the spring is at its natural length and the system is released from rest. If both the blocks just miss to hit the horizontal plane then spring constant k is equal to



(1) $\frac{mg}{h}$ (2) $\frac{4mg}{h}$

(3) $\frac{2mg}{h}$ (4) $\frac{mg}{4h}$

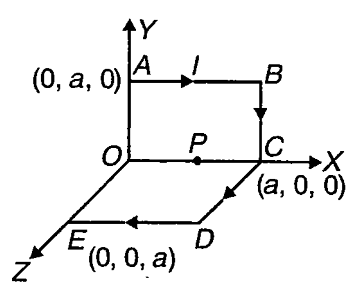
173. In the adjacent figure, magnetic field at point P is



(1) $\frac{\mu_0 I}{4\pi a}\left(1+\frac{1}{\sqrt{2}}\right)$ (2) $\frac{\mu_0 I}{4\pi a}(1+2\sqrt{2})$

(3) $\frac{\mu_0 I}{4\pi a}(1-\sqrt{2})$ (4) $\frac{\mu_0 I}{4\pi a}(1+\sqrt{2})$

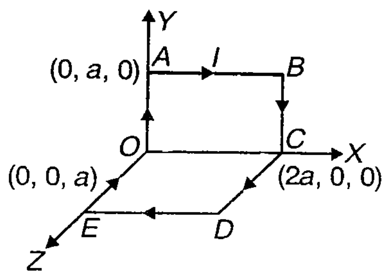
174. The conductor $ABCDE$ carries a current I. If an external uniform magnetic field $B_0 k$ exists in the region, then net force on the conductor will be



(1) $iB_0 a\hat{j}$ (2) $-iB_0 a\hat{i}$

(3) $-iB_0 a(\hat{i}+\hat{j})$ (4) $iB_0 a(\hat{i}+\hat{j})$

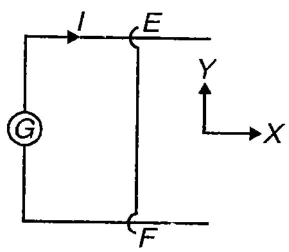
175. For loop $OABCDEO$ carrying current I, the magnetic field at point $P(a, 0, 0)$ will be



(1) $\frac{\mu_0 I}{\sqrt{2}\pi a}[-\hat{k}-\hat{j}]$ (2) $\frac{\mu_0 I\sqrt{2}}{\pi a}[-\hat{k}-\hat{j}]$

(3) $\frac{\mu_0 I}{\pi a}[-\hat{k}-\hat{j}]$ (4) $\frac{\mu_0 I}{2\pi a}[-\hat{k}-\hat{j}]$

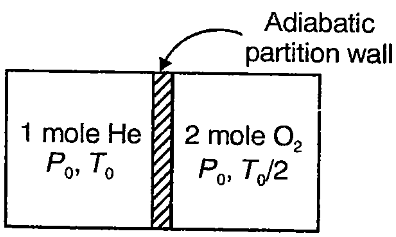
176. A conducting slider EF of mass m and length L is placed on two parallel long conducting rails. The generator (G) maintains constant current I in the circuit. The coefficient of friction between the slider (EF) and the conducting rails is 0.50. If a magnetic field $\vec{B} = -B_0\hat{i} - B_0\hat{k}$ exists in entire region, the acceleration of the slider will be



(1) $\frac{ILB_0}{2m}$ (2) $\frac{ILB_0}{m}$

(3) $\frac{3ILB_0}{2m}$ (4) Zero

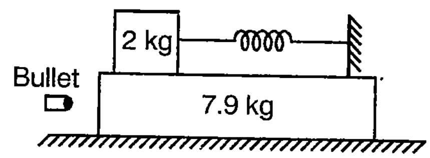
177. 1 mole of He and 2 moles of O_2 are contained in an adiabatic cylinder at pressures and temperatures as shown in figure. If the adiabatic partition wall is removed then the final pressure will be



(1) $\frac{12}{13}P_0$ (2) $\frac{13}{16}P_0$

(3) P_0 (4) None of these

178. A plank of mass 7.9 kg rests on a smooth horizontal surface and supports a block of mass 2 kg as shown in figure. There is no friction anywhere. The spring constant of the spring is 1000 N/m. If the bullet of mass 100 gm and travelling with horizontal velocity of 400 m/s, hits the plank and gets embedded into it, then the maximum extension of spring during the motion after collision will be



(1) 0.10 m

(2) 0.20 m

(3) 0.02 m

(4) 0.30 m

179. Kinetic energy of a particle moving along a straight line varies uniformly w.r.t. time. The force acting on the particle is

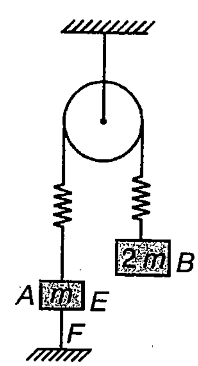
(1) Constant

(2) Proportional to velocity

(3) Inversely proportional to velocity

(4) Inversely proportional to square root of velocity

180. In the adjacent figure pulley is ideal and string are inextensible and massless. Initially the system is in equilibrium. Now if the string EF is burnt then the acceleration of blocks A and B just after the string is burnt will be respectively



(1) g upward and 0

(2) g downward and 0

(3) 0 and g upward

(4) 0 and g downward

181. Two charged particles of masses m and $2\,m$ and having charge $+q$ and $-2q$ respectively, are projected simultaneously from the same point each with same velocity v_0 perpendicular to uniform magnetic field $\vec{B}$ directed into the plane of paper. The maximum separation between the two particles during their motion will be (neglect electrical and gravitational forces)

(1) $\frac{mv_0}{Bq}$ (2) $\frac{2mv_0}{Bq}$

(3) $\frac{4mv_0}{Bq}$ (4) $\frac{mv_0}{2Bq}$

182. The wavelength of first Lyman series is minimum for

(1) Hydrogen atom (2) He^+

(3) Deuterium atom (4) Li^{+2}

183. A positively charged particle is projected in gravity free space in the direction due north. An electric field exists in the direction due east. If the charge particle moves undeflected, then the magnetic field in the region

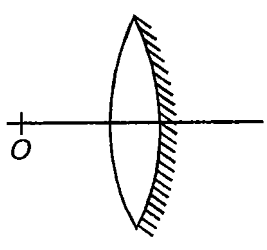
(1) Must be due north

(2) Must be due east

(3) Must be vertically downward

(4) May be in a vertical plane passing through north-south

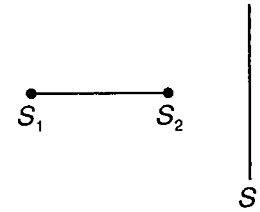
184. An equiconvex lens of refractive index μ and radius of curvature R has its one surface silvered. A point source O is placed before the silvered lens so that its image is coincident with it, the distance of the object from the lens is



(1) $\frac{R}{(\mu-1)}$ (2) $\frac{2R}{(\mu-1)}$

(3) $\frac{R}{(2\mu-1)}$ (4) $\frac{2R}{(2\mu-1)}$

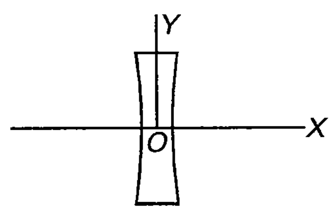
185. Two coherent sources S_1 and S_2 are situated on the x-axis. A screen S is placed in y-z plane (as shown). The shape of fringes on screen is



(1) Straight line (2) Elliptical

(3) Circular (4) Rectangular

186. There is a concave lens of focal length f. A ray $y = b$, is incident on the lens from the left side. A plane mirror is placed in the path of the emergent ray so that it retraces its path after reflection. The inclination of plane mirror with the X-axis should be



(1) $\frac{\pi}{2}-\tan^{-1}\left(\frac{f}{b}\right)$

(2) $\frac{\pi}{2}+\tan^{-1}\left(\frac{b}{f}\right)$

(3) $\frac{\pi}{2}-\tan^{-1}\left(\frac{2f}{b}\right)$

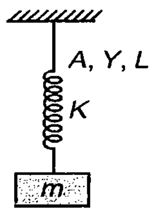
(4) $\pi-\tan^{-1}\left(\frac{2b}{f}\right)$

187. A point source is sinking down in a liquid of refractive index μ with a constant velocity v_0. The rate of change of the area through which light will escape from the liquid when the source is at a depth h_0 will be

(1) $\frac{2\pi h_0 v_0}{(\mu^2+1)}$ (2) $\frac{2\pi h_0 v_0}{(\mu^2-1)}$

(3) $\frac{2\pi h_0 v_0}{\sqrt{\mu^2-1}}$ (4) $\frac{\pi h_0 v_0}{(2\mu^2-1)}$

188. A spring block system attached with a wire has been shown in the figure. Mass of the block is m and for the wire cross sectional area is A length L and Young's modulus of elasticity is Y. The system is executing simple harmonic motion with amplitude a. The de Broglie wavelength associated with the block when it is in equilibrium position, should be



(1) $\frac{h}{a}\sqrt{\frac{KL}{mAY}}$ (2) $\frac{h}{a}\sqrt{\frac{KL+AY}{mAYK}}$

(3) $\frac{h}{a}\sqrt{\frac{mAYK}{(KL+AY)}}$ (4) $\frac{a}{h}\sqrt{\frac{(KL+AY)}{mAYK}}$

189. A spring of spring constant k is broken into two parts in the ratio $n : 1$ ($n > 1$). A block of mass m is attached with the longer part and this is suspended from a fixed ceiling. The time period of oscillation for this system will be

(1) $2\pi\sqrt{\frac{m}{(n+1)k}}$

(2) $2\pi\sqrt{\frac{nm}{(n-1)k}}$

(3) $2\pi\sqrt{\frac{(n+1)m}{k}}$

(4) $2\pi\sqrt{\frac{nm}{(n+1)k}}$

190. A radiation of wavelength λ is incident on a photo-sensitive plate. The de Broglie wavelength associated with the most energetic photoelectron is n times the threshold wavelength. At the same time it is found that kinetic energy of this photoelectron is four times the work function, then which of the following relations is correct?

(1) $\lambda_0 = 3\lambda$ (2) $\lambda_0 = \frac{5\lambda}{2n}$

(3) $\lambda_0 = \frac{1}{n}\sqrt{\frac{5h\lambda}{8mc}}$ (4) $\frac{1}{n}\sqrt{\frac{2h\lambda}{5mc}}$

191. In a series of photoelectric emission experiments, a number of metals of work function W, were illuminated with monochromatic light of different frequencies and intensities. It was found that for each experiment, the emitted electrons emerged with a spread of kinetic energy upto a certain maximum value. The maximum kinetic energy depends on

(1) W but not frequency or intensity

(2) W & frequency but not on intensity

(3) W & intensity, but not on frequency

(4) Frequency & intensity but not on W.

192. A radioactive sample of mass number A is undergoing alpha decay. Its initial activity is A_0 and decay constant for this decay is λ. Which of the following statement is incorrect?

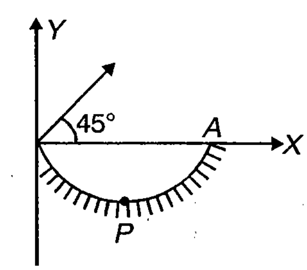
(1) The ratio of kinetic energies of the alpha particle and the daughter product is $\frac{(A-4)}{4}$

(2) Initially present number of radioactive nuclei is $\frac{A_0}{\lambda}$

(3) At time t, the activity is reduced to $\frac{1}{n}$ times the initial activity then $t = \ln\left(\frac{n}{\lambda}\right)$

(4) Momentum of the alpha particle will vary from zero to a certain maximum value

193. A hemispherical concave mirror of radius R is placed as shown in figure. A particle is projected under gravity at an angle 45° with the horizontal from O. The particle strikes mirror at A. The distance of image of the particle from P, when it is at its maximum height will be



(1) $\frac{2R}{3}$ above P (2) $\frac{2R}{3}$ below P

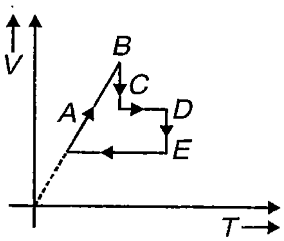
(3) $\frac{3R}{4}$ above P (4) $\frac{3R}{2}$ below P

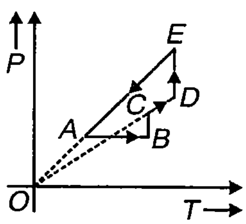
194. A source of sound of frequency f and wavelength λ is moving towards an observer which is stationary. The speed of sound is v and speed of source is $\frac{2}{3}v$. The wavelength, frequency and velocity of sound observed by observer are respectively

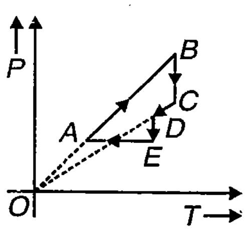
(1) $\lambda, 3f, 3v$ (2) $\frac{\lambda}{3}, 3f, v$

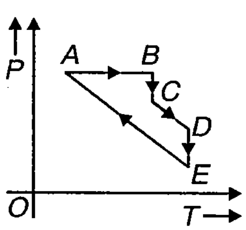
(3) λ, f, v (4) $\frac{3}{2}\lambda, \frac{3\lambda}{2}, v$

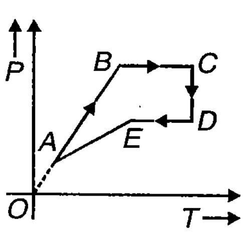
195. The following figure shows V-T plot for a given number of moles of an ideal gas, then the corresponding P-T plot for the given ideal gas will be



(1)


(2)


(3)


(4)


196. At a certain moment, the angle between velocity and acceleration of a body are inclined at an obtuse angle with each other. The speed of the body

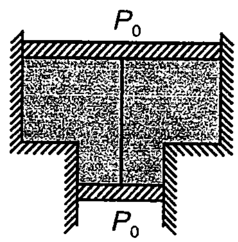
(1) Must be decreasing

(2) May be decreasing

(3) Must be increasing

(4) May be increasing

197. A smooth vertical tube having two different sections is open at both ends and equipped with two pistons having cross-sectional areas $2A$ and A respectively. Each piston slides within a respective tube section. One mole of ideal gas is enclosed between the pistons tied with a non-stretchable thread. The outside pressure P_0 atm. If the combined mass of the two pistons is m and system is in equilibrium then pressure of the ideal gas will be



(1) $P = P_0 - \frac{mg}{A}$

(2) $P = P_0 + \frac{mg}{2A}$

(3) $P = P_0 + \frac{mg}{A}$

(4) $P = P_0 + \frac{2mg}{A}$

198. The sensitivity of a potentiometer can be increased by

(1) Decreasing the length of potentiometer wire

(2) Increasing the length of potentiometer wire

(3) Increasing the emf of the cell in primary circuit

(4) Decreasing the external resistance connected in primary circuit

199. At a temperature t°C, a liquid is completely filled in a spherical shell. Let bulk modulus of the vessel and liquid be k_1 and k_2. Coefficient of cubic expansion of the liquid be γ and the coefficient of linear expansion of the material of the shell be α, then the outward pressure dP that results from an increase in temperature dT of the whole arrangement is ($\gamma > 3\alpha$)

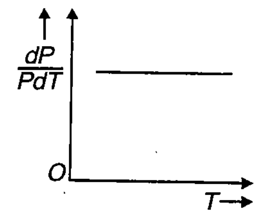
(1) $k_2(3\alpha - \gamma)\, dT$

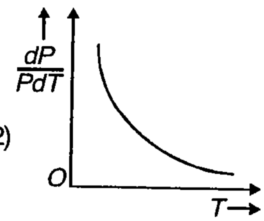
(2) $k_2(\gamma - 3\alpha) dT$

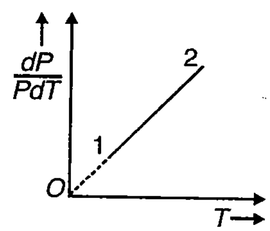
(3) $\left(\frac{k_1 k_2}{k_1 + k_2}\right)(1 + (\gamma - 3\alpha)\, dT)$

(4) $\gamma(3\alpha - k_1) dT$

200. For an ideal gas confined in a container P, V and T are the pressure, volume and temperature respectively. Keeping the volume constant, temperature is increased by small value dT and pressure changes by dP. Choose the correct plot for $\left(\frac{1}{P}\right)\left(\frac{dP}{dT}\right)$ and the temperature T

(1)


(2)


(3)


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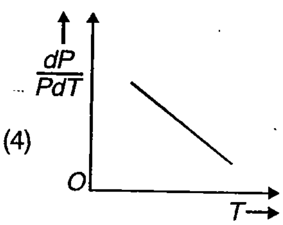
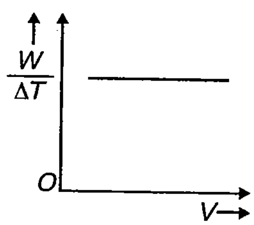
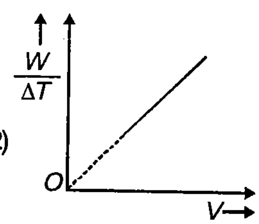
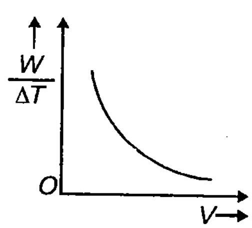
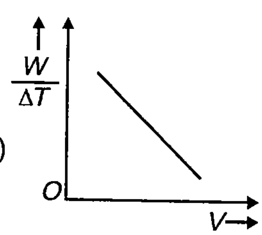


201. In a process volume V and Temperature T of an ideal gas are related as VT = constant. If the temperature of gas be increased by ΔT and W be the corresponding work done, then choose correct plot

(1)


(2)


(3)


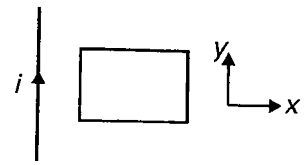
(4)


202. An object is moving in the xy plane with the position as a function of time given by $\vec{r} = x(t)\hat{i} + y(t)\hat{j}$. The object is definitely moving towards origin O when

(1) $V_x > 0,\ V_y < 0$ (2) $V_x < 0,\ V_y < 0$

(3) $xV_x + yV_y < 0$ (4) $xV_x + yV_y > 0$

203. A conducting loop is placed near a long straight wire carrying a current i. If the current in the straight conductors starts increasing with time, the loop



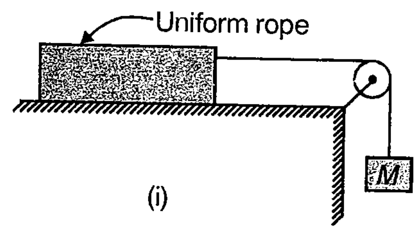
(1) Starts moving along $+x$-axis

(2) Starts moving along $-x$-axis

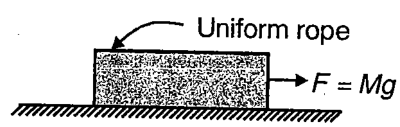
(3) Starts moving along $+y$-axis

(4) Does not move at all

204. In the following figures ((i) and (ii)), all the surfaces are smooth string is massless and pulley is ideal. The mass of the rope is m in both the cases. If T_1 and T_2 be the tensions at the mid points of the ropes in figure (i) and figure (ii) respectively, then $T_1 : T_2$ is



(i)

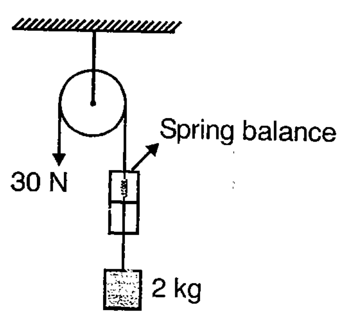


(ii)

(1) $m : M$ (2) $m : (M + m)$

(3) $(M + m) : m$ (4) $1 : 1$

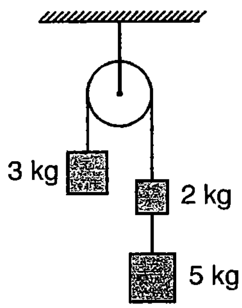
205. In the adjacent figure, the spring balance and string are massless and the pulley is ideal, The reading of spring balance will be



(1) 2 kg (2) 3 kg

(3) 2.5 kg (4) Zero

206. In the adjacent figure, all the springs and massless and pulley is ideal. The system is released for rest and if after 1 s of motion string connecting 2 kg and 5 kg blocks is burnt. The maximum height reached by the 3 kg block from its initial position will be



(1) 2 m

(2) 4 m

(3) 6 m

(4) 8 m

207. A particle is projected with speed V_0 at angle θ above the horizontal such that the ratio of kinetic energy at highest point and at the time of projection is 3 : 4. The change in velocity of the particle between point of projection and the highest point will be

(1) $\frac{V_0}{2}$ vertically downward

(2) $\frac{V_0}{2}$ vertically upward

(3) $2V_0\sqrt{3}$ due east

(4) $\frac{V_0\sqrt{3}}{2}$ vertically downward

208. During the upward motion of an oblique projectile

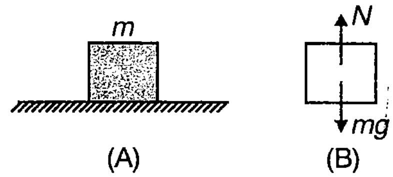
(1) The tangential acceleration decreases in magnitude

(2) The normal acceleration decreases in magnitude

(3) Speed remains constant, but velocity decreases

(4) Speed decreases but velocity remain constant

209. A block of mass m is placed on the flat horizontal surface of a platform as shown in figure (A) and the corresponding free body diagram of the block is given in figure (B). Consider the following statements



(i) Normal force applied by the platform on the block is more when the platform is accelerated upward than when it is accelerated downward

(ii) When the platform is accelerated downward with acceleration more than g, then the block looses contact with the platform

(iii) Normal force (N) and mg are pair of action reaction forces

Choose the correct statement

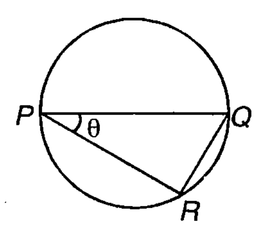
(1) (i) & (iii)

(2) (i) & (ii)

(3) (ii) & (iii)

(4) (i), (ii) & (iii)

210. In the given figure PR and QR are smooth chords of a vertical circle of radius 5.0 m P and Q are diametrically opposite points. A particle released from rest from point P reaches point R in 2 seconds then time taken by a particle released from point Q to reach point R will be



(1) 2 s

(2) 3 s

(3) 1 s

(4) 4 s

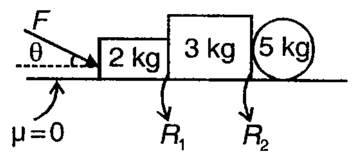
SECTION - B

Multiple Choice Questions

This section contains 80 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **MORE THAN ONE** is correct.

Choose the correct answers :

1. In the figure, R_1 and R_2 are reaction forces between the blocks. Which of the following is not possible?



(1) $R_2 > R_1$ and 5 kg block will roll

(2) $R_2 > R_1$ and 5 kg block will skid

(3) $R_1 > R_2$ and 5 kg block will roll

(4) $R_1 > R_2$ and 5 kg block will skid

2. When an electron revolving in the ground state of a hydrogen atom jumps to its 2nd excited state,

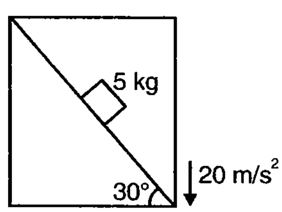
(1) Its frequency of revolution becomes $(3)^{2/3}$ times

(2) Its frequency of revolution becomes $(3)^{-3}$ times

(3) Its speed becomes $\left(\frac{1}{3}\right)$ times

(4) Its speed becomes $\left(\frac{1}{9}\right)$ times

3. A lift is moving down with an acceleration 20 m/s^2. Which of the following is not true?



(1) Acceleration of 5 kg block along incline is 15 m/s^2

(2) Normal force is $25\sqrt{3}$ and acceleration is 5 m/s^2 along incline

(3) Normal force is zero

(4) Acceleration of 5 kg is 20 m/s^2 downwards

4. Electrons of energy 12.1 eV are fired at hydrogen atoms in a discharge tube. If the ionization potential of hydrogen is 13.6 eV, then

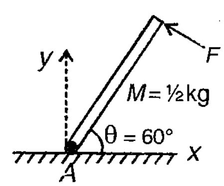
(1) Hydrogen atom may emit a wavelength 1028 Å

(2) Hydrogen atom may emit a wavelength 6581 Å

(3) Hydrogen atom may emit a wavelength 970 Å

(4) Hydrogen atom may emit a wavelength 1217 Å

5. A rod of mass M = ½ kg is hinged at point 'A' and held with the help of 'F' acting perpendicularly as shown. The rod is in equilibrium. The force applied by hinge at 'A'



(1) Has a component along x-axis

(2) Has a component along y-axis

(3) Is at some angle and in 1st quadrant

(4) Is at some angle and in 2nd quadrant

6. The half life of a radioactive substance is T_0. At t = 0, the number of active nuclei are N_0. Select the correct alternative

(1) The number of nuclei decayed in time interval $0 \rightarrow t$ is $N_0e^{-\lambda t}$

(2) The number of nuclei decayed in time interval $0 \rightarrow t$ is $N_0(1 - e^{-\lambda t})$

(3) The probability that a radioactive nuclei does not decay in interval $0 \rightarrow t$ is $e^{-\lambda t}$

(4) The probability that a radioactive nuclei does not decay in interval $0 - t$ is $1 - e^{-\lambda t}$

7. Two heavy bodies B_1 and B_2, not far off from each other are seen to revolve in orbits

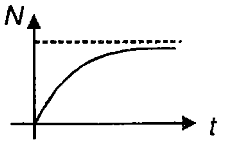
(1) Around their common centre of mass

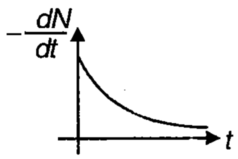
(2) With equal and opposite momenta

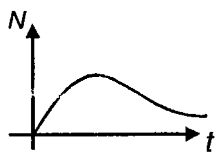
(3) With S_1 fixed and S_2 moving round S_1

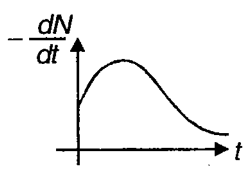
(4) With S_2 fixed and S_1 moving round S_2

8. Radioactive nuclei are being generated at a constant rate by some kind of nuclear reaction. If the decay constant for the radioactive nuclei is λ, which of the following graphical representation is correct? (initially, there are no radioactive nuclei present)

(1) 

(2) 

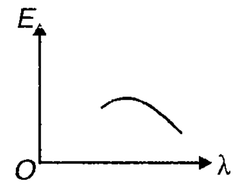
(3) 

(4) 

9. In which of the following process, convection takes place?
   (1) Sea and land breeze
   (2) Boiling of water
   (3) Warming of glass of bulb due to filament
   (4) Heating of air around a furnace

10. The electron in a hydrogen atom jumps back from an excited state to ground state, by emitting a photon of wavelength $\lambda_0 = \frac{16}{15R}$, where R is Rydberg's constant. In place of emitting one photon, the electron could come back to ground state by
   (1) Emitting 3 photons of wavelengths λ_1, λ_2 and λ_3 such that $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}+\frac{1}{\lambda_3}=\frac{15R}{16}$
   (2) Emitting 2 photons of wavelength λ_1 and λ_2 such that $\frac{1}{\lambda_1}+\frac{1}{\lambda_2}=\frac{15R}{16}$
   (3) Emitting 2 photons of wavelength λ_1 and λ_2 such that $\lambda_1+\lambda_2=\frac{16}{15R}$
   (4) Emitting 3 photons of wavelength λ_1, λ_2 and λ_3 such that $\lambda_1+\lambda_2+\lambda_3=\frac{16}{15R}$

11. The energy distribution E with the wavelength λ for the black body radiation at temperature T kelvin is shown in figure. As the temperature is increased then which of following statements is incorrect about peak of curve

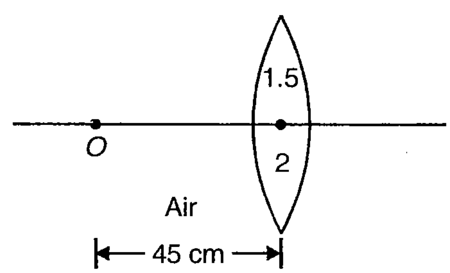


   (1) Shift towards left and become higher
   (2) Rise high but will not shift
   (3) Shift towards right and become higher
   (4) Shift towards left and the curve will be come broader

12. The potential difference applied to an X-ray tube is increased. As a result, in the emitted radiation
   (1) Intensity increases
   (2) Cut-off wavelength changes
   (3) Number of X-ray photons emitted remain same
   (4) Minimum wavelength increases

13. In which case standing waves can be produced?
   (1) On a string clamped at both ends
   (2) On a string clamped at one end and free at the other
   (3) When incident wave gets reflected from a wall
   (4) When two identical waves with a phase difference of π are moving in the same direction

14. An object is placed at a distance of 45 cm from a convex lens. The upper half of the convex lens is made of a transparent material of refractive index 1.5 and lower half is made of a transparent material of refractive index 2. The focal length of upper half is 30 cm. Select the correct statement



   (1) The focal length of lower half is 15 cm
   (2) An image is formed at a distance 90 cm behind the lens
   (3) An image is formed at a distance 22.5 cm behind the lens
   (4) No real image will be formed

15. Choose the correct statement

 (1) For the isothermal process the nature of P-V plot is rectangular hyperbola

 (2) If absolute temperature is double, mean square velocity gets doubled

 (3) At constant temperature for a gas confined in a container, if the separation between the molecules is doubled, then pressure will be halved

 (4) At constant temperature for a gas confined in a container, if the separation between the molecules is doubled, then pressure will become $\frac{1}{8}$ of original

16. For a sample of β-active material, which of the following is incorrect?

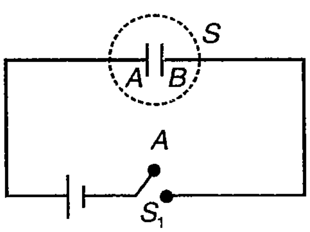
 (1) The Beta particles emitted have same energy

 (2) The antineutrino emitted in a β-decay has zero momentum

 (3) The active nucleus changes into one of its isobars after the Beta-decay

 (4) The atomic number of the active nucleus remain same in β-decay

17. Related to adjacent circuit after switch S_1 is closed, which of the following statements are correct?



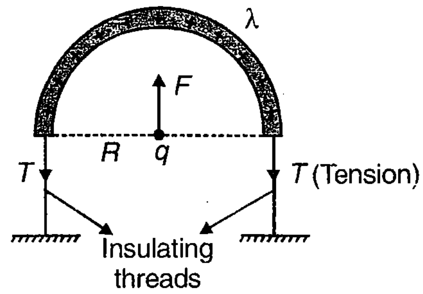
 (1) Flux through closed surface S is zero

 (2) Energy stored by the capacitor is less than work done by battery in charging the capacitor

 (3) Direction of electric field between the plates of the capacitor is from A to B

 (4) None of these

18. A thin semicircular rod of plastic having uniform charge per unit length λ is placed on a smooth horizontal surface and it is tied by two insulating threads as shown. A point charge q is held at rest at the centre of the ring by applying a force F. Which of the following statements is correct?



 (1) $F = \frac{\lambda q}{2\pi\varepsilon_0 R}$ (2) $F = 0$

 (3) $T = \frac{\lambda q}{2\pi\varepsilon_0 R}$ (4) $T = \frac{\lambda q}{4\pi\varepsilon_0 R}$

19. Two cylinders A and B of equal capacity are connected to each other via a stop cock. A contains a gas at standard temperature and pressure. B is completely evacuated. The entire system is thermally insulated. If the stop cock is suddenly opened then

 (1) Final pressure of gas in A and B is 0.5 atm

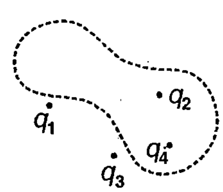
 (2) There is no change in internal energy of the system

 (3) The intermediate states of the system (before settling to the final equilibrium state) are well defined

 (4) Through out the process, temperature remains constant.

20. In the arrangement of charges shown, the dotted boundary represents a Gaussian surface. For this surface, Gauss law has the form $\oint \vec{E} \cdot \vec{ds} = \frac{q}{\varepsilon_0}$.

Select the correct alternative ($\vec{E_1}, \vec{E_2}, \vec{E_3}$ and $\vec{E_4}$ are electric field vectors due to the four charges)



 (1) $q = q_2 + q_4$

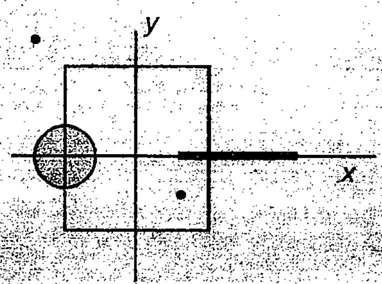
 (2) $q = q_2 + q_4 - q_1 - q_3$

 (3) $\vec{E} = \vec{E_1} + \vec{E_2} + \vec{E_3} + \vec{E_4}$

 (4) $\vec{E} = \vec{E_2} + \vec{E_4}$

(IIT-JEE 2009)

20(a) A disk of radius $a/4$ having a uniformly distributed charge 6 C is placed in the x-y plane with its centre at $(-a/2, 0, 0)$. A rod of length a carrying a uniformly distributed charge 8 C is placed on the x-axis from $x = a/4$ to $x = 5a/4$. Two point charges -7 C and 3 C are placed at $(a/4, -a/4, 0)$ and $(-3a/4\ 3a/4, 0)$, respectively. Consider a cubical surface formed by six surfaces $x = \pm a/2$, $y = \pm a/2$, $z = \pm a/2$. The electric flux through this cubical surface is

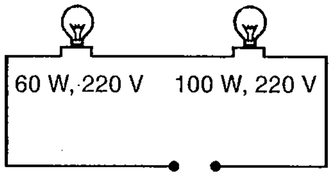


(1) $\frac{-2C}{\varepsilon_0}$ (2) $\frac{2C}{\varepsilon_0}$

(3) $\frac{10C}{\varepsilon_0}$ (4) $\frac{12C}{\varepsilon_0}$

21. Which of the following statements are correct?
    (1) Two bodies at different temperatures T_1 and T_2 brought in thermal contact do not necessarily settle to mean temperature $\frac{(T_1+T_2)}{2}$
    (2) The coolant in a chemical or nuclear plant should have low specific heat
    (3) The climate of a harbour town is more temperate than that of a town in a desert at the same latitude
    (4) None of these

22. Two bulbs rated 220 V, 100 W and 220 V, 60 W are connected in series across a voltage supply V. The bulbs can be assumed as purely resistive and they cannot withstand a voltage more than their voltage rating. Select the correct alternative



    (1) When $V = 220$ V, total power output is 37.5 W
    (2) When $V = 220$ V, $P_{60} > P_{100}$
    (3) When $V = 440$ V, 60 W bulb will fuse
    (4) The maximum safe value of V is 352 V

23. A polythene piece rubbed with wool is found to have a negative charge of 3.2×10^{-7} coulomb. Choose correct statements
    (1) 2×10^{12} electrons are transferred from polythene to wool
    (2) 2×10^{12} electrons are transferred from wool to polythene
    (3) Very small amount of mass is transferred from wool to polythene
    (4) No transfer of mass takes place in this process

24. Two point charges q_1 and q_2 attract each other by a force F. When a charge of +1 μC is added to both the charges, the force remains same in magnitude but changes in direction. The charges, q_1 and q_2, can be
    (1) 0.5 μC, –0.5 μC (2) –0.5 μC, –0.5 μC
    (3) –0.6 μC, 2 μC (4) $-\frac{2}{3}$ μC, 1 μC

25. The figure shown below is the electric field lines of a single positive and negative charge respectively, let v denote the potential. The correct statements, are

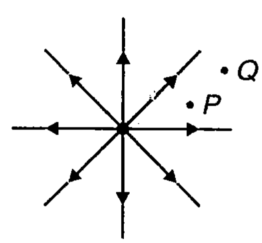


Figure (i)

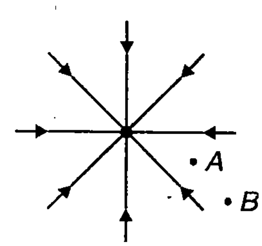
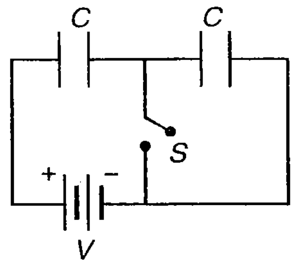


Figure (ii)

    (1) $V_P - V_Q > 0$ and $V_A - V_B > 0$
    (2) $V_P - V_Q > 0$ and $V_A - V_B < 0$
    (3) Work done by the field in moving a small positive charge from P to Q is positive
    (4) Work done by the external agent in moving a small negative charge from B to A is positive

26. In the circuit shown, the switch is in position S for a long time and then closed. Let q represents the charge flown through the battery, and H represents the heat developed in the system, after closing the switch, then



(1) $q = CV$ (2) $q = \frac{CV}{2}$

(3) $H = \frac{CV^2}{4}$ (4) $H = \frac{CV^2}{2}$

27. A monkey of mass 40 kg climbs on a rope which can stand maximum tension of 600 N. In which of the following case will the rope do not break?

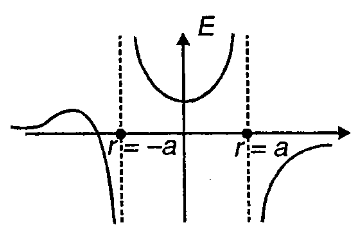
(1) The monkey climbs up with an acceleration of 5 m/s^2

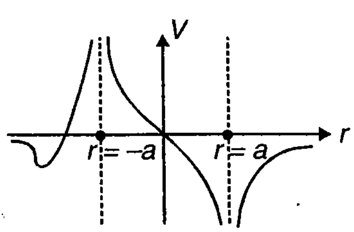
(2) The monkey climbs down with an acceleration of 4 m/s^2

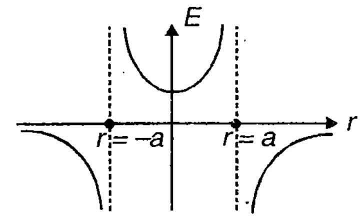
(3) The monkey climbs up with uniform speed of 5 m/s

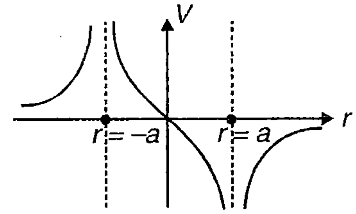
(4) The monkey falls down the rope nearly under gravity

28. Two point charges $4q$ and $-4q$ are placed at $x = -a$ and $x = +a$ respectively on x-axis. Let V represents the electrical potential and E represents electric field strength at a point on x-axis at a distance r from $x = 0$, then select the graph which represents the correct variation

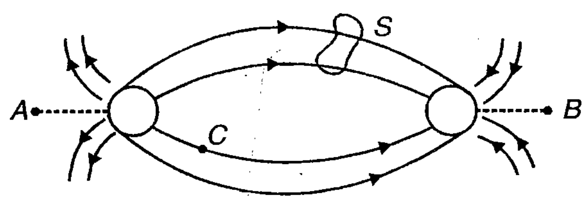
(1) 

(2) 

(3) 

(4) 

29. For the given electric lines of force, select the correct out of following statements



(1) Flux through closed surface S is zero

(2) $V_A - V_B = 0$

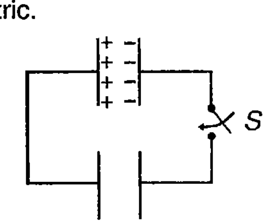
(3) $\int_A^B \vec{E}.\vec{dr}$ is positive

(4) If a point charge particle is released at point C then its path will be straight line

30. In the given figure, two identical capacitors are shown, with one of them having charge Q and the other being uncharged

Process (a) : A dielectric of dielectric constant k is introduced between the plates of the charged capacitor and then the switch S is closed.

Process (b) : Switch S is closed without inserting the dielectric.



(1) Energy lost during process (a) is more as compared to process (b)

(2) Charge transferred to the uncharged capacitor in process (a) is more as compared to process (b)

(3) Common potential difference after redistribution of charge is more in process (b) as compared to process (a)

(4) In process (b), electric field between the plates, in both the capacitors, becomes same, after redistribution of charge.

31. Consider the following statements. Which statements are wrong?

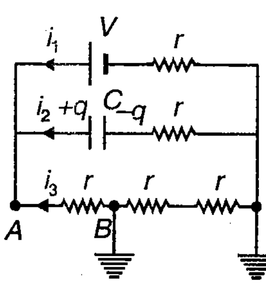
(1) Two large conducting spheres carrying charges Q_1 and Q_2 are brought close to each other, then the magnitude of electrostatic force between them will be exactly $\frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$, where r is the distance between their centres

(2) If Coulomb's law involves $\frac{1}{r^3}$ dependence, (instead of $\frac{1}{r^2}$) the Gauss's law will still be true

(3) A small test charge is released at rest at a point in an electrostatic field configuration, then it will necessarily travel along the line of force passing through that point

(4) The electric field is discontinues where as electric potential is continuous across the surface of a charged conductor

32. In the circuit shown, points B and C are grounded. Select the correct alternative



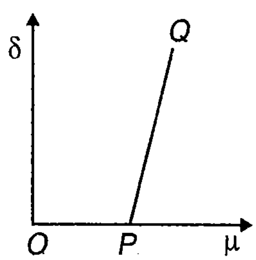
(1) $i_1 = \frac{V}{4r}$

(2) $i_2 = \frac{-V}{2r}$

(3) $i_3 = \frac{-V}{2r}$

(4) $q = \frac{CV}{2}$

33. For a small angled prism with angle of prism A, the angle of minimum deviation varies with refractive index of the prism as shown in the graph



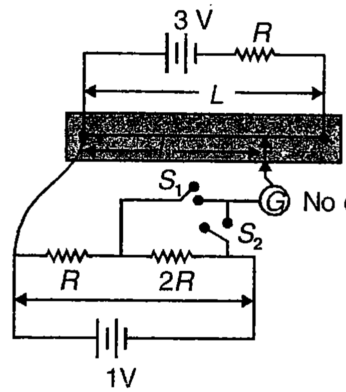
(1) δ is not proportional to μ

(2) Slope of the line $PQ = \frac{A}{\delta}$

(3) Slope of line $PQ = A$

(4) δ does not depend on A

34. Figure shows a potentiometer circuit. The length of potentiometer wire is L and its resistance is $2R$. Neglect the internal resistance of the cells. Select the correct alternative



(1) When only S_1 is closed, $\frac{l}{L} = \frac{1}{6}$

(2) When only S_2 is closed, $\frac{l}{L} = \frac{1}{2}$

(3) When both S_1 and S_2 are closed, $\frac{l}{L} = \frac{1}{6}$

(4) When both S_1 and S_2 are closed, $\frac{l}{L} = \frac{1}{2}$

35. Photoelectric effect supports following statements

(1) There is minimum frequency of light below which no photoelectrons are emitted

(2) The maximum kinetic energy of photoelectrons depends only on the frequency of light and not on intensity

(3) Even when a metal surface is faintly illuminated, the photoelectrons leave the surface immediately

(4) Electric charge of the photoelectrons is quantized

36. The current flowing in a coil of self inductance L is given by $I = Ate^{-\alpha^2 t}$ ampere (where α and A are constant). Select the correct alternatives

(1) The potential difference across the coil is $LAe^{-\alpha^2 t}[\alpha^2 t - 1]$

(2) The potential difference across the coil is $LAe^{-\alpha^2 t}$

(3) The energy stored in the inductor at any instant is $\frac{LA^2t^2e^{-2\alpha^2 t}}{2}$

(4) The energy stored in the inductor at any instant is $\frac{1}{2}LA^2e^{-2\alpha^2 t}$

37. Two rods B and C having same length and made of the same material are being pulled by a pair of oppositely directed axial force of equal magnitude. If the cross-sectional areas of rod B and C be A and $2A$ respectively then consider the following statements correct

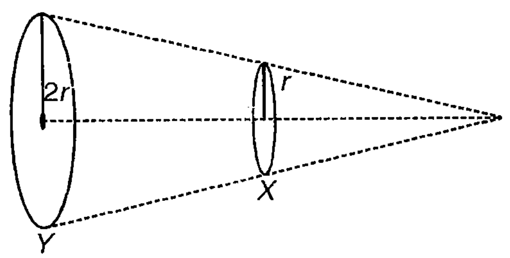
(1) Ratio of extension in rods B and C is 2 : 1

(2) Ratio of extension in rods B and C is 1 : 2

(3) Ratio of energy stored per unit volume in rod B and C is 4 : 1

(4) Ratio of energy stored per unit volume in rods B and C is 2 : 1

38. Two circular coils X and Y having equal number of turns and carrying equal currents in same sense are placed co-axially, such that they subtend the same solid angle at O. Let B be the magnetic field at O due to smaller coil X, then



(1) Magnetic field at O due to larger coil = $2B$

(2) Magnetic field at O due to larger coil = $\frac{B}{2}$

(3) Total magnetic field at O is $\frac{3B}{2}$

(4) Total magnetic field at O is $\frac{\sqrt{5}B}{2}$

39. In a collidge tube used to produce X-rays

(1) The intensity of X-ray beam depends on the current flowing through the filament

(2) The frequency of the shortest wavelength produced depends on the target material

(3) The penetrating power of X-rays is a function of the potential different between cathode and target

(4) The X-rays falling on any kind of metal cannot emit X-rays again

(IIT-JEE 2008)

39(a). Which one of the following statements is WRONG in the context of X - rays generated from a X-ray tube?

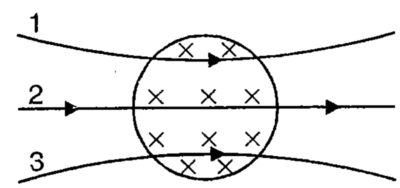
(1) Wavelength of characteristic X-rays decreases when the atomic number of the target increases

(2) Cut-off wavelength of the continuous X-rays depends on the atomic number of the target

(3) Intensity of the characteristic X-rays depends on the electrical power given to the X-ray tube

(4) Cut-off wavelength of the continuous X-rays depends on the energy of the electrons in the X-ray tube

40. There is a magnetic field acting perpendicular to plane of paper inwards. Particles in vacuum move in the plane of paper from left to right as shown. The paths are numbered as 1 to 3



(1) 1 could be an α-particle's path

(2) 2 is for a neutron

(3) 3 is for an electron

(4) 1 is for a proton

41. When photons of energy $\left(\frac{hc}{\lambda}\right)$ fall on a metal surface, photo-electrons are ejected from it. If the work function of the surface is $h\nu_0$, then which of following is false?

(1) Maximum kinetic energy of the electron is $\left(\frac{hc}{\lambda} - h\nu_0\right)$

(2) Maximum kinetic energy is equal to $\left(\frac{hc}{\lambda}\right)$

(3) All electrons come out with the same K.E $(h\nu - h\nu_0)$

(4) Minimum K.E is equal to $h\nu_0$

42. In case of a charged particle in a non-uniform magnetic field,
   (1) Speed remains constant
   (2) Momentum remains constant
   (3) Kinetic energy remains constant
   (4) Work done is zero

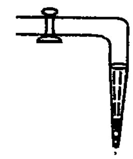
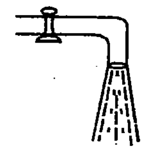
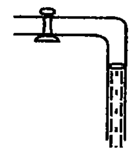
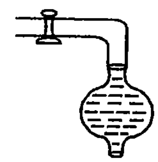
43. Threshold wavelength of certain metal is λ_0, light of wavelength slightly less than λ_0 is incident on the plate. It is found that after some time the emission of electron stops. Then choose the incorrect statement
   (1) All electrons of the metal plate are lost
   (2) The ejected electrons experience retarding force due to development of positive charge on the plate
   (3) It is not possible
   (4) None of these

44. The SI system of inductance Henry can be written as
   (1) $\frac{Wb}{A}$ (2) $\frac{V-s}{A}$
   (3) JA^{-2} (4) Ω-s

45. When a monochromatic point-source of light is at a distance of 0.2 m from a photoelectric cell, the stopping potential and the saturation current are respectively 0.6 volt and 18.0 mA. If the same source is placed 0.6 m away from the photoelectric cell, then
   (1) The stopping potential will be 0.6 V
   (2) The stopping potential will be 1.8 V
   (3) The saturation current will be 6.0 mA
   (4) The saturation current will be 2.0 mA

46. Select the correct statement
   (1) The dimensions of electric and magnetic flux are same
   (2) The dimensions of $\left(\frac{h}{e}\right)$ is same as that of magnetic flux ϕ
   (3) A coil of metal wire is kept stationary in a non-uniform magnetic field. An emf is induced in the coil
   (4) An emf can be induced between the two-ends of a straight copper wire when it is moved through a magnetic field

47. As water falls from a tap, the shapes of stream which are not possible for steady flow are

(1) 
(2) 
(3) 
(4) 

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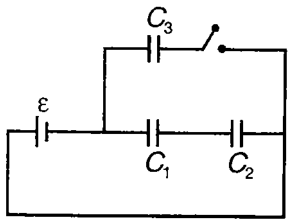
47(a). STATEMENT-1 : The stream of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down.

and

STATEMENT-2 : In any steady flow of an incompressible fluid, the volume flow rate of the fluid remains constant.
   (1) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is a correct explanation for STATEMENT-1
   (2) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is NOT a correct explanation for STATEMENT-1
   (3) STATEMENT-1 is True, STATEMENT-2 is False
   (4) STATEMENT-1 is False, STATEMENT-2 is True

48. A proton beam passes undeviated through a region of crossed fields, where $B = 50 \times 10^{-3}$T and $E = 1.20 \times 10^5$ N/C and strikes a target (which is grounded). If beam current is 800 μA
   (1) Force exerted by the beam on target $= 2 \times 10^{-5}$ N
   (2) Speed of each proton is 2.4×10^6 m/s
   (3) Force exerted by the beam on target $= 4 \times 10^5$ N
   (4) Speed of each proton is 4.8×10^6 m/s

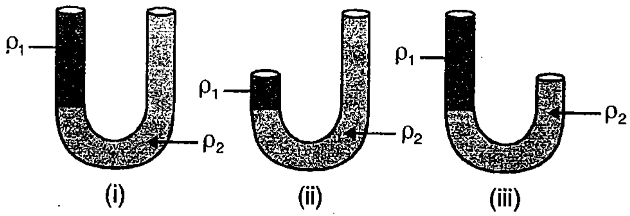
49. The given circuit is in steady state. Now switch S is closed. The charge transferred through the battery will not depend on the capacitance of capacitors



(1) C_1 (2) C_3

(3) C_1 and C_3 (4) C_2

50. Two immiscible liquids having densities ρ_1 and ρ_2 ($\rho_2 > \rho_1$) are filled into U-tubes as shown below. Which of the given situation is not possible?



(1) (i) (2) (ii)

(3) (iii) (4) None of these

51. In a series LCR circuit, supply voltage is $V = 100 \sin(\omega t - \pi/4)$ and supply current is $i = 20\sin(\omega t)$. Select the correct alternatives

(1) Impedance of circuit is 5 Ω

(2) Resistance of circuit is $5\sqrt{2}\ \Omega$

(3) Reactance of circuit is $\frac{5}{\sqrt{2}}\Omega$

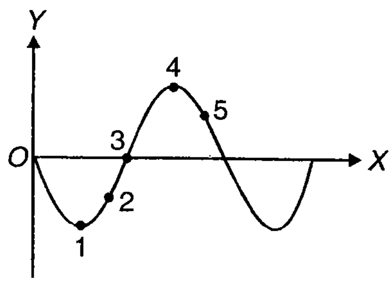
(4) Power factor is $\frac{1}{\sqrt{2}}$

52. For a particle moving along a circular path, the radial acceleration a_R is proportional to time t. If a_T is the tangential acceleration, then which of the following will be dependent of time t?

(1) a_T (2) $a_R \times a_T$

(3) $\frac{a_R}{a_T}$ (4) $a_R(a_T)^2$

53. A wave is passing along a string in the positive x-direction as shown in figure. Select the correct options from following statements



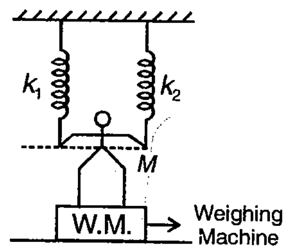
(1) Acceleration is positive at point 1

(2) Velocity is negative at point 3

(3) Velocity and acceleration are in opposite direction at point 2

(4) Speeds at point 1 and 4 are equal

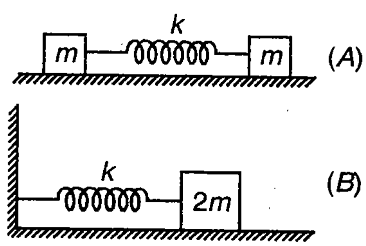
54. A man is standing on weighing machine as shown and he manages his both hands horizontal. Reading of weighing machine is $Mg/2$ and extension in both springs is equal after streching. If $k_2 = 2k_1$ then reading of k_1 and k_2 spring are R_1 and R_2 such that



(1) $R_1 = \frac{Mg}{6}$ (2) $R_2 = \frac{Mg}{3}$

(3) $R = 3\ Mg$ (4) $R_2 = 6\ Mg$

55. Two spring pendulum systems are shown in figure. If in both cases, the amplitude of oscillation is same, then



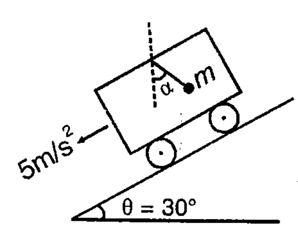
(1) 4 (Max. K.E.$_A$) = (Max. K.E.$_B$)

(2) $f_A : f_B = 2 : 1$

(3) $T_A : T_B = 1$

(4) Max. $v_A >$ Max. v_B

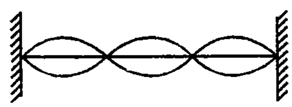
56. If the car shown is moving down the incline with 5 m/s^2, then



(1) $\alpha = 60°$ (2) Tension is $\frac{\sqrt{3}}{2}mg$

(3) $\alpha = 30°$ (4) Tension is $\frac{mg}{2}$

57. A stretched string, fixed at both ends, vibrates at frequency of 12 Hz with standing wave pattern as shown in figure



Select the correct alternative

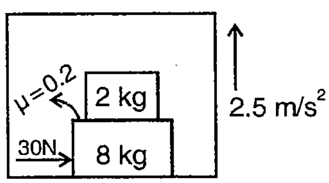
(1) The fundamental frequency is 6 Hz

(2) The fundamental frequency is 4 Hz

(3) The frequency of first overtone is 8 Hz

(4) The frequency of first overtone is 6 Hz

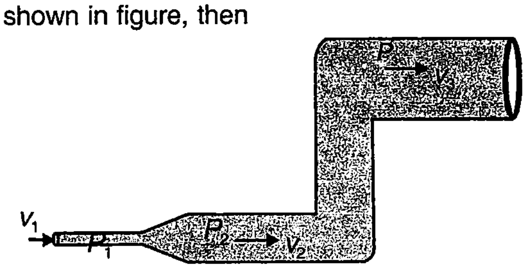
58. A lift is going up with 2.5 m/s^2 and its floor is smooth, but co-efficient of friction between blocks is 0.2. A force of 30 N is applied on 8 kg block. The accelerations of 2 kg and 8 kg blocks are a_1 and a_2 respectively, such that



(1) $a_1 = 3$ m/s^2 (2) $a_1 = 2.5$ m/s^2

(3) $a_2 = 1.5$ m/s^2 (4) $a_2 = \frac{25}{8}$ m/s^2

59. Water is flowing through a pipe as shown in figure. Let P_1, P_2 and P_3 the pressures and v_1, v_2 and v_3 be velocities of water at the different sections as shown in figure, then



(1) $P_1 > P_2 > P_3$ (2) $v_1 > v_2 > v_3$

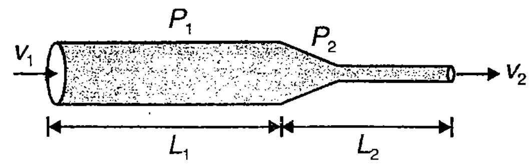
(3) $P_2 > P_1$ (4) $v_3 > v_2 > v_1$

60. There are three vectors $\vec{P}$, $\vec{Q}$ and $\vec{R}$. The angle between $\vec{P}$ and $\vec{Q}$ is 60° and $\vec{R}$ is perpendicular to the plane containing the vectors $\vec{P}$ and $\vec{Q}$. Which the following relations can not be possibly correct?

(1) $\vec{P}+\vec{Q}+\vec{R}=0$ (2) $\vec{P}\times\vec{Q}=\vec{R}$

(3) $\vec{P}\times\vec{R}=\vec{Q}$ (4) All of these

61. Select the correct option for the adjoining situation in which liquid is flowing through a pipe of variable cross-section (P_1, P_2 represent pressure)



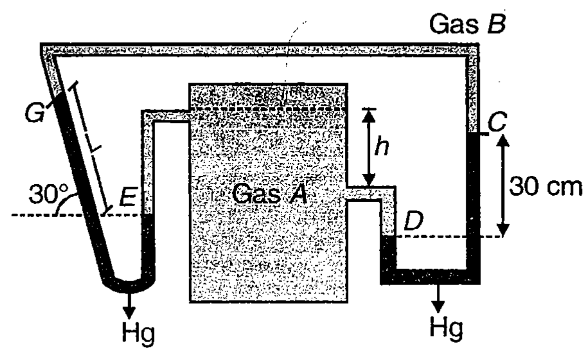
(1) $v_1 > v_2$ if $L_1 > L_2$

(2) $v_1 < v_2$ $\forall$ values of L_1 and L_2

(3) $P_1 < P_2$ $\forall$ values of L_1 and L_2

(4) $P_1 > P_2$ $\forall$ values of L_1 and L_2

62. In the given figure if the whole system is in equilibrium then



(1) $L = 60$ cm

(2) $L = 30$ cm

(3) L is independent of h

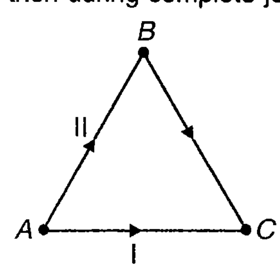
(4) L will not depend on pressure of gas B

63. The dimensions of heat are

(1) +1 in mass (2) +1 in length

(3) +2 in length (4) –2 in time

64. Two particles I and II start motion simultaneously from point A and reach point C simultaneously. Particle I moves along path AC and II moves along path ABC, then during complete journey



(1) Average speed of I will be equal to that of II

(2) Average velocity for I and II will be equal

(3) Average speed for I will be less than that of II

(4) Average velocity as well as average speed for I will be greater than that of II

65. An object is projected vertically upward with certain initial velocity at the moment $t = 0$. It is observed to be located at a certain height h at two different instants of time $t = t_1$ and $t = t_2$. Neglecting air-resistance and variation of g, which of the following are correct?

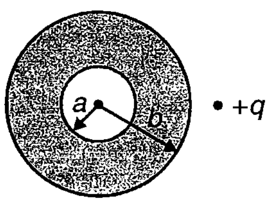
(1) Initial velocity of projection is $\frac{g(t_1 + t_2)}{2}$

(2) The height $h = \frac{1}{2} g t_1 t_2$

(3) Maximum height attained is $\frac{g}{8}[t_1 + t_2]^2$

(4) Total time of journey is $\frac{t_1 + t_2}{2}$

66. A point charge $+q$ is placed outside a spherical conducting shell of inner radius a and outer radius b as shown in figure. If r be the radial distance from centre of a general point then the electric potential is constant in the region, defined by



(1) $r \geq b$

(2) $0 \leq r \leq a$

(3) $0 \leq r \leq a$, but not $a \leq r \leq b$

(4) $a \leq r \leq b$

67. A body is projected from ground with speed v at an angle θ above horizontal such that its time of flight is T and maximum height is H. When the body is projected vertically up with same speed, the corresponding time of flight and maximum height are T' and H' respectively such that

(1) $T' = T \operatorname{cosec}\theta$ (2) $H' = H \sin^2\theta$

(3) $T' = T \sin\theta$ (4) $H' = H \operatorname{cosec}^2\theta$

68. A uniform electric field exists in the region given by $\vec{E} = E_0\hat{i} + E_0\hat{j}$. There are four points $A(-a, 0)$, $B(0, a)$, $C(0, -a)$ and $D(a, 0)$ lying in the x-y plane. Which of the following is the correct relation for the electric potential?

(1) $V_A = V_C$

(2) $V_C > V_B$

(3) $V_A > V_C > V_B = V_D$

(4) $V_A < V_C < V_B < V_D$

69. A particle moves in the x-y plane with velocity $\vec{V} = \hat{i} + 2x^2\hat{j}$, where $\hat{i}$ and $\hat{j}$ are the unit vectors along x-axis and y-axis respectively. Initially particle is at origin. Select the correct statement

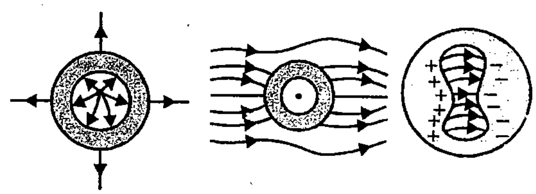
(1) Equation of trajectory of the particle is given by $y = 2x^2$

(2) Equation of trajectory of the particle is given by $y = \frac{2x^3}{3}$

(3) Normal acceleration of the particle at $x = 2$ m is 8 m/s^2

(4) Net acceleration of the particle at $x = 2$ m is 8 m/s^2

70. Consider the following representation of electric lines of force of electrostatic origin in presence of conducting shell as shown in figures. Then correct representation will be



(i) (ii) (iii)

(1) (i)

(2) (ii)

(3) (iii)

(4) (i), (ii) & (iii)

71. Let $\vec{R} = \vec{A} + \vec{B} + \vec{C}$ and $|\vec{R}| = |\vec{A}| = |\vec{B}| = |\vec{C}|$, then which of the following is incorrect?

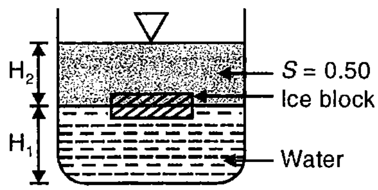
(1) $\vec{R}$ must be perpendicular to any two of $\vec{A}, \vec{B}$ and $\vec{C}$

(2) $\vec{R}$ must be parallel to any two of $\vec{A}, \vec{B}$ and $\vec{C}$

(3) $\vec{R}$ may be parallel to any two of $\vec{A}, \vec{B}$ and $\vec{C}$

(4) $\vec{R}$ must be parallel to exactly one of $\vec{A}, \vec{B}$ and $\vec{C}$

72. A block of ice (specific gravity $S_i = 0.90$) is floating in a container having two immiscible liquids (one of specific gravity $S_1 = 0.50$ and other is water) as shown in figure. Now the ice block melts, then



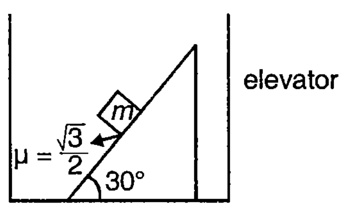
(1) H_2 will decrease

(2) H_1 will increase

(3) H_1 will remain unchanged, whereas H_2 will decrease

(4) Both H_1 and H_2 will increase

73. A block of mass 1 kg is placed on a rough wedge which is fixed on an elevator going upward with acceleration 2 ms^{-2}. The block is at rest with respect to the wedge. Select the correct alternative (take g = 10 ms^{-1})



(1) Normal reaction force on the block is $6\sqrt{3}$ N

(2) Net reaction force acting on the block is 12 N

(3) Net force on the block is zero

(4) Net force on the block is 2 N

74. A proton, a neutron and an α-particle are accelerated from rest through same potential difference. Their final speed are v_p, v_d and v_α such that

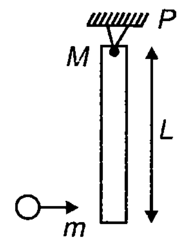
(1) $\dfrac{v_p}{v_d} = \sqrt{2}$

(2) $v_p = v_p = v_a$

(3) $v_d / v_\alpha = 1$

(4) $v_p / v_\alpha = \sqrt{2}$

75. A ball of mass m collides with a vertically hanging rod of mass M and length L at the lowest point as shown. We can apply



(1) Conservation of K.E. when collision is inelastic

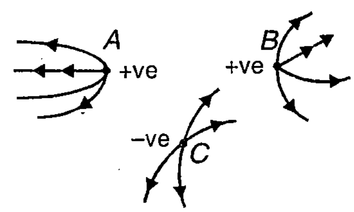
(2) Conservation of angular momentum about center of mass of system

(3) Conservation of angular momentum about point P

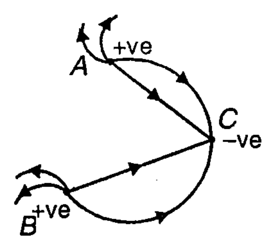
(4) Newton's law of restitution at point of collision

76. Two +ve and one –ve charge are placed at the vertex of an equilateral triangle ABC. The resulting line of force can not be

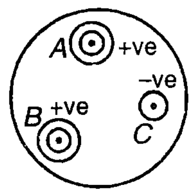
(1)



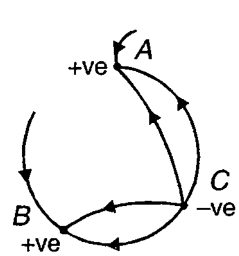
(2)



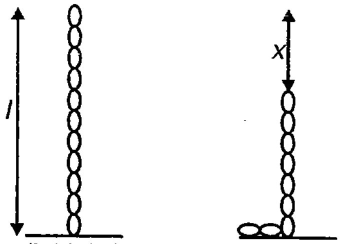
(3)



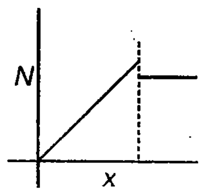
(4)

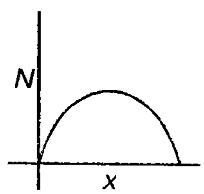


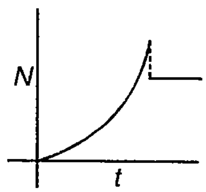
77. A chain of mass m and length l is initially held in vertical position according to the diagram. It is released from the rest, then which of the following graphs are correct? Here N represents normal force by ground on the chain

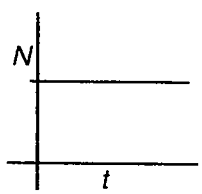


(initially) after some time (t)

(1) 

(2) 

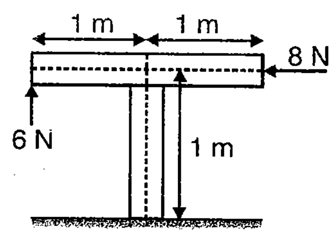
(3) 

(4) 

78. Photoelectric effect supports the quantum nature of light, which statements are incorrect regarding the effect?
   (1) There is a minimum frequency of light below which no photo electrons are emitted
   (2) The maximum K.E of photoelectrons depends only on the frequency of light and on its intensity
   (3) Even when the metal surface is faintly illuminated by light of the approximate wavelength, the photo electrons leave the surface immediately
   (4) Electric charge of photoelectrons is quantized

79. A particle is projected from earth's surface with speed which is $\sqrt{3}$ times of escape speed. Which of the following is correct?
   (1) The particle escapes from earth following a parabolic path
   (2) The particle escapes from earth following a hyperbolic path
   (3) Kinetic energy of the particle in interstellar space is non zero
   (4) Total energy of the particle is positive

80. Consider a thin massless T-shaped rod fixed to the ground (shown in the figure). Two forces of 8 N (horizontal) and 6 N (vertical) are being applied on the rod. Choose the correct alternative



Ground

   (1) Ground applies a force of 6 N on the rod
   (2) Ground applies a force of 10 N on the rod
   (3) Ground applies a moment of 14 N (clockwise) on the rod
   (4) Ground applies a moment of 2 N (clockwise) on the rod

❑ ❑ ❑

SECTION - C

Linked Comprehension Type

This section contains 39 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Comprehensions :

C1. The maximum and minimum distances of a planet from the centre of the sun are $2R$ and $4R$ respectively, where R is radius of sun. Let M be the mass of sun.

Choose the correct answer :

1. What is the ratio of maximum KE to minimum KE of the planet? (when observer is on the sun)

(1) 1 : 4 (2) 3 : 1

(3) 2 : 1 (4) Cannot determine

2. The maximum speed of planet is

(1) $\sqrt{\dfrac{GM}{6R}}$ (2) $\sqrt{\dfrac{2GM}{3R}}$

(3) $\sqrt{\dfrac{GM}{R}}$ (4) $\sqrt{\dfrac{GM}{2R}}$

3. Radius of curvature at the point of minimum distance is

(1) $\dfrac{8R}{3}$ (2) $\dfrac{R}{2}$

(3) $\dfrac{5R}{3}$ (4) $\dfrac{R}{3}$

C2. In a binary star system, two stars of masses m and $2m$ distance r apart are revolving about their common centre of mass under their mutual gravitational attraction.

Choose the correct answer :

1. The ratio of angular momenta of two star is

(1) 2 : 1 (2) 1 : 2

(3) 1 : 1 (4) 1 : 4

2. The ratio of kinetic energy of two star is

(1) 2 : 1 (2) 1 : 2

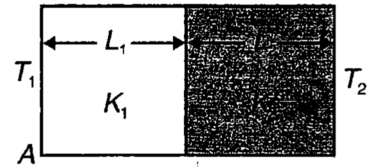
(3) 1 : 1 (4) 1 : 4

3. The ratio of linear momentum of two star is

(1) 2 : 1 (2) 1 : 2

(3) 1 : 1 (4) 1 : 4

C3. Two plates each of area A, respective thickness L_1 and L_2 and thermal conductivities K_1 and K_2 are joined to form a single plate of thickness $(L_1 + L_2)$, as shown below.



Choose the correct answer :

1. What is rate of flow of heat between two terminal ends at steady state?

(1) $\dfrac{A(T_1 - T_2)}{\left(\dfrac{L_1}{K_1} + \dfrac{L_2}{K_2}\right)}$

(2) $\dfrac{A(T_1 - T_2)}{\left(\dfrac{K_1}{L_1} + \dfrac{K_2}{L_2}\right)}$

(3) $\dfrac{A(T_1 + T_2)}{\left(\dfrac{L_1}{K_1} + \dfrac{L_2}{K_2}\right)}$

(4) $\dfrac{A(T_1 - T_2)}{\left(\dfrac{L_1}{2K_1} - \dfrac{L_2}{2K_2}\right)}$

2. What is the thermal resistance of combination (T)?

(1) $\dfrac{\rho_1}{K_1 A} + \dfrac{\rho_2}{K_2 A}$

(2) $\dfrac{\rho_1 - \rho_2}{(K_1 - K_2)A}$

(3) $\dfrac{\rho_1 + \rho_2}{(K_1 + K_2)A}$

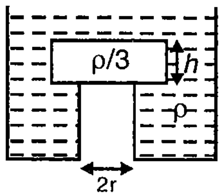
(4) $\dfrac{\rho_1}{K_1 A} - \dfrac{\rho_2}{K_2 A}$

3. The equivalent thermal conductivity of composite slab is given by

(1) $K_{eq} = \dfrac{L_1 + L_2}{\dfrac{L_1}{K_1} + \dfrac{L_2}{K_2}}$ (2) $K_{eq} = \dfrac{(K_1 + K_2)}{2}$

(3) $K_{eq} = \dfrac{\dfrac{L_1}{K_1} + \dfrac{L_2}{K_2}}{L_1 + L_2}$ (4) $K_{eq} = \dfrac{K_1 K_2}{K_1 + K_2}$

C4. A wooden cylinder of diameter $4r$, height h and density $\dfrac{\rho}{3}$ is kept on a hole of diameter $2r$ of a tank filled with liquid of density ρ as shown in the figure.



Choose the correct answer :

1. The level of the liquid starts decreasing slowly. When the level of liquid is at a height h_1 above the cylinder, the block starts moving up. At what value of h_1, will the block begin to rise?

(1) $\dfrac{4h}{9}$ (2) $\dfrac{5h}{9}$

(3) $\dfrac{5h}{3}$ (4) h

2. The block in the above question is maintained at the position by external means and the level of liquid is lowered. The height h_2 of the liquid level above hole, when this external force reduces to zero, is

(1) $\dfrac{4h}{9}$ (2) $\dfrac{5h}{9}$

(3) h (4) $\dfrac{2h}{3}$

3. If height of water level is further decreased, then

(1) Cylinder will remains at its original position

(2) For $h_2 = \dfrac{h}{3}$, cylinder again starts moving up

(3) For $h_2 = \dfrac{h}{4}$, cylinder again starts moving up

(4) For $h_2 = \dfrac{h}{5}$, cylinder again starts moving up

C5. A ball of density d is dropped on to a horizontal solid surface, it bounces elastically from the surface and returns to its original position in a time t. Next the ball is released and it falls through the same height before striking the surface of a liquid of density d_L.

Choose the correct answer :

1. Velocity of the ball just before it collides with liquid is

(1) $v = \dfrac{gt}{2}$ (2) $v = gt$

(3) $v = \dfrac{1}{3}gt$ (4) $v = \dfrac{1}{4}gt$

2. Time taken by the ball to come to rest after it enters into the liquid is

(1) $\dfrac{dt}{2(d_L - d)}$ (2) $\dfrac{dt}{4(d_L - d)}$

(3) $\dfrac{dt}{2(d_L + d)}$ (4) $\dfrac{dt}{4(d_L + d)}$

3. Time taken by ball to come back to the position from where it was released is

(1) $\dfrac{td_L}{d_L - d}$ (2) $\dfrac{td_L}{d_L + d}$

(3) $\dfrac{td_L}{2(d_L - d)}$ (4) $\dfrac{td_L}{2(d_L + d)}$

C6. The vibrations of a string of length 40 cm fixed at both ends are represented by the equation

$$y = 4\sin\left(\frac{\pi x}{10}\right)\cos(96\pi t)$$

Here x and y are in cm and t in seconds.

Choose the correct answer :

1. What is the maximum displacement of a point at $x = 5$ cm?

(1) 4 cm (2) 2 cm

(3) Zero (4) $2\sqrt{2}$ cm

2. What is the distance between two consecutive nodes?

(1) 10 cm (2) 15 cm

(3) 20 cm (4) 7.5 cm

3. What is the velocity of particle at $x = 5$ cm at $t = 0.25$ s?

(1) 2 cm/s^2 (2) –386 cm/s^2

(3) 386 cm/s^2 (4) Zero

C7. The air column in a pipe closed at one end is made to vibrate in its third overtone by a tuning fork of frequency 660 Hz. The speed of sound in air is 330 m/s. (end correction is negligible). Let P_0 denote the mean pressure at any point in pipe.

Choose the correct answer :

1. What is the length L of the air column?

(1) $\frac{7}{8}$ m (2) $\frac{1}{8}$ m

(3) $\frac{1}{4}$ m (4) $\frac{5}{4}$ m

2. What is the maximum pressures at the open end of the pipe?

(1) P_0 (2) $\frac{P_0}{2}$

(3) $2P_0$ (4) Zero

3. The variation of pressure will be maximum at the

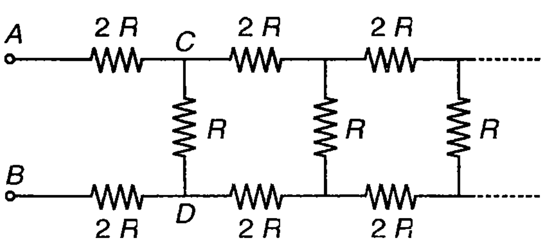
(1) Open end

(2) At a distance $\frac{1}{8}$ m from open end

(3) At the middle point of the tube

(4) At a distance $\frac{7}{32}$ m from the open end

C8. The infinite network of resistor shown in figure is known as an attenuator chain, since this chain of resistor causes the potential difference between the upper and lower wires to decreases or alternate, along the length. Take $\beta = R(1+\sqrt{2})$



Choose the correct answer :

1. The equivalent resistance between points AB

(1) β (2) 2β

(3) 3β (4) 4β

2. If the potential difference between A and B is v_0. Find the potential difference between C and D is

(1) $\frac{v_0 R}{2\beta+R}$ (2) $\frac{2\beta v_0}{3\beta+2R}$

(3) $\frac{\beta v_0}{3\beta+2R}$ (4) None of these

3. How many segments are needed to decrease the potential difference v_n to less than 1.0% of v_0?

(1) 3 (2) 4

(3) 5 (4) 6

C9. A tool moving in x-y plane under a quality control process under the action of various forces. One force is $\vec{F} = -\alpha xy^2\hat{j}$, a force in the negative y-direction whose magnitude depends on the position of the tool. The constant α is 2.50 N/m^3. Consider the displacement of the tool from the origin to the point $x = 3.00$ m, $y = 3.00$ m.

Choose the correct answer :

1. Calculate the work done on the tool by the force $\vec{F}$ if this displacement is along the straight line $y = x$ that connects these two points

(1) -50.6 joule (2) -67.5 joule

(3) -77.5 joule (4) -60.5 joule

2. If the tool is first moved out along the x-axis to the point (3, 0) and then moved out parallel to the y-axis to (3, 3), the work done will be

(1) -50.6 joule (2) -67.5 joule

(3) -77.5 joule (4) -60.5 joule

3. Predict the nature of the force given in the paragraph

(1) Conservative (2) Non conservative

(3) Can't be predicted (4) Restoring force

C10. A region in space contains a total positive charge Q that is distributed spherically such that the volume charge density $\rho(r)$ given by

$\rho(r) = \alpha$ for $r \le \frac{R}{2}$

$\rho(r) = 2\alpha\left(1-\frac{r}{R}\right)$ for $\frac{R}{2} \le r \le R$

$\rho(r) = 0$ for $r \ge R$

Here α is a positive constant having units of C/m^3.

Choose the correct answer :

1. The value of α in terms of Q and R is

(1) $\frac{6Q}{5\pi R^3}$ (2) $\frac{7Q}{5\pi R^3}$

(3) $\frac{8Q}{5\pi R^3}$ (4) $\frac{9Q}{5\pi R^3}$

2. The correct statement from the following are

(1) Electric field at $r < \frac{R}{2}$ is $\frac{8Qr}{15\pi\varepsilon_0 R^3}$

(2) Electric field at $\frac{R}{2} < r < R$ is $\frac{8Qr}{15\pi\varepsilon_0 R^3}$

(3) Electric field at $r < \frac{R}{2}$ is $\frac{Q}{60\pi\varepsilon_0 r^2}$

(4) Electric field at $r > R$ is $\frac{2kQ}{R^2}$

3. What fraction of the total charge is contained within the region $r \le \frac{R}{2}$?

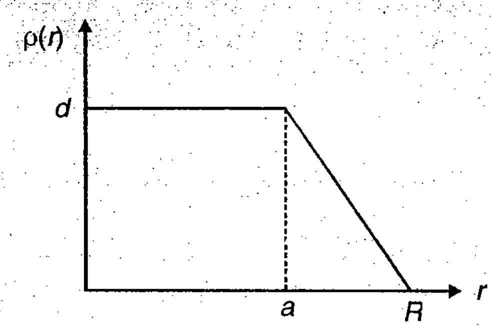
(1) $\frac{1}{4}$ (2) $\frac{11}{20}$

(3) $\frac{3}{14}$ (4) $\frac{4}{15}$

(IIT-JEE 2008)

C10(a) The nuclear charge (Ze) is non-uniformly distributed within a nucleus of radius R. The charge density $\rho(r)$ [charge per unit volume] is dependent only on the radial distance r from the centre of the nucleus as shown in figure. The electric field is only along the radial direction.

Figure :



1. The electric field at $r = R$ is

(1) Independent of a

(2) Directly proportional to a

(3) Directly proportional to a^2

(4) Inversely proportional to a

2. For $a = 0$, the value of d (maximum value of ρ as shown in the figure) is

(1) $\frac{3Ze}{4\pi R^3}$ (2) $\frac{3Ze}{\pi R^3}$

(3) $\frac{4Ze}{3\pi R^3}$ (4) $\frac{Ze}{3\pi R^3}$

3. The electric field within the nucleus is generally observed to be linearly dependent on r. This implies

(1) $a = 0$ (2) $a = \frac{R}{2}$

(3) $a = R$ (4) $a = \frac{2R}{3}$

C11. In a potentiometre circuit, two wires of same material of restivity ρ, one of radius of cross-section a and other of radius of cross-section $2a$ are joined in series. They are of length ℓ and 2ℓ respectively. This combination act as potentiometer wire of length 3ℓ. The emf of the cell in the primary circuit is ε and internal resistance is $\frac{\rho\ell}{2\pi a^2}$. This cell is connected to the potentiometer wire by a conducting wire of negligible resistance with positive terminal of the cell connected to one end (call it A) of longer wire.

Choose the correct answer :

1. The maximum voltage which can be balanced on the potentiometer wire is

(1) $\frac{2\varepsilon}{2}$ (2) $\frac{3\varepsilon}{4}$

(3) $\frac{3\varepsilon}{8}$ (4) $\frac{E}{2}$

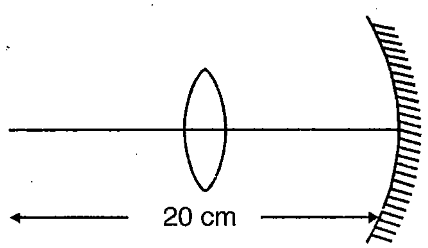
2. The balanced length measured from point A obtained in measurement of emf of cell of emf $\frac{\varepsilon}{2}$ is

(1) $\frac{3\ell}{2}$ (2) $\frac{5\ell}{2}$

(3) $\frac{2}{3}\ell$ (4) $\frac{5}{7}\ell$

3. If positive terminal of emf $\frac{E}{2}$ and internal resistance $\frac{\rho\ell}{2\pi a^2} = R$ is connected to point A and other terminal is joined to the junction of the two wires. The current through the cell $\frac{E}{2}$ is
   (1) $\frac{3E}{2R}$ (2) $\frac{5E}{4R}$
   (3) $\frac{2E}{3R}$ (4) $\frac{E}{10R}$

C12. A concave mirror of radius of curvature 20 cm is shown in the figure. A circular disc of time varying diameter (1.0 + 0.2*t*) cm is placed on the principle axis of mirror with its plane perpendicular to the principle axis at a distance 15 cm from the pole of the mirror.



Choose the correct answer :

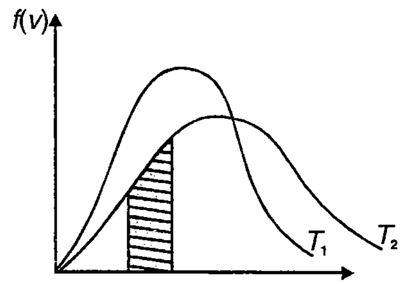
1. The image formed by the mirror will be in the shape of a
   (1) Circular disc
   (2) Elliptical disc with major axis horizontal
   (3) Elliptical disc with major axis vertical
   (4) Distorted disc of irregular shape
2. In the above question, the area of image of the disc at t = 1 second is
   (1) 1.2π cm^2 (2) 1.44π cm^2
   (3) 1.52π cm^2 (4) None of these
3. What will be the rate at which the horizontal radius of image will be changing?
   (1) 0.2 cm/s
   (2) –0.2 cm/s
   (3) 0.4 cm/s
   (4) –0.4 cm/s

C13. A particle moves on parabolic path whose equation is given by $y = 2x^2$ with a constant speed of 2 m/s.

Choose the correct answer :

1. Find the acceleration of a particle at the origin
   (1) 8 m/s^2 (2) 16 m/s^2
   (3) 32 m/s^2 (4) 64 m/s^2
2. Find the radius of curvature of the parabola at the origin
   (1) 0.25 m (2) 2 m
   (3) 4 m (4) 0.5 m
3. Find the angle made by instantaneous velocity withy x-axis, when it is at (2, 4)
   (1) $\tan^{-1}(8)$ (2) $\tan^{-1}(4)$
   (3) $\tan^{-1}(2)$ (4) $\tan^{-1}(6)$

C14. Figure shows one experimental scheme for measuring the distribution of molecular speed. A substance is vaporized in a furnace, molecules or the vapour escape through an aperture in the wall and enter into a vacuum chamber. A series of slits block all molecules except those in a norrow beam which is aimed at a pair of rotating disk. A molecule passing from the first disk is blocked by the second disk unless it arrives just as the slit in the second disk in lined up with the beam. This range of speed can be varied by changing disk rotation speed. We can measure how many molecules lie within each of various speed ranges, by the help of plotting a graph between $f(v)$ called distribution function and velocity.



Choose the correct answer :

1. Let the spacing between the two disks is x, and angular spacing between the slits on the disks is θ. Find the velocity of a molecule able to pass through the disk rotating with an angular velocity ω
   (1) $v = \frac{\omega x}{\theta}$ (2) $v = \frac{QR}{\omega}$
   (3) $v = \frac{R\omega}{\theta}$ (4) $v = \frac{\theta R}{\omega}$
2. If function f(v) described the actual distribution of molecular speed is $f(v) = av^2e^{-bv^2}$, then the most probable speed will be (Here, a and b are temperature dependent quantities)
   (1) $\sqrt{\frac{a}{b}}$ (2) $\sqrt{\frac{1}{a}}$
   (3) $\sqrt{\frac{1}{b}}$ (4) None of these

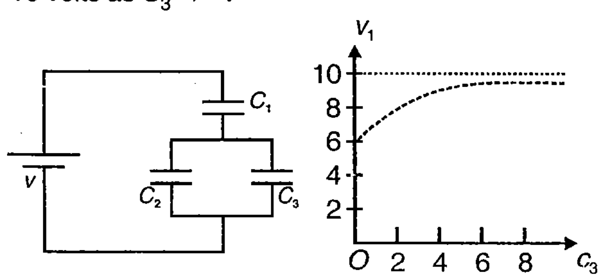
3. The area shown under the distribution curve will give
   (1) Kinetic energy
   (2) Potential energy
   (3) Internal energy
   (4) Number of particles

C15. A ball is thrown at an angle of 53° with the horizontal from the centre of the bottom of a well with a speed of 50 m/s. The ball collide elastically with the vertical walls of the well. The total number of collision on both walls is 12 (Take $g = 10$ m/s^2)

Choose the correct answer :

1. The minimum height of the wall so that the ball may not come out of the well
   (1) 80 m (2) 79.4 m
   (3) 40.25 m (4) 81.5 m
2. The diameter of the well so that the particle falls back to the initial point of the projection is
   (1) 10 m (2) 20 m
   (3) 30 m (4) 40 m
3. The impulse provided by the wall during the 3rd collision with the wall, if the mass of the ball is 1 kg, is
   (1) 60 N-s (2) 70 N-s
   (3) 80 N-s (4) 90 N-s

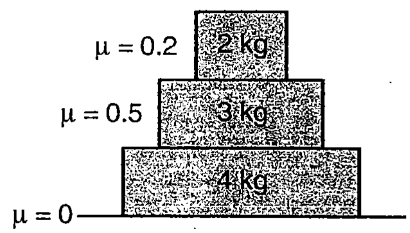
C16. Capacitor C_3 in the circuit is a variable capacitor (its capacitance can be varied). Graph is plotted between potential difference v_1 (across capacitor C_1) versus C_3. Electric potential v_1 approaches on asymtote of 10 volts as $C_3 \to \infty$.



Choose the correct answer :

1. The ratio of the capacitance $\frac{C_1}{C_2}$ will be
   (1) $\frac{2}{3}$ (2) $\frac{4}{3}$
   (3) $\frac{3}{4}$ (4) $\frac{3}{2}$
2. The value of C_3 for which potential across C_1 will become $8V$ is
   (1) 1.5 C_1
   (2) 2.5 C_1
   (3) 3.5 C_1
   (4) 4.5 C_1
3. The ratio of energy stored in capacitor C_1 to that of total energy, when C_3 approaches infinity, is
   (1) Zero
   (2) $\frac{1}{3}$
   (3) 1
   (4) Data insufficient

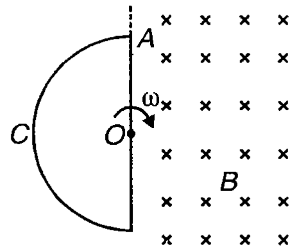
C17. Three blocks of masses 2 kg, 3 kg, 4 kg are placed as shown in the figure. Coefficient of friction between the surfaces are 0.2, 0.5, 0.0. A horizontal force is applied on 3 kg block



Choose the correct answer :

1. The maximum horizontal force for which no sliping takes place between the blocks, when the force is applied on 3 kg block is
   (1) 15 N (2) 18 N
   (3) 21 N (4) 24 N
2. Find the maximum force for which sliping takes place between the upper blocks only [No sliping for 3 kg and 4 kg]
   (1) 15 N (2) 30 N
   (3) 56.25 N (4) 60 N
3. The work done by the friction when the force of 50 newton acts on the 3 kg blocks for 2 second
   (1) 54 joule (2) 108 joule
   (3) 216 joule (4) 512 joule

C18. Magnetic field $B = 2T$ as shown in figure is directed into plane of paper. $ACDA$ is semicircular conducting loop of radius 1 m with centre O. Now loop is made to rotate clockwise with angular velocity ω about axis through O and perpendicular to plane of paper. Loop has resistance 100 Ω, capacitance 200 μF and inductance 2 H then



Choose the correct answer :

1. For what value of ω current in loop is maximum?

(1) 50 rad/s (2) 100 rad/s

(3) 150 rad/s (4) 200 rad/s

2. For what value of ω current in loop leads voltage by $\frac{\pi}{4}$ radians approximately?

(1) 100 rad/s (2) 112 rad/s

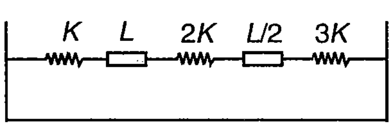
(3) 31 rad/s (4) 62 rad/s

3. RMS value of current at $\omega = 50$ rad/s

(1) 1 A (2) $\frac{1}{2}$ A

(3) 2 A (4) $\frac{3}{4}$ A

C19. The system shown in figure consist of three spring and two rigid rods. The temperature of rods is increased by $\Delta T = 100°C$. The springs are initially relaxed. There is no friction and coefficient of linear expansion of rods is 10^{-2} / °C. Assume no thermal stress



Choose the correct answer :

1. Energy stored in spring of spring constant k is

(1) $\frac{81}{128}kL^2$ (2) $\frac{81}{242}kL$

(3) $\frac{81}{158}kL^2$ (4) None of these

2. Energy stored in spring of spring constant $2k$ is

(1) $\frac{81}{484}kL^2$ (2) $\frac{81}{242}kL$

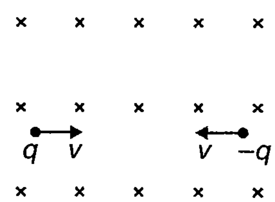
(3) $\frac{27}{242}kL^2$ (4) None of these

3. Energy stored in spring is spring constant $3k$

(1) $\frac{81}{484}kL^2$ (2) $\frac{81}{242}kL$

(3) $\frac{27}{128}kL^2$ (4) None of these

C20. Two particles each of mass 1 kg are placed at a separation of 2 m in a uniform magnetic field $B = 2T$ as shown in figure. They have same charge of 1 C. At $t = 0$, the particles are projected towards each other, each with speed 4 m/s. Suppose coulombian force between the charges is switched off.



Choose the correct answer :

1. If the collision is perfectly inelastic, then find the velocity of the particles after collision, is

(1) 4 m/s (2) 2 m/s

(3) 1 m/s (4) $\frac{1}{2}$ m/s

2. Find the radius of curvature of the path after perfectly inelastic collision?

(1) 2 m (2) 4 m

(3) 1 m (4) $\frac{1}{2}$ m

3. At what instant, both particles will collide?

(1) $\frac{\pi}{4}$ s (2) $\frac{\pi}{6}$ s

(3) $\frac{\pi}{24}$ s (4) $\frac{\pi}{12}$ s

C21. N men having mass m stand on stationary flat car of mass M. They jumps off from one end with velocity v relative to flat car. The car rolls in opposite direction without friction find final velocity of car when

Choose the correct answer :

1. One man jumps of car

(1) $\frac{mv}{M+m}$ (2) $\frac{Mv}{M+Nm}$

(3) $\frac{mv}{M+Nm}$ (4) None of these

2. If all of them jump of simultaneously in one direction

(1) $\frac{Nmv}{Nm+M}$ (2) $\frac{Nmv}{NM+m}$

(3) $\frac{Mv}{M+Nm}$ (4) None of these

3. If they jumps one after another

(1) $mv\left[\frac{1}{M+Nm}+\frac{1}{M+(N-1)m}+...+\frac{1}{M+m}\right]$

(2) $Mv\left[\frac{1}{M+Nm}+\frac{1}{M+(N-1)m}+...+\frac{1}{M+m}\right]$

(3) $Nmv\left[\frac{1}{m+NM}+\frac{1}{m+(N-1)M}+...+\frac{1}{m+M}\right]$

(4) None of these

C22. A rail road car is loaded with 20 tonnes of coal in 2 seconds while it travels through a distance of 10 m beneath hopper from which coal is discharged

Choose the correct answer :

1. What average extra force must be applied to car during this loading process to keep it moving with constant speed?

(1) 10^5 N (2) 10^4 N

(3) 2×10^4 N (4) 5×10^4 N

2. How much work does this force perform?

(1) 10^6 J (2) 10^5 J

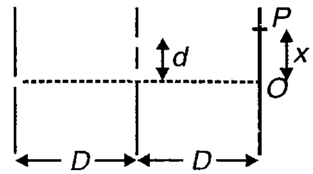
(3) 2×10^5 J (4) 5×10^5 J

3. What is the increase in kinetic energy of coal?

(1) 2.5×10^5 J (2) 5×10^5 J

(3) 10^5 J (4) 10^6 J

C23. Consider the arrangement shown in figure. The distance D is large compared to separation d between slits.



1. Find minimum value of d so that dark fringe is formed at O

(1) $\sqrt{\frac{\lambda D}{2}}$ (2) $\sqrt{2\lambda D}$

(3) $\sqrt{\frac{\lambda D}{3}}$ (4) None of these

2. For the above value of d, the next bright fringe is at x =

(1) $3d$ (2) $2d$

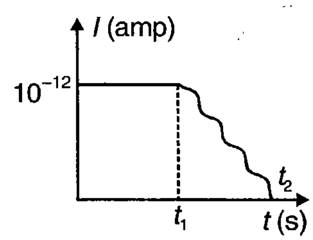
(3) d (4) $4d$

3. The fringe width is

(1) d (2) $2d$

(3) $3d$ (4) $4d$

C24. A parallel plate capacitor of capacitance 100 μF and separation of 1 cm is charged with a battery to a potential difference of 10 V. The battery is then disconnected. Electromagnetic radiation is now incident on negatively charged plate which emits electrons with kinetic energies ranging from 0 to 1.5 eV. The electrons are attracted to positive plate. The current which flows between two plates varies with time t as shown in figure



Choose the correct answer :

1. What is potential difference between plates at time t_1?

(1) 0 V (2) 1 V

(3) 2 V (4) 3 V

2. What is numerical value of t_1?

(1) 10^8 s (2) 10^{10} s

(3) 10^9 s (4) 10^7 s

3. What is potential difference between plates for $t > t_2$?
   (1) 1 V (2) 1.5 V
   (3) 2 V (4) 2.5 V

C25. Electric field and magnetic field in region of space are given by and $\vec{E} = E_0\hat{j}$ and $\vec{B} = B_0\hat{j}$. A particle of specific charge α (charge per unit mass) is released from origin with velocity $\vec{V} = V_0\hat{i}$. Determine

Choose the correct answer :

1. Path of particle is
   (1) Straight line
   (2) Circular path
   (3) Helix with increasing pitch
   (4) Helix with uniform pitch

2. y coordinate of particle when it crosses y axis for nth time is
   (1) $\dfrac{2n^2\pi^2E_0}{B_0^2\alpha}$ (2) $\dfrac{n^2\pi E_0}{B_0^2\alpha}$
   (3) $\dfrac{2\pi^2E_0}{n^2B_0\alpha}$ (4) Zero

3. Angle inbetween particle's velocity and y-axis at that moment is
   (1) $\tan^{-1}\left(\dfrac{V_0B_0}{2\pi E_0}\right)$ (2) $\tan^{-1}\left(\dfrac{V_0B_0}{2\pi nE_0}\right)$
   (3) $\tan^{-1}\left(\dfrac{V_0B_0}{E_0}\right)$ (4) $\tan^{-1}\left(\dfrac{B_0}{E_0}\right)$

C26. Electric potential V in volts in a region of space is given by $V = ax^2 + ay^2 + 2az^2$ where a is constant of proper dimensions.

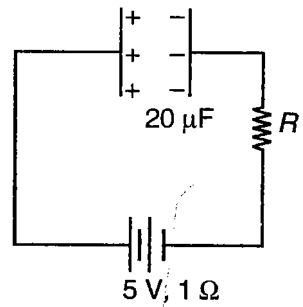
Choose the correct answer :

1. The work done by field when a 2 μC test charge moves from point (0, 0, 0.1 m) to origin is 5×10^{-5} J. Determine 'a'
   (1) 1.25×10^3 V/m^2 (2) 2.5×10^3 V/m^2
   (3) 3.75×10^3 V/m^2 (4) None of these

2. Locus of equipotential points in $Z = 0$ plane is
   (1) Concentric circles
   (2) Lines parallel to Y axis
   (3) Lines parallel to $Y = X$ lines
   (4) Lines parallel to X axis

3. What is radius of circle of equipotential line corresponding to $V = 6250$ volts and $Z = \sqrt{2}$ m?
   (1) 4 m (2) 3 m
   (3) 2 m (4) 1 m

C27. A capacitor of capacitance 2 μF is given a charge 20 μC. Now its (the) plate is connected to the (+ve) terminal and (–ve) plate to the (–ve) terminal of a battery of emf 5 volt. The internal resistance of the cell is 1 Ω and R = 49 Ω



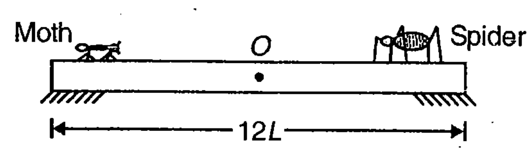
Choose the correct answer :

1. Find the final energy stored in the capacitor
   (1) 100 J (2) 25 J
   (3) 250 J (4) 2.5 J

2. Total heat produced in the battery
   (1) 0.5 J (2) 25 J
   (3) 1 J (4) 2.5 J

3. Energy stored in the battery
   (1) 25 J (2) 50 J
   (3) 100 J (4) 2.5 Jk

C28. A uniform bar of length $12L$ and mass $48m$ is supported horizontally on two smooth tables as shown in the figure. A small moth (insect) of mass $8m$ is sitting on end A of the bar and a spider of mass $16m$ is sitting on the end B. Both insects start moving towards each other along the bar, with moth moving at speed $2v$ and the spider at half of this speed. They meet at a point O on the bar and the spider eats the moth. After this spider move with a velocity $\dfrac{v}{2}$ relative to the bar toward the end A. The spider take negligible time in eating the moth. Also let $v = \dfrac{L}{T}$ where T is constant having value 4 s. Find



Choose the correct answer :

1. Displacement of the bar by the time when insects meet is

(1) $\frac{L}{2}$ (2) L

(3) $\frac{3L}{4}$ (4) Zero

2. The speed of the bar after the spider eat up the moth and move towards A is

(1) $\frac{v}{2}$ (2) v

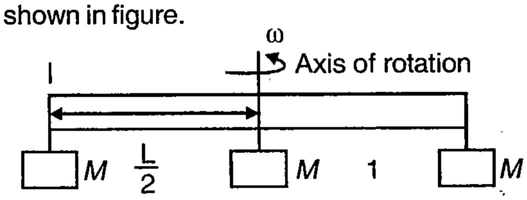
(3) $\frac{v}{6}$ (4) $2v$

3. By what distance the centre of mass of bar shifts when spider reaches the end A after starting from end B?

(1) $\frac{8L}{3}$ (2) $\frac{4L}{3}$

(3) L (4) $\frac{L}{3}$

C29. Three objects of identical shape and mass M, are attached to a rod of length L and negligible mass. The entire system rotates about the centre of rod as shown in figure.



Choose the correct answer :

1. What is the moment of interia of the system?

(1) $\frac{1}{2}ML^2$ (2) ML^2

(3) $2ML^2$ (4) $3ML^2$

2. A 20.0 kg steel cylinder has an 80 cm diameter what is the cylinders moment of inertia when it is rotated through an axis parallel to its length and 10 cm from its centre?

(1) 1.8 kg-m^2 (2) 6.6 kg-m^2

(3) 1.8×10^4 kg-m^2 (4) 6.6×10^4 kg-m^2

3. If all three masses are removed and let the mass of rod be M that rotates around an axis perpendicular to its length and located at one of its ends. What is the moment of inertia for this arrangement. (Assume rod is uniform and thin)

(1) $\frac{7}{12}ML^2$ (2) $\frac{ML^2}{3}$

(3) $\frac{ML^2}{12}$ (4) $\frac{13ML^2}{12}$

C30. A liquid flowing from a vertical pipe has a very definite shape as it flows from the pipe. To get the equation for this shape, assume that the liquid is in free fall once it leaves the pipe. Just as it leaves the pipe, the liquid has speed v_0 and radius of the stream of liquid is r_0.

Choose the correct answer :

1. An equation for the speed of the liquid as a function of the distance of y it has fallen, is given as

(1) $v^2 = v_0^2 + 2gy$ (2) $v^2 = v_0^2 - 2gy$

(3) $v^2 = v_0^2 - 2gr_0$ (4) $v^2 = v_0^2 + 2gr_0$

2. Combining the above result with equation of continuity, the expression for radius of the stream as a function of y is

(1) $r = \frac{r_0\sqrt{v_0}}{(v_0^2+2gy)^{1/4}}$ (2) $r = \frac{r_0\sqrt{v_0}}{(2v_0+gy)^{1/2}}$

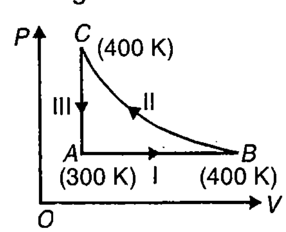
(3) $r = (v_0^2 + 2gy)^{1/2}$ (4) $r = (v_0^2 + 2gy)^{1/4}$

3. If water flow out of a vertical pipe at a speed of 1.2 m/s, how far below the outlet will the radius be half the original value of radius of stream?

(1) 110 m (2) 11 m

(3) 1.1 m (4) 2 m

C31. 8 g of oxygen at pressure one atmosphere and at temperature 27°C is enclosed in a cylinder fitted with a frictionless piston. The following operation are preformed in the given order.



(i) The gas is heated at constant pressure to 127°C

(ii) Then it is compressed isothermally to its initial volume and

(iii) Finally it is cooled to its initial temperature at constant volume.

Take the specific heat of oxygen C_v = 670 J/kg-K, molecular weight of O_2 = 32, 1 atm = 1.013×10^5 N/m^2.

Choose the correct answer :

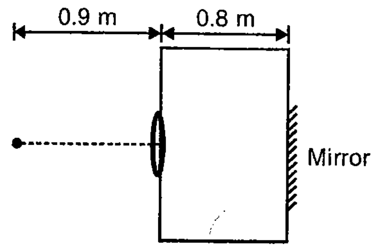
1. Heat absorbed by the gas during operation (I) is
   (1) 750.4 J (2) 74.38 J
   (3) 7.438 J (4) 0.7438 J
2. Work done by gas in stage $A \to B$ is
   (1) 20.78 J (2) +207.8 J
   (3) −207.8 J (4) −20.78 J
3. Work done by the gas in the process $B \to C$ is
   (1) +239.1 J (2) 23.9 J
   (3) −239.1 J (4) −23.91 J

C32. The displacement of the medium in a sound wave is given by the equation $y_1 = A\cos(ax + bt)$, where A, a, b are positive constants. The wave is reflected by an obstacle situated at $x = 0$. The intensity of reflected wave is 0.64 times that of incident wave. Then find

Choose the correct answer :

1. The wavelength and the frequency of the incident wave are
   (1) $\lambda = \frac{\pi}{a}, n = \frac{b}{2\pi}$ (2) $\lambda = \frac{2\pi}{a}, n = \frac{b}{2\pi}$
   (3) $\lambda = \frac{2\pi}{a}, n = \frac{b}{\pi}$ (4) $\lambda = \frac{\pi}{a}, n = \frac{b}{\pi}$
2. The equation for reflected wave is
   (1) $y_1 = 0.8\,A\sin(bt - ax)$
   (2) $y_1 = 0.8\,A\cos(bt - ax)$
   (3) $y_1 = -0.8\,A\sin(bt - ax)$
   (4) $y_1 = -0.8\,A\cos(bt - ax)$
3. In the resultant wave formed after reflection, the maximum and minimum values of particle speeds in medium are
   (1) $V_{max} = 1.8\,Ab$, $V_{min} = 0.2\,Ab$
   (2) $V_{max} = 1.6\,Ab$, $V_{min} = 0.1\,Ab$
   (3) $V_{max} = 1.4\,Ab$, $V_{min} = 0.1\,Ab$
   (4) $V_{max} = 1.2\,Ab$, $V_{min} = 0.2\,Ab$

C33. A thin equiconvex lens of glass of refractive index $\mu = \frac{3}{2}$ and focal length 0.3 m in air is sealed into an opening at one end of a tank filled with water $\left(\mu = \frac{4}{3}\right)$. On the opposite side of the lens a mirror is placed inside the tank, on the tank wall perpendicular to the lens axis. The separation between the lens and mirror is 0.8 m. A small object is placed outside the tank in front of the lens at a distance of 0.9 m from the lens along its axis.



Choose the correct answer :

1. Radius of the curvature of any of the curved surface of equiconvex lens is
   (1) 0.3 m (2) 0.4 m
   (3) 0.5 m (4) 0.6 m
2. After refraction at glass water interface the position of real image formed by the mirror is
   (1) At a distance of 0.4 m from the lens
   (2) At a distance of 0.3 m from the lens
   (3) At a distance of 0.2 m from the lens
   (4) At a distance of 0.1 m from the lens
3. After refraction at glass air interface, where the image appears to be formed?
   (1) 0.6 m from the lens on side of mirror
   (2) 0.9 m from the lens on side of mirror
   (3) 0.5 m from the lens on side of mirror
   (4) 0.4 m from the lens on side of mirror

C34. A ball of radius R carries a positive charge whose volume charge density depends only on the distance r from the ball's centre as $\rho = \rho_0\left(1 - \frac{r}{R}\right)$, where ρ_0 is a constant. Assume ε as permittivity of the ball.

Choose the correct answer :

1. The magnitude of electric field as a function of the distance r inside the ball is given by
   (1) $E = \frac{\rho_0}{\varepsilon}\left[\frac{r}{3} - \frac{r^2}{4R}\right]$ (2) $E = \frac{\rho_0}{\varepsilon}\left[\frac{r}{4} - \frac{r^2}{3R}\right]$
   (3) $E = \frac{\rho_0}{\varepsilon}\left[\frac{r}{3} + \frac{r^2}{4R}\right]$ (4) $E = \frac{\rho_0}{\varepsilon}\left[\frac{r}{4} + \frac{r^2}{3R}\right]$

2. The magnitude of electric field as a function of the distance r outside the ball is

(1) $E = \frac{\rho_0 R^3}{8\varepsilon r^2}$ (2) $E = \frac{\rho_0 R^3}{12\varepsilon r^2}$

(3) $E = \frac{\rho_0 R^2}{8\varepsilon r^3}$ (4) $E = \frac{\rho_0 R^2}{12\varepsilon r^3}$

3. The maximum electric field intensity is

(1) $E_m = \frac{\rho_0 R}{9\varepsilon}$ (2) $E_m = \frac{\rho_0 R}{3\varepsilon}$

(3) $E_m = \frac{\rho_0 \varepsilon}{9R}$ (4) $E = \frac{\rho_0 R}{6\varepsilon}$

C35. An energy of 68.0 eV is required to excite a hydrogen like atom from its second Bohr orbit to third. The nuclear charge is Ze. Given that $e = 1.6 \times 10^{-19}$ C, $m = 9.1 \times 10^{-31}$ kg, $\varepsilon_0^{-1} = 36\pi \times 10^9$ Vm/A-s, $h = 6.6 \times 10^{-34}$ J-s, $c = 3 \times 10^8$ m/s.

Choose the correct answer :

1. The value of atomic number Z is given by

(1) 3 (2) 4

(3) 5 (4) 6

2. Kinetic energy of electron in first Bohr orbit is

(1) 4.896 eV (2) 48.96 eV

(3) 489.6 eV (4) 0.489 eV

3. The wavelength of electromagnetic radiation required to eject the electron from the first orbit to infinity is given by

(1) λ = 2.528 Å (2) 25.28 Å

(3) λ = 252.8 Å (4) 0.2528 Å

C36. A beam of light has three wavelength 4144 Å, 4972. Å and 6216 Å with a total intensity of 3.6×10^{-3} W/m^2 equally distributed amongst the three wavelength. The beam falls normally on an area 1.0 cm^2 of a clean metallic surface of work function 2.3 eV. Assume that there is no loss of light by reflection and that each energetically capable photon ejects one electron. Given that $h = 6.63 \times 10^{-34}$ J-s and $c = 3 \times 10^8$ m/s.

Choose the correct answer :

1. The wavelength which are capable of ejecting photoelectrons are

(1) 4144 Å, 4972 Å and 6216 Å

(2) 4910 Å, 6216 Å only

(3) 4144 Å, 4972 Å only

(4) 4144 Å only

2. Number of photons falling per second per unit area of the surface, corresponding to any wavelength λ is

(1) $\frac{I\lambda}{3hc}$ (2) $\frac{I\lambda}{hc}$

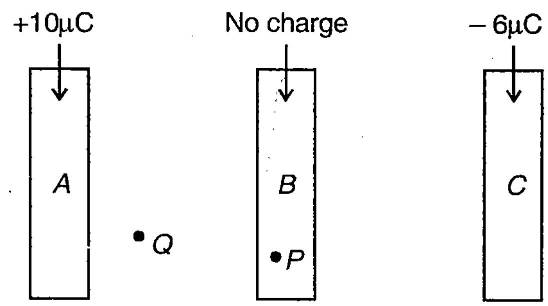
(3) $\frac{I\lambda}{2hc}$ (4) $\frac{I\lambda}{4hc}$

3. Number of photoelectrons liberated in 2 seconds is

(1) 11×10^9 (2) 11×10^{10}

(3) 11×10^{11} (4) 11×10^{12}

C37. Figure shows an arrangement of three long metallic plates. Also shown are two points: P and Q.



Choose the correct answer :

1. Charge on the left face of plate A is

(1) 2 μC (2) 3 μC

(3) 4 μC (4) 5 μC

2. Fields at point P and point Q respectively are

(1) Zero, zero

(2) Zero, non-zero

(3) Non-zero, zero

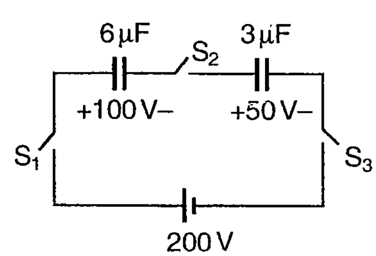
(4) Non-zero, non-zero

3. If plate C is removed, net charge on plate B will be

(1) 10 μC (2) 6 μC

(3) Zero (4) 2 μC

C38. Two capacitors 6 μF and 3 μF are charged to 100 V and 50 V seperately and connected as shown. Now all three switches are closed



Choose the correct answer :

1. Charges of 6 μF and 3 μF capacitors in steady state will be

   (1) 400 μC, 400 μC (2) 700 μC, 250 μC

   (3) 800 μC, 350 μC (4) 300 μC, 450 μC

2. Charge supplied by battery is

   (1) 50 μC (2) 100 μC

   (3) 200 μC (4) 150 μC

3. Suppose q_1, q_2 & q_3 be the magnitudes of charges flown from switches S_1, S_2 and S_3 after they are closed, then

   (1) $q_1 = q_2$ and $q_3 = 0$

   (2) $q_1 = q_3 = \frac{q_2}{2}$

   (3) $q_1 = q_2 = 3q_2$

   (4) $q_1 = q_2 = q_3$

C39. A particle having a charge q and mass m is projected from origin with velocity $\vec{v} = v_0\hat{i}$ in a uniform magnetic field $\vec{B} = \frac{B_0}{2}\hat{i} + \frac{\sqrt{3}B_0}{2}\hat{j}$ at the moment $t = 0$.

Choose the correct answer :

1. Pitch of the helical path described by the particle is

   (1) $\frac{2\pi m v_0}{qB_0}$ (2) $\frac{\pi m v_0}{qB_0}$

   (3) $\frac{5\pi m v_0}{qB}$ (4) $\frac{6\pi m v_0}{qB}$

2. z-component of velocity becomes $\frac{\sqrt{3}v_0}{2}$ at time $t =$ ______

   (1) $\frac{2\pi m}{B_0 q}$ (2) $\frac{\pi m}{B_0 q}$

   (3) $\frac{\pi m}{2B_0 q}$ (4) $\frac{2\pi m}{4B_0 q}$

3. Maximum z-coordinate of the particle is

   (1) $\frac{\sqrt{3}m v_0}{B_0 q}$ (2) $\frac{2\sqrt{3}m v_0}{B_0 q}$

   (3) $\frac{2m v_0}{B_0 q}$ (4) $\frac{m v_0}{B_0 q}$

❑ ❑ ❑

SECTION - D

Assertion - Reason Type

This section contains 146 questions. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Instructions for Assertion - Reason Type questions :

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

Choose the correct answer :

1. STATEMENT-1 : A body becomes weightless at the centre of earth.

   and

   STATEMENT-2 : As the distance from centre of earth decreases acceleration due to gravity increases.

2. STATEMENT-1 : A person sitting in an artificial satellite revolving around the earth feels weightless.

   and

   STATEMENT-2 : There is no gravitational force on the satellite.

3. STATEMENT-1 : The speed of satellite always remains constant in an orbit.

   and

   STATEMENT-2 : The speed of a satellite depends on its path.

4. STATEMENT-1 :The speed of revolution of an artificial satellite revolving very near the earth is 8 km/s.

   and

   STATEMENT-2 : Orbital velocity of a satellite, becomes independent of height of satellite near earth.

5. STATEMENT-1 : Radiation is the fastest mode of heat transfer.

   and

   STATEMENT-2 : Radiation can be transmitted in zig-zag motion.

6. STATEMENT-1 : Animals curl into a ball, when they feel very cold.

   and

   STATEMENT-2 : Animals by curling their body reduce the surface area.

7. STATEMENT-1 : Snow is better insulator of heat than ice.

   and

   STATEMENT-2 : Snow contains air packet and air is good insulator of heat.

8. STATEMENT-1 : The absorbance of a perfect black body is unity.

   and

   STATEMENT-2 : A perfect black body when heated emits radiations of all possible wavelengths at that temperature.

9. STATEMENT-1 : The stretching of a coil is determined by its Shear modulus.

   and

   STATEMENT-2 : Shear modulus changes only shape of a body keeping its dimensions unchanged.

10. STATEMENT-1 : Steel is more elastic than rubber.

    and

    STATEMENT-2 : Under given deforming force, steel is deformed less than rubber.

11. STATEMENT-1 : The bridges are declared unsafe after a long use.

    and

    STATEMENT-2 : Elastic strength of bridges decreases with time.

12. STATEMENT-1 : Young's modulus for a perfectly plastic body is zero.

    and

    STATEMENT-2 : For a perfectly plastic body, restoring force is zero.

13. STATEMENT-1 : Transverse waves are not produced in liquids and gases.

    and

    STATEMENT-2 : Light waves are transverse waves.

14. STATEMENT-1 : Particle velocity and wave velocity both are independent of time.

    and

    STATEMENT-2 : For the propagation of mechanical wave, the medium must have the properties of elasticity and inertia.

15. STATEMENT-1 : The speed of sound in solid is maximum though their density is large.

    and

    STATEMENT-2 : The coefficient of elasticity of solid is large.

16. STATEMENT-1 : The fundamental frequency of an open organ pipe increases as the temperature is increased.

    and

    STATEMENT-2 : As the temperature increases, the velocity of sound increases more rapidly than length of the pipe.

17. STATEMENT-1 : Work done by gas in a thermodynamic process does not depend on initial and final state.

    and

    STATEMENT-2 : Work done by gas is not a state function.

18. STATEMENT-1 : The root mean square velocity of molecules of a gas having Maxwellian distribution of velocities is higher than their most probable velocity, at any temperature.

    and

    STATEMENT-2 : A very small number of molecules of a gas which posses very large velocities increase the root mean square velocity, without affecting the most probable velocity.

19. STATEMENT-1 : A beam containing α and β particles moving with the same velocity is subjected to a magnetic field perpendicular to its direction of motion. The radius of circular path on which the α-particle move will be smaller than that of β-particle.

    and

    STATEMENT-2 : The mass of the α-particle is several orders of magnitude higher than that of β-particle and its magnitude of charge is two times that of β-particle.

20. STATEMENT-1 : An isolated radioactive atom may not decay at all whatever be its half life.

    and

    STATEMENT-2 : Radioactive decay is a statistical phenomenon.

21. STATEMENT-1 : The work done by gravity in bringing a body down from the top to the base along a frictionless inclined plane is the same as the work-done in bringing it down along a vertical side.

    and

    STATEMENT-2 : The gravitational force on the body on the inclined plane is in the same direction as that along the vertical side.

22. STATEMENT-1 : The pressure exerted by a gas is independent of the size of the molecules.

    and

    STATEMENT-2 : Molecular collision will invariably change the velocities of individual molecules but the number of molecules having any particular velocity will remain unaltered.

23. STATEMENT-1 : Friction force on a body moving on an inclined surface may be half the limiting friction.

    and

    STATEMENT-2 : In rolling motion on inclined plane, friction is static.

24. STATEMENT-1 : When white light passes through a prism then deviation of red light is less than that of violet.

    and

    STATEMENT-2 : Wavelength of red light is greater than that of violet.

25. STATEMENT-1 : During a quasi-static isothermal compression of copper, work done exceeds the heat liberated.

    and

    STATEMENT-2 : The internal energy of a thermodynamic system depends on volume besides temperature when the atoms of the system are held together by strong forces.

26. STATEMENT-1 : Dielectric breakdown may occur under the influence of an intense light beam.

    and

    STATEMENT-2 : Electromagnetic radiation exerts pressure.

27. STATEMENT-1 : Fragments produced in the fission of U^{235} are β-active.

    and

    STATEMENT-2 : The fragments have abnormally high proton to neutron ratio.

28. STATEMENT-1 : The magnetic flux through a closed surface can't be non-zero.

    and

    STATEMENT-2 : Gauss law applies in the case of electric flux only.

29. STATEMENT-1 : In a stationary wave there is no transfer of energy from one region to other.

    and

    STATEMENT-2 : Nodes in stationary wave don't allow transfer of energy.

30. STATEMENT-1 : A changing electric-field produces a magnetic field.

    and

    STATEMENT-2 : A changing magnetic-field produces an electric field.

31. STATEMENT-1 : Isotopes of an element can be separated using a mass-spectrometer.

    and

    STATEMENT-2 : Separation of isotopes is possible becuase of the difference in electron numbers of isotopes.

32. STATEMENT-1 : Gauge pressure may be negative.

    and

    STATEMENT-2 : Atmospheric pressure may decrease with factors such as with height.

33. STATEMENT-1 : The shape of an automobile is so designed that it resembles the streamline pattern of the fluid through which it moves.

    and

    STATEMENT-2 : Resistance offered by fluid is proportional to v^2.

34. STATEMENT-1 : When two vibrating tuning forks having frequencies 256 Hz and 512 Hz are held near each other beats cannot be heard.

    and

    STATEMENT-2 : The principle of super position is valid only if the frequencies of the oscillators are nearly equal.

35. STATEMENT-1 : Resonance is a special case of forced vibration in which the natural frequency of vibration of the body is the same as impressed frequency and the amplitude of forced vibration is maximum.

    and

    STATEMENT-2 : The amplitude of forced vibrations of a body increases with the increase in the frequency of the externally impressed periodic force.

36. STATEMENT-1 : A single lens produces a coloured image of an object illuminated by white light.

    and

    STATEMENT-2 : The refractive index of the material of lens is different for different wavelengths of light.

37. STATEMENT-1 : At room temperature ice does not sublimate from ice to steam.

    and

    STATEMENT-2 : The critical point of water is much above the room temperature.

38. STATEMENT-1 : It is not possible for a system, unaided by an external agency to transfer heat from a body at a lower temperature to another at a higher temperature.

    and

    STATEMENT-2 : It cannot violate the second law of thermodynamics.

39. STATEMENT-1 : In the absence of an externally applied electric field, the dipole moment per unit volume of a polar dielectric material is always zero.

    and

    STATEMENT-2 : In polar dielectrics each molecule has a permanent dipole moment but these are randomly oriented in the absence of an externally applied electric field.

40. STATEMENT-1 : If a heavy nucleus is split into two medium sized ones, each of the new nuclei will have more binding energy per nucleon than the original nucleus.

    and

    STATEMENT-2 : Joining two light nuclei together to give a single nucleus of medium size means more binding energy per nucleon in the new nucleus.

41. STATEMENT-1 : In the process of nuclear fission, the fragments emit two or three neutrons as soon as they are formed and subsequently emit β-particles.

    and

    STATEMENT-2 : As the fragments contain an excess of neutrons over protons, emission of neutrons and β-particles bring their neutron/proton ratio to stable values.

42. STATEMENT-1 : The energy gap between the valence band and conduction band is greater in silicon than in germanium.

    and

    STATEMENT-2 : Thermal energy produces fewer minority carriers in silicon than in germanium.

43. STATEMENT-1 : The shape of a liquid drop is spherical.

    and

    STATEMENT-2 : The pressure inside the drop is greater than that of outside.

44. STATEMENT-1 : A particle takes time $\frac{T}{12}$ in going from mean position to position mid-way between mean and extreme position. (T = Time period).

    and

    STATEMENT-2 : It is $\frac{1}{12}$th oscillation.

45. STATEMENT-1 : Angular momentum of a particle executing uniform circular motion is constant.

    and

    STATEMENT-2 : Momentum of a particle executing uniform circular motion is constant.

46. STATEMENT-1 : At cryogenic temperatures, the electrical resistivity in metallic conductors diminishes.

    and

    STATEMENT-2 : Thermal oscillations of atoms which hinder motion of free electrons under the influence of an external field become insignificant.

47. STATEMENT-1 : Molar specific heat of a gas may be negative.

    and

    STATEMENT-2 : Energy of gas may decrease on supplying energy, in a process.

48. STATEMENT-1 : In a tangent galvanometer, the suspended magnet is made as small as possible.

    and

    STATEMENT-2 : The needle being at centre of the coil, the deflections are uniform.

49. STATEMENT-1 : An electron microscope can achieve better resolving power than an optical microscope.

    and

    STATEMENT-2 : The de Broglie wavelength of the electrons emitted from an electron gun is much less than 500 nm.

50. STATEMENT-1 : Light nuclei having equal number of protons and neutrons are more stable.

    and

    STATEMENT-2 : In heavy nuclei, there is an excess of neutrons due to coulomb repulsion between protons.

51. STATEMENT-1 : In adiabatic expansion, temperature of gas must decrease.

    and

    STATEMENT-2 : Propagation of sound in air is adiabatic in nature.

52. STATEMENT-1 : At a fixed temperature, silicon will have a minimum conductivity when it has a smaller acceptor doping.

    and

    STATEMENT-2 : The conductivity of an intrinsic semiconductor is slightly higher than that of a lightly doped p-type.

53. STATEMENT-1 : Magnetic forces do not do any work.

    and

    STATEMENT-2 : Energy content of magnetic field region can't change with time.

54. STATEMENT-1 : $\frac{e}{m}$ of accelerating beta particles is not constant.

    and

    STATEMENT-2 : Velocities of beta particles are quite high and are comparable to the velocity of light.

55. STATEMENT-1 : In Compton effect, the scattered photon has more energy than the incident photon.

    and

    STATEMENT-2 : Energy and momentum are conserved during the scattering of a photon by an electron.

56. STATEMENT-1 : When a sound wave propagates through air, the displacements take place in the direction of propagation.

    and

    STATEMENT-2 : Sound waves can be polarized as in the case of light rays.

57. STATEMENT-1 : A large convex lens may suffer from chromatic aberration.

    and

    STATEMENT-2 : All parallel rays passing through a large convex lens may not focus at a single point.

58. STATEMENT-1 : Mechanical energy of the system under central force is constant.

    and

    STATEMENT-2 : Inverse square law force is conservative.

59. STATEMENT-1 : Sound wave cannot be polarised.

and

STATEMENT-2 : Polarisation is shown by transverse wave only.

60. STATEMENT-1 : The upper surface of the wings of an aeroplane is made convex and the lower surface is made concave.

and

STATEMENT-2 : The air currents at the top have a smaller velocity and thus less pressure at the bottom than at the top.

61. STATEMENT-1 : All the rain drops hit the surface of the earth with the same constant velocity.

and

STATEMENT-2 : An object falling through a viscous medium eventually attains a terminal velocity.

62. STATEMENT-1 : Experimental results indicate that the molar specific heat of hydrogen gas at costant volume below 50 K is equal to $\frac{3}{2}R$ where R is the universal gas constant.

and

STATEMENT-2 : Below 50 K diatomic hydrogen molecule possesses only three translational degree of freedom and rotational motion freezes.

63. STATEMENT-1 : Light is electromagnetic in nature.

and

STATEMENT-2 : Magnetic and electric fields propagate with speed of light.

64. STATEMENT-1 : With the help of a reversible engine it is possible to extract heat from a source and convert all of it into mechanical work.

and

STATEMENT-2 : Internal energy of source is converted into mechanical energy in a heat engine.

65. STATEMENT-1 : Photoelectric effect can take place only with an electron bound in the atom.

and

STATEMENT-2 : Electron is a ferminon where as proton is a boson.

66. STATEMENT-1 : Fission of ${}^{235}_{92}U$ is brought about by a thermal neutron, where as that of ${}^{238}_{92}U$ is brought about by a fast neutron.

and

STATEMENT-2 : ${}^{235}_{92}U$ is an even-odd nucleus, whereas ${}^{238}_{92}U$ is an even-even nucleus.

67. STATEMENT-1 : In the arrangement of Helmholtz coils, second derivative of magnetic field with respect to position is zero in region mid way between the coils.

and

STATEMENT-2 : Magnetic field in the mid way region is uniform.

68. STATEMENT-1 : The lines of magnetic field ($\vec{B}$ vector) are always closed curves and they surround, the conductors carrying current that set up the field.

and

STATEMENT-2 : The poles (a source or a sink) of magnetic flux are absent.

69. STATEMENT-1 : A temperature gradient (positive or negative) occurs between the two junctions of a thermocouple. When current is passed through it.

and

STATEMENT-2 : Free electron density is different in different metals.

70. STATEMENT-1 : Electron capture process is followed by emission of characteristic X-rays.

and

STATEMENT-2 : Gamma ray photon emitted by excited nucleus after electron capture, subsequently ejects electron from K or L shell.

71. STATEMENT-1 : Cadmium is used as control rod material in a nuclear reactor.

and

STATEMENT-2 : The isotope Cd-113 constitute about 12% of natural cadmium.

72. STATEMENT-1 : The apparent weight of a person standing in a lift, which moves upwards with uniform acceleration is always higher than his true weight.

and

STATEMENT-2 : The weight always acts downwards.

73. STATEMENT-1 : Coefficient of viscosity of a liquid decreases while that of a gas increases with rise in temperature.

and

STATEMENT-2 : Density of a liquid and that of a gas vary in opposite manner with increase in temperature.

74. STATEMENT-1 : Two metallic spheres of same size, one of copper and the other of aluminium, heated to the same temperature, will cool at the same rate when they are suspended in same enclosure.

    and

    STATEMENT-2 : For small temperature difference with surroundings. The rate of cooling of a body is directly proportional to the excess of temperature of the body over the surroundings.

75. STATEMENT-1 : On a rotating object, all particle have acceleration directed towards axis.

    and

    STATEMENT-2 : All particles on a rotating body are moving on circle.

76. STATEMENT-1 : The impendence of a parallel *LCR* circuit is minimum at resonance.

    and

    STATEMENT-2 : In an a.c. circuit resonance occurs when the inductive reactance is exactly equal to the capacitative reactance.

77. STATEMENT-1 : While travelling through air, sound waves, from two different sources pass through each other without being destroyed.

    and

    STATEMENT-2 : The frequency of simple harmonic waves is independent of their amplitude.

78. STATEMENT-1 : A skater brings his hand closer to his body to spin faster.

    and

    STATEMENT-2 : Only then his moment of inertia will decrease and angular velocity will increase.

79. STATEMENT-1 : The pressure of air inside a small soap bubble is greater than the pressure of air inside a large bubble.

    and

    STATEMENT-2 : The excess pressure of air is inversely proportional to the surface area of the bubble.

80. STATEMENT-1 : If a compass needle be kept at magnetic north pole of the earth, the compass needle may stay in any direction.

    and

    STATEMENT-2 : Dip needle will stay vertical at the north pole of earth.

81. STATEMENT-1 : A body can have acceleration even if its velocity is zero at a given instant of time.

    and

    STATEMENT-2 : A body momentarily at rest when it reverses its direction of motion.

82. STATEMENT-1 : Radio waves can be polarised.

    and

    STATEMENT-2 : Sound waves in air are longitudinal in nature.

83. STATEMENT-1 : In series LCR circuit resonance can take place.

    and

    STATEMENT-2 : Resonance takes place if inductive and capacitive, reactances are equal and opposite.

84. STATEMENT-1 : If the half-life of a radioactive substance is 40 days then 25% substance decays in 20 days.

    and

    STATEMENT-2 : $N_t = N_0\left(\frac{1}{2}\right)^{\eta}$, where $\eta = \frac{\text{time elapsed}}{\text{half - life period}}$.

85. STATEMENT-1 : A body with constant acceleration always moves along a straight line.

    and

    STATEMENT-2 : A body with constant acceleration may not speed up.

86. STATEMENT-1 : Melting of solid causes no change in internal energy.

    and

    STATEMENT-2 : Latent heat is the heat required to melt a unit mass of solid.

87. STATEMENT-1 : Different colours travel with different speed in vacuum.

    and

    STATEMENT-2 : Wavelength of light depends on refractive index of medium.

88. STATEMENT-1 : Cyclotron is not used to accelerate electron.

    and

    STATEMENT-2 : Mass of the electron is very small.

89. STATEMENT-1 : The average speed of an object may be equal to arithmetic mean of initial and final speeds.

    and

    STATEMENT-2 : Average speeds is equal to total distance travelled per total time taken.

90. STATEMENT-1 : A spaceship while entering the earth's atmosphere is likely to catch fire.

    and

    STATEMENT-2 : The temperature of upper atmosphere is very high.

91. STATEMENT-1 : A balloon filled with hydrogen will fall with acceleration $\frac{g}{6}$ on the moon.

    and

    STATEMENT-2 : Moon has no atmosphere.

92. STATEMENT-1 : For monoatomic gas atom the number of degrees of freedom is 3.

    and

    STATEMENT-2 : Rotational motion of monoatomic molecules is not possible.

93. STATEMENT-1 : A tunning fork is in resonance with a closed pipe. But the same tunning fork cannot be in resonance with an open pipe of the same length.

    and

    STATEMENT-2 : The same tunning fork will not be in resonance with open pipe of same length due to end correction of pipe.

94. STATEMENT-1 : The refractive index of diamond is $\sqrt{6}$ and that of liquid is $\sqrt{3}$. If the light travels from diamond to the liquid it will be totally reflected when the angle of incidence is 30°.

    and

    STATEMENT-2 : $n = \frac{1}{\sin c}$, where n is the refractive index of diamond with respect to liquid c is the critical angle.

95. STATEMENT-1 : The setting sun appears to be red.

    and

    STATEMENT-2 : Scattering of light is directly proportional to the wavelength.

96. STATEMENT-1 : If the speed of charged particle increases both the mass as well as charge increases.

    and

    STATEMENT-2 : If m_0 be rest mass and m the mass at velocity v then $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$ where c = speed of light.

97. STATEMENT-1 : Mass of moving photon varies inversely as the wavelength.

    and

    STATEMENT-2 : Energy of the particle = mass × (speed of light)^2.

98. STATEMENT-1 : A rocket moves upward by pushing burnt fuel backwards.

    and

    STATEMENT-2 : It derives necessary thrust to move forward according to Newton's law of motion.

99. STATEMENT-1 : In adiabatic compression, the internal energy and temperature of the system get decreased.

    and

    STATEMENT-2 : Practically adiabatic compression is a fast process.

100. STATEMENT-1 : In Young's experiment, when white light is used the fringe width for dark fringes is different from that for white fringes.

    and

    STATEMENT-2 : In Young's double slit experiment when the fringes are performed with a source of monochromatic light then only black and bright fringes are observed.

101. STATEMENT-1 : The isothermal curves do not intersect each other.

    and

    STATEMENT-2 : If an isothermal curve and an adiabatic curve intersect at a point then at point of intersection adiabatic curve is more steeper than isothermal curve.

102. STATEMENT-1 : Blue colour of sky appears due to scattering of blue colour.

    and

    STATEMENT-2 : Blue colour has shortest wavelength in visible spectrum.

103. STATEMENT-1 : X-rays travel with the speed of light.

and

STATEMENT-2 : X-rays are electromagnetic rays.

104. STATEMENT-1 : When the speed of an electron increases, its specific charge decreases.

and

STATEMENT-2 : Specific charge is the ratio of charge to mass.

105. STATEMENT-1 : Coloured spectrum is seen when we look through a **muslin** cloth.

and

STATEMENT-2 : It is due to the diffraction of white light on passing through fine slits.

106. STATEMENT-1 : When a tiny circular obstacle is placed in the path of light from some distance a bright spot is seen at the centre of shadow of the obstacle.

and

STATEMENT-2 : Distructive interference occurs at the centre of the shadow.

107. STATEMENT-1 : The quantity $\frac{L}{R}$ possesses dimension of time.

and

STATEMENT-2 : To reduce the rate of increase of current through a solenoid, we should increase the time constant $\left(\frac{L}{R}\right)$.

108. STATEMENT-1 : Stress is the internal force per unit area of a body.

and

STATEMENT-2 : Rubber is more elastic than steel.

109. STATEMENT-1 : Faraday's second law is a consequence of conservation of energy.

and

STATEMENT-2 : In a purely resistive AC circuit, the current lags behind emf.

110. STATEMENT-1 : The internal energy of an ideal gas does not change during an isothermal process.

and

STATEMENT-2 : The decrease in volume of a gas is compensated by a corresponding increase in pressure when its temperature is kept constant.

111. STATEMENT-1 : If a porter carries a luggage of 30 kg from the waiting room of a railway station to the platform and bring it back to the waiting room the work done by him is zero.

and

STATEMENT-2 : Work done is defined as the scalar product of force applied and the displacement vector which in this case is zero.

112. STATEMENT-1 : To drink, chilled juice, we use ice cubes at 0°C instead of cold water at 0°C.

and

STATEMENT-2 : Ice tends to absorb heat from the juice for its melting, this makes the juice cooler.

113. STATEMENT-1 : Small liquid drops tend to be spherical whereas large drops tend to be flat.

and

STATEMENT-2 : Force of gravity is more in case of big drop.

114. STATEMENT-1 : Bubbles of air rise through a large water column with constant speed.

and

STATEMENT-2 : Density of water is greater than that of bubbles, and the terminal velocity is directed upwards.

115. STATEMENT-1 : The Bohr model of the hydrogen atom does not explain the fine structure of spectral lines.

and

STATEMENT-2 : The Bohr model does not take into account the spin of electron.

116. STATEMENT-1 : On a glass plate of refractive index 1.5 when an unpolarised beam is incident at angle of incidence 56.3°, the reflected beam is plane polarised.

and

STATEMENT-2 : The glass absorbs the ordinary ray and reflects only the extra-ordinary ray.

117. STATEMENT-1 : The acceleration due to gravity on the moon is about one sixth of that on the surface of the earth.

and

STATEMENT-2 : The mass of the moon is only about $\frac{1}{80}$ of the mass of the earth, and radius of the moon is only about $\frac{7}{26}$ that of the earth.

118. STATEMENT-1 : If the rocket motor is turned off, the rocket immediately stops ascending.

and

STATEMENT-2 : There is no force of propulsion after turning off.

119. STATEMENT-1 : Gravitational potential energy is not an absolute quantity.

and

STATEMENT-2 : Change in gravitational potential energy depends on reference.

120. STATEMENT-1 : A laser beam does not undergo any increase in diameter even at very large distances.

and

STATEMENT-2 : It is monochromatic coherent beam.

121. STATEMENT-1 : Ice floats in water.

and

STATEMENT-2 : With only four nearest neighbours around each molecule, ice crystals have extremely open structure and water molecules on the average are packed more closely than the ice molecules.

122. STATEMENT-1 : Two separate sources of light giving out light of the same frequency do not show interference.

and

STATEMENT-2 : The amplitude of the waves from the sources are not equal.

123. STATEMENT-1 : When a rocket carrying a spacecraft is fired to lift the spacecraft away from the earth. A man inside the spacecraft would feel weightless.

and

STATEMENT-2 : Effective gravity in a space craft accelerating upwards is different from g.

124. STATEMENT-1 : In a stationary wave, all the particles between two adjacent nodes vibrate in phase.

and

STATEMENT-2 : Particles on opposite side of a node vibrate with a phase difference of π.

125. STATEMENT-1 : Electric field lines may form closed loops.

and

STATEMENT-2 : Electric field may be non-conservative in nature.

126. STATEMENT-1 : To a person on a moving train who observes through a window a second train moving faster on a close parallel track in the same direction, it appears that his own train moves backward.

and

STATEMENT-2 : There is no absolute motion for any object.

127. STATEMENT-1 : An object can be projected from a given point in any direction with a given speed so as to have the same horizontal range on the ground.

and

STATEMENT-2 : Earth attracts every object with an inverse square law force.

128. STATEMENT-1 : When an object moves through air at a velocity greater than that of sound, it produces shock waves.

and

STATEMENT-2 : Ultrasonic waves cause great pressure disturbances in air.

129. STATEMENT-1 : Newton's law of motion do not hold true in an accelerated frame of reference.

and

STATEMENT-2 : No force can act in an accelerated frame.

130. STATEMENT-1 : Entropy measures the degree of disorder in a physical system.

and

STATEMENT-2 : Reversible adiabatic process are isentropic.

131. STATEMENT-1 : There is no electric field inside a charged closed hollow conductor.

and

STATEMENT-2 : Gauss's law is only applicable for a closed surface.

132. STATEMENT-1 : Planets in a solar system move in fixed elliptical orbits around the sun.

and

STATEMENT-2 : Gravitational force between two objects is a central force.

133. STATEMENT-1 : Real gases do not strictly obey the ideal gas equation.

and

STATEMENT-2 : Molecules of a gas have finite radii and exert force on one another.

134. STATEMENT-1 : Parallel electrical wires carrying currents attract or repel each other.

and

STATEMENT-2 : Electrons in metals are free and are responsible for the high conductivity of the metals.

135. STATEMENT-1 : The optics of waves and satisfactory explanation of propagation of light in media demonstrate the wave theory of light.

and

STATEMENT-2 : Maxwell's equations establish the relations between the electrical and magnetic field vectors in an electromagnetic field.

136. STATEMENT-1 : The beta particles in beta decay of a nucleus are identical to electrons. It demonstrates the presence of electrons within the nuclei of atoms.

and

STATEMENT-2 : Electrons cannot be localised within even the target nuclei becuase of the uncertainty principle.

137. STATEMENT-1 : No external condition, like temperature or pressure or chemical reaction has any effect on the rate of decay of a radioactive atom.

and

STATEMENT-2 : Radioactivity is a spontaneous process.

138. STATEMENT-1 : Laser beams produce highly powerful and well-directed radiations.

and

STATEMENT-2 : Atoms in the excited states, emit radiation when they return to the ground state.

139. STATEMENT-1 : When a ball is thrown vertically upward while there is air resistance, the time taken for the downward journey is greater than that for the upward journey.

and

STATEMENT-2 : The air resistance is greater during the downward journey.

140. STATEMENT-1 : In travelling through the same horizontal distance, the electron in a beam from an electron gun does not fall as much owing to gravity as a water droplet in a jet of water.

and

STATEMENT-2 : The horizontal velocity of an electron from electron gun is generally very large.

141. STATEMENT-1 : For Thomson's $\frac{e}{m}$ experiment to work properly, it is essential that the electrons have a fairly constant speed.

and

STATEMENT-2 : The magnetic force depends on the velocity of the electrons.

142. STATEMENT-1 : In YDSE, on introduction of glass slab in front of one of the slits, fringe pattern shifts.

and

STATEMENT-2 : While passing through slab, frequency of wave changes.

143. STATEMENT-1 : A capillary dropped in a liquid shows a rise of liquid to some height. When the temperature of the liquid is raised, the height of the liquid in the capillary will decrease.

and

STATEMENT-2 : The capillary undergoes thermal expansion.

144. STATEMENT-1 : The white light incident on and emerging from the prism will form a spectrum of colours.

and

STATEMENT-2 : For different colours, glass has different refractive indices.

145. STATEMENT-1 : Two long parallel conductors carrying currents in the same direction experience a force of attraction.

and

STATEMENT-2 : The magnetic fields produced in the space between them are in the opposite direction.

146. STATEMENT-1 : A large soap bubble expands while a small bubble shrinks, when they are connected to each other by a capillary tube.

and

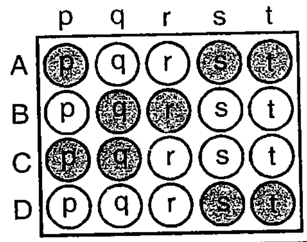
STATEMENT-2 : The excess pressure (due to surface tension) inside a spherical bubble increases as its volume decreases.

SECTION - E

Matrix-Match Type

This section contains 28 questions. Each question contains statements given in two columns which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **One OR More** statement(s) in **Column II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example :

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.



1. Match the following

Column I		Column II
(A) The escape velocity on the moon's surface	(p)	11.2 km/s
(B) The escape velocity on the earth surface	(q)	2.5 km/s
(C) Total energy of a closed system with usual reference level	(r)	Positive
(D) Total kinetic energy of a closed system	(s)	Negative
	(t)	$\sqrt{\frac{2GM}{R}}$

2. Match the following

Column I

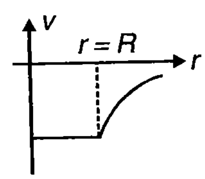
(A) Gravitational potential versus distance (from centre) graph for a spherical shell

(B) Gravitational potential versus distance (from centre) graph for solid sphere

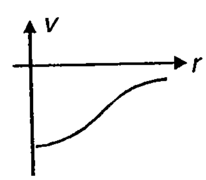
(C) Gravitational potential versus distance (from centre) graph for ring

Column II

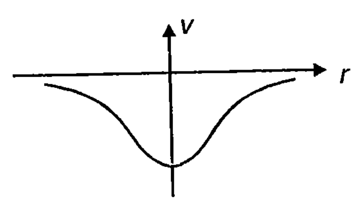
(p)



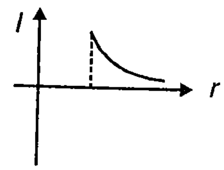
(q)



(r)



(D) Gravitational field versus distance graph for spherical shell

(s) 

(t) Is continuous

3. Match the following

Column I

(A) Unit of rate of heat flow will remain same if

(B) Unit of thermal conductivity will if

(C) Unit of thermal resistance will get half if

(D) Unit of temperature gradient will remain same if

Column II

(p) Unit of mass is doubled

(q) Unit of length is doubled

(r) Unit of temperature is doubled

(s) Unit of time is doubled

(t) Unit of mass is halved

4. Match the following

Column I

(A) Majority heat transfer in liquid (heated from bottom)

(B) Majority heat transfer in mercury

(C) Majority heat transfer in gases (heated from top)

(D) Majority heat transfer in liquid (heated from top)

Column II

(p) Convection

(q) Conduction

(r) Conduction/convection

(s) Radiation

(t) Depends on local medium density

5. Match the following

Column I

(A) Unit of stress

(B) Unit of coefficient of viscosity

(C) Unit of velocity gradient

(D) Unit of pressure

Column II

(p) N/m^2

(q) J/m^3

(r) Pa - s

(s) Will remain same when unit both mass and length is doubled

(t) Unit will remain same if that of length is doubled

6. Match the following

Column I

(A) A block weighs 15 N in air and 12 N. When immersed in water. The specific gravity of the block is

(B) Two identical drops of water are falling through air with a steady velocity 2 m/s. If the drops coalesce, the new velocity will be ____ m/s

Column II

(p) $2^{5/3}$

(q) 12

(C) A thick shell looses half its weight in water. Relative density of shell is 5.0. What fraction of its volume is hollow? (r) 3/5

(D) A balloon has volume of 10 m^3. It is filled with hydrogen ($\rho = 0.09$ g/l). If the density of air is 1.29 g/l, it can lift a total weight of ____ kg. (s) 5

(t) > 1

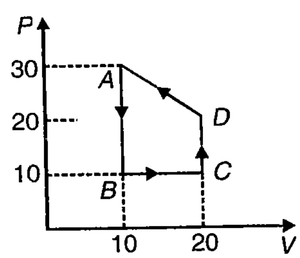
7. Match the following

Column I	Column II
(A) The ratio of amplitude of wave is 2 : 1. The ratio of maximum and minimum intensity on superposition	(p) 1 : 4
(B) The intensity ratio of the waves is 1 : 16. The ratio of their amplitudes	(q) 9 : 1
(C) The minimum audible wavelength at room temperature	(r) 5×10^{-7} m
(D) The wavelength of ultrasonic waves in air is of the order of	(s) 20×10^{-3} m
	(t) Same dimension as that of strain

8. Match the following

Column I	Column II
(A) Ratio of consecutive overtones is 2 : 3 : 4	(p) Open organ pipe
(B) Ratio of consecutive overtones is 3 : 5 : 7	(q) String vibration
(C) Ratio of consecutive harmonics is 1 : 3 : 5	(r) Closed organ pipe at one end
(D) All even and odd harmonics are present	(s) Sonometer
	(t) Resonance tube

9. The figure shows a cylic process *ABCDA*.



Column I	Column II
(A) *AB*	(p) $\Delta W < 0$
(B) *BC*	(q) $Q > 0$
(C) *CD*	(r) $\Delta W > 0$
(D) *DA*	(s) $Q < 0$
	(t) $\Delta U > 0$

10. Match the Column-I and Column-II

Column I	Column II
(A) Angular magnification of telescope	(p) Dispersion of lens
(B) Sharpness of the image	(q) f_0 and f_e
(C) Light gathering power	(r) Aperature of lens
(D) Length of the telescope	(s) Spherical aberration
	(t) Electron efected from the nucleus

11. Match the Column-I and Column-II

Column I	Column II
(A) Nuclear fusion	(p) Converts some amount of matter into energy
(B) Nuclear fission	(q) For atoms with high atomic number
(C) β-decay	(r) For atoms with low atomic number
(D) Exothermic nuclear reaction	(s) Weak nuclear forces
	(t) Neutrino or antineutrino is emitted

12. Which of the effect (s) given in column-II will be produced by a loop mentioned in column-I?

Column I	Column II
(A) Stationary dielectric ring having uniform charge	(p) Electric field
(B) Dielectric ring having uniform charge rotating with constant angular velocity	(q) Magnetic field
(C) A copper loop carrying constant current I_0	(r) Outside the loop time dependent induced electric field
(D) Copper loop having time varying current $I = I_0 \cos\omega t$	(s) Magnetic moment in the loop
	(t) Gravitational field

13. On a vector diagram, show a pair of vectors $\vec{d}$ and $\vec{e}$ such that as mentioned in column-I they could match with the cases mentioned in column-II. Mark the correct matches

Column I	Column II
(A) $\vec{d}+\vec{e}=\vec{f}$, $f=d-e$	(p) $\vec{d}, \vec{e}$ are aligned antiparallel
(B) $\vec{d}+\vec{e}=\vec{f}$, $f=d+e$	(q) $\vec{d}, \vec{e}$ are aligned parallel
(C) $\vec{d}-\vec{e}=\vec{f}$, $f=d+e$	(r) $\vec{d}, \vec{e}$ are aligned at 90°
(D) $\vec{d}+\vec{e}=\vec{f}$, $f=d\sqrt{2}$, $d=e$	(s) $\vec{d}, \vec{e}$ are aligned at 270°
	(t) All $\vec{d}, \vec{e}$ and $\vec{f}$ are in same direction

14. A particle start moving along x-axis from origin. Its position is given by $x = 20t - t^2$

Column I	Column II
(A) Average velocity of the particle is zero from $t = 0$, to $t = t_1$	(p) For only value t_1
(B) Speed of the particle is 10 unit at $t = t_1$	(q) For three values of t_1
(C) Magnitude of displacement of the particle from origin is 50 unit at $t = t_1$	(r) For two values t_1
(D) Magnitude of average acceleration of the particle from $t = 0$ to $t = t_1$ is 2 unit	(s) For only one value of t_1
	(t) $t = 15$ s

15. A block of mass m is resting on a rough inclined plane making angle θf from horizontal. If $\overline{N}$ represents the normal force, $\bar{f}$ represent friction force, and $\overline{F}$ represent net centaent force then match the entries in is **Column-I** and **Column-II**

Column I	**Column II**
(A) N	(p) $\|\overline{N}+\overline{W}\|$
(B) f	(q) $\|\overline{W}+\bar{f}\|$
(C) $mg\cos\theta$	(r) mg
(D) $\|\overline{N}+\bar{f}\|$	(s) $\dfrac{mg}{\sin\theta+\mu\cos\theta}$
	(t) $N\tan\theta$

16. Match the Column-I and Column-II

Column I	**Column II**
(A) Transition between two atomic energy level	(p) Characteristic X-rays
(B) Electron emission from a material	(q) Photoelectric effect
(C) Mosley's law	(r) Hydrogen spectrum
(D) Change of photon energy into kinetic energy of electrons	(s) β-decay
	(t) Frequency of X-ray spectrum line depends on the atomic number

17. Match the Column-I and Column-II

Column I	**Column II**
(A) A charged capacitor is connected to the ends of the wire	(p) A constant current flows through the wire
(B) The wire is moved perpendicular to its length with a constant velocity in a uniform magnetic field perpendicular to the plane of motion	(q) Thermal energy is generated in the wire
(C) The wire is placed in a constant electric field that has a direction along the length of the wire	(r) A constant potential difference develops between the the ends of the wire
(D) A battery of constant emf is connected to the ends of the wire	(s) Charge of constant magnitude appear at the ends of the wire
	(t) Motional e.m.f. is developed

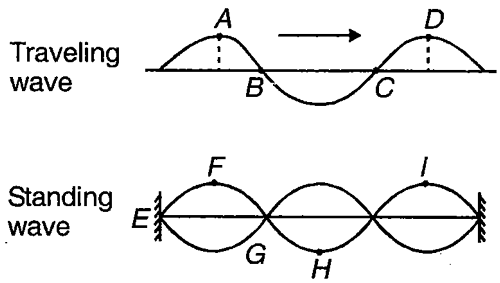
18. Match the Column-I and Column-II

Column I	**Column II**
(A) Bimetallic strip	(p) Radiation from hot body
(B) Steam engine	(q) First law of thermodynamics
(C) Incandescent lamp	(r) Melting
(D) Electric fuse	(s) Thermal expansion of solids
	(t) Low resistance

19. Match the following

Column I	Column II
(A) $y = a \sin (kx - \omega t)$	(p) Standing wave
(B) $y = a \sin kx.\cos\omega t$	(q) Travelling wave
(C) $y = a \sin(kx + \omega t)$	(r) Travelling in + ve x direction
(D) $\Delta x = a \sin (kx - \omega t)$	(s) Longitudinal wave
	(t) Transverse wave

20. Figure shows travelling wave and stationary waves



Match the following

Column I	Column II
(A) Particles in the same phase	(p) F & I
(B) Particles in the opposite phase	(q) A & D
(C) Particles with same amplitude	(r) B & C
(D) Particles with opposite velocity	(s) F & H
	(t) H & I

21. Match the following

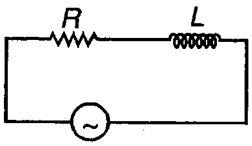
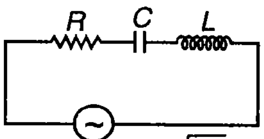
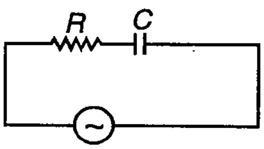
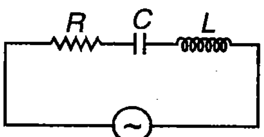
Column I	Column II
(A) Linear momentum of the system remains constant	(p) $\vec{a}_{CM} = 0$
(B) Kinetic energy of a system remains zero	(q) $\vec{V}_{CM} = 0$
(C) Center of mass of the system remains at rest	(r) $\vec{V}_{CM} \neq 0$
(D) Linear momentum of the system varies	(s) $\vec{F}_{ext} = 0$
	(t) $\vec{F}_{ext} \neq 0$

22. Match the following

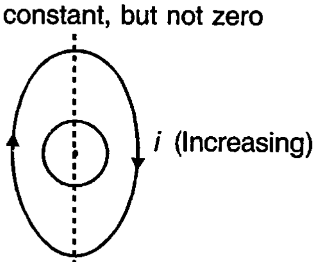
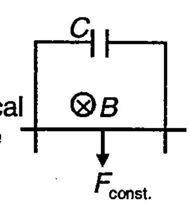
Column I	Column II
(A) On heating, iron first becomes dull red then reddish yellow	(p) Wein's displacement law
(B) A green glass heated in furnace when taken out in dark glows with red light	(q) Scattering
(C) We can find temperature of sun's surface by	(r) Kirchhoff's law
(D) Colour of sun is red at sunset	(s) Stefan's law
	(t) Wavelength shift

23. Some AC circuits are given below, i & V are current and voltage of circuit

Match the following

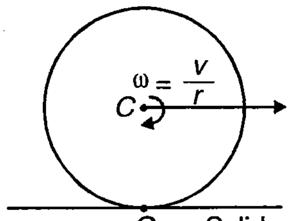
Column I	**Column II**
(A) 	(p) Current leads applied voltage
(B)  $\omega = \sqrt{\frac{1}{LC}}$	(q) Current lag behind applied voltage
(C) 	(r) Current and voltage are in same phase
(D)  $\omega > \frac{1}{\sqrt{LC}}$	(s) On increasing frequency of alternating emf, current decrease
	(t) Power factor is not equal to zero

24. Match the following

Column I	**Column II**
(A) Magnetic flux passing through the loop is maximum	(p) Magnetic flux is zero
(B) Magnetic flux passing through loop is constant, but not zero	(q) Induced emf is constant
(C)  Plane of loops are perpendicular	(r) Induced emf is zero
(D) Vertical plane 	(s) Induced emf is variable
	(t) Magnetic flux is non-zero

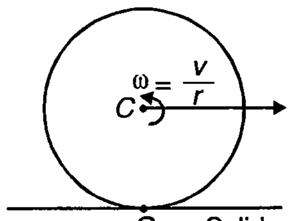
25. **Column-I** gives some physical situation and **Column-II** gives angular momentum about different point then match entries in **Column-I** with all possible entries in **Column-II**

Column I | **Column II**

(A) 

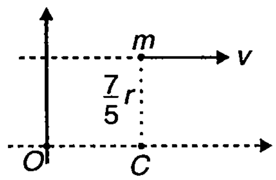
Solid sphere

(p) $L_0 = \frac{7}{5} mvr$

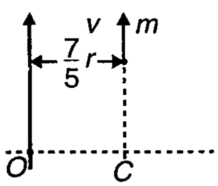
(B) 

Solid sphere

(q) $L_C = \frac{2}{5} mvr$

(C) 

(r) $.L_0 = L_C$

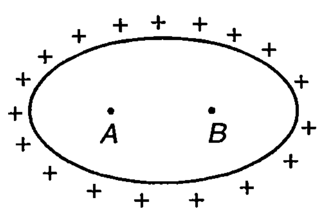
(D) 

(s) $L_0 = \frac{3}{5} mvr$

(t) $L_0 \neq L_C$

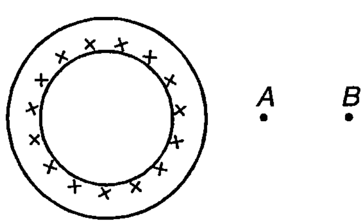
26. Column I gives some system of charged conductor and Column II gives possible value of electric field and potential then match the Columns. Match the following :

Column I | **Column II**

(A) 

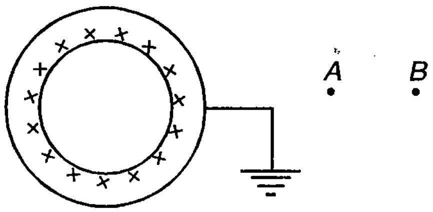
Solid conductor

(p) $E_A = E_B$

(B) 

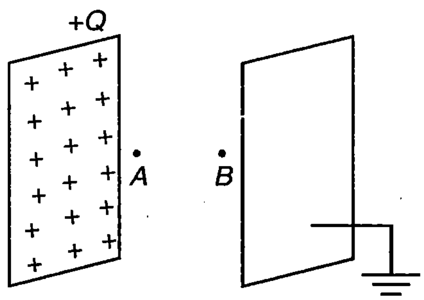
Two conducting shells
Inner is charged

(q) $E_A > E_B$

(C) 

Outer shell is earthed

(r) $V_A = V_B$

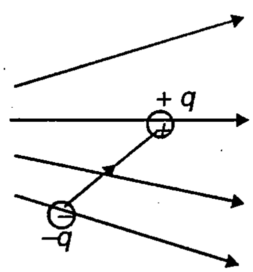
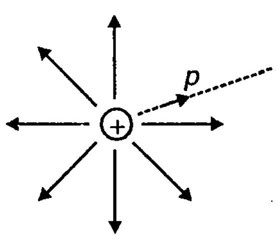
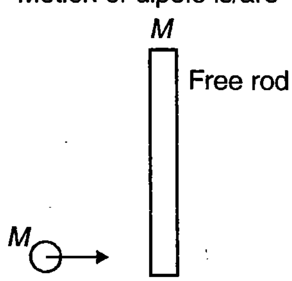
(D) 

Large plates placed close to each other

(s) $V_A > V_B$

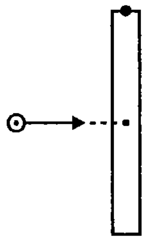
(t) E_A or E_B is equal to zero

27. Match the following

Column I	**Column II**
(A)  Motion of dipole is/are	(p) Rotational
(B)  Motion of dipole is/are	(q) Translational
(C)  Motion of rod after collision is/are	(r) We can apply conservation of $\vec{L}$ for system about only one point

A

The rod is hinged from A

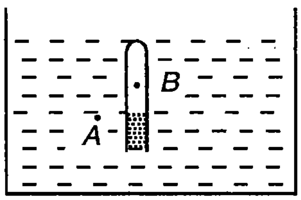
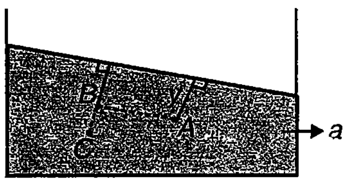
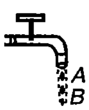
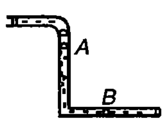
(D) 

Motion of rod after collision is/are

(s) We can apply conservation of linear momentum

(t) We can apply conservation of $\vec{L}$ for system about any point

28. Match the following

Column I	Column II
(A) 	(p) $P_A = P_B$
(B) 	(q) $P_A < P_B$
(C) 	(r) $P_A < P_C$
(D)  Assume area of streamline = area of tube	(s) Velocity at A < Velocity at B
	(t) Velocity of A = Velocity of B

❑ ❑ ❑

SECTION - F

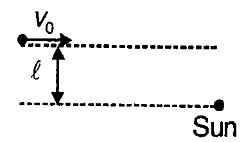
Subjective Type Questions

This section contains 105 subjective questions.

Solve the followings :

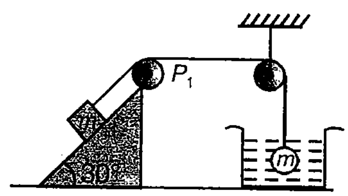
1. Two equal masses m and m are hung from a balance whose scale pans differ in vertical height by h. ($<< R$) Calculate the error in weighing, if any in terms of density of earth ρ.

2. A cosmic body A moves to the sun with velocity v_0 (when far from the sun) and aiming parameter l the arm of the vector v_0 relative to the centre of the sun as shown in figure. Find the minimum distance by which this body will get to the sun. [Let mass of sun is M_s).

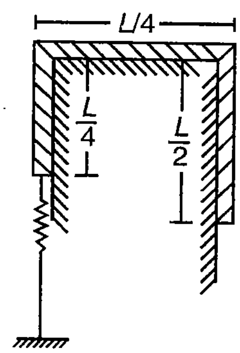


3. Find the temperature distribution in a substance placed between two parallel plates kept at temperature T_1 and T_2. The plate separation is equal to l, the heat conductivity coefficient of the substance $K \propto \sqrt{T}$.

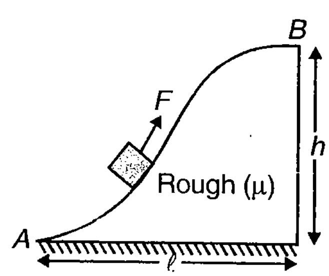
4. A block of mass 1 kg is kept on a light smooth wedge. Block is attached to a sphere of same mass through fixed massless pullies P_1 and P_2. Sphere is dipped inside water as shown. If specific gravity of material of sphere is 2. Find the acceleration of sphere.



5. A uniform rope of mass M and total length 'L' is placed on smooth table as shown in figure. At the given position the massless spring is at its natural length. If the system is released from rest at the given position such that maximum extension in the spring is $\frac{L}{4}$, then find the spring constant k.



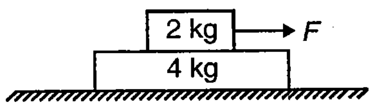
6. A body of mass m is slowly hauled up the hill by a force F which at each point is directed along a tangent to the trajectory. Find the work performed by this force in moving the body from A to B if the height of the surface is h, the length of its base is ℓ and the coefficient of friction between the body and the surface is given by $\mu = \tan\alpha$ where α is the angle between the normal force applied by the surface and the vertical.



7. A massless rigid rod of length 'L' is hinged at one end and a particle of mass 'm' is attached at the other end. The system is free to rotate in the vertical plane about the hinged point. When the rod is horizontal, the particle is given vertically upward velocity $v = \sqrt{2gL}$. Taking force applied by the rod on the particle towards centre as positive and assuming that rod will exert force only along its length, draw the graph of force (F) applied by the rod on the particle versus $\sin\theta$ (where θ is the angle rotated by the rod from the horizontal) for $0 \le \theta \le \frac{\pi}{2}$.

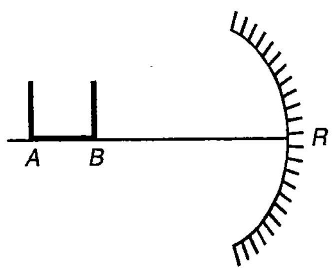
8. A block of mass 'm' moves on a horizontal circle against the wall of a cylindrical room of radius R. The floor of the room on which the block moves in smooth but the friction coefficient between the wall and the block is μ. The block is given an initial speed v_0. Find the power developed by the resultant force acting on the block as a function of distance travelled S.

9. A plank of mass 4 kg is placed on a smooth horizontal surface. A block of mass 2 kg is placed on the plank and is being acted upon a horizontal force $F = 0.5\ t$ where F is in Newton and t is in s. If the coefficient of friction between the block and the plank is 0.10 then find the velocity of 2 kg block at $t = 10$ s.



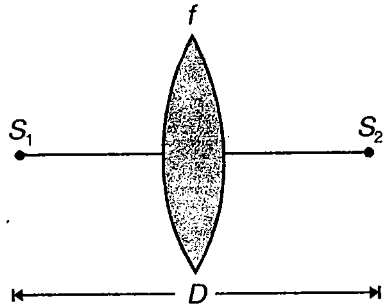
10. An ideal diatomic gas with $c_V = \frac{5R}{2}$ occupies a volume V_0 at a pressure P_0. The gas undergoes a process in which the pressure is proportional to the volume. A the end of the process, it is found that the r.m.s. speed of the gas molecules has doubled from its initial value. Determine the amount of heat absorbed by the gas in terms of p_0 and v_0.

11. A U-shaped wire is placed before a concave mirror of curvature R. One bend 'B' is at the centre of curvature as shown in figure. Separation between vertical limbs of the structure is R, where R is the radius of corvature of the mirror. Find the ratio of the lengths of the images of the nearer and the farther limbs.

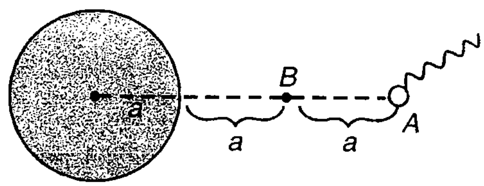


12. A sphere of photosensitive material is suspended with the help of a string from a fixed ceiling. If the mass of the sphere is m, find the strain developed in the wire. Given that Young's modulus of elasticity is Y and the cross-section is A. Now a radiation of wavelength $\frac{\lambda_0}{3}$ is incident on the sphere producing photoemission, λ_0 being the threshold wavelength. When electron cease to be emitted a constant electric field E_0 is switched on directed vertically downward. Find the change in the strain of the wire.

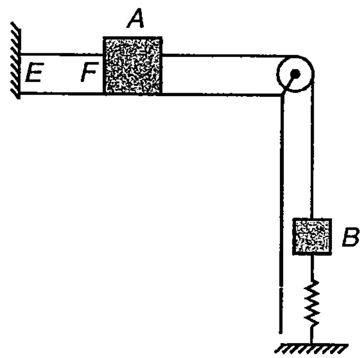
13. S_1 and S_2 are fixed sources with a separation D. A convex lens of focal length f is placed between them, such that the images of the sources formed, by the lens coincide. Find the distance of the lens from the source S_1 assuming the images are formed on the left side of the lens.



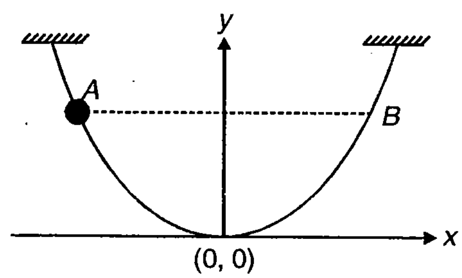
14. There is a sphere of radius 'a'. Positive charge is distributed throughout the sphere such that the charge density $\rho = \rho_0 r^2$ where ρ_0 is a constant and r is the distance from the centre of the sphere. At the point A, a piece of photosensitive material is placed. A radiation falls on it. Variation of electric field in the radiation is given as $E = E_0 \sin\frac{\pi}{\lambda}(ct - x)$. It is observed that most energetic photo electrons which happens to move towards the sphere, attains a K.E. just twice the initial kinetic energy when it reaches point B. What should be the threshold wave length for the photosensitive material?



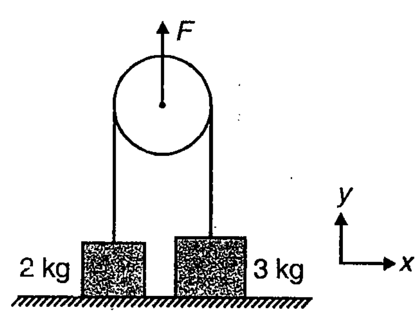
15. In the given figure, all the surfaces are smooth. The spring and string are massless. The mass of each block is 2 kg and spring constant is 100 N/m. In the given position, the spring is at its natural length. If the string EF is burnt, then find the maximum compression of the spring from its natural length.



16. A smooth parabolic wire track defined by the relation $y = \frac{x^2}{2a}$ is fixed in x-y plane in a gravity free space as shown in figure. An electric field $\vec{E} = \alpha y\hat{i} + \alpha x\hat{j}$ (where α is a positive constant) exists in the region. A small ring of mass 'm' and carrying charge $+q$, which just fits in wire track is released from rest at position $A\left(-a, \frac{a}{2}\right)$. As it reaches to position $B\left(a, \frac{a}{2}\right)$, find the speed of the ring.



17. In the given figure surface of massless pulley is smooth. The string is massless. The two blocks of 2 kg and 3 kg are placed on a smooth horizontal surface. A time dependent vertical force $F = 20t$ (where F is in newton and t is in second) is applied. Considering the two blocks, the pulley and the string as a single system find at $t = 5$ second



(a) Velocity of centre of mass of the system.

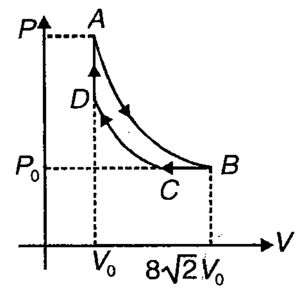
(b) y-coordinate of centre of mass of the system.

18. Two blocks of mass m_1 = 5 kg and m_2 = 1 kg connected to each other by a massless inextensible string of length 1.0 m, are placed with string taut on a horizontal turntable. The surface of m_1 is rough and m_2 is smooth, when turn table is fixed and m_2 is given velocity 5 m/s in the plane of turn table and perpendicular to the length of the string, m_1 is just likely to slip. Now the masses (m_1 and m_2) are placed along the diameter of a turn table on either side of the centre O such that mass m_1 is at a distance 20 cm from O. The turn table is rotated at angular velocity 10 rad/s about vertical axis passing through O, the masses are observed to be at rest w.r.t. an observer on the turn table.

    (a) Calculate the frictional force on m_1 and tension in the string.

    (b) What should be minimum angular speed of turn table so that masses will slip from this position?

19. The cyclic process $ABCDA$ has been performed on helium gas which behaves ideally. Process AB is isothermal and CD is adiabatic. The ratio of maximum to minimum temperature in complete cycle is 4. Find the change in internal energy in the process CD in terms of P_0 and V_0.



20. A heat conducting piston can freely move inside a closed thermally insulated cylinder with an ideal gas. In equilibrium, the piston divides the cylinder into two equal parts, the gas temperature being equal to T_0. The piston is slowly displaced. Find the gas temperature as a function of the ratio η of the volumes of the greater and smaller sections. The adiabatic exponent of the gas is equal to γ.

21. A particle of mass m is moving in a circular orbit. Its potential energy is $U = A + Br^2$, where A and B are positive constants and r is the radius of the orbit. If Bohr's quantum condition holds here find

    (a) Maximum possible de Broglie wavelength associated with the particle.

    (b) The total energy of the particle in terms of the quantum number 'n'.

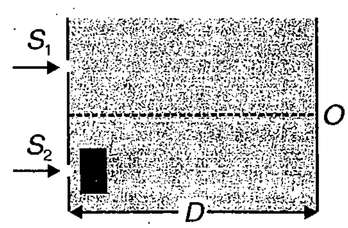
22. A radioactive substance A transforms into another radioactive substance B. Decay constant for A and B are λ and 2 λ respectively. If only A type radioactive nuclei N_0 are initially present, express the number of B type radioactive nuclei as a function of time t. Find the time at which number of B type nuclei will be maximum.

23. A hollow cylinder of length 'H' is fitted with a thin plano convex lens at its lower end. This is filled with a viscous liquid of refractive index μ. A small spherical body is dropped from some height along the axis of the lens. It is observed that the spherical body moves down in the liquid with a constant velocity just after entering it. Find

    (a) The height from which the spherical body is dropped.

    (b) The position of the final image formed after all refractions at the time the spherical body is at the centre of the container when viewed from under the cylinder. Assume that radius of curvature for the lens is R, refractive index is μ_0. The coefficient of viscosity for the liquid is η and its density is $\frac{\rho}{2}$, ρ being the density of the spherical body.

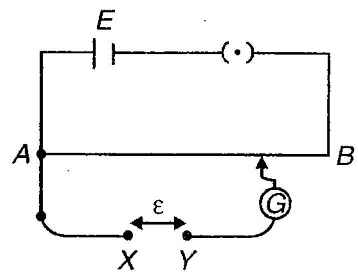
24. Parallel rays of wavelength λ = 4500 Å (in medium of refractive index $\mu_{m_1} = \frac{4}{3}$) are incident on the two slits of Young's double slit experiment. The space between the slits and the screen is filled with a material of refractive index $\mu_{m_2} = \frac{5}{3}$. A glass slab of thickness 10 μm and refractive index $\mu_g = \frac{3}{2}$ is placed before S_2. Distance between the slits is 0.5 mm and between the slits and the screen = 1 m.



    (a) Find the position of central maxima from O.

    (b) Find the ratio of the intensities at O and at central maxima.

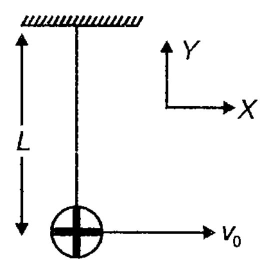
25. For the potentiometer circuit shown in the given figure, points X and Y represent the two terminals of an unknown e.m.f. ε. A student observed that when the jockey is moved from the end A to the end B of the potentiometer wire, the deflection in the galvanometer remains in the same direction. What are the two possible faults in the circuit that could result in this observation?



Which of the two faults listed above, would be there in the circuit if the galvanometer deflection is (a) more at B (b) more at A? Give reasons in support of your answer in each case.

26. Least count of a vernier calipers is 0.01 cm. When the two jaws of the instrument touch each other, the 5th division of the vernier scale coincides with a main scale division and the zero of the vernier scale lies to the left of the zero of the main scale. Further more, while measuring the diameter of a sphere, the zero mark of the vernier scale lies between 2.4 cm and 2.5 cm and the 6th vernier division coincides with a main scale division. Calculate the diameter of the sphere.

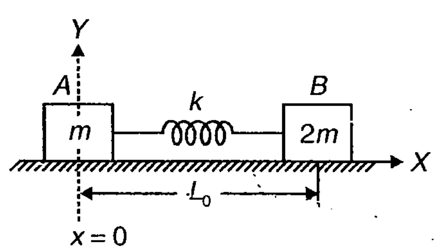
27. A particle of mass m and having charge $+q$ is tied to one end of the string whose other end is fixed. The whole system is placed in a gravity free space having uniform electric field $\vec{E} = E_0\hat{i}$. If the particle is given velocity $v_0\hat{i}$ at the position shown in figure, then find minimum velocity v_0 such that the particle completes the circle.



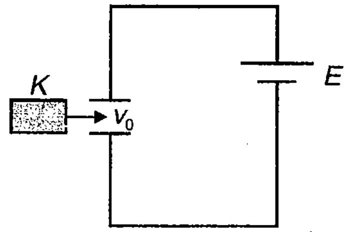
28. A transverse wave in a stretched string of linear mass density 0.10 kg/m is given by $y = 0.5\sin(\pi x - \pi t)$, where x and y are in the meters and t is in seconds. Find the power developed at $t = 0.25$ s, at a point of string which is located at $x = 0.5$ m.

29. A slightly divergent beam of non-relativistic charged particles accelerated by a potential difference V propagates from point A along the axis of a straight solenoid. The beam is brought into focus at a distance d from the point A at two successive values of magnetic induction B_1 and B_2. Find the specific charge $\frac{q}{m}$ of the particles.

30. Two blocks A and B having mass m and $2m$ respectively are attached to the opposite end of a massless spring of spring constant k and natural length L_0. At time $t = 0$, the block A is at $x = 0$. A constant horizontal force F acts on the system. If the x-coordinate of block A is L_0 at $t = t_0$ then find the corresponding x-coordinate of block B.

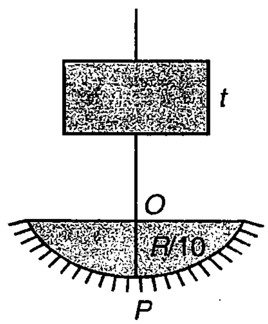


31. The plate of capacitor has dimension $a \times a$ with separation between the plates d. A dielectric slab of dielectric constant K is inserted between the plates with constant speed v_0 as shown in figure. At $t = 0$, slab enters between the plates. Find the current as a function of time t.



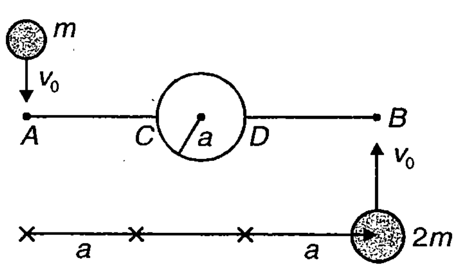
32. There is a spherical water drop of radius R and R.I. ($\mu = \frac{4}{3}$). A luminous point object is placed before it on the axis at a distance $3R$ from the nearer surface. A concave mirror is placed on the other side of the sphere in such a ways that its axis coincides with the axis of the sphere. If the image of the object is coincident with the object itself and the focal length of the mirror is F, find the distance of the mirror from the centre of the sphere. Illustrate your answer with proper ray diagrams.

33. There is a concave mirror placed on a horizontal table. A luminous point object is fixed at a point on its axis. It is observed that the image formed by the mirror is coincident with the object. Now a liquid ($\mu = \frac{4}{3}$) is poured into the mirror to a depth $\frac{R}{10}$, R being the radius of curvature of the mirror and at the same time, a rectangular glass sheet ($\mu = 1.5$) is introduced between the object and the mirror. Again the image formed after all reflections and refractions is coincident with the object. Find the thickness of the glass sheet.



34. A particular type of nucleus whose decay constant is λ is produced at a steady rate of p nuclei per second show that the number of nuclei N present t second after the production starts is $N = \frac{p}{\lambda}(1 - e^{-\lambda t})$.

35. A ring of radius a and having mass m is placed on a smooth horizontal surface. Two massless rigid rods AC and BD each of length a are attached to diametrically opposite points of the ring as shown in figure. A particle of mass m moving with velocity v_0 and another particle of mass $2m$ moving with velocity v_0 (see figure) strikes simultaneously the end A and B respectively and stick to rod, then find

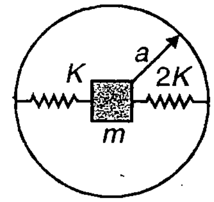


(a) The displacement of centre of mass of the system (ring + rigid rods + particles) in the time in which the whole system makes one complete revolution about its centre of mass.

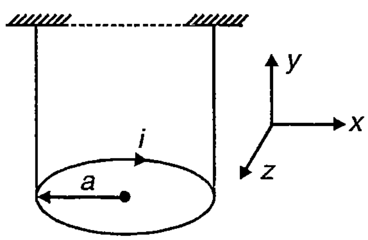
(b) The velocity of the two particles just after collision.

36. A particle of mass m and having charge $+q$ is projected from origin with velocity $\vec{v} = v_0\hat{i}$ in a region having magnetic field $\vec{B} = B_0\hat{i} + B_0\sqrt{3}\hat{j}$. Find the position of the particle as it touches n^{th} times, the line $y = \sqrt{3}x$ and also find the corresponding velocity vector.

37. A ring of radius a and having mass M lies on a smooth horizontal surface. One end of each of the two massless springs, one of spring constant K and other of spring constant $2K$ are fixed to the diametrically opposite points of ring. The other end of the two springs is attached to a block of mass m which lies at the centre of the ring. In this position springs are at their natural length. If the block is displaced by $\frac{a}{2}$ along the length of springs, such that spring of spring constant $2K$ is compressed by $\frac{a}{2}$ and is released, then find the velocity and the displacement of the ring at the instant when each spring achieves its natural length.



38. A rigid conducting ring of radius a and mass M is suspended with the help of two identical wires as shown in figure. The ring lies in horizontal x-y plane and carries a current I in the clockwise sense as shown. If a uniform magnetic field $\vec{B} = B_0\hat{i}$ exists in the entire region, then find B_0 such that the same tuning fork may excite the wire on the left into its fundamental vibrations and that on right into its first overtone. Take gravitational forces into account.



39. A metal block of heat capacity 80 J/°C placed in a room at 20°C is heated electrically. The heater is switched off when the temperature reaches 30°C. The temperature of the block rises at the rate of 2 °C/s just after the heater is switched on and falls at the rate of 0.2 °C/s just after the heater is switched off. Assume Newton's law of cooling to hold,

(a) Find the power of the heater.

(b) Find the power radiated by the block just after the heater is switched off

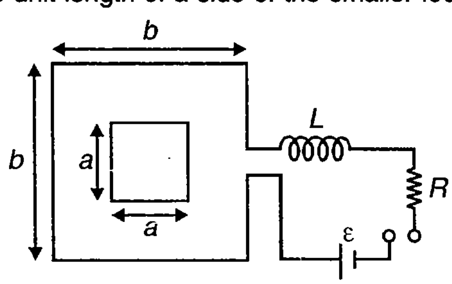
(c) Find the power radiated by the block when the temperature of the block is 25°C

(d) Assuming that the power radiated at 25°C represents the average value in the heating process, find the time for which the heater was kept on

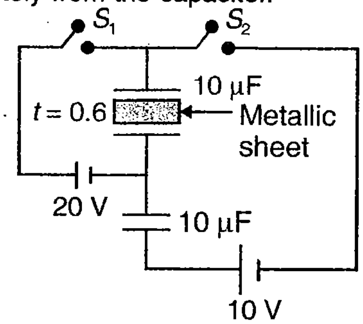
40. A small square loop of side a is having resistance r and negligible inductance. It is placed at the centre of a large square loop ($a << b$) as shown in figure. Larger square loop is having negligible resistance and inductance but is connected with inductor and the resistor and the source of e.m.f. as shown in figure. The switch S is closed at $t = 0$. Find

(a) Current induced in the smaller loop as a function of time t

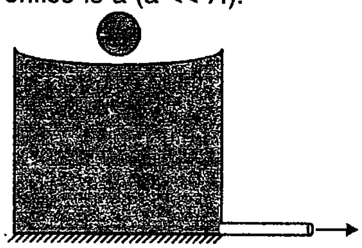
(b) Maximum force acting on the unit length of a side of the smaller loop due to the current in the larger loop



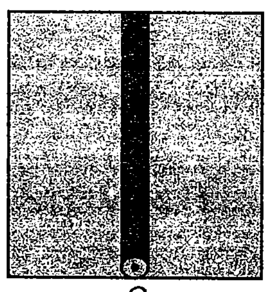
41. In the arrangement shown, each capacitor has capacitance 10 μF without metallic sheet. A metallic sheet whose thickness is $t = 0.6\ d$, where d is the separation between the plates of the capacitors is inserted in one of the capacitors. First the switch S_1 is opened and S_2 is closed. Again when steady state is reached, switch S_2 is also opened and metallic plate is pulled out. Find the work performed by the external agent in pulling out the metallic plate completely from the capacitor.



42. There is a cylindrical container of depth h. Its bottom is silvered. A point object is fixed at the mouth of the container. Initially the container is completely filled with water $\left(\mu = \frac{4}{3}\right)$. Now the orifice at the bottom is opened. Find the time after which the separation between the object and its image will be $\frac{7}{4}h$. Cross-sectional area of the container is A and that of the orifice is a ($a << A$).



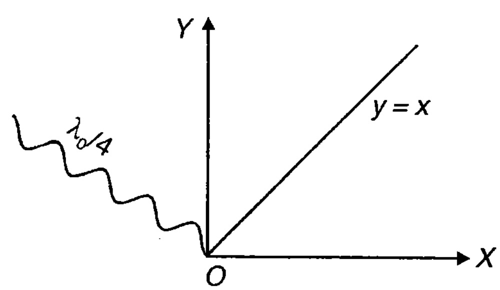
43. A uniform vertical rod of length L and density ρ_0 is placed inside a non-viscous liquid of density ($\rho > \rho_0$) such that it can rotate about an axis through O. The rod is given a small displacement and left.



(a) Show that the motion of the rod will be simple harmonic.

(b) If $\rho = 4\rho_0$, find the length of the equivalent simple pendulum. If we assume that the mass of the bob of this simple pendulum to be m and angular amplitude θ_0, what should be minimum de Broglie wavelength associated with the bob?

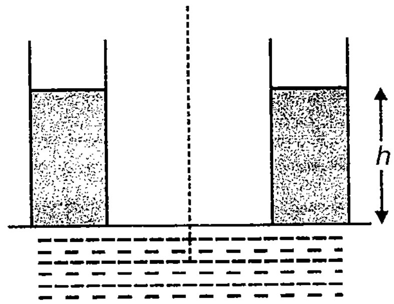
44. A piece of photosensitive material is placed at the origin O. Radiation of wavelength $\frac{\lambda_0}{4}$ is incident on it, λ_0 being the threshold wavelength. The most energetic photoelectrons happen to come out along the y-axis.



(a) Find the distance of the point where this electron will strike the line $y = x$. If an electric field $\vec{E} = E_0\left(-\hat{i} + \frac{\hat{j}}{2}\right)$ exists in the space.

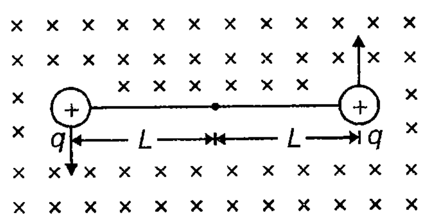
(b) What will be the de Broglie wavelength associated with the electron at the moment it strikes the line $y = x$? Assume the mass of the electron to be m.

45. A cylindrical capacitor connected to a dc voltage source V touches the surface of water with its end (as shown in figure). The separation d between the capacitor electrodes is substantially less than their mean radius. Find a height h which the water level in the gap will rise. The capillary effects are to be neglected.



46. A soap bubble of radius r_1 is blown at the end of a capillary tube of length ℓ and of cross-sectional radius a. Calculate the time taken by the bubble to reduce to radius $r_2 < r_1$. Surface tension of soap is T and coefficient of viscosity of air is η.

47. Two charged particles each of mass m carrying charge $+q$ and connected with each other by a massless inextensible string of length $2L$, are describing circular path in the plane of paper each with speed $v = \frac{qB_0L}{m}$ about their centre of mass in the region in which an uniform magnetic field $\vec{B}$ exists into the plane of paper as shown in figure. Here, B_0 is a constant. Neglect any effect of electrical and gravitational forces.

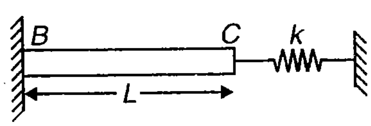


(a) Find the magnitude of the magnetic field $\vec{B}$ such that no tension is developed in the string.

(b) If the actual magnitude of magnetic field is half of that calculated in part (i) then find the tension in the string.

(c) Given that the string breaks when the tension is $T = \frac{3}{4}\frac{q^2B_0^2L}{m}$. Now if the magnetic field reduced to such a value that string just breaks, then find the maximum separation between the two particles during their motion.

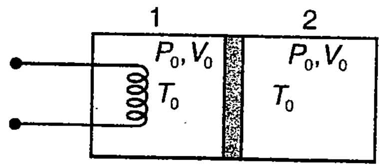
48. A rod BC of negligible mass is fixed at end B and connected to a spring of spring constant $k = 10^4$ N/m at end C, as shown in figure. For the rod BC, length L = 4m, area of cross-section $A = 4 \times 10^{-6}$ m^2, Young's modulus $Y = 10^{11}$ N/m^2 and coefficient of linear expansion $\alpha = 4.4 \times 10^{-4}$ K^{-1}. if the rod BC is cooled from temperature 100°C to 0°C, then find



(a) Decrease in length of rod

(b) Total energy stored by the system (rod + spring)

49. A frictionless adiabatic piston divides a cylindrical vessel into two compartments 1 and 2 each of length L. The compartments 1 and 2 each contain the same ideal gas ($\gamma = 1.5$) at initial pressure, volume and temperature as shown in figure. Now the gas in compartment 1 is heated slowly such that the final volume of compartment 2 becomes $\frac{V_0}{4}$. Find

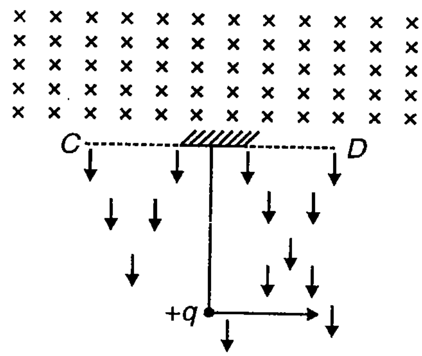


(a) Final temperature of each compartment.

(b) Change in internal energy of the gas is compartment 1.

(c) Heat absorbed by the gas in compartment 1.

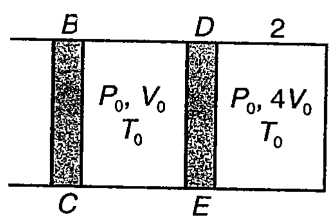
50. In gravity free space, a uniform horizontal magnetic field exists into the plane of paper only in the region beyond CD. A uniform, vertically downward electric field of magnitude E exists only in the region below CD as shown in figure. The bob of a simple pendulum of length L with point of suspension on line CD and having mass m and charge $+q$ is given horizontal velocity at the lowest point such that the tension in the string at this point is $T = 5qE$



(a) Find the magnitude of magnetic field $\vec{B}$ such that as the bob enters the magnetic field the string becomes slack and then it passes through the point of suspension.

(b) Find the maximum magnitude of magnetic field such that the bob of the pendulum still completes the vertical circle.

51. An adiabatic cylindrical vessel is fitted with two pistons BC and DE. The piston BC is diathermic and is fixed whereas the piston DE is adiabatic and frictionless. Piston DE divides the vessel in two compartments 1 and 2. The compartments 1 and 2 contain same ideal gas ($\gamma = 1.5$) at the pressure, volume and temperature as shown in figure. Now the piston DE is slowly moved such that the final volume of compartment 1 becomes $4V_0$. Find

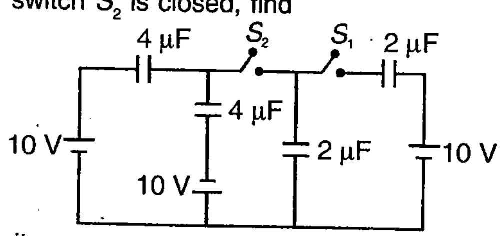


(a) Work done by the external agent.

(b) Heat absorbed by the gas in compartment 1.

(c) Change in internal energy of the gas contained in compartment 2.

52. In the given circuit, first switch S_1 is closed while S_2 is still open. When charging is complete switch S_1 is opened and S_2 is closed. After switch S_2 is closed, find



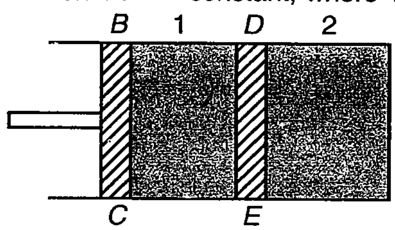
(a) Final charge on each capacitor.

(b) Work done by each 10 V battery.

(c) Amount of heat generated.

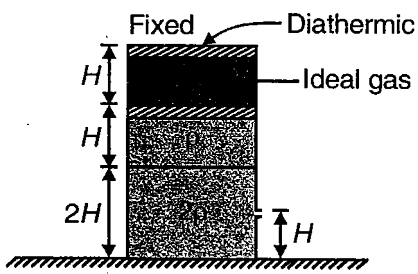
53. A uniform electric field $\vec{E} = E_0\hat{j}$ exists in the complete region but uniform magnetic field $B_0\hat{j}$ exists only in the region between $y = 0$ and $y = d$. A positively charged particle of mass m and charge $+q$ is projected from origin with speed v_0 in the positive x-direction.
    (a) Find the distance d such that charge leaves the region of magnetic field after one revolution.
    (b) At point $P(0, d, 0)$ the positive charge particle collides with another particle of same mass m and having charge $-2q$ which is initially at rest and sticks to it after collision. Find the coordinate of the point where the combined particle will again enter the region of magnetic field.
    (c) As the combined particle enters the magnetic field, find the velocity vector after one revolution.

54. An adiabatic cylinder is fitted with an adiabatic piston BC. The adiabatic partition wall DE divides the vessel into two compartments 1 and 2. The piston BC is initially fixed but can be moved. Compartment 1 contains 1.0 mole of He $\left(\gamma = \frac{5}{3}\right)$ at pressure 100 kPa and temperature 300 K. The compartment 2 contains $O_2\left(\gamma = \frac{7}{5}\right)$ at pressure 200 kPa and temperature 600 K. Now the partition DE is removed and when piston BC is moved slowly then the mixture follows the relation $TV^{1/2}$ = constant, where T is temperature and V is volume. Find



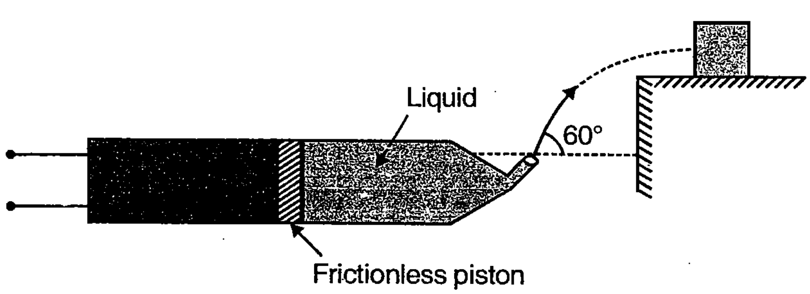
    (a) Number of moles of O_2.
    (b) Final pressure and temperature of gaseous mixture.

55. An open tank of large cross-sectional area A contains two immiscible liquids of densities ρ and 2ρ and an ideal gas as shown in figure. A frictionless piston of negligible mass separates the ideal gas whose pressure is $2P_0$. The top of the part containing ideal gas is diathermic such that its temperature remains constant. The tank is fitted with an orifice of cross-sectional area a ($a << A$) at a height H above the bottom of the tank. The atmospheric pressure is P_0.Find



    (a) The initial range (x_1) of the liquid flowing out of orifice.
    (b) The range of the liquid flowing out of orifice at the instant when liquid of density ρ just starts flowing out.

56. A vessel fitted with a nozzle of cross-sectional area (<< cross-sectional area of pistion) contains a liquid of density ρ and an ideal gas maintained at constant pressure $2P_0$ by heating it as shown in figure, P_0 being the atmospheric pressure. If the total volume of liquid is V



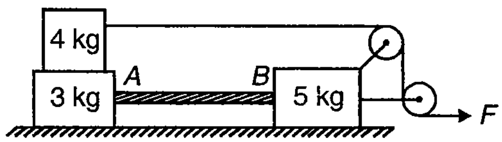
(a) Find the time t to squeeze out the liquid of vessel completely

If the liquid emerges at 60° from the horizontal and strikes horizontally a block of mass m kept on a rough platform as shown in figure, and splashes in vertical direction then find.

(b) Area of cross-section of jet just before it strikes the block.

(c) Minimum coefficient of friction between block and platform to keep block in equilibrium.

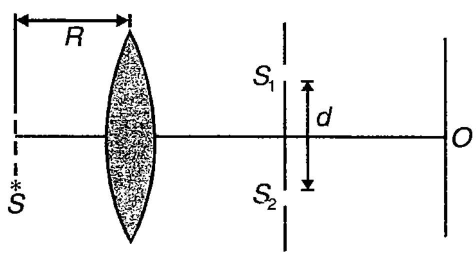
57. Two blocks of masses 3 kg and 5 kg connected with each other by a massless rigid rod AB, are placed on a horizontal surface as shown in figure. The coefficient of friction between 5 kg block and the horizontal surface is $\mu_s = \mu_k = 0.20$ where as the surface of 3 kg block in contact with horizontal surface is smooth. A 4 kg block is placed over the 3 kg block and the whole system is being acted upon by a horizontal force F as shown in figure. The coefficient of friction between 3 kg and 4 kg block is $\mu_s = \mu_k = 0.30$.



(a) Find the magnitude of force F which will just impend the motion of 5 kg block.

(b) For $F = 15N$, find the acceleration of each block.

58. A point source S is placed at a distance $\frac{d}{2}$ below the principal axis of an equiconvex lens of refractive index 1.5 and radius R. The emergent light from lens fall on the slits S_1 and S_2 placed symmertically with the principal axis. The resulting interference pattern is observed on the screen kept at a distance D from the plane of the slit. Find

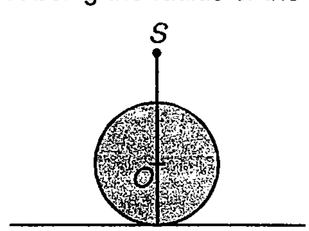


(a) The position of central maximum

(b) The intensity at point O

(c) If the intensity at point O is $\left(\frac{1}{4}\right)^{th}$ of the maximum intensity, then that what should be the minimum separation between the slits. Assume that the source to be monochromatic, emitting light of wavelength λ and $d << R, D$.

59. There is an opaque spherical body placed on a level surface. A point source is fixed along the diametrical axis of the sphere above it at a distance R, R being the radius of the sphere.



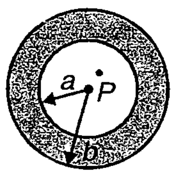
(a) Find the radius of the shadow of the sphere on the level ground.

(b) Find the radius of the shadow if the sphere is half dipped in water (refractive index of water = $\frac{4}{3}$).

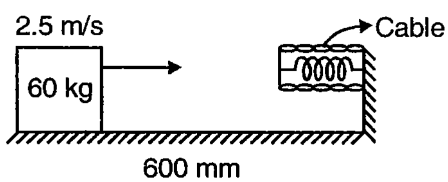
(c) If the sphere is a transparent body placed on a level plane mirror and the final image formed is coincident with the point source, what should the refractive index for the material of the sphere.

60. For a certain hypothetical one-electron atom, the wavelength (in Å) for the spectral lines for tansitions originating at $n = p$ and terminating at $n = 1$ are given by $\lambda = \dfrac{1500\,p^2}{p^2 - 1}$ where $p = 2, 3, 4$.
   (a) Find the wavelength of the least energetic and the most energetic photons in this series.
   (b) Construct an energy level diagram for this element showing the energies of the lowest three levels.
   (c) What is the ionization potential of this element?

61. (a) A potential difference of 20 kV is applied across an X-ray tube. The minimum wavelength of X-ray generated is ____________ Å.
   (b) The wavelength of K_α X-rays produced by an X-ray tube is 0.76 Å. The atomic number of anode material is ____________.
   (c) Consider the following reaction
   $_1H^2 + {_1H^2} = 2He^4 + Q$
   Mass of deuterium atom = 2.0141 u
   Mass of helium atom = 4.0024 u
   This is a nuclear ____________ reaction in which the energy released is ____________ MeV.
   (d) A point charge $+Q$ is placed at point P at a distance of $\frac{a}{2}$ from the centre of a spherical conducting shell of inner radius a and outer radius b as shown in figure. The potential at the centre of the shell is ____________.

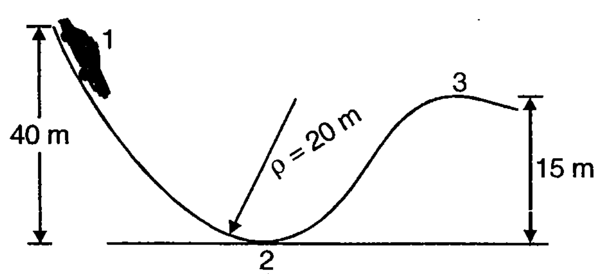


62. A spring is used to stop a 60 kg package which is sliding on a horizontal surface. The spring has a stiffness k = 20 kN/m and is held by cables so that it is initially compressed by 120 mm. Knowing that the package has a velocity of 2.5 m/s in the position shown and that the maximum additional deflection of the spring is 40 mm determine,



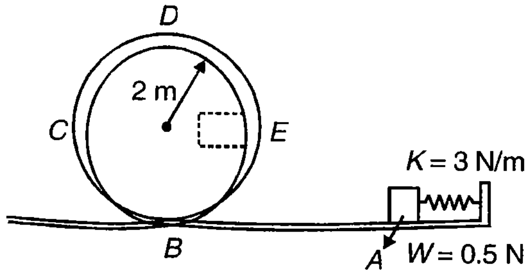
   (a) The coefficient of kinetic friction between the package and the surface.
   (b) The velocity of the package as it passes again through the position shown.

63. A 200 kg car starts from rest at point 1 and moves without friction down the track as shown

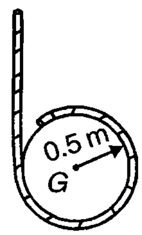


   (a) Determine the force exerted by the track on the car at point 2 where the radius of curvature of the track is 20 m.
   (b) Determine the minimum safe value of the radius of curvature at point 3.

64. The 0.5 N pellet is pushed against the spring at A and released from rest. Neglecting friction determine the smallest deflection of the spring for which the pallet will travel around the loop $ABCDE$ and remain at all times in contact with loop.



65. A cord is wrapped around a homogeneous disk of radius $r = 0.5$ m and mass $m = 15$ kg. If the cord is pulled upward with a force T of magnitude 180 N determine.

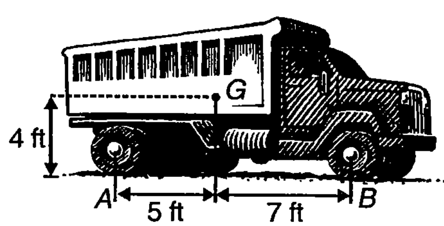


(a) The acceleration of the centre of the disk.

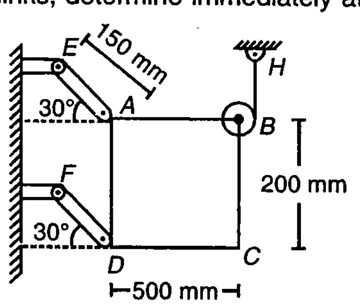
(b) The angular acceleration of the disk.

(c) The acceleration of the cord.

66. When the forward speed of the truck shown was 30 ft/s, the brakes were suddenly applied, causing all four wheels to stop rotating. It was observed that the truck skidded to rest in 20 ft. Determine the magnitude of the normal reaction and of the friction force at each wheel as the truck skidded to rest. (Take weight of truck W)



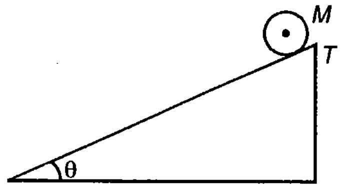
67. The thin plate $ABCD$ has a mass of 8 kg and is held in the position shown by the wire BH and two links AE and DF. Neglecting the mass of the links, determine immediately after wire H has been cut.



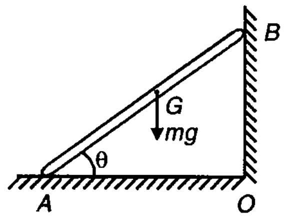
(a) The acceleration of the plate.

(b) The force in each link.

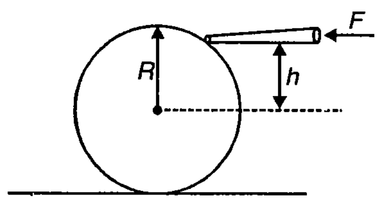
68. A solid cylinder of mass M and radius R rolls down an incline plane without slipping. Find the velocity of centre of mass when it reaches the bottom of incline and also show that $\frac{f}{N} = \tan\theta\left(1+\frac{MR^2}{I_{cm}}\right)^{-1} \geq \mu$.



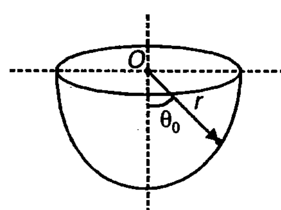
69. A uniform ladder of length ℓ is kept standing against a frictionless wall (as shown in figure). The floor is also frictionless. Describe the motion of the centre of gravity of the ladder when it is left free to move. How does the angle that the ladder makes with the floor change with time?



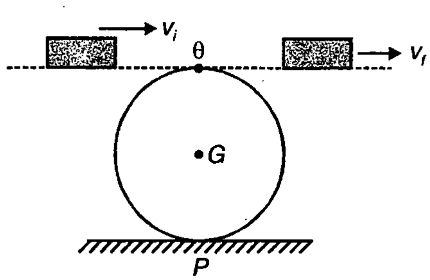
70. A billiard ball initially at rest is given a sharp impulse by a cue (as shown in figure). The cue is held horizontally at a distance h above the centre line. The ball leaves the cue with a speed v_0 and acquires a final velocity of $\frac{9v_0}{7}$. Show that $h = \frac{4R}{5}$ where R is the radius of the ball.



71. A particle is projected horizontally along the interior of a smooth hemispherical bowl of radius r at rest from the position shown. Find the initial speed v_0 required for the particle to just reach the top of the bowl.



72. A rough cylinder of mass M resting on a rough horizontal surface is touched on the top by a rough block of mass m with initial velocity v_i (as shown in figure). Assume that the block drags on the cylinder and leaves in the same line, ultimately without slipping, with a final velocity v_f. Find the final linear speed of the cylinder in terms of m, M and v_i.



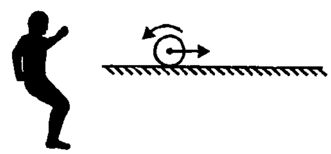
73. Consider a loop tract as shown in figure. A metal ball of mass m is put at the point A, whose vertical distance from the lowermost point of the tract is a multiple of the radius of its circular part. Find the linear velocity of the ball when it just rolls to height R (the point B) in the circular tract.

74. Five identical cylindrical drums rotate around fixed axes parallel to their length. A wooden board of mass M is placed gently on these drums. The length of the board is enough to rest on all the five drums. If each drum is of radius R and rotates with initial angular velocity ω_0, then

(a) How far does the wooden board move before it stops slipping on the drums?

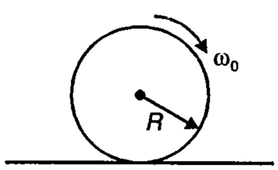
(b) How far does it go in time t after the slipping has stopped?

75. A bicycle wheel is thrown forward on a road, with a linear velocity v and reverse spin ω_0. The coefficient of kinetic (as well as static) friction between the wheel and the road is μ.



Find the condition that the wheel (i) will return (ii) will stop dead and (iii) will not return

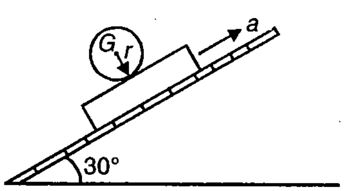
76. A disc of radius R spins on its axis at a constant angular velocity ω_0 (as shown in figure) and is gently lowered on to a level floor. If the coefficient of friction between the floor and the disc is μ



(a) Find the time that would elapse before pure rolling results.

(b) With what acceleration will the wheel move?

77. Determine the acceleration a of the supporting surface required to keep the centre of gravity G of the circular cylinder in a fixed position during the motion (as shown in figure). No slipping takes place between the cylinder and its support.

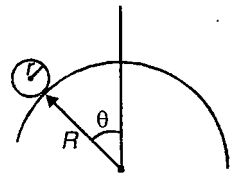


78. A solid homogeneous cylinder of height h and base radius r is kept vertically on a conveyor belt moving horizontally with an increasing velocity $v = a + bt^2$

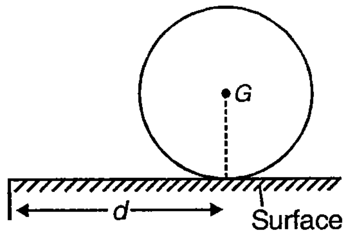
(a) Find the time when the cylinder starts slipping.

(b) If the cylinder is not allowed to slip find the time t when it is on the verge of tipping over.

79. A circular disc of mass m and radius r is released from rest with θ essentially zero, and rolls without slipping on the circular guide of radius R (as shown in figure). Determine the expression for the normal force N between the disc and the guide in terms of θ.

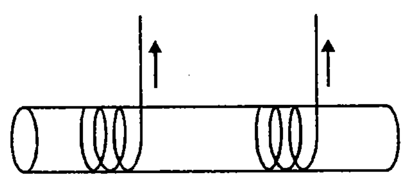


80. A truck initially at rest with a solid cylindrical roll of paper (as shown in figure) moves forward with a constant acceleration a. Find the distance S which the truck travels before the paper roll moves off the edge of its horizontal surface. Friction is sufficient its prevent slipping.



81. A solid cylinder at rest is placed on a belt which is driven by a force $\vec{F}$. The cylinder slips and at the same time moves forward. If also rotates with an angular speed ω while moving forward. Find the time for the cylinder to moves through a distance S. Determine also the angular velocity ω of the cylinder at that position. The radius of the cylinder is r and the coefficient of friction between the belt and the cylinder is μ.

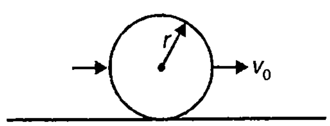
82. A string is wrapped around a cylinder of mass M and radius R, and is pulled vertically upward such that the centre of mass of the cylinder remains stationary (as shown in figure). In the process, the string gets unwound.



(a) Find a relation of work done on the cylinder as a function of its angular speed?

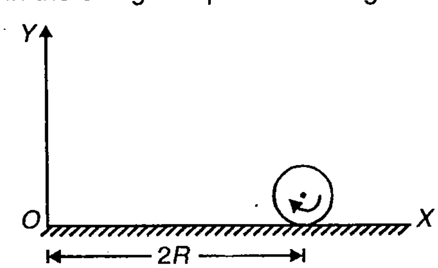
(b) How much string is unwound?

83. A billiard ball is struck by a cue (the billiard stick as shown in figure). The line of action of the applied impulse is horizontal and passes through the centre of the ball. The initial velocity v_0 of the ball its radius R, mass m and coefficient of friction μ between the ball and the table are known. How far will the ball move before it ceases to slip on the table?

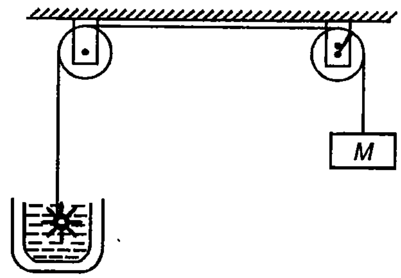


84. The bob of a simple pendulum of mass m and string length L is given horizontal velocity $\sqrt{gL}$ at the lowest position. Find the net force on the bob at a position where tension in the string is equal to its weight.

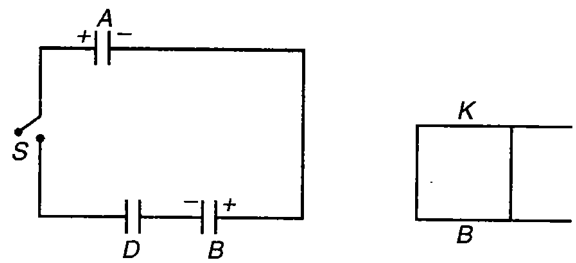
85. A solid cylinder of mass m and radius R is rotated with angular velocity ω_0 and is placed on a rough horizontal plane at a position $x = 2R$ as shown in figure. If the coefficient of kinetic friction between the cylinder and the horizontal plane is μ then find the angular momentum of the cylinder about the origin when rolling without slipping occurs.



86. Figure shows some water in a container having 2.0 mm thick walls made of a material of thermal conductivity 0.50 W/m-°C. The container is kept in a melting ice both at 0°C. The total surface area in contact with water is 0.05 m². A wheel is clamped inside the water and is coupled to a block of mass M as shown in the figure. As the block goes down, the wheel rotates. It is found that after some time, a steady state is reached in which block goes down with a constant speed of 10 cm/s and the temperature of the water remains constant at 1.0°C. Find the mass M of the block. Assume that the heat flows out of the water only through the walls in contact.



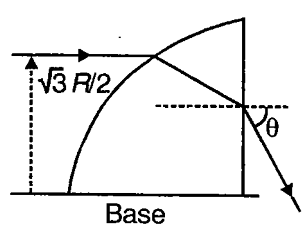
87. In the given circuit, parallel plate capacitor A, B and D are each of capacitance C_0. Initially capacitors A and B are having charges $2q_0$ and q_0 respectively and capacitor D is uncharged. Now switch S is closed and after steady state is reached, the capacitor B is isolated and half of the space between the plates is filled with the dielectric of dielectric constant K and resistivity ρ at $t = 0$ as shown in the figure. If the charge leaks through the dielectric filler, then find the charge on the capacitor as a function of time t.



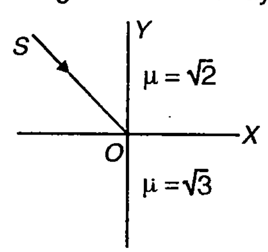
88. Eight particles each of mass m are placed at the corners of a cube of edge a. Find the work required to be done in disassembling this system of particles against mutual gravitational attraction.

89. A capacitor, a resistor of 5 Ω and an inductor of 50 mH are in series with an a.c. source marked 100 V, 50 Hz. It is found that the voltage is in phase with the current. Calculate the capacitance of the capacitor.

90. A guarter cylinder having an index of refraction $\sqrt{3}$ and radius R is kept in vacuum and is in the shape of quarter circle of radius R. A light ray parallel to the base of the material is incident from the left at a distance $\frac{\sqrt{3}R}{2}$ above the base and emerges out of the material at an angle θ. Find the value of the angle θ and the total deviation suffered by the emergent ray.



91. In the figure x-z plane separates two optical medial of refractive indices $\sqrt{2}$ and $\sqrt{3}$. A ray $\overrightarrow{SO} = 2\sqrt{3}\,\hat{i} - 2\hat{j}$ is incident on the plane. Find unit vector along the refracted ray.



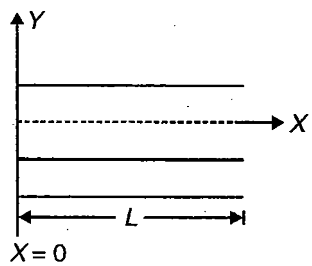
92. X-rays are produced by coolidge tube. If the ratio of the de Broglie wavelength associated with accelerated electrons and the cut off wavelength of the X-rays produced is 0.1, find the potential difference applied between the target and the filament. The specific charge of electron is 1.8×10^{11} C/kg.

93. Two particles *A* and *B* having mass *m* and 2m and carrying charge $+q$ and $-q$ respectively, are attached to the opposite ends of a massless non-conducting rigid rod of length *L*. The electric dipole so constituted is placed in the uniform external electric field *E*. Initially the dipole moment vector makes an angle 30° with the electric field $\vec{E}$ and then system is released from this position. Assuming gravity free space, find the net force acting on the particle *A*.

    (a) Just after the release.

    (b) When dipole moment vector becomes parallel to the electric field.

94. Air column in an organ pipe of length *L*, closed at one end, vibrates in its first overtone with frequency ν. Mean pressure of the air is P_0. The amplitude of the pressure variation at the closed end (located at $x = 0$ as shown in figure) is P_m.



    (a) Write the equation describing the standing wave if at $x = 0$ and $t = 0$ the pressure is $P_0 + \frac{P_m}{2}$.

    (b) Find the amplitude of pressure variation at the mid point of the organ pipe.

95. A brake mechanism used to reduced recoil in certain types of guns consists essentially of a piston which is attached to the barrel and may move in a fixed cylinder filled with oil. As the barrel recoils with an initial velocity v_0, the piston moves and oil is forced through orifices in the piston, causing, the piston and the barrel to decelerate at a rate proportional to their velocity, that is $a = -kv$. Find

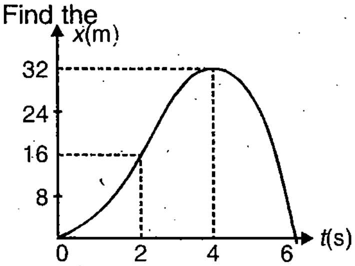
    (a) Velocity as a function of time

    (b) Displacement *x* as a function of time

    (c) Velocity as a function of distance

    (d) Draw approximate curves for the above three cases

96. Consider a particle is moving in a straight line and assume that its position is defined by the displacement time graph and the relation $x = 6t^2 - t^3$. From position versus time graph, draw a velocity versus time graph and acceleration versus time graph. Find the



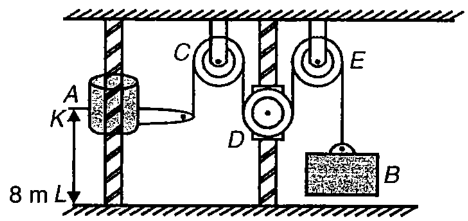
    (a) Average velocity of the particle from zero to 2 second

    (b) The maximum velocity of the particle

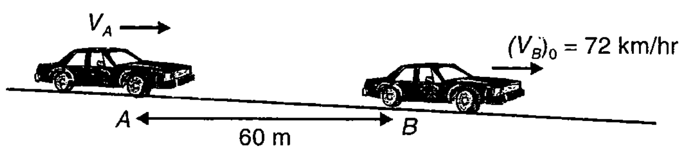
    (c) When particle is at its maximum *x*-coordinate then velocity of the particle acceleration of the particle and its direction

    (d) When the particle will reach the origin, at this time find the acceleration and velocity of the particle

97. Collar A and B are connected by cable passing over three pulleys C, D and E as shown. Pulleys C and E are fixed, while D is attached to a collar which is pulled downward with a constant velocity of 3 m/s. At $t = 0$, collar A starts moving downward from position K with a constant acceleration and no initial velocity. Knowing that the velocity of collar A is 12 m/s as it passes through point L, determine the change in elevation, the velocity, and the acceleration of block B when collar A passes through L.



98. Car A is travelling at a constant speed V_A. It approaches car B, which is travelling in the same direction at the constant speed of 72 km/hr. The driver of car B notices car A when it is still 60 m behind him and then accelerates at constant rate of 0.75 m/s^2 to avoid being passed or struck by car A. Knowing that the closest that A comes to B is 6 m, determine the speed V_A.

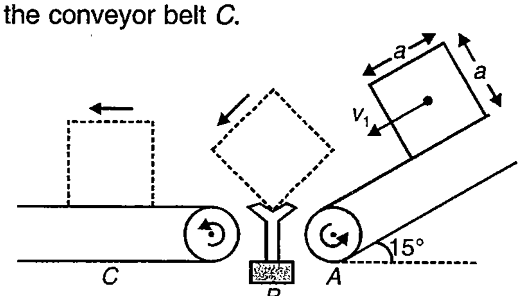


99. A uniform sphere of mass m and radius r is projected along a rough horizontal surface with a linear velocity $\vec{v_1}$ and no angular velocity. Denoting by μ_k the coefficient of kinetic friction between the sphere and the surface, determine

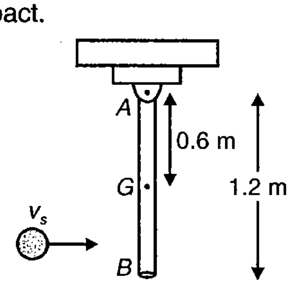
(a) The time t_2 at which the sphere will start rolling without sliding

(b) The linear and angular velocities of the sphere at time t_2

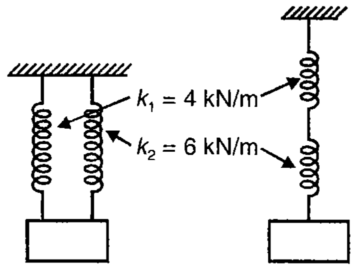
100. A square package of side a and mass m moves down a conveyor belt A with a constant velocity v_1. At the end of the conveyor belt, the corner of the package strikes a rigid support at B. Assuming that the impact at B is perfectly plastic, drive an expression for the smallest magnitude of the velocity $\vec{v_1}$ for which the package will rotate about B and reach the conveyor belt C.



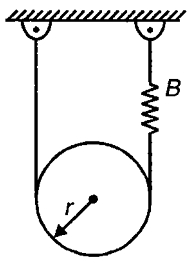
101. A 2 kg sphere moving horizontally to the right with an initial velocity of 5 m/s strikes the lower end of an 8 kg rigid rod AB. The rod is suspended from a hing at A and is initially at rest. Knowing that the coefficient of restitution between the rod and the sphere is 0.80, determine the angular velocity of the rod and the velocity of the sphere immediately after the impact.



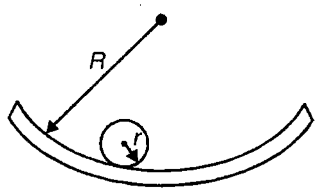
102. A 50 kg block moves between vertical guides as shown. The block is pulled 40 mm down from its equilibrium position and released. For each spring arrangement, determine the period of vibration, the maximum velocity of the block, and the maximum acceleration of the block.



103. A cylinder of weight W and radius r is suspended from a looped cord as shown. One end of the cord is attached directly to a rigid support, while the other end is attached to a spring of constant k. Determine the period and frequency of vibration of the cylinder.



104. Determine the period of oscillation of cylinder of radius r which rolls without slipping inside a curved surface of radius R.

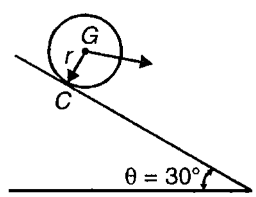


105. A sphere of radius r and weight W is released with no initial velocity on the incline and rolls without slipping. Determine

(a) The minimum valve of the coefficient of static friction compatible with the rolling motion.

(b) The velocity of the centre G of the sphere after the sphere has rolled 10 m.

(c) The velocity of G if the sphere were to move 10 m down a frictionless 30° inclined.



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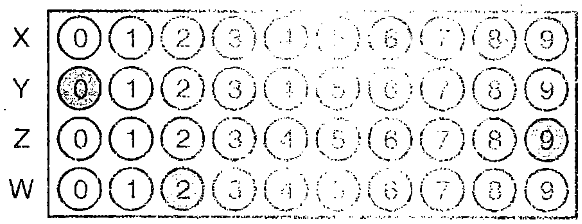
SECTION - G

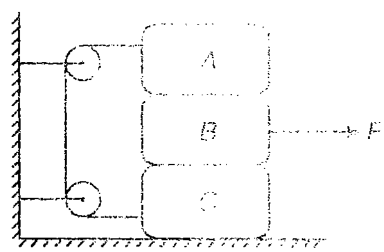
Integer Answer Type

This section contains 16 questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W(say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following :



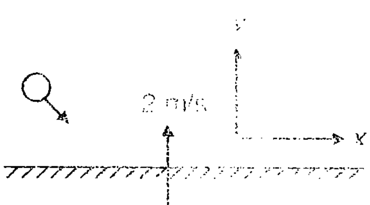
1. Velocity of a particle moving in space is given by $\vec{v} = (-y\hat{i} + x\hat{j} + \sqrt{2}\hat{k})$. At initial moment ($t = 0$) the particle is at $(\sqrt{2}, 0, 0)$. Find the distance travelled (in m) by the particle in 1 s (All quantities are in SI units).

2. Consider following arrangement of three blocks A, B and C. Mass of the each block is 1 kg. The coefficient of friction between any two blocks is 0.2. There is no friction between the block C and ground. Find the minimum value of F (in N) for which sliding occurs at all the surfaces.



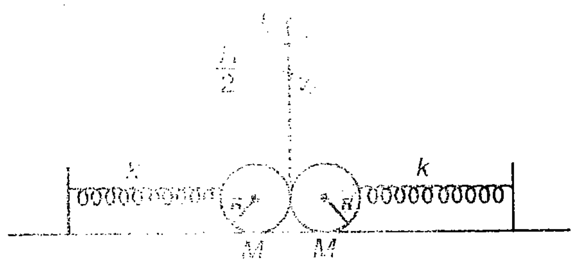
Smooth ground

3. Consider a horizontal surface moving vertically upward with velocity 2 m/s. A small ball of mass 2 kg is moving with velocity $2\hat{i} - 2\hat{j}$. If coefficient of restitution is $\frac{1}{2}$ and friction coefficient is $\frac{1}{3}$ then find horizontal component of velocity of the ball after collision.

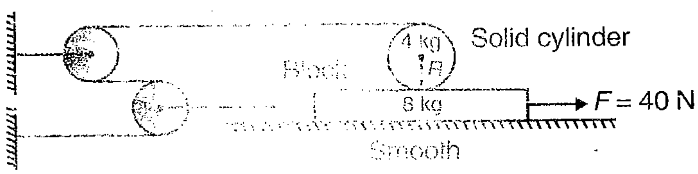


4. If dimensions of length is to be expressed in terms of the universal gravitational constant G, the speed of light c, and the Planck's constant (h), then the dimensional formula is $G^x c^y h^z$. Find the value of $(3x + y)$.

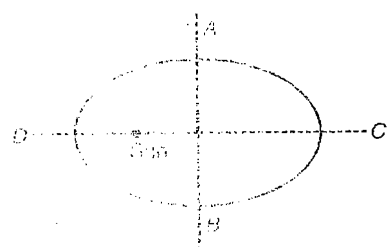
5. Two identical balls each of mass M (= 1.25 kg) and radius R are kept in contact and are connected to two identical unstretched springs each of force constant k (= 100 N/m). A third ball also of mass M but radius $\frac{R}{2}$ strikes with the two balls symmetrically with speed v_0 (= 1.6 m/s) and comes to rest just after the impact. Find the maximum compression in each spring in cm.



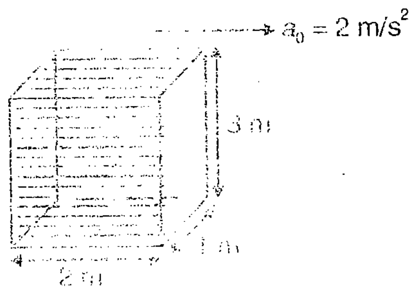
6. An ideal string is wrapped several times on a solid cylinder of mass 4 kg and radius 1 m. The pulleys are ideal and the surface between block and ground is smooth. If the torque acting on the cylinder is $\frac{10x}{9}$ N-m, then find the value of x.



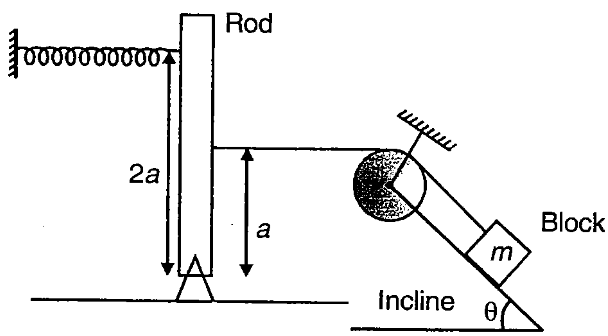
7. A planet is revolving around the sun in an elliptical orbit of eccentricity $\frac{\pi}{4}$. If t_1 and t_2 are the time taken by the planet in going along ACB and t_2 in returning along BDA then find $\frac{t_1}{t_2}$.



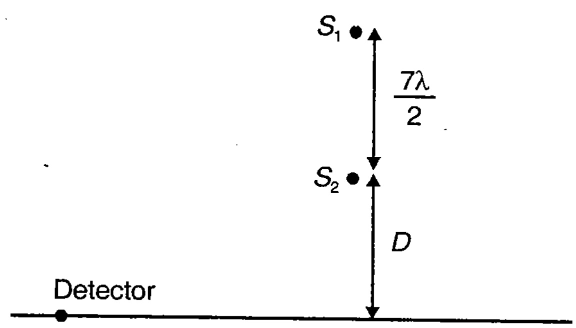
8. An open tank having dimensions 1 m × 2 m × 3 m completely filled with water is kept on a horizontal surface. The mass of water that spills out is $100x$ kg, when the tank is slowly accelerated at the rate of 2 m/s^2 then find the value of x.



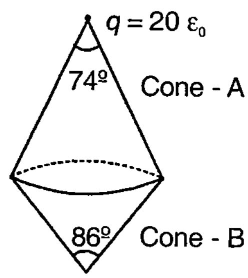
9. In the arrangement shown, the rod is light and the surface between block and incline is smooth. Mass of the block is 1 kg and force constant of spring is 100 N/m. If the angular frequency (in s^{-1}) of small oscillations of the block is $5x$, then find the value of x.



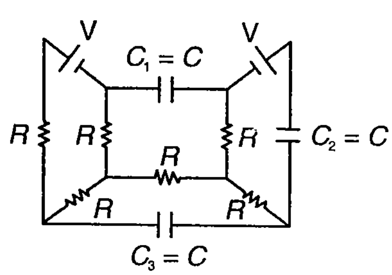
10. Two point sound sources S_1 and S_2 emitting sound of wavelength λ are kept separated by a distance $\frac{7\lambda}{2}$ as shown. A detector is moved along the line shown. Find the number of minimas observed by the detector. (Assume $D >>> \lambda$)



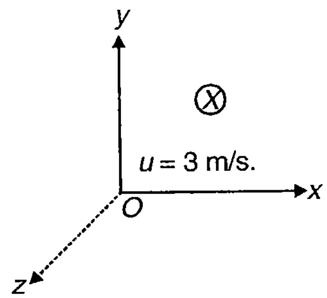
11. A point charge $q = 20\ \varepsilon_0$ (S.I.) unit is placed at vertex of an imaginary cone (cone –A) as shown. Electric flux (in S.I. unit) through curved surface of another cone B sharing its base with cone A is ________



12. Consider the electrical circuit shown in steady state. Electrostatic potential energy stored by the capacitor C_2 is how many times the electrical energy stored by capacitor C_1?



13. A charged particle enters in a region where both electric field and magnetic field have been applied. Magnetic field of magnitude 5. Tesla has been applied along the negative z-axis and the electric field is given as $\vec{E} = 2x\hat{i} + 2\hat{k}$ N/C, where x is in metre. A particle of mass $2g$ of having charge 2 mC enters the region from origin with speed 3 m/s. along the positive x-axis. Find out the speed of particle when it reaches at point (2, 3, 2)



14. The current in a coil of self inductance 4 H is changing according to the law $I = \sin t$. Find out the amount of magnetic energy (in J) stored in the inductor during the time interval $t = 0$ to $t = \frac{\pi}{4}$ s.

15. Hydrogen atom in its ground state, is excited by means of monochromatic radiation of wavelength 975 Å. How many different lines are possible in the resulting spectrum?

16. Two identical glass $\left(\mu_g = \frac{3}{2}\right)$ equiconvex lenses of radius of curvature R = 12 cm are kept in contact. The space between the two lenses is filled with water $\left(\mu_w = \frac{4}{3}\right)$. Find the focal length (in cm) of the combination.

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SECTION - H

Multiple True-False Type Questions

Identify the correct combination of true and false of the given three statements.

1. STATEMENT-1 : If $\vec{A}\times\vec{B}=\vec{C}$, then $\vec{A}.\vec{C}$ must be equal to zero.

   STATEMENT-2 : If resultant of three vectors is zero then they must be of equal magnitudes.

   STATEMENT-3 : Cross product of two unit vectors is also a unit vector.

   (1) T F F (2) T T F (3) F F T (4) F F F

2. STATEMENT-1 : Radial acceleration is always directed perpendicular to net force on the particle.

   STATEMENT-2 : If two particles are moving with velocities $\overline{v_A}$ and $\overline{v_B}$, then the maximum magnitude of relative velocity is $v_A + v_B$.

   STATEMENT-3 : If net force acting on a system of particles is zero then kinetic energy of the system remains constant.

   (1) F F F (2) F T F (3) T F T (4) T T F

3. STATEMENT-1 : Spring constant and surface tension have same dimension formula.

   STATEMENT-2 : If you do not have memory you cannot observe the motion.

   STATEMENT-3 : The value of 2.0 m in centimetre is 200 cm

   (1) F T F (2) T T T (3) T T F (4) F T T

4. STATEMENT-1 : When a body accelerates downwards inside a liquid the centre of mass of the liquid rises up.

   STATEMENT-2 : Centre of mass and centre of gravity always lie at the same point.

   STATEMENT-3 : If moon is stopped for a moment and released then the centre of mass of moon-earth system will move towards earth neglecting motion of earth around sun.

   (1) T F T (2) T F F (3) F F T (4) F F F

5. STATEMENT-1 : In the relation $a = r\alpha$, a represents the resultant acceleration of the particle.

   STATEMENT-2 : When a concentric disc is cut out from a larger disc then the moment of inertia of the disc about its own axis will decrease but its radius of gyration will increase.

   STATEMENT-3 : No work is done against friction force in pure rolling.

   (1) F F T (2) F T T (3) F T F (4) F F F

6. STATEMENT-1 : Radius of earth at the equator is larger than the radius at poles by about 45 km.

   STATEMENT-2 : Ratio of gravitational and inertial mass is 1.

   STATEMENT-3 : A body placed at the poles will become weightless if time period of earth's rotation becomes 1.4 hrs.

   (1) F T F (2) F F T (3) F T T (4) T T F

7. STATEMENT-1 : Shearing strain has unit same as that of shearing stress.

STATEMENT-2 : For floatation density of liquid should be more than the density of floating body.

STATEMENT-3 : Terminal velocity of rain drops is quadrupled if its radius is doubled.

(1) T F F (2) F F T (3) T F T (4) T T T

8. STATEMENT-1 : In SHM the difference between kinetic and potential energy oscillates with a frequency twice that of the oscillating body.

STATEMENT-2 : In SHM the ratio of maximum velocity and maximum acceleration depends upon the time period.

STATEMENT-3 : When a floating body is slightly depressed and released then it executes SHM (Liquid is ideal).

(1) T T T (2) F F T (3) F T T (4) T F F

9. STATEMENT-1 : Equation of a plane progressive wave can be written in different forms depending upon the initial phase.

STATEMENT-2 : Waxing and waning of sound is noticeable if a waxing and a waning repeats at an interval less than $\left(\frac{1}{10}\right)$ second.

STATEMENT-3 : The whistle of a train approaching a station appears shrill to a passenger standing on the platform.

(1) T T T (2) T F F (3) T F T (4) F T F

10. Consider the following statements

STATEMENT-1 : Kirchhoff's first law is based on conservation of charge.

STATEMENT-2 : As temperature of a conductor increases, relaxation time of electrons decreases.

STATEMENT-3 : Kirchhoff's second law is based on conservation of potential energy

(1) F T F (2) F F T (3) T F F (4) T T T

11. Consider the following statements

STATEMENT-1 : As dielectric is inserted between capacitor plates, its capacitance increases.

STATEMENT-2 : As dielectric is inserted between capacitor plates, potential difference between plates may not change.

STATEMENT-3 : As dielectric is inserted between capacitor plates, charge on the capacitor must change.

(1) T T F (2) T F T (3) F T T (4) F T F

12. STATEMENT-1 : Fleming's left hand rule is used to find the direction of force on the current carrying conductor due to magnetic field.

STATEMENT-2 : Right hand rule is used to find the direction of magnetic field lines due to current through circulr coil or straight conductor.

STATEMENT-3 : Right hand thumb rule is used to find the direction of magnetic field lines due to current through circular coil.

(1) T T T (2) F F F (3) F T F (4) T T F

13. STATEMENT-1 : The magnetic flux through a coil maintains a current in the coil.

STATEMENT-2 : Heat generation takes place in an inductor due to resistance of material of inductor.

STATEMENT-3 : A glowing bulb becomes dim when a copper bar is put in the inductor in the a-c circuit.

(1) F T T (2) F F F (3) F T F (4) T T F

14. STATEMENT-1 : If a graph is plotted between accelerating potential (V) and maximum frequency (ν_{max}) of continuous X-ray spectrum, a straight line passing through origin is obtained.

STATEMENT-2 : Continuous X-ray spectrum depends on the material of the target (anode).

STATEMENT-3 : Photoelectric effect is the reverse process of the production of continuous X-ray spectrum.

(1) T T T (2) T F T (3) F T T (4) T T F

15. STATEMENT-1 : A lens is a piece of transparent refractive medium, bounded by two surfaces, one of which at least must be spherical.

STATEMENT-2 : The focal length is negative for a plano-convex lens, while it is positive for a plano-concave lens.

STATEMENT-3 : The focal length of a lens decreases when the lens is placed in water.

(1) F F T (2) F F F (3) F T F (4) T F F

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Brain Storming Comprehensions

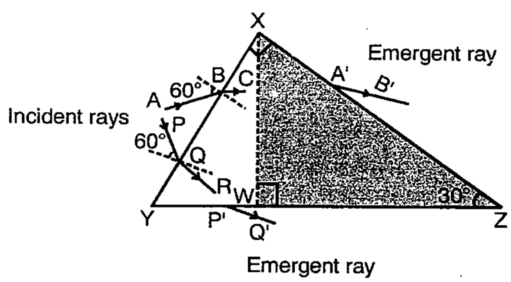
UNIT 6

Linked Comprehension Type

This section contains 12 paragraphs. Each paragraph based upon, 3 multiple choice questions have to be answered. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Comprehensions :

C1. The prism XYZ shown here is made up of two different materials. Section XYW is made up of material of refractive index $\sqrt{3}$, while the other section XWZ is made up of material of unknown refractive index μ Rays AB and PQ are incident on face XY of the prism as shown corresponding to AB and PQ, A'B' and P'Q' are the emergent rays.



Choose the correct answer :

1. What is the angle between rays BC and QR?

(1) 15° (2) 30°

(3) 45° (4) 60°

2. What is the value of μ for which $A'B'$ is parallel to $P'Q'$?

(1) $\frac{2}{\sqrt{3}}$ (2) $\sqrt{3}$

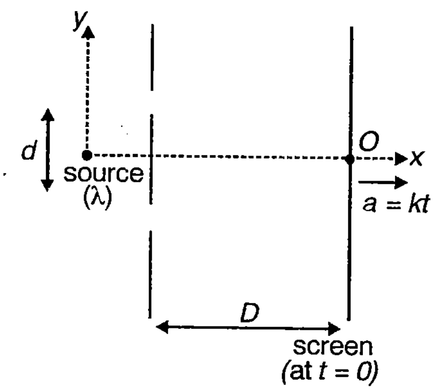
(3) $\frac{4}{\sqrt{3}}$ (4) 2

3. Value of μ, for which there is no emergent ray Theminimum should be just greater than

(1) $\frac{2}{\sqrt{3}}$ (2) $\sqrt{3}$

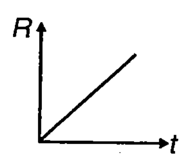
(3) $\frac{4}{\sqrt{3}}$ (4) 2

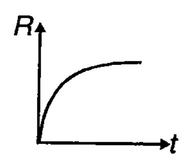
C2. Consider the YDSE arrangement shown; The screen in the arrangement starts accelerating from rest in the positive x - direction, with $a = kt$, at time $t = 0$, (Here k = constant and t denotes time)

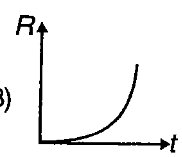


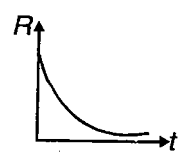
Choose the correct answer :

1. Rate of change of fringe width (R) for the fringe pattern on the screen varies with time t as shown by

(1) 

(2) 

(3) 

(4) 

2. Velocity (at any time t) of n^{th} maxima (above point 0) in frame of ground is

(1) $\frac{kt^2}{2}\left(\hat{i} + \frac{n\lambda}{d}\hat{j}\right)$ (2) $kt\left(\hat{i} + \frac{n\lambda}{d}\hat{j}\right)$

(3) $\frac{kt^3}{2}\left(\frac{n\lambda}{d}\hat{i} + \hat{j}\right)$ (4) $kt\left(\frac{n\lambda}{d}\hat{i} + \hat{j}\right)$

3. Acceleration (at any time t) of n^{th} maxima (above point 0) w.r.t $(n-1)^{th}$ maxima is

(1) $\frac{\lambda kt}{d}(\hat{i}+\hat{j})$ (2) $\frac{\lambda kt}{d}(-\hat{i}+\frac{\hat{j}}{2})$

(3) $\frac{\lambda kt}{d}\hat{i}$ (4) $\frac{\lambda kt}{d}\hat{j}$

C3. For an object, uncertainty in the position of the object (Δx) and uncertainty in the momentum of the object in the x-direction (Δp) at the same instant are related by the equation

$$\Delta x \,.\, \Delta p \geq \frac{\hbar}{2}$$

(here $\hbar = \frac{h}{2\pi} = 1.054 \times 10^{-34}$ j.s)

This equation is known as the uncertainty principle. This principle can also be stated in terms of energy and time. Corresponding to energy E emitted in an atomic process (measured during the interval Δt) if the uncertainty is ΔE, then

$$\Delta E \,.\, \Delta t \geq \frac{\hbar}{2}$$

Choose the correct answer :

1. In an experiment position of a proton is measured with an accuracy of $\pm 1.00 \times 10^{-10}$m. The minimum uncertainty in the proton's position 0.500s later is

(1) 1.58×10^2 m (2) 1.57×10^3 m

(3) 1.6×10^2 m (4) 1.6×10^3 m

2. Uncertainty (Δp) in the momentum of an electron in a hydrogen atom is given by (given that radius of hydrogen atom is 0.53×10^{-10} m)

(1) $\Delta p \geq 10^{-24}$ kg.m/s

(2) $\Delta p \geq 10^{-25}$ kg.m/s

(3) $\Delta p \geq 9.9 \times 10^{-24}$ kg.m/s

(4) $\Delta p \geq 9.9 \times 10^{-25}$ kg.m/s

3. Consider that the minimum uncertainty in the number of waves counted in the wave group is one wave. This would mean that uncertainty in our frequency measurement ($\Delta \nu$) is given by

$$\Delta \nu \geq \frac{1}{\Delta t}$$

In this case which of these equations would you arrive at ? (ΔE = uncertainty in energy)

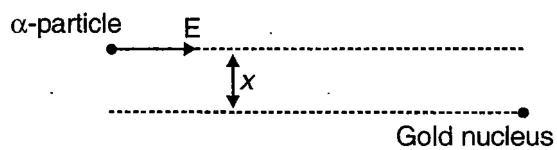
(1) $\Delta E \cdot \Delta t \geq \hbar$ (2) $\Delta E \cdot \Delta t \geq \frac{\hbar}{2}$

(3) $\Delta E \cdot \Delta t \geq 2\pi\hbar$ (4) $\Delta E \cdot \Delta t \geq 2\hbar$

C4. After α– particle scattering (by gold foil) experiment, Rutherford proposed a fresh model of atom, which was accepted, as Rutherford's experimental results on amount of scattering matched with those calculated mathematically by him.

Assume that the α– particle (charge q mass m) was thrown with kinetic energy E from large distance towards the foil (charge on gold atom = Q) gold

Also, assume that initial direction of motion of α– particle is shifted by distance 'x' from the axis of the nucleus of the gold nucleus towards which the α– particle is targated (as shown)



Consider that only interaction between the α– particle and the gold nucleus is electrostatic. Gold nucleus is heavy so that it can be considered to be fixed.

Long time after the α– particle is thrown.

Choose the correct answer :

1. Kinetic energy of the α– particle is

(1) E (2) $\frac{E}{2}$

(3) Zero (4) Infinite

2. Angular momentum of the α– particle about the gold nucleus is

(1) $\sqrt{2Em}\ x$ (2) $> \sqrt{2Em}\ x$

(3) $< \sqrt{2Em}\ x$ (4) Infinite

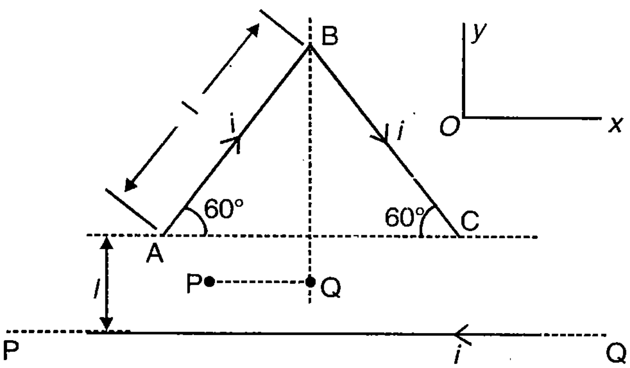
3. Scattering suffered by the α– particle is

[Here k = $\frac{1}{4\pi\varepsilon_0}$]

(1) $2\cot^{-1}\left(\frac{2 \cdot E \cdot x}{kqQ}\right)$ (2) $2\tan^{-1}\left(\frac{2 \cdot E \cdot x}{kqQ}\right)$

(3) $2\cot^{-1}\left(\frac{E \cdot x}{k2qQ}\right)$ (4) $2\tan^{-1}\left(\frac{E \cdot x}{2kqQ}\right)$

C5. A long current-carrying wire PQ and a current carrying conductor ABC are lying on smooth horizontal xy-plane. At $t = 0$, AC is parallel to PQ and the conductor ABC is released from rest from the position shown in figure. Ignore induction effects and magnetic field due to conductor ABC.



Choose the correct answer :

1. Net force acting on the conductor ABC at $t = 0$ is

(1) $\frac{\mu_0 i^2}{\sqrt{3}\pi} \ln\left(1+\frac{\sqrt{3}}{2}\right)$; along +ve y-direction

(2) $\frac{\mu_0 i^2}{\sqrt{3}\pi} \ln\left(\frac{\sqrt{3}}{2}\right)$; along –ve y-direction

(3) $\frac{\mu_0 i^2}{2\sqrt{3}\pi} \ln\left(1+\frac{\sqrt{3}}{2}\right)$; along +ve y-direction

(4) $\frac{\mu_0 i^2}{2\sqrt{3}\pi} \ln\left(1+\frac{\sqrt{3}}{2}\right)$; along –ve y-direction

2. Q is a point on the perpendicular bisector of AC. Total angular momentum of conductor ABC about point Q

(1) Remains zero

(2) Remains non-zero but constant

(3) Increases

(4) Decreases

3. P is another point displaced from Q as shown in the figure. Total angular momentum of conductor ABC about point P

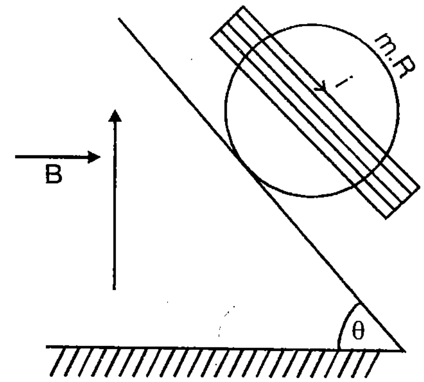
(1) Remains zero

(2) Remains non-zero but constant

(3) Increases

(4) Decreases of conductor ABC

C6. A solid sphere of mass m and radius R has a circular coil of N turns carrying current i wrapped around its equational circle. Solid sphere is on an inclined plane and uniform magnetic field $\vec{B}$ exists in the entire region.



Choose the correct answer :

1. If friction is sufficient to prevent sliding, what should be the magnitude of magnetic field to keep the sphere in equilibrium?

(1) $\frac{2mg}{\pi RiN}$ (2) $\frac{mg}{\pi RiN}$

(3) $\frac{mg}{2\pi RiN}$ (4) $\frac{mg}{4\pi RiN}$

2. For the value of $\vec{B}$ calculated in the above question, the minimum coefficient of friction needed between sphere and inclined plane to maintain the equilibrium of sphere is

(1) $\frac{B}{Rg}\tan\theta$ (2) $\frac{B^2}{Rg}\tan\theta$

(3) $\tan\theta$ (4) $\frac{\tan\theta}{2}$

3. If friction is sufficient, but value of magnetic field is half of the value calculated in previous question, then acceleration of centre of mass of the sphere (neglect mass of the wire) is

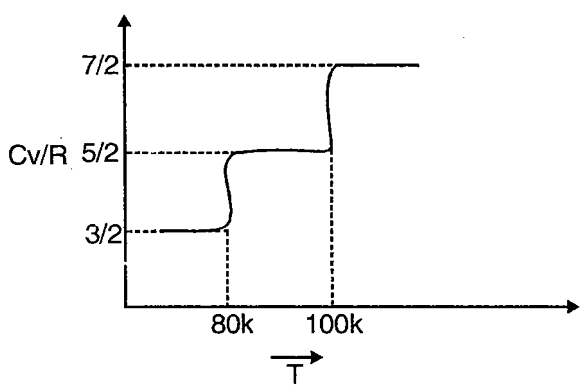
(1) $\frac{5}{7}g\sin\theta$ (2) $\frac{5}{14}g\sin\theta$

(3) $\frac{3}{7}g\sin\theta$ (4) $\frac{3}{14}g\sin\theta$

C7. A plot of C_V/R versus temperature for hydrogen gas is shown in figure.Because rotational and oscillatory motions begin at certain energies, only translation is possible at very low temperature. As the temperature increases rotational motion can begin. This result can be explained with the help of quantum mechanics. According to quantum mechanics, the angular momentum of a rotating object may assume only values specified by the condition

$$L = \frac{h}{2\pi}\sqrt{j(j+1)}$$ [j = Angular quantum number]

Where h is the planck's constant. This gives a lower limit to the rotational kinetic energy. So at low temperature rotational degree of freedom freezes.



Choose the correct answer :

1. If the moment of inertia of the hydrogen molecule is 4.6 $\times 10^{-48}$ kg m^2. So minimum position rotational kinetic energy of the H_2 molecules is

   (1) 2.4×10^{-21} J (2) 1.2×10^{-21} J

   (3) 9.1×10^{-21} J (4) 2.4×10^{-48} J

2. The temperature at which the probability of rotational motion is practically nil?

   (1) 40 K (2) 200 K

   (3) 300 K (4) 1000 K

3. There is practically no freezing out of rotational degrees of freedom of nitrogen gas because

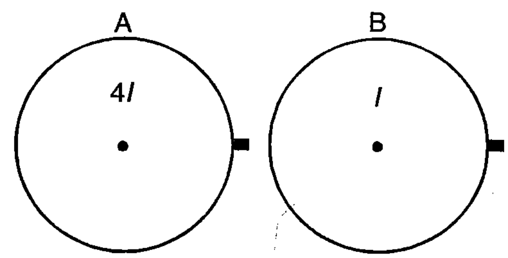
   (1) The moment of inertia is very less

   (2) The moment of inertia is 30 time that of H_2

   (3) Quantum theory is not applicable

   (4) None of these

C8. Two discs A & B having small projections are free to rotate about their axis, which are parallel to each other as shown in figure. The disc B starts rotating with angular velocity ω. It's projection hit's the projection of other disc at rest after time T. The coefficent of restitution is $\frac{1}{2}$. The two discs are of same radius but their moment of inertia are 4I and I respectively.



Choose the correct answer :

1. The angular velocity of the disc A after collision is

   (1) $\frac{3\omega}{10}$ (2) $\frac{\omega}{5}$

   (3) $\frac{2\omega}{5}$ (4) $\frac{3\omega}{5}$

2. The second collision between projection will take place after time

   (1) 10 T (2) 20 T

   (3) 30 T (4) 15 T

3. If the moment of inertia of two disc were same and the coefficent of restitution is one then the collisions will take place with regular interval of

   (1) T (2) 2 T

   (3) $T/2$ (4) 4T

C9. A sphere of mass m and radius R is released from rest while completly submerged in a river. The flow velocity is v_0 and there is no turbulence. The specific gravity of material of the sphere is 5. The force of buoyancy is equal to weight of the sphere.

Choose the correct answer :

1. Find the fraction of the sphere which is empty

   (1) $\frac{4}{5}$ (2) $\frac{3}{5}$

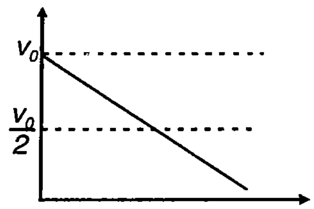
   (3) $\frac{2}{5}$ (4) $\frac{1}{5}$

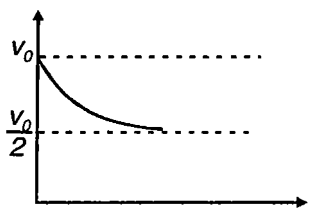
2. The acceleration of the sphere at the instant when velocity of the sphere is $\frac{V_0}{2}$ is

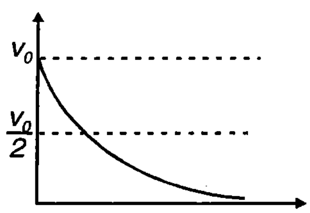
(1) $\frac{6\pi\eta r v_0}{m}$ (2) $\frac{3\pi\eta r v_0}{m}$

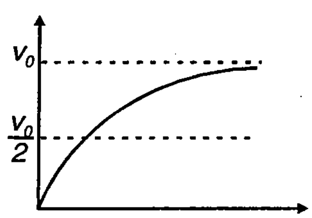
(3) $\frac{2}{3}\frac{\pi\eta r v_0}{m}$ (4) $\frac{4\pi\eta r v_0}{m}$

3. The graph of the velocity with time is best represented as

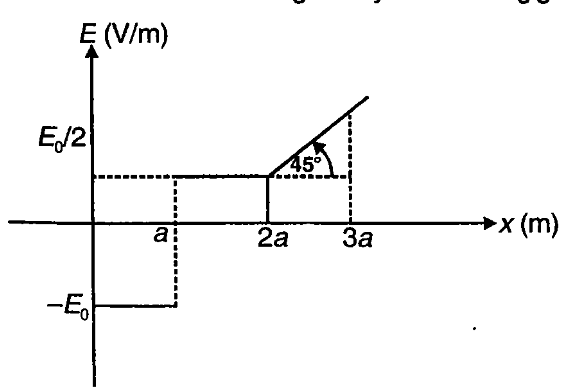
(1)


(2)


(3)


(4)


C10. In a certain region of space, the electric field is along x-axis and its variation is given by the following graph.



Choose the correct answer :

1. Let V_1 be the potential of a point marked by $x = \frac{a}{2}$ and V_2 be the potential at the point marked by $x = \frac{3a}{2}$. The value of $V_1 - V_2$ is

(1) $\frac{3E_0a}{4}$ (2) $\frac{-3E_0a}{4}$

(3) $\frac{E_0a}{4}$ (4) Zero

2. Let there an infinite, thin non-conducting surface parallel to $y-z$ plane lying at $x = a$. What will be the surface charge density of the surface?

(1) $\frac{3}{2}\varepsilon_0 E$ (2) $-\frac{3}{2}\varepsilon_0 E$

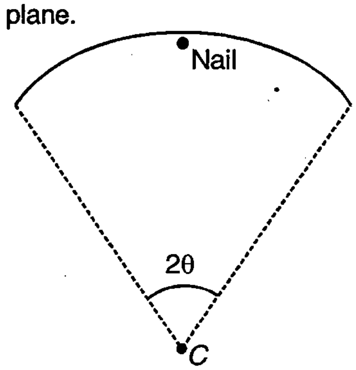
(3) $\frac{\varepsilon_0 E_0}{2}$ (4) $\frac{-\varepsilon_0 E_0}{2}$

3. The volume charge density at $x = 3a$ is

(1) $\frac{E_0}{2}$ (2) $-\frac{E_0}{2}$

(3) ε_0 (4) $-\varepsilon_0$

C11. A uniform wire of length l is bent to form a circular arc that subtends an angle θ at the centre. This wire is subtended by a small nail projecting out of a smooth vertical wall, so that the wire can move in a vertical plane.



Choose the correct answer :

1. If the mass of the wire is m, the moment of inertia of the wire about a horizontal axis through the centre of the arc is

(1) $\frac{ml^2}{4\pi^2}$ (2) $4ml^2\theta^2$

(3) $\frac{ml^2}{4\theta^2}$ (4) $\frac{ml^2\theta^2}{4\pi^2}$

2. The centre of mass of this arc lies a distance x vertically above C, where x is

(1) $\frac{l(1-\cos\theta)}{\theta^2}$ (2) $\frac{l(1-\sin\theta)}{\theta^2}$

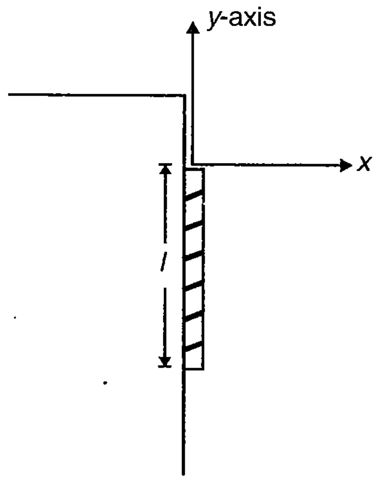
(3) $\frac{2l}{\pi\theta}$ (4) Zero

3. The time of small oscillations of the wire about the nail in the vertical plane is

(1) $2\pi\sqrt{\frac{l}{g}}$ (2) $2\pi\sqrt{\frac{2l}{g}}$

(3) $2\pi\sqrt{\frac{2l}{g\theta}}$ (4) $2\pi\sqrt{\frac{l}{g\theta}}$

C12. The following figure shows a long, rough vertical wall against which a uniform rope with mass per unit length m and charge per unit length λ is held at rest by a uniform horizontal electric field that is limited to the region $y = 0$ to $y = \frac{-l}{2}$. Here, l is the total length of the rope. The coefficient of friction between the wall and surface is μ.



Choose the correct answer :

1. The minimum electric field required to keep the rope in equilibrium is

(1) $\frac{mg}{\mu\lambda}$ (2) $\frac{2mg}{\mu\lambda}$

(3) $\frac{mg}{2\mu\lambda}$ (4) $\frac{4mg}{\mu\lambda}$

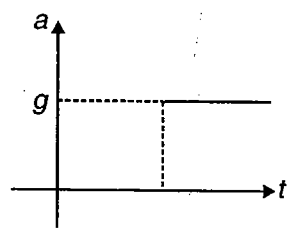
2. Suppose the electric field applied extends from $y = 0$ to $y = -l$ and has the value obtained in previous question at the moment $t = 0$. The field starts decreasing in magnitude exponentially with a decay constant α at the moment $t = 0$. The moment of time after which the rope starts slipping is

(1) $\frac{1}{\alpha}$ (2) $\frac{\ln 2}{\alpha}$

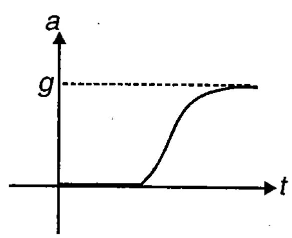
(3) α (4) $\frac{\alpha}{\ln 2}$

3. Which of the following graph represents the variation of electric field with time for the situation described in above situation?

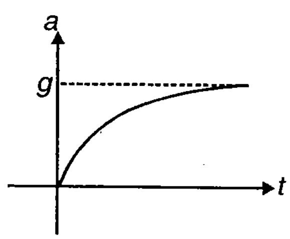
(1)



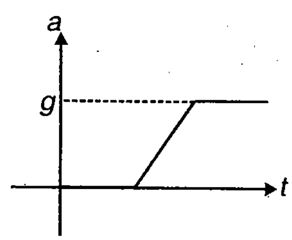
(2)



(3)



(4)



❑ ❑ ❑

ANSWERS

UNIT - 1 : Mechanics

Section A : Straight Objective Type

1.	(3)	2.	(1)	3.	(1)	4.	(4)	5.	(3)	6.	(2)	7.	(4)
8.	(3)	9.	(2)	10.	(2)	11.	(3)	12.	(2)	13.	(1)	14.	(3)
15.	(4)	16.	(2)	17.	(3)	18.	(2)	19.	(3)	20.	(2)	21.	(3)
21(a).	(2)	22.	(1)	23.	(1)	24.	(1)	25.	(3)	26.	(4)	27.	(1)
28.	(1)	29.	(3)	29a.	(2)	30.	(4)	31.	(1)	32.	(4)	33.	(3)
34.	(2)	35.	(1)	36.	(4)	37.	(3)	38.	(2)	39.	(3)	40.	(1)
41.	(2)	42.	(4)	43.	(4)	44.	(1)	45.	(2)	46.	(3)	47.	(1)
48.	(4)	49.	(4)	50.	(1)	51.	(2)	52.	(3)	53.	(3)	54.	(1)
55.	(2)	56.	(2)	57.	(4)	58.	(4)	59.	(1)	60.	(3)	61.	(4)
62.	(3)	63.	(3)	64.	(2)	65.	(4)	66.	(1)	67.	(4)	68.	(3)
69.	(3)	70.	(2)	71.	(3)	72.	(2)	73.	(4)	74.	(3)	75.	(1)
76.	(2)	77.	(2)	78.	(3)	79.	(1)	80.	(3)	81.	(2)	82.	(1)
83.	(3)	84.	(4)	85.	(4)	86.	(4)	87.	(3)	88.	(2)	89.	(1)
90.	(2)	91.	(1)	92.	(2)	93.	(3)	94.	(3)	95.	(2)	96.	(1)
97.	(3)	98.	(1)	99.	(1)	100.	(4)	101.	(1)	102.	(2)	103.	(1)
104.	(3)	105.	(3)	106.	(3)	107.	(2)	108.	(1)	109.	(3)	110.	(1)
111.	(1)	112.	(1)	113.	(2)	114.	(3)	115.	(3)	116.	(2)	117.	(2)
118.	(3)	119.	(3)	120.	(1)	121.	(1)	122.	(2)	122a.	(3)	123.	(3)
124.	(3)	125.	(3)	126.	(4)	127.	(2)	128.	(1)	129.	(3)	130.	(4)
131.	(1)	132.	(2)	133.	(2)	134.	(2)	135.	(1)	136.	(4)	137.	(2)
138.	(2)	139.	(2)	140.	(3)	141.	(2)	142.	(2)	143.	(3)	144.	(4)
145.	(1)	146.	(3)	147.	(2)	148.	(2)	149.	(3)	150.	(2)	151.	(3)
152.	(4)	153.	(1)	154.	(2)	155.	(4)	156.	(4)	157.	(3)	158.	(1)
159.	(1)	160.	(1)	161.	(4)	162.	(1)	163.	(2)	164.	(2)	165.	(2)
166.	(3)	167.	(2)	168.	(2)	169.	(4)	170.	(2)	171.	(1)	172.	(3)
173.	(4)	174.	(4)	175.	(2)	176.	(3)	177.	(4)	178.	(3)	179.	(3)
180.	(3)	181.	(3)	182.	(4)	183.	(3)	184.	(1)	185.	(4)	186.	(4)
187.	(1)	188.	(2)	189.	(2)	190.	(3)	191.	(4)	192.	(2)	193.	(4)
194.	(4)	195.	(1)	196.	(2)	197.	(4)	198.	(2)	199.	(3)	200.	(1)
201.	(4)	202.	(3)	203.	(1)	204.	(1)	205.	(2)	206.	(2)	207.	(2)

208.	(4)	209.	(1)	210.	(2)	211.	(2)	212.	(3)	213.	(3)	214.	(3)
215.	(4)	216.	(1)	217.	(3)	218.	(4)	219.	(3)	220.	(2)	221.	(1)
222.	(3)	223.	(3)	224.	(2)	225.	(3)	226.	(3)	227.	(1)	228.	(1)
229.	(2)	230.	(3)	231.	(2)	232.	(1)	233.	(2)	234.	(2)	235.	(3)
236.	(2)	237.	(2)	238.	(1)	239.	(4)	240.	(1)	241.	(2)	242.	(4)
243.	(4)	244.	(4)	245.	(3)	246.	(2)	247.	(4)	248.	(1)	249.	(3)
250.	(1)	251.	(2)	252.	(1)	253.	(3)	254.	(2)	255.	(3)	256.	(1)
257.	(3)	258.	(3)	259.	(1)	260.	(4)	261.	(2)	262.	(3)	263.	(2)
264.	(2)	265.	(4)	266.	(1)	267.	(1)	268.	(3)	269.	(4)	270.	(1)
271.	(4)	272.	(2)	273.	(2)	274.	(2)	275.	(1)	276.	(2)	277.	(3)
278.	(4)	279.	(2)	280.	(3)	280a.	(3)	281.	(1)	282.	(4)	283.	(1)
284.	(4)	285.	(3)	286.	(3)	287.	(1)	288.	(4)	289.	(4)	290.	(1)
291.	(1)	292.	(3)	293.	(2)	294.	(1)	295.	(4)	296.	(1)	296a.	(4)
297.	(2)	298.	(4)	299.	(3)	300.	(1)	301.	(4)	302.	(4)	303.	(3)
304.	(3)	305.	(1)	306.	(3)	307.	(4)	308.	(3)	309.	(3)	310.	(2)
311.	(3)	312.	(1)	313.	(2)	314.	(1)	315.	(4)	316.	(1)	317.	(1)
318.	(3)	319.	(3)	320.	(2)	321.	(1)	322.	(4)	323.	(1)	324.	(1)
325.	(1)	326.	(1)	327.	(4)	328.	(4)	329.	(4)	330.	(2)	331.	(3)
332.	(2)	333.	(3)	334.	(2)								

Section - B : Multiple Choice Questions

1.	(2, 3)	1(a).	(2)	1(b).	(1, 3)	2.	(1, 4)	3.	(1, 2, 3, 4)	4.	(1, 3, 4)		
5.	(2, 3, 4)	6.	(1, 2, 4)	7.	(1, 2, 4)	8.	(1, 2, 3)	9.	(3, 4)	10.	(1, 2, 3)		
11.	(2, 3, 4)	12.	(1, 2, 3, 4)	13.	(1, 4)	14.	(2, 3, 4)	15.	(1, 4)	16.	(1, 2, 3, 4)		
17.	(2, 3)	18.	(1, 3, 4)	19.	(1, 3)	20.	(1, 2, 3, 4)	21.	(1, 2, 4)	22.	(3, 4)		
23.	(1, 2, 3, 4)	24.	(1, 2, 3, 4)	25.	(3, 4)	26.	(2, 4)	27.	(2, 4)	28.	(2, 3)		
29.	(2, 3)	30.	(2, 4)	31.	(2, 3)	32.	(2, 4)	33.	(1, 3)	34.	(1, 2, 3, 4)		
35.	(1, 3, 4)	36.	(1, 2)	37.	(2, 4)	38.	(1, 2, 3, 4)	39.	(1, 3)	40.	(1, 2)		
41.	(1, 3, 4)	42.	(1, 2)	43.	(1, 3)	44.	(2, 3, 4)	44(a)	(3)	45.	(1, 2, 3)		
46.	(1, 2, 3, 4)	47.	(1, 3, 4)	48.	(1, 2, 3, 4)	49.	(1, 2, 3)	50.	(1, 2, 3)	51.	(1, 2, 3)		
51(a).	(1, 3)	52.	(2, 4)	53.	(1, 2, 3, 4)	53(a).	(1, 3)	54.	(1, 2, 3)	55.	(1, 2, 3, 4)		
56.	(2, 3, 4)	57.	(2, 3, 4)	58.	(2, 3, 4)	58(a).	1. (3), 2. (2), 3. (4)			59.	(1, 2, 4)		
60.	(1, 2, 3, 4)	61.	(2, 3, 4)	62.	(1, 2, 3, 4)	63.	(1, 2, 3, 4)	64.	(2, 3)	65.	(1, 2, 4)		
66.	(1, 2, 3, 4)	67.	(1, 2, 3)	68.	(2, 4)	69.	(3, 4)	70.	(1, 4)	71.	(2, 3)		
72.	(2, 3)	73.	(1, 2)	74.	(1, 3, 4)	75.	(1, 3, 4)	76.	(1, 2, 3, 4)	77.	(2, 3, 4)		
78.	(1, 2, 3, 4)	79.	(1, 4)	80.	(1, 2, 3, 4)	81.	(1, 3)	82.	(1, 2, 3, 4)	83.	(1, 3)		

84. (1, 2, 3)	85. (2, 4)	86. (1, 3)	87. (1, 3)	88. (1, 2, 3, 4)	89. (1, 2, 3)
90. (2, 4)	91. (1, 2, 3)	92. (2, 3)	93. (1, 2, 3, 4)	94. (1, 2, 3, 4)	95. (1, 3, 4)
96. (1, 2, 3, 4)	97. (2, 4)	98. (1, 2, 3)	99. (1, 3)	100. (1, 3)	101. (3, 4)
102. (1, 2)	103. (1, 2, 4)	104. (2, 3)	105. (2, 3)	106. (1, 2)	107. (2, 3, 4)
108. (3, 4)	109. (1, 2, 3)	110. (1, 2, 4)	111. (1, 2, 3, 4)	112. (1, 2, 3, 4)	113. (2, 3)
114. (1, 2, 3, 4)	115. (2, 3, 4)				

Section - C : Linked Comprehension Type

C1.	1. (4)	2. (4)	3. (4)
C2.	1. (4)	2. (1)	3. (4)
C3.	1. (2)	2. (4)	3. (1)
C4.	1. (3)	2. (1)	3. (1)
C5.	1. (2)	2. (3)	3. (4)
C6.	1. (2)	2. (4)	3. (1)
C7.	1. (1)	2. (3)	3. (3)
C8.	1. (2)	2. (4)	3. (2)
C9.	1. (4)	2. (1)	3. (2)
C10.	1. (1)	2. (3)	3. (2)
C11.	1. (1)	2. (1)	3. (1)
C12.	1. (2)	2. (1)	3. (2)
C13.	1. (1)	2. (3)	3. (1)
C14.	1. (4)	2. (2)	3. (1)
C15.	1. (4)	2. (3)	3. (1)
C16.	1. (2)	2. (2)	3. (3)
C17.	1. (4)	2. (2)	3. (2)
C18.	1. (4)	2. (4)	3. (1)
C19.	1. (4)	2. (4)	3. (3)
C20.	1. (1)	2. (1)	3. (2)
C21.	1. (1)	2. (1)	3. (2)
C22.	1. (4)	2. (1)	3. (3)
C23.	1. (2)	2. (3)	3. (1)
C24.	1. (4)	2. (1)	3. (1)
C25.	1. (2)	2. (1)	3. (1)
C26.	1. (1)	2. (3)	3. (4)
C27.	1. (2)	2. (3)	3. (4)
C28.	1. (1)	2. (1)	3. (3)

C29.	1. (3)	2. (1)	3. (4)
C30.	1. (1)	2. (4)	3. (2)
C31.	1. (4)	2. (1)	3. (2)
C32.	1. (4)	2. (1)	3. (2)
C33.	1. (2)	2. (3)	3. (3)
C34.	1. (2)	2. (2)	3. (4)
C35.	1. (1)	2. (3)	3. (2)
C36.	1. (2)	2. (3)	3. (1)
C37.	1. (1)	2. (3)	3. (1)
C38.	1. (2)	2. (4)	3. (1)
C39.	1. (1)	2. (1)	3. (4)
C40.	1. (2)	2. (4)	3. (3)
C41.	1. (3)	2. (1)	3. (4)
C42.	1. (2)	2. (4)	3. (4)
C43.	1. (2)	2. (3)	3. (4)
C44.	1. (3)	2. (3)	3. (3)
C45.	1. (4)	2. (2)	3. (3)
C46.	1. (2)	2. (3)	3. (2)
C47.	1. (2)	2. (1)	3. (2)
C48.	1. (4)	2. (1)	3. (2)
C49.	1. (1)	2. (2)	3. (1)

C49(a). (7)

Section - D : Assertion - Reason Type

1. (3)	2. (2)	3. (4)	4. (4)	5. (1)	6. (4)	7. (1)
8. (4)	9. (4)	10. (2)	11. (1)	12. (2)	13. (2)	14. (4)
15. (4)	16. (1)	17. (2)	18. (2)	19. (1)	20. (1)	21. (4)
22. (1)	23. (1)	24. (3)	25. (4)	26. (2)	27. (4)	28. (1)
29. (4)	30. (1)	31. (4)	32. (2)	33. (3)	34. (4)	35. (4)
36. (4)	37. (2)	38. (3)	39. (4)	40. (3)	41. (3)	42. (4)
43. (1)	44. (3)	45. (1)	46. (1)	47. (4)	48. (1)	49. (2)
50. (1)	51. (2)	52. (4)	53. (3)	54. (2)	55. (2)	56. (4)
57. (3)	58. (4)	59. (1)	60. (4)	61. (1)	62. (4)	63. (1)
64. (3)	65. (2)	66. (2)	67. (4)	68. (4)	69. (1)	70. (3)
71. (3)	72. (1)	73. (2)	74. (1)	75. (2)	76. (1)	77. (4)
78. (3)	79. (2)	80. (4)	81. (3)	82. (1)	83. (4)	84. (1)

85. (4)	86. (1)	87. (1)	88. (4)	89. (2)	89(a). (1)	90. (4)
90(a). (1)	91. (2)	92. (2)	93. (4)	94. (2)	95. (1)	96. (2)
97. (4)	98. (3)	99. (3)	100. (4)	101. (1)	102. (3)	103. (2)
104. (1)	105. (4)	106. (3)	107. (1)	108. (1)	109. (2)	110. (3)
111. (4)	112. (4)	113. (2)	114. (4)	115. (1)	116. (4)	117. (4)
118. (1)	119. (1)	120. (3)	121. (2)	122. (1)	123. (3)	124. (4)
125. (3)	126. (2)	127. (1)	128. (4)			

Section - E : Matrix-Match Type

1. A(p, q, s, t), B(r), C(s), D(r, t)
2. A(s), B(r), C(q), D(q)
3. A(p), B(q), C(t), D(r, t)
4. A(p, t), B(r, s), C(q), D(p, t)
5. A(s), B(p, q), C(r), D(t)
6. A(s), B(r), C(p, q), D(p)
7. A(p, q, s), B(p, r, s), C(p, s, t), D(p, q, r, s, t)
8. A(p, t), B(s, t), C(r, t), D(q, t)
9. A(p, q, r, s), B(p, q, s), C(q, r, t), D(q, r, s, t)
10. A(r), B(p), C(q), D(q)
11. A(p, q, r), B(p, q, r, s, t), C(r, s), D(p, q, s, t)
12. A(t), B(p, q), C(p, s), D(r, s)
13. A(p, q, t), B(s, t), C(r, s), D(p, s)
14. A(p), B(r, s), C(t), D(q)
15. A(p, r), B(p, s), C(p), D(p, r, t)
16. A(p, s), B(q, t), C(p, s), D(r)
17. A(p, q, s), B(p, q), C(p, q, r, t), D(p, t)
18. A(q, r, s), B(p, q, r, s), C(p, r), D(r, s)
19. A(p, q), B(p, s), C(r), D(r)
20. A(p, q), B(p, q), C(p), D(p)
21. A(r, t), B(p), C(q, t), D(s)
22. A(s), B(s), C(q, r, s), D(p, q, r, s)
23. A(p), B(q, s), C(r), D(t)

24. A(r), B(p), C(q), D(s)
25. A(r), B(q), C(p), D(s)
26. A(s), B(r), C(q), D(p)
27. A(q, s, t), B(q, t), C(r, t), D(p, r, s, t)
28. A(q), B(p, t), C(r, t), D(s, t)
29. A(q, t), B(s, t), C(p, t), D(r)
30. A(q, s), B(p), C(p, q, r, s, t), D(q, s)
31. A(q, t), B(p), C(p), D(q, t)
32. A(q, s), B(r, s), C(p, s, t), D(p, s, t)
33. A(p, r, s), B(q), C(p, r), D(q)
34. A(r, t), B(p, q), C(s), D(p, q, r, t)
35. A(q, t), B(r), C(q, t), D(s, t)
36. A(p, q), B(q, r, s), C(q, r, s), D(q, r, s)
37. A(s, t), B(q, t), C(r, t), D(p, t)
38. A(r), B(q), C(s), D(p, t)
39. A(r, t), B(s, t), C(q, s), D(p)
40. A(q, t), B(r, t), C(p), D(s)
41. A(r, t), B(q, t), C(p, t), D(s, t)
42. A(q, t), B(s, t), C(r), D(s, t)
43. A(p), B(r), C(r), D(r)
44. A(p), B(r, t), C(p), D(q, t)
45. A(q, t), B(p, q, t), C(r, s), D(r, s)
46. A(p, q, t), B(r, s), C(r, s), D(p, q, t)
47. A(p, r, t), B(r, s), C(q, r), D(p, r, t)
48. A(p, r), B(r), C(s, t), D(s, t)
49. A(q, t), B(q, r, t), C(p), D(s)
50. A(p, q, r), B(p, r), C(p, q, r), D(p, q, r, s, t)
51. A(p, t), B(q, t), C(r). D(s, t)
52. A(q, t), B(p, t), C(r, t), D(s)
53. A(q, t), B(p), C(r), D(s)
54. A(q), B(r, t), C(p), D(s, t)
55. A(p, q), B(p, q, t), C(r, s), D(r, s, t)
56. A(q, s, t), B(q, s, t), C(p). D(q, r, t)
57. A(q, s, t), B(p, q, s, t), C(p, q, t), D(p, q, t)
58. A(r), B(q, s), C(q, s), D(q, t)
59. A(s), B(p), C(p), D(q, t)
60. A(s, t), B(p), C(q), D(r)

Section - F : Subjective Type

1. 5.66 mm
2. $[\rho^1 G^1 \omega^{ñ2} R^0]$ or $[\rho^{ñ1} G^{ñ1} \omega^2 R^0]$
3. Angular velocity = A
5. $\left[\dfrac{(3x^2 \text{ ñ } 18x)\,j + \grave{\hat{i}}}{\sqrt{9x^4 + 324x^2 \text{ ñ } 108x^3 + 1}}\right]$
6. 50 cm
7. $[(10.1 \pm 0.2)\text{ms}^{ñ2}]$
8. $\sqrt{\dfrac{fs}{n}(3n-1)}$
9. $\left[1+\dfrac{1}{m}+\dfrac{1}{n}\right]$
10. (a) $\dfrac{\alpha}{\sqrt{\beta}}$

    (b) $\dfrac{2\alpha}{\beta}$

    (c) $\dfrac{\alpha}{\beta}$
11. (a) $\left[\dfrac{2gh}{2+\cot^2\theta}\right]^{1/2}$

    (b) $2\sqrt{\dfrac{2h\cos^2\theta}{g(1+\sin^2\theta)}}$

    (c) $\dfrac{h\sin 2\theta}{1+\sin^2\theta}, \dfrac{h\cos^2\theta}{1+\sin^2\theta}$
13. $(2+\sqrt{2})t_1$
14. $\dfrac{d\theta}{dt} = \dfrac{-(v_1+v_2)\sin^2\theta}{R\cos\theta}$
15. $a_8 = 8.4$ m/s^2 downwards (approx.)

    $a_2 = 3.6$ m/s^2 downwards (approx.)

    $a_4 = 3$ m/s^2 upwards (approx.)
16. $a_6 = \dfrac{35}{19}\text{m/s}^2$

    $a_4 = \dfrac{46}{19}\text{m/s}^2$

17. (a) $\frac{3g}{25}$ down the plane

(b) $\frac{2g}{5}$ down the plane

(c) Zero

18. $T_{\min} = \frac{\mu mg}{\sqrt{1+\mu^2}}$, $\alpha = \tan^{-1}(\mu)$

19. $\mu = \frac{g\sin\theta - \frac{2l}{t^2}}{g\cos\theta}$

20. (a) 4.9 N

(b) 24.5 N

(c) 0.2

21. (a) μ is given by $\frac{2r}{l} = \frac{\sin^2\theta(1-\mu^2)}{\mu}$

(b) 0.24

22. T = 13.6 N

23. 0.33

24. $\frac{1500}{67}$ kg m/s

25. $u\sqrt{\frac{m}{k}\frac{(1+2n-3n^2)}{4}}$

26. $\left(\frac{mMu^2}{2(M+m)x}\right)$

27. $\sqrt{\frac{gR}{4\pi}\left[8+3\pi^2\right]}$

28. $\theta_{\max} = 90^{\circ}$

$T_{\max} = mg(1+\theta_0^2)$

29. 0.48 h

30. 3.478 m/s^2

31. $V_0 \le \sqrt{\left(\frac{7\sqrt{3}}{6}-\frac{4}{3}\right)gR}$

32. $t = \dfrac{\omega_0 R}{g(3\mu\cos\theta - \sin\theta)}$

33. $\left[\dfrac{\dfrac{m_2 L}{2} + m_1(L+r)}{\dfrac{m_2 L^2}{3} + \dfrac{m_1 r^2}{2} + m_1(L+r)^2}\right] g\sin\theta$

34. (a) $\dfrac{3g}{2L\sqrt{2}}$

(b) $\sqrt{\dfrac{3g}{L}\left(1 - \dfrac{1}{\sqrt{2}}\right)}$

35. $\mu_{min} = \dfrac{2}{7\sqrt{3}}$

36. (a) $\dfrac{5}{7}, \dfrac{2}{7}$

(b) $\dfrac{17}{7}$ mg

37. $-\dfrac{3}{2}\dfrac{GMm}{R}$

38. $v_1 = \sqrt{\dfrac{2Gm_2^2}{m_1 + m_2}\left(\dfrac{1}{l} - \dfrac{1}{L}\right)}$, $v_2 = \sqrt{\dfrac{2Gm_1^2}{m_1 + m_2}\left(\dfrac{1}{l} - \dfrac{1}{L}\right)}$

39. $\dfrac{-GM_0 m}{L^2}\left[1 - \dfrac{1}{8\left(1 - \dfrac{R}{2L}\right)^2}\right]$

40. $\vec{F} = -\left(\dfrac{GM_0 m}{R_0^3}\right)\vec{R}$

42. $2\sqrt{2g}\left(\sqrt{h_1} - \sqrt{h_2}\right)$

43. 2.35 ◊ $10^{ñ3}$ m

44. 0.5 ◊ 10^4 N

45. 0.25

46. 1.8 m/s

47. (a) $\tan^{-1}\left(\frac{2}{\pi}\right)$

(b) $T = 2\pi\sqrt{\dfrac{\dfrac{mR^2}{2} - m\left(\dfrac{2R}{\pi}\right)^2 + m\left(\dfrac{2R}{\pi\sin\alpha}\right)^2}{mg\left(\dfrac{2g}{\pi\sin\alpha}\right)}}$

48. Ratio is $\sqrt{\frac{7}{5}} : \sqrt{\frac{3}{2}} : \sqrt{\frac{2}{1}}$

49. $\Delta t = \dfrac{1}{\omega}\left[\pi - 2\sin^{-1}\left(\dfrac{x_0}{\sqrt{\left(\dfrac{v_0}{\omega}\right)^2 + x_0^2}}\right)\right]$

50. $\frac{4}{3}t + \frac{2}{3}\sqrt{\frac{4}{15}}\sin(\sqrt{60}t)$

51. $(12)^{\circ}$ $s^{ñ1}$

52. $\dfrac{2\pi\sqrt{7}}{15}$ s

53. $10 + 6\sin(10t + \pi)$

54. $y = A\sin[(\omega + kv)t$ ñ $kx']$; $v' = v + \dfrac{\omega}{k}$

55. 1 m

56. 1.4

57. $\frac{2}{3}W_0$

58. 100 m

59. 878.156 Hz

60. 336 m/s

Section - G : Integer Answer Type

1. 3
2. 2
3. 6
4. 2
5. 4
6. 3
7. 9
8. 1
9. 3
10. 4
11. 8
12. 4
13. 4
14. 1
15. 5
16. 1
17. 4
18. 3
19. 6
20. 5
21. 2
22. 5
23. 2
24. 8
25. 1
26. 1
27. 3
28. 5
29. 3
30. 5
31. 8
32. 3
33. 6
34. 4

35. 5
36. 2
37. 6
38. 4
39. 8
40. 5
41. 5
42. 6
43. 4
44. 2
45. 2
46. 2
47. 4
48. 2
49. 5
50. 9
51. 2

Section - H : Multiple True-False Type Questions

1.	(3)	2.	(1)	3.	(4)	4.	(2)	5.	(2)	6.	(3)	7.	(1)
8.	(2)	9.	(3)	10.	(2)	11.	(2)	12.	(2)	13.	(4)	14.	(4)
15.	(3)	16.	(1)	17.	(3)	18.	(1)	19.	(2)	20.	(3)		

UNIT - 2 : Heat

Section A : Straight Objective Type

1.	(4)	2.	(3)	3.	(3)	4.	(3)	5.	(1)	6.	(3)	7.	(3)
8.	(2)	9.	(1)	10.	(1)	10(a).	(2, 4)	11.	(1)	12.	(3)	13.	(1)
14.	(3)	15.	(2)	16.	(3)	17.	(4)	18.	(3)	19.	(2)	20.	(2)
21.	(4)	22.	(1)	23.	(3)	24.	(3)	25.	(1)	26.	(1)	27.	(2)
28.	(1)	29.	(3)	30.	(4)	31.	(2)	32.	(2)	33.	(1)	34.	(3)
35.	(2)	36.	(4)	37.	(3)	38.	(3)	39.	(4)	40.	(1)	41.	(3)
42.	(1)	43.	(1)	44.	(3)	45.	(3)	46.	(2)	47.	(4)	48.	(1)
49.	(2)	50.	(1)	51.	(3)	52.	(4)	53.	(4)	54.	(2)	55.	(4)
56.	(2)	57.	(1)	58.	(3)	59.	(1)	60.	(1)	61.	(3)	62.	(1)
63.	(1)	64.	(2)	65.	(3)	66.	(4)	67.	(3)	68.	(1)	69.	(4)
69(a).	(9)	70.	(3)	71.	(2)	72.	(4)	73.	(1)	74.	(1)	75.	(4)

76.	(2)	77.	(1)	78.	(2)	78(a).	(1, 2)	79.	(2)	79(a).	(9)	80.	(2)
81.	(2)	82.	(3)	83.	(4)	84.	(1)	85.	(3)	86.	(1)	87.	(2)
88.	(1)	89.	(1)	90.	(4)	91.	(3)	92.	(2)	93.	(2)	94.	(3)
95.	(1)	96.	(3)										

Section - B : Multiple Choice Questions

1.	(1, 3)	2.	(1, 2, 3, 4)	3.	(1, 2, 3, 4)	4.	(2, 3)	5.	(1, 2)	6.	(2, 4)
7.	(2, 3)	8.	(2, 4)	9.	(1, 4)	10.	(1, 2, 3, 4)	11.	(1, 2, 3, 4)	12.	(2, 3)
13.	(1, 2, 3, 4)	14.	(1, 2, 3, 4)	15.	(3, 4)	16.	(1, 2, 3, 4)	17.	(1, 2)	18.	(1, 2, 3)
19.	(1, 2)	20.	(1, 2, 3, 4)								

Section - C : Linked Comprehension

C1.	1.	(2)	2.	(3)	3.	(1)
C2.	1.	(1)	2.	(2)	3.	(1)
C3.	1.	(4)	2.	(1)	3.	(3)
C4.	1.	(2)	2.	(2)	3.	(2)
C5.	1.	(2)	2.	(3)	3.	(1)
C6.	1.	(2)	2.	(2)	3.	(4)
C7.	1.	(3)	2.	(3)	3.	(2)
C8.	1.	(1)	2.	(4)	3.	(3)
C9.	1.	(1)	2.	(3)	3.	(2)
C10.	1.	(3)	2.	(1)	3.	(3)
C11.	1.	(2)	2.	(2)	3.	(2)

Section - D : Assertion - Reason Type

1.	(1)	2.	(4)	3.	(2)	4.	(1)	5.	(2)	6.	(1)	7.	(1)
8.	(2)	9.	(4)	10.	(4)	11.	(3)	12.	(2)	13.	(3)	14.	(4)
15.	(2)	16.	(1)	17.	(4)	18.	(4)	19.	(1)	20.	(1)	21.	(1)
22.	(4)	23.	(1)	24.	(1)	25.	(2)	26.	(1)	27.	(4)	28.	(3)
29.	(2)	30.	(2)	31.	(3)	32.	(1)	33.	(2)				

Section - E : Matrix-Match Type

1. A(p, t), B(r, s), C(q), D(s)
2. A(p), B(s), C(q), D(r)
3. A(r), B(r, s, t), C(p, t), D(r, t)
4. A(q, t), B(s, t), C(r, t), D(p, t)

5. A(q, t), B(r, t), C(s, t), D(p)
6. A(r), B(p), C(s, t), D(q)
7. A(q, r), B(p), C(s), D(p, t)
8. A(p, s, t), B(s, t), C(p, s, t), D(q, r)
9. A(q, r), B(p, s, t), C(p, r, t), D(q, s, t)
10. A(q), B(r), C(s, t), D(p)
11. A(r), B(p), C(q, t), D(p)
12. A(r, s), B(p), C(p, t), D(q)
13. A(p, q, r), B(p, q, r, t), C(q), D(r)

Section - F : Subjective Type

1. (a) $V_{rms} = 495$ m/s

   (b) Molecular weight of gas is 40 and the gas is Argon.

2. 72 cm of Hg
3. 422 K
4. P = 1.03 atm
5. $P = P_0 e^{-\alpha t/V_0}$

   $t = \frac{V_0}{\alpha} \log_e(3)$

6. $P_{min} = 2R\sqrt{\alpha T_0}$
7. $T_{max} = \frac{2P_0}{3R}\left(\frac{P_0}{3\alpha}\right)^{\frac{1}{2}}$
8. Change in pressure is ñ7%
9. $C = C_v + \frac{R}{\alpha V}$
10. $C = C_P + \frac{RT_0}{\alpha V}$
11. $H = \frac{k_0 A T_0}{L_0}\left(1 + \frac{3\alpha T_0}{2}\right)$
12. t = 10.03 hrs.
13. t = 160 s
14. 8 min 20 s

Section - G : Integer Answer Type

1. 1
2. 2
3. 3
4. 3
5. 2
6. 2
7. 3

Section - H : Multiple True-False Type Questions

1.	(1)	2.	(1)	3.	(1)

UNIT - 3 : Electromagnetism

Section A : Straight Objective Type

1.	(1)	2.	(3)	3.	(2)	4.	(3)	5.	(2)	6.	(1)	7.	(2)
8.	(1)	9.	(3)	10.	(1)	11.	(1)	12.	(2)	13.	(1)	14.	(1)
15.	(2)	16.	(3)	17.	(1)	18.	(4)	19.	(3)	20.	(1)	21.	(4)
22.	(1)	23.	(3)	24.	(2)	25.	(2)	26.	(3)	27.	(1)	28.	(4)
29.	(3)	30.	(3)	31.	(3)	32.	(1)	33.	(4)	34.	(2)	35.	(1)
36.	(3)	37.	(1)	38.	(3)	39.	(3)	40.	(2)	41.	(1)	42.	(2)
43.	(2)	44.	(4)	45.	(3)	46.	(2)	47.	(3)	48.	(4)	48(a)	(2)
49.	(2)	50.	(3)	51.	(2)	51(a)	(2)	52.	(4)	53.	(1)	54.	(2)
55.	(3)	56.	(2)	57.	(2)	58.	(4)	59.	(3)	60.	(1)	61.	(1)
62.	(3)	63.	(3)	64.	(4)	65.	(1)	66.	(1)	67.	(2)	68.	(1)
69.	(2)	70.	(2)	71.	(3)	72.	(2)	73.	(1)	74.	(2)	75.	(4)
76.	(2)	77.	(3)	78.	(2)	79.	(2)	80.	(1)	81.	(3)	82.	(4)
83.	(2)	84.	(1)	85.	(1)	86.	(1)	87.	(3)	88.	(4)	89.	(1)
90.	(1)	91.	(1)	92.	(2)	93.	(3)	94.	(3)	95.	(1)	96.	(1)
97.	(3)	98.	(2)	99.	(1)	100.	(2)	101.	(2)	102.	(3)	103.	(4)
104.	(3)	105.	(1)	106.	(1)	107.	(1)	108.	(3)	109.	(4)	110.	(1)
111.	(1)	112.	(2)	113.	(2)	114.	(4)	115.	(3)	116.	(4)	117.	(3)
118.	(3)	119.	(1)	120.	(1)	121.	(4)	122.	(2)	123.	(3)	124.	(1)
125.	(3)	126.	(4)	127.	(4)	128.	(1)	129.	(3)	130.	(2)	131.	(2)
132.	(4)	133.	(3)	134.	(2)	135.	(4)	136.	(2)	137.	(3)	138.	(1)
139.	(2)	140.	(4)	141.	(2)	142.	(4)	143.	(2)	144.	(1)	145.	(2)

146. (2)	147. (3)	148. (1)	149. (3)	150. (4)	151. (3)	152. (1)
153. (4)	154. (3)	155. (4)	156. (2)	157. (2)	158. (1)	159. (3)
160. (2)	161. (2)	162. (1)	163. (3)	164. (1)	165. (3)	166. (3)
167. (3)	168. (1)	169. (4)	170. (2)	171. (4)	172. (1)	173. (2)
174. (2)	175. (4)	176. (1)	177. (2)	178. (2)	179. (2)	180. (1)
181. (3)	182. (1)	183. (2)	184. (3)	185. (1)	186. (2)	187. (4)
188. (2)	189. (1)	190. (1)	191. (1)	192. (3)	193. (2)	

Section - B : Multiple Choice Questions

1. (1, 2, 3)	2. (1, 2, 3, 4)	3. (2, 4)	4. (2, 4)	5. (1, 2, 3)	6. (1, 2, 4)
7. (1, 3, 4)	8. (1, 2, 3)	9. (1, 2, 3)	10. (2, 4)	11. (1, 2, 3)	12. (3, 4)
13. (1, 4)	14. (2)	15. (1, 2, 3, 4)	16. (1, 2)	17. (1, 2, 3)	18. (3)
19. (2, 3)	20. (2, 3)	21. (2, 3, 4)	22. (1, 3)	23. (1, 4)	24. (1, 2, 3)
25. (2, 3, 4)	26. (2, 3, 4)	27. (1, 4)	28. (2, 3)	29. (2, 3, 4)	30. (2, 3)
31. (2, 3)	32. (1, 2, 4)	33. (2, 3)	34. (2, 3)	35. (3, 4)	35(a). (1, 3, 4)
36. (1, 4)	37. (1, 2, 3)	38. (1, 4)	39. (2, 4)	40. (1, 2, 3)	41. (1, 3)
42. (1, 3, 4)	43. (1, 2, 3)	44. (1, 3, 4)	45. (2, 4)	46. (1, 2, 3)	47. (1, 3)
48. (1, 2, 4)					

Section - C : Linked Comprehension

C1.	1. (4)	2. (3)	3. (1)
C2.	1. (3)	2. (2)	3. (3)
C3.	1. (1)	2. (1)	3. (2)
C4.	1. (1)	2. (2)	3. (3)
C5.	1. (4)	2. (3)	3. (1)
C6.	1. (4)	2. (1)	3. (3)
C7.	1. (1)	2. (1)	3. (1)
C8.	1. (2)	2. (1)	3. (4)
C9.	1. (2)	2. (2)	3. (2)
C10.	1. (2)	2. (1)	3. (2)
C11.	1. (1)	2. (1)	3. (1)
C12.	1. (2)	2. (1)	3. (4)
C13.	1. (3)	2. (1)	3. (2)
C14.	1. (3)	2. (2)	3. (3)
C15.	1. (3)	2. (3)	3. (2)
C16.	1. (3)	2. (3)	3. (4)

C17.	1. (4)	2. (1)	3. (1)
C18.	1. (4)	2. (2)	3. (1)
C19.	1. (4)	2. (3)	3. (2)
C20.	1. (1)	2. (3)	3. (1)
C21.	1. (1)	2. (1)	3. (1)
C22.	1. (1)	2. (4)	3. (4)
C23.	1. (2)	2. (1)	3. (3)
C24.	1. (4)	2. (4)	3. (4)
C25.	1. (1)	2. (3)	3. (4)

Section - D : Assertion - Reason Type

1.	(2)	2.	(4)	3.	(3)	4.	(2)	5.	(1)	6.	(1)	7.	(2)
8.	(2)	9.	(2)	10.	(3)	11.	(1)	12.	(4)	13.	(1)	14.	(1)
15.	(1)	16.	(3)	17.	(1)	18.	(1)	19.	(2)	20.	(1)	21.	(3)
22.	(3)	23.	(1)	24.	(1)	25.	(1)	26.	(2)	27.	(2)	28.	(1)
29.	(1)	30.	(4)	31.	(3)	32.	(3)	33.	(2)	34.	(3)	35.	(1)
36.	(1)	37.	(2)	38.	(1)	39.	(2)	40.	(1)	41.	(3)	42.	(4)
43.	(3)	44.	(4)	45.	(1)	46.	(2)	47.	(4)	48.	(4)	49.	(4)
50.	(4)	51.	(3)	52.	(4)	53.	(1)	53(a)	(2, 4)	54.	(1)	55.	(1)
56.	(1)	57.	(3)	58.	(4)	59.	(1)	60.	(1)	61.	(1)	62.	(1)
63.	(3)	64.	(4)	65.	(4)	66.	(1)	67.	(4)	68.	(2)	69.	(3)
70.	(2)	71.	(4)	72.	(4)	73.	(1)	74.	(1)				

Section - E : Matrix-Match Type

1. A(p, t), B(q, s), C(p, s), D(r, s)
2. A(p), B(p), C(r, s), D(p)
3. A(p, r, s), B(t), C(p, r), D(p, q, r)
4. A(p, q), B(p, r, s, t), C(p, r, s, t), D(r, s, t)
5. A(p, q, s), B(r, t), C(s), D(p, r, t)
6. A(r), B(r), C(q), D(q)
7. A(q, r, t), B(q, s, t), C(q, s, t), D(q, s, t)
8. A(p), B(p, q, r, t), C(p, t), D(p, q, r, t)
9. A(p, q, r, t), B(p, r, t), C(p, q, r, s), D(q, t)
10. A(r, s), B(q, r, s), C(q, r, s), D(p, q, r, s, t)
11. A(q, r), B(q, r), C(q), D(q)
12. A(p, s, t), B(s), C(p, q, r, t), D(q)
13. A(r, s, t), B(r, t), C(q), D(p, q, r, s)

14. A(p, r), B(p, r), C(p, s), D(p, s)
15. A(q, r), B(q, r, t), C(s), D(p, s, t)
16. A(p, q), B(p, r), C(p, s, t), D(p, s, t)
17. A(p), B(q), C(p), D(s, t)
18. A(q, r), B(p, t), C(s), D(r)
19. A(r, t), B(q, t), C(s, t), D(p, t)
20. A(q, s, t), B(p, s, t), C(q, r, t), D(p, r, t)
21. A(r), B(s, t), C(p), D(q, t)
22. A(q, r), B(p, r, s, t), C(q, r), D(p, r, s, t)
23. A(p), B(s, t), C(q), D(r)
24. A(p, t), B(p, t), C(q, s), D(q, r)
25. A(p, q, r, s, t), B(q, r, t), C(p, q, r, s, t), D(q)
26. A(p), B(p, q, r, t), C(p), D(q, t)

26a. (4)

27. A(p, s), B(r), C(q), D(r, s)
28. A(p, r, s, t), B(p, r, s, t), C(p, r, s, t), D(p, r, s, t)
29. A(p), B(q, t), C(r), D(s)
30. A(p, t), B(q), C(p, t), D(q)
31. A(p, r, s, t), B(q, r, s), C(p, r, s, t), D(p, r, s, t)

31(a). A(r, s, t), B(q, r, s, t), C(p, q), D(q, r, s, t)

Section - F : Subjective Type

1. $\frac{p}{2\varepsilon_0 a}$
2. $T = \frac{\lambda^2}{4\pi\varepsilon_0}$
3. $\Delta Q = \frac{\varepsilon_0 AE}{3d}$
4. 220.5 μJ
5. $\tau = \frac{\rho a^2 Q}{6\varepsilon_0}$
6. (A) 4.5 V, $\frac{5}{56}A$

   (B) 4.9 V, 0.048 A
7. $\frac{\rho}{2\pi}\ln\left(\frac{b}{a}\right)$
8. $\frac{10}{3}$ volt
9. $\frac{8}{3}$

10. 4.13 J

11. (i) $t = \dfrac{mv_0}{\mu(mg+qE)}$ (ii) $t = \dfrac{qBR}{\mu(mg+qE)}$ (iii) $l = \dfrac{mv_0^2}{2\mu(mg+qE)}$

12. (6.4 m, 0, 0) and (6.4 m, 0, 2 m)

13. (i) $\vec{B} = 10^{-3}(\mathrm{T})\vec{i}$ (ii) $F_y = 10^{-2}$ N

14. $v = \dfrac{V}{RB\ln\left(\dfrac{b}{a}\right)}, \dfrac{q}{m} = \dfrac{V}{R^2B^2\ln\left(\dfrac{b}{a}\right)}$

15. $\dfrac{Q\omega}{4}h^2\tan^2\theta$

16. (i) $\dfrac{2}{3}\pi^2 NB_0\dfrac{(a^2+ab+b^2)}{T}$ (ii) $t = 0, \dfrac{T}{2}$

(iii) $i_{max} = \dfrac{2\pi^2NB_0(a^2+ab+b^2)}{3RT}$ (iv) $t = \dfrac{T}{4}$

17. emf $= \left[\dfrac{3\sqrt{3}(\sqrt{3}-1)+4\pi}{6\sqrt{2}}\right]\alpha r^2$ in clockwise i.e. along PQR

18. (i) $\dfrac{B\omega l^2}{2}$ (ii) $i = \dfrac{B\omega l^2}{2R}\left[1-e^{-\frac{Rt}{L}}\right]$ and $\tau = \dfrac{B^2l^4\omega}{4R}$

19. (i) $F = Bld$ and emf $= I(R+2\lambda x)$

(ii) $v = \left[\dfrac{R+2\lambda x}{Bd}\right]I$ and $F = Bld + \dfrac{2\lambda ml^2}{B^2d^2}(R+2\lambda x)$

(iii) Fraction $= \left[1+\dfrac{2\lambda ml(R+2\lambda x)}{B^3d^3}\right]^{-1}$

20. (i) 0.0150 A
(ii) 0.150 A
(iii) 1.50 A

21. (i) 922 Ω
(ii) 0.0542 A
(iii) 10.8 V, 48.8 V
(iv) 77.5° leads

22. (i) 379 Ω, −58.2° – lags
(ii) 369 Ω, +57.2° – leads

23. (i) 745 rad/s
(ii) V_1 : 106 V ; V_2 : 356 V ; V_3 : 356 V ; V_4 = 0 V ; V_5 : 106 V
(iii) 0.53 A

24. (i) 20
    (ii) 0.750 A
    (iii) 4.50 W
    (iv) 3200 Ω
25. (i) 568 Ω
    (ii) 0.866 A
    (iii) 266 V
26. (i) 5.77×10^3 rad/s
    (ii) 2.40 A
    (iii) 4.16×10^3 V
    (iv) 4.16×10^3 V
    (v) 0.864 J, 0.864 J

Section - G : Integer Answer Type

1. 2
2. 4
3. 5
4. 2
5. 4
6. 9
7. 1
8. 2
9. 5
10. 0
11. 4
12. 3
12(a). 3
13. 8
14. 5
15. 2
16. 4
17. 1
18. 9
19. 4
20. 7
21. 8
22. 0
23. 2

Section - H : Multiple True-False Type Questions

1.	(4)	2.	(2)	3.	(1)	4.	(2)	5.	(1)	6.	(1)	7.	(1)
8.	(1)												

UNIT - 4 : Optics and Modern Physics

Section A : Straight Objective Type

1. (2)	2. (4)	3. (3)	4. (2)	5. (1)	6. (1)	7. (3)
8. (1)	9. (3)	10. (4)	11. (1)	12. (3)	13. (3)	14. (2)
15. (3)	16. (1)	17. (2)	18. (1)	19. (1)	19(a). (2)	20. (3)
20(a). (1, 2, 3)	21. (4)	21(a). (1)	22. (3)	23. (4)	24. (1)	25. (4)
26. (3)	27. (2)	28. (1)	29. (4)	30. (2)	31. (4)	32. (2)
33. (2)	34. (2)	35. (1)	36. (3)	37. (3)	38. (1)	39. (1)
40. (2)	41. (1)	42. (4)	43. (3)	44. (1)	45. (3)	46. (1)
47. (1)	48. (2)	49. (1)	50. (3)	50(a). (1, 2)	51. (2)	52. (4)
53. (4)	54. (3)	55. (2)	56. (1)	57. (1)	58. (3)	59. (1)
60. (3)	61. (2)	62. (1)	63. (2)	64. (2)	65. (3)	66. (1)
67. (1)	68. (2)	69. (2)	70. (4)	71. (1)	72. (2)	73. (4)
74. (2)	75. (4)	76. (2)	77. (1)	78. (1)	79. (4)	80. (1)
81. (4)	82. (1)	83. (1)	84. (2)	85. (2)	86. (3)	87. (1)
88. (1)	89. (2)	90. (2)	91. (4)	92. (2)	93. (2)	94. (2)
95. (1)	96. (1)	97. (3)	98. (2)	99. (1)	100. (3)	101. (3)
102. (1)	103. (3)	104. (2)	105. (2)	106. (3)	107. (2)	108. (3)
109. (4)	110. (3)	111. (3)	112. (1)	113. (1)	114. (4)	115. (3)
116. (4)						

Section - B : Multiple Choice Questions

1. (1, 2, 3, 4)	2. (1, 4)	3. (3, 4)	4. (1, 2)	5. (2, 3, 4)	6. (1, 4)
7. (1, 2, 4)	8. (2, 3)	9. (1, 2, 3)	10. (1, 3)	11. (1, 2, 4)	11a. (3)
12. (1, 3)	12(a). (6)	13. (1, 2, 3, 4)	14. (1, 2, 4)	15. (1, 2, 3, 4)	16. (1, 2, 3, 4)
17. (2, 4)	18. (1, 2, 3)	19. (1, 2, 4)	20. (2, 4)	21. (3, 4)	22. (1, 2, 3, 4)
23. (2, 4)	24. (1, 3)	25. (1, 2)	26. (1, 2, 3, 4)	27. (2, 4)	28. (1, 4)
29. (1, 2, 4)	30. (1, 2)	31. (1, 3)	32. (1, 2, 4)	33. (1, 2, 3, 4)	34. (1, 4)
35. (1, 2, 4)	36. (1, 2, 3, 4)	37. (1, 2)	38. (1, 4)	39. (1, 2, 3)	40. (3, 4)
41. (1, 4)	42. (1, 2, 3)	43. (1, 2, 3)	44. (1, 2, 4)		

Section - C : Linked Comprehension Type

C1.	1. (3)	2. (1)	3. (2)
C2.	1. (1)	2. (1)	3. (2)
C3.	1. (2)	2. (3)	3. (3)
C4.	1. (1)	2. (2)	3. (3)

C5.	1. (1)	2. (1)	3. (1)
C6.	1. (1)	2. (1)	3. (2)
C7.	1. (2)	2. (3)	3. (4)
C8.	1. (2)	2. (1)	3. (3)
8(a).	(2, 4)		
C9.	1. (2)	2. (3)	3. (1)
C10.	1. (1)	2. (2)	3. (2)
C11.	1. (1)	2. (4)	3. (3)
C12.	1. (2)	2. (1)	3. (4)
C13.	1. (4)	2. (4)	3. (4)
C14.	1. (2)	2. (1)	3. (3)
C15.	1. (2)	2. (3)	3. (1)
C16.	1. (4)	2. (1)	3. (3)

Section - D : Assertion - Reason Type

1.	(4)	2.	(2)	3.	(3)	4.	(2)	5.	(4)	6.	(4)	7.	(2)
8.	(3)	9.	(4)	10.	(2)	11.	(4)	12.	(4)	13.	(4)	14.	(3)
15.	(4)	16.	(4)	17.	(1)	18.	(4)	19.	(3)	20.	(4)	21.	(3)
22.	(2)	23.	(2)	24.	(2)	25.	(4)	26.	(2)	27.	(1)	28.	(3)
29.	(1)	30.	(3)	31.	(3)	32.	(1)	33.	(2)	34.	(4)	35.	(1)
36.	(1)	37.	(2)	38.	(2)	39.	(3)	40.	(1)	41.	(1)	42.	(3)
43.	(3)	44.	(2)	45.	(2)	46.	(2)	47.	(1)				

Section - E : Matrix-Match Type

1. A(q), B(r, t), C(p), D(s)
2. A(q, t), B(p, s), C(p, t), D(r, t)
3. A(r, s, t), B(p, q, t), C(r, s), D(r, s, t)

3(a). A(p, q, r, s), B(q), C(p, q, r, s), D(p, q, r, s)

4. A(q), B(p), C(r), D(s, t)
5. A(p, s), B(p, t), C(p, s), D(p, t)
6. A(t), B(p), C(q, s), D(r)
7. A(p, q), B(t), C(s), D(r)

7a. A(p, s); B(q); C(t), D(r, s, t)

8. A(q), B(r), C(p), D(t)
9. A(p, q), B(r, s), C(s, t), D(p)
10. A(p, r), B(p), C(p, r, t), D(s)
11. A(p), B(r), C(q), D(s, t)

12. A(s, t), B(r), C(q), D(p, t)
13. A(q, s), B(r, t), C(p), D(p, q, r, s)
14. A(r), B(q, t), C(s), D(p)
15. A(q, t), B(p, r), C(q), D(p, r, s)
16. A(q, t), B(p, r), C(s), D(p, r)
17. A(q, r), B(r), C(s), D(p, t)
18. A(p), B(q, r, s), C(p, t), D(q, r, s)
19. A(q), B(r), C(p, t), D(s)
20. A(p, s), B(q, s), C(r), D(p, s)
21. A(r, t), B(q), C(p), D(s)

Section - F : Subjective Type

1. 0.03 mm/s
2. $\theta_{max} = 0°$
3. $\phi = 2\tan^{-1}(1.38)$
4. $\hat{r} = -\sqrt{\frac{3}{5}}\hat{i} - \sqrt{\frac{2}{5}}\hat{j}$
5. $\sqrt{5} - 1$
6. $\frac{I_0}{9}\left(1+8\cos^2\frac{\pi}{\lambda}2d\sin\theta\right)$
7. $t = \frac{n\lambda}{\mu - 1}$ for maxima.

   $t = \left[\left(\frac{2n+1}{2}\right)\frac{\lambda}{(\mu-1)}\right]$ for minima.

   $11\lambda \times 10^{-2}$

   55×10^{-2} mm

   $11\lambda \times 10^{-2}$.
8. (a) Constructive (b) 0.55 mm
9. 0.001178 cm
10. $1 - e^{-\frac{GM}{Rc^2}}$
11. $\lambda_2 = 179.76$ Å
12. 2.58×10^{-7} m, –2.53 keV
13. $f = f_0\left(1+\frac{v}{c}\right)$
14. $\Delta N = 13 \times 10^{10}$
15. $\frac{t}{T_{1/2}} = 3.32$
16. $\lambda_\alpha = 0.65 \times 10^{-4}$ sec^{-1}
17. 1.118×10^4 years

18. $\bar{E} = 4.55 \times 10^4$ kWh.

Section - G : Integer Answer Type

1. 2
2. 2
3. 2
4. 4
5. 3
6. 2
7. 6
8. 2
9. 5
10. 9
11. 5
12. 5
13. 4
14. 4
15. 1
16. 1
17. 2

Section - H : Multiple True-False Type Questions

1. (1) 2. (2) 3. (3) 4. (2)

UNIT - 5 : Miscellaneous Questions

Section A : Straight Objective Type

1. (4)	2. (1)	3. (2)	4. (3)	5. (3)	6. (3)	7. (2)
8. (4)	9. (3)	10. (4)	11. (2)	12. (3)	13. (2)	14. (2)
15. (1)	16. (2)	17. (1)	18. (1)	19. (4)	20. (1)	21. (1)
22. (3)	23. (2)	24. (1)	25. (2)	26. (4)	27. (3)	28. (4)
29. (1)	30. (3)	31. (4)	32. (3)	33. (4)	34. (1)	35. (2)
36. (2)	37. (2)	38. (2)	39. (3)	40. (3)	41. (2)	42. (3)
43. (1)	44. (3)	45. (4)	46. (3)	47. (4)	48. (1)	49. (3)
50. (1)	51. (1)	52. (4)	53. (2)	54. (4)	55. (1)	56. (1)
57. (2)	58. (1)	59. (3)	60. (4)	61. (2)	62. (3)	63. (2)

64.	(1)	65.	(2)	66.	(3)	67.	(3)	68.	(1)	69.	(3)	70.	(3)
71.	(3)	72.	(2)	73.	(3)	74.	(4)	75.	(1)	76.	(4)	77.	(1)
78.	(1)	79.	(2)	80.	(3)	81.	(2)	82.	(3)	83.	(4)	84.	(1)
85.	(3)	86.	(2)	87.	(3)	88.	(3)	89.	(1)	90.	(1)	91.	(3)
92.	(2)	93.	(4)	94.	(1)	95.	(3)	96.	(2)	97.	(2)	98.	(4)
99.	(2)	100.	(1)	101.	(2)	102.	(1)	103.	(4)	104.	(1)	105.	(2)
106.	(1)	107.	(3)	108.	(2)	109.	(1)	110.	(1)	111.	(3)	112.	(2)
113.	(2)	114.	(3)	115.	(4)	116.	(1)	117.	(4)	118.	(3)	119.	(1)
120.	(1)	121.	(2)	122.	(1)	123.	(2)	124.	(1)	125.	(1)	126.	(4)
127.	(1)	128.	(3)	129.	(1)	130.	(1)	131.	(3)	132.	(1)	133.	(1)
134.	(1)	135.	(3)	136.	(4)	137.	(3)	138.	(2)	139.	(3)	140.	(2)
141.	(1)	142.	(2)	143.	(4)	144.	(2)	145.	(3)	146.	(1)	147.	(4)
148.	(1)	149.	(2)	150.	(4)	151.	(4)	152.	(3)	153.	(4)	154.	(2)
155.	(2)	156.	(1)	157.	(3)	158.	(3)	159.	(2)	160.	(4)	161.	(1)
162.	(2)	163.	(1)	164.	(4)	165.	(3)	166.	(2)	167.	(3)	168.	(1)
169.	(4)	170.	(2)	171.	(4)	172.	(1)	173.	(4)	174.	(2)	175.	(1)
176.	(1)	177.	(1)	178.	(2)	179.	(3)	180.	(1)	181.	(3)	182.	(4)
183.	(4)	184.	(3)	185.	(3)	186.	(2)	187.	(2)	188.	(2)	189.	(4)
190.	(3)	191.	(2)	192.	(4)	193.	(3)	194.	(2)	195.	(1)	196.	(1)
197.	(3)	198.	(2)	199.	(3)	200.	(2)	201.	(1)	202.	(3)	203.	(1)
204.	(2)	205.	(2)	206.	(3)	207.	(1)	208.	(1)	209.	(2)	210.	(3)

Section - B : Multiple Choice Questions

1.	(1, 2, 3)	2.	(2, 3)	3.	(1, 2, 4)	4.	(1, 2, 4)	5.	(1, 2, 3)	6.	(2, 3)
7.	(1, 2)	8.	(1, 2)	9.	(1, 2, 4)	10.	(1, 2)	11.	(1, 3, 4)	12.	(2, 3)
13.	(1, 2, 3)	14.	(1, 2, 3)	15.	(1, 2, 4)	16.	(1, 2, 4)	17.	(1, 2, 3)	18.	(1, 4)
19.	(1, 2)	20.	(1, 3, 4)	20a.	(1)	21.	(1, 3)	22.	(1, 2, 3, 4)	23.	(2, 3)
24.	(3, 4)	25.	(2, 3, 4)	26.	(2, 3)	27.	(1, 2, 3, 4)	28.	(3, 4)	29.	(1, 3)
30.	(1, 3, 4)	31.	(1, 2, 3)	32.	(3, 4)	33.	(1, 3)	34.	(1, 2, 4)	35.	(1, 2, 3, 4)
36.	(2, 3)	37.	(1, 3)	38.	(2, 3)	39.	(1, 4)	39(a).	(2)	40.	(1, 2, 3, 4)
41.	(2, 3, 4)	42.	(1, 3, 4)	43.	(1, 2)	44.	(1, 2, 3, 4)	45.	(1, 2, 3, 4)	46.	(2, 4)
47.	(2, 3, 4)	47(a).	(1)	48.	(1, 2)	49.	(1, 4)	50.	(1, 2)	51.	(1, 3, 4)
52.	(1, 2, 3)	53.	(1, 2, 3, 4)	54.	(1, 2)	55.	(1, 2, 4)	56.	(2, 3)	57.	(2, 3)
58.	(2, 4)	59.	(2, 3)	60.	(1, 3)	61.	(2, 4)	62.	(1, 3, 4)	63.	(1, 3, 4)

64. (2, 3)	65. (1, 2, 3)	66. (2, 4)	67. (1, 4)	68. (1, 2)	69. (2, 4)
70. (1, 2)	71. (1, 2, 4)	72. (1, 2)	73. (1, 2, 4)	74. (1, 3, 4)	75. (3, 4)
76. (1, 3, 4)	77. (1, 3)	78. (1, 4)	79. (2, 3, 4)	80. (2, 4)	

Section - C : Linked Comprehension

C1.	1. (2)	2. (2)	3. (1)
C2.	1. (1)	2. (1)	3. (3)
C3.	1. (1)	2. (1)	3. (1)
C4.	1. (3)	2. (1)	3. (1)
C5.	1. (1)	2. (1)	3. (1)
C6.	1. (1)	2. (1)	3. (4)
C7.	1. (1)	2. (1)	3. (2)
C8.	1. (2)	2. (1)	3. (1)
C9.	1. (1)	2. (2)	3. (2)
C10.	1. (3)	2. (1)	3. (4)
C10(a).	1. (1)	2. (2)	3. (3)
C11.	1. (2)	2. (2)	3. (4)
C12.	1. (1)	2. (2)	3. (1)
C13.	1. (2)	2. (1)	3. (1)
C14.	1. (1)	2. (3)	3. (4)
C15.	1. (2)	2. (4)	3. (1)
C16.	1. (1)	2. (2)	3. (4)
C17.	1. (2)	2. (3)	3. (3)
C18.	1. (1)	2. (3)	3. (2)
C19.	1. (2)	2. (1)	3. (4)
C20.	1. (2)	2. (1)	3. (3)
C21.	1. (3)	2. (1)	3. (1)
C22.	1. (4)	2. (4)	3. (1)
C23.	1. (1)	2. (3)	3. (2)
C24.	1. (1)	2. (3)	3. (2)
C25.	1. (3)	2. (1)	3. (2)
C26.	1. (1)	2. (1)	3. (4)
C27.	1. (2)	2. (1)	3. (2)
C28.	1. (4)	2. (3)	3. (1)
C29.	1. (1)	2. (1)	3. (2)
C30.	1. (1)	2. (2)	3. (3)

C31.	1. (1)	2. (2)	3. (3)
C32.	1. (2)	2. (4)	3. (1)
C33.	1. (1)	2. (1)	3. (2)
C34.	1. (1)	2. (2)	3. (1)
C35.	1. (4)	2. (3)	3. (2)
C36.	1. (3)	2. (1)	3. (3)
C37.	1. (1)	2. (2)	3. (3)
C38.	1. (2)	2. (2)	3. (4)
C39.	1. (2)	2. (3)	3. (1)

Section - D : Assertion - Reason Type

1. (3)	2. (3)	3. (4)	4. (1)	5. (3)	6. (1)	7. (1)
8. (2)	9. (1)	10. (1)	11. (1)	12. (1)	13. (2)	14. (4)
15. (1)	16. (1)	17. (4)	18. (1)	19. (1)	20. (1)	21. (2)
22. (1)	23. (1)	24. (2)	25. (1)	26. (1)	27. (3)	28. (3)
29. (1)	30. (2)	31. (3)	32. (2)	33. (3)	34. (3)	35. (3)
36. (1)	37. (1)	38. (1)	39. (1)	40. (3)	41. (1)	42. (1)
43. (2)	44. (3)	45. (3)	46. (1)	47. (1)	48. (1)	49. (1)
50. (2)	51. (2)	52. (3)	53. (3)	54. (2)	55. (2)	56. (3)
57. (2)	58. (1)	59. (1)	60. (3)	61. (1)	62. (1)	63. (2)
64. (4)	65. (2)	66. (1)	67. (1)	68. (1)	69. (1)	70. (1)
71. (2)	72. (2)	73. (3)	74. (4)	75. (4)	76. (4)	77. (2)
78. (1)	79. (3)	80. (2)	81. (2)	82. (2)	83. (1)	84. (4)
85. (4)	86. (4)	87. (4)	88. (1)	89. (1)	90. (3)	91. (1)
92. (1)	93. (3)	94. (4)	95. (3)	96. (4)	97. (2)	98. (1)
99. (4)	100. (2)	101. (2)	102. (3)	103. (1)	104. (2)	105. (1)
106. (3)	107. (3)	108. (3)	109. (3)	110. (1)	111. (4)	112. (1)
113. (1)	114. (1)	115. (1)	116. (3)	117. (1)	118. (4)	119. (3)
120. (4)	121. (1)	122. (3)	123. (4)	124. (2)	125. (1)	126. (1)
127. (2)	128. (1)	129. (3)	130. (2)	131. (2)	132. (2)	133. (1)
134. (2)	135. (2)	136. (4)	137. (2)	138. (2)	139. (3)	140. (1)
141. (1)	142. (3)	143. (2)	144. (1)	145. (2)	146. (1)	

Section - E : Matrix-Match Type

1. A(q, t), B(p, t), C(s), D(r)
2. A(p, t), B(q, t), C(r, t), D(s)
3. A(q), B(r, t), C(s, t), D(p, t)

4. A(p, t), B(q. t), C(q, t), D(q, t)
5. A(p, q, s), B(r, s), C(t), D(p, q, s)
6. A(s, t), B(p, t), C(r), D(q, t)
7. A(q, t), B(p, t), C(s), D(r)
8. A(p, q, s), B(q, r, t), C(q, r, t), D(p, q, s)
9. A(s), B(q, r, t), C(q, t), D(p, s)
10. A(q), B(p, s), C(r), D(q)
11. A(p, r), B(p, q) C(q, r, s, t), D(p, q, r)
12. A(p t), B(p, q, t), C(q, s, t), D(r, s, t)
13. A(p), B(q, t), C(p), D(r, s)
14. A(s), B(r, t), C(q), D(p)
15. A(q, s), B(p, t), C(q, s), D(r)
16. A(p, r), B(q, s), C(p, t), D(q)
17. A(q), B(r, s, t), C(s), D(p, q, r)
18. A(s), B(q), C(p, q), D(r, t)
19. A(q, r, t), B(p, t), C(q, t), D(q, r, s)
20. A(p, q), B(r, s, t), C(p, q, r, s, t), D(r, s, t)
21. A(p, s), B(p, q, s), C(p, q, s), D(t)
22. A(p, t), B(r, t), C(p, s, t), D(q)
23. A(q, s, t), B(r, s, t), C(p, t), D(q, s, t)
24. A(r, t), B(p, r, t), C(p, r), D(s, t)
25. A(p, q, t), B(q, s, t), C(p, r), D(p, t)
26. A(p, r, t), B(q, s), C(p, r), D(p, s)
27. A(p, q), B(q), C(p, q, s, t), D(p, r)
28. A(p), B(p, r), C(p, s), D(q, t)

Section - F : Subjective Type

1. Error $= \dfrac{8\pi}{3}\rho Gmh$

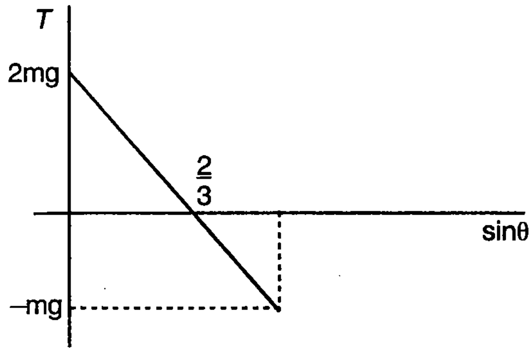
2. $\dfrac{GM}{v_0^2}\left[\sqrt{1+\left(\dfrac{lv_0^2}{GM}\right)^2}-1\right]$

3. $\boxed{T = T_1^{\frac{3}{2}} - \frac{x}{l}(T_1^{\frac{3}{2}} - T_2^{\frac{3}{2}})}$

4. $a = \dfrac{g}{2}$

5. $K = \frac{4Mg}{L}$

6. $W = 2mgh$

7. 

8. $P = -\frac{\mu m v_0^3}{R} e^{-3\mu s/R}$

9. v = 5.5 m/s

10. Q = 9 P_0V_0

11. 3 : 1

12. $\frac{E_0}{YA}\left(\frac{8\pi\varepsilon_0 Rhc}{e\lambda_0}\right)$

13. $\frac{D-\sqrt{D^2-2Df}}{2}$

14. $\left\{\frac{1}{2\lambda} - \frac{\rho_0 e a^4}{30\varepsilon_0 hc}\right\}$

15. 0.45 m

16. $v = \sqrt{\frac{2q\alpha a^2}{m}}$

17. (a) V_{cm} = 13 m/s

 (b) Y_{cm} = 11.67 m

18. (a) 20 N, 80 N

 (b) 11.17 rad/s

19. $3\sqrt{2}\, P_0V_0$

20. $T = T_0\left[\frac{(\eta+1)^2}{4\eta}\right]^{\frac{\gamma-1}{2}}$

21. (a) $\lambda_{max} = h\left(\frac{\pi}{h}\right)^{\frac{1}{2}}\left(\frac{2}{mB}\right)^{\frac{1}{4}}$

(b) $E = A + \frac{nh}{\pi}\left(\frac{B}{2m}\right)^{\frac{1}{2}}$

22. (a) $N_2 = N_0\,(e^{-\lambda t} - e^{-2\lambda t})$

(b) $t = \frac{\ln 2}{\lambda}$

23. (a) $\frac{r^4\rho^2 g}{162\eta^2}$

(b) $\frac{RH}{H(\mu_0 - 1) - 2R\mu}$

24. (a). 2 mm

(b) $\cos^2\left(\frac{25\pi}{9}\right)$

25. (a) Reverse polarities of unknown emf and standard emf connected.

(b) Unknown emf and ε is greater than standard emf E (ε > E).

26. 2.51 cm

27. $v_0 \geq \sqrt{\frac{3qE}{m}}\,L$

28. $P = \frac{\pi^2}{8}$ W

29. $\frac{q}{m} = \frac{2\pi v_1}{d(B_1 - B_2)}$

30. $x_2 = \frac{1}{2}\left(L_0 + \frac{Ft_0^2}{2m}\right)$

31. $I = \frac{E\varepsilon_0 a}{d}(k-1)v_0$

32. $d = 4R$

33. $t = \frac{27R}{40}$

34. $N = \frac{P}{\lambda}(1 - e^{-\lambda t})$

35. (a) $y = \frac{12\pi a}{11}$

(b) $V_A = \dfrac{43v_0}{48}$ (Downward) $\quad V_B = \dfrac{15v_0}{16}$ (Upward)

36. $x = \dfrac{\pi nmv_0}{4qB_0}$

$y = \dfrac{\sqrt{3}\,\pi nmv_0}{4qB_0}$

$\vec{v} = v_0\hat{i}$

37. $x_0 = \dfrac{ma}{2(M+m)}$

$v_1 = \sqrt{\dfrac{3Ka^2m}{4M(M+m)}}$

38. $B_0 = \dfrac{3Mg}{5\pi al}$

39. (a) $P = 160$ W

(b) $P = 16$ W

(c) $P = 8$ W

(d) $t = 5.2$ s

40. (a) $i' = \dfrac{2\sqrt{2}\,\mu_0 a^2 \varepsilon e^{-Rt/L}}{\pi bLr}$

(b) $F_{max} = \dfrac{2\varepsilon_0^2 a^2 \mu_0^2}{\pi^2 b^2 LRr}$

41. $W = 153$ J

42. $t = \dfrac{A}{a}\sqrt{\dfrac{h}{g}}\,(\sqrt{2}-1)$

43. (b) Length $= \dfrac{8L}{9}$

$\lambda_{min} = \dfrac{3h}{4m\sin\left(\dfrac{\theta_0}{2}\right)\sqrt{2gL}}$

44. (a) $y = \sqrt{\dfrac{hc}{3\lambda_0 eE_0}}$

(b) $\lambda = \sqrt{\dfrac{3h\lambda_0}{34\,mc}}$

45. $h = \dfrac{\varepsilon_0 (k-1) v^2}{2\rho g d^2}$

46. $t_0 = \dfrac{2\ell\eta}{a^4 T}(r_1^4 - r_2^4)$

47. (a) $B = \dfrac{mv}{qL}$

(b) $T = \dfrac{q^2 B_0^2 L}{2m}$

(c) Maximum separation = $4L$

48. (a) Decrease in length of rod = 0.16 m

(b) Energy stored = 141 J

49. (a) Final temperature = $14T_0$

(b) Change in internal energy = $26\ P_0V_0$

(c) Heat absorbed = $28\ P_0V_0$

50. (a) $B = \sqrt{\dfrac{8mE}{qL}}$

(b) $B_{max} = \dfrac{m}{qL}\sqrt{\dfrac{2qEL}{m}}$

51. (a) $W_{external} = 6.614\ P_0V_0$

(b) Heat absorbed = $2\ P_0V_0 \log_e 2$

(c) $\Delta U = 8\ P_0V_0$

52. (a) $q_1 = 36 \times 10^{-6}$ C

$q_2 = 44 \times 10^{-6}$ C

$q_3 = 2 \times 10^{-6}$ C

(b) Work done by battery (1) = $-40\ \mu$J

Work done by battery (2) = $+40\ \mu$J

(c) Heat generated = $20\ \mu$J

53. (a) $d = \dfrac{2\pi^2 m E_0}{qB^2}$

(b) $V_y = \dfrac{2\pi E}{B}$

(c) $\vec{V} = \dfrac{V_0}{2}\hat{i} - \dfrac{3\pi E_0}{B}\hat{j}$

54. (a) Number of moles of $O_2 = 1$

(b) Final temperature = 487.5 K

Final pressure = 162.5 kPa

55. (a) Initial range $\sqrt{\left(\frac{P_0 + 3H\rho g}{\rho}\right)\frac{2H}{g}}$

(b) Range of liquid when liquid of density ρ just starts flowing out = $2H$

56. (a) Time $t = \frac{v}{a}\sqrt{\frac{\rho}{2P_0}}$

(b) Area of cross-section = $2a$

(c) $\mu_{min} = \frac{aP_0}{mg}$

57. (a) Force $F = 10$ N

(b) A of 3 kg and 5 kg = 0.25 m/s^2

A of 4 kg = $\frac{3}{4}$ = 0.75 m/s^2

58. (a) Position of central maximum = $\frac{dD}{2R}$

(b) $I = I_{max}\cos^2\left(\frac{\pi d^2}{2\lambda R}\right)$

(c) $d = \sqrt{\frac{2\lambda R}{3}}$

59. (a) Radius of shadow = $\sqrt{3}R$

(b) Now radius of shadow = $\frac{2R}{\sqrt{3}} + \frac{3R}{\sqrt{55}}$

(c) Refractive index = $\frac{4}{3}$

60. (a) λ_{max} = 2000 A

λ_{min} = 1500 A

(b) E_1 = 0 eV

E_2 = 8.25 eV

E_3 = 7.32 eV

(c) Ionisation potential = 8.25 eV

61. (a) λ_{min} = 0.62 Å

(b) Atomic number $Z = 41$

(c) Fusion, 24.03 MeV

(d) $V = \frac{Q}{4\pi\varepsilon_0}\left(\frac{a+b}{ab}\right)$

62. (a) $\mu_{min} = 0.2$

 (b) $V = 1.1$ m/s

63. (a) force = 10,000 N

 (b) Radius of curvature = 50 m

64. $X = \sqrt{\frac{10}{6}}$ m

65. (a) 2.19 m/s^2

 (b) 48 rad/s^2

 (c) 26.2 m/s^2

66. $N_B = 0.650$ W

 $N_A = 0.350$ W

 $F_B = 0.454$ W

 $F_A = 0.245$ W

67. (a) $a = 8.5$ m/s^2

 (b) $F_{AE} = 47.9$ N

 $F_{DF} = 8.7$ N

68. $\frac{1}{3}\tan\theta \ge \mu$

69. $\frac{d\theta}{dt} = -\left[\left(\frac{3g}{l}\right)(1-\sin\theta)\right]^{\frac{1}{2}}$

71. $V_0 = \sqrt{\frac{2gr}{\cos\theta_0}}$

72. $V_{cy} = \frac{4mV_i}{8m+3M}$

73. $v = \left[\frac{10gR(n-1)}{7}\right]^{\frac{1}{2}}$

74. (a) $t = \frac{\omega_0 R}{\mu g}$

 (b) $s = \frac{R^2\omega_0^{\,2}}{2\mu g}$

75. (i) $\omega_0 > \frac{\mu g t}{R}$

 (ii) $\omega_0 = \frac{\mu g t}{R}$

 (iii) $\omega_0 < \frac{\mu g t}{R}$

76. (a) $t = \frac{R\omega_0}{3\mu g}$

 (b) $a = \mu g$

77. $a = 10\ m/s^2$

78. (a) $t = \dfrac{\mu_s g}{2b}$

(b) $t = \dfrac{gr}{bh}$

79. $N = \dfrac{mg\ (7\cos\theta - 4)}{3}$

80. $S = \dfrac{3d}{2}$

81. $d = v_0 \dfrac{\left[\left\{\mu g - \dfrac{(F-f)}{M}\right\} t - v_0\right]}{\left[\mu g - \left(\dfrac{F-f}{M}\right) - \dfrac{fr^2}{I}\right]}$

82. (a) $W = \dfrac{mR^2\omega^2}{4}$

(b) $\ell = \dfrac{\omega^2 R^2}{4g}$

83. $S = \dfrac{12 v_0{}^2}{49\mu g}$

84. $F_n = \sqrt{\dfrac{2}{3}} mg$

85. $L_0 = \dfrac{mR^2}{2}\omega_0$

86. $m = 12.5$ kg

87. $q = 0$ charge on capacitor is zero which is independent of time t.

88. $W_{ext} = \dfrac{4Gm^2}{a}\left[3\left(1+\dfrac{1}{\sqrt{2}}\right)+\dfrac{1}{\sqrt{3}}\right]$

89. $C = 2 \times 10^{-4}$ F

90. $\delta = 60°$ and $\theta = 60°$

91. $\dfrac{1}{\sqrt{2}}(\hat{i} - \hat{j})$

92. 10 kV

93. (a) $F_N = \dfrac{qE}{2}$

(b) $F = qE(2-\sqrt{3})$

94. (a) $P = P_m \cos\left(\frac{3\pi}{2L}x\right)\cos\left(2\pi vt + \frac{\pi}{3}\right)$

(b) $\frac{P_m}{\sqrt{2}}$

95. (a) $V = V_0 e^{-kt}$

(b) $x = \frac{V_0}{k}(1 - e^{-kt})$

(c) $V = V_0 - kx$

96. (a) 8 m/s

(b) $V_{max} = 12$ m/s

(c) $V = 0$, a = 12 m/s^2 along –ve X axis

(d) $t = 6$ s particle reaches to origin its velocity will be –36 m/s, a = –24 m/s^2

97. Elevation of $B = 16$ m

$V_B = 18$ m/s

$a_B = 9$ m/s^2

98. $V_A = 104.4$ km/hr

99. (a) $t_1 = \frac{2V_0}{7\mu g}$

$V_1 = \frac{5V_0}{7}$

(b) $\omega_1 = \frac{5}{7}\frac{V_0}{r}$

100. $V_1 = \frac{4}{3}\sqrt{0.285\,ga}$

101. $\omega = 3.21$ rad/s $\quad V = -0.143$ m/s

102. (a) $t = 0.444$ s

$V_m = 0.566$ m/s

$a = 8$ m/s^2

(b) $t = 0.907$ s

$V_m = 0.277$ m/s

$a = 1.92$ m/s^2

103. $T = 2\pi\sqrt{\dfrac{3m}{8k}}$ and $f = \dfrac{1}{2\pi}\sqrt{\dfrac{8k}{3m}}$

104. $T = 2\pi\sqrt{\dfrac{3}{2}\dfrac{(R-r)}{g}}$

105. (a) $\mu_s = 0.165$

(b) $V = 8.45$ m/s

(c) $V = 10$ m/s

Section - G : Integer Answer Type

1. 2
2. 8
3. 0
4. 0
5. 8
6. 8
7. 3
8. 4
9. 4
10. 7
11. 2
12. 9
13. 5
14. 1
15. 6
16. 9

Section - H : Multiple True-False Type Questions

1. (1)	2. (2)	3. (3)	4. (2)	5. (2)	6. (1)	7. (2)
8. (3)	9. (3)	10. (4)	11. (1)	12. (1)	13. (1)	14. (2)
15. (4)						

UNIT - 6 : Brain Storming Comprehension

Linked Comprehension Type :

C1.	1. (4)	2. (1)	3. (1)
C2.	1. (3)	2. (1)	3. (4)
C3.	1. (1)	2. (4)	3. (3)
C4.	1. (1)	2. (1)	3. (1)

C5.	1. (1)	2. (1)	3. (3)
C6.	1. (2)	2. (3)	3. (2)
C7.	1. (1)	2. (1)	3. (2)
C8.	1. (1)	2. (2)	3. (2)
C9.	1. (1)	2. (2)	3. (4)
C10.	1. (3)	2. (1)	3. (3)
C11.	1. (3)	2. (1)	3. (3)
C12.	1. (2)	2. (2)	3. (2)

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