KCET PYQ 2024
PHYSICS

Q1 The ratio of molar specific heats of oxygen is [KCET 2024]

(A) 1.4 (B) 1.67
(C) 1.33 (D) 1.28

Q2 For a particle executing simple harmonic motion (SHM), at its mean position [KCET 2024]

(A) Velocity is zero and acceleration is maximum.
(B) Velocity is maximum and acceleration is zero.
(C) Both velocity and acceleration are maximum.
(D) Both velocity and acceleration are zero

Q3 A motor-cyclist moving towards a huge cliff with a speed of $18 kmh^{-1}$, blows a horn of source frequency 325 Hz. If the speed of the sound in air is $330 ms^{-1}$, the number of beats heard by him is

(A) 5 (B) 4
(C) 10 (D) 7

Q4 A body has a charge of $-3.2\ \mu C$. The number of excess electrons will be

(A) 5.12×10^{25}
(B) 5×10^{12}
(C) 2×10^{13}
(D) 5.12×10^{13}

Q5 A point charge A of +10μC and another point charge B of +20μC are kept 1 m apart in free space. The electrostatic force on A due to B is F_1 and the electrostatic force on B due to A is F_2. Then [KCET 2024]

(A) $F_1 = -2F_2$ (B) $F_1 = -F_2$
(C) $2F_1 = -F_2$ (D) $F_1 = F_2$

Q6 A uniform electric field $E = 3 \times 10^5 NC^{-1}$ is acting along the positive Y-axis. The electric flux through a rectangle of area 10 cm x 30 cm whose plane is parallel to the ZX-plane is [KCET 2024]

(A) 12×10^3 Vm
(B) 9×10^3 Vm
(C) 15×10^3 Vm
(D) 18×10^3 Vm

Q7 The total electric flux through a closed spherical surface of radius r enclosing an electric dipole of dipole moment $2aq$ is (Give ε_0 =permittivity of free space) [KCET 2024]

(A) Zero
(B) $\frac{q}{\varepsilon_o}$
(C) $\frac{2q}{\varepsilon_o}$
(D) $\frac{8\pi r^2 q}{\varepsilon_o}$

Q8 Under electrostatic condition of a charged conductor, which among the following statements is true? [KCET 2024]

(A) The electric field on the suriacie of a charged conductor is where o is the surface charge density.
(B) The electric potential inside a charged conductor is always zero.
(C) Any excess charge resides on the surface of the conductor.
(D) The net electric filed is tangential to the surface of the conductor

Q9 A cube of side 1 cm contains 100 molecules each having an induced dipole moment of 0.2 × 10^{-6} C–m electric field of $4NC^{-1}$. The electric susceptibility of the materials is ____ $C^2N^{-1}m^{-2}$ [KCET 2024]

(A) 50 (B) 5

(C) 0.5 (D) 0.05

Q10 A capacitor of capacitance 5μ F is charged by a battery of emf 10 V. At an instant of time, the potential difference across the capacitors is 4 V and the time rate of change of potential difference across the capacitor is $0.6Vs^{-1}$. Then, the time rate at which energy is stored the capacitor at > instant is

(A) $12\mu W$ (B) $3\mu W$

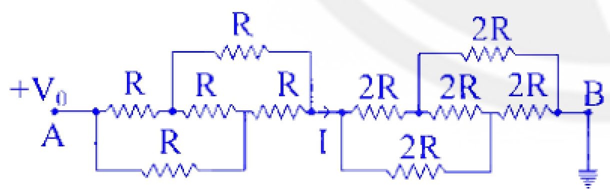
(C) Zero (D) $30\mu W$

Q11 *E* is the electric field inside a conductor whose material has conductivity σ and resistivity ρ. The current density inside the conductor is *J*. The correct form of Ohm's law is

(A) $E=\sigma J$ (B) $J=\rho E$

(C) $E=\rho J$ (D) $E.\rho=\rho$

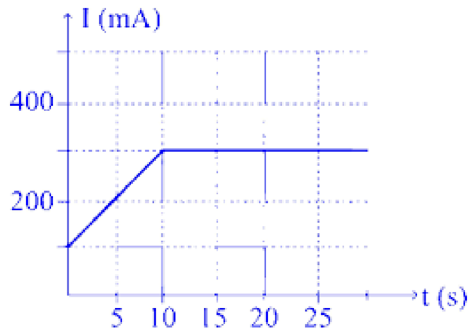
Q12 In the circuit shown, the end *A* is at potential V_0 and end *B* is grounded. The electric current *I* indicated in the circuit is



(A) V_o/R (B) $2V_o/R$

(C) $3V_o/R$ (D) $V_o/3R$

Q13 The electric current flowing through a given conductor varies with time as shown in the graph below. The number of free electrons which flow through a given cross-section of the conductor in the time interval $0 \le t \le 20s$ is [KCET 2024]



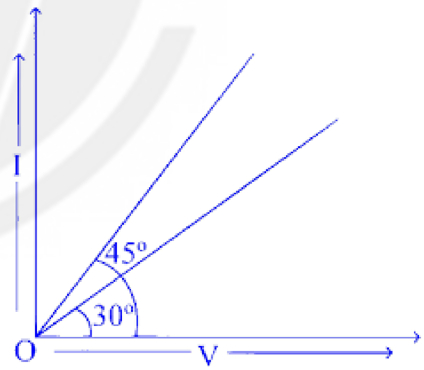
(A) 3.125 × 10^{19}

(B) 1.6 × 10^{19}

(C) 6.25 × 10^{18}

(D) 1.625 × 10^{18}

Q14 The IV graph for a conductor at two different temperatures 100°C and 400°C is as shown in the figure. The temperature coefficient of resistance of the conductor is about (in per degree Celsius).



(A) 3×10^{-3}

(B) 2×10^{-3}

(C) 9×10^{-3}

(D) 12×10^{-3}

Q15 An electric blub of 60 W, 120 V is to be connected to 220 V source. What resistance should be connected in series with the bulb, so that the bulb glows properly?

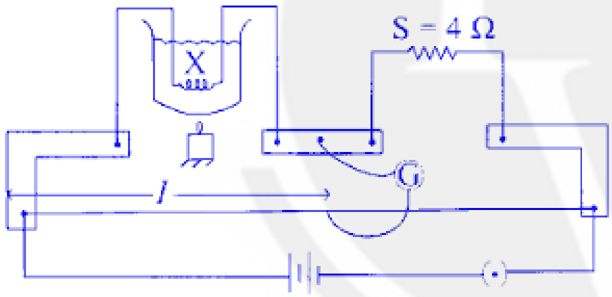
(A) $50\,\Omega$

(B) $100\ \Omega$

(C) $200\ \Omega$

(D) $288\ \Omega$

Q16 In an experiment to determine the temperature coefficient of resistance of a conductor, a coil of wire X is immersed in a liquid. It is heated by an external agent. A meter bridge set up is used to determine resistance of the coil X at different temperatures. The balancing points measured at temperatures $t_1 = 0°C$ and $t_2 = 100°C$ are 50 cm and 60 cm respectively. If the standard resistance taken out is $S = 4\Omega$ in both trials, the temperature coefficient of the coil is [KCET 2024]



(A) $0.05°C^{-1}$

(B) $0.02°C^{-1}$

(C) $0.005°C^{-1}$

(D) $2.0°C^{-1}$

Q17 A moving electron produces [KCET 2024]

(A) only electric filed both

(B) electric and magnetic-field

(C) only magnetic field

(D) neither electric nor magnetic field

Q18 A coil having 9 turns carrying a current produces magnetic field B_1 at the centre. Now the coil is rewounded into 3 turns carrying same current. Then, the magnetic field at the centre B_2 = [KCET 2024]

(A) $B_1/9$ (B) $9B_1$

(C) $3B_1$ (D) $B_1/3$

Q19 A particle of specific charge $q/m = \pi C kg^{-1}$ is projected the origin towards positive X-axis with the velocity 10 ms^{-1} uniform magnetic field $B = 2\hat{k}T$. The velocity v of particle after time t = 1/12 s will be (in ms^{-1}) [KCET 2024]

(A) $5(\hat{i} + \hat{j})$ (B) $5\left(\hat{i} + \sqrt{3}\hat{j}\right)$

(C) $5\left(\sqrt{3}\hat{i} + \hat{j}\right)$ (D) $5\left(\sqrt{3}\hat{i} - \hat{j}\right)$

Q20 The magnetic field at the centre of a circular coil of radius R carrying current I is 64 times the magnetic field at a distance x on its axis from the centre of the coil. Then, the value of X is

(A) $\frac{R}{4}\sqrt{15}$ (B) $R\sqrt{3}$

(C) $\frac{R}{4}$ (D) $R\sqrt{15}$

Q21 Magnetic hysterisis is exhibited by .... magnetic materials [KCET 2024]

(A) Only para

(B) Only dia

(C) Only ferro

(D) Both para and ferro

Q22 Magnetic susceptibility of Mg at 300 K is 1.2×10^{-5}. What is its susceptibility at 200

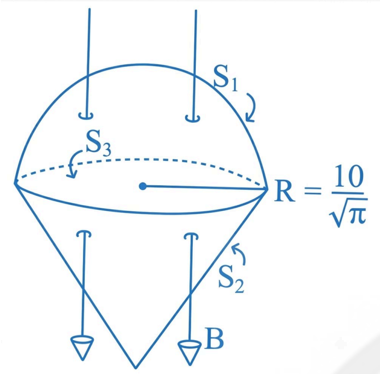
(A) 18×10^{-5}

(B) 180×10^{-5}

(C) 1.8×10^{-5}

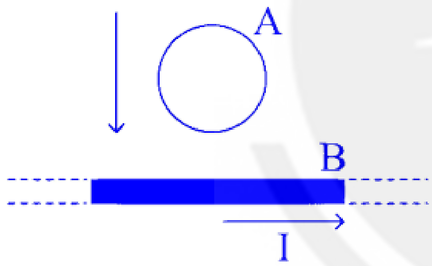
(D) 0.18×10^{-5}

Q23 A uniform magnetic field of strength $B = 2mT$ exists vertically downwards. These magnetic field lines pass through a closed surface as shown in the figure. The closed surface consists of a hemisphere S_1, a right circular cone S_2 and a circular surface S_3. The magnetic flux through S_1 and S_2 are respectively



(A) $\Phi_{S_1} = -20\mu Wb, \Phi_2 S_1 = +20\mu Wb$
(B) $\Phi_{S_1} = +20\mu Wb, \Phi_{S_2} = -20\mu Wb$
(C) $\Phi_{S_1} = -40\mu Wb, \Phi_{S_2} = +40\mu Wb$
(D) $\Phi_{S_1} = +40\mu Wb, \Phi_{S_2} = -40\mu Wb$

Q24

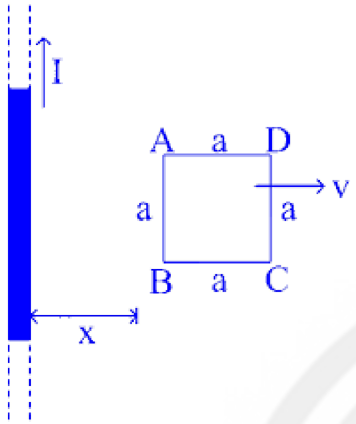


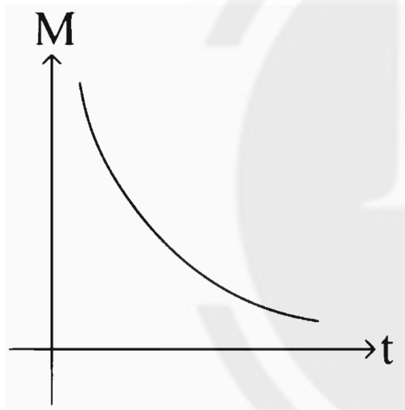
In the figure, a conducting ring of certain resistance is falling towards a current carrying straight long conductor. The ring and conductor are in the same plane. Then, the
(A) induced electric current is zero
(B) induced electric current is anti-clockwise
(C) induced electric current is clockwise
(D) ring will come to rest

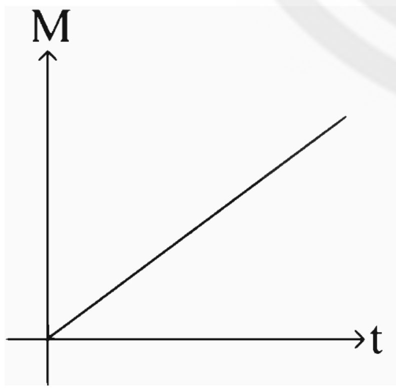
Q25 An induced current of 2 A flows through a coil. The resistance of the coil is 10Ω. What is the change in magnetic flux associated with the coil in 1 ms ? [KCET 2024]

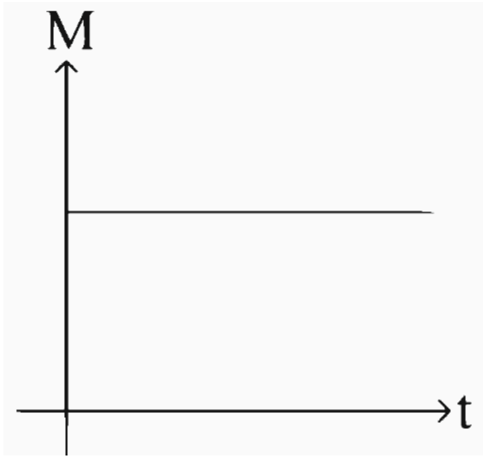
(A) 0.2×10^{-2} Wb
(B) 2×10^{-2} Wb
(C) 22×10^{-2} Wb
(D) 0.22×10^{-2} Wb

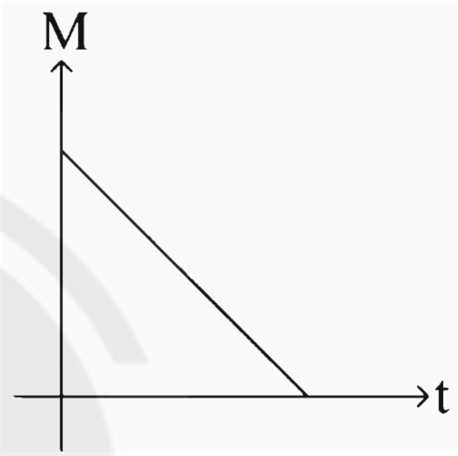
Q26 A square loop of side length a is moving away from an infinitely long current carrying conductor at a constant speed v as shown. Let x be the instantaneous distance between the long conductor and side AB. The mutual inductance M of the square loop-long conductor pair changes with time t according to which of the following graphs? [KCET 2024]



(A)


(B)


(C)


(D)


Q27 Which of the following combinations should be selected for better tuning of an L - C - R circuit used for communication ?

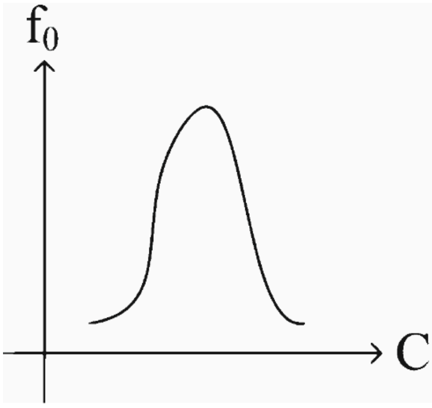
(A) $R = 20\Omega L = 1.5H, C = 35\mu F$

(B) $R = 25\Omega L = 2.5H, C = 45\mu F$

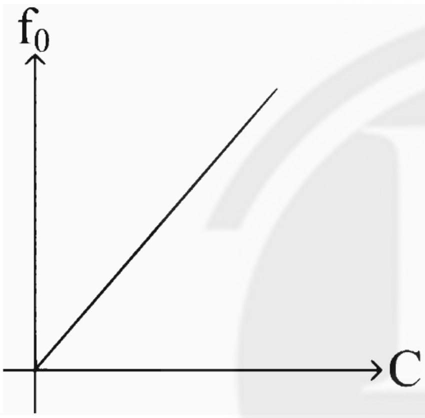
(C) $R = 25\Omega L = 1.5H, C = 45\mu F$

(D) $R = 15\Omega L = 3.5, H = 30\mu F$

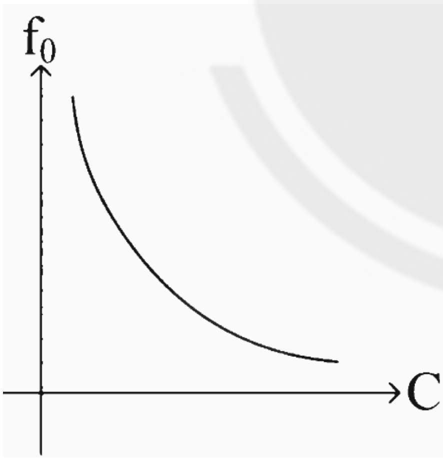
Q28 In an L–C–R series circuit, the value of only capacitance C is varied. The resulting variation of resonance frequency fo as a function of C can be represented as



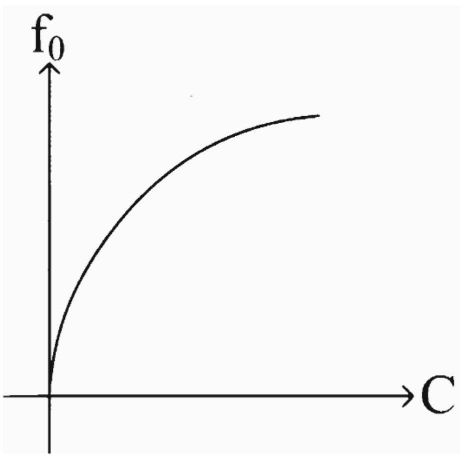
(A)



(B)

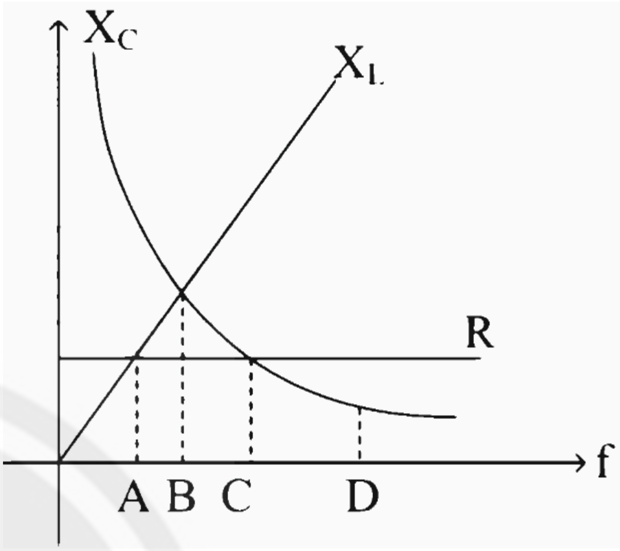


(C)



(D)

Q29 The figure shows variation of R, XL and X with frequency f in a series LCR circuit. Then, for what frequency point is the circuit capacitive? [KCET 2024]



(A) B (B) D
(C) A (D) C

Q30 Electromagnetic waves are incident normally on a perfectly reflecting surface having surface area A. If I is the intensity of the incident electromagnetic radiation and c is the speed of light in vacuum, the force exerted by the electromagnetic wave on the reflecting surface is

(A) 2I A/c (B) LA /C
(C) IA/2c (D) I/2Ac

Q31 The final image formed by an astronomical telescope is [KCET 2024]

(A) real, erect and diminished
(B) virtual, inverted and diminished
(C) real, inverted and magnified
(D) virtual, inverted and magnified

Q32 If the angle of minimum deviation is equal to angle of a prism for an equilateral prism, then the speed of light inside the prism is [KCET 2024]

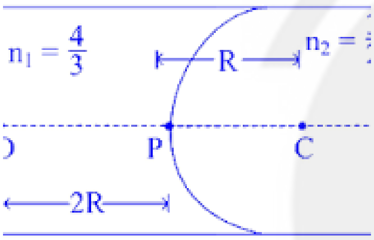
(A) $3 \times 10^8 ms^{-1}$

(B) $2\sqrt{3} \times 10^8 ms^{-1}$

(C) $\sqrt{3} \times 10^8 ms^{-1}$

(D) $\frac{\sqrt{3}}{2} \times 10^8 ms^{-1}$

Q33 A luminous point object *O* is placed at a distance 2*R* from the spherical boundary separating two transparent media of refractive indices n_1 and as shown, where R is the radius of curvature of the n_2 spherical surface. If $n_1 = \frac{4}{3}, n_2 = \frac{3}{2}$ $and\ R = 10cm$ the image is obtained at a distance from *P* equal to



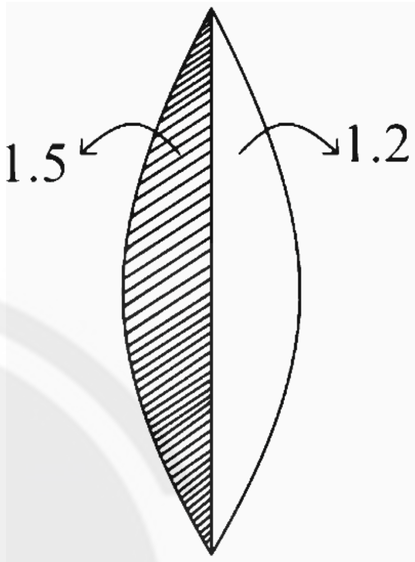
(A) 30 cm in the rarer medium

(B) 30 cm in the denser medium

(C) 18 cm in the rarer medium

(D) 18 cm in the denser medium

Q34 An equiconvex lens of radius of curvature 14 cm is made up of two different materials. Left half and right half of vertical portion is made up of material of refractive index 1.5 and 1.2 respectively as shown in the figure. If a point object is placed at a distance of 40 cm , calculate the image distance.



(A) 25 cm (B) 50 cm

(C) 35 cm (D) 40 cm

Q35 A galaxy is moving away from the Earth so that a spectral line at 600 nm is observed at 601 nm . Then, the speed of the galaxy with respect to the Earth is [KCET2024]

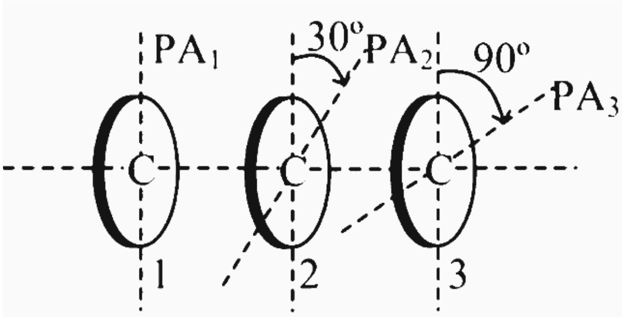
(A) 500 km s^{-1}

(B) 200 km s^{-1}

(C) 50 km s^{-1}

(D) 20 km s^{-1}

Q36



Three polaroid sheets are co-axially placed as indicated in the diagram. Pass axes of the polaroids 2 and 3 make 30 deg and 90 deg with pass axis of polaroid sheet 1. If I_0 is the intensity of the incident unpolarised light entering sheet 1, the intensity of the emergent light through sheet 3 is [KCET 2024]

(A) Zero
(B) $\frac{3I_o}{32}$
(C) $\frac{3I_o}{8}$
(D) $\frac{3I_o}{16}$

Q37 In Young's double slit experiment, an electron beam is used to produce interference fringes of width β_1 Now the electron beam is replaced by a beam of protons with the same experimental set-up and same speed. The fringe width obtained is β_2 The correct relation between β_1 and β_2 is [KCET 2024]

(A) $\beta_1 = \beta_2$
(B) No fringes are formed
(C) $\beta_1 < \beta_2$
(D) $\beta_1 > \beta_2$

Q38 Light of energy *E* falls normally on a metal of work function E/3. The kinetic energies *K* of the photo electrons are

(A) $K = \frac{2E}{3}$
(B) $K = \frac{E}{3}$
(C) $0 \leq K \leq \frac{2E}{3}$
(D) $0 \leq K \leq \frac{E}{3}$

Q39 The photoelectric work function for photo metal is 2.4 eV . Among the four wavelengths, the wavelength of light for which photoemission does not take place is [KCET 2024}]

(A) 200 nm
(B) 300 nm
(C) 700 nm
(D) 400 nm

Q40 In alpha particle scattering experiment, if *v* is the initial velocity of the particle, then the distance of closest approach is *d*. If the velocity is doubled, then the distance of closest approach becomes [KCET 2024]

(A) 4 d
(B) 2 d
(C) d/2
(D) d/4

Q41 The ratio of area of first excited state to ground state of orbit of hydrogen atom is [KCET 2024]

(A) 1 : 16
(B) 1 : 4
(C) 4 : 1
(D) 16 : 1

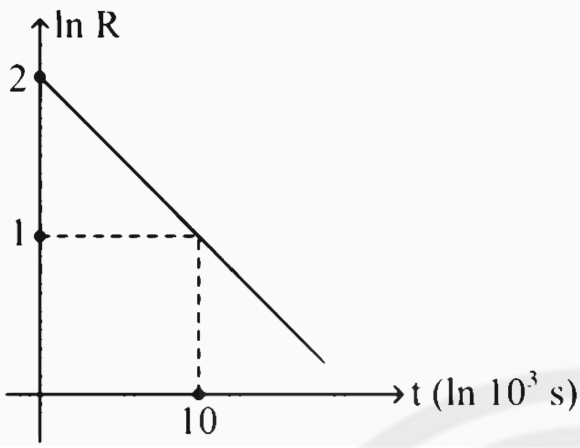
Q42 The ratio of volume of Al^{27} nucleus to its surface area is (Given, $R_o = 1.2 \times 10^{-15} m$)

(A) 2.1×10^{-15} m
(B) 1.3×10^{-15} m
(C) 0.22×10^{-15} m
(D) 1.2×10^{-15} m

Q43 Consider the nuclear fission reaction ${}_0^1n + {}_{92}^{235}U \rightarrow {}_{56}^{144}Ba + {}_{36}^{89}Kr + 3{}_0^1n.$
Assuming all the kinetic energy is carried away by the fast neutrons only and total binding energies of ${}_{92}^{235}U, {}_{56}^{144}Ba$ and ${}_{36}^{89}Kr$ to be $18000MeV$, $1200MeV$ respectively, the average kinetic energy carried by each fast neutron is (in MeV) [KCET 2024]

(A) 200
(B) 180
(C) 67
(D) 60

Q44 The natural logarithm of the activity R of a radioactive sample varies with time t as shown. At t = 0, there are No undecayed nuclei. Then, No is equal to [Take e^2 = 7.5] [KCET 2024]

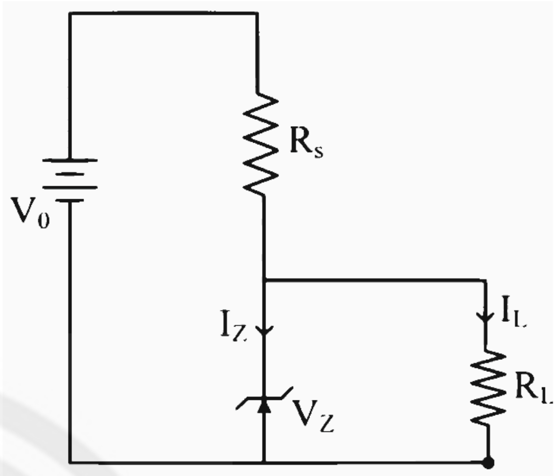


(A) 7500 (B) 3500
(C) 75000 (D) 150000

Q45 Depletion region in an unbiased semiconductor diode is a region consisting of [KCET 2024]
(A) both free electrons and holes
(B) neither free electrons nor holes
(C) only free electrons
(D) only holes

Q46 The upper level of valence band and lower level of conduction band overlap in the case of [KCET 2024]
(A) Silicon (B) Copper
(C) Carbon (D) germanium

Q47 In the diagram shown, the Zener diode has a reverse breakdown voltage of V_Z. The current through the load resistance R_L is I_L. The current through the Zener diode is [KCET 2024]



(A) $\frac{v_0-V_z}{R_s}$
(B) $\frac{v_0-V_z}{R_L}$
(C) $\frac{V_z}{R_L}$
(D) $\left(\frac{V_o-V_z}{R_S}\right)= I_L$

Q48 A $p-n$ junction diode is connected to a battery of emf 5.7 V in series with a resistant $5k\Omega$ such that it is forward biased. If the barrier potential of the diode is 0.7 V , neglecting the diode resistance, the current in the circuit is
(A) 1.14 mA (B) 1 mA
(C) 1 A (D) 1.14 A

Q49 An athlete runs along a circular track of diameter 80 m . The distance travelled and the magnitude of displacement of the athlete when he covers 3/4 th of the circle is (in m) [KCET 2024]
(A) $60\pi, 40\sqrt{2}$ (B) $40\pi, 60\sqrt{2}$
(C) $120\pi, 80\sqrt{2}$ (D) $80\pi, 120\sqrt{2}$

Q50 Among the given pair of vectors, the resultant of two vectors can never be 3 units. The vectors are [KCET 2024]

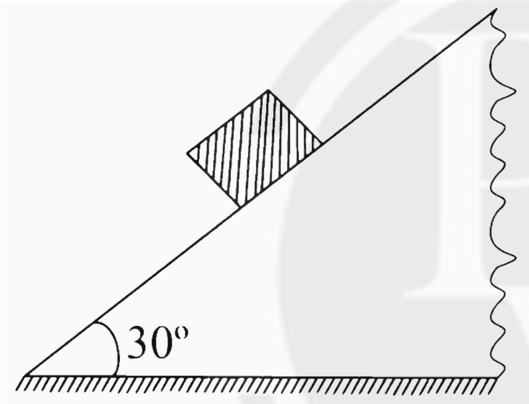
(A) 1 unit and 2 units

(B) 3 units and 6 units

(C) 2 units and 5 units

(D) 4 units and 8 units

Q51 A block of certain mass is placed on a rough inclined plane. The angle between the plane and the horizontal is 30° The coefficients of static and kinetic frictions between the block and the inclined plane are 0.6 and 0.5 respectively. Then, the magnitude of the acceleration of the block is [Take g = 10 ms^{-2}]



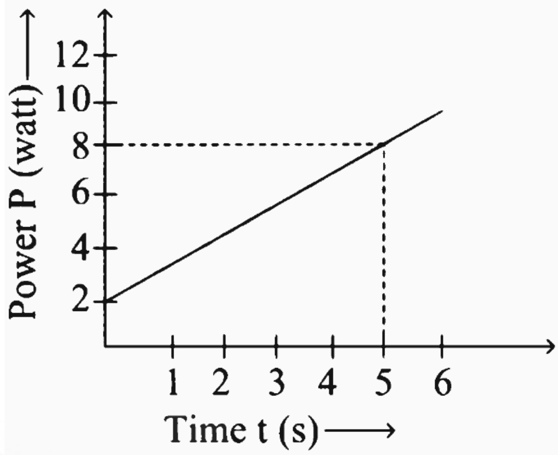
(A) 2 ms^{-2}

(B) Zero

(C) 0.196 ms^{-2}

(D) 0.67 ms^{-2}

Q52 A particle of mass 500 g is at rest. It is free to move along a straight line. The power delivered to the particle varies with time according to the following graph [KCET 2024]



The momentum of the particle at t = 5 s is

(A) $2\sqrt{5} N-s$ (B) $5\sqrt{2} N-s$

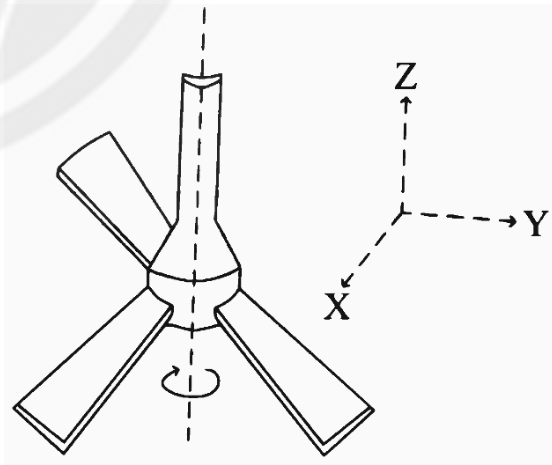
(C) $5 N-s$ (D) $5.5 N-s$

Q53 Dimensional formula for activity of a radioactive substance is [KCET 2024]

(A) $\left[M^0 L^1 T^{-1}\right]$ (B) $\left[M^0 L^{-1} T^0\right]$

(C) $\left[M^0 L^0 T^{-1}\right]$ (D) $\left[M^{-1} L^0 T^0\right]$

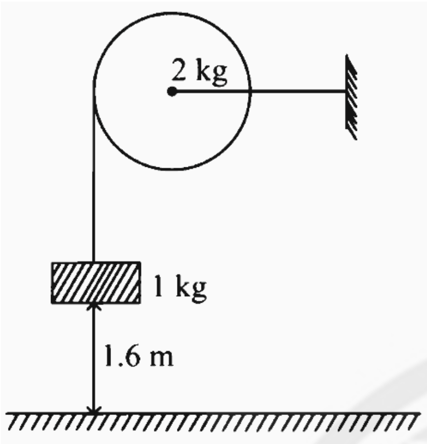
Q54 A ceiling fan is rotating around a fixed axle as shown. The direction of angular velocity is along .... [KCET 2024]



(A) $+\hat{j}$ (B) $-\hat{j}$

(C) $+\hat{k}$ (D) $-\hat{k}$

Q55 A body of mass 1 kg is suspended by a weightless string which passes over a frictionless pulley of mass 2 kg as shown in the figure. The mass is released from a height of 1.6 m from the ground. With what velocity does it strike the ground?



(A) 16 ms^{-1}

(B) 8 ms^{-1}

(C) $4\sqrt{2}ms^{-1}$

(D) $4\,ms^{-1}$

Q56 What is the value of acceleration due to gravity at a height equal to half the radius of the Earth, from its surface ? [KCET 2024]

(A) 4.4 ms^{-2}

(B) 6.5 ms^{-2}

(C) Zero

(D) 9.8 ms^{-2}

Q57 A thick metal wire of density ρ and length L is hung from a rigid support. The increase in length of the wire due to its own weight is (Y = Young's modulus of the material of the wire)

(A) $\frac{\rho g L}{Y}$ (B) $\frac{1}{2}\frac{\rho g L^2}{Y}$

(C) $\frac{\rho g L^2}{Y}$ (D) $\frac{1}{4Y}\rho g L^2$

Q58 Water flows through a horizontal pipe of varying cross-section at a rate of $0.31\ m^3\ s^{-1}$. The velocity of water at a point where the radius of the pipe is 10 cm is

(A) 0.1 ms^{-1} (B) 1 ms^{-1}

(C) 10 ms^{-1} (D) 100 ms^{-1}

Q59 A solid cube of mass m at a temperature θ_0 is heated at a constant rate. It becomes liquid at temperature θ_1 and vapour at temperature θ_2. Let s_1 and s_2 be specific heats in its solid and liquid states respectively. If L_f and L_v are latent heats of fusion and vaporisation respectively, then the minimum heat energy supplied to the cube until it vaporises is

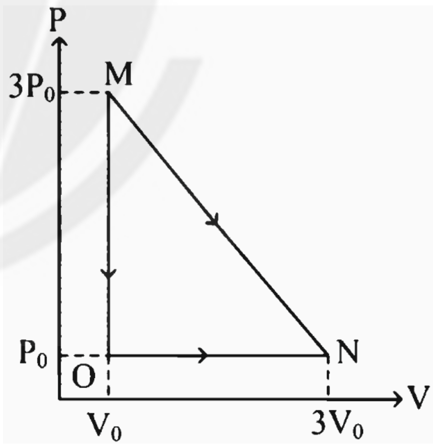
(A) $ms_1(\theta_1-\theta_0)+ms_2(\theta_2-\theta_1)$

(B) $mL_f+ms_2(\theta_2-\theta_1)+mL_v$

(C) $ms_1(\theta_1-\theta_2)+mL_f+ms_2(\theta_2-\theta_1)+mL_v$

(D) $ms_1(\theta_1-\theta_0)+mL_f+ms_2(\theta_2-\theta_0)+mL_v$

Q60 One mole of an ideal monoatomic gas is taken round the cyclic process MNOM. The work done by the gas is



(A) $4.5p_0V_o$ (B) $4p_0V_o$

(C) $9p_0V_o$ (D) $2p_0V_o$

Answer Key

Q1	A
Q2	B
Q3	C
Q4	C
Q5	B
Q6	B
Q7	A
Q8	C
Q9	B
Q10	A
Q11	C
Q12	D
Q13	A
Q14	B
Q15	C
Q16	C
Q17	B
Q18	A
Q19	D
Q20	D
Q21	C
Q22	C
Q23	A
Q24	C
Q25	B
Q26	C
Q27	D
Q28	C
Q29	C
Q30	A
Q31	D
Q32	C
Q33	A
Q34	D
Q35	A
Q36	B
Q37	D
Q38	C
Q39	C
Q40	D
Q41	A
Q42	D
Q43	D
Q44	C
Q45	B
Q46	B
Q47	D
Q48	B
Q49	A
Q50	D
Q51	B
Q52	C
Q53	C
Q54	D
Q55	D
Q56	A
Q57	B
Q58	C
Q59	C
Q60	D

Vernacular

Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Text Solution:

The ratio of molar specific heats $\left(C_p \text{ and } C_V\right) is$

$\gamma = 1 + \frac{2}{f}$

For O_2

$f = 5$

$\therefore \quad \gamma = 1 + \frac{2}{5} = 1 + 0.4 = 1.4$

Q2 Text Solution:

We know that velocity v and acceleration of a particle in SHM.

$v = \omega\sqrt{A^2 - y^2} \text{ and } a = -\omega^2 y$

$\therefore$ At mean position, $y = 0$

$\therefore \quad v = \omega\sqrt{A^2 - 0}$

$\Rightarrow \quad v_{\max} = \omega A \text{ and } a = 0$

Q3 Text Solution:

find the number of beats heard by the motor-cyclist:

Convert the speed of the motor-cyclist:

The speed given is 18 km/h.

Convert km/h to m/s:

$v_s = v_0 = 18 \times \frac{5}{18} m/s = 5 m/s$, this is speed of observer as well speed of source.

Determine the properties given:

Frequency of the source, f = 325Hz

Speed of sound in air, v = 330m / s

Motor cyclist hears two frequencies ,

Direct sound from the horn f_1 = 325 Hz,

Reflected sound from the cliff f_2

$f_2 = f\left[\frac{v+v_o}{v-v_s}\right] = 325\left[\frac{330+5}{330-5}\right] = 335\ Hz$

$beat\ frequency\ n = f_2 - f_1 = 335 - 325 = 10$

Q4 Text Solution:

Charge on body, $q = -3.2\mu C = -3.2 \times 10^{-6} C$

Number of excess eletrons

$n = \frac{q}{e} = \frac{-3.2\times10^{-6}}{-1.6\times10^{-19}}$

$= 2 \times 10^{13}$

Q5 Text Solution:

Electrostatic force on each charges placed at certain distance is equal in magnitude but opposite in direction.

Q6 Text Solution:

Given, $\mathbf{E} = 3 \times 10^5 \hat{\mathbf{j}}\ \mathrm{NC}^{-1}$

$A = 10\mathrm{cm} \times 30\mathrm{cm} = 3 \times 10^{-2}\mathrm{m}^2$

$\therefore \quad \mathbf{A} = 3 \times 10^{-2}\hat{\mathbf{j}}\mathrm{m}^2 \quad (\text{For ZX-plane})$

$\therefore$ Electric flux, $\phi = \mathbf{E} \cdot \mathbf{A}$

$= 3 \times 10^5\hat{\mathbf{j}} \times 3 \times 10^{-2}\hat{\mathbf{j}}$

$= 9 \times 10^3\ \mathrm{V - m}$

Q7 Text Solution:

The total electric flux through a closed surface is given by Gauss's Law, which states that:

$\Phi = \frac{Q_{\text{enc}}}{\varepsilon_0}$

Where Φ is the electric flux, Q_{enc} is the total charge enclosed by the surface, and ε_o is the permittivity of free space.

In the case of an electric dipole, the dipole consists of two equal and opposite charges separated by some distance. Therefore, the net charge Q_{enc} enclosed by the spherical surface is zero, because the positive and negative charges cancel each other out.

Thus, the total electric flux through the closed spherical surface enclosing an electric dipole is:

$\Phi = \frac{0}{\varepsilon_0} = 0$

Therefore, the correct option is:

Q8 Text Solution:

Since, there is no electric field inside the conductor, hence according to Coulomb's law, the mutual repulsion of like charges demands that the charges be as for apart as possible. Hence, on the surface of the conductor, the net electric charge resides entirely on its surface. Electric field on the surface of a charged conductor is σ/ε_o Electric potential inside a charged conductor is constant (non-zero). The net electric field lines is perpendicular to the surface of the conductor.

Q9 Text Solution:

Induced dipole moment, $p = 0.2 \times 10^{-5}\mathrm{C}$

Number of molecuels, n = 100 molecule/ cm^3

$= 100 \times 10^6 \mathrm{molecule/m}^3$

$E = 4\mathrm{N/C}$

Electric susceptibility

$$\chi_e = \frac{p}{E} \times n = \frac{0.2\times10^{-6}\times100\times10^6}{4}$$

$$= 5\mathrm{C}^2\mathrm{N}^{-1}\mathrm{m}^{-2}$$

Q10 Text Solution:

Given, battery emf, $e = 10\mathrm{V}$

$C = 5\mu\mathrm{F} = 5 \times 10^{-6}\mathrm{F}.$

We know that stored energy,

$$U = \frac{1}{2}CV^2$$

$$\therefore \quad \frac{dU}{dt} = \frac{1}{2}C \cdot 2V\frac{dV}{dt} = CV\frac{dV}{dt}$$

$$= 5 \times 10^{-6} \times 4 \times 0.6$$

$$= 12 \times 10^{-6}\mathrm{W} = 12\mu\mathrm{W}$$

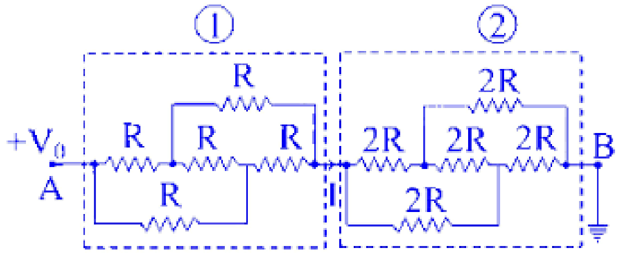
Q11 Text Solution:

We know that, $V = IR$(Ohm's law)

$$\Rightarrow \quad V = I \cdot \rho \cdot \frac{l}{A} \Rightarrow \frac{V}{l} = \frac{I}{A} \cdot \rho$$

$$\Rightarrow \quad E = J\rho \Rightarrow E = \rho J$$

Q12 Text Solution:



1st and 2nd networks form balanced Wheatstone bridge.

Hence, circuit diagram can be redrawn as

$$\therefore R_{AB} = 2R \| 2R + 4R \| 4R$$

$$= \frac{2R\times2R}{2R+2R} + \frac{4R\times4R}{4R+4R} = R + 2R = 3R$$

$$\therefore \quad I = \frac{V_0}{R_{AB}} = \frac{V_0}{3R}$$

Q13 Text Solution:

Total charge flowing the cross-section of the conductor is equal to area under I - t graph.

$$\therefore Q = \frac{(100+300)}{2} 10 \times 10^{-3} + \left(20 - 10\right) \times 300 \times 10^{-3}$$

$$= 1 + 3 = 4\mathrm{C}$$

Since, $Q = ne$

$$\therefore \quad n = \frac{Q}{e} = \frac{4}{1.6\times10^{-19}} = 3.125 \times 10^{19}$$

Q14 Text Solution:

$at\ temperature\ t_1\ ,\ R1 = \frac{1}{\tan\ 45^o} = 1\Omega$

$at\ temperatue\ t_2\ ,\ R_2 = \frac{1}{\tan\ 30^o} = \sqrt{3}\Omega$

$we\ have\ \alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)} = \frac{1.732-1}{1(400-100)} = 2$

$.4\ x\ 10^{-3}\ /c^o$

Q15 Text Solution:

Resistance of the bulb,

$$R = \frac{V^2}{P} = \frac{120\times120}{60} = 240\Omega$$

$$\therefore \quad I = \frac{P}{V} = \frac{60}{120} = 0.5\ \mathrm{A}$$

Since, bulb is connected with 220 V supply.

$\therefore$ Resistance required,

$$R' = \frac{V}{I} = \frac{220}{0.5} = 440\Omega$$

Thus, for the bulb to glow properly required resistance in series

$= R' - R$
$= 440 - 240 = 200\Omega$

Q16 Text Solution:

Standard resistance $S = 4\Omega$

At $t_1 = 0^{\circ}\mathrm{C}, l_1 = 50\,\mathrm{cm}$

$\therefore R_1 = \frac{l_1}{100-l} \times S = \frac{50}{100-50} \times 4 = 4\Omega$

$t_2 = 100^{\circ}, l_2 = 60\,\mathrm{cm}$

$\therefore R_2 = \frac{l_2}{100-l_2} \times S = \frac{60}{100-60} \times 4 = 6\Omega$

Temperture coefficient of the coil,

$\alpha = \frac{R_2-R_1}{R_1 t_2 - R_2 t_1} = \frac{6-4}{4\times100-6\times0} = \frac{1}{200}$

$= 0.005^{\circ}\mathrm{C}^{-1}$

Q17 Text Solution:

A moving electron produces electric field and magnetic field both, while static charge produces only electric field.

Q18 Text Solution:

Case - I

Number of turns$N_1 = 9$

$\therefore$

$\therefore B_1 = \frac{\mu_0 N_1 I}{2R} = \frac{9\mu_0 I}{2R}$

Case-II $N_2 = 3$

If radius of turns be R', then

$9 \times 2\pi R = 3 \times 2\pi R'$

$\Rightarrow \quad R' = 3R$

$\therefore \quad B_2 = \frac{\mu_0 N_2 I}{2R'} = \frac{\mu_0 \times 3 \times I}{2\times 3R} = \frac{\mu_0 I}{2R}$

$\therefore \quad \frac{B_2}{B_1} = \frac{\frac{\mu_0 I}{2R}}{\frac{9\mu_0 E}{2R}} = \frac{1}{9} \Rightarrow B_2 = \frac{B_1}{9}$

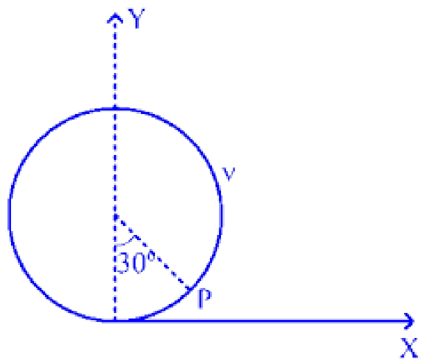
Q19 Text Solution:

We know that time period, $T = \frac{2\pi m}{qB} = \frac{2\pi}{\frac{q}{m}B} 1s$

Since, the particle will be at point *P* after time,

$t = \frac{1}{12}\,\mathrm{s} = \frac{T}{12}\,\mathrm{s}$

It will be deviated by an angle, $\theta = 2\pi/12 = 30^{\circ}$



Hence, velocity at point P,

$\mathbf{v} = 10\left(\cos 30^{\circ}\hat{\mathbf{i}} - \sin 30^{\circ}\hat{\mathbf{j}}\right)$

$= 10\left(\frac{\sqrt{3}}{2}\hat{\mathbf{i}} + \frac{1}{2}\hat{\mathbf{j}}\right) = 5\left(\sqrt{3}\hat{i} - \hat{\mathbf{j}}\right)$

Q20 Text Solution:

The magnetic field at the center of a circular coil with radius R carrying a current I is given by:

$B_{center} = \frac{\mu_o I}{2R}$

where μ_o is the permeability of free space.

The magnetic field at a distance x on the axis from the center of the coil is given by:

$B_x = \frac{\mu_o I R^2}{2\left(R^2+x^2\right)^{3/2}}$

According to the problem, the field at the center is 64 times the field at distance x:

$B_{center} = 64 B_x$

Substituting the expressions for B_{center} and B_x we get:

$\frac{\mu_0 I}{2R} = 64 \cdot \frac{\mu_0 I R^2}{2\left(R^2+x^2\right)^{3/2}}$

Simplifying, and cancelling out common terms, we have:

Rearranging gives:

$\frac{1}{R} = 64 \cdot \frac{R^2}{\left(R^2+x^2\right)^{3/2}}$

Taking the cube roots on both sides:

$\left(R^2 + x^2\right)^{3/2} = 64R^3$

Calculating the right-hand side:

$R^2 + x^2 = \left(64R^3\right)^{2/3} R^2$

Since $64 = 4^3$, we can simplify $64^{2/3}$ as:

$64^{2/3} = 4^2 = 16$

So the equation becomes

$$R^2 + x^2 = 64^{2/3} R^2$$

Therefore:

$$x^2 = 15R^2$$

Thus, the value of x is

$$x = R\sqrt{15}$$

The correct answer is option D:

Q21 Text Solution:

Magnetic hysteresis is exhibited by ferromagnetic materials.

In ferromagnetism, materials like iron and cobalt show hysteresis when subjected to an external magnetic field. The process involves the alignment of magnetic domains in response to the applied field and retains a certain level of magnetization even when the field is removed. This characteristic behavior, which results from the energy loss in the system, manifests as a lag between changes in magnetization and the external magnetic field, forming a hysteresis loop.

Therefore, the correct choice is:

Q22 Text Solution:

We know that magnetic susceptibility.

$$\chi \propto \frac{1}{T}$$

$$\Rightarrow \quad \frac{\chi_2}{\chi_1} = \frac{T_1}{T_2} \Rightarrow \chi_2 = \frac{T_1}{T_2} \times \chi_1$$

$$= 1.2 \times 10^{-5} \times \frac{300}{200} = 1.8 \times 10^{-5}$$

Q23 Text Solution:

Given

$$B = 2\,\mathrm{mT}$$

$$= 2 \times 10^{-3}\mathrm{T},\ R = \frac{10}{\sqrt{\pi}}\mathrm{cm}$$

Magnetic flux passing through surface S_1

$$\phi_{S_1} = BS_1 \cos 180^\circ$$

$$= 2 \times 10^{-3} \times \pi R^2 (-1)$$

$$= -2 \times 10^{-3} \times \pi \times \frac{100}{\pi} \times 10^{-4}$$

$$= -20 \times 10^{-6}\mathrm{Wb} = -20\mu\,\mathrm{Wb}$$

Since, Total entering magnetic flux = Total leaving magnetic flux

$$\therefore \quad \phi_{S_2} = -\phi_{S_1} = 20\mu\,\mathrm{Wb}$$

Q24 Text Solution:

Magnetic field around the current carrying straight long conductor.

$$B = \frac{\mu_0 I}{2\pi r}$$

where, r is distance from the conductor.

Hence, magnetic field increases on moving towards the conductor.

Since, metal ring is moving towards the conducting wire, hence flux linked with ring, increases continuously in the out of plane direction. Hence, the induced current produces a magnetic field into the plane of paper. Thus, induced current will produce in the clockwise direction.

Q25 Text Solution:

Given $I = 2\mathrm{A},\ R = 10\Omega$

$t = 1\mathrm{ms} = 10^{-3}\mathrm{s}$

We know that,

$$|\varepsilon| = \frac{\Delta\phi}{\Delta t} \Rightarrow IR = \frac{\Delta\phi}{\Delta t}$$

$$\Rightarrow \quad \Delta\phi = IR\Delta t = 2 \times 10 \times 10^{-3}$$

$$= 0.02\mathrm{Wb} = 2 \times 10^{-2}\ \mathrm{Wb}$$

Q26 Text Solution:

As the mutual inductance is independent with time, hence graph shown in option (c) is correct.

Q27 Text Solution:

For better tunning of an $L - C - R$ circuit used in for communication, quality factor Q must be high.

$$\therefore \quad Q = \frac{1}{R}\sqrt{fracLC}$$

In option (d), R and C is minimum and L is maximum. Thus, the value of R, Land C given in option (d) suitable for better communication.

Q28 Text Solution:

Resonance frequency in L–C–R series circuit,

$$f_0 = \frac{1}{2\pi\sqrt{LC}} \Rightarrow f_0 \propto \frac{1}{\sqrt{C}}$$

i.e. f_0 decreases with C, hence graph shown in option (c) is correct.

Q29 Text Solution:

For a capacitive circuit, $X_C > X_L$ For the given diagram in question, the value X_C corresponding A is greater than the value of X_L

Q30 Text Solution:

The force exerted by electromagnetic waves on a perfectly reflecting surface can be derived using the concept of radiation pressure. When electromagnetic waves are incident on a reflecting surface, they exert a pressure due to the change in momentum as they reflect.

For a perfectly reflecting surface, the radiation pressure *P* is given by:

$$P = \frac{2I}{c}$$

where:

I is the intensity of the incident radiation,

c is the speed of light.

The force F exerted on a surface due to radiation pressure is given by multiplying the radiation pressure by the surface area *A*:

$$F = P \times A = \frac{2I}{c} \times A = \frac{2IA}{c}$$

Therefore, the correct expression for the force exerted by the electromagnetic wave on the reflecting surface is:

Option A

$\frac{2IA}{c}$

Q31 Text Solution:

The final image formed by an astronomical telescope is:

Option D

virtual, inverted and magnified

In an astronomical telescope, the objective lens (or mirror) creates a real, inverted image of a distant object at its focal plane. The eyepiece, which functions as a magnifying glass, then takes this real image and forms a virtual image that is also inverted but magnified for the viewer's eye. This is why when you look through an astronomical telescope, the image appears larger and upside down.

Q32 Text Solution:

Given that the angle of minimum deviation δ_m is equal to the angle of the prism A for an equilateral prism, we have:

$$A = 60^\circ, \quad \delta_m = 60^\circ$$

The refractive index μ of the prism can be determined using the formula:

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}$$

Substitute the values:

$$\mu = \frac{\sin\left(\frac{60^\circ+60^\circ}{2}\right)}{\sin\frac{60^\circ}{2}} = \frac{\sin 60^\circ}{\sin 30^\circ} = \frac{\sqrt{3}/2}{1/2} = \sqrt{3}$$

Therefore, if v is the speed of light inside the prism, the relationship with μ is:

$$\mu = \frac{c}{v}$$

Rearrange to find v:

$$v = \frac{c}{\mu} = \frac{3\times10^8 \text{ m/s}}{\sqrt{3}} = \sqrt{3} \times 10^8 \text{ m/s}$$

Q33 Text Solution:

From the given diagram in question,

$n_1 = \frac{4}{3} n_2 = \frac{3}{2}$

$u = -2R$

Using refraction formula through convex spherical surface.

$\frac{n_2}{v} - \frac{n_1}{\mu} = \frac{n_2 - n_1}{R}$

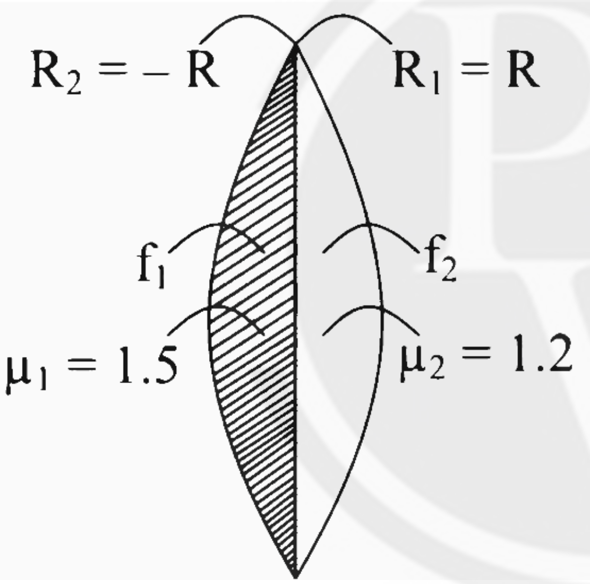
$\Rightarrow \quad \frac{\frac{3}{2}}{v} - \frac{4}{3(-2R)} = \frac{\frac{3}{2} - \frac{4}{3}}{R} \Rightarrow v = -3R$

$= -3 \times 10 \quad [\because R = 10 \text{ cm}]$

$= -30 \text{ cm}$

Since, v is negative, thus image is obtained al a distance from P equal to 30 cm in the rarer medium.

Q34 Text Solution:



From the diagram,

$\frac{1}{f_1} = (\mu_1 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$= (\mu_1 - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right)$

$\frac{1}{f_1} = \frac{\mu_1 - 1}{R} \text{and} \frac{1}{f_2} = (\mu_2 - 1)\left(\frac{1}{\infty} - \frac{1}{-R}\right)$

$\frac{1}{f_2} = \frac{\mu_2 - 1}{R}$

Combined focal length,

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{\mu_1 - 1}{R} + \frac{\mu_2 - 1}{R}$

$= \frac{\mu_1 + \mu_2 - 2}{R} = \frac{1.5 + 1.2 - 2}{14}$

$\Rightarrow \quad \frac{1}{f} = \frac{0.7}{14}$

$\Rightarrow \quad f = 20 \text{ cm}$

Again, $v = -40 \text{ cm}, v = ?$

Using lens formula,

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\therefore \quad \frac{1}{20} = \frac{1}{v} - \frac{1}{(-40)} \Rightarrow \frac{1}{v} = \frac{1}{20} - \frac{1}{40} = \frac{1}{40}$

$\Rightarrow v = 40 \text{ cm}$

Q35 Text Solution:

The Doppler effect describes the change in frequency or wavelength of a wave in relation to an observer moving relative to the source of the waves. For light, this effect is observed in the form of redshift or blueshift, depending on whether the object is moving away from or towards the observer, respectively.

The formula to calculate the redshift z can be written as:

$z = \frac{\lambda_{\text{observed}} - \lambda_{\text{original}}}{\lambda_{\text{original}}}$

where:

$\lambda_{Obeserved} = 601 nm$ (the wavelength observed),

$\lambda_{\text{Original}} = 600\, nm$ (the original wavelength).

Substitute the given values:

$z = \frac{601 \text{ nm} - 600 \text{ nm}}{600 \text{ nm}} = \frac{1}{600}$

The redshift is also related to the velocity v of the galaxy and the speed of light c by the formula:

$z = \frac{v}{c}$

Using this relationship, we can solve for v, the speed of the galaxy:

$v = z \cdot c = \left(\frac{1}{600}\right) \cdot (3 \times 10^5 \text{ km/s})$

Calculating this gives:

$v = \frac{3 \times 10^5 \text{ km/s}}{600} = 500 \text{ km/s}$

Thus, the speed of the galaxy with respect to the Earth is 500 km/s

Correct Option: A

Q36 Text Solution:

After passing through sheet I

$I_1 = \frac{I_0}{2}$

$after\ pas\sin g\ through\ sheet\ 2$

$I_2 = I_1\cos^2\theta = \frac{I_0}{2}\cos^2(30^o) = \frac{3I_o}{8}$

$After\ pas\sin g\ through\ sheet\ 3$

$I_3 = I_2\cos^2(60^o) = {}^{3I_0}/_{32}$

Q37 Text Solution:

In Young's double slit experiment, the fringe width β is determined by the formula:

$\beta = \frac{\lambda D}{d}$

where λ is the wavelength of the particles involved, D is the distance from the slits to the screen, and d is the separation between the two slits.

For particles like electrons and protons, the de Broglie wavelength λ is given by:

$\lambda = \frac{h}{mv}$

where h is Planck's constant, m is the mass of the particle, and v is the velocity (or speed) of the particle.

Both electrons and protons are used at the same speed v in this scenario, and the experimental setup (slit separation d and distance to screen D) remains unchanged. Therefore, the ratio of their fringe widths, β_1 (for electrons) and β_2 (for protons), is determined by their respective de Broglie wavelengths:

Calculate the wavelength of the electrons:

$\lambda_{\text{electron}} = \frac{h}{m_{\text{electron}} \cdot v}$

Calculate the wavelength of the protons:

$\lambda_{\text{proton}} = \frac{h}{m_{\text{proton}} \cdot v}$

Since $m_{proton} > m_{elctrons}$, it follows that $\lambda_{proton} < \lambda_{electron}$ when both have the same speed. The narrower wavelength of protons results in narrower fringes. Therefore:

$\beta_1 = \frac{\lambda_{\text{electron}} D}{d} > \frac{\lambda_{\text{proton}} D}{d} = \beta_2$

Thus, the correct relation between β_1 and β_2 is:

Option D:

Q38 Text Solution:

Given, work function, $\phi_o = E/3$

According to Einstein's photoelectric equation,

$$K_{\max} = E - \phi_0 = E - \frac{E}{3}$$

$$\Rightarrow \quad K_{\max} = \frac{2E}{3}$$

$\therefore$ Kinetic energy lies between 0 to $2E/3$

Q39 Text Solution:

Given, $\phi_o = 24eV$

We know that, $\phi_o = \frac{1240}{\lambda_o(in\,nm)}$ in

$\Rightarrow \quad \lambda_0(\text{ in nm}) = \frac{1240}{\phi_0} = \frac{1240}{24} = 516.6\text{ nm}$

$\therefore$ For $\lambda = 700\ nm$, photoelectric emission does not take place

Q40 Text Solution:

If r_0 be the distance of closest approach, then

$$(\text{KE})_\alpha = \frac{(Ze)(2e)}{4\pi\varepsilon_0 \cdot (r_0)_\alpha} \Rightarrow \frac{1}{2}mv_\alpha^2 = \frac{(Ze)(2e)}{4\pi\varepsilon_0 \cdot (r_0)_\alpha}$$

$$\Rightarrow \quad v_\alpha^2 \propto \frac{1}{(r_0)_\alpha} \Rightarrow (r_0)_\alpha \propto \frac{1}{v_\alpha^2}$$

$$\Rightarrow \quad \frac{(r_0)_{\alpha_i}}{(r_0)_{\alpha_f}} = \frac{v_{\alpha f}^2}{v_{\alpha i}^2} = \frac{(2v_{\alpha_i})^2}{v_{\alpha_i}^2} = 4$$

$$\therefore \quad (r_0)_{\alpha_f} = \frac{(r_0)\alpha_i}{4} = \frac{d}{4} \quad [\because (r_0)_{\alpha_i} = d]$$

Q41 Text Solution:

Since, $r_n \propto n^2$

$\therefore$ Area, $A_n \propto r_n^2 \propto n^4$

$$\Rightarrow \quad \frac{A_{n_1}}{A_{n_2}} = \left(\frac{n_1}{n_2}\right)^4 = \left(\frac{n}{2n}\right)^4 = \frac{1}{16}$$

$\therefore A_{n_1} : A_{n_2} = 1 : 16$

Q42 Text Solution:

$$\frac{\text{Volume of Al}^{27}\text{ nucleus}}{\text{Surface area}} = \frac{\frac{4}{3}\pi R^3}{4\pi R^2} = \frac{R}{3}$$

$$= \frac{1}{3}\left(R_0 A^{\frac{1}{3}}\right)$$

$$\left[\because R = R_0 A^{\frac{1}{3}}\right]$$

$$= \frac{1}{3} \times 1.2 \times 10^{-15}(27)^{\frac{1}{3}}$$

$$= 1.2 \times 10^{-15}\text{m}$$

Q43 Text Solution:

Binding energy $^{235}_{92}\mathrm{U}$, $BE_1 = 1800\,\mathrm{MeV}$
Binding energy $^{144}_{56}\mathrm{Ba}$, $BE_2 = 1200\,\mathrm{MeV}$
Binding energy $^{89}_{36}\mathrm{Kr}$, $BE_3 = 780\,\mathrm{MeV}$
Binding energy of reactants $= BE_1 = 1800\,\mathrm{MeV}$
Binding energy of products $= BE_2 = BE_2 + BE_3$
$= 1200 + 780$
$= 1980\,\mathrm{MeV}$
Average kinetic energy carried by each fast neutron

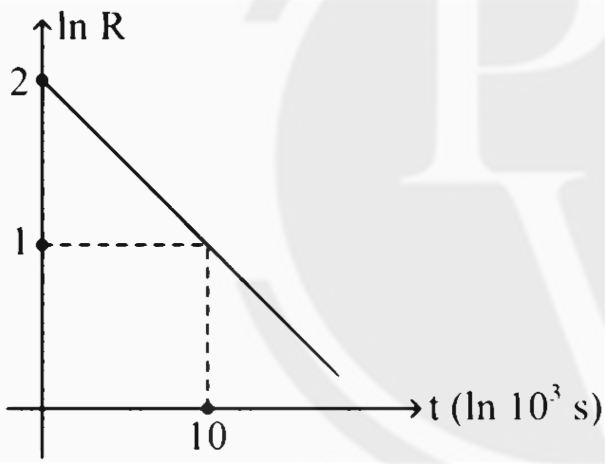
$$= \frac{\text{Binding energy of products- Binding energy of reactants}}{3}$$

$$= \frac{1980-1800}{3} = 60\,\mathrm{MeV}$$

Q44 Text Solution:

From the diagram at $t = 0$

$\log_e R_o = 2$



$\Rightarrow$

$$R_0 = e^2 = 7.5$$

$$\text{Since,} \quad R_0 = \lambda N_0 \quad \ldots\text{(i)}$$

$$\text{Since,} \quad \lambda = \text{Slope of graph}$$

$$= \frac{1}{10\times10^3} = 10^{-4}\,\mathrm{s}^{-1}$$

$$\therefore \text{From Eq. (i)}, N_0 = \frac{R_0}{\lambda} = \frac{7.5}{10^{-4}} = 75000$$

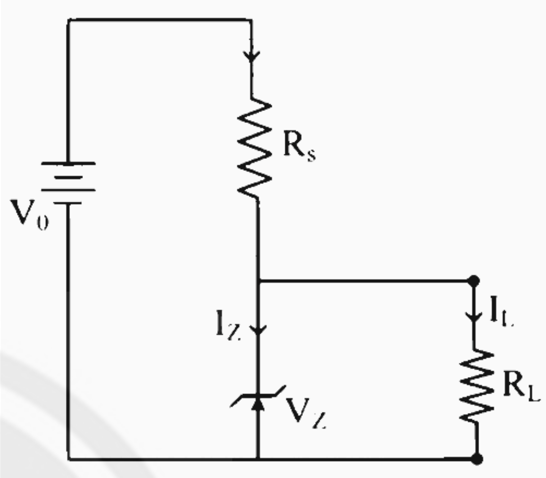
Q45 Text Solution:

Depletion region in an unbiased semiconductor diode is a region consisting of immobile ions only. i.e. In depletion region, neither free elements nor holes exist.

Q46 Text Solution:

There is no forbidden energy gap between conduction bond and valence band for a conductor (copper). Hence, in copper, valence band and conduction band are overlapped.

Q47 Text Solution:

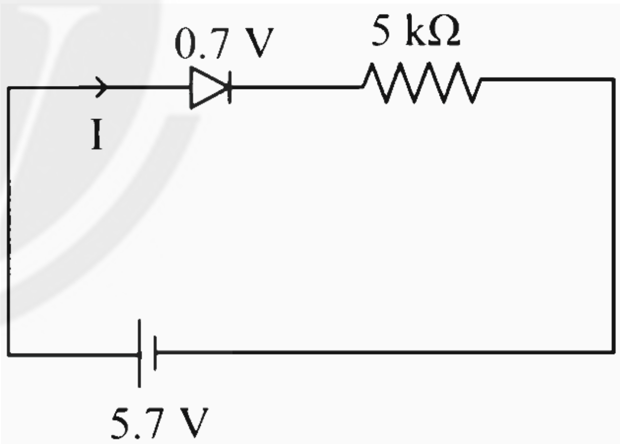


$$I = I_Z + I_L$$

$$\Rightarrow \quad I_Z = I - I_L = \frac{V_O - V_Z}{R_S} - I_L$$

Q48 Text Solution:

Given, barrier potential, $V_B = 0.7V$



Series resistance,

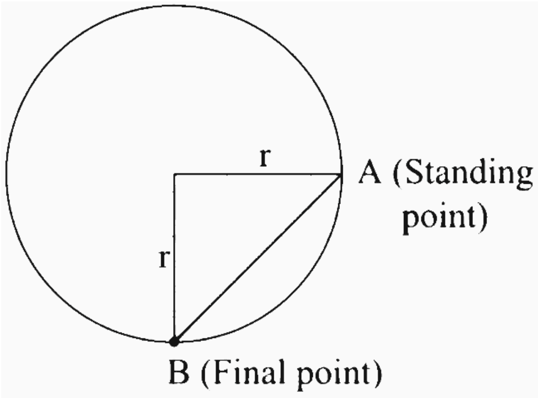
$$R_S = 5\mathrm{k}\Omega = 5\times10^3\,\Omega$$

$$\therefore \quad I = \frac{V - V_B}{R_S} = \frac{5.7-0.7}{5\times10^3} = 1\times10^{-3}\,\mathrm{A} = 1\,\mathrm{mA}$$

Q49 Text Solution:

Given, diameter, d = 80 m

$r = 40m$



Distance travelled after completion of 3/4 revolution

$= \frac{3}{4} \times 2\pi r = \frac{3\pi}{2} \times 40 = 60\pi \text{m}$

$= \sqrt{r^2 + r^2} = r\sqrt{2} = 40\sqrt{2}\text{m}$

Q50 Text Solution:

To determine in which case the resultant of two vectors can never be 3 units, we need to use the triangle inequality theorem for vectors: For two vectors with magnitudes |A| and B, the resultant vector |R| satisfies: ||A| - |B|| <= |R| <= |A| + |B|

Let's analyze each option to see if a resultant of 3 units is possible:

Option A: 1 unit and 2 units Minimum resultant: |1 - 2| = 1

Maximum resultant: 1+2=3

A resultant of 3 is possible.

Option B: 3 units and 6 units

Minimum resultant: |3 - 6| = 3

Maximum resultant: 3+6=9

A resultant of 3 is possible.

Option C: 2 units and 5 units

Minimum resultant: |2 - 5| = 3

Maximum resultant: 2+5=7

A resultant of 3 is possible.

Option D: 4 units and 8 units

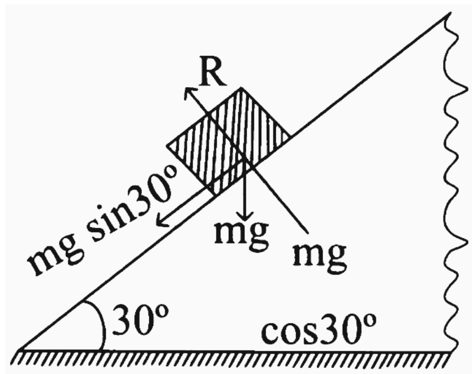
Minimum resultant: | 4–8| = 4

Maximum resultant: 4 + 8 = 12

A resultant of 3 units is not possible as the minimum resultant is 4.

Therefore, the pair of vectors where the resultant can never be 3 units is **Option D (4 units and 8 units)**.

Q51 Text Solution:



From the diagram, frictional force

$f_s = \mu R = \mu mg \cos 30^\circ$

$= 0.6 \times \text{mg} \times \frac{\sqrt{3}}{2}$

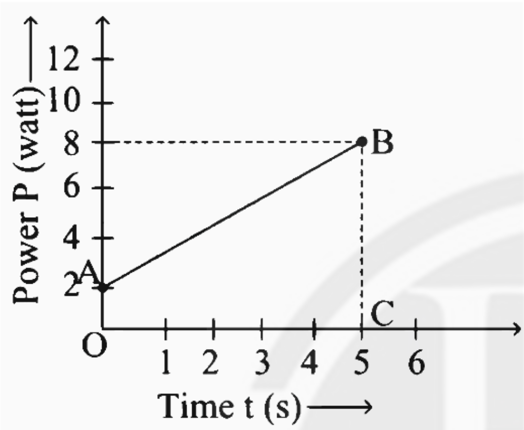
$= 0.3\sqrt{3}\text{mg} = 0.5196\text{mg}$

Magnitude of force pulling the block along the plane downward,
$F' = mg\sin 30^\circ = mg/2 = 0.5mg$

Since, $f_s > F'$

Hence, block will not move.

Q52 Text Solution:



Area under P – t graph is equal to work done (or change in kinetic energy)

$\therefore \quad \Delta k = \frac{P^2}{2m} = \text{area of region} OABC$

$\Rightarrow \quad \frac{P^2}{2m} = \frac{(2+8)5}{2}$

$\Rightarrow \quad \frac{P^2}{2\times 0.5} = 25 \quad \left[\because m = 500\text{g} = 0.5\,\text{kg}\right]$

$\Rightarrow \quad P^2 = 25 \Rightarrow P = 5\,\text{kgms}^{-1}$

Q53 Text Solution:

The dimensional formula for the activity of a radioactive substance is expressed as the number of disintegrations per unit time. Therefore, the dimensions are related to inverse time.

$\left[\text{M}^0\,\text{L}^0\,\text{T}^{-1}\right]$

This indicates that activity is independent of mass (M^0) and length (L^0), and it depends on inverse time (T^{-1}). Hence, the correct option is C.

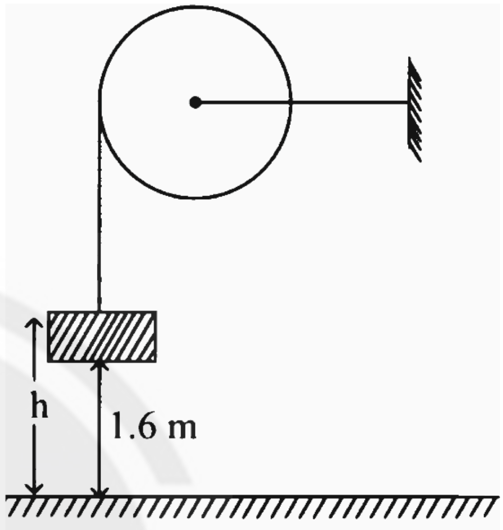
Q54 Text Solution:

According to right hand rule, direction of angular velocity is along Z-axis.

Q55 Text Solution:

Given, mass of the body, $m_1 = 1\ kg$

Mass of pulley, $m_2 = 2\ kg$



According to conservation of energy,

$m_1 gh = \frac{1}{2}m_1 v^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2}\omega_1 v^2 + \frac{1}{2} \times \frac{m_2 R^2}{2} \times \left(\frac{v}{R}\right)^2$

$\left[\because I = \frac{m_2 R^2}{2} \text{and} \omega = \frac{v}{R}\right]$

$\Rightarrow \quad m_1 gh = \frac{1}{2}m_1 v^2 + \frac{1}{4} \times m_2 v^2$

$\Rightarrow 1 \times 10 \times 1.6 = \frac{1}{2} \times 1 \times v^2 + \frac{1}{4} \times 2 \times v^2$

$\Rightarrow \quad v^2 = 4\text{m/s}$

Q56 Text Solution:

Acceleration due to gravity at height h from the surface of the earth.

$g_h = \frac{g}{\left(1+\frac{h}{R}\right)^2}$

Given, $\quad h = \frac{R}{2}$

$\therefore \quad g_h = \frac{g}{\left(1+\frac{\frac{R}{2}}{R}\right)^2} = \frac{g}{\left(\frac{3}{2}\right)^2}$

$= \frac{4}{9}g = \frac{4}{9} \times 9.8 = 4.4\text{m/s}^2$

Q57 Text Solution:

Weight of the metal wire, $w = mg$

Longitudinal stress $= \frac{w}{A} = \frac{mg}{A}$

$\therefore \quad Y = \frac{\text{Longitudinal stress}}{\text{Longitudinal strain}} = \frac{\frac{mg}{A}}{\frac{\Delta l}{\left(\frac{l}{2}\right)}}$

[$\because$ Weight of the wire acts at its centre $\therefore L' = \frac{L}{2}$]

$$\Rightarrow \quad \Delta l = \frac{mgl}{2YA}$$
$$= \frac{m}{AL} \cdot \frac{L^2 g}{2Y}$$
$$= \frac{\rho L^2 g}{2Y}$$

Q58 Text Solution:

Given flow rate

$Q = 0.314 \mathrm{m}^3 \mathrm{s}^{-1}$

$r = 10 \mathrm{cm} = 0.1 \mathrm{m}$

$= 10^{-1} \mathrm{m}$

Since,

$,Q = Av$

$0.314 = \pi r^2 v$

$0.314 = 314 \times 10^{-2} v$

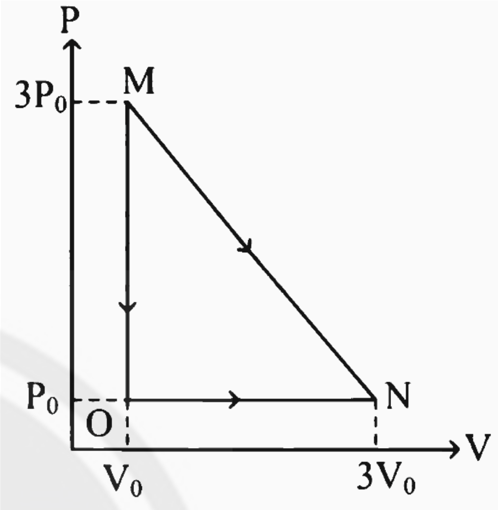
$\Rightarrow \quad v = 10 \mathrm{m/s}$

Q59 Text Solution:

Minimum heat energy supplied to the cube until it vaporises, is given as Q = heat given to liquify at $\theta_1 + m\times$ latent heat of fusion + heat given to vaporise at $\theta_2 + m\times$ latent Heat of vaporisation

$= ms_1(\theta_1 - \theta_0) + mL_f + ms_2(\theta_2 - \theta_1) + mL_2$

Q60 Text Solution:



$W =$ Area enclosed in cyclic process

$= \frac{1}{2} \times ON \times OM$

$= \frac{1}{2} \times (3V_0 - V_0) \times (3p_0 - p_0)$

$= V_0 \times 2p_0 = 2p_0 V_0$