ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)
path to success

Chapter 01 Contents

JEE (MAIN) TOPICWISE TEST PAPERS JANUARY & APRIL 2019

PHYSICS

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Chapter Contents 01

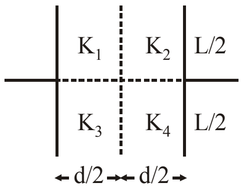
JEE (MAIN) TOPICWISE TEST PAPERS JANUARY & APRIL 2019

PHYSICS

JANUARY & APRIL 2019 ATTEMPT (PHYSICS)

CAPACITOR

1. A parallel plate capacitor with square plates is filled with four dielectrics of dielectric constants K_1, K_2, K_3, K_4 arranged as shown in the figure. The effective dielectric constant K will be :



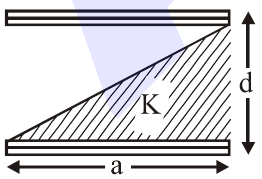
(1) $K = \dfrac{(K_1+K_2)(K_3+K_4)}{2(K_1+K_2+K_3+K_4)}$

(2) $K = \dfrac{(K_1+K_2)(K_3+K_4)}{(K_1+K_2+K_3+K_4)}$

(3) $K = \dfrac{(K_1+K_4)(K_2+K_3)}{2(K_1+K_2+K_3+K_4)}$

(4) $K = \dfrac{(K_1+K_3)(K_2+K_4)}{K_1+K_2+K_3+K_4}$

2. A parallel plate capacitor is made of two square plates of side 'a', separated by a distance d (d<<a). The lower triangular portion is filled with a dielectric of dielectric constant K, as shown in the figure.



Capacitance of this capacitor is :

(1) $\dfrac{1}{2}\dfrac{k\in_0 a^2}{d}$ (2) $\dfrac{k\in_0 a^2}{d}\ln K$

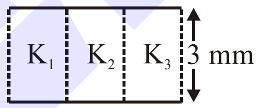
(3) $\dfrac{k\in_0 a^2}{d(K-1)}\ln K$ (4) $\dfrac{k\in_0 a^2}{2d(K+1)}$

3. A parallel plate capacitor having capacitance 12 pF is charged by a battery to a potential difference of 10 V between its plates. The charging battery is now disconnected and a porcelain slab of dielectric constant 6.5 is slipped between the plates the work done by the capacitor on the slab is :

(1) 692 pJ (2) 60 pJ

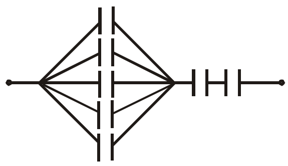
(3) 508 pJ (4) 560 pJ

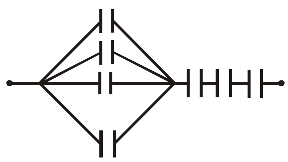
4. A parallel plate capacitor is of area 6 cm^2 and a separation 3 mm. The gap is filled with three dielectric materials of equal thickness (see figure) with dielectric constants K_1, = 10, K_2 = 12 and K_3 = 14. The dielectric constant of a material which when fully inserted in above capacitor, gives same capacitance would be :

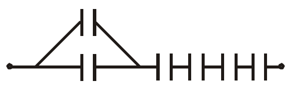


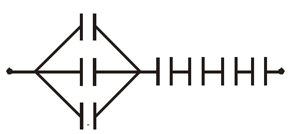
(1) 12 (2) 4 (3) 36 (4) 14

5. Seven capacitors, each of capacitance 2 μF, are to be connected in a configuration to obtain an effective capacitance of $\left(\dfrac{6}{13}\right)\mu F$. Which of the combinations, shown in figures below, will achieve the desired value ?

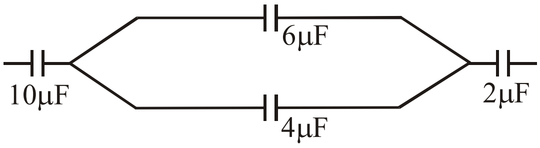
(1)


(2)


(3)


(4)


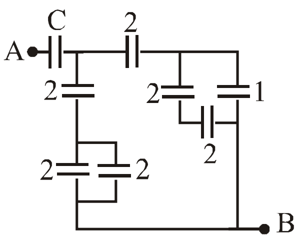
6. In the figure shown below, the charge on the left plate of the 10 μF capacitor is –30 μC. ? The charge on the right plate of the 6 μF capacitor is :



(1) –18 μC (2) –12 μC

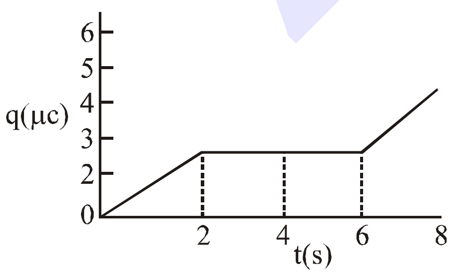
(3) +12 μC (4) +18 μC

7. In the circuit shown, find C if the effective capacitance of the whole circuit is to be 0.5 μF. All values in the circuit are in μF.



(1) $\frac{7}{10}$μF (2) $\frac{7}{11}$μF (3) $\frac{6}{5}$μF (4) 4μF

8. The charge on a capacitor plate in a circuit, as a function of time, is shown in the figure: What is the value of current at t = 4 s ?



(1) 3μA (2) 2μA

(3) zero (4) 1.5μA

9. A parallel plate capacitor with plates of area 1m^2 each, area t a separation of 0.1 m. If the electric field between the plates is 100 N/C, the magnitude of charge each plate is :-

(Take $\varepsilon_0 = 8.85\times10^{-12}\frac{C^2}{N-m^2}$)

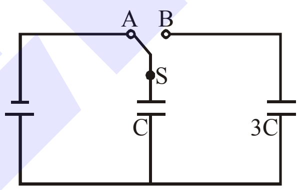
(1) 7.85×10^{-10} C

(2) 6.85×10^{-10} C

(3) 9.85×10^{-10} C

(4) 8.85×10^{-10} C

10. In the figure shown, after the switch 'S' is turned from position 'A' to position 'B', the energy dissipated in the circuit in terms of capacitance 'C' and total charge 'Q' is:



(1) $\frac{3}{8}\frac{Q^2}{C}$ (2) $\frac{3}{4}\frac{Q^2}{C}$

(3) $\frac{1}{8}\frac{Q^2}{C}$ (4) $\frac{5}{8}\frac{Q^2}{C}$

11. A parallel plate capacitor has 1μF capacitance. One of its two plates is given +2μC charge and the other plate, +4μC charge. The potential difference developed across the capacitor is:-

(1) 5V (2) 2V

(3) 3V (4) 1V

12. Voltage rating of a parallel plate capacitor is 500V. Its dielectric can withstand a maximum electric field of 10^6 V/m. The plate area is 10^{-4} m^2. What is the dielectric constant is the capacitance is 15 pF? (given $\in_0 = 8.86 \times 10^{-12}$ C^2/Nm^2)

(1) 3.8 (2) 4.5

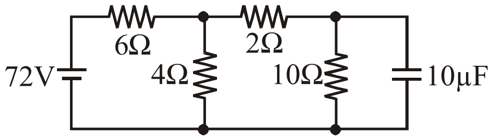
(3) 6.2 (4) 8.5

13. The parallel combination of two air filled parallel plate capacitors of capacitance C and nC is connected to a battery of voltage, V. When the capacitors are fully charged, the battery is removed and after that a dielectric material of dielectric constant K is placed between the two plates of the first capacitor. The new potential difference of the combined system is :-

(1) $\frac{V}{K+n}$ (2) V

(3) $\frac{(n+1)V}{(K+n)}$ (4) $\frac{nV}{K+n}$

14. Determine the charge on the capacitor in the following circuit :



(1) 2μC (2) 60μC

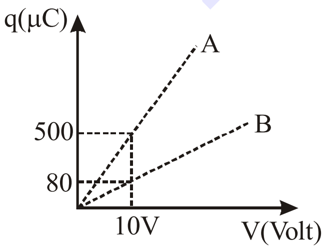
(3) 200μC (4) 10μC

15. A capacitor with capacitance 5μF is charged to 5μC. If the plates are pulled apart to reduce the capacitance to 2μF, how much work is done ?

(1) 3.75×10^{-6} J (2) 2.55×10^{-6} J

(3) 2.16×10^{-6} J (4) 6.25×10^{-6} J

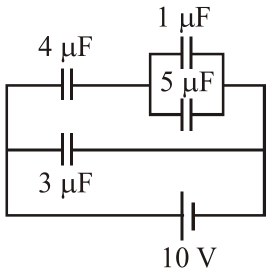
16. Figure shows charge (q) versus voltage (V) graph for series and parallel combination of two given capacitors. The capacitances are :



(1) 50 μF and 30 μF (2) 20 μF and 30 μF

(3) 60 μF and 40 μF (4) 40 μF and 10 μF

17. In the given circuit, the charge on 4 μF capacitor will be :

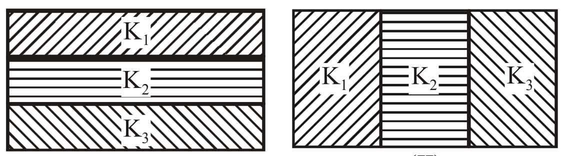


(1) 5.4 μC (2) 24 μC

(3) 13.4 μC (4) 9.6 μC

18. Two identical parallel plate capacitors, of capacitance C each, have plates of area A, separated by a distance d. The space between the plates of the two capacitors, is filled with three dielectrics, of equal thickness and dielectric constants K_1, K_2 and K_3. The first capacitor is filled as shown in fig. I, and the second one is filled as shown in fig. II.

If these two modified capacitors are charged by the same potential V, the ratio of the energy stored in the two, would be (E_1 refers to capacitor (I) and E_2 to capacitor (II)) :



(I) (II)

(1) $\frac{E_1}{E_2} = \frac{9K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

(2) $\frac{E_1}{E_2} = \frac{K_1K_2K_3}{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}$

(3) $\frac{E_1}{E_2} = \frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{K_1K_2K_3}$

(4) $\frac{E_1}{E_2} = \frac{(K_1+K_2+K_3)(K_2K_3+K_3K_1+K_1K_2)}{9K_1K_2K_3}$

CIRCULAR MOTION

1. A body is projected at t = 0 with a velocity 10 ms^{-1} at an angle of 60° with the horizontal. The radius of curvature of its trajectory at t = 1s is R. Neglecting air resistance and taking acceleration due to gravity g = 10 ms^{-2}, the value of R is :

(1) 2.5 m (2) 10.3 m

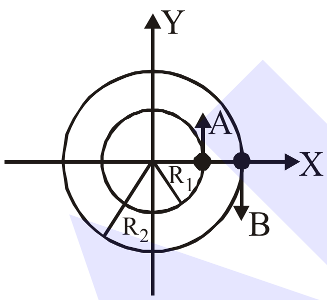
(3) 2.8 m (4) 5.1 m

2. A particle is moving along a circular path with a constant speed of 10 ms^{-1}. What is the magnitude of the change is velocity of the particle, when it moves through an angle of 60° around the centre of the circle?

(1) zero (2) 10 m/s

(3) $10\sqrt{3}$ m/s (4) $10\sqrt{2}$ m/s

3. Two particles A, B are moving on two concentric circles of radii R_1 and R_2 with equal angular speed ω. At t = 0, their positions and direction of motion are shown in the figure :

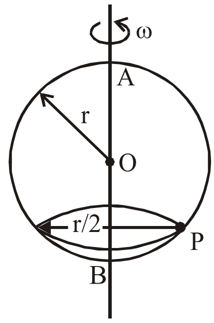


The relative velocity $\vec{\upsilon}_A - \vec{\upsilon}_B$ at $t = \frac{\pi}{2\omega}$ is given by :

(1) $-\omega(R_1 + R_2)\hat{i}$ (2) $\omega(R_1 + R_2)\hat{i}$

(3) $\omega(R_1 - R_2)\hat{i}$ (4) $\omega(R_2 - R_1)\hat{i}$

4. A smooth wire of length 2πr is bent into a circle and kept in a vertical plane. A bead can slide smoothly on the wire. When the circle is rotating with angular speed ω about the vertical diameter AB, as shown in figure, the bead is at rest with respect to the circular ring at position P as shown. Then the value of ω^2 is equal to :



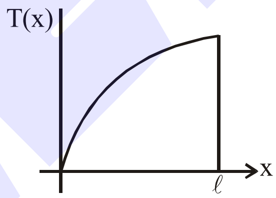
(1) $\left(g\sqrt{3}\right)/r$

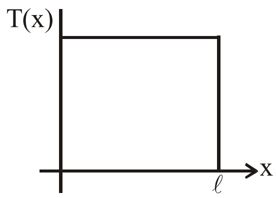
(2) $\frac{\sqrt{3}g}{2r}$

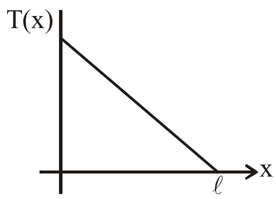
(3) 2g/r

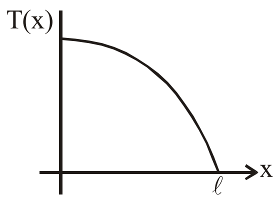
(4) $2g/\left(r\sqrt{3}\right)$

5. A uniform rod of length ℓ is being rotated in a horizontal plane with a constant angular speed about an axis passing through one of its ends. If the tension generated in the rod due to rotation is T(x) at a distance x from the axis, then which of the following graphs depicts it most closely?

(1)


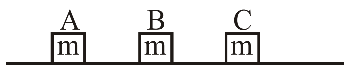
(2)


(3)


(4)


COM & COLLISION

1. Three blocks A, B and C are lying on a smooth horizontal surface, as shown in the figure. A and B have equal masses, m while C has mass M. Block A is given an brutal speed v towards B due to which it collides with B perfectly inelastically. The combined mass collides with C, also perfectly inelastically $\frac{5}{6}$ th of the initial kinetic energy is lost in whole process. What is value of M/m ?



(1) 4 (2) 5

(3) 3 (4) 2

2. A piece of wood of mass 0.03 kg is dropped from the top of a 100 m height building. At the same time, a bullet of mass 0.02 kg is fired vertically upward, with a velocity 100 ms^{-1}, from the ground. The bullet gets embedded in the wood. Then the maximum height to which the combined system reaches above the top of the building before falling below is : ($g = 10ms^{-2}$)

(1) 30 m (2) 10 m

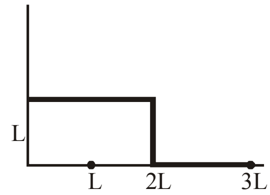
(3) 40 m (4) 20 m

3. A simple pendulum, made of a string of length l and a bob of mass m, is released from a small angle θ_0. It strikes a block of mass M, kept on a horizontal surface at its lowest point of oscillations, elastically. It bounces back and goes up to an angle θ_1. Then M is given by :

(1) $\frac{m}{2}\left(\frac{\theta_0-\theta_1}{\theta_0+\theta_1}\right)$ (2) $\frac{m}{2}\left(\frac{\theta_0+\theta_1}{\theta_0-\theta_1}\right)$

(3) $m\left(\frac{\theta_0+\theta_1}{\theta_0-\theta_1}\right)$ (4) $m\left(\frac{\theta_0-\theta_1}{\theta_0+\theta_1}\right)$

4. The position vector of the centre of mass $\vec{r}$ cm of an symmetric uniform bar of negligible area of cross-section as shown in figure is :



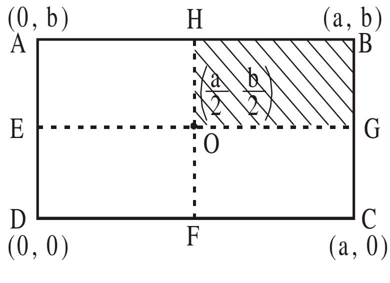
(1) $\vec{r}\,cm = \frac{13}{8}L\hat{x} + \frac{5}{8}L\hat{y}$

(2) $\vec{r}\,cm = \frac{11}{8}L\,\hat{x} + \frac{3}{8}L\hat{y}$

(3) $\vec{r}\,cm = \frac{3}{8}L\,\hat{x} + \frac{11}{8}L\hat{y}$

(4) $\vec{r}\,cm = \frac{5}{8}L\,\hat{x} + \frac{13}{8}L\hat{y}$

5. A uniform rectangular thin sheet ABCD of mass M has length a and breadth b, as shown in the figure. If the shaded portion HBGO is cut-off, the coordinates of the centre of mass of the remaining portion will be :-



(1) $\left(\frac{2a}{3}, \frac{2b}{3}\right)$ (2) $\left(\frac{5a}{3}, \frac{5b}{3}\right)$

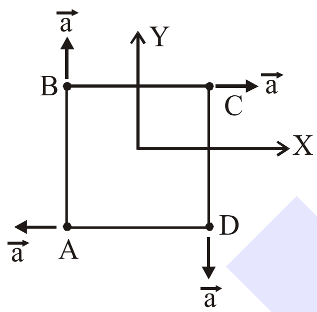
(3) $\left(\frac{3a}{4}, \frac{3b}{4}\right)$ (4) $\left(\frac{5a}{12}, \frac{5b}{12}\right)$

6. A body of mass m_1 moving with an unknown velocity of $v_1\hat{i}$, undergoes a collinear collision with a body of mass m_2 moving with a velocity $v_2\hat{i}$. After collision, m_1 and m_2 move with velocities of $v_3\hat{i}$ and $v_4\hat{i}$, respectively. If $m_2 = 0.5\ m_1$ and $v_3 = 0.5\ v_1$, then v_1 is :-

(1) $v_4 - \frac{v_2}{4}$ (2) $v_4 - \frac{v_2}{2}$

(3) $v_4 - v_2$ (4) $v_4 + v_2$

7. Four particles A, B, C and D with masses $m_A = m$, $m_B = 2m$, $m_C = 3m$ and $m_D = 4m$ are at the corners of a square. They have accelerations of equal magnitude with directions as shown. The acceleration of the centre of mass of the particles is :



(1) $\frac{a}{5}\left(\hat{i}-\hat{j}\right)$ (2) $\frac{a}{5}\left(\hat{i}+\hat{j}\right)$

(3) Zero (4) $a\left(\hat{i}+\hat{j}\right)$

8. A particle of mass 'm' is moving with speed '2v' and collides with a mass '2m' moving with speed 'v' in the same direction. After collision, the first mass is stopped completely while the second one splits into two particles each of mass 'm', which move at angle 45° with respect to the origianl direction. The speed of each of the moving particle will be :-

(1) $v/\left(2\sqrt{2}\right)$ (2) $2\sqrt{2}v$

(3) $\sqrt{2}v$ (4) $v/\sqrt{2}$

9. A wedge of mass M = 4m lies on a frictionless plane. A particle of mass m approaches the wedge with speed v. There is no friction between the particle and the plane or between the particle and the wedge. The maximum height climbed by the particle on the wedge is given by :-

(1) $\frac{2v^2}{7g}$ (2) $\frac{v^2}{g}$

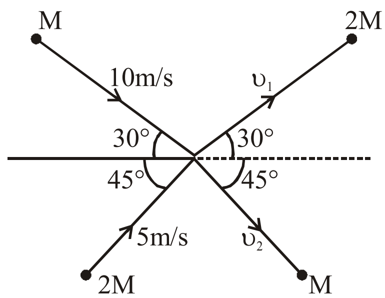
(3) $\frac{2v^2}{5g}$ (4) $\frac{v^2}{2g}$

10. A body of mass 2 kg makes an eleastic collision with a second body at rest and continues to move in the original direction but with one fourth of its original speed. What is the mass of the second body ?

(1) 1.8 kg (2) 1.2 kg

(3) 1.5 kg (4) 1.0 kg

11. Two particles, of masses M and 2M, moving, as shown, with speeds of 10 m/s and 5 m/s, collide elastically at the origin. After the collision, they move along the indicated directions with speeds υ_1 and υ_2, respectively. The values of υ_1 and υ_2 are nearly :



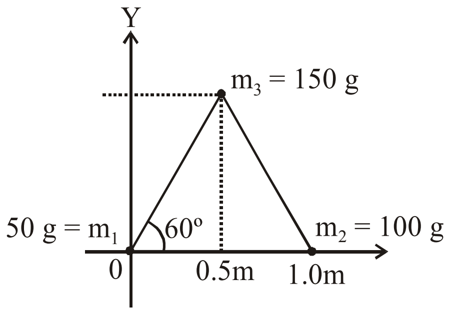
(1) 3.2 m/s and 6.3 m/s

(2) 3.2 m/s and 12.6 m/s

(3) 6.5 m/s and 6.3 m/s

(4) 6.5 m/s and 3.2 m/s

12. Three particles of masses 50 g, 100 g and 150g are placed at the vertices of an equilateral triangle of side 1 m (as shown in the figure). The (x, y) coordinates of the centre of mass will be :



(1) $\left(\frac{7}{12}\text{m}, \frac{\sqrt{3}}{8}\text{m}\right)$ (2) $\left(\frac{\sqrt{3}}{4}\text{m}, \frac{5}{12}\text{m}\right)$

(3) $\left(\frac{7}{12}\text{m}, \frac{\sqrt{3}}{4}\text{m}\right)$ (4) $\left(\frac{\sqrt{3}}{8}\text{m}, \frac{7}{12}\text{m}\right)$

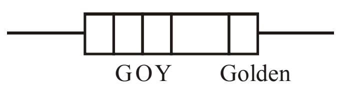
13. A man (mass = 50 kg) and his son (mass = 20 kg) are standing on a frictionless surface facing each other. The man pushes his son so that he starts moving at a speed of 0.70 ms^{-1} with respect to the man. The speed of the man with respect to the surface is :

(1) 0.20 ms^{-1} (2) 0.14 ms^{-1}

(3) 0.47 ms^{-1} (4) 0.28 ms^{-1}

CURRENT ELECTRICITY

1. A carbon resistance has a following colour code. What is the value of the resistance ?



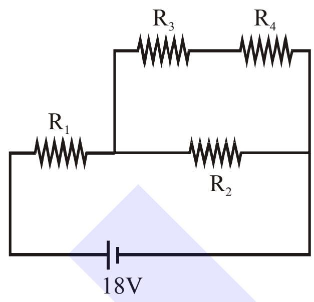
(1) 1.64 MΩ ± 5%

(2) 530 kΩ ± 5%

(3) 64 kΩ ± 10%

(4) 5.3 MΩ ± 5%

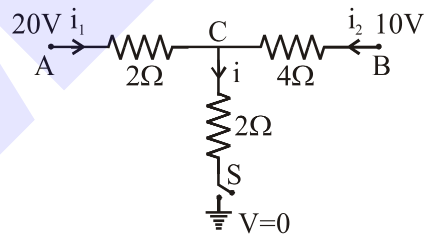
2. In the given circuit the internal resistance of the 18 V cell is negligible. If R_1 = 400 Ω, R_3 = 100 Ω and R_4 = 500 Ω and the reading of an ideal voltmeter across R_4 is 5V, then the value R_2 will be:



(1) 300 Ω (2) 230 Ω

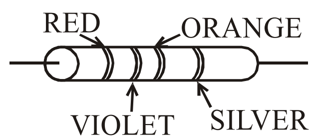
(3) 450 Ω (4) 550 Ω

3. When the switch S, in the circuit shown, is closed, then the value of current *i* will be :



(1) 3 A (2) 5 A (3) 4 A (4) 2 A

4. A resistance is shown in the figure. Its value and tolerance are given respectively by:



(1) 27 KΩ, 20% (2) 270 KΩ, 5%

(3) 270 KΩ, 10% (4) 27 KΩ, 10%

5. A copper wire is stretched to make it 0.5% longer. The percentage change in its electrical resistance if its volume remains unchanged is:

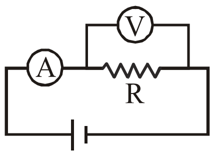
(1) 2.5% (2) 0.5%

(3) 1.0% (4) 2.0%

6. Drift speed of electrons, when 1.5 A of current flows in a copper wire of cross section 5 mm, is v. If the electron density in copper is 9×10^{28} /m^3 the value of v in mm/s is close to (Take charge of electron to be $= 1.6 \times 10^{-19}$C)

(1) 0.2 (2) 3 (3) 2 (4) 0.02

7. The actual value of resistance R, shown in the figure is 30Ω. This is measured in an experiment as shown using the standard formula $R = \frac{V}{I}$, where V and I are the readings of the voltmeter and ammeter, respectively. If the measured value of R is 5% less, then the internal resistance of the voltmeter is :



(1) 350Ω (2) 570Ω (3) 35 Ω (4) 600 Ω

8. A current of 2 mA was passed through an unknown resistor which dissipated a power of 4.4 W. Dissipated power when an ideal power supply of 11V is connected across it is :

(1) 11×10^{-5} W

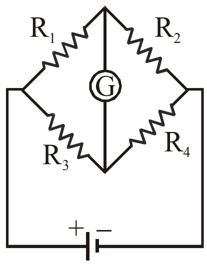
(2) 11×10^{-4} W

(3) 11×10^{5} W

(4) 11×10^{-3} W

9. The Wheatstone bridge shown in Fig. here, gets balanced when the carbon resistor used as R_1 has the colour code (Orange, Red, Brown). The resistors R_2 and R_4 are 80Ω and 40Ω, respectively.

Assuming that the colour code for the carbon resistors gives their accurate values, the colour code for the carbon resistor, used as R_3, would be :



(1) Red, Green, Brown

(2) Brown, Blue, Brown

(3) Grey, Black, Brown

(4) Brown, Blue, Black

10. A uniform metallic wire has a resistance of 18 Ω and is bent into an equilateral triangle. Then, the resistance between any two vertices of the triangle is :

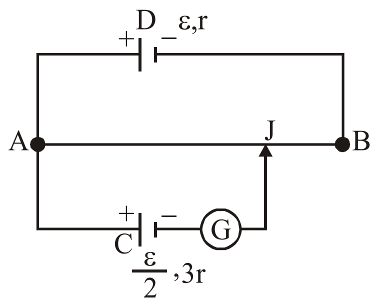
(1) 8 Ω (2) 12 Ω (3) 4 Ω (4) 2Ω

11. A 2 W carbon resistor is color coded with green, black, red and brown respectively. The maximum current which can be passed through this resistor is :

(1) 63 mA (2) 0.4 mA

(3) 100 mA (4) 20 mA

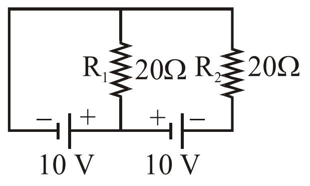
12. A potentiometer wire AB having length L and resistance 12 r is joined to a cell D of emf ε and internal resistance r. A cell C having emf ε/2 and internal resistance 3r is connected. The length AJ at which the galvanometer as shown in fig. shows no deflection is :



(1) $\frac{5}{12}$L (2) $\frac{11}{24}$L

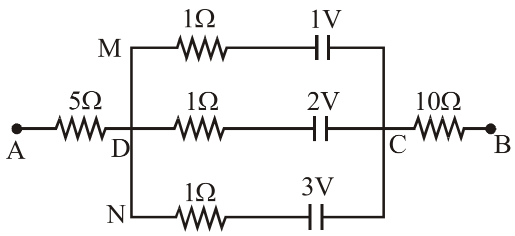
(3) $\frac{11}{12}$L (4) $\frac{13}{24}$L

13. In the given circuit the cells have zero internal resistance. The currents (in Amperes) passing through resistance R_1, and R_2 respectively, are:



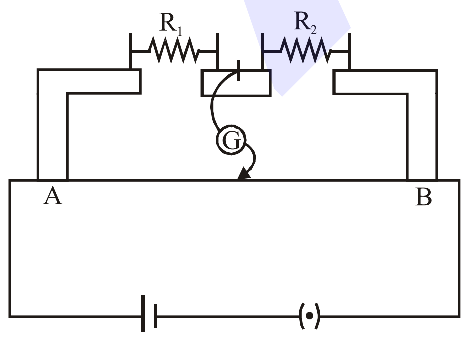
(1) 2, 2 (2) 0,1 (3) 1,2 (4) 0.5,0

14. In the circuit , the potential difference between A and B is :-



(1) 6 V (2) 1 V (3) 3 V (4) 2 V

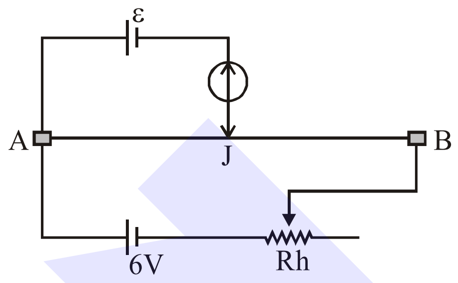
15. In the experimental set up of metre bridge shown in the figure, the null point is obtained at a distance of 40 cm from A. If a 10Ω resistor is connected in series with R_1, the null point shifts by 10 cm. The resistance that should be connected in parallel with $(R_1 + 10)\Omega$ such that the null point shifts back to its initial position is



(1) 40 Ω (2) 60 Ω

(3) 20 Ω (4) 30Ω

16. The resistance of the meter bridge AB is given figure is 4Ω. With a cell of emf $\varepsilon = 0.5$ V and rheostat resistance $R_h = 2\ \Omega$ the null point is obtained at some point J. When the cell is replaced by another one of emf $\varepsilon = \varepsilon_2$ the same null point J is found for $R_h = 6\ \Omega$. The emf ε_2 is;



(1) 0.6 V (2) 0.5 V

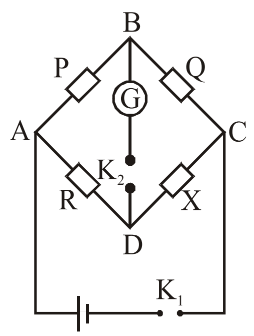
(3) 0.3 V (4) 0.4 V

17. Two equal resistance when connected in series to a battery, consume electric power of 60 W. If these resistances are now connected in parallel combination to the same battery, the electric power consumed will be :

(1) 60 W (2) 240 W

(3) 30 W (4) 120 W

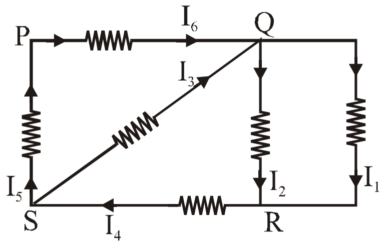
18. In a Wheatstone bridge (see fig.), Resistances P and Q are approximately equal. When R = 400 Ω, the bridge is equal. When R = 400 Ω, the bridge is balanced. On inter-changing P and Q, the value of R, for balance, is 405 Ω. The value of X is close to :



(1) 403.5 ohm (2) 404.5 ohm

(3) 401.5 ohm (4) 402.5 ohm

19. In the given circuit diagram, the currents, I_1 =–0.3A, I_4 = 0.8 A and I_5 = 0.4 A, are flowing as shown. The currents I_2,I_3 and I_6,respectively, are :



(1) 1.1 A, 0.4 A, 0.4 A
(2) –0.4 A, 0.4 A, 1.1 A
(3) 0.4 A, 1.1 A, 0.4 A
(4) 1.1 A,–0.4 A, 0.4 A

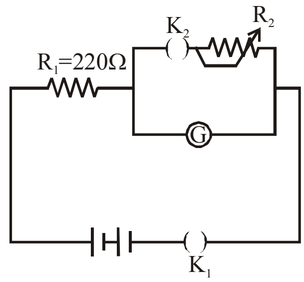
20. A galvanometer, whose resistance is 50 ohm, has 25 divisions in it. When a current of 4×10^{-4} A passes through it, its needle (pointer) deflects by one division. To use this galvanometer as a voltmeter of range 2.5 V, it should be connected to a resistance of:

(1) 6250 ohm (2) 250 ohm
(3) 200 ohm (4) 6200 ohm

21. Two electric bulbs, rated at (25 W, 220 V) and (100 W, 220 V), are connected in series across a 220 V voltage source. If the 25 W and 100 W bulbs draw powers P_1 and P_2 respectively, then:

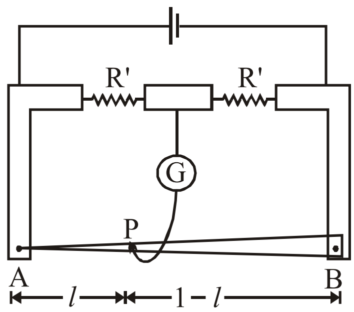
(1) P1 = 9 W, P_2 = 16 W
(2) P_1 = 4 W, P_2 = 16W
(3) P_1 = 16 W, P_2 = 4W
(4) P_1 16 W, P_2 = 9W

22. The galvanometer deflection, when key K_1 is closed but K_2 is open, equals θ_0 (see figure). On closing K_2 also and adjusting R_2 to 5Ω, the deflection in galvanometer becomes $\frac{\theta_0}{5}$. The resistance of the galvanometer is, then, given by [Neglect the internal resistance of battery]:



(1) 12Ω (2) 25Ω
(3) 5Ω (4) 22Ω

23. In a meter bridge, the wire of length 1 m has a non-uniform cross-section such that, the variation $\frac{dR}{d\ell}$ of its resistance R with length ℓ is $\frac{dR}{d\ell}\propto\frac{1}{\sqrt{\ell}}$. Two equal resistances are connected as shown in the figure. The galvanometer has zero deflection when the jockey is at point P. What is the length AP?

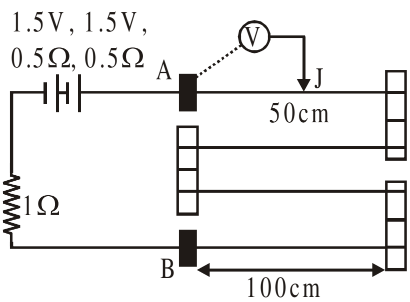


(1) 0.25 m (2) 0.3m
(3) 0.35 m (4) 0.2 m

24. An ideal battery of 4 V and resistance R are connected in series in the primary circuit of a potentiometer of length 1 m and resistance 5Ω. The value of R, to give a potential difference of 5 mV across 10 cm of potentiometer wire, is :

(1) 490 Ω (2) 480 Ω
(3) 395 Ω (4) 495 Ω

25. In the circuit shown, a four-wire potentiometer is made of a 400 cm long wire, which extends between A and B. The resistance per unit length of the potentiometer wire is r = 0.01 Ω/cm. If an ideal voltmeter is connected as shown with jockey J at 50 cm from end A, the expected reading of the voltmeter will be :-



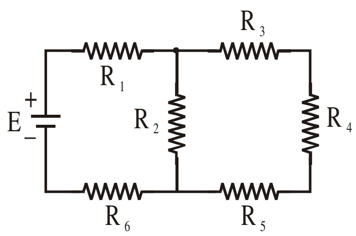
(1) 0.20 V (2) 0.25 V
(3) 0.75 V (4) 0.50V

26. A cell of internal resistance r drives current through an external resistance R. The power delivered by the cell to the external resistance will be maximum when :-

(1) R = 1000 r (2) R = 0.001 r
(3) R = 2r (4) R = r

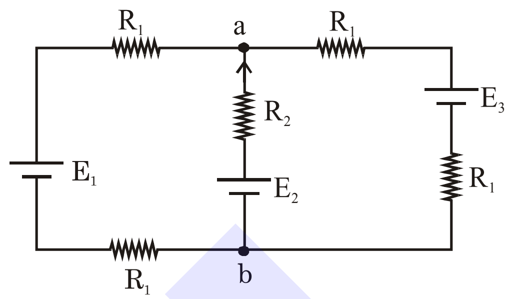
27. In the figure shown, what is the current (in Ampere) drawn from the battery ? You are given:

R_1 = 15Ω, R_2 = 10 Ω, R_3 = 20 Ω, R_4 = 5Ω, R_5= 25Ω, R_6 = 30 Ω, E = 15 V



(1) 7/18 (2) 13/24 (3) 9/32 (4) 20/3

28. For the circuit shown, with R_1 = 1.0Ω, R_2 = 2.0 Ω, E_1 = 2 V and E_2 = E_3 = 4 V, the potential difference between the points 'a' and 'b' is approximately (in V) :



(1) 2.7 (2) 3.3
(3) 2.3 (4) 3.7

29. A 200 Ω resistor has a certain color code. If one replaces the red color by green in the code, the new resistance will be :

(1) 100 Ω (2) 400 Ω
(3) 500 Ω (4) 300 Ω

30. A metal wire of resistance 3 Ω is elongated to make a uniform wire of double its previous length. This new wire is now bent and the ends joined to make a circle. If two points on this circle make an angle 60° at the centre, the equivalent resistance between these two points will be :-

(1) $\frac{12}{5}$Ω (2) $\frac{5}{3}$Ω
(3) $\frac{5}{2}$Ω (4) $\frac{7}{2}$Ω

31. The resistance of a galvanometer is 50 ohm and the maximum current which can be passed through it is 0.002 A. What resistance must be connected to it in order to convert it into an ammeter of range 0 – 0.5 A ?

(1) 0.2 ohm (2) 0.002 ohm
(3) 0.02 ohm (4) 0.5 ohm

32. In a conductor, if the number of conduction electrons per unit volume is $8.5 \times 10^{28}\ m^{-3}$ and mean free time is $25fs$ (femto second), it's approximate resistivity is :-

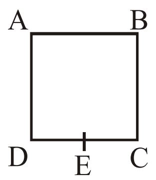
($m_e = 9.1 \times 10^{-31}$ kg)

(1) $10^{-5}\ \Omega m$ (2) $10^{-6}\ \Omega m$

(3) $10^{-7}\ \Omega m$ (4) $10^{-8}\ \Omega m$

33. A wire of resistance R is bent to form a square ABCD as shown in the figure. The effective resistance between E and C is :

(E is mid-point of arm CD)



(1) R (2) $\frac{1}{16}R$

(3) $\frac{7}{64}R$ (4) $\frac{3}{4}R$

34. A moving coil galvanometer has resistance 50Ω and it indicates full deflection at 4mA current. A voltmeter is made using this galvanometer and a 5 kΩ resistance. The maximum voltage, that can be measured using this voltmeter, will be close to :

(1) 10 V (2) 20 V

(3) 40 V (4) 15 V

35. Space between two concentric conducting spheres of radii a and b (b > a) is filled with a medium of resistivity ρ. The resistance between the two spheres will be :

(1) $\frac{\rho}{4\pi}\left(\frac{1}{a}-\frac{1}{b}\right)$ (2) $\frac{\rho}{2\pi}\left(\frac{1}{a}-\frac{1}{b}\right)$

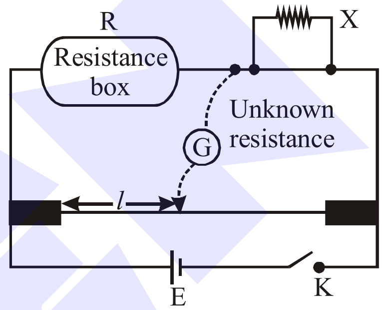
(3) $\frac{\rho}{2\pi}\left(\frac{1}{a}+\frac{1}{b}\right)$ (4) $\frac{\rho}{4\pi}\left(\frac{1}{a}+\frac{1}{b}\right)$

36. A current of 5 A passes through a copper conductor (resistivity = $1.7 \times 10^{-8}\ \Omega m$) of radius of cross-section 5 mm. Find the mobility of the charges if their drift velocity is 1.1×10^{-3} m/s.

(1) 1.3 m^2/Vs (2) 1.5 m^2/Vs

(3) 1.8 m^2/Vs (4) 1.0 m^2/Vs

37. In a meter bridge experiment, the circuit diagram and the corresponding observation table are shown in figure

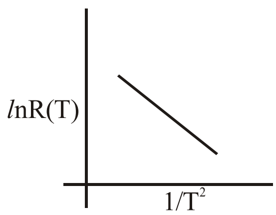


SI. No.	R(Ω)	l(cm)
1.	1000	60
2.	100	13
3.	10	1.5
4.	1	1.0

Which of the readings is inconsistent?

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

38. In an experiment, the resistance of a material is plotted as a function of temperature (in some range). As shown in the figure, it is a straight line. One may conclude that :



(1) $R(T) = \frac{R_0}{T^2}$ (2) $R(T) = R_0 e^{-T^2/T_0^2}$

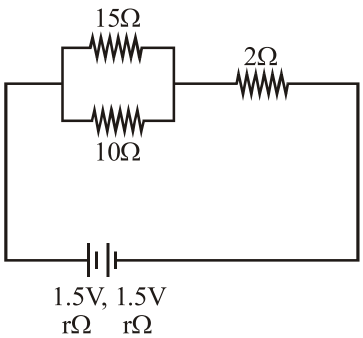
(3) $R(T) = R_0 e^{-T_0^2/T^2}$ (4) $R(T) = R_0 e^{T^2/T_0^2}$

39. A moving coil galvanometer allows a full scale current of 10^{-4}A. A series resistance of 2 MΩ is required to convert the above galvanometer into a voltmeter of range 0-5 V. Therefore the value of shunt resistance required to convert the above galvanometer into an ammeter of range 0-10 mA is :

(1) 200 Ω (2) 100 Ω

(3) 10 Ω (4) 500 Ω

40. In the given circuit, an ideal voltmeter connected across the 10Ω resistance reads 2V. The internal resistance r, of each cell is :



(1) 1Ω (2) 1.5Ω (3) 0Ω (4) 0.5Ω

41. A moving coil galvanometer, having a resistance G, produces full scale deflection when a current I_g flows through it. This galvanometer can be converted into (i) an ammeter of range 0 to I_0 ($I_0 > I_g$) by connecting a shunt resistance R_A to it and (ii) into a voltmeter of range 0 to V($V = GI_0$) by connecting a series resistance R_V to it. Then,

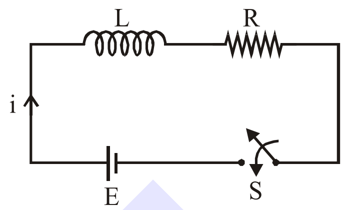
(1) $R_AR_V = G^2\left(\frac{I_g}{I_0-I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_0-I_g}{I_g}\right)^2$

(2) $R_AR_V = G^2$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{I_0-I_g}\right)^2$

(3) $R_AR_V = G^2$ and $\frac{R_A}{R_V} = \frac{I_g}{(I_0-I_g)}$

(4) $R_AR_V = G^2\left(\frac{I_0-I_g}{I_g}\right)$ and $\frac{R_A}{R_V} = \left(\frac{I_g}{I_0-I_g}\right)^2$

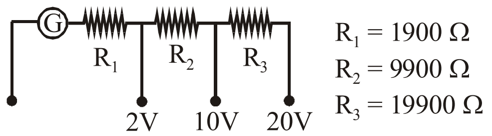
42. Consider the LR circuit shown in the figure. If the switch S is closed at t = 0 then the amount of charge that passes through the battery between t = 0 and t = $\frac{L}{R}$ is :

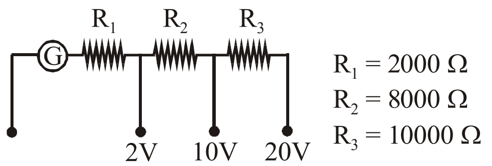


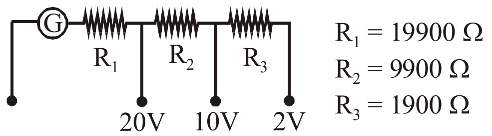
(1) $\frac{EL}{7.3R^2}$ (2) $\frac{EL}{2.7R^2}$

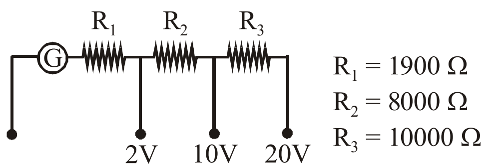
(3) $\frac{7.3EL}{R^2}$ (4) $\frac{2.7EL}{R^2}$

43. A galvanometer of resistance 100Ω has 50 divisions on its scale and has sensitivity of 20 μA/division. It is to be converted to a voltmeter with three ranges, of 0–2 V, 0–10 V and 0–20 V. The appropriate circuit to do so is :

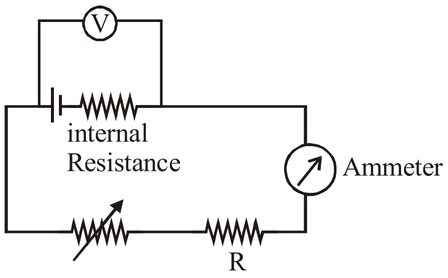
(1)


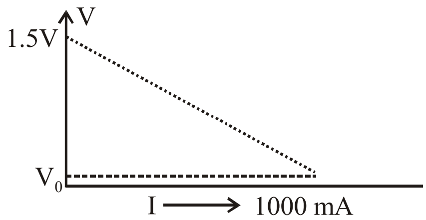
(2)


(3)


(4)


44. To verify Ohm's law, a student connects the voltmeter across the battery as, shown in the figure. The measured voltage is plotted as a function of the current, and the following graph is obtained:





If V_0 is almost zero, identify the correct statement:

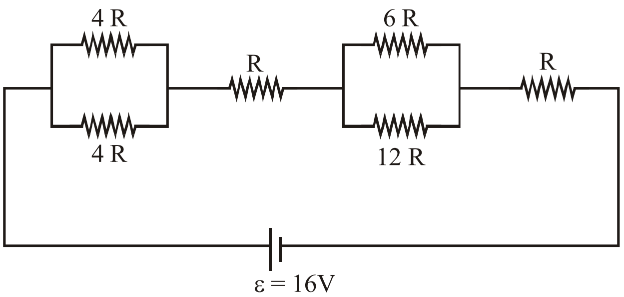
(1) The value of the resistance R is 1.5 Ω

(2) The emf of the battery is 1.5 V and the value of R is 1.5 Ω

(3) The emf of the battery is 1.5 V and its internal resistance is 1.5 Ω

(4) The potential difference across the battery is 1.5 V when it sends a current of 1000mA.

45. The resistive network shown below is connected to a D.C. source of 16V. The power consumed by the network is 4 Watt. The value of R is :



(1) 8Ω (2) 6Ω (3) 1Ω (4) 16Ω

ELECTROSTATICS

1. Two point charges $q_1(\sqrt{10}\ \mu C)$ and $q_2(-25\ \mu C)$ are placed on the x-axis at x = 1 m and x = 4 m respectively. The electric field (in V/m) at a point y = 3 m on y-axis is,

$\left[\text{take } \frac{1}{4\pi\varepsilon_0} = 9\times10^9\,Nm^2C^{-2}\right]$

(1) $(-63\hat{i}+27\hat{j})\times10^2$

(2) $(81\hat{i}-81\hat{j})\times10^2$

(3) $(63\hat{i}-27\hat{j})\times10^2$

(4) $(-81\hat{i}+81\hat{j})\times10^2$

2. Charge is distributed within a sphere of radius R with a volume charge density $\rho(r) = \frac{A}{r^2}e^{-2r/a}$, where A and a are constants. If Q is the total charge of this charge distribution, the radius R is :

(1) $\frac{a}{2}\log\left(1-\frac{Q}{2\pi aA}\right)$

(2) $a\log\left(1-\frac{Q}{2\pi aA}\right)$

(3) $a\log\left(\frac{1}{1-\frac{Q}{2\pi aA}}\right)$

(4) $\frac{a}{2}\log\left(\frac{1}{1-\frac{Q}{2\pi aA}}\right)$

3. Three charges +Q, q, + Q are placed respectively, at distance, 0, d/2 and d from the origin, on the x-axis. If the net force experienced by + Q, placed at x = 0, Ls zero, then value of q is :

(1) +Q/2 (2) –Q/2

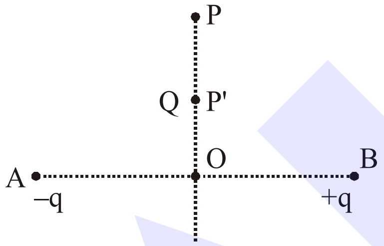
(3) –Q/4 (4) +Q/4

4. For a uniformly charged ring of radius R, the electric field on its axis has the largest magnitude at a distance h from its centre. Then value of h is :

(1) $\frac{R}{\sqrt{5}}$ (2) R

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

5. Charges –q and +q located at A and B, respectively, constitute an electric dipole. Distance AB = 2a, O is the mid point of the dipole and OP is perpendicular to AB. A charge Q is placed at P where OP = y and y >> 2a. The charge Q experiences and electrostatic force F. If Q is now moved along the equatorial line to P' such that $OP' = \left(\frac{y}{3}\right)$, the force on Q will be close to : $\left(\frac{y}{3} >> 2a\right)$



(1) $\frac{F}{3}$ (2) 3F (3) 9F (4) 27F

6. Four equal point charges Q each are placed in the xy plane at (0, 2), (4, 2), (4, –2) and (0, –2). The work required to put a fifth charge Q at the origin of the coordinate system will be :

(1) $\frac{Q^2}{2\sqrt{2}\pi\varepsilon_0}$ (2) $\frac{Q^2}{4\pi\varepsilon_0}\left(1+\frac{1}{\sqrt{5}}\right)$

(3) $\frac{Q^2}{4\pi\varepsilon_0}\left(1+\frac{1}{\sqrt{3}}\right)$ (4) $\frac{Q^2}{4\pi\varepsilon_0}$

7. A charge Q is distributed over three concentric spherical shells of radii a, b, c (a < b < c) such that their surface charge densities are equal to one another. The total potential at a point at distance r from their common centre, where r < a, would be :

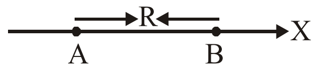
(1) $\frac{Q}{4\pi\varepsilon_0(a+b+c)}$

(2) $\frac{Q(a+b+c)}{4\pi\varepsilon_0(a^2+b^2+c^2)}$

(3) $\frac{Q}{12\pi\varepsilon_0}\frac{ab+bc+ca}{abc}$

(4) $\frac{Q}{4\pi\varepsilon_0}\frac{(a^2+b^2+c^2)}{(a^3+b^3+c^3)}$

8. Two electric dipoles, A, B with respective dipole moments $\vec{d}_A = -4qa\hat{i}$ and $\vec{d}_B = -2qa\hat{i}$ placed on the x-axis with a separation R, as shown in the figure



The distance from A at which both of them produce the same potential is :

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

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

9. An electric field of 1000 V/m is applied to an electric dipole at angle of 45°. The value of electric dipole moment is 10^{-29} C.m. What is the potential energy of the electric dipole ?

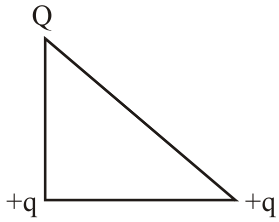
(1) – 9 × 10^{-20} J

(2) – 7 × 10^{-27} J

(3) – 10 × 10^{-29} J

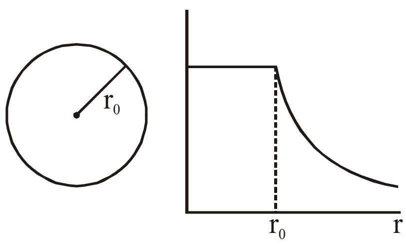
(4) – 20 × 10^{-18} J

10. The charges Q + q and +q are placed at the vertices of a right-angle isosceles triangle as shown below. The net electrostatic energy of the configuration is zero, it the value of Q is:



(1) $\frac{-\sqrt{2}q}{\sqrt{2}+1}$ (2) –2q (3) $\frac{-q}{1+\sqrt{2}}$ (4) +q

11. The given graph shows variation (with distance r from centre) of :



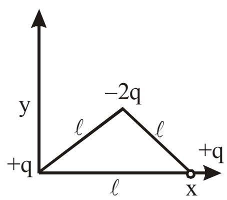
(1) Potential of a uniformly charged sphere

(2) Potential of a uniformly charged spherical shell

(3) Electric field of uniformly charged spherical shell

(4) Electric field of uniformly charged sphere

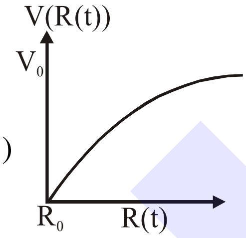
12. Determine the electric dipole moment of the system of three charges, placed on the vertices of an equilateral triangle, as shown in the figure:

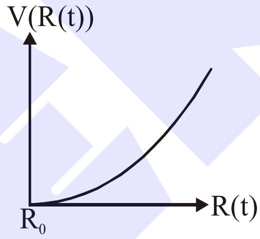


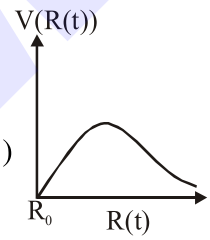
(1) $(q\ell)\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ (2) $\sqrt{3}q\ell\frac{\hat{j}-\hat{i}}{\sqrt{2}}$

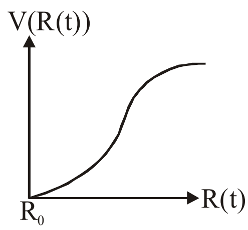
(3) $-\sqrt{3}q\ell\hat{j}$ (4) $2q\ell\hat{j}$

13. There is a uniform spherically symmetric surface charge density at a distance R_0 from the origin. The charge distribution is initially at rest and starts expanding because of mutual repulsion. The figure that represents best the speed V(R(t)) of the distribution as a function of its instantaneous radius R (t) is :

(1) 

(2) 

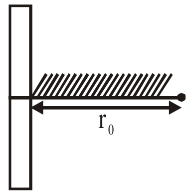
(3) 

(4) 

14. An electric dipole is formed by two equal and opposite charges q with separation d. The charges have same mass m. It is kept in a uniform electric field E. If it is slightly rotated from its equilibrium orientation, then its angular frequency ω is :-

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

15. A positive point charge is released from rest at a distance r_0 from a positive line charge with uniform density. The speed (v) of the point charge, as a function of instantaneous distance r from line charge, is proportional to :-



(1) $v \propto e^{+r/r_0}$

(2) $v \propto \ell n\left(\frac{r}{r_0}\right)$

(3) $v \propto \left(\frac{r}{r_0}\right)$

(4) $v \propto \sqrt{\ell n\left(\frac{r}{r_0}\right)}$

16. The electric field in a region is given by $\vec{E} = (Ax + B)\hat{i}$, where E is in NC^{-1} and x is in metres. The values of constants are A = 20 SI unit and B = 10 SI unit. If the potential at x = 1 is V_1 and that at x = –5 is V_2, then $V_1 - V_2$ is :-

(1) –48 V

(2) –520 V

(3) 180 V

(4) 320 V

17. The bob of a simple pendulum has mass 2g and a charge of 5.0 μC. It is at rest in a uniform horizontal electric field of intensity 2000 V/m. At equilibrium, the angle that the pendulum makes with the vertical is : (take g = 10 m/s^2)

(1) $\tan^{-1}(5.0)$

(2) $\tan^{-1}(2.0)$

(3) $\tan^{-1}(0.5)$

(4) $\tan^{-1}(0.2)$

18. A solid conducting sphere, having a charge Q, is surrounded by an uncharged conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of –4 Q, the new potential difference between the same two surfaces is :

(1) V (2) 2V

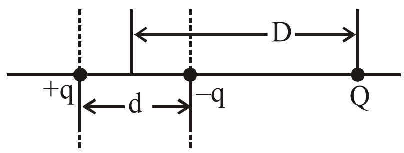
(3) –2V (4) 4V

19. Four point charges –q, +q, +q and –q are placed on y-axis at y = –2d, y = –d, y = +d and y = +2d, respectively. The magnitude of the electric field E at a point on the x-axis at x = D, with D >> d, will behave as :-

(1) $E \propto \frac{1}{D}$ (2) $E \propto \frac{1}{D^3}$

(3) $E \propto \frac{1}{D^2}$ (4) $E \propto \frac{1}{D^4}$

20. A system of three charges are placed as shown in the figure :



If D >> d, the potential energy of the system is best given by :

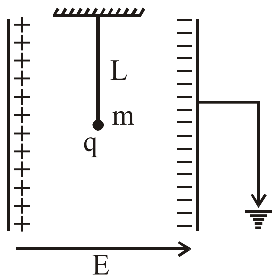
(1) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d} - \frac{qQd}{2D^2}\right]$

(2) $\frac{1}{4\pi\varepsilon_0}\left[+\frac{q^2}{d} + \frac{qQd}{D^2}\right]$

(3) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d} + \frac{2qQd}{D^2}\right]$

(4) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d} - \frac{qQd}{D^2}\right]$

21. A simple pendulum of length L is placed between the plates of a parallel plate capacitor having electric field E, as shown in figure. Its bob has mass m and charge q. The time period of the pendulum is given by :



(1) $2\pi\sqrt{\dfrac{L}{\sqrt{g^2+\left(\dfrac{qE}{m}\right)^2}}}$ (2) $2\pi\sqrt{\dfrac{L}{\left(g+\dfrac{qE}{m}\right)}}$

(3) $2\pi\sqrt{\dfrac{L}{\left(g-\dfrac{qE}{m}\right)}}$ (4) $2\pi\sqrt{\dfrac{L}{\sqrt{g^2-\dfrac{q^2E^2}{m^2}}}}$

22. In free space, a particle A of charge 1 μC is held fixed at a point P. Another particle B of the same charge and mass 4 μg is kept at a distance of 1 mm from P. if B is released, then its velocity at a distance of 9 mm from P is :

$$\left[\text{Take } \frac{1}{4\pi\varepsilon_0} = 9\times10^9\,\text{Nm}^2\,\text{C}^{-2}\right]$$

(1) 2.0×10^3 m/s (2) 3.0×10^4 m/s

(3) 1.5×10^2 m/s (4) 1.0 m/s

23. A uniformly charged ring of radius 3a and total charge q is placed in xy-plane centred at origin. A point charge q is moving towards the ring along the z-axis and has speed u at z = 4a. The minimum value of u such that it crosses the origin is :

(1) $\sqrt{\dfrac{2}{m}}\left(\dfrac{1}{15}\dfrac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

(2) $\sqrt{\dfrac{2}{m}}\left(\dfrac{2}{15}\dfrac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

(3) $\sqrt{\dfrac{2}{m}}\left(\dfrac{4}{15}\dfrac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

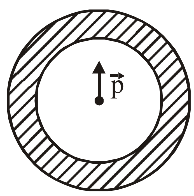
(4) $\sqrt{\dfrac{2}{m}}\left(\dfrac{1}{5}\dfrac{q^2}{4\pi\varepsilon_0 a}\right)^{1/2}$

24. Let a total charge 2Q be distributed in a sphere of radius R, with the charge density given by $\rho(r) = kr$, where r is the distance from the centre. Two charges A and B, of –Q each, are placed on diametrically opposite points, at equal distance, a, from the centre. If A and B do not experience any force, then :

(1) $a = \dfrac{3R}{2^{1/4}}$ (2) $a = R/\sqrt{3}$

(3) $a = 8^{-1/4}R$ (4) $a = 2^{-1/4}\,R$

25. Shown in the figure is a shell made of a conductor. It has inner radius a and outer radius b, and carries charge Q. At its centre is a dipole $\vec{p}$ as shown. In this case :



(1) Electric field outside the shell is the same as that of a point charge at the centre of the shell.

(2) Surface charge density on the inner surface of the shell is zero everywhere.

(3) Surface charge density on the inner surface is uniform and equal to $\dfrac{(Q/2)}{4\pi a^2}$.

(4) Surface charge density on the outer surface depends on $|\vec{p}|$

26. A point dipole $\vec{p} = -p_0\hat{x}$ is kept at the origin. The potential and electric field due to this dipole on the y-axis at a distance d are, respectively: (Take V = 0 at infinity) :

(1) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$ (2) $0, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$

(3) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$ (4) $0, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$

EMI & AC

1. A series AC circuit containing an inductor (20 mH), a capacitor (120 μF) and a resistor (60Ω) is driven by an AC source of 24V/50Hz. The energy dissipated in the circuit in 60 s is :

(1) 2.26×10^3 J (2) 3.39×10^3 J

(3) 5.65×10^2 J (4) 5.17×10^2 J

2. A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns. The output power is delivered at 230 V bv the transformer. If the current in the primary of the transformer is 5A and its efficiency is 90%, the output current would be :

(1) 25 A (2) 50 A

(3) 35 A (4) 45 A

3. The self induced emf of a coil is 25 volts. When the current in it is changed at uniform rate from 10 A to 25 A in 1s, the change in the energy of the inductance is :

(1) 437.5 J (2) 637.5 J

(3) 740 J (4) 540 J

4. A solid metal cube of edge length 2 cm is moving in a positive y direction at a constant speed of 6 m/s. There is a uniform magnetic field of 0.1 T in the positive z-direction. The potential difference between the two faces of the cube perpendicular to the x-axis, is :

(1) 6 mV (2) 1 mV (3) 12 mV (4) 2 mV

5. A copper wire is wound on a wooden frame, whose shape is that of an equilateral triangle. If the linear dimension of each side of the frame is increased by a factor of 3, keeping the number of turns of the coil per unit length of the frame the same, then the self inductance of the coil :

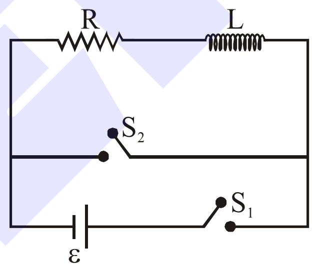
(1) Decreases by a factor of $9\sqrt{3}$

(2) Increases by a factor of 3

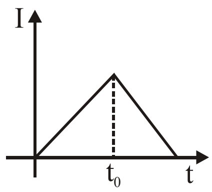
(3) Decreases by a factor of 9

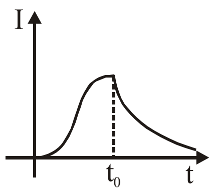
(4) Increases by a factor of 27

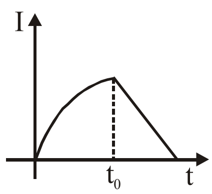
6. In the circuit shown,

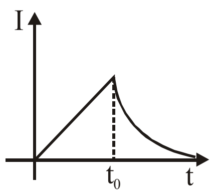


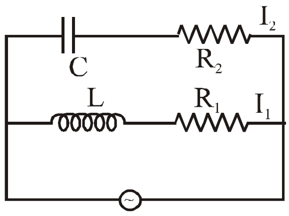
the switch S_1 is closed at time t = 0 and the switch S_2 is kept open. At some later time (t_0), the switch S_1 is opened and S_2 is closed. The behavious of the current I as a function of time 't' is given by :

(1) 

(2) 

(3) 

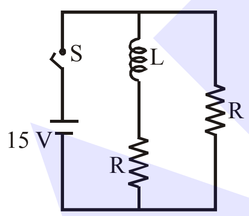
(4) 

7. 

In the above circuit, $C = \frac{\sqrt{3}}{2}\mu F$, $R_2 = 20\Omega$, $L = \frac{\sqrt{3}}{10}$ H and $R_1 = 10\Omega$. Current in L-R_1 path is I_1 and in C-R_2 path it is I_2. The voltage of A.C source is given by $V = 200\sqrt{2}\sin(100t)$ volts. The phase difference between I_1 and I_2 is :

(1) 30° (2) 0° (3) 90° (4) 60°

8. In the figure shown, a circuit contains two identical resistors with resistance $R = 5\Omega$ and an inductance with $L = 2mH$. An ideal battery of 15 V is connected in the circuit. What will be the current through the battery long after the switch is closed?



(1) 6A (2) 7.5A (3) 5.5A (4) 3A

9. A circuit connected to an ac source of emf $e = e_0\sin(100t)$ with t in seconds, gives a phase difference of $\frac{\pi}{4}$ between the emf e and current i. Which of the following circuits will exhibit this ?

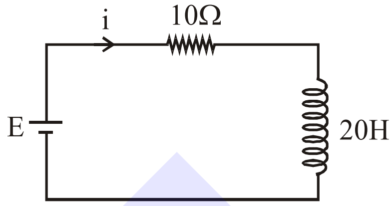
(1) RC circuit with R = 1 kΩ and C = 1μF

(2) RL circuit with R = 1kΩ and L = 1mH

(3) RL circuit with R = 1 kΩ and L = 10 mH

(4) RC circuit with R = 1kΩ and C = 10 μF

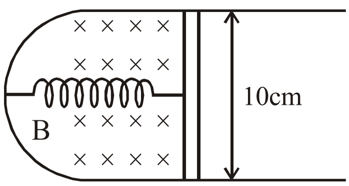
10. A 20 Henry inductor coil is connected to a 10 ohm resistance in series as shown in figure. The time at which rate of dissipation of energy (joule's heat) across resistance is equal to the rate at which magnetic energy is stored in the inductor is :



(1) $\frac{2}{\ell n2}$ (2) $\ell n2$

(3) $2\ell n2$ (4) $\frac{1}{2}\ell n2$

11. A thin strip 10 cm long is on a U shaped wire of negligible resistance and it is connected to a spring of spring constant 0.5 Nm^{-1} (see figure). The assembly is kept in a uniform magnetic field of 0.1 T. If the strip is pulled from its equilibrium position and released, the number of oscillation it performs before its amplitude decreases by a factor of e is N. If the mass of the strip is 50 grams, its resistance 10Ω and air drag negligible, N will be close to :



(1) 50000 (2) 5000

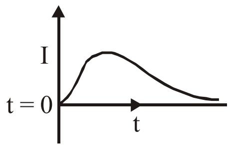
(3) 10000 (4) 1000

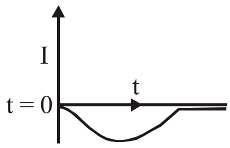
12. An alternating voltage v(t) = 220 sin 100 πt volt is applied to a purely resistance load of 50 Ω. The time taken for the current to rise from half of the peak value to the peak value is :

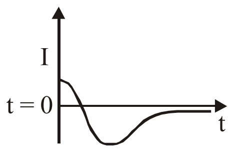
(1) 2.2 ms (2) 5 ms

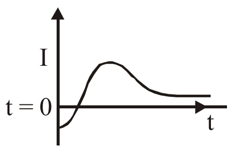
(3) 3.3 ms (4) 7.2 ms

13. A very long solenoid of radius R is carrying current $I(t) = kte^{-\alpha t}(k > 0)$, as a function of time $(t \geq 0)$. counter clockwise current is taken to be positive. A circular conducting coil of radius 2R is placed in the equatorial plane of the solenoid and concentric with the solenoid. The current induced in the outer coil is correctly depicted, as a function of time, by :-

(1) 

(2) 

(3) 

(4) 

14. The total number of turns and cross-section area in a solenoid is fixed. However, its length L is varied by adjusting the separation between windings. The inductance of solenoid will be proportional to :

(1) $1/L^2$ (2) $1/L$

(3) L (4) L^2

15. A coil of self inductance 10 mH and resistance 0.1 Ω is connected through a switch to a battery of internal resistance 0.9 Ω. After the switch is closed, the time taken for the current to attain 80% of the saturation value is : (Take $ln5 = 1.6$)

(1) 0.103 s (2) 0.016 s

(3) 0.002 s (4) 0.324 s

16. A transformer consisting of 300 turns in the primary and 150 turns in the secondary gives output power of 2.2 kW. If the current in the secondary coil is 10A, then the input voltage and current in the primary coil are :

(1) 220 V and 10A

(2) 440 V and 5A

(3) 440 V and 20 A

(4) 220 V and 20 A

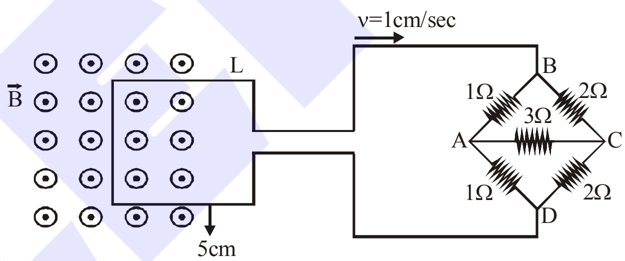
17. The displacement of a damped harmonic oscillator is given by

$x(t) = e^{-0.1t}\cos(10\pi t + \phi)$. Here t is in seconds.

The time taken for its amplitude of vibration to drop to half of its initial value is close to :

(1) 13 s (2) 7 s (3) 27 s (4) 4 s

18. The figure shows a square loop L of side 5 cm which is connected to a network of resistances. The whole setup is moving towards right with a constant speed of 1 cms^{-1}. At some instant, a part of L is in a uniform magnetic field of 1T, perpendicular to the plane of the loop. If the resistance of L is 1.7 Ω, the current in the loop at that instant will be close to :



(1) 115 μA (2) 170 μA

(3) 60 μA (4) 150 μA

EMW

1. The energy associated with electric field is (U_E) and with magnetic field is (U_B) for an electromagnetic wave in free space. Then :

(1) $U_E = \frac{U_B}{2}$ (2) $U_E < U_B$

(3) $U_E = U_B$ (4) $U_E > U_B$

2. A plane electromagnetic wave of frequency 50 MHz travels in free space along the positive x-direction. At a particular point in space and time, $\vec{E} = 6.3\hat{j}\,V/m$. The corresponding magnetic field $\vec{B}$, at that point will be:

(1) $18.9 \times 10^{-8}\hat{k}T$ (2) $6.3 \times 10^{-8}\hat{k}T$

(3) $2.1 \times 10^{-8}\hat{k}T$ (4) $18.9 \times 10^{8}\hat{k}T$

3. A conducting circular loop made of a thin wire, has area 3.5×10^{-3} m^2 and resistance 10Ω. It is placed perpendicular to a time dependent magnetic field $B(t) = (0.4T)\sin(50\pi t)$. The field is uniform in space. Then the net charge flowing through the loop during t = 0 s and t = 10 ms is close to :

(1) 14mC (2) 21 mC
(3) 6 mC (4) 7 mC

4. The electric field of a plane polarized electromagnetic wave in free space at time t= 0 is given by an expression

$\vec{E}(x,y) = 10\hat{j}\cos[(6x + 8z)]$

The magnetic field $\vec{B}$ (x, z, t) is given by : (c is the velocity of light)

(1) $\frac{1}{c}(6\hat{k}+8\hat{i})\cos[(6x-8z+10ct)]$

(2) $\frac{1}{c}(6\hat{k}-8\hat{i})\cos[(6x+8z-10ct)]$

(3) $\frac{1}{c}(6\hat{k}+8\hat{i})\cos[(6x+8z-10ct)]$

(4) $\frac{1}{c}(6\hat{k}-8\hat{i})\cos[(6x+8z+10ct)]$

5. If the magnetic field of a plane electromagnetic wave is given by (The speed of light = 3×10^8/m/s)

$B=100 \times 10^{-6}\sin\left[2\pi\times 2\times 10^{15}\left(t-\frac{x}{c}\right)\right]$ then the maximum electric field associated with it is :

(1) 4×10^4 N/C
(2) 4.5×10^4 N/C
(3) 6×10^4 N/C
(4) 3×10^4 N/C

6. A 27 mW laser beam has a cross-sectional area of 10 mm^2. The magnitude of the maximum electric field in this electromagnetic wave is given by [Given permittivity of space $\epsilon_0 = 9 \times 10^{-12}$ SI units, Speed of light $c = 3 \times 10^8$ m/s]:-

(1) 1 kV/m (2) 2 kV/m
(3) 1.4 kV/m (4) 0.7 kV/m

7. An electromagnetic wave of intensity 50 Wm^{-2} enters in a medium of refractive index 'n' without any loss. The ratio of the magnitudes of electrric fields, and the ratio of the magnitudes of magnetic fields of the wave before and after entering into the medium are respectively, given by :

(1) $\left(\frac{1}{\sqrt{n}},\frac{1}{\sqrt{n}}\right)$ (2) $\left(\sqrt{n},\frac{1}{\sqrt{n}}\right)$

(3) $\left(\sqrt{n},\sqrt{n}\right)$ (4) $\left(\frac{1}{\sqrt{n}},\sqrt{n}\right)$

8. The mean intensity of radiation on the surface of the Sun is about 10^8 W/m^2. The rms value of the corresponding magnetic field is closest to :

(1) 10^2T (2) 10^{-4}T (3) 1T (4) 10^{-2}T

9. The magnetic field of an electromagnetic wave is given by :-

$$\vec{B} = 1.6\times 10^{-6}\cos\left(2\times 10^7 z + 6\times 10^{15} t\right)\left(2\hat{i}+\hat{j}\right)\frac{Wb}{m^2}$$

The associated electric field will be :-

(1) $\vec{E} = 4.8\times 10^2\cos\left(2\times 10^7 z + 6\times 10^{15} t\right)\left(\hat{i}-2\hat{j}\right)\frac{V}{m}$

(2) $\vec{E} = 4.8\times 10^2\cos\left(2\times 10^7 z - 6\times 10^{15} t\right)\left(2\hat{i}+\hat{j}\right)\frac{V}{m}$

(3) $\vec{E} = 4.8\times 10^2\cos\left(2\times 10^7 z - 6\times 10^{15} t\right)\left(-2\hat{j}+\hat{i}\right)\frac{V}{m}$

(4) $\vec{E} = 4.8\times 10^2\cos\left(2\times 10^7 z + 6\times 10^{15} t\right)\left(-\hat{i}+2\hat{j}\right)\frac{V}{m}$

10. A plane electromagnetic wave travels in free space along the x-direction. The electric field component of the wave at a particular point of space and time is $E = 6\ V\ m^{-1}$ along y-direction. Its corresponding magnetic field component, B would be :

(1) 6×10^{-8} T along z-direction

(2) 6×10^{-8} T along x-direction

(3) 2×10^{-8} T along z-direction

(4) 2×10^{-8} T along y-direction

11. The magnetic field of a plane electromagnetic wave is given by :

$\vec{B} = B_0\hat{i}[\cos(kz-\omega t)] + B_1\hat{j}\cos(kz+\omega t)$ where $B_0 = 3 \times 10^{-5}$ T and $B_1 = 2 \times 10^{-6}$ T. The rms value of the force experienced by a stationary charge $Q = 10^{-4}$ C at z = 0 is closest to :

(1) 0.9 N (2) 0.1 N

(3) 3×10^{-2} N (4) 0.6 N

12. The electric field of a plane electromagnetic wave is given by

$\vec{E} = E_0\hat{i}\cos(kz)\cos(\omega t)$

The corresponding magnetic field $\vec{B}$ is then given by :

(1) $\vec{B} = \frac{E_0}{C}\hat{j}\sin(kz)\cos(\omega t)$

(2) $\vec{B} = \frac{E_0}{C}\hat{j}\sin(kz)\sin(\omega t)$

(3) $\vec{B} = \frac{E_0}{C}\hat{k}\sin(kz)\cos(\omega t)$

(4) $\vec{B} = \frac{E_0}{C}\hat{j}\cos(kz)\sin(\omega t)$

13. A plane electromagnetic wave having a frequency $\nu = 23.9$ GHz propagates along the positive z-direction in free space. The peak value of the electric field is 60 V/m. Which among the following is the acceptable magnetic field component in the electromagnetic wave ?

(1) $\vec{B} = 2\times10^{7}\sin(0.5\times10^{3}z + 1.5\times10^{11}t)\hat{i}$

(2) $\vec{B} = 2\times10^{-7}\sin(1.5\times10^{2}x + 0.5\times10^{11}t)\hat{j}$

(3) $\vec{B} = 2\times10^{-7}\sin(0.5\times10^{3}z - 1.5\times10^{11}t)\hat{i}$

(4) $\vec{B} = 60\sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{k}$

14. An electromagnetic wave is represented by the electric field

$\vec{E} = E_0\hat{n}\sin[\omega t + (6y - 8z)]$. Taking unit vectors in x, y and z directions to be $\hat{i}, \hat{j}, \hat{k}$, the direction of propogation $\hat{s}$, is :

(1) $\hat{s} = \frac{4\hat{j} - 3\hat{k}}{5}$ (2) $\hat{s} = \frac{3\hat{i} - 4\hat{j}}{5}$

(3) $\hat{s} = \left(\frac{-3\hat{j} + 4\hat{k}}{5}\right)$ (4) $\hat{s} = \frac{-4\hat{k} + 3\hat{j}}{5}$

ERROR & MEASUREMENT

1. The pitch and the number of divisions, on the circular scale, for a given screw gauge are 0.5 mm and 100 respectively. When the screw gauge is fully tightened without any object, the zero of its circular scale lies 3 divisions below the mean line.

The readings of the main scale and the circular scale, for a thin sheet, are 5.5 mm and 48 respectively, the thickness of this sheet is :

(1) 5.755 m (2) 5.725 mm

(3) 5.740 m (4) 5.950 mm

2. The diameter and height of a cylinder are measured by a meter scale to be 12.6 ± 0.1 cm and 34.2 ± 0.1 cm, respectively. What will be the value of its volume in appropriate significant figures ?

(1) $4260 \pm 80\ cm^3$

(2) $4300 \pm 80\ cm^3$

(3) $4264.4 \pm 81.0\ cm^3$

(4) $4264 \pm 81\ cm^3$

3. The least count of the main scale of a screw gauge is 1 mm. The minimum number of divisions on its circular scale required to measure 5μm diameter of wire is :

(1) 50 (2) 100 (3) 200 (4) 500

4. In a simple pendulum experiment for determination of acceleration due to gravity (g), time taken for 20 oscillations is measured by using a watch of 1 second least count. The mean value of time taken comes out to be 30 s. The length of pendulum is measured by using a meter scale of least count 1 mm and the value obtained is 55.0 cm. The percentage error in the determination of g is close to :-

(1) 0.7% (2) 0.2%

(3) 3.5% (4) 6.8%

5. The area of a square is 5.29 cm^2. The area of 7 such squares taking into account the significant figures is :-

(1) 37 cm^2 (2) 37.0 cm^2

(3) 37.03 cm^2 (4) 37.030 cm^2

6. In the density measurement of a cube, the mass and edge length are measured as (10.00 ± 0.10) kg and (0.10 ± 0.01) m, respectively. The error in the measurement of density is :

(1) 0.10 kg/m^3 (2) 0.31 kg/m^3

(3) 0.07 kg/m^3 (4) 0.01 kg/m^3

FLUIDS MECHANICS

1. The top of a water tank is open to air and its water level is maintained. It is giving out 0.74 m^3 water per minute through a circular opening of 2 cm radius in its wall. The depth of the centre of the opening from the level of water in the tank is close to :

(1) 9.6 m (2) 4.8 m

(3) 2.9 m (4) 6.0 m

2. A cylindrical plastic bottle of negligible mass is filled with 310 ml of water and left floating in a pond with still water. If pressed downward slightly and released, it starts performing simple harmonic motion at angular frequency ω. If the radius of the bottle is 2.5 cm then ω close to : (density of water = 10^3 kg / m^3)

(1) 5.00 rad s^{-1}

(2) 1.25 rad s^{-1}

(3) 3.75 rad s^{-1}

(4) 2.50 rad s^{-1}

3. Water flows into a large tank with flat bottom at the rate of 10^{-4} m^3s^{-1}. Water is also leaking out of a hole of area 1 cm^2 at its bottom. If the height of the water in the tank remains steady, then this height is:

(1) 4 cm (2) 2.9 cm

(3) 1.7 cm (4) 5.1 cm

4. A liquid of density ρ is coming out of a hose pipe of radius a with horizontal speed v and hits a mesh. 50% of the liquid passes through the mesh unaffected. 25% looses all of its momentum and 25% comes back with the same speed. The resultant pressure on the mesh will be :

(1) ρv^2 (2) $\frac{3}{4}\rho v^2$

(3) $\frac{1}{2}\rho v^2$ (4) $\frac{1}{4}\rho v^2$

5. A load of mass M kg is suspended from a steel wire of length 2 m and radius 1.0 mm in Searle's apparatus experiment. The increase in length produced in the wire is 4.0 mm. Now the load is fully immersed in a liquid of relative density 2. The relative density of the material of load is 8. The new value of increase in length of the steel wire is :

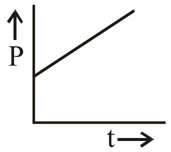
(1) 4.0mm (2) 3.0mm

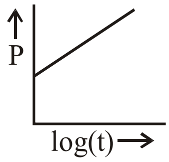
(3) 5.0mm (4) zero

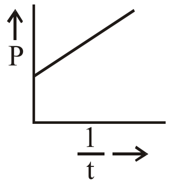
6. A long cylindrical vessel is half filled with a liquid. When the vessel is rotated about its own vertical axis, the liquid rises up near the wall. If the radius of vessel is 5 cm and its rotational speed is 2 rotations per second, then the difference in the heights between the centre and the sides, in cm, will be:

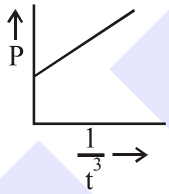
(1) 1.2 (2) 0.1 (3) 2.0 (4) 0.4

7. A soap bubble, blown by a mechanical pump at the mouth of a tube, increases in volume, with time, at a constant rate. The graph that correctly depicts the time dependence of pressure inside the bubble is given by :-

(1) 

(2) 

(3) 

(4) 

8. Water from a pipe is coming at a rate of 100 litres per minute. If the radius of the pipe is 5 cm, the Reynolds number for the flow is of the order of : (density of water = 1000 kg/m^3, coefficient of viscosity of water = 1mPas)

(1) 10^6 (2) 10^3

(3) 10^4 (4) 10^2

9. A wooden block floating in a bucket of water has $\frac{4}{5}$ of its volume submerged. When certain amount of an oil is poured into the bucket, it is found that the block is just under the oil surface with half of its volume under water and half in oil. The density of oil relative to that of water is :-

(1) 0.5 (2) 0.7 (3) 0.6 (4) 0.8

10. If 'M' is the mass of water that rises in a capillary tube of radius 'r', then mass of water which will rise in a capillary tube of radius '2r' is :

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

11. A submarine experiences a pressure of 5.05×10^6 Pa at a depth of d_1 in a sea. When it goes further to a depth of d_2, it experiences a pressure of 8.08×10^6 Pa., Then $d_2 - d_1$ is approximately (density of water = 10^3 kg/m^3 and acceleration due to gravity = 10 ms^{-2})

(1) 500 m (2) 400 m

(3) 300 m (4) 600 m

12. Water from a tap emerges vertically downwards with an initial speed of 1.0 ms^{-1}. The cross-sectional area of the tap is 10^{-4} m^2. Assume that the pressure is constant throughout the stream of water and that the flow is streamlined. The cross-sectional area of the stream, 0.15 m below the tap would be: (Take g = 10 ms^{-2})

(1) 1×10^{-5} m^2 (2) 5×10^{-5} m^2

(3) 2×10^{-5} m^2 (4) 5×10^{-4} m^2

13. A cubical block of side 0.5 m floats on water with 30% of its volume under water. What is the maximum weight that can be put on the block without fully submerging it under water? (Take density of water = 10^3 kg/m^3)

(1) 65.4 kg (2) 87.5 kg

(3) 30.1 kg (4) 46.3 kg

14. The radtio of surface tensions of mercury and water is given to be 7.5 while the ratio of thier densities is 13.6. Their contact angles, with glass, are close to 135° and 0°, respectively. It is observed that mercury gets depressed by an amount h in a capillary tube of radius r_1, while water rises by the same amount h in a capillary tube of radius r_2. The ratio, (r_1/r_2), is then close to :

(1) 2/3 (2) 3/5

(3) 2/5 (4) 4/5

15. A solid sphere, of radius R acquires a terminal velocity ν_1 when falling (due to gravity) through a viscous fluid having a coefficient of viscosity η. The sphere is broken into 27 identical solid spheres. If each of these spheres acquires a terminal velocity, ν_2, when falling through the same fluid, the ratio (ν_1/ν_2) equals:

(1) 1/27 (2) 1/9 (3) 27 (4) 9

GEOMETRICAL OPTICS

1. Two plane mirrors arc inclined to each other such that a ray of light incident on the first mirror (M_1) and parallel to the second mirror (M_2) is finally reflected from the second mirror (M_2) parallel to the first mirror (M_1). The angle between the two mirrors will be :

(1) 90° (2) 45° (3) 75° (4) 60°

2. A convex lens is put 10 cm from a light source and it makes a sharp image on a screen, kept 10 cm from the lens. Now a glass block (refractive index 1.5) of 1.5 cm thickness is placed in contact with the light source. To get the sharp image again, the screen is shifted by a distance d. Then d is :

(1) 0.55 cm away from the lens
(2) 1.1 cm away from the lens
(3) 0.55 cm towards the lens
(4) 0

3. The eye can be regarded as a single refracting surface . The radius of curvature of this surface is equal to that of cornea (7.8 mm). This surface separates two media of refractive indices 1 and 1.34. Calculate the distance from the refracting surface at which a parallel beam of light will come to focus.

(1) 2 cm (2) 1 cm
(3) 3.1 cm (4) 4.0 cm

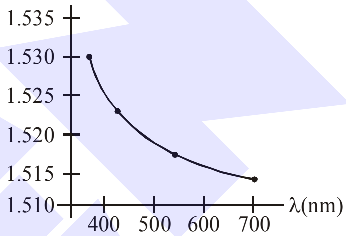
4. A plano convex lens of refractive index μ_1 and focal length f_1 is kept in contact with another plano concave lens of refractive index μ_2 and focal length f_2. If the radius of curvature of their spherical faces is R each and $f_1 = 2f_2$, then μ_1 and μ_2 are related as :

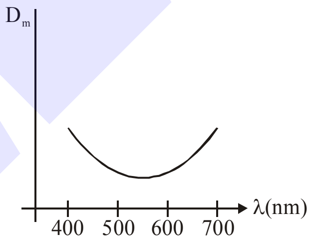
(1) $\mu_1 + \mu_2 = 3$ (2) $2\mu_1 - \mu_2 = 1$
(3) $2\mu_2 - \mu_1 = 1$ (4) $3\mu_2 - 2\mu_1 = 1$

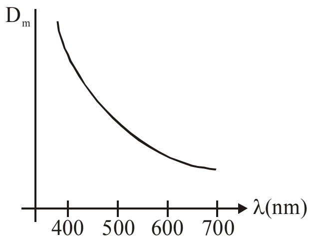
5. A monochromatic light is incident at a certain angle on an equilateral triangular prism and suffers minimum deviation. If the refractive index of the material of the prism is $\sqrt{3}$, then the angle of incidence is :-

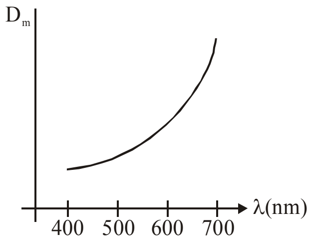
(1) 30° (2) 45° (3) 90° (4) 60°

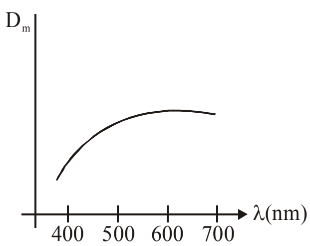
6. The variation of refractive index of a crown glass thin prism with wavelength of the incident light is shown. Which of the following graphs is the correct one, if D_m is the angle of minimum deviation?



(1)


(2)


(3)


(4)


7. An object is at a distacen of 20 m from a convex lens of focal length 0.3 m. The lens forms an image of the object. If the object moves away from the lens at a speed of 5 m/s, the speed and direction of the image will be :

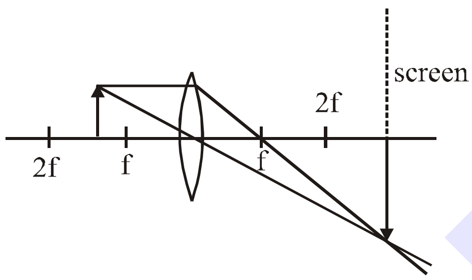
(1) 0.92×10^{-3} m/s away from the lens

(2) 2.26×10^{-3} m/s away from the lens

(3) 1.16×10^{-3} m/s towards the lens

(4) 3.22×10^{-3} m/s towards the lens

8. Formation of real image using a biconvex lens is shown below :



If the whole set up is immersed in water without disturbing the object and the screen position, what will one observe on the screen ?

(1) Image disappears

(2) No change

(3) Erect real image

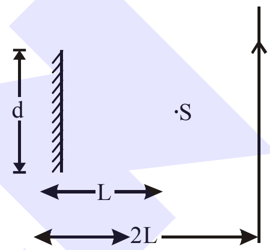
(4) Magnified image

9. A plano-convex lens (focal length f_2, refractive index μ_2, radius of curvature R) fits exactly into a plano-concave lens (focal length f_1, refractive index μ_1, radius of curvature R). Their plane surfaces are parallel to each other. Then, the focal length of the combination will be :

(1) $f_1 - f_2$ (2) $f_1 + f_2$

(3) $\dfrac{R}{\mu_2 - \mu_1}$ (4) $\dfrac{2f_1 f_2}{f_1 + f_2}$

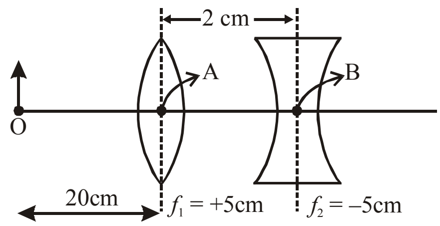
10. A point source of light, S is placed at a distance L in front of the centre of plane mirror of width d which is hanging vertically on a wall. A man walks in front of the mirror along a line parallel to the mirror, at a distance 2L as shown below. The distance over which the man can see the image of the light source in the mirror is :



(1) 3d (2) $\dfrac{d}{2}$

(3) d (4) 2d

11. What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths)



(1) 70 cm from point B at left; virtual

(2) 40 cm from point B at right; real

(3) $\dfrac{20}{3}$ cm from point B at right , real

(4) 70 cm from point B at right, real

12. A convex lens (of focal length 20 cm) and a concave mirror, having their principal axes along the same lines, are kept 80 cm apart from each other. The concave mirror is to the right of the convex lens. When an object is kept at a distance of 30 cm to the left of the convex lens, its image remains at the same position even if the concave mirror is removed. The maximum distance of the object for which this concave mirror, by itself would produce a virtual image would be :-

(1) 20 cm (2) 10 cm (3) 25 cm (4) 30 cm

13. An upright object is placed at a distance of 40 cm in front of a convergent lens of focal length 20 cm. A convergent mirror of focal length 10 cm is placed at a distance of 60 cm on the other side of the lens. The position and size of the final image will be :

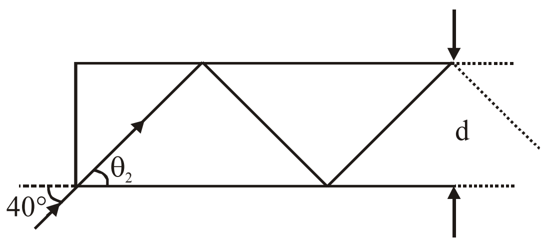
(1) 40 cm from the convergent mirror, same size as the object

(2) 20 cm from the convergent mirror, same size as the object

(3) 20 cm from the convergent mirror, twice the size of the object

(4) 40 cm from the convergent lens, twice the size of the object

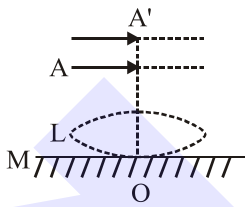
14. In figure, the optical fiber is $\ell = 2$m long and has a diameter of d = 20 μm. If a ray of light is incident on one end of the fiber at angle $\theta_1 = 40°$, the number of reflection it makes before emerging from the other end is close to: (refractive index of fibre is 1.31 and sin 40° = 0.64)



(1) 55000 (2) 57000

(3) 66000 (4) 45000

15. A thin convex lens L (refractive index = 1.5) is placed on a plane mirror M. When a pin is placed at A, such that OA = 18 cm, its real inverted image is formed at A itself, as shown in figure. When a liquid of refractive index μ_1 is put between the lens and the mirror, The pin has to be moved to A', such that OA' = 27 cm, to get its inverted real image at A' itself. The value of μ_1 will be :-



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

16. A convex lens of focal length 20 cm produces images of the same magnification 2 when an object is kept at two distances x_1 and x_2 $(x_1 > x_2)$ from the lens. The ratio of x_1 and x_2 is:-

(1) 5 : 3 (2) 2 : 1

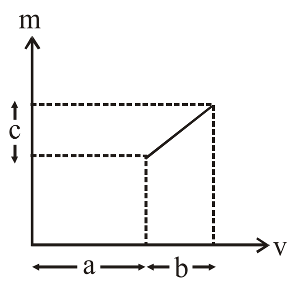
(3) 4 : 3 (4) 3 : 1

17. A concave mirror for face viewing has focal length of 0.4 m. The distance at which you hold the mirror from your face in order to see your image upright with a magnification of 5 is :

(1) 1.60 m (2) 0.24 m

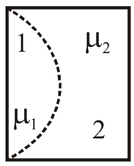
(3) 0.16 m (4) 0.32 m

18. The graph shows how the magnification m produced by a thin lens varies with image distance v. What is the focal length of the lens used ?



(1) $\frac{b^2c}{a}$ (2) $\frac{b^2}{ac}$ (3) $\frac{a}{c}$ (4) $\frac{b}{c}$

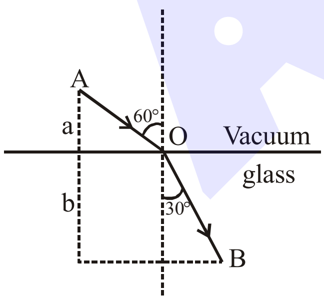
19. One plano-convex and one plano-concave lens of same radius of curvature 'R' but of different materials are joined side by side as shown in the figure. If the refractive index of the material of 1 is μ_1 and that of 2 is μ_2, then the focal length of the combination is :



(1) $\frac{R}{2-(\mu_1-\mu_2)}$ (2) $\frac{2R}{\mu_1-\mu_2}$

(3) $\frac{R}{2(\mu_1-\mu_2)}$ (4) $\frac{R}{\mu_1-\mu_2}$

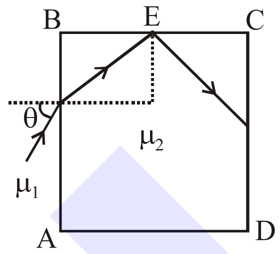
20. A ray of light AO in vacuum is incident on a glass slab at angle 60° and refracted at angle 30° along OB as shown in the figure. The optical path length of light ray from A to B is:



(1) 2a + 2b (2) $2a+\frac{2b}{3}$

(3) $\frac{2\sqrt{3}}{a}+2b$ (4) $2a+\frac{2b}{\sqrt{3}}$

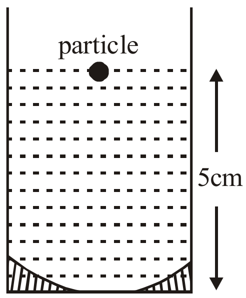
21. A transparent cube of side d, made of a material of refractive index μ_2, is immersed in a liquid of refractive index $\mu_1(\mu_1 < \mu_2)$. A ray is incident on the face AB at an angle θ(shown in the figure). Total internal reflection takes place at point E on the face BC. The θ must satisfy :



(1) $\theta < \sin^{-1}\frac{\mu_1}{\mu_2}$ (2) $\theta < \sin^{-1}\sqrt{\frac{\mu_2^2}{\mu_1^2}-1}$

(3) $\theta > \sin^{-1}\frac{\mu_1}{\mu_2}$ (4) $\theta > \sin^{-1}\sqrt{\frac{\mu_2^2}{\mu_1^2}-1}$

22. A concave mirror has radius of curvature of 40 cm. It is at the bottom of a glass that has water filled up to 5 cm (see figure). If a small particle is floating on the surface of water, its image as seen, from directly above the glass, is at a distance d from the surface of water. The value of d is close to : (Refractive index of water = 1.33)



(1) 8.8 cm (2) 11.7 cm

(3) 6.7 cm (4) 13.4 cm

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GRAVITATION

1. The energy required to take a satellite to a height 'h' above Earth surface (radius of Earth $= 6.4 \times 10^3$ km) is E_1 and kinetic energy required for the satellite to be in a circular orbit at this height is E_2. The value of h for which E_1 and E_2 are equal, is:

(1) 1.28×10^4 km (2) 6.4×10^3 km

(3) 3.2×10^3 km (4) 1.6×10^3 km

2. If the angular momentum of a planet of mass m, moving around the Sun in a circular orbit is L, about the center of the Sun, its areal velocity is :

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

3. Two stars of masses 3×10^{31} kg each, and at distance 2×10^{11}m rotate in a plane about their common centre of mass O. A meteorite passes through O moving perpendicular to the star's rotation plane. In order to escape from the gravitational field of this double star, the minimum speed that meteorite should have at O is : (Take Gravitational constant $G = 6.67 \times 10^{-11}\ Nm^2\ kg^{-2}$)

(1) 1.4×10^5 m/s

(2) 24×10^4 m/s

(3) 3.8×10^4 m/s

(4) 2.8×10^5 m/s

4. A satellite is moving with a constant speed v in circular orbit around the earth. An object of mass 'm' is ejected from the satellite such that it just escapes from the gravitational pull of the earth. At the time of ejection, the kinetic energy of the object is :

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

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

5. The mass and the diameter of a planet are three times the respective values for the Earth. The period of oscillation of a simple pendulum on the Earth is 2s. The period of oscillation of the same pendulum on the planet would be :-

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

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

6. A satellite is revolving in a circular orbit at a height h from the earth surface, such that h << R where R is the radius of the earth. Assuming that the effect of earth's atmosphere can be neglected the minimum increase in the speed requried so that the satellite could escapte from the gravitational field of earth is:

(1) $\sqrt{gR}\left(\sqrt{2}-1\right)$ (2) $\sqrt{2gR}$

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

7. Two satellites, A and B, have masses m and 2m respectively. A is in a circular orbit of radius R, and B is in a circular orbit of radius 2R around the earth. The ratio of their kinetic energies, T_A/T_B, is:

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

8. A straight rod of length L extends from x = a to x=L + a. The gravitational force is exerts on a point mass 'm' at x = 0, if the mass per unit length of the rod is $A + Bx^2$, is given by:

(1) $Gm\left[A\left(\frac{1}{a+L}-\frac{1}{a}\right)-BL\right]$

(2) $Gm\left[A\left(\frac{1}{a}-\frac{1}{a+L}\right)+BL\right]$

(3) $Gm\left[A\left(\frac{1}{a+L}-\frac{1}{a}\right)+BL\right]$

(4) $Gm\left[A\left(\frac{1}{a}-\frac{1}{a+L}\right)-BL\right]$

9. A satellite of mass M is in a circular orbit of radius R about the centre of the earth. A meteorite of the same mass, falling towards the earth, collides with the satellite completely inelastically. The speeds of the satellite and the meteorite are the same, just before the collision. The subsequent motion of the combined body will be :

(1) in a circular orbit of a different radius

(2) in the same circular orbit of radius R

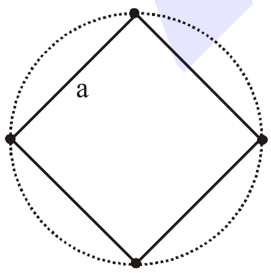
(3) in an elliptical orbit

(4) such that it escapes to infinity

10. A rocket has to be launched from earth in such a way that it never returns. If E is the minimum energy delivered by the rocket launcher, what should be the minimum energy that the launcher should have if the same rocket is to be launched from the surface of the moon ? Assume that the density of the earth and the moon are equal and that the earth's volume is 64 times the volume of the moon :-

(1) $\frac{E}{4}$ (2) $\frac{E}{16}$ (3) $\frac{E}{32}$ (4) $\frac{E}{64}$

11. Four identical particles of mass M are located at the corners of a square of side 'a'. What should be their speed if each of them revolves under the influence of other's gravitational field in a circular orbit circumscribing the square?



(1) $1.21\sqrt{\frac{GM}{a}}$ (2) $1.41\sqrt{\frac{GM}{a}}$

(3) $1.16\sqrt{\frac{GM}{a}}$ (4) $1.35\sqrt{\frac{GM}{a}}$

12. A test particle is moving in a circular orbit in the gravitational field produced by a mass density $\rho(r) = \frac{K}{r^2}$. Identify the correct relation between the radius R of the particle's orbit and its period T :

(1) T/R^2 is a constant

(2) TR is a constant

(3) T^2/R^3 is a constant

(4) T/R is a constant

13. A solid sphere of mass 'M' and radius 'a' is surrounded by a uniform concentric spherical shell of thickness 2a and mass 2M. The gravitational field at distance '3a' from the centre will be :

(1) $\frac{2GM}{9a^2}$ (2) $\frac{GM}{3a^2}$

(3) $\frac{GM}{9a^2}$ (4) $\frac{2GM}{3a^2}$

14. A spaceship orbits around a planet at a height of 20 km from its surface. Assuming that only gravitational field of the planet acts on the spaceship, what will be the number of complete revolutions made by the spaceship in 24 hours around the planet ?

[Given : Mass of planet = 8×10^{22} kg ;

Radius of planet = 2×10^6 m,

Gravitational constant G = 6.67×10^{-11} Nm^2/kg^2]

(1) 9 (2) 11 (3) 13 (4) 17

15. The value of acceleration due to gravity at Earth's surface is 9.8 ms^{-2}. The altitude above its surface at which the acceleration due to gravity decreases to 4.9 ms^{-2}, is close to : (Radius of earth = 6.4×10^6 m)

(1) 1.6×10^6 m (2) 6.4×10^6 m

(3) 9.0×10^6 m (4) 2.6×10^6 m

16. The ratio of the weights of a body on the Earth's surface to that on the surface of a planet is 9 : 4. The mass of the planet is $\frac{1}{9}$th of that of the Earth. If 'R' is the radius of the Earth, what is the radius of the planet ? (Take the planets to have the same mass density)

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

(3) $\frac{R}{4}$ (4) $\frac{R}{9}$

HEAT & THERMODYNAMICS

1. A 15 g mass of nitrogen gas is enclosed in a vessel at a temperature 27°C. Amount of heat transferred to the gas, so that rms velocity of molecules is doubled, is about :

[Take R = 8.3 J/ K mole]

(1) 10 kJ

(2) 0.9 kJ

(3) 6 kJ

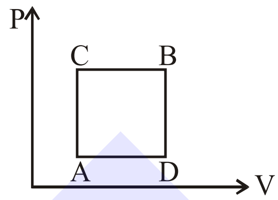
(4) 14 kJ

2. Two Carrnot engines A and B are operated in series. The first one, A, receives heat at T_1(= 600 K) and rejects to a reservoir at temperature T_2. The second engine B receives heat rejected by the first engine and, in turn, rejects to a heat reservoir at T_3(= 400 K). Calculate the temperature T_2 if the work outputs of the two engines are equal :

(1) 400 K (2) 600 K

(3) 500 K (4) 300 K

3. A gas can be taken from A to B via two different processes ACB and ADB. When path ACB is used 60 J of heat flows into the system and 30 J of work is done by the system. If path ADB is used work done by the system is 10 J. The heat Flow into the system in path ADB is:



(1) 80 J (2) 20 J

(3) 100 J (4) 40 J

4. A mixture of 2 moles of helium gas (atomic mass = 4 u), and 1 mole of argon gas (atomic mass = 40 u) is kept at 300 K in a container. The ratio of their rms speeds $\left[\frac{V_{rms}(\text{helium})}{V_{rms}((\text{argon})}\right]$, is close to:

(1) 2.24 (2) 0.45

(3) 0.32 (4) 3.16

5. A rod, of length L at room temperature and uniform area of cross section A, is made of a metal having coefficient of linear expansion α/°C. It is observed that an external compressive force F, is applied on each of its ends, prevents any change in the length of the rod, when its temperature rises by ΔT K. Young's modulus, Y, for this metal is :

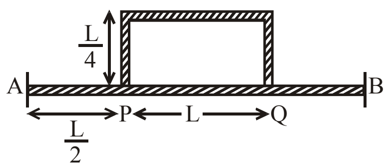
(1) $\frac{F}{2A\alpha\Delta T}$

(2) $\frac{F}{A\alpha(\Delta T-273)}$

(3) $\frac{F}{A\alpha\Delta T}$

(4) $\frac{2F}{A\alpha\Delta T}$

6. Temperature difference of 120°C is maintained between two ends of a uniform rod AB of length 2L. Another bent rod PQ, of same cross-section as AB and length $\frac{3L}{2}$, is connected across AB (See figure). In steady state, temperature difference between P and Q will be close to :



(1) 60ºC (2) 75ºC (3) 35ºC (4) 45ºC

7. An unknown metal of mass 192 g heated to a temperature of 100ºC was immersed into a brass calorimeter of mass 128 g containing 240 g of water a temperature of 8.4ºC Calculate the specific heat of the unknown metal if water temperature stabilizes at 21.5ºC (Specific heat of brass is 394 J kg^{-1} K^{-1})

(1) 1232 J kg^{-1} K^{-1}

(2) 458 J kg^{-1} K^{-1}

(3) 654 J kg^{-1} K^{-1}

(4) 916 J kg^{-1} K^{-1}

8. Half mole of an ideal monoatomic gas is heated at constant pressure of 1atm from 20 ºC to 90ºC. Work done by gas is close to : (Gas constant R = 8.31 J /mol.K)

(1) 73 J (2) 291 J

(3) 581 J (4) 146 J

9. Two kg of a monoatomic gas is at a pressure of 4×10^4 N/m^2 . The density of the gas is 8 kg /m^3. What is the order of energy of the gas due to its thermal motion ?

(1) 10^3 J (2) 10^5 J

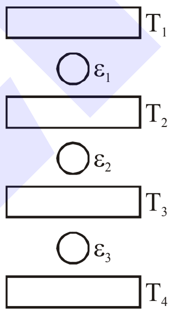
(3) 10^6 J (4) 10^4 J

10. A heat source at T= 10^3 K is connected to another heat reservoir at T=10^2 K by a copper slab which is 1 m thick. Given that the thermal conductivity of copper is 0.1 WK^{-1} m^{-1}, the energy flux through it in the steady state is :

(1) 90 Wm^{-2} (2) 200 Wm^{-2}

(3) 65 Wm^{-2} (4) 120 Wm^{-2}

11. Three Carnot engines operate in series between a heat source at a temperature T_1 and a heat sink at temperature T_4 (see figure). There are two other reservoirs at temperature T_2, and T_3, as shown, with $T_2 > T_2 > T_3 > T_4$. The three engines are equally efficient if:



(1) $T_2 = \left(T_1^2T_4\right)^{1/3}; T_3 = \left(T_1T_4^2\right)^{1/3}$

(2) $T_2 = \left(T_1T_4^2\right)^{1/3}; T_3 = \left(T_1^2T_4\right)^{1/3}$

(3) $T_2 = \left(T_1^3T_4\right)^{1/4}; T_3 = \left(T_1T_4^3\right)^{1/4}$

(4) $T_2 = (T_1T_4)^{1/2}; T_3 = (T_1^2T_4)^{1/3}$

12. Two rods A and B of identical dimensions are at temperature 30°C. If A is heated upto 180°C and B upto T°C, then the new lengths are the same. If the ratio of the coefficients of linear expansion of A and B is 4 : 3, then the value of T is :-

(1) 270°C (2) 230°C

(3) 250°C (4) 200°C

13. When 100 g of a liquid A at 100°C is added to 50 g of a liquid B at temperature 75°C, the temperature of the mixture becomes 90°C. The temperature of the mixture, if 100 g of liquid A at 100°C is added to 50 g of liquid B at 50°C, will be :-

(1) 80°C (2) 60°C
(3) 70°C (4) 85°C

14. A thermometer graduated according to a linear scale reads a value x_0 when in contact with boiling water, and $x_0/3$ when in contact with ice.

What is the temperature of an object in 0 °C, if this thermometer in the contact with the object reads $x_0/2$?

(1) 35 (2) 25
(3) 60 (4) 40

15. In a process, temperature and volume of one mole of an ideal monoatomic gas are varied according to the relation VT = K, where K is a constant. In this process the temperature of the gas is incresed by ΔT. The amount of heat absorbed by gas is (R is gas constant) :

(1) $\frac{1}{2}R\Delta T$ (2) $\frac{3}{2}R\Delta T$

(3) $\frac{1}{2}KR\Delta T$ (4) $\frac{2K}{3}\Delta T$

16. A metal ball of mass 0.1 kg is heated upto 500°C and dropped into a vessel of heat capacity 800 JK^{-1} and containing 0.5 kg water. The initial temperature of water and vessel is 30°C. What is the approximate percentage increment in the temperature of the water ? [Specific Heat Capacities of water and metal are, respectively, 4200 $Jkg^{-1}K^{-1}$ and 400 $JKg^{-1}K^{-1}$]

(1) 30% (2) 20%
(3) 25% (4) 15%

17. A rigid diatomic ideal gas undergoes an adiabatic process at room temperature. The relation between temperature and volume of this process is TV^x = constant, then x is :

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

18. The gas mixture constists of 3 moles of oxygen and 5 moles of argon at temperature T. Considering only translational and rotational modes, the total inernal energy of the system is:

(1) 12 RT (2) 20 RT
(3) 15 RT (4) 4 RT

19. Ice at –20° C os added tp 50 g of water at 40°C. When the temperature of the mixture reaches 0°C, it is found that 20 g of ice is still unmelted. The amount of ice added to the water was close to

(Specific heat of water = 4.2 J/g/°C)

Specific heat of Ice = 2.1 J/g/°C

Heat of fusion of water at 0°C = 334 J/g)

(1) 50 g (2) 40 g
(3) 60 g (4) 100 g

20. A vertical closed cylinder is separated into two parts by a frictionless piston of mass m and of negligible thickness. The piston is free to move along the length of the cylinder. The length of the cylinder above the piston is ℓ_1, and that below the piston is ℓ_2, such that $\ell_1 > \ell_2$. Each part of the cylinder contains n moles of an ideal gas at equal temperature T. If the piston is stationary, its mass, m, will be given by :

(R is universal gas constant and g is the acceleration due to gravity)

(1) $\frac{nRT}{g}\left[\frac{1}{\ell_2}+\frac{1}{\ell_1}\right]$ (2) $\frac{nRT}{g}\left[\frac{\ell_1-\ell_2}{\ell_1\ell_2}\right]$

(3) $\frac{RT}{g}\left[\frac{2\ell_1+\ell_2}{\ell_1\ell_2}\right]$ (4) $\frac{RT}{ng}\left[\frac{\ell_1-3\ell_2}{\ell_1\ell_2}\right]$

21. An ideal gas is enclosed in a cylinder at pressure of 2 atm and temperature, 300 K. The mean time between two successive collisions is 6×10^{-8} s. If the pressure is doubled and temperature is increased to 500 K, the mean time between two successive collisions will be close to:

(1) 4×10^{-8}s (2) 3×10^{-6}s

(3) 2×10^{-7}s (4) 0.5×10^{-8}s

22. A cylinder of radius R is surrounded by a cylindrical shell of inner radius R and outer radius 2R. The thermal conductivity of the material of the inner cylinder is K_1 and that of the outer cylinder is K_2. Assuming no loss of heat, the effective thermal conductivity of the system for heat flowing along the length of the cylinder is:

(1) $K_1 + K_2$ (2) $\frac{K_1 + K_2}{2}$

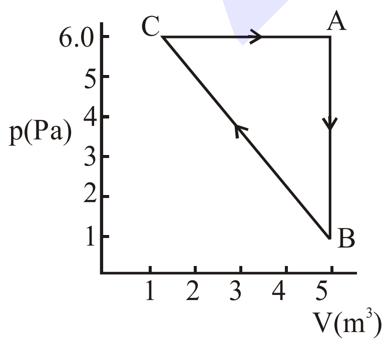
(3) $\frac{2K_1 + 3K_2}{5}$ (4) $\frac{K_1 + 3K_2}{4}$

23. An ideal gas occupies a volume of $2m^3$ at a pressure of 3×10^6 Pa. The energy of the gas is:

(1) 3×10^2 (2) 10^8 J

(3) 6×10^4 J (4) 9×10^6 J

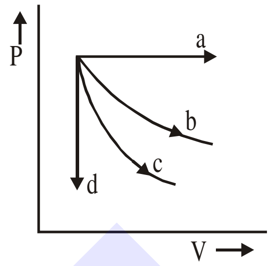
24. For the given cyclic process CAB as shown for a gas, the work done is :



(1) 1 J (2) 5 J

(3) 10 J (4) 30 J

25. The given diagram shows four processes i.e., isochoric, isobaric, isothermal and adiabatic. The correct assignment of the processes, in the same order is given by :-



(1) d a c b (2) a d c b

(3) a d b c (4) d a b c

26. The temperature, at which the root mean square velocity of hydrogen molecules equals their escape velocity from the earth, is closest to :

[Boltzmann Constant $k_B = 1.38 \times 10^{-23}$ J/K

Avogadro Number $N_A = 6.02 \times 10^{26}$ /kg

Radius of Earth : 6.4×10^6 m

Gravitational acceleration on Earth = $10ms^{-2}$]

(1) 650 K (2) 3×10^5 K

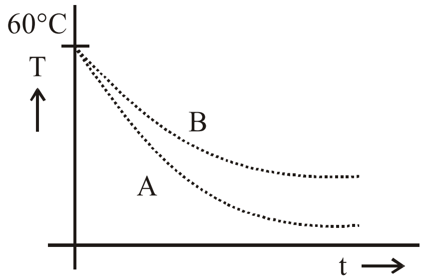
(3) 10^4 K (4) 800 K

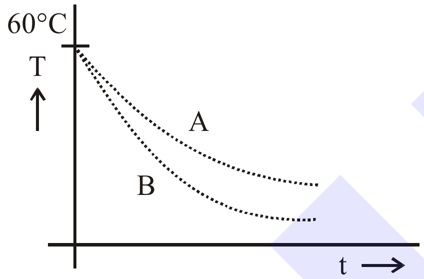
27. A boy's catapult is made of rubber cord which is 42 cm long, with 6 mm diameter of cross-section and of negligible mass. The boy keeps a stone weighing 0.02kg on it and stretches the cord by 20 cm by applying a constant force. When released, the stone flies off with a velocity of 20 ms^{-1}. Neglect the change in the area of cross-section of the cord while stretched. The Young's modulus of rubber is closest to:

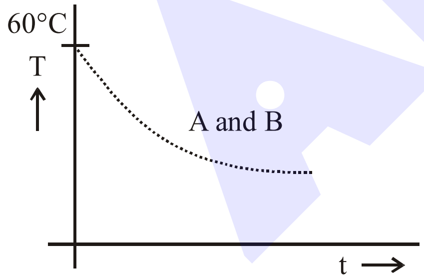
(1) 10^4 Nm^{-2} (2) 10^8 Nm^{-2}

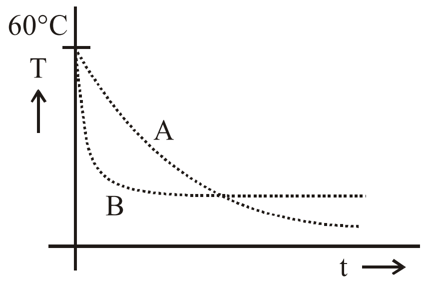
(3) 10^6 Nm^{-2} (4) 10^3 Nm^{-2}

28. Two identical breakers A and B contain equal volumes of two different liquids at 60°C each and left to cool down. Liquid in A has density of 8×10^2 kg/m^3 and specific heat of 2000 J kg^{-1} K^{-1} while liquid in B has density of 10^3 kg m^{-3} and specific heat of 4000 J kg^{-1} K^{-1}. Which of the following best describes their temperature versus time graph schematically? (assume the emissivity of both the beakers to be the same)

(1) 

(2) 

(3) 

(4) 

29. A steel wire having a radius of 2.0 mm, carrying a load of 4 kg, is hanging from a ceiling. Given that g = 3.1 π ms^{-2}, what will be the tensile stress that would be developed in the wire ?

(1) 4.8×10^6 Nm^{-2}

(2) 5.2×10^6 Nm^{-2}

(3) 6.2×10^6 Nm^{-2}

(4) 3.1×10^6 Nm^{-2}

30. A thermally insulated vessel contains 150g of water at 0°C. Then the air from the vessel is pumped out adiabatically. A fraction of water turns into ice and the rest evaporates at 0°C itself. The mass of evaporated water will be closest to :

(Latent heat of vaporization of water = 2.10×10^6 J kg^{-1} and Latent heat of Fusion of water = 3.36×10^5 J kg^{-1})

(1) 130 g (2) 35 g

(3) 20 g (4) 150 g

31. If 10^{22} gas molecules each of mass 10^{-26} kg collide with a surface (perpendicular to it) elastically per second over an area 1 m^2 with a speed 10^4 m/s, the pressure exerted by the gas molecules will be of the order of :

(1) 10^8 N/m^2 (2) 10^4 N/m^2

(3) 10^3 N/m^2 (4) 10^{16} N/m^2

32. A massless spring (k = 800 N/m), attached with a mass (500 g) is completely immersed in 1 kg of water. The spring is stretched by 2 cm and released so that it starts vibrating. What would be the order of magnitude of the change in the temperature of water when the vibrations stop completely ? (Assume that the water container and spring receive negligible heat and specific heat of mass = 400 J/kg K, specific heat of water = 4184 J/kg K)

(1) 10^{-3}K (2) 10^{-4} K

(3) 10^{-1} K (4) 10^{-5}K

33. The specific heats, C_P and C_V of a gas of diatomic molecules, A, are given (in units of J mol^{-1} K^{-1}) by 29 and 22, respectively. Another gas of diatomic molecules, B, has the corresponding values 30 and 21. If they are treated as ideal gases, then :-

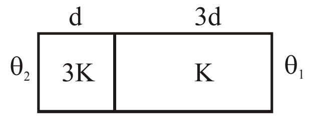
(1) A has one vibrational mode and B has two

(2) Both A and B have a vibrational mode each

(3) A is rigid but B has a vibrational mode

(4) A has a vibrational mode but B has none

34. Two materials having coefficients of thermal conductivity '3K' and 'K' and thickness 'd' and '3d', respectively, are joined to form a slab as shown in the figure. The temperatures of the outer surfaces are 'θ_2' and 'θ_1' respectively, ($\theta_2 > \theta_1$). The temperature at the interface is :-



(1) $\frac{\theta_2 + \theta_1}{2}$ (2) $\frac{\theta_1}{10} + \frac{9\theta_2}{10}$

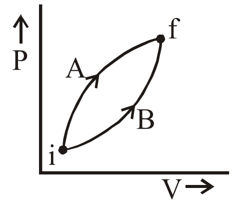
(3) $\frac{\theta_1}{3} + \frac{2\theta_2}{3}$ (4) $\frac{\theta_1}{6} + \frac{5\theta_2}{6}$

35. An HCl molecule has rotational, translational and vibrational motions. If the rms velocity of HCl molecules in its gaseous phase is $\overline{v}$, m is its mass and k_B is Boltzmann constant, then its temperature will be :

(1) $\frac{m\overline{v}^2}{6k_B}$ (2) $\frac{m\overline{v}^2}{5k_B}$

(3) $\frac{m\overline{v}^2}{3k_B}$ (4) $\frac{m\overline{v}^2}{7k_B}$

36. Following figure shows two processes A and B for a gas. If ΔQ_A and ΔQ_B are the amount of heat absorbed by the system in two cases, and ΔU_A and ΔU_B are changes in internal energies, respectively, then :



(1) $\Delta Q_A = \Delta Q_B$; $\Delta U_A = \Delta U_B$

(2) $\Delta Q_A > \Delta Q_B$; $\Delta U_A = \Delta U_B$

(3) $\Delta Q_A > \Delta Q_B$; $\Delta U_A > \Delta U_B$

(4) $\Delta Q_A < \Delta Q_B$; $\Delta U_A < \Delta U_B$

37. For a given gas at 1 atm pressure, rms speed of the molecule is 200 m/s at 127°C. At 2 atm pressure and at 227°C, the rms speed of the molecules will be :

(1) 80 m/s (2) $100\sqrt{5}$ m/s

(3) $80\sqrt{5}$ m/s (4) 100 m/s

38. The elastic limit of brass is 379 MPa. What should be the minimum diameter of a brass rod if it is to support a 400 N load without exceeding its elastic limit ?

(1) 1.16 mm (2) 0.90 mm

(3) 1.36 mm (4) 1.00 mm

39. When heat Q is supplied to a diatomic gas of rigid molecules, at constant volume its temperature increases by ΔT. The heat required to produce the same change in temperature, at a constant pressure is :

(1) $\frac{7}{5}Q$ (2) $\frac{3}{2}Q$ (3) $\frac{5}{3}Q$ (4) $\frac{2}{3}Q$

40. In an experiment, bras and steel wires of length 1m each with areas of cross section 1 mm^2 are used. teh wires are connected in series and one end of the combined wire is connected to a rigid support and other end is subjected to elongation. The stress required to produce a net elongation of 0.2 mm is :

(Given, the Young's Modulus for steel and brass are respectively, 120×10^9 N/m^2 and 60×10^9 N/m^2)

(1) 0.2×10^6 N/m^2 (2) 4.0×10^6 N/m^2

(3) 1.8×10^6 N/m^2 (4) 1.2×10^6 N/m^2

41. One mole of an ideal gas passes through a process where pressure and volume obey the relation $P = P_o\left[1-\frac{1}{2}\left(\frac{V_0}{V}\right)^2\right]$. Here P_o and V_o are constants. Calculate the change in the temperature of the gas if its volume changes from V_o to $2V_o$.

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

(3) $\frac{5}{4}\frac{P_oV_o}{R}$ (4) $\frac{1}{4}\frac{P_oV_o}{R}$

42. A cylinder with fixed capacity of 67.2 lit contains helium gas at STP. The amount of heat needed to raise the temperature of the gas by 20°C is : [Given that R = 8.31 J mol^{-1} K^{-1}]

(1) 748 J (2) 374 J

(3) 350 J (4) 700 J

43. A 25×10^{-3} m^3 volume cylinder is filled with 1 mol of O_2 gas at room temperature (300K). The molecular diameter of O_2, and its root mean square speed, are found to be 0.3 nm, and 200 m/s, respectively. What is the average collision rate (per second) for an O_2 molecule ?

(1) $\sim 10^{11}$ (2) $\sim 10^{13}$

(3) $\sim 10^{10}$ (4) $\sim 10^{12}$

44. n moles of an ideal gas with constant volume heat capcity C_V undergo an isobaric expansion by certain volume. The ratio of the work done in the process, to the heat supplied is :

(1) $\frac{4nR}{C_V - nR}$ (2) $\frac{nR}{C_V - nR}$

(3) $\frac{nR}{C_V + nR}$ (4) $\frac{4nR}{C_V + nR}$

45. One kg of water, at 20°C, is heated in an electric kettle whose heating element has a mean (temperature averaged) resistance of 20 Ω. The rms voltage in the mains is 200 V. Ignoring heat loss from the kettle, time taken for water to evaporate fully, is close to :

[Specific heat of water = 4200 J/kg °C), Latent heat of water = 2260 kJ/kg]

(1) 3 minutes

(2) 22 minutes

(3) 10 minutes

(4) 16 minutes

46. The number density of molecules of a gas depends on their distance r from the origin as, $n(r) = n_0 e^{-\alpha r^4}$. Then the total number of molecules is proportional to :

(1) $n_0\alpha^{1/4}$ (2) $n_0\alpha^{-3}$

(3) $n_0\alpha^{-3/4}$ (4) $\sqrt{n_0}\,\alpha^{1/2}$

47. A Carnot engine has an efficiency of 1/6. When the temperature of the sink is reduced by 62°C, its efficiency is doubled. The temperatures of the source and the sink are, respectively

(1) 124°C, 62°C

(2) 37°C, 99°C

(3) 62°C, 124°C

(4) 99°C, 37°C

48. A diatomic gas with rigid molecules does 10 J of work when expanded at constant pressure. What would be the heat energy absorbed by the gas, in this process ?

(1) 35 J (2) 40 J

(3) 25 J (4) 30 J

49. A uniform cylindrical rod of length L and radius r, is made from a material whose Young's modulus of Elasticity equals Y. When this rod is heated by temperature T and simultaneously subjected to a net longitudinal compressional force F, its length remains unchanged. The coefficient of volume expansion, of the material of the rod, is (nearly) equals to :

(1) $F/(3\pi r^2 YT)$ (2) $3F/(\pi r^2 YT)$

(3) $6F/(\pi r^2 YT)$ (4) $9F/(\pi r^2 YT)$

50. When M_1 gram of ice at –10°C (specific heat = 0.5 cal g^{-1}°C^{-1}) is added to M_2 gram of water at 50°C, finally no ice is left and the water is at 0°C. The value of latent heat of ice, in cal g^{-1} is:

(1) $\frac{5M_1}{M_2} - 50$ (2) $\frac{50M_2}{M_1}$

(3) $\frac{50M_2}{M_1} - 5$ (4) $\frac{5M_2}{M_1} - 5$

51. Two moles of helium gas is mixed with three moles of hydrogen molecules (taken to be rigid). What is the molar specific heat of mixture at constant volume ? (R = 8.3 J/mol K)

(1) 21.6 J/mol K (2) 19.7 J/mol K

(3) 17.4 J/mol K (4) 15.7 J/mol K

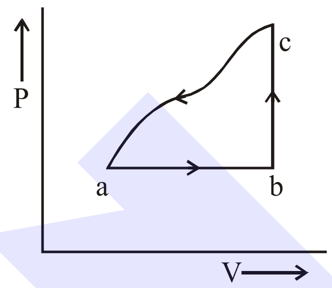
52. At 40°C, a brass wire of 1 mm radius is hung from the ceiling. A small mass, M is hung from the free end of the wire. When the wire is cooled down from 40°C to 20°C it regains its original length of 0.2 m. The value of M is close to :

(Coefficient of linear expansion and Young's modulus of brass are 10^{-5}/°C and 10^{11} N/m², respectively; g = 10 ms^{-2})

(1) 1.5 kg (2) 9 kg

(3) 0.9 kg (4) 0.5 kg

53. A sample of an ideal gas is taken through the cyclic process abca as shown in the figure. The change in the internal energy of the gas along the path ca is –180J. The gas absorbs 250 J of heat along the path ab and 60 J along the path bc. The work done by the gas along the path abc is :



(1) 100 J (2) 120 J

(3) 140 J (4) 130 J

KINEMATICS

1. The position co-ordinates of a particle moving in a 3-D coordinate system is given by

$x = a\cos\omega t$

$y = a\sin\omega t$

and $z = a\omega t$

The speed of the particle is :

(1) $a\omega$ (2) $\sqrt{3}\,a\omega$

(3) $\sqrt{2}\,a\omega$ (4) $2a\omega$

2. In a car race on straight road, car A takes a time t less than car B at the finish and passes finishing point with a speed 'v' more than that of car B. Both the cars start from rest and travel with constant acceleration a_1 and a_2 respectively. Then 'v' is equal to :

(1) $\frac{a_1 + a_2}{2}t$ (2) $\sqrt{2a_1a_2}\,t$

(3) $\frac{2a_1a_2}{a_1 + a_2}t$ (4) $\sqrt{a_1a_2}\,t$

3. A particle is moving with a velocity $\vec{v} = K(y\hat{i} + x\hat{j})$, where K is a constant. The general equation for its path is:

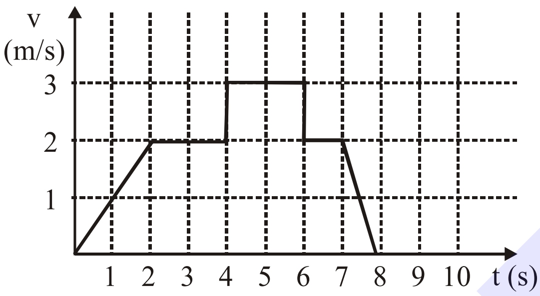
(1) xy = constant

(2) $y^2 = x^2$ + constant

(3) $y = x^2$ + constant

(4) $y^2 = x$ + constant

4. A particle starts from the origin at time t = 0 and moves along the positive x-axis. The graph of velocity with respect to time is shown in figure. What is the position of the particle at time t = 5s ?



(1) 6 m (2) 9 m (3) 3 m (4) 10 m

5. Two guns A and B can fire bullets at speeds 1 km/s and 2 km/s respectively. From a point on a horizontal ground, they are fired in all possible directions. The ratio of maximum areas covered by the bullets fired by the two guns, on the ground is :

(1) 1 : 2 (2) 1 : 4 (3) 1 : 8 (4) 1 : 16

6. A particle moves from the point $(2.0\hat{i} + 4.0\hat{j})$ m, at t = 0, with an initial velocity $(5.0\hat{i} + 4.0\hat{j})$ ms^{-1}. It is acted upon by a constant force which produces a constant acceleration $(4.0\hat{i} + 4.0\hat{j})$ ms^{-2}. What is the distance of the particle from the origin at time 2 s ?

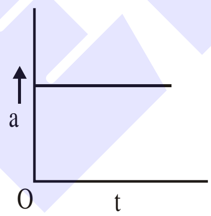
(1) $20\sqrt{2}$ m (2) $10\sqrt{2}$ m

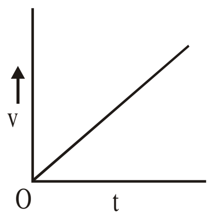
(3) 5 m (4) 15 m

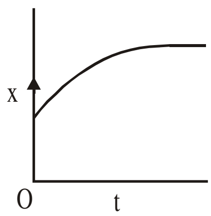
7. A passenger train of length 60m travels at a speed of 80 km/hr. Another freight train of length 120 m travels at a speed of 30 km/hr. The ratio of times taken by the passenger train to completely cross the freight train when : (i) they are moving in the same direction, and (ii) in the opposite directions is :

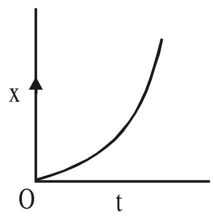
(1) $\frac{5}{2}$ (2) $\frac{25}{11}$ (3) $\frac{3}{2}$ (4) $\frac{11}{5}$

8. A particle starts from origin O from rest and moves with a uniform acceleration along the positive x-axis. Identify all figures that correctly represent the motion qualitatively. (a = acceleration, v = velocity, x = displacement, t = time)

(A) 

(B) 

(C) 

(D) 

(1) (A), (B), (C) (2) (A)

(3) (A), (B), (D) (4) (B), (C)

9. Ship A is sailing towards north-east with velocity $\vec{v} = 30\hat{i} + 50\hat{j}$ km/hr where $\hat{i}$ points east and $\hat{j}$, north. Ship B is at a distance of 80 km east and 150 km north of Ship A and is sailing towards west at 10 km/hr. A will be at minimum distance from B in :

(1) 4.2 hrs. (2) 2.2 hrs.

(3) 3.2 hrs. (4) 2.6 hrs.

10. The position of a particle as a function of time t, is given by

$x(t) = at + bt^2 - ct^3$

where a, b and c are constants. When the particle attains zero acceleration, then its velocity will be :

(1) $a + \frac{b^2}{4c}$ (2) $a + \frac{b^2}{c}$

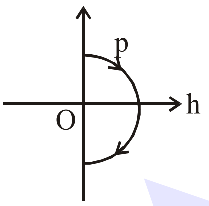
(3) $a + \frac{b^2}{2c}$ (4) $a + \frac{b^2}{3c}$

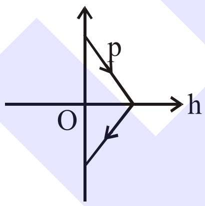
11. The position vector of a particle changes with time according to the relation $\vec{r}(t) = 15t^2\hat{i} + (4 - 20t^2)\hat{j}$. What is the magnitude of the acceleration at t = 1 ?

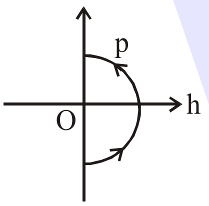
(1) 40 (2) 100

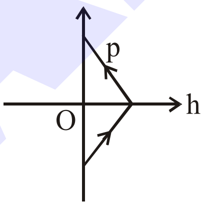
(3) 25 (4) 50

12. A ball is thrown vertically up (taken as +z-axis) from the ground. The correct momentum-height (p-h) diagram is :

(1) 

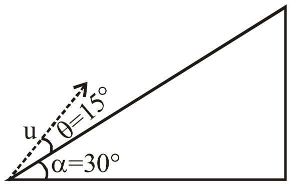
(2) 

(3) 

(4) 

13. A plane is inclined at an angle $\alpha = 30°$ with a respect to the horizontal. A particle is projected with a speed $u = 2\ ms^{-1}$ from the base of the plane, making an angle $\theta = 15°$ with respect to the plane as shown in the figure. The distance from the base, at which the particle hits the plane is close to :

(Take $g = 10\ ms^{-2}$)



(1) 14 cm (2) 20 cm

(3) 18 cm (4) 26 cm

14. A particle is moving with speed $v = b\sqrt{x}$ along positive x-axis. Calculate the speed of the particle at time $t = \tau$ (assume that the particle is at origin at t = 0).

(1) $\frac{b^2\tau}{4}$ (2) $\frac{b^2\tau}{2}$

(3) $b^2\tau$ (4) $\frac{b^2\tau}{\sqrt{2}}$

15. Two particles are projected from the same point with the same speed u such that they have the same range R, but different maximum heights, h_1 and h_2. Which of the following is correct ?

(1) $R^2 = 2h_1h_2$ (2) $R^2 = 16h_1h_2$

(3) $R^2 = 4h_1h_2$ (4) $R^2 = h_1h_2$

16. The trajectory of a projectile near the surface of the earth is given as $y = 2x - 9x^2$. If it were launched at an angle θ_0 with speed v_0 then ($g = 10\ ms^{-2}$) :

(1) $\theta_0 = \cos^{-1}\left(\frac{1}{\sqrt{5}}\right)$ and $v_0 = \frac{5}{3}ms^{-1}$

(2) $\theta_0 = \sin^{-1}\left(\frac{1}{\sqrt{5}}\right)$ and $v_0 = \frac{5}{3}ms^{-1}$

(3) $\theta_0 = \sin^{-1}\left(\frac{2}{\sqrt{5}}\right)$ and $v_0 = \frac{3}{5}ms^{-1}$

(4) $\theta_0 = \cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$ and $v_0 = \frac{3}{5}ms^{-1}$

17. A shell is fired from a fixed artillery gun with an initial speed u such that it hits the target on the ground at a distance R from it. If t_1 and t_2 are the values of the time taken by it to hit the target in two possible ways, the product t_1t_2 is :

(1) R/g (2) R/4g

(3) 2R/g (4) R/2g

MEC

1. One of the two identical conducting wires of length L is bent in the form of a circular loop and the other one into a circular coil of N identical turns. If the same current is passed in both, the ratio of the magnetic field at the central of the loop (B_L) to that at the centre of the coil (B_C), i.e. R $\frac{B_L}{B_C}$ will be :

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

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

2. A particle having the same charge as of electron moves in a circular path of radius 0.5 cm under the influence of a magnetic field of 0.5 T. If an electric field of 100 V/m makes it to move in a straight path, then the mass of the particle is (Given charge of electron $=1.6 \times 10^{-19}$C)

(1) 2.0×10^{-24} kg

(2) 1.6×10^{-19} kg

(3) 1.6×10^{-27} kg

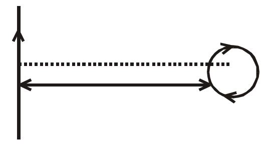
(4) 9.1×10^{-31} kg

3. A bar magnet is demagnetized by inserting it inside a solenoid of length 0.2 m, 100 turas, and carrying a current of 5.2 A. The coercivitv of the bar magnet is :

(1) 1200 A/m (2) 2600 A/m

(3) 520 A/jm (4) 285 A/m

4. An infinitely long current carrying wire and a small current carrying loop are in the plane of the paper as shown. The radius of the loop is a and distance of its centre from the wire is d (d»a). If the loop applies a force F on the wire then :



(1) $F \propto \left(\frac{a^2}{d^3}\right)$ (2) $F \propto \left(\frac{a}{d}\right)$

(3) $F \propto \left(\frac{a}{d}\right)^2$ (4) F = 0

5. At some location on earth the horizontal component of earth's magnetic field is 18×10^{-6}T. At this location, magnetic neeedle of length 0.12 m and pole strength 1.8 Am is suspended from its mid-point using a thread, it makes 45° angle with horizontal in equilibrium. To keep this needle horizontal, the vertical force that should be applied at one of its ends is :

(1) 3.6×10^{-5} N (2) 6.5×10^{-5} N

(3) 1.3×10^{-5} N (4) 1.8×10^{-5} N

6. A hoop and a solid cylinder of same mass and radius are made of a permanent magnetic material with their magnetic moment parallel to their respective axes. But the magnetic moment of hoop is twice of solid cylinder. They are placed in a uniform magnetic field in such a manner that their magnetic moments make a small angle with the field. If the oscillation periods of hoop and cylinder are T_h and T_c respectively, then :

(1) $T_h = 0.5\ T_c$

(2) $T_h = 2\ T_c$

(3) $T_h = 1.5\ T_c$

(4) $T_h = T_c$

7. A magnet of total magnetic moment $10^{-2}\hat{i}$ A-m^2 is placed in a time varying magnetic field, $B\hat{i}(\cos\omega t)$ where B = 1 Tesla and $\omega = 0.125$ rad/s. The work done for reversing the direction of the magnetic moment at t = 1 second, is :

(1) 0.007 J

(2) 0.014 J

(3) 0.01 J

(4) 0.028 J

8. An insulating thin rod of length ℓ has a x linear charge density $p(x) = \rho_0 \frac{x}{\ell}$ on it. The rod is rotated about an axis passing through the origin (x = 0) and perpendicular to the rod. If the rod makes n rotations per second, then the time averaged magnetic moment of the rod is :

(1) $\frac{\pi}{4}n\rho\ell^3$ (2) $n\rho\ell^3$

(3) $\pi n\rho\ell^3$ (4) $\frac{\pi}{3}n\rho\ell^3$

9. A paramagnetic substance in the form of a cube with sides 1 cm has a magnetic dipole moment of 20×10^{-6} J/T when a magnetic intensity of 60×10^3 A/m is applied. Its magnetic susceptibility is :-

(1) 2.3×10^{-2}

(2) 3.3×10^{-2}

(3) 3.3×10^{-4}

(4) 4.3×10^{-2}

10. A galvanometer having a resistance of 20 Ω and 30 divisions on both sides has figure of merit 0.005 ampere/division. The resistance that should be connected in series such that it can be used as a voltmeter upto 15 volt, is :-

(1) 80 Ω (2) 120 Ω

(3) 125 Ω (4) 100 Ω

11. The region between y = 0 and y = d contains a magnetic field $\vec{B} = B\hat{z}$. A particle of mass m and charge q enters the region with a velocity $\vec{v} = v\hat{i}$. If $d = \frac{mv}{2qB}$, the acceleration of the charged particle at the point of its emergence at the other side is :-

(1) $\frac{qvB}{m}\left(\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

(2) $\frac{qvB}{m}\left(\frac{1}{2}\hat{i}-\frac{\sqrt{3}}{\sqrt{2}}\hat{j}\right)$

(3) $\frac{qvB}{m}\left(\frac{-\hat{j}+\hat{i}}{\sqrt{2}}\right)$

(4) $\frac{qvB}{m}\left(\frac{\sqrt{3}}{2}\hat{i}+\frac{1}{2}\hat{j}\right)$

12. A particle of mass m and charge q is in an electric and magnetic field given by

$\vec{E} = 2\hat{i}+3\hat{j}$; $\vec{B} = 4\hat{j}+6\hat{k}$.

The charged particle is shifted from the origin to the point P(x = 1 ; y = 1) along a straight path. The magnitude of the total work done is :-

(1) (0.35)q (2) (0.15)q

(3) (2.5)q (4) 5q

13. There are two long co-axial solenoids of same length *l*. the inner and outer coils have radii r_1 and r_2 and number of turns per unit length n_1 and n_2 respectively. The rate of mutual inductance to the self-inductance of the inner-coil is :

(1) $\frac{n_2}{n_1}\cdot\frac{r_2^2}{r_1^2}$ (2) $\frac{n_2}{n_1}\cdot\frac{r_1}{r_2}$ (3) $\frac{n_1}{n_2}$ (4) $\frac{n_2}{n_1}$

14. In an experiment electrons are accelerated, from rest, by applying a voltage of 500 V. Calculate the radius of the path if a magnetic field 100 mT is then applied.

[Charge of the electron = 1.6×10^{-19} C

Mass of the electron = 9.1×10^{-31} kg]

(1) 7.5×10^{-4} m

(2) 7.5×10^{-3} m

(3) 7.5 m

(4) 7.5×10^{-2} m

15. A paramagnetic material has 10^{28}atoms/m^3. Its magnetic susceptibility at temperature 350 K is 2.8×10^{-4}. Its susceptibility at 300 K is :

(1) 3.672×10^{-4}

(2) 3.726×10^{-4}

(3) 3.267×10^{-4}

(4) 2.672×10^{-4}

16. A 10 m long horizontal wire extends from North East to South West. It is falling with a speed of $5.0 ms^{-1}$, at right angles to the horizontal component of the earth's magnetic field, of $0.3 \times 10^{-4} Wb/m^2$. The value of the induced emf in wire is :

(1) 2.5×10^{-3}V

(2) 1.1×10^{-3}V

(3) 0.3×10^{-3}V

(4) 1.5×10^{-3}V

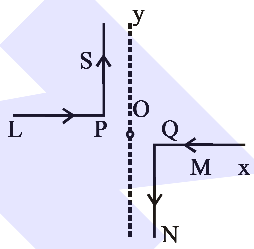
17. A proton and an α-particle (with their masses in the ratio of 1:4 and charges in the ratio of 1:2) are accelerated from rest through a potential difference V. If a uniform magnetic field (B) is set up perpendicular to their velocities, the ratio of the radii $r_p : r_\alpha$ of the circular paths described by them will be :

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

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

18. As shown in the figure, two infinitely long, identical wires are bent by 90° and placed in such a way that the segments LP and QM are along the x-axis, while segments PS and QN are parallel to the y-axis. If OP = OQ = 4cm, and the magnitude of the magnetic field at O is 10^{-4} T, and the two wires carry equal currents (see figure), the magnitude of the current in each wire and the direction of the magnetic field at O will be

($\mu_0 = 4\pi \times 10^{-7}$ NA^{-2}) :



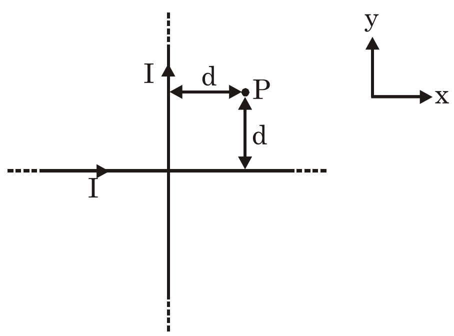
(1) 40 A, perpendicular into the page

(2) 40 A, perpendicular out of the page

(3) 20 A, perpendicular out of the page

(4) 20 A, perpendicular into the page

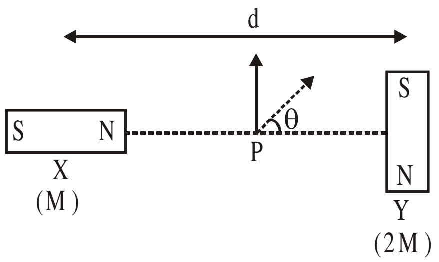
19. Two very long, straight, and insulated wires are kept at 90° angle from each other in xy-plane as shown in the figure. These wires carry currents of equal magnitude I, whose directions are shown in the figure. The net magnetic field at point P will be :



(1) Zero (2) $\frac{+\mu_0 I}{\pi d}(\hat{z})$

(3) $-\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$ (4) $\frac{\mu_0 I}{2\pi d}(\hat{x}+\hat{y})$

20. Two magnetic dipoles X and Y are placed at a separation d, with their axes perpendicular to each other. The dipole moment of Y is twice that of X. A particle of charge q is passing, through their midpoint P, at angle $\theta = 45°$ with the horizontal line, as shown in figure. What would be the magnitude of force on the particle at that instant ? (d is much larger than the dimensions of the dipole)



(1) $\sqrt{2}\left(\frac{\mu_0}{4\pi}\right)\frac{M}{(d/2)^3}\times qv$

(2) $\left(\frac{\mu_0}{4\pi}\right)\frac{2M}{(d/2)^3}\times qv$

(3) $\left(\frac{\mu_0}{4\pi}\right)\frac{M}{(d/2)^3}\times qv$

(4) 0

21. A circular coil having N turns and radius r carries a current I. It is held in the XZ plane in a magnetic field $B\hat{i}$. The torque on the coil due to the magnetic field is :

(1) $B\pi r^2 IN$ (2) $\frac{Br^2 I}{\pi N}$

(3) Zero (4) $\frac{B\pi r^2 I}{N}$

22. Two coils 'P' and 'Q' are separated by some distance. When a current of 3 A flows through coil 'P', a magnetic flux of 10^{-3} Wb passes through 'Q'. No current is passed through 'Q'. When no current passes through 'P' and a current of 2 A passes through 'Q', the flux through 'P' is :-

(1) 6.67×10^{-3} Wb

(2) 6.67×10^{-4} Wb

(3) 3.67×10^{-4} Wb

(4) 3.67×10^{-3} Wb

23. A moving coil galvanometer has a coil with 175 turns and area 1 cm^2. It uses a torsion band of torsion constant 10^{-6} N-m/rad. The coil is placed in a maganetic field B parallel to its plane. The coil deflects by 1° for a current of 1 mA. The value of B (in Tesla) is approximately:-

(1) 10^{-3} (2) 10^{-1}

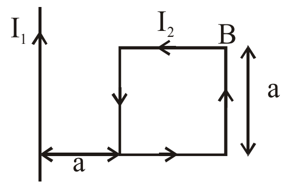
(3) 10^{-4} (4) 10^{-2}

24. The stream of a river is flowing with a speed of 2km/h. A swimmer can swim at a speed of 4km/h. What should be the direction of the swimmer with respect to the flow of the river to cross the river straight ?

(1) 60° (2) 150°

(3) 90° (4) 120°

25. A rigid square loop of side 'a' and carrying current I_2 is lying on a horizontal surface near a long current I_1 carrying wire in the same plane as shown in figure. The net force on the loop due to wire will be :



(1) Attractive and equal to $\frac{\mu_0 I_1 I_2}{3\pi}$

(2) Repulsive and equal to $\frac{\mu_0 I_1 I_2}{4\pi}$

(3) Repulsive and equal to $\frac{\mu_0 I_1 I_2}{2\pi}$

(4) Zero

26. A rectangular coil (Dimension 5 cm × 2.5 cm) with 100 turns, carrying a current of 3 A in the clock-wise direction is kept centered at the origin and in the X-Z plane. A magnetic field of 1 T is applied along X-axis. If the coil is tilted through 45° about Z-axis, then the torque on the coil is :

(1) 0.55 Nm

(2) 0.27 Nm

(3) 0.38 Nm

(4) 0.42 Nm

27. The magnitude of the magnetic field at the center of an equilateral triangular loop of side 1m which is carrying a current of 10 A is :
[Take $\mu_0 = 4\pi \times 10^{-7}$ NA^{-2}]

(1) 18 μT (2) 3 μT

(3) 1 μT (4) 9 μT

28. A square loop is carrying a steady current I and the magnitude of its magnetic dipole moment is m. If this square loop is changed to a circular loop and it carries the same current, the magnitude of the magnetic dipole moment of circular loop will be :

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

(3) $\frac{2m}{\pi}$ (4) $\frac{m}{\pi}$

29. In the formula $X = 5YZ^2$, X and Z have dimensions of capacitance and magnetic field, respectively. What are the dimensions of Y in SI units ?

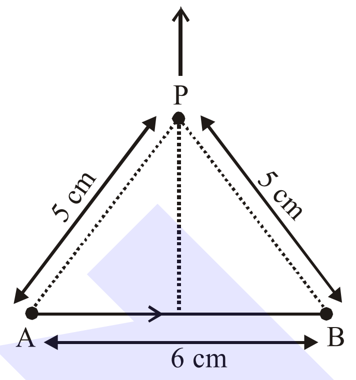
(1) $[M^{-2} L^{-2} T^6 A^3]$

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

(3) $[M^{-3} L^{-2} T^8 A^4]$

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

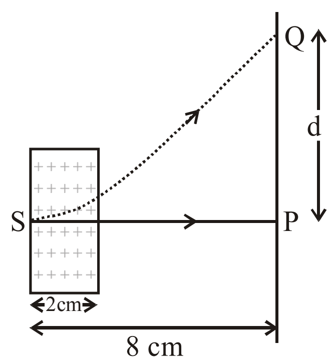
30. Find the magnetic field at point P due to a straight line segment AB of length 6 cm carrying a current of 5 A. (See figure)
($\mu_0 = 4\pi \times 10^{-7}$ N-A^{-2})



(1) 3.0×10^{-5} T (2) 2.5×10^{-5} T

(3) 2.0×10^{-5} T (4) 1.5×10^{-5} T

31. An electron, moving along the x-axis with an initial energy of 100 eV, enters a region of magnetic field $\vec{B} = (1.5 \times 10^{-3} T)\hat{k}$ at S (See figure). The field extends between x = 0 and x = 2 cm. The electron is detected at the point Q on a screen placed 8 cm away from the point S. The distance d between P and Q (on the screen) is :
(electron's charge = 1.6×10^{-19} C, mass of electron = 9.1×10^{-31} kg)



(1) 12.87 cm (2) 1.22 cm

(3) 11.65 cm (4) 2.25 cm

32. A thin ring of 10 cm radius carries a uniformly distributed charge. The ring rotates at a constant angular speed of 40 π rad s^{-1} about its axis, perpendicular to its plane. If the magnetic field at its centre is 3.8×10^{-9} T, then the charge carried by the ring is close to

($\mu_0 = 4\pi \times 10^{-7}$ N/A^2) :

(1) 2×10^{-6} C (2) 3×10^{-5} C

(3) 4×10^{-5} C (4) 7×10^{-6} C

33. A magnetic compass needle oscillates 30 times per minute at a place where the dip is 45°, and 40 times per minute where the dip is 30°. If B_1 and B_2 are respectively the total magnetic field due to the earth at the two places, then the ratio B_1/B_2 is best given by :

(1) 2.2 (2) 1.8 (3) 0.7 (4) 3.6

MODERN PHYSICS

1. At a given instant, say t = 0, two radioactive substances A and B have equal activities. The ratio $\frac{R_B}{R_A}$ of their activities after time t itself decays with time t as e^{-3t}. If the half-life of A is $\ell n2$, the half-life of B is :

(1) $\frac{\ell n2}{2}$ (2) $2\ell n2$

(3) $\frac{\ell n2}{4}$ (4) $4\ell n2$

2. The magnetic field associated with a light wave is given, at the origin, by

$B = B_0 [\sin(3.14 \times 10^7)ct + \sin(6.28 \times 10^7)ct]$.

If this light falls on a silver plate having a work function of 4.7 eV, what will be the maximum kinetic energy of the photo electrons ?

($c = 3 \times 10^8 ms^{-1}$, $h = 6.6 \times 10^{-34}$ J-s)

(1) 7.72 eV (2) 8.52 eV

(3) 12.5 eV (4) 6.82 eV

3. A sample of radioactive material A, that has an activity of 10 mCi(1 Ci = 3.7×10^{10} decays/s), has twice the number of nuclei as another sample of a different radioactive maternal B which has an activity of 20 mCi. The correct choices for hall-lives of A and B would then be respectively :

(1) 20 days and 5 days

(2) 20 days and 10 days

(3) 5 days and 10 days

(4) 10 days and 40 days

4. Surface of certain metal is first illuminated with light of wavelength λ_1 =350 nm and then, by light of wavelength λ_2=540 nm. It is found that the maximum speed of the photo electrons in the two cases differ by a factor of 2. The work function of the metal (in eV) is close to:

(Energjr of photon = $\frac{1240}{\lambda(\text{in nm})}$eV)

(1) 1.8 (2) 1.4 (3) 2.5 (4) 5.6

5. Condiser the nuclear fission

$Ne^{20} \rightarrow 2He^4 + C^{12}$

Given that the binding energy/nucleon of Ne^{20}, He^4 and C^{12} are, respectively, 8.03 MeV, 7.07 MeV and 7.86 MeV, identify the correct statement :

(1) 8.3 MeV energy will be released

(2) energy of 12.4 MeV will be supplied

(3) energy of 11.9 MeV has to be supplied

(4) energy of 3.6 MeV will be released

6. A metal plate of area 1×10^{-4} m^2 is illuminated by a radiation of intensity 16 mW/m^2.The work function of the metal is 5eV. The energy of the incident photons is 10 eV and only 10% of it produces photo electrons. The number of emitted photo electrons per second and their maximum energy, respectively, will be : [1 eV = 1.6×10^{-19}J]

(1) 10^{10} and 5 eV (2) 10^{14} and 10 eV

(3) 10^{12} and 5 eV (4) 10^{11} and 5 eV

7. Using a nuclear counter the count rate of emitted particles from a radioactive source is measured. At t = 0 it was 1600 counts per second and t = 8 seconds it was 100 counts per second. The count rate observed, as counts per second, at t = 6 seconds is close to :

(1) 150 (2) 360
(3) 200 (4) 400

8. In an electron microscope, the resolution that can be achieved is of the order of the wavelength of electrons used. To resolve a width of 7.5×10^{-12}m, the minimum electron energy required is close to :

(1) 100 keV (2) 500 keV
(3) 25 keV (4) 1 keV

9. In a hydrogen like atom, when an electron jumps from the M - shell to the L - shell, the wavelength of emitted radiation is λ. If an electron jumps from N-shell to the L-shell, the wavelength of emitted radiation will be :-

(1) $\frac{27}{20}\lambda$ (2) $\frac{16}{25}\lambda$ (3) $\frac{20}{27}\lambda$ (4) $\frac{25}{16}\lambda$

10. In a photoelectric experiment, the wavelength of the light incident on a metal is changed from 300 nm to 400 nm. The decrease in the stopping potential is close to :

$\left(\frac{hc}{e} = 1240\,\text{nm} - \text{V}\right)$

(1) 0.5 V (2) 1.0 V
(3) 2.0 V (4) 1.5 V

11. A hydrogen atom, initially in the ground state is excited by absorbing a photon of wavelength 980Å. The radius of the atom in the excited state, it terms of Bohr radius a_0, will be :

(h_c = 12500 eV – Å)

(1) $9a_0$ (2) $25a_0$
(3) $4a_0$ (4) $16a_0$

12. If the deBronglie wavelenght of an electron is equal to 10^{-3} times the wavelength of a photon of frequency 6×10^{14} Hz, then the speed of electron is equal to :

(Speed of light = 3×10^8 m/s

Planck's constant = 6.63×10^{-34} J.s

Mass of electron = 9.1×10^{-31} kg)

(1) 1.45×10^6 m/s (2) 1.7×10^6 m/s
(3) 1.8×10^6 m/s (4) 1.1×10^6 m/s

13. When a certain photosensistive surface is illuminated with monochromatic light of frequency ν, the stopping potential for the photo current is $-V_0/2$. When the surface is illuminated by monochromatic light of frequency $\nu/2$, the stopping potential is $-V_0$. The threshold frequency for photoelectric emission is:

(1) $\frac{3\nu}{2}$ (2) 2ν (3) $\frac{4}{3}\nu$ (4) $\frac{5\nu}{3}$

14. In a radioactive decay chain, the initial nucleus is ${}^{232}_{90}\text{Th}$. At the end there are 6 α-particles and 4 β-particles which are emitted. If the end nucleus, If ${}^{A}_{Z}X$, A and Z are given by :

(1) A = 208; Z = 80 (2) A = 202; Z = 80
(3) A = 200; Z = 81 (4) A = 208; Z = 82

15. An alpha-particle of mass m suffers 1-dimensional elastic coolision with a nucleus at rest of unknown mass. It is scattered directly backwards losing, 64% of its initial kinetic energy. The mass of the nucleus is :-

(1) 4 m (2) 3.5 m (3) 2 m (4) 1.5 m

16. In a Frank-Hertz experiment, an electron of energy 5.6 eV passes through mercury vapour and emerges with an energy 0.7 eV. The minimum wavelength of photons emitted by mercury atoms is close to :-

(1) 2020 nm (2) 220 nm
(3) 250 nm (4) 1700 nm

17. A particle of mass m moves in a circular orbit in a central potential field $U(r) = \frac{1}{2}kr^2$. If Bohr's quantization conditions are applied, radii of possible orbitals and energy levels vary with quantum number n as:

(1) $r_n \propto n^2$, $E_n \propto \frac{1}{n^2}$ (2) $r_n \propto \sqrt{n}, E_n \propto \frac{1}{n}$

(3) $r_n \propto n$, $E_n \propto n$ (4) $r_n \propto \sqrt{n}$, $E_n \propto n$

18. A particle A of mass 'm' and charge 'q' is accelerated by a potential difference of 50 V. Another particle B of mass '4 m' and charge 'q' is accelerated by a potential difference of 2500 V. The ratio of de-Broglie wavelengths $\frac{\lambda_A}{\lambda_B}$ is close to :

(1) 10.00 (2) 14.14

(3) 4.47 (4) 0.07

19. The ratio of mass densities of nuclei of ^{40}Ca and ^{16}O is close to :-

(1) 1 (2) 2

(3) 0.1 (4) 5

20. A damped harmonic oscillator has a frequency of 5 oscillations per second. The amplitude drops to half its value for every 10 oscillations. The time it will take to drop to $\frac{1}{1000}$ of the original amplitude is close to :-

(1) 100 s (2) 20 s (3) 10 s (4) 50 s

21. A nucleus A, with a finite de-broglie wavelength λ_A, undergoes spontaneous fission into two nuclei B and C of equal mass. B flies in the same direction as that of A, while C flies in the opposite direction with a velocity equal to half of that of B. The de-Broglie wavelengths λ_B and λ_C of B and C are respectively :-

(1) $2\lambda_A, \lambda_A$ (2) $\lambda_A, 2\lambda_A$

(3) $\lambda_A, \frac{\lambda_A}{2}$ (4) $\frac{\lambda_A}{2}, \lambda_A$

22. Radiation coming from transitions n = 2 to n = 1 of hydrogen atoms fall on He^+ ions in n = 1 and n = 2 states. The possible transition of helium ions as they absorb energy from the radiation is :

(1) $n = 1 \rightarrow n = 4$

(2) $n = 2 \rightarrow n = 4$

(3) $n = 2 \rightarrow n = 5$

(4) $n = 2 \rightarrow n = 3$

23. Two particles move at right angle to each other. Their de-Broglie wavelengths are λ_1 and λ_2 respectively. The particles suffer perfectly inelastic collision. The de-Broglie wavelength λ, of the final particle, is given by :

(1) $\lambda = \frac{\lambda_1 + \lambda_2}{2}$ (2) $\frac{2}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

(3) $\lambda = \sqrt{\lambda_1\lambda_2}$ (4) $\frac{1}{\lambda^2} = \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2}$

24. A particle 'P' is formed due to a completely inelastic collision of particles 'x' and 'y' having de-Broglie wavelengths 'λ_x' and 'λ_y' respectively. If x and y were moving in opposite directions, then the de-Broglie wavelength of 'P' is :-

(1) $\lambda_x + \lambda_y$ (2) $\frac{\lambda_x\lambda_y}{\lambda_x + \lambda_y}$

(3) $\frac{\lambda_x\lambda_y}{|\lambda_x - \lambda_y|}$ (4) $\lambda_x - \lambda_y$

25. 50 W/m^2 energy density of sunlight is normally incident on the surface of a solar panel. Some part of incident energy (25%) is reflected from the surface and the rest is absorbed. The force exerted on $1m^2$ surface area will be close to ($c = 3 \times 10^8$ m/s) :-

(1) 15×10^{-8} N (2) 35×10^{-8} N

(3) 10×10^{-8} N (4) 20×10^{-8} N

26. A He^+ ion is in its first excited state. Its ionization energy is :-

(1) 6.04 eV (2) 13.60 eV
(3) 54.40 eV (4) 48.36 eV

27. The electric field of light wave is given as

$$\vec{E} = 10^{-3}\cos\left(\frac{2\pi x}{5\times10^{-7}} - 2\pi\times6\times10^{14}t\right)\hat{x}\frac{N}{C}$$ .This light falls on a metal plate of work function 2eV. The stopping potential of the photo-electrons is :

Given, E (in eV) = $\frac{12375}{\lambda(\text{in Å})}$

(1) 0.48 V (2) 2.0 V
(3) 2.48 V (4) 0.72 V

28. Taking the wavelength of first Balmer line in hydrogen spectrum (n = 3 to n = 2) as 660 nm, the wavelength of the 2^{nd} Balmer line (n = 4 to n = 2) will be :

(1) 889.2 nm (2) 642.7 nm
(3) 488.9 nm (4) 388.9 nm

29. Light is incident normally on a completely absorbing surface with an energy flux of 25 Wcm^{-2}. if the surface has an area of 25 cm^{-2}, the momentum transferred to the surface in 40 min time duration will be :

(1) 5.0×10^{-3} Ns (2) 3.5×10^{-6} Ns
(3) 1.4×10^{-6} Ns (4) 6.3×10^{-4} Ns

30. A 2 mW laser operates at a wavelength of 500 nm. The number of photons that will be emitted per second is :

[Given Planck's constant h = 6.6×10^{-34} Js, speed of light c = 3.0×10^{8} m/s]

(1) 2×10^{16} (2) 1.5×10^{16}
(3) 5×10^{15} (4) 1×10^{16}

31. In Li^{++}, electron in first Bohr orbit is excited to a level by a radiation of wavelength λ. when the ion gets deexcited to the ground state in all possible ways (including intermediate emissions), a total of six spectral lines are observed. What is the value of λ ?

(Given : h = 6.63×10^{-34} Js; c = 3×10^{8} ms^{-1})

(1) 9.4 nm (2) 12.3 nm
(3) 10.8 nm (4) 11.4 nm

32. Two radioactive substances A and B have decay constants 5λ and λ respectively. At t = 0, a sample has the same number of the two nuclei. The time taken for the ratio of the number of nuclei to become $\left(\frac{1}{e}\right)^2$ will be :

(1) $1 / 4\lambda$ (2) $1 / \lambda$
(3) $1 / 2\lambda$ (4) $2 / \lambda$

33. A proton, an electron, and a Helium nucleus, have the same energy. They are in circular orbits in a plane due to magnetic field perpendicualr to the plane. Let r_p, r_e and r_{He} be their respective radii, then,

(1) $r_e > r_p > r_{He}$ (2) $r_e < r_p < r_{He}$
(3) $r_e < r_p = r_{He}$ (4) $r_e > r_p = r_{He}$

34. In a photoelectric effect experiment the threshold wavelength of the light is 380 nm. If the wavelentgh of incident light is 260 nm, the maximum kinetic energy of emitted electrons will be: Given E (in eV) = $\frac{1237}{\lambda(\text{in nm})}$

(1) 1.5 eV (2) 4.5 eV
(3) 15.1 eV (4) 3.0 eV

35. Two radioactive materials A and B have decay constants 10λ and λ, respectively. It initially they have the same number of nuclei, then the ratio of the number of nuclei of A to that of B will be 1/e after a time :

(1) $\frac{11}{10\lambda}$ (2) $\frac{1}{9\lambda}$ (3) $\frac{1}{10\lambda}$ (4) $\frac{1}{11\lambda}$

36. The electron in a hydrogen atom first jumps from the third excited state to the second excited state and subsequently to the first excited state. The ratio of the respective wavelengths, λ_1/λ_2, of the photons emitted in this process is :

(1) 9/7 (2) 7/5

(3) 27/5 (4) 20/7

37. Consider an electron in a hydrogen atom, revolving in its second excited state (having radius 4.65Å). The de-Broglie wavelength of this electron is :

(1) 12.9 Å (2) 3.5 Å

(3) 9.7 Å (4) 6.6 Å

38. Half lives of two radioactive nuclei A and B are 10 minutes and 20 minutes, respectively. If, initially a sample has equal number of nuclei, then after 60 minutes, the ratio of decayed numbers of nuclei A and B will be :

(1) 9 : 8 (2) 1 : 8

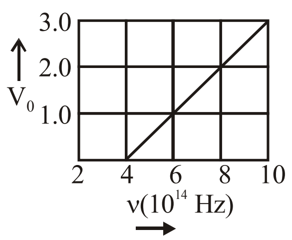
(3) 8 : 1 (4) 3 : 8

39. The stopping potential V_0 (in volt) as a function of frequency (ν) for a sodium emitter, is shown in the figure. The work function of sodium, from the data plotted in the figure, will be :

(Given : Planck's constant

(h) = 6.63×10^{-34} Js, electron

charge e = 1.6×10^{-19} C)



(1) 1.95 eV (2) 1.82 eV

(3) 1.66 eV (4) 2.12 eV

40. An excited He^+ ion emits two photons in succession, with wavelengths 108.5 nm and 30.4 nm, in making a transition to ground state. The quantum number n, corresponding to its initial excited state is (for photon of wavelength λ, energy $E = \frac{1240\text{eV}}{\lambda(\text{in nm})}$) :

(1) n = 5 (2) n = 4

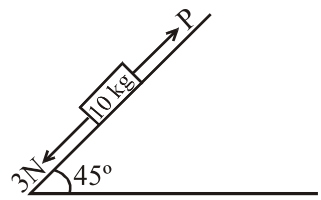
(3) n = 6 (4) n = 7

NLM & FRICTION

1. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the rope at some point, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is (g = 10 ms $^{-2}$)

(1) 200 N (2) 100 N (3) 140 N (4) 70 N

2. A block of mass 10 kg is kept on a rough inclined plane as shown in the figure. A force of 3 N is applied on the block. The coefficient of static friction between the plane and the block is 0.6. What should be the minimum value of force P, such that the block doesnot move downward ? (take g = 10 ms^{-2})

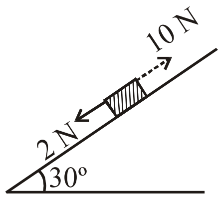


(1) 32 N (2) 25 N (3) 23 N (4) 18 N

3. A particle of mass m is moving in a straight line with momentum p. Starting at time t = 0, a force F = kt acts in the same direction on the moving particle during time interval T so that its momentum changes from p to 3p. Here k is a constant. The value of T is :-

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

4. A block kept on a rough inclined plane, as shown in the figure, remaias at rest upto a maximum force 2 N down the inclined plane. The maximum external force up the inclined plane that does not move the block is 10 N. The coefficient of static friction betwreen the block and the plane is : [Take g = 10 m/s^2]



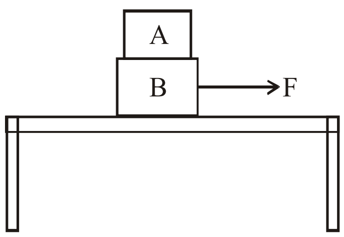
(1) $\frac{2}{3}$ (2) $\frac{\sqrt{3}}{2}$ (3) $\frac{\sqrt{3}}{4}$ (4) $\frac{1}{2}$

5. A bullet of mass 20 g has an initial speed of 1 ms^{-1}, just before it starts penetrating a mud wall of thickness 20 cm. if the wall offers a mean resistance of 2.5×10^{-2} N, the speed of the bullet after emerging from the other side of the wall is close to :

(1) 0.4 ms^{-1} (2) 0.1 ms^{-1}

(3) 0.3 ms^{-1} (4) 0.7 ms^{-1}

6. Two blocks A and B of masses m_A = 1 kg and m_B = 3 kg are kept on the table as shown in figure. The coefficient of friction between A and B is 0.2 and between B and the surface of the table is also 0.2. The maximum force F that can be applied on B horizontally, so that the block A does not slide over the block B is: (Take g = 10 m/s^2)



(1) 16 N (2) 40 N (3) 12 N (4) 8 N

7. A ball is thrown upward with an initial velocity V_0 from the surface of the earth. The motion of the ball is affected by a drag force equal to $m\gamma\upsilon^2$ (where m is mass of the ball, υ is its instantaneous velocity and γ is a constant). Time taken by the ball to rise to its zenith is :

(1) $\frac{1}{\sqrt{\gamma g}}\sin^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$

(2) $\frac{1}{\sqrt{\gamma g}}\tan^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$

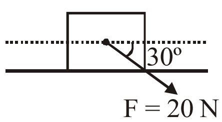
(3) $\frac{1}{\sqrt{2\gamma g}}\tan^{-1}\left(\sqrt{\frac{2\gamma}{g}}V_0\right)$

(4) $\frac{1}{\sqrt{\gamma g}}\ln\left(1+\sqrt{\frac{\gamma}{g}}V_0\right)$

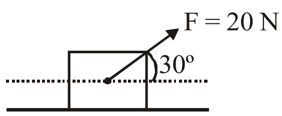
8. A spring whose unstretched length is l has a force constant k. The spring is cut into two pieces of unstretched lengths l_1 and l_2 where, $l_1 = nl_2$ and n is an integer. The ratio k_1/k_2 of the corresponding force constants, k_1 and k_2 will be :

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

9. A block of mass 5 kg is (i) pushed in case (A) and (ii) pulled in case (B), by a force F = 20 N, making an angle of 30º with the horizontal, as shown in the figures. The coefficient of friction between the block and floor is μ = 0.2. The difference between the accelerations of the block, in case (B) and case (A) will be : (g = 10 ms^{-2})



(A)



(B)

(1) 0 ms^{-2} (2) 0.8 ms^{-2}

(3) 0.4 ms^{-2} (4) 3.2 ms^{-2}

POC

1. In a communication system operating at wavelength 800 nm, only one percent of source frequency is available as signal bandwidth. The number of channels accomodated for transmitting TV signals of band width 6 MHz are (Take velocity of light c = 3 × 10^8m/s, h = 6.6 × 10^{-34} J-s)

(1) 3.75 × 10^6 (2) 4.87 × 10^5

(3) 3.86 × 10^6 (4) 6.25 × 10^5

2. The modulation frequency of an AM radio station is 250 kHz, which is 10% of the carrier wave. If another AM station approaches you for license what broadcast frequency will you allot ?

(1) 2750 kHz (2) 2000 kHz

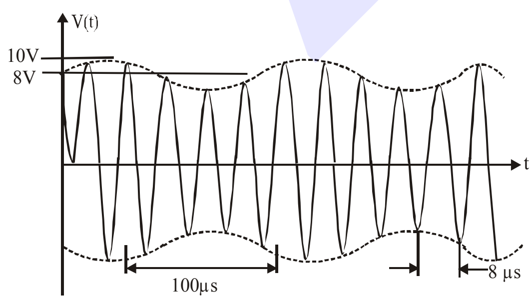
(3) 2250 kHz (4) 2900 kHz

3. A TV transmission tower has a height of 140 m and the height of the receiving antenna is 40 m. What is the maximum distance upto which signals can be broadcasted from this tower in LOS(Line of Sight) mode ?

(Given : radius of earth = 6.4 × 10^6m).

(1) 80 km (2) 48 km (3) 40 km (4) 65 km

4. An amplitude modulated signal is plotted below :-



Which one of the following best describes the above signal ?

(1) (9 + sin (2.5π × 10^5 t)) sin (2π × 10^4t)V

(2) (9 + sin (4π × 10^4 t)) sin (5π × 10^5t)V

(3) (1 + 9sin (2π × 10^4 t)) sin (2.5π × 10^5t)V

(4) (9 + sin (2π × 10^4 t)) sin (2.5π × 10^5t)V

5. An amplitude modulated signal is given by V(t)= 10[1 + 0.3cos(2.2 × 10^4t)]sin(5.5 × 10^5t). Here t is in seconds. The sideband frequencies (in kHz) are, [Given π = 22/7]

(1) 1785 and 1715 (2) 892.5 and 857.5

(3) 89.25 and 85.75 (4) 178.5 and 171.5

6. To double the coverging range of a TV transmittion tower, its height should be multiplied by :-

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

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

7. A 100 V carrier wave is made to vary between 160 V and 40 V by a modulating signal. What is the modulation index?

(1) 0.6 (2) 0.5

(3) 0.3 (4) 0.4

8. In a line of sight radio communication, a distance of about 50 km is kept between the transmitting and receiving antennas. If the height of the receiving antenna is 70m, then the minimum height of the transmitting antenna should be : (Radius of the Earth = 6.4 × 10^6 m).

(1) 40 m (2) 51 m (3) 32 m (4) 20 m

9. The physical sizes of the transmitter and receiver antenna in a communication system are :-

(1) proportional to carrier frequency

(2) inversely proportional to modulation frequency

(3) inversely proportional to carrier frequency

(4) independent of both carrier and modulation frequency

10. A signal $A\cos\omega t$ is transmitted using $\nu_0 \sin \omega_0 t$ as carrier wave. The correct amplitude modulated (AM) signal is :

(1) $\nu_0 \sin \omega_0 t + A\cos\omega t$

(2) $\nu_0 \sin \omega_0 t + \frac{A}{2}\sin(\omega_0 - \omega)t + \frac{A}{2}\sin(\omega_0 + \omega)t$

(3) $(\nu_0 + A)\cos\omega t \sin \omega_0 t$

(4) $\nu_0 \sin[\omega_0(1 + 0.01A\sin\omega t)t]$

11. A message signal of frequency 100 MHz and peak voltage 100 V is used to execute amplitude modulation on a carrier wave of frequency 300 GHz and peak voltage 400 V. The modulation index and difference between the two side band frequencies are :

(1) 4; 1×10^8 Hz (2) 0.25; 1×10^8 Hz

(3) 4; 2×10^8 Hz (4) 0.25; 2×10^8 Hz

12. Given below in the the left column are different modes of communication using the kinds of waves given the right column.

A.	Optical Fibre communication	P.	Ultrasound
B.	Radar	Q.	Infrared Light
C.	Sonar	R.	Microwaves
D.	Mobile Phones	S.	Radio Waves

(1) A-S, B-Q, C-R, D-P

(2) A-R, B-P, C-S, D-Q

(3) A-Q, B-S, C-R, D-P

(4) A-Q, B-S, C-P, D-R

13. In an amplitude modulator circuit, the carrier wave is given by,

$C(t) = 4\sin(20000\,\pi t)$ while modulating signal is given by, $m(t) = 2\sin(2000\,\pi t)$. The values of modulation index and lower side band frequency are :

(1) 0.5 and 9 kHz (2) 0.5 and 10 kHz

(3) 0.3 and 9 kHz (4) 0.4 and 10 kHz

14. The wavelength of the carrier waves in a modern optical fiber communication network is close to :

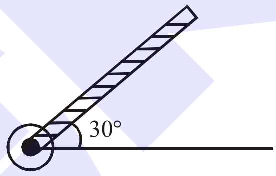
(1) 600 nm (2) 900 nm

(3) 2400 nm (4) 1500 nm

ROTATIONAL MECHANICS

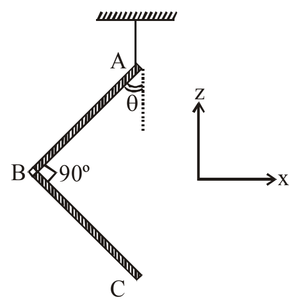
1. A rod of length 50cm is pivoted at one end. It is raised such that if makes an angle of 30° from the horizontal as shown and released from rest. Its angular speed when it passes through the horizontal (in rad s^{-1}) will be

($g = 10ms^{-2}$)



(1) $\sqrt{30}$ (2) $\sqrt{\frac{30}{2}}$ (3) $\frac{\sqrt{30}}{2}$ (4) $\frac{\sqrt{20}}{3}$

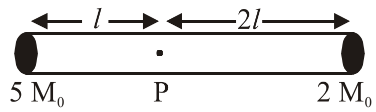
2. An L-shaped object, made of thin rods of uniform mass density, is suspended with a string as shown in figure. If AB = BC, and the angle made by AB with downward vertical is θ, then :



(1) $\tan\theta = \frac{2}{\sqrt{3}}$ (2) $\tan\theta = \frac{1}{3}$

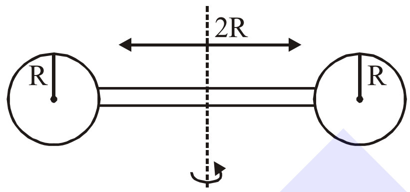
(3) $\tan\theta = \frac{1}{2}$ (4) $\tan\theta = \frac{1}{2\sqrt{3}}$

3. A rigid massless rod of length $3l$ has two masses attached at each end as shown in the figure. The rod is pivoted at point P on the horizontal axis (see figure). When released from initial horizontal position, its instantaneous angular acceleration will be :



(1) $\frac{g}{2l}$ (2) $\frac{7g}{3l}$ (3) $\frac{g}{13l}$ (4) $\frac{g}{3l}$

4. Two identical spherical balls of mass M and radius R each are stuck on two ends of a rod of length 2R and mass M (see figure). The moment of inertia of the system about the axis passing perpendicularly through the centre of the rod is :



(1) $\frac{152}{15}MR^2$ (2) $\frac{17}{15}MR^2$

(3) $\frac{137}{15}MR^2$ (4) $\frac{209}{15}MR^2$

5. To mop-clean a floor, a cleaning machine presses a circular mop of radius R vertically down with a total force F and rotates it with a constant angular speed about its axis. If the force F is distributed uniformly over the mop and if coefficient of friction between the mop and the floor is μ, the torque, applied by the machine on the mop is :

(1) $\frac{2}{3}\mu FR$ (2) $\mu FR/3$

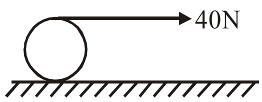
(3) $\mu FR/2$ (4) $\mu FR/6$

6. A homogeneous solid cylindrical roller of radius R and mass M is pulled on a cricket pitch by a horizontal force. Assuming rolling without slipping, angular acceleration of the cylinder is :

(1) $\frac{3F}{2m R}$ (2) $\frac{F}{3m R}$

(3) $\frac{2F}{3m R}$ (4) $\frac{F}{2m R}$

7. A string is wound around a hollow cylinder of mass 5 kg and radius 0.5 m. If the string is now pulled with a horizontal force of 40 N, and the cylinder is rolling without slipping on a horizontal surface (see figure), then the angular acceleration of the cylinder will be (Neglect the mass and thickness of the string):-



(1) 12 rad/s^2 (2) 16 rad/s^2

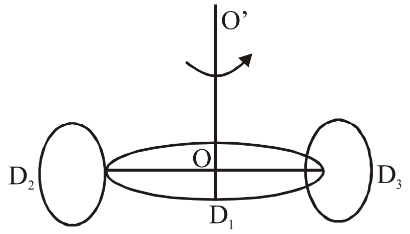
(3) 10 rad/s^2 (4) 20 rad/s^2

8. The magnitude of torque on a particle of mass 1kg is 2.5 Nm about the origin. If the force acting on it is 1 N, and the distance of the particle from the origin is 5m, the angle between the force and the position vector is (in radians) :-

(1) $\frac{\pi}{8}$ (2) $\frac{\pi}{6}$

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

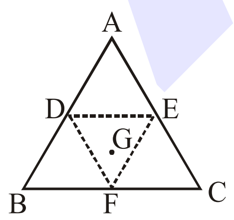
9. A circular disc D_1 of mass M and radius R has two identical discs D_2 and D_3 of the same mass M and radius R attached rigidly at its opposite ends (see figure). The moment of inertia of the system about the axis OO', passing through the centre of D_1, as shown in the figure, will be:-



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

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

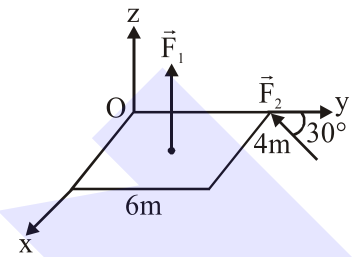
10. An equilateral triangle ABC is cut from a thin solid sheet of wood. (see figure) D, E and F are the mid-points of its sides as shown and G is the centre of the triangle. The moment of inertia of the triangle about an axis passing through G and perpendicular to the plane of the triangle is I_0. It the smaller triangle DEF is removed from ABC, the moment of inertia of the remaining figure about the same axis is I. Then:



(1) $I = \frac{9}{16}I_0$ (2) $I = \frac{3}{4}I_0$

(3) $I = \frac{I_0}{4}$ (4) $I = \frac{15}{16}I_0$

11. A slob is subjected to two forces $\vec{F}_1$ and $\vec{F}_2$ of same magnitude F as shown in the figure. Force $\vec{F}_2$ is in XY-plane while force F_1 acts along z-axis at the point $(2\vec{i}+3\vec{j})$. The moment of these forces about point O will be :



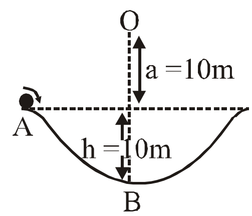
(1) $(3\hat{i}-2\hat{j}-3\hat{k})F$

(2) $(3\hat{i}+2\hat{j}+3\hat{k})F$

(3) $(3\hat{i}+2\hat{j}-3\hat{k})F$

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

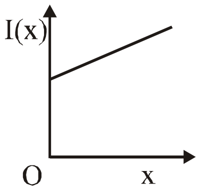
12. A particle of mass 20 g is released with an initial velocity 5 m/s along the curve from the point A, as shown in the figure. The point A is at height h from point B. The particle slides along the frictionless surface. When the particle reaches point B, its angular momentum about O will be : (Take g= 10 m/s^2)

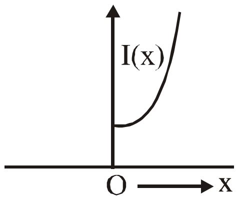


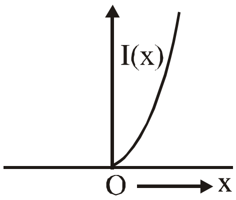
(1) 8kg-m^2/s (2) 6kg-m^2/s

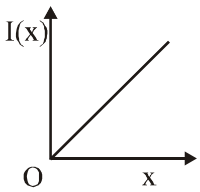
(3) 3kg-m^2/s (4) 2kg-m^2/s

13. The moment of inertia of a solid sphere, about an axis parallel to its diameter and at a distance of x from it, is I(x)'. Which one of the graphs represents the variation of I(x) with x correctlv?

(1) 

(2) 

(3) 

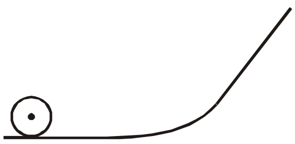
(4) 

14. Let the moment of inertia of a hollow cylinder of length 30 cm (inner radius 10 cm and outer radius 20 cm), about its axis be I. The radius of a thin cylinder of the same mass such that its moment of inertia about its axis is also I, is:

(1) 12 cm (2) 18 cm

(3) 16 cm (4) 14 cm

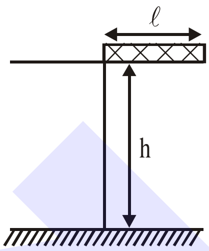
15. A solid sphere and solid cylinder of identical radii approach an incline with the same linear velocity (see figure). Both roll without slipping all throughout. The two climb maximum heights h_{sph} and h_{cyl} on the incline. The ratio $\frac{h_{sph}}{h_{cyl}}$ is given by :-



(1) $\frac{14}{15}$ (2) $\frac{4}{5}$

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

16. A rectangular solid box of length 0.3 m is held horizontally, with one of its sides on the edge of a platform of height 5m. When released, it slips off the table in a very short time $\tau = 0.01$s, remaining essentially horizontal. The angle by which it would rotate when it hits the ground will be (in radians) close to :-



(1) 0.02 (2) 0.28 (3) 0.5 (4) 0.3

17. A thin circular plate of mass M and radius R has its density varying as $\rho(r) = \rho_0 r$ with ρ_0 as constant and r is the distance from its centre. The moment of Inertia of the circular plate about an axis perpendicular to the plate and passing through its edge is $I = aMR^2$. The value of the coefficient a is :

(1) $\frac{3}{2}$ (2) $\frac{1}{2}$ (3) $\frac{3}{5}$ (4) $\frac{8}{5}$

18. Moment of inertia of a body about a given axis is 1.5 kg m^2. Initially the body is at rest. In order to produce a rotational kinetic energy of 1200 J, the angular accleration of 20 rad/s^2 must be applied about the axis for a duration of :-

(1) 2 s (2) 5s (3) 2.5 s (4) 3 s

19. A thin smooth rod of length L and mass M is rotating freely with angular speed ω_0 about an axis perpendicular to the rod and passing through its center. Two beads of mass m and negligible size are at the center of the rod initially. The beads are free to slide along the rod. The angular speed of the system, when the beads reach the opposite ends of the rod, will be :-

(1) $\frac{M\omega_0}{M+3m}$ (2) $\frac{M\omega_0}{M+m}$

(3) $\frac{M\omega_0}{M+2m}$ (4) $\frac{M\omega_0}{M+6m}$

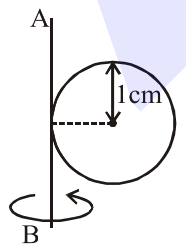
20. The following bodies are made to roll up (without slipping) the same inclined plane from a horizontal plane. : (i) a ring of radius R, (ii) a solid cylinder of radius $\frac{R}{2}$ and (iii) a solid sphere of radius $\frac{R}{4}$. If in each case, the speed of the centre of mass at the bottom of the incline is same, the ratio of the maximum heights they climb is :

(1) 4 : 3 : 2 (2) 14 : 15 : 20
(3) 10 : 15 : 7 (4) 2 : 3 : 4

21. A stationary horizontal disc is free to rotate about its axis. When a torque is applied on it, its kinetic energy as a function of θ, where θ is the angle by which it has rotated, is given as $k\theta^2$. If its moment of inertia is I then the angular acceleration of the disc is :

(1) $\frac{k}{2I}\theta$ (2) $\frac{k}{I}\theta$ (3) $\frac{k}{4I}\theta$ (4) $\frac{2k}{I}\theta$

22. A metal coin of mass 5 g and radius 1 cm is fixed to a thin stick AB of negligible mass as shown in the figure. The system is initially at rest. The constant torque, that will make the system rotate about AB at 25 rotations per second in 5 s, is close to :



(1) 4.0×10^{-6} Nm
(2) 2.0×10^{-5} Nm
(3) 1.6×10^{-5} Nm
(4) 7.9×10^{-6} Nm

23. The time dependence of the position of a particle of mass m = 2 is given by $\vec{r}(t) = 2t\,\hat{i} - 3t^2\,\hat{j}$. Its angular momentum, with respect to the origin, at time t = 2 is :

(1) $36\,\hat{k}$ (2) $-34(\hat{k}-\hat{i})$
(3) $48(\hat{i}+\hat{j})$ (4) $-48\hat{k}$

24. A solid sphere of mass M and radius R is divided into two unequal parts. The first part has a mass of $\frac{7M}{8}$ and is converted into a uniform disc of radius 2R. The second part is converted into a uniform solid sphere. Let I_1 be the moment of inertia of the disc about its axis and I_2 be the moment of inertia of the new sphere about its axis. The ratio I_1/I_2 is given by :

(1) 185 (2) 65 (3) 285 (4) 140

25. A thin disc of mass M and radius R has mass per unit area $\sigma(r) = kr^2$ where r is the distance from its centre. Its moment of inertia about an axis going through its centre of mass and perpendicular to its plane is :

(1) $\frac{MR^2}{6}$ (2) $\frac{MR^2}{3}$
(3) $\frac{2MR^2}{3}$ (4) $\frac{MR^2}{2}$

26. Two coaxial discs, having moments of inertia I_1 and $\frac{I_1}{2}$, are rotating with respective angular velocities ω_1 and $\frac{\omega_1}{2}$, about their common axis. They are brought in contact with each other and thereafter they rotate with a common angular velocity. If E_f and E_i are the final and initial total energies, then $(E_f - E_i)$ is :

(1) $\frac{I_1\omega_1^2}{12}$ (2) $\frac{3}{8}I_1\omega_1^2$
(3) $\frac{I_1\omega_1^2}{6}$ (4) $\frac{I_1\omega_1^2}{24}$

27. A particle of mass m is moving along a trajectory given by

$x = x_0 + a\cos\omega_1 t$

$y = y_0 + b\sin\omega_2 t$

The torque, acting on the particle about the origin, at t = 0 is :

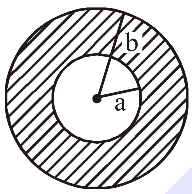
(1) $m(-x_0 b + y_0 a)\,\omega_1^2\hat{k}$

(2) $+m y_0 a\,\omega_1^2\hat{k}$

(3) $-m(x_0 b\omega_2^2 - y_0 a\omega_1^2)\hat{k}$

(4) Zero

28. A circular disc of radius b has a hole of radius a at its centre (see figure). If the mass per unit area of the disc varies as $\left(\frac{\sigma_0}{r}\right)$, then the radius of gyration of the disc about its axis passing through the centre is :



(1) $\frac{a+b}{2}$ (2) $\frac{a+b}{3}$

(3) $\sqrt{\frac{a^2+b^2+ab}{2}}$ (4) $\sqrt{\frac{a^2+b^2+ab}{3}}$

29. A person of mass M is, sitting on a swing of length L and swinging with an angular amplitude θ_0. If the person stands up when the swing passes through its lowest point, the work done by him, assuming that his centre of mass moves by a distance ℓ ($\ell << L$), is close to :

(1) $Mg\ell$

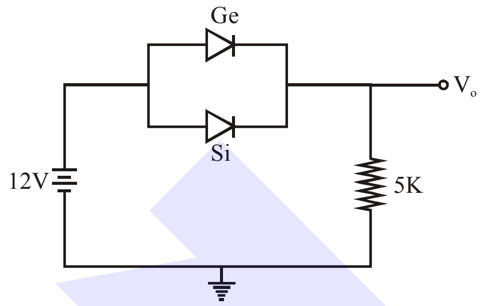
(2) $Mg\ell(1+\theta_0^2)$

(3) $Mg\ell(1-\theta_0^2)$

(4) $Mg\ell\left(1+\frac{\theta_0^2}{2}\right)$

SEMICONDUCTOR

1. Ge and Si diodes start conducting at 0.3 V and 0.7 V respectively. In the following figure if Ge diode connection are reversed, the value of V_o changes by : (assume that the Ge diode has large breakdown voltage)



(1) 0.6 V (2) 0.8 V

(3) 0.4 V (4) 0.2 V

2. Mobility of electrons in a semiconductor is defined as the ratio of their drift velocity to the applied electric field. If, for an n-type semiconductor, the density of electrons is $10^{19} m^{-3}$ and their mobility is $1.6\ m^2/(V.s)$ then the resistivity of the semiconductor (since it is an n-type semiconductor contribution of holes is ignored) is close to:

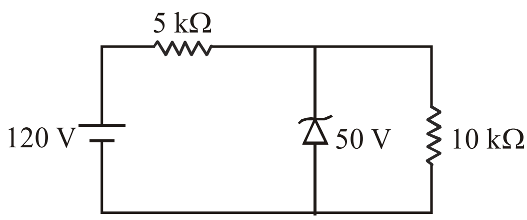
(1) 2Ωm

(2) 0.4Ωm

(3) 4Ωm

(4) 0.2Ωm

3. For the circuit shown below, the current through the Zener diode is :



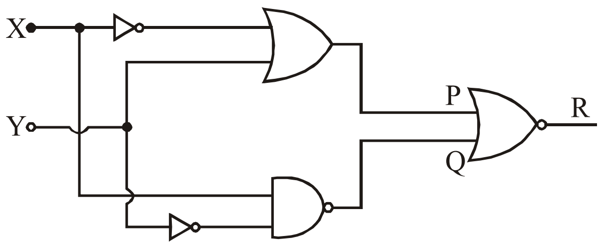
(1) 5 mA

(2) Zero

(3) 14 mA

(4) 9 mA

4. To get output '1' at R, for the given logic gate circuit the input values must be :



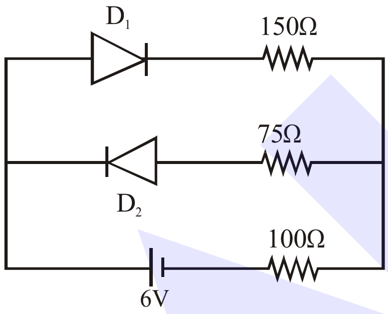
(1) X = 0, Y = 1

(2) X =1 , Y = 1

(3) X = 0, Y = 0

(4) X = 1, Y = 0

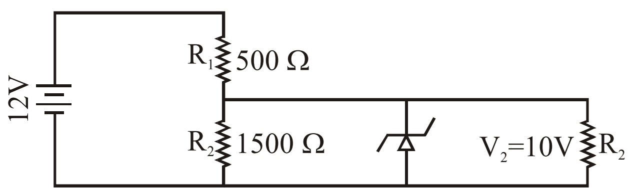
5. The circuit shown below contains two ideal diodes, each with a forward resistance of 50Ω. If the battery voltage is 6 V, the current through the 100 Ω resistance (in Amperes) is :-



(1) 0.027 (2) 0.020

(3) 0.030 (4) 0.036

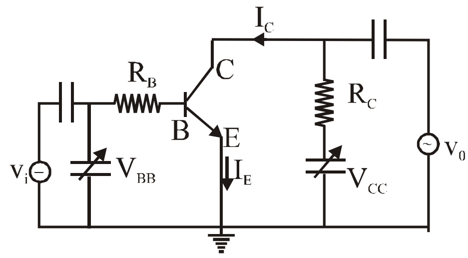
6. In the given circuit the current through Zener Diode is close to :



(1) 6.0 mA (2) 4.0 mA

(3) 6.7 mA (4) 0.0 mA

7.



In the figure, given that V_{BB} supply can vary from 0 to 5.0 V, V_{CC} = 5V, β_{dc} = 200, R_B = 100 kΩ, R_C=1 kΩ and V_{BE}=1.0 V, The minimum base current and the input voltage at which the transistor will go to saturation, will be, respectively :

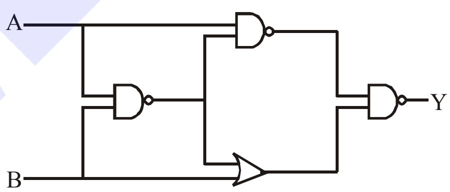
(1) 20μA and 3.5V

(2) 25μA and 3.5V

(3) 25μA and 2.8V

(4) 20μA and 2.8V

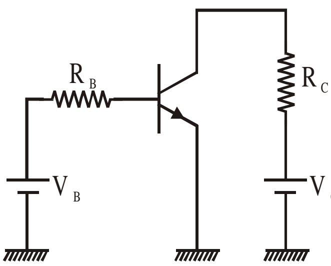
8. The output of the given logic circuit is :



(1) $\overline{A}B$ (2) $A\overline{B}$

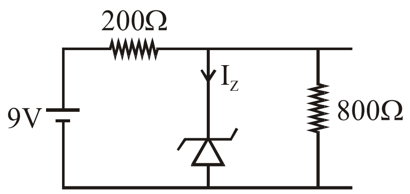
(3) $AB+\overline{AB}$ (4) $A\overline{B}+\overline{A}B$

9. A common emitter amplifier circuit, built using an npn transistor, is shown in the figure. Its dc current gain is 250, R_C = 1kΩ and V_{CC} = 10 V. What is the minimum base current for V_{CE} to reach saturation ?



(1) 100 μA (2) 7 μA (3) 40 μA (4) 10 μA

10. The reverse breakdown voltage of a Zener diode is 5.6 V in the given circuit.

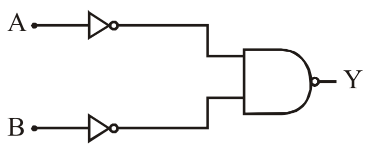


The current I_Z through the Zener is :

(1) 7 mA (2) 17 mA

(3) 10 mA (4) 15mA

11. The logic gate equivalent to the given logic circuit is :-



(1) OR (2) AND

(3) NOR (4) NAND

12. An NPN transistor is used in common emitter configuration as an amplifier with 1 kΩ load resistance. Signal voltage of 10 mV is applied across the base-emitter. This produces a 3 mA change in the collector current and 15μA change in the base current of the amplifier. The input resistance and voltage gain are :

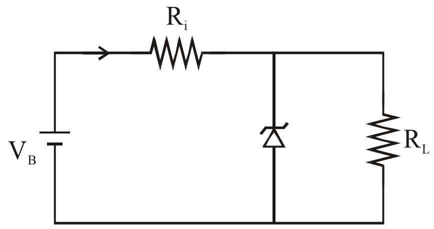
(1) 0.33 kΩ, 1.5

(2) 0.67 kΩ, 200

(3) 0.33 kΩ, 300

(4) 0.67 kΩ, 300

13. The figure represents a voltage regulator circuit using a Zener diode. The breakdown voltage of the Zener diode is 6V and the load resistance is R_L = 4 kΩ. The series resistance of the circuit is R_i = 1 kΩ. If the battery voltage V_B varies from 8V to 16V, what are the minimum and maximum values of the current through Zener diode ?



(1) 0.5 mA ; 6 mA

(2) 0.5 mA ; 8.5 mA

(3) 1.5 mA ; 8.5 mA

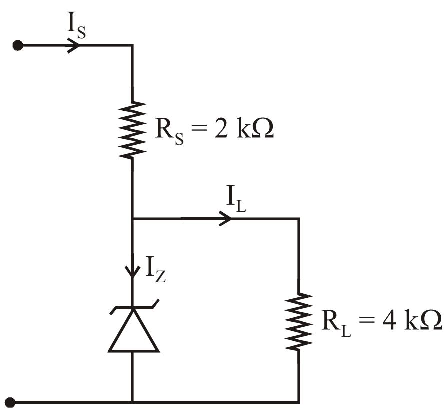
(4) 1 mA ; 8.5 mA

14. An npn transistor operates as a common emitter amplifier, with a power gain of 60 dB. The input circuit resistance is 100Ω and the output load resistance is 10 kΩ. The common emitter current gain β is :

(1) 60 (2) 10^4

(3) 6×10^2 (4) 10^2

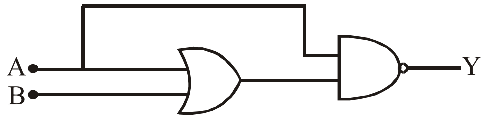
15. Figure shown a DC voltage regulator circuit, with a Zener diode of breakdown voltage = 6V. If the unregulated input voltage varies between 10 V to 16 V, then what is the maximum Zener current ?



(1) 2.5 mA (2) 3.5 mA

(3) 7.5 mA (4) 1.5 mA

16. The truth table for the circuit given in the fig. is:



(1)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

(2)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

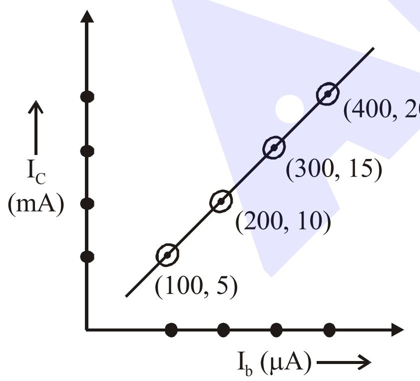
(3)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(4)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	1

17. The transfer characteristic curve of a transistor, having input and output resistance 100 Ω and 100 kΩ respectively, is shown in the figure. The Voltage and Power gain, are respectively:



(1) 5×10^4, 5×10^5

(2) 5×10^4, 5×10^6

(3) 5×10^4, 2.5×10^6

(4) 2.5×10^4, 2.5×10^6

SHM

1. A rod of mass 'M' and length '2L' is suspended at its middle by a wire. It exhibits torsional oscillations; If two masses each of 'm' are attached at distance 'L/2' from its centre on both sides, it reduces the oscillation frequency by 20%. The value of ratio m/M is close to :

(1) 0.17 (2) 0.37

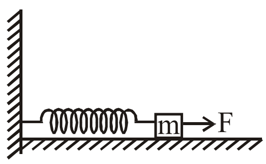
(3) 0.57 (4) 0.77

2. A particle is executing simple harmonic motion (SHM) of amplitude A, along the x-axis, about x = 0. When its potential Energy (PE) equals kinetic energy (KE), the position of the particle will be :

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

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

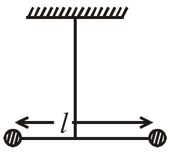
3. A block of mass m, lying on a smooth horizontal surface, is attached to a spring (of negligible mass) of spring constant k. The other end of the spring is fixed, as shown in the figure. The block is initally at rest in its equilibrium position. If now the block is pulled with a constant force F, the maximum speed of the block is :



(1) $\frac{\pi F}{\sqrt{mk}}$ (2) $\frac{2F}{\sqrt{mk}}$

(3) $\frac{F}{\sqrt{mk}}$ (4) $\frac{F}{\pi\sqrt{mk}}$

4. Two masses m and $\frac{m}{2}$ are connected at the two ends of a massless rigid rod of length l. The rod is suspended by a thin wire of torsional constant k at the centre of mass of the rod-mass system(see figure). Because of torsional constant k, the restoring torque is $\tau = k\theta$ for angular displacement 0. If the rod is rota ted by θ_0 and released, the tension in it when it passes through its mean position will be:



(1) $\frac{3k\theta_0^2}{l}$ (2) $\frac{k\theta_0^2}{2l}$

(3) $\frac{2k\theta_0^2}{l}$ (4) $\frac{k\theta_0^2}{l}$

5. A particle executes simple harmonic motion with an amplitude of 5 cm. When the particle is at 4 cm from the mean position, the magnitude of its velocity in SI units is equal to that of its acceleration. Then, its periodic time in seconds is :

(1) $\frac{7}{3}\pi$ (2) $\frac{3}{8}\pi$

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

6. A simple pendulum of length 1 m is oscillating with an angular frequency 10 rad/s. The support of the pendulum starts oscillating up and down with a small angular frequency of 1 rad/s and an amplitude of 10^{-2} m. The relative change in the angular frequency of the pendulum is best given by :-

(1) 10^{-3} rad/s (2) 10^{-1} rad/s

(3) 1 rad/s (4) 10^{-5} rad/s

7. A pendulum is executing simple harmonic motion and its maximum kinetic energy is K_1. If the length of the pendulum is doubled and it performs simple harmonic motion with the same amplitude as in the first case, its maximum kinetic energy is K_2. Then :-

(1) $K_2 = \frac{K_1}{4}$

(2) $K_2 = \frac{K_1}{2}$

(3) $K_2 = 2K_1$

(4) $K_2 = K_1$

8. A particle undergoing simple harmonic motion has time dependent displacement given by $x(t) = A\sin\frac{\pi t}{90}$. The ratio of kinetic to potential energy of this particle at t = 210 s will be :

(1) 2 (2) $\frac{1}{9}$

(3) 3 (4) 1

9. A simple harmonic motion is represented by:

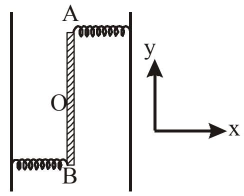
$y = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$ cm

The amplitude and time period of the motion are:

(1) 5cm, $\frac{3}{2}$s (2) 5cm, $\frac{2}{3}$s

(3) 10cm, $\frac{3}{2}$s (4) 10cm, $\frac{2}{3}$s

10. Two light identical springs of spring constant k are attached horizontally at the two ends of a uniform horizontal rod AB of length ℓ and mass m. The rod is pivoted at its centre 'O' and can rotate freely in horizontal plane. The other ends of the two springs are fixed to rigid supports as shown in figure. The rod is gently pushed through a small angle and released. The frequency of resulting oscillation is:



(1) $\frac{1}{2\pi}\sqrt{\frac{6k}{m}}$

(2) $\frac{1}{2\pi}\sqrt{\frac{2k}{m}}$

(3) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$

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

11. A simple pendulum oscillating in air has period T. The bob of the pendulum is completely immersed in a non-viscous liquid. The density of the liquid is $\frac{1}{16}$th of the material of the bob. If the bob is inside liquid all the time, its period of oscillation in this liquid is :

(1) $4T\sqrt{\frac{1}{15}}$ (2) $2T\sqrt{\frac{1}{10}}$

(3) $4T\sqrt{\frac{1}{14}}$ (4) $2T\sqrt{\frac{1}{14}}$

UNIT & DIMENSION

1. Expression for time in terms of G (universal gravitational constant), h (Planck constant) and c (speed of light) is proportional to :

(1) $\sqrt{\frac{Gh}{c^3}}$ (2) $\sqrt{\frac{hc^5}{G}}$

(3) $\sqrt{\frac{c^3}{Gh}}$ (4) $\sqrt{\frac{Gh}{c^5}}$

2. The density of a material in SI units is 128 kg m^{-3}. In certain units in which the unit of length is 25 cm and the unit of mass is 50 g, the numerical value of density of the material is :

(1) 410 (2) 640 (3) 16 (4) 40

3. If speed (V), acceleration (A) and force (F) are considered as fundamental units, the dimension of Young's modulus will be :-

(1) $V^{-2} A^2F^2$ (2) $V^{-4}A^2F$

(3) $V^{-4}A^{-2}F$ (4) $V^{-2}A^2F^{-2}$

4. The force of interaction between two atoms is given by $F = \alpha\beta \exp\left(-\frac{x^2}{\alpha kt}\right)$; where x is the distance, k is the Boltzmann constant and T is temperature and α and β are two constants. The dimension of β is :

(1) $M^2L^2T^{-2}$ (2) M^2LT^{-4}

(3) $M^0L^2T^{-4}$ (4) MLT^{-2}

5. Let ℓ, r, c and v represent inductance, resistance, capacitance and voltage, respectively. The dimension of $\frac{\ell}{rcv}$ in SI units will be:

(1) [LTA] (2) [LA^{-2}]

(3) [A^{-1}] (4) [LT^2]

6. If surface tension (S), Moment of inertia (I) and Planck's constant (h), were to be taken as the fundamental units, the dimensional formula for linear momentum would be :-

(1) $S^{3/2}I^{1/2}h^0$ (2) $S^{1/2}I^{1/2}h^0$

(3) $S^{1/2}I^{1/2}h^{-1}$ (4) $S^{1/2}I^{3/2}h^{-1}$

7. In SI units, the dimesions of $\sqrt{\frac{\epsilon_0}{\mu_0}}$ is :

(1) A^{-1} TML^3 (2) $A^2T^3M^{-1}L^{-2}$

(3) $AT^2M^{-1}L^{-1}$ (4) $AT^{-3}ML^{3/2}$

8. Which of the following combinations has the dimension of electrical resistance (ε_0 is the permittivity of vacuum and μ_0 is the permeability of vacuum) ?

(1) $\sqrt{\frac{\varepsilon_0}{\mu_0}}$ (2) $\frac{\mu_0}{\varepsilon_0}$

(3) $\sqrt{\frac{\mu_0}{\varepsilon_0}}$ (4) $\frac{\varepsilon_0}{\mu_0}$

VECTOR

1. Two forces P and Q of magnitude 2F and 3F, respectively, are at an angle θ with each other. If the force Q is doubled, then their resultant also gets doubled. Then, the angle is :

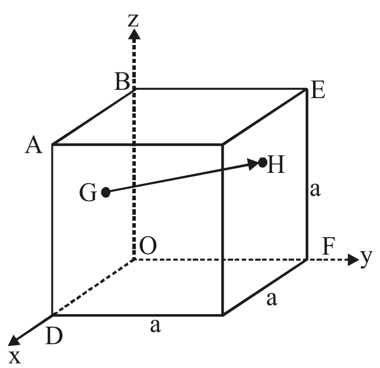
(1) 30º (2) 60º
(3) 90º (4) 120º

2. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. The magnitude of $(\vec{A}+\vec{B})$ is 'n' times the magnitude of $(\vec{A}-\vec{B})$. The angle between $\vec{A}$ and $\vec{B}$ is :

(1) $\sin^{-1}\left[\frac{n^2-1}{n^2+1}\right]$ (2) $\cos^{-1}\left[\frac{n-1}{n+1}\right]$

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

3. In the cube of side 'a' shown in the figure, the vector from the central point of the face ABOD to the central point of the face BEFO will be:



(1) $\frac{1}{2}a(\hat{i}-\hat{k})$ (2) $\frac{1}{2}a(\hat{j}-\hat{i})$

(3) $\frac{1}{2}a(\hat{k}-\hat{i})$ (4) $\frac{1}{2}a(\hat{j}-\hat{k})$

4. Let $|\vec{A}_1|=3$, $|\vec{A}_2|=5$ and $|\vec{A}_1+\vec{A}_2|=5$. The value of $(2\vec{A}_1+3\vec{A}_2).(3\vec{A}_1-2\vec{A}_2)$ is :-

(1) –112.5 (2) –106.5
(3) –118.5 (4) –99.5

WAVE MOTION

1. A musician using an open flute of length 50 cm produces second harmonic sound waves. A person runs towards the musician from another end of a hall at a speed of 10 km/h. If the wave speed is 330 m/s, the frequency heard by the running person shall be close to :

(1) 753 Hz (2) 500 Hz
(3) 333 Hz (4) 666 Hz

2. Two coherent sources produce waves of different intensities which interfere. After interference, the ratio of the maximum intensity to the minimum intensity is 16. The intensity of the waves are in the ratio:

(1) 4 : 1 (2) 25 : 9
(3) 16 : 9 (4) 5 : 3

3. A heavy ball of mass M is suspended from the ceiling of a car by a light string of mass m (m<<M). When the car is at rest, the speed of transverse waves in the string is 60 ms^{-1}. When the car has acceleration a, the wave-speed increases to 60.5 ms^{-1}. The value of a, in terms of gravitational acceleration g, is closest to :

(1) $\frac{g}{5}$ (2) $\frac{g}{20}$ (3) $\frac{g}{10}$ (4) $\frac{g}{30}$

4. A closed organ pipe has a fundamental frequency of 1.5 kHz. The number of overtones that can be distinctly heard by a person with this organ pipe will be :

(Assume that the highest frequency a person can hear is 20,000 Hz)

(1) 7 (2) 5 (3) 6 (4) 4

5. A string of length 1 m and mass 5 g is fixed at both ends. The tension in the string is 8.0 N. The siring is set into vibration using an external vibrator of frequency 100 Hz. The separation between successive nodes on the string is close to :

(1) 16.6 cm (2) 20.0 cm

(3) 10.0 cm (4) 33.3 cm

6. A train moves towards a stationary observer with speed 34 m/s. The train sounds a whistle and its frequency registered by the observer is f_1. If the speed of the train is reduced to 17 m/s, the frequency registered is f_2. If speed of sound is 340 m/s, then the ratio f_1/f_2 is :

(1) 18/17 (2) 19/18 (3) 20/19 (4) 21/20

7. Equation of travelling wave on a stretched string of linear density 5 g/m is

y = 0.03 sin(450 t – 9x)

where distance and time are measured is SI units. The tension in the string is :

(1) 10 N (2) 12.5 N (3) 7.5 N (4) 5 N

8. A resonance tube is old and has jagged end. It is still used in the laboratory to determine velocity of sound in air. A tuning fork of frequency 512 Hz produces first resonance when the tube is filled with water to a mark 11 cm below a reference mark, near the open end of the tube. The experiment is repeated with another fork of frequency 256 Hz which produces first resonance when water reaches a mark 27 cm below the reference mark. The velocity of sound in air, obtained in the experiment, is close to:

(1) $328 ms^{-1}$ (2) $322 ms^{-1}$

(3) $341 ms^{-1}$ (4) $335 ms^{-1}$

9. A travelling harmonic wave is represented by the equation y (x, t) = 10^{-3} sin (50 t + 2x), where x and y are in meter and t is in seconds. Which of the following is a correct statement about the wave?

The wave is propagating along the

(1) negative x-axis with speed $25 ms^{-1}$

(2) The wave is propagating along the positive x-axis with speed $25 ms^{-1}$

(3) The wave is propagating along the positive x-axis with speed $100 ms^{-1}$

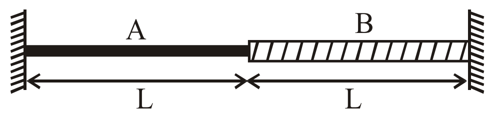
(4) The wave is propagating along the negative x-axis with speed $100 ms^{-1}$

10. A person standing on an open ground hears the sound of a jet aeroplane, coming from north at an angle 60° with ground level. But he finds the aeroplane right vertically above his position. If υ is the speed of sound, speed of the plane is :

(1) $\frac{2\upsilon}{\sqrt{3}}$ (2) υ

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

11. A wire of length 2L, is made by joining two wires A and B of same length but different radii r and 2r and made of the same material. It is vibrating at a frequency such that the joint of the two wires forms a node. If the number of antinodes in wire A is p and that in B is q then the ratio p : q is :



(1) 4 : 9 (2) 3 : 5

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

12. A string 2.0 m long and fixed at its ends is driven by a 240 Hz vibrator. The string vibrates in its third harmonic mode. The speed of the wave and its fundamental frequency is :-

(1) 320m/s, 120 Hz (2) 180m/s, 80 Hz

(3) 180m/s, 120 Hz (4) 320m/s, 80 Hz

13. The pressure wave, P = 0.01 sin [1000t – 3x] Nm^{-2}, corresponds to the sound produced by a vibrating blade on a day when atmospheric temperature is 0°C. On some other day, when temperature is T, the speed of sound produced by the same blade and at the same frequency is found to be 336 ms^{-1}. Approximate value of T is :

(1) 15°C (2) 12°C

(3) 4°C (4) 11°C

14. A string is clamped at both the ends and it is vibrating in its 4^{th} harmonic. The equation of the stationary wave is Y = 0.3 sin(0.157x) cos(200πt). The length of the string is : (All quantities are in SI units.)

(1) 20 m (2) 80 m

(3) 60 m (4) 40 m

15. A source of sound S is moving with a velocity of 50 m/s towards a stationary observer. The observer measures the frequency of the source as 1000 Hz. What will be the apparent frequency of the source when it is moving away from the observer after crossing him ? (Take velocity of sound in air is 350 m/s)

(1) 857 Hz (2) 807 Hz

(3) 750 Hz (4) 1143 Hz

16. A stationary source emits sound waves of frequency 500 Hz. Two observers moving along a line passing through the source detect sound to be of frequencies 480 Hz and 530Hz. Their respective speeds are, in ms^{-1},

(Given speed of sound = 300 m/s)

(1) 16, 14 (2) 12, 18

(3) 12, 16 (4) 8, 18

17. A tuning fork of frequency 480 Hz is used in an experiment for measuring speed of sound (ν) in air by resonance tube method. Resonance is observed to occur at two successive lengths of the air column, l_1 = 30 cm and l_2 = 70 cm. Then ν is equal to :

(1) 332 ms^{-1} (2) 379 ms^{-1}

(3) 384 ms^{-1} (4) 338 ms^{-1}

18. Two sources of sound S_1 and S_2 produce sound waves of same frequency 660 Hz. A listener is moving from source S_1 towards S_2 with a constant speed u m/s and he hears 10 beats/s. The velocity of sound is 330 m/s. Then, u equals :

(1) 2.5 m/s (2) 15.0 m/s

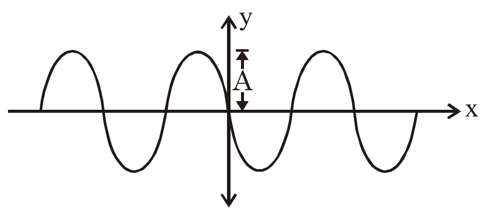
(3) 5.5 m/s (4) 10.0 m/s

19. A small speaker delivers 2 W of audio output. At what distance from the speaker will one detect 120 dB intensity sound ? [Given reference intensity of sound as $10^{-12}W/m^2$]

(1) 10 cm (2) 30 cm

(3) 40 cm (4) 20 cm

20. A progressive wave travelling along the positive x-direction is represented by y(x, t) = A sin (kx – ωt + φ). Its snapshot at t = 0 is given in the figure:



For this wave, the phase φ is :

(1) 0 (2) $-\frac{\pi}{2}$ (3) π (4) $\frac{\pi}{2}$

21. A submarine (A) travelling at 18 km/hr is being chased along the line of its velocity by another submarine (B) travelling at 27 km/hr. B sends a sonar signal of 500 Hz to detect A and receives a reflected sound of frequency ν. The value of ν is close to :

(Speed of sound in water = 1500 ms^{-1})

(1) 499 Hz (2) 502 Hz

(3) 507 Hz (4) 504 Hz

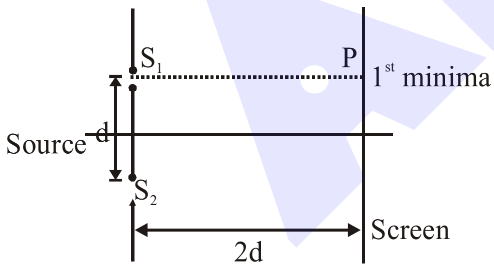
WAVE OPTICS

1. In a Young's double slit experiment, the slits are placed 0.320 mm apart. Light of wavelength $\lambda = 500$ nm is incident on the slits. The total number of bright fringes that are observed in the angular range $-30° \le \theta \le 30°$ is:

(1) 320 (2) 641

(3) 321 (4) 640

2. Consider a Young's double slit experiment as shown in figure. What should be the slit separation d in terms of wavelength λ such that the first minima occurs directly in front of the slit (S_1) ?



(1) $\frac{\lambda}{2(5-\sqrt{2})}$ (2) $\frac{\lambda}{(5-\sqrt{2})}$

(3) $\frac{\lambda}{(\sqrt{5}-2)}$ (4) $\frac{\lambda}{2(\sqrt{5}-2)}$

3. In a Young's double slit experiment with slit separation 0.1 mm, one observes a bright fringe at angle $\frac{1}{40}$ rad by using light of wavelength λ_1. When the light of wavelength λ_2 is used a bright fringe is seen at the same angle in the same set up. Given that λ_1 and λ_2 are in visible range (380 nm to 740 nm), their values are :

(1) 380 nm, 500 nm

(2) 625 nm, 500 nm

(3) 380 nm, 525 nm

(4) 400 nm, 500 nm

4. In a double-slit experiment, green light (5303 Å) falls on a double slit having a separation of 19.44 μm and a width of 4.05 μm. The number of bright fringes between the first and the second diffraction minima is :-

(1) 09 (2) 10

(3) 04 (4) 05

5. In a Young's double slit experiment, the path different, at a certain point on the screen, between two interfering waves is $\frac{1}{8}$th of wavelength. The ratio of the intensity at this point to that at the centre of a brigth fringe is close to :

(1) 0.94 (2) 0.74

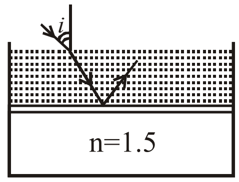
(3) 0.85 (4) 0.80

6. A light wave is incident normally on a glass slab of refractive index 1.5. If 4% of light gets reflected and the amplitude of the electric field of the incident light is 30V/m, then the amplitude of the electric field for the wave propogating in the glass medium will be:

(1) 10 V/m (2) 24 V/m

(3) 30 V/m (4) 6 V/m

7. Consider a tank made of glass(reiractive index 1.5) with a thick bottom. It is filled with a liquid of refractive index μ,. A student finds that, irrespective of what the incident angle *i* (see figure) is for a beam of light entering the liquid, the light reflected from the liquid glass interface is never completely polarized. For this to happen, the minimum value of μ is :



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

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

8. Young's moduli of two wires A and B are in the ratio 7 : 4. Wire A is 2 m long and has radius R. Wire B is 1.5 m long and has radius 2 mm. If the two wires stretch by the same length for a given load, then the value of R is close to :-

(1) 1.9 mm

(2) 1.7 mm

(3) 1.5 mm

(4) 1.3 mm

9. In an interference experiment the ratio of amplitudes of coherent waves is $\frac{a_1}{a_2}=\frac{1}{3}$. The ratio of maximum and minimum intensities of fringes will be :

(1) 4 (2) 2

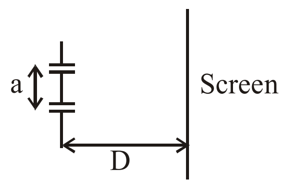
(3) 9 (4) 18

10. Two cars A and B are moving away from each other in opposite directions. Both the cars are moving with a speed of 20 ms^{-1} with respect to the ground. If an observer in car A detects a frequency 2000 Hz of the sound coming from car B, what is the natural frequency of the sound source in car B ? (speed of sound in air = 340 ms^{-1}) :-

(1) 2250 Hz (2) 2060 Hz

(3) 2150 Hz (4) 2300 Hz

11. The figure shows a Young's double slit experimental setup. It is observed that when a thin transparent sheet of thickness t and refractive index μ is put in front of one of the slits, the central maximum gest shifted by a distance equal to n fringe widths. If the wavelength of light used is λ, t will be :



(1) $\frac{2D\lambda}{a(\mu-1)}$ (2) $\frac{D\lambda}{a(\mu-1)}$

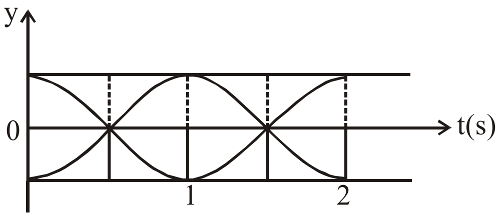
(3) $\frac{2nD\lambda}{a(\mu-1)}$ (4) $\frac{nD\lambda}{a(\mu-1)}$

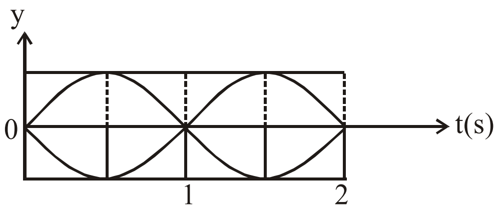
12. In a Young's doubble slit experiment, the ratio of the slit's width is 4 : 1. The ratio of the intensity of maxima to minima, close to the central fringe on the screen, will be :

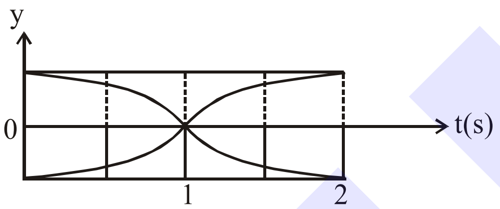
(1) $(\sqrt{3}+1)^4 : 16$ (2) 9 : 1

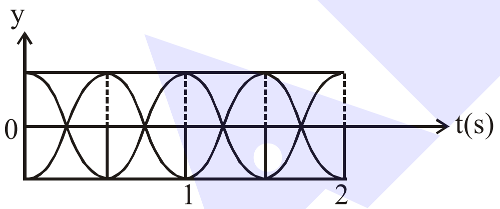
(3) 4 : 1 (4) 25 : 9

13. The correct figure that shows, schematically, the wave pattern produced by superposition of two waves of frequencies 9 Hz and 11 Hz is :

(1) 

(2) 

(3) 

(4) 

14. A system of three polarizers P_1, P_2, P_3 is set up such that the pass axis of P_3 is crossed with respect to that of P_1. The pass axis of P_2 is inclined at 60° to the pass axis of P_3. When a beam of unpolarized light of intensity I_0 is incident on P_1, the intensity of light transmitted by the three polarizers is I. The ratio (I_0/I) equals (nearly) :

(1) 16.00 (2) 1.80
(3) 5.33 (4) 10.67

15. In a double slit experiment, when a thin film of thickness t having refractive index μ is introduced in front of one of the slits, the maximum at the centre of the fringe pattern shifts by one fringe width. The value of t is (λ is the wavelength of the light used) :

(1) $\frac{\lambda}{2(\mu-1)}$ (2) $\frac{\lambda}{(2\mu-1)}$

(3) $\frac{2\lambda}{(\mu-1)}$ (4) $\frac{\lambda}{(\mu-1)}$

16. Calculate the limit of resolution of a telescope objective having a diameter of 200 cm, if it has to detect light of wavelength 500 nm coming from a star :-

(1) 305×10^{-9} radian
(2) 152.5×10^{-9} radian
(3) 610×10^{-9} radian
(4) 457.5×10^{-9} radian

17. Diameter of the objective lens of a telescope is 250 cm. For light of wavelength 600nm. coming from a distant object, the limit of resolution of the telescope is close to :-

(1) 1.5×10^{-7} rad (2) 2.0×10^{-7} rad
(3) 3.0×10^{-7} rad (4) 4.5×10^{-7} rad

18. The value of numerical aperature of the objective lens of a microscope is 1.25. If light of wavelength 5000 Å is used, the minimum separation between two points, to be seen as distinct, will be :

(1) 0.24 μm (2) 0.48 μm
(3) 0.12 μm (4) 0.38 μm

WORK, POWER & ENERGY

1. A force acts on a 2 kg object so that its position is given as a function of time as $x = 3t^2 + 5$. What is the work done by this force in first 5 seconds ?

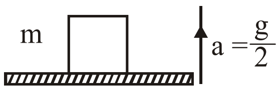
(1) 850 J (2) 900 J
(3) 950 J (4) 875 J

2. A particle which is experiencing a force, given by $\vec{F} = 3\vec{i} - 12\vec{j}$, undergoes a displacement of $\vec{d} = 4\vec{i}$. If the particle had a kinetic energy of 3 J at the beginning of the displacement, what is its kinetic energy at the end of the displacement ?

(1) 15 J (2) 10 J

(3) 12 J (4) 9 J

3. A block of mass m is kept on a platform which starts from rest with constant acceleration g/2 upward, as shown in fig. Work done bv normal reaction on block in time t is :



(1) 0 (2) $\frac{3mg^2t^2}{8}$

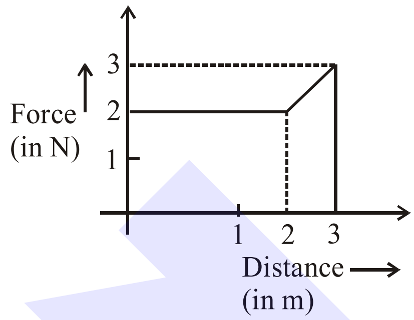
(3) $-\frac{mg^2t^2}{8}$ (4) $\frac{mg^2t^2}{8}$

4. A body of mass 1 kg falls freely from a height of 100 m on a platform of mass 3 kg which is mounted on a spring having spring constant k = 1.25 × 10^6 N/m. The body sticks to the platform and the spring's maximum compression is found to be x. Given that g = 10 ms^{-2}, the value of x will be close to :

(1) 4 cm (2) 8 cm

(3) 80 cm (4) 40 cm

5. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3m is :



(1) 6.5 J (2) 2.5 J

(3) 4 J (4) 5 J

6. A uniform cable of mass 'M' and length 'L' is placed on a horizontal surface such that its $\left(\frac{1}{n}\right)^{th}$ part is hanging below the edge of the surface. To lift the hanging part of the cable upto the surface, the work done should be :

(1) $\frac{MgL}{n^2}$ (2) $\frac{MgL}{2n^2}$

(3) $\frac{2MgL}{n^2}$ (4) nMgL

ANSWER KEY

CAPACITOR

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	Bonus	3	3	1	4	4	2	3	4	1
Que.	11	12	13	14	15	16	17	18		
Ans.	4	4	3	3	1	4	2	1		

CIRCULAR MOTION

Que.	1	2	3	4	5
Ans.	3	2	4	4	4

COM & COLLISION										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	1	3	3	1	4	3	1	2	3	2
Que.	**11**	**12**	**13**							
Ans.	3	3	1							

CURRENT ELECTRICITY										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	1	2	4	3	4	2	1	2	3
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	4	4	4	2	3	2	4	1	3
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	3	4	1	3	2	4	3	2	3	2
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	1	4	3	2	1	4	1	3	Bonus	4
Que.	**41**	**42**	**43**	**44**	**45**					
Ans.	2	2	4	3	1					

ELECTROSTATICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	3	4	3	3	4	2	2	3	2	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	2	3	1	3	4	3	3	1	4	4
Que.	**21**	**22**	**23**	**24**	**25**	**26**				
Ans.	1	1	2	3	1	4				

EMI & AC										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	4	4	1	3	2	2	3	1	4	3
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**		
Ans.	2	3	4	2	2	2	2	2		

EMW										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	3	3	1	2	4	3	2	2	4	3
Que.	**11**	**12**	**13**	**14**						
Ans.	4	2	3	3						

ERROR & MEASUREMEMNT							
Que.	**1**	**2**	**3**	**4**	**5**	**6**	
Ans.	2	1	3	4	2	Allen : (Bonus) NTA : (2)	

FLUIDS MECHANICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	Bonus	4	2	2	3	Bonus	3	3	3
Que.	**11**	**12**	**13**	**14**	**15**					
Ans.	3	2	2	3	4					

GEOMETRICAL OPTICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	4	1	3	2	4	2	3	1	3	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	2	Allen : (Bonus) NTA : (2)	Allen : (1) or (2) NTA : (2)	2	4	4	4	4	1
Que.	**21**	**22**								
Ans.	2	1								

GRAVITATION										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	3	3	4	2	2	1	3	2	3	2
Que.	**11**	**12**	**13**	**14**	**15**	**16**				
Ans.	3	4	2	2	4	2				

HEAT & THERMODYNAMICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	1	3	4	4	3	4	4	2	4	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	1	2	1	2	1	2	2	3	2	2
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	1	4	4	3	4	3	3	1	4	3
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	Allen : (Bonus) NTA : (3)	4	4	2	3	2	2	1	1	Allen : (Bonus) NTA : (2)
Que.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
Ans.	3	1	Allen : (3) NTA : (4)	3	2	3	4	1	2	3
Que.	**51**	**52**	**53**							
Ans.	3	2	4							

KINEMATICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	3	4	2	2	4	1	4	3	4	4
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**			
Ans.	4	1	2	2	2	1	3			

MEC

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	1	2	3	2	4	2	1	3	1
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	Bonus	4	4	1	3	2	1	4	1	4
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	1	2	1	4	2	2	1	2	3	4
Que.	31	32	33							
Ans.	1	2	3							

MODERN PHYSICS

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	1	1	1	3	4	3	3	3	2
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	Bonus	4	1	3	4	2	1	2
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	4	2	4	3	4	2	1	3	1	3
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	3	3	3	1	2	4	3	1	3	1

NLM & FRICTION

Que.	1	2	3	4	5	6	7	8	9	
Ans.	2	1	1	2	4	1	2	3	2	

POC

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	2	4	4	3	2	1	3	3	2
Que.	11	12	13	14						
Ans.	4	4	1	4						

ROTATIONAL MECHANICS

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	2	3	3	1	3	2	2	1	4
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	4	2	2	3	1	3	4	1	4	2
Que.	21	22	23	24	25	26	27	28	29	
Ans.	4	2	4	4	3	4	2	4	2	

SEMICONDUCTOR										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	3	2	4	4	2	4	2	2	3	3
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**			
Ans.	1	4	2	4	2	1	3			

SHM										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	3	3	4	4	1	2	3	4	1
Que.	**11**									
Ans.	1									

UNIT & DIMENSION									
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Ans.	4	4	2	2	3	2	2	3	

VECTOR					
Que.	**1**	**2**	**3**	**4**	
Ans.	4	3	2	3	

WAVE MOTION										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	4	2	1	1	2	2	2	1	1	3
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	4	4	3	2	3	2	3	1	3	3
Que.	**21**									
Ans.	2									

WAVE OPTICS										
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Ans.	2	4	2	4	3	2	1	2	1	1
Que.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**		
Ans.	Allen : (Bonus) NTA : (4)	2	4	4	4	1	3	1		

WORK, POWER & ENERGY							
Que.	**1**	**2**	**3**	**4**	**5**	**6**	
Ans.	2	1	2	Bonus	1	2	

IMPORTANT NOTES