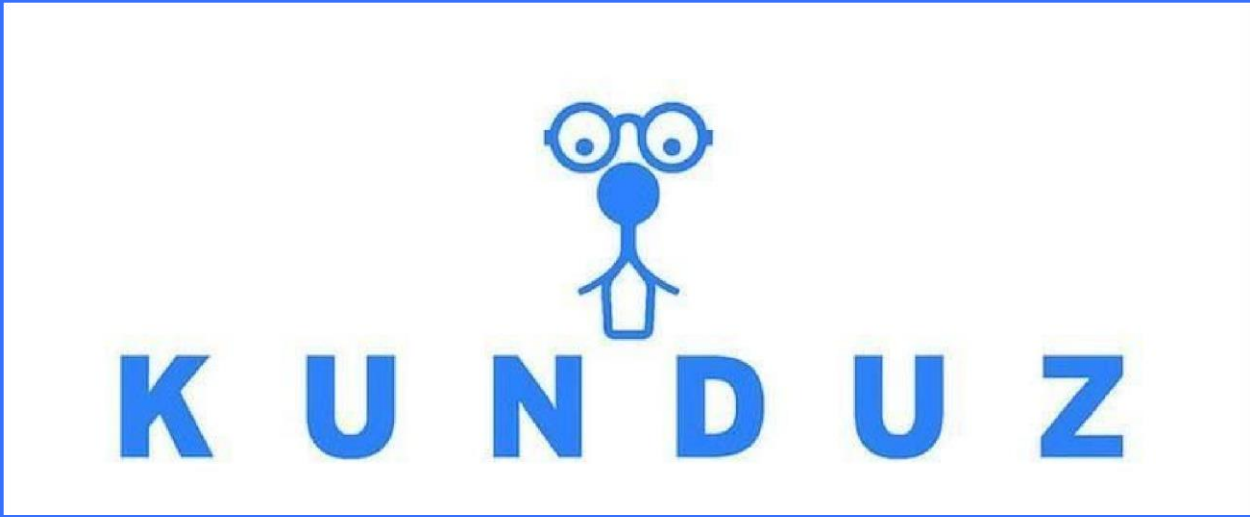


JEE Mains 2nd September 2020 shift 1 Physics solutions prepared by KUNDUZ tutors

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Question number

Question and Answers

1

Q1) A particle of mass m with an initial velocity $v\hat{i}$ collides perfectly elastically with a mass $3m$ at rest. It moves with velocity $v\hat{j}$ after collision, then v is given by.

1) $v = \sqrt{\frac{2}{3}}\,v$ 2) $v = \frac{v}{\sqrt{3}}$ 3) $v = \frac{v}{\sqrt{6}}$ 4) $v = \frac{v}{\sqrt{2}}$

Sol) Let the speed of $3m$ be $\sqrt{v_1^2 + v_2^2}$, this means velocity $= v_1\hat{i} + v_2\hat{j}$.

In x direction:

By conservation of momentum:

$$mv = 3mv_1 \Rightarrow \boxed{v_1 = \frac{v}{3}}$$

In y direction:

By conservation of momentum:

$$0 = mv + 3mv_2 \Rightarrow \boxed{v_2 = -\frac{v}{3}}$$

$\Rightarrow$ speed of $3m = \frac{1}{3}\sqrt{v^2 + v^2}$

Velocity of approach $= v\hat{i}$

velocity of seperation $= v_1\hat{i} + (v - v_2)\hat{j}$

$$\Rightarrow e = 1 = \frac{\left|\frac{v}{3}\hat{i} + \left(v + \frac{v}{3}\right)\hat{j}\right|}{|v\hat{i}|}$$

$$\Rightarrow v = \sqrt{\left(\frac{v}{3}\right)^2 + \left(\frac{4v}{3}\right)^2} \Rightarrow v^2 - \frac{v^2}{9} = \frac{16v^2}{9}$$

$$\Rightarrow \frac{8v^2}{9} = \frac{16v^2}{9} \Rightarrow \boxed{v = \frac{v}{\sqrt{2}}}$$

Thus, option 4 is correct.

2

Q2) Two identical strings x and z made of same material have tension T_x and T_z in them. If their fundamental frequencies are 450 Hz and 300 Hz, then ratio T_x / T_z is :

1) 1.25 2) 0.44 3) 1.4 4) 2.25

Sol) We know that $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

Given $f_x = 450\ Hz$, $f_z = 300\ Hz$

$$\Rightarrow \frac{f_x}{f_z} = \sqrt{\frac{T_x}{T_z}} \Rightarrow \frac{T_x}{T_z} = \left(\frac{f_x}{f_z}\right)^2$$

$$\Rightarrow \frac{T_x}{T_z} = \left(\frac{450}{300}\right)^2 = \frac{9}{4} = 2.25$$

$$\Rightarrow \boxed{\frac{T_x}{T_z} = 2.25}$$

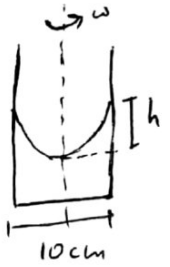
Thus, option 4 is correct.

3

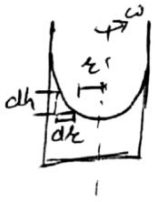
Q3) A cylindrical vessel containing a liquid is rotated about its axis so that the liquid rises at its sides as shown in the figure. The radius of vessel is 5 cm and the angular speed of rotation is ω. The difference of height h (in cm):

1) $5\omega^2/2g$ 2) $2\omega^2/25g$

3) $25\omega^2/2g$ 4) $2\omega^2/5g$



Sol) Let us consider a differential element of length dr at depth dh and r from axis.



FBD of dr →

$A(P_0 + \rho g dh) \longrightarrow \square \longleftarrow P_0 A$ { A is cross-sectional area }

$\Rightarrow P_0A + \rho A g\, dh - P_0A = dm\, r\omega^2$

$\Rightarrow \rho A g dh = dm\, r\omega^2$

$dm = \rho \times dr \times A \Rightarrow \rho A g\, dh = \rho A\, dr\, r\omega^2$

$\Rightarrow g\, dh = \omega^2 r\, dr$

$\Rightarrow \int_0^h g\, dh = \omega^2 \int_0^5 r\, dr \Rightarrow g \times h = \frac{1}{2} \times \omega^2 \times 5^2$

$\Rightarrow \boxed{h = \frac{25\omega^2}{2g}}$

Thus, option 3 is correct.

4

Q4) The least count of the main scale of a vernier callipers is 1 mm. Its vernier scale is divided into 10 divisions and coinside with 9 divisions of main scale. When jaws are touching each other, the 7th division of verier scale coincides with a division of main scale and the zero of vernier scale is lying right side of zero of main scale. When this vernier is used to measure the length of cylinder, the zero of the vernier scale is between 3.1 cm and 3.2 cm and the 4th VSD coinsides with the main scale division. The length of cylinder is:

1) 2.99 cm 2) 3.07 cm 3) 3.21 cm 4) 3.2 cm.

Sol) Least count $= \frac{0.1}{10}$ cm $= 0.01$ cm

Zero error $= 7 \times 0.01 = 0.07$ cm

When cylinder is measured:

MSR $= 3.1$ cm

VSR $= 4 \times 0.01 = 0.04$

$\Rightarrow$ length $=$ MSR + VSR $-$ zero error

$= 3.1 + 0.04 - 0.07$

$= \boxed{3.07 \text{ cm}}$

Thus, option 2 is correct.

5

Q 5) A gas mixture consists of 3 moles of oxygen and 5 moles of argon at temperature T. Assuming the gases to be ideal and oxygen bond to be rigid, the total internal energy (in units of RT) of the mixture is:

1) 15 2) 13 3) 20 4) 11

Sol) Oxygen is diatomic rigid gas.

$\Rightarrow f = 5$

$\Rightarrow \gamma = 1 + \frac{2}{f} = \frac{7}{5}$

$\Rightarrow \frac{C_p}{C_v} = \frac{7}{5}$, $C_p - C_v = R$

$\Rightarrow C_v = \frac{5R}{2}$

$\Rightarrow U_{oxygen} = n C_v \Delta T = 3 \times \frac{5R}{2} \times T = \boxed{\frac{15RT}{2}}$

For Argon:

$f = 3$

$\Rightarrow \gamma = 1 + 2/f = 5/3$

$\Rightarrow C_v = \frac{3R}{2} \Rightarrow U_{Argon} = 5 \times \frac{3R}{2} \times T$

$= \boxed{\frac{15RT}{2}}$

$\Rightarrow U_{Total} = U_{oxygen} + U_{Argon}$

$= \frac{15RT}{2} + \frac{15RT}{2} = \boxed{15RT}$

Thus, option 1 is correct.

6

Q6. Interference fringes are observed on a screen by illuminating two thin slits 1mm apart with a light source (λ=632.8 nm). The distance between the screen and the slits is 100 cm. If a bright fringe is observed on a screen at distance of 1.27 mm from the central bright fringe, then the path difference between the waves, which are reaching this point from the slits is close to:

(1) 2.87 (2) 2nm (3) 1.27μm (4) 2.05μm

Sol> We know that path difference $= d\sin(\theta)$

for small angles $\sin(\theta) \approx \tan(\theta)$

$\Rightarrow \Delta x = d\tan(\theta)$

$\tan(\theta) = y/D$

$\Rightarrow \Delta x = dy/D = \dfrac{10^{-3} \times 1.27 \times 10^{-3}}{1}$

$\Rightarrow \Delta x = 1.27 \times 10^{-6}$ m

$\Rightarrow \boxed{\Delta x = 1.27\,\mu m}$

Thus, option 3 is correct.

7

87. An amplitude modulated waves is represented by expression $v_m = 5(1+0.6 \cos 6280t) \sin(211 \times 10^4 t)$ volts. The minimum and maximum amplitudes modulated wave are, respectively :

(1) 5V, 8V (2) $\frac{5}{2}$V, 8V (3) 3V, 5V (4) $\frac{3}{2}$V, 5V

Sol> Given that $\mu = 0.6$

$A_m = \mu A_c$

$A_c = 5V$

$\Rightarrow A_m = 0.6 \times 5 = 3$

$$\frac{A_{max} + A_{min}}{2} = A_c \quad , \quad \frac{A_{max} - A_{min}}{2} = A_m$$

$\Rightarrow A_{max} + A_{min} = 10$ — (1)

$A_{max} - A_{min} = 6$ — (2)

(1) + (2) $\Rightarrow 2A_{max} = 16$

$\Rightarrow \boxed{A_{max} = 8V}$

$\Rightarrow \boxed{A_{min} = 2V}$

8

Q8) Mass density of spherical galaxy varies as K/r over a large distance r from its centre. In that region, a small star is in a circular orbit of radius R. Then the period T of revolution depend on R as:

1) $T^2 \propto \frac{1}{R^3}$ 2) $T^2 \propto R$ 3) $T \propto R$ 4) $T^2 \propto R^3$

Sol) Let us consider a sphere of radius r and thick-ness dr.

$\Rightarrow$ dV = volume of differential component

$\Rightarrow dV = 4\pi r^2 dr$

$\Rightarrow dm = 4\pi r^2 dr \times \frac{K}{r} = 4\pi K r dr$

$\Rightarrow \int_0^M dm = \int_0^R 4\pi K r dr \Rightarrow \boxed{M = 2\pi K R^2}$

$\Rightarrow$ Gravitational force $= \frac{GMm}{R^2} = G 2\pi K m$

Here Gravitational force is centripetal force

$\Rightarrow 2\pi G K m = m R \omega^2 \Rightarrow \omega = \sqrt{\frac{2\pi G K}{R}}$

$\Rightarrow T = \frac{2\pi R}{R\omega} = 2\pi \sqrt{\frac{R}{2\pi G K}}$

$\Rightarrow \boxed{T \propto \sqrt{R}} \Rightarrow \boxed{T^2 \propto R}$

Thus, option 2 is correct.

9

Que 9) A beam of protons with speed $4 \times 10^5 \text{ ms}^{-1}$ enters a uniform $B = 0.3\text{ T}$ at angle of 60° to Magnetic field. The pitch of helical path is close to: (Mass of proton = 1.67×10^{-27} Kg, charge on proton = 1.69×10^{-19} C)

(A) 12 cm (B) 2 cm (C) 4 cm (D) 5 cm

Ans → By formula, Pitch = $(V \cos\theta)\, T$

and $T = \frac{2\pi m}{qB}$

Putting the values from the question

$$\text{Pitch} = (V\cos\theta) \times \frac{2\pi m}{qB}$$

$$= \left(4 \times 10^5 \times \frac{1}{2}\right) \times \left(\frac{2\pi \times 1.67 \times 10^{-27}}{1.69 \times 10^{-19} \times 0.3}\right)$$

$$= (2 \times 10^5) \times \left(\frac{2\pi}{3} \times 10^{-7}\right)$$

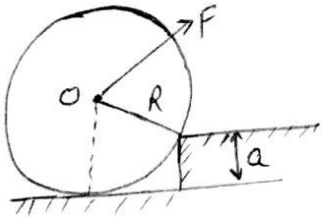
$$= \frac{4\pi}{3} \times 10^{-2}$$

since $\pi \approx 3$

Pitch $\approx 4 \times 10^{-2}$ m = 4 cm (option C)

10

Q10) A uniform cylinder of mass M and radius R is to be pulled over a step of height a ($a<R$) by applying a force F at its centre O perpendicular to the plane through the axes of the cylinder on the edge of the step (see figure). The minimum value of F required is:



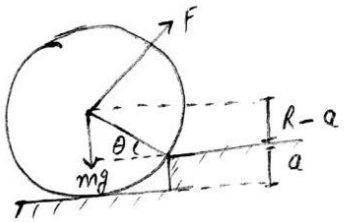
1) $Mg\left[1-\left[\frac{R-a}{R}\right]^2\right]^{1/2}$

2) $Mg\sqrt{1-a^2/R^2}$

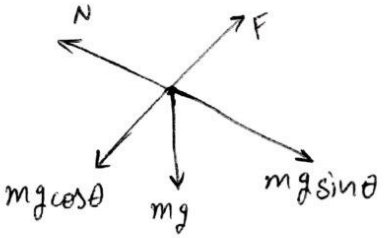
3) $Mg\sqrt{\frac{R}{R-a}-1}$

4) $Mg\frac{a}{R}$

Sol)



FBD of cylinder →



To just lift up:

Torque of F = Torque of $mg\cos\theta$

$\Rightarrow FR = mg\cos\theta\,(R) \Rightarrow (F = mg\cos\theta)$

$\Rightarrow F = mg \times \sqrt{1-\sin^2\theta}$

$\Rightarrow F = mg\sqrt{1-\left(\frac{R-a}{R}\right)^2}$

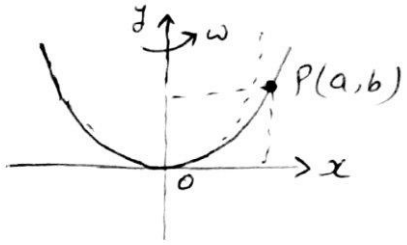
Thus, option 1 is correct.

11

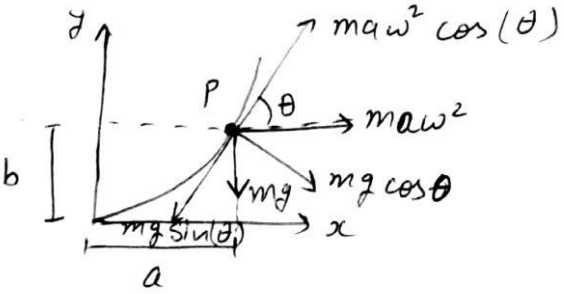
Q 11) A bead of mass m stays at a point $P(a,b)$ on a wire bent in the shape of a parabola $y = 4cx^2$ and rotating with angular speed ω (see figure). The value of ω is:

1) $\sqrt{2gc}$ 2) $\sqrt{\frac{2gc}{ab}}$

3) $\sqrt{\frac{2g}{c}}$ 4) $2\sqrt{2gc}$



Sol)



Let us see from bead frame of reference.

$\Rightarrow$ centrifugal force $= ma\omega^2$

$\Rightarrow mg\sin(\theta) = ma\omega^2\cos(\theta)$

$\Rightarrow g\tan(\theta) = a\omega^2$ —— (1)

$\tan(\theta)$ is slope at P.

$y = 4cx^2 \Rightarrow \frac{dy}{dx} = 8cx$

$\Rightarrow \tan(\theta) = 8ca \Rightarrow \omega^2 = g \times \frac{8ca}{a}$

$\Rightarrow \boxed{\omega = \sqrt{8gc}} \Rightarrow \boxed{\omega = 2\sqrt{2gc}}$

Thus, option 4 is correct.

12

Q12) If speed V, area A and Force F are chosen as fundamental units then dimension of youngs modulus is:

1) FA^2V^{-3} 2) FA^2V^{-1} 3) FA^2V^{-2} 4) $FA^{-1}V^0$

Sol) Let $Y \propto F^a V^b A^c$

Dimension of $Y = ML^{-1}T^{-2}$, Dimension of $A = L^2$

Dimension of $F = MLT^{-2}$, Dimension of $V = LT^{-1}$

$\Rightarrow ML^{-1}T^{-2} \propto (MLT^{-2})^a (LT^{-1})^b (L^2)^c$

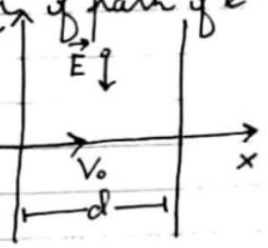
$\Rightarrow a = 1, \; -1 = a+b+2c, \; -2 = -2a-b$

$\Rightarrow b = 0, \; c = -2/2 = -1 \Rightarrow \boxed{Y \propto F^1 V^0 A^{-1}}$

Thus, option 4 is correct.

13

Que 13) A charged particle (m, q) moves along x-axis with velocity V_0. When it passes through the origin it enters a region using uniform $\vec{E} = -E\hat{j}$ which extends upto $x = d$. Equation of path of $e^{\ominus}$ in the region (x > d)



(1) $y = \left(\frac{qEd}{mV_0^2}\right)x$ (2) $y = \frac{qEd}{mV_0^2}(x-d)$

(3) $y = \frac{qEd}{mV_0^2}\left(\frac{d}{2} - x\right)$ (4) $y = \left(\frac{qEd^2}{mV_0^2}\right)x$

Ans ⇒ In the region, $x \in [0, d]$, the force $q\vec{E}$ acting on $e^{\ominus}$ in the $-\hat{Y}$ direction $(-\hat{j})$

so, $x = V_0 t$ ↓ No force

$y = \frac{1}{2}\left(\frac{qE}{m}\right)t^2(-\hat{j})$

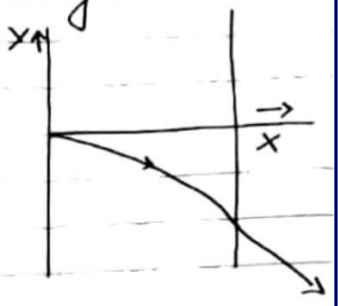
Trajectory of the charge will be

$y = \frac{1}{2}\left(\frac{qE}{m}\right) \times \frac{x^2}{V_0^2}(-\hat{j})$

$= -\left(\frac{qE}{2mV_0^2}\right) \cdot x^2$

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The trajectory for $x > d$, will be the tangent on the parabola at $(x, y) \equiv \left(d, -\frac{qEd^2}{2mv_0^2}\right)$



Using differentiation to find slope of line

$$y = -\left(\frac{qE}{2mv_0^2}\right) \cdot x^2$$

$$\frac{dy}{dx} = -\left(\frac{qE}{mv_0^2}\right)(x)$$

At $x = d$, $m = -\frac{qEd}{mv_0^2}$

so the eqn of line will be

$$y = \left(-\frac{qEd}{mv_0^2}\right)x + c$$

Satisfying the point $\left(d, -\frac{qEd^2}{2mv_0^2}\right)$

$$c = \frac{qEd^2}{2mv_0^2}$$

$$\Rightarrow \quad y = -\left(\frac{qEd}{mv_0^2}\right)x + \frac{qEd^2}{2mv_0^2}$$

$$= \frac{qE}{mv_0^2}\left(\frac{d}{2} - x\right) \quad \text{option (3)}$$

14

Q14. In a reactor, 2 kg of $_{92}U^{235}$ fuel used up in 30 days. The energy released per fission is 200 Mev. Given that the Avogadro number, $N = 6.023 \times 10^{26}$ per kilo mole and $1eV = 1.6 \times 10^{-19}$ J. The power output of the reactor is close to:

(1) 54MW (2) 60MW (3) 125 MW (4) 35MW

Sol> no. of moles $= \frac{2\ kg}{235\ g} = \frac{2000}{235} = \frac{400}{47}$ moles

$\Rightarrow$ no. of atoms $= n = \frac{400}{47} \times N_A$

$= \frac{400}{47} \times 6.023 \times 10^{23}$

$= 5.126 \times 10^{24}$

$\Rightarrow$ Total energy released $= E = 5.126 \times 10^{24} \times 200$

$= 1.0252 \times 10^{27}$ MeV

$\Rightarrow E = 1.64 \times 10^{14}$ J

$\Rightarrow P = \frac{E}{t} = \frac{1.64 \times 10^{14}}{30 \times 24 \times 3600}$

$\Rightarrow \boxed{P \approx 60MW}$

15

Q15> A plane electromagnetic wave has frequency of 2×10^{10} Hz and its energy density is 1.02×10^{-8} J/m^3 in vacuum. The amplitude of magnetic field of the wave is close to :

1) 160 nT 2) 180 nT 3) 190 nT 4) 150 nT

Sol> We know that :

$$\text{energy density} = \frac{B^2}{2\mu_0}$$

Given, energy density $= 1.02 \times 10^{-8}$ J/m^3

Also $\mu_0 = 4\pi \times 10^{-7}$

$$\Rightarrow 1.02 \times 10^{-8} = \frac{B^2}{2 \times 4\pi \times 10^{-7}}$$

$$\Rightarrow B = \sqrt{1.02 \times 2 \times 4\pi \times 10^{-15}}$$

$$\Rightarrow B = \sqrt{25.6 \times 10^{-15}} = \sqrt{256 \times 10^{-16}}$$

$$\Rightarrow B = 16 \times 10^{-8} \text{ T} \Rightarrow B = 160 \times 10^{-9} \text{ T}$$

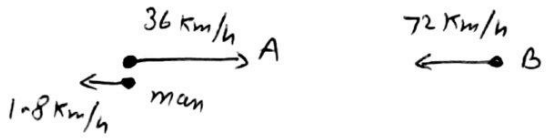
$$\Rightarrow \boxed{B = 160 \text{ nT}}$$

16

Q16) Train A and train B are running on a parallel tracks in the opposite direction with speed of 36 Km/h and 72 Km/h respectively. A person is walking in train A in the direction opposite to the motion with a speed of 1.8 Km/h. Speed in (m/s) of this person as observed from train B will be close to :

1) 30.5 2) 29.5 3) 31.5 4) 28.5

Sol)



Let right side be +ve and left be -ve.

$\Rightarrow V_A = 36$ Km/h , $V_B = -72$ Km/h

$V_{man} = -1.8$ Km/h

$\Rightarrow V_{man\,B} = (V_{man} + V_A) - V_B$

$= (-1.8 + 36) - (-72)$

$= 106.2$ Km/h

$\Rightarrow V_{man\,B} = 106.2 \times \frac{5}{18}$ m/s

$= \boxed{29.5 \text{ m/s}}$

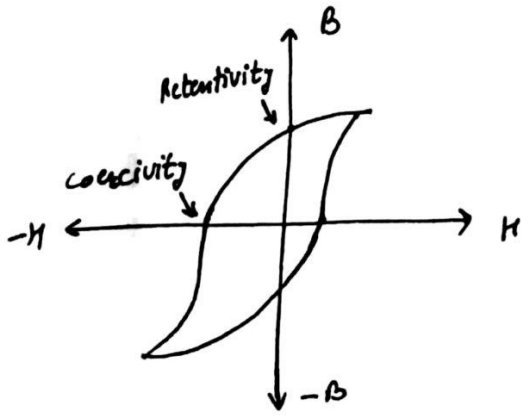
Thus, option 2 is correct.

17

Q17) Magnetic materials used for making permanent magnets (P) and magnets in transformer (T) have different properties, of the following, which property best matches for the type of magnet required.

1) T: Large retentivity, large coercivity.
2) P: Large retentivity, large coercivity.
3) T: Large retentivity, small coercivity.
4) T: Small retentivity, large coercivity.

sol)

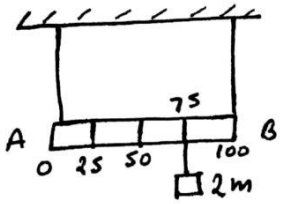


For a permanent magnet we need large retentivity and large coercivity.

Thus, option 2 is correct.

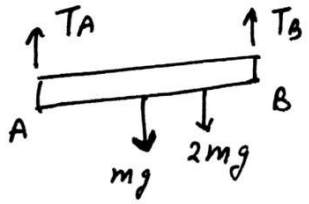
18

Q18> Shown in the figure is rigid and uniform one meter long rod AB held in horizontal position by two strings, tied to its ends and attached to the celing. The rod of mass m has another weight of mass 2m hung at a distance of 75 cm from A. The tension in the string at A is:



1> 0.75 mg 2> 1mg
3> 0.5 mg 4> 2mg.

Sol>



$\Rightarrow T_A + T_B = 3mg$ —①

Balancing torque about A →

$mg \times 50 + 2mg \times 75 = T_B \times 100$

$\Rightarrow T_B = 2mg$

① $\Rightarrow T_A = 3mg - T_B$

$\Rightarrow \boxed{T_A = mg}$

Thus, option 2 is correct.

19

Q19) Consider four conducting materials - copper, tungsten, mercury, aluminium with resistivity ρ_C, ρ_T, ρ_M, ρ_A respectively. Then:

1) $\rho_C > \rho_A > \rho_T$

2) $\rho_A > \rho_T > \rho_C$

3) $\rho_A > \rho_M > \rho_C$

4) $\rho_M > \rho_A > \rho_C$

Sol)

$\rho_M = 98 \times 10^{-8}\ \Omega\text{-m}$

$\rho_C = 1.724 \times 10^{-8}\ \Omega\text{-m}$

$\rho_A = 2.65 \times 10^{-8}\ \Omega\text{-m}$

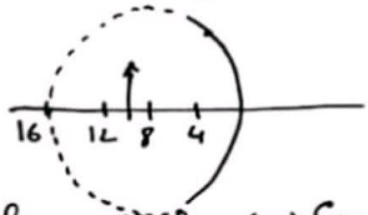
$\rho_T = 5.65 \times 10^{-8}\ \Omega\text{ m}$

$\Rightarrow \rho_M > \rho_T > \rho_A > \rho_C$

Thus, option 4 is correct.

20

Que 20) Given spherical mirror and position of object. Find nature of image



(i) Inverted, real, magnified (ii) Erect, virtual, unmagnified
(iii) Inverted, real, unmagnified (iv) Erect, virtual, magnified.

Ans) By observation, the diameter of sphere is 16 m.
So radius of curvature is 8 m. focal length = 4
since $|u| > 4$ and it's a concave mirror,
the image is real and inverted.

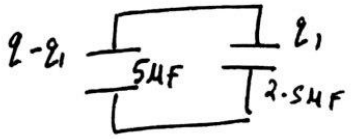
Now, since $|u| > 8$ (Radius of curvature), the image will be bigger in size (Property of concave mirror).
option (iii) is correct.

21

Q.21. A 5μF capacitor is charged fully by a 220 V supply. It is then disconnected from the supply and is connected in series to another uncharged 2.5μF capacitor. If the energy change during the charge redistribution is $\frac{X}{100}$ J then the value of X to the nearest integer is:

Sol>

$$\text{Charge} = q = CV = 5\mu \times 220 = 1100\,\mu C$$



Let q_1 charge move from 5μF capacitor to 2.5 μF capacitor.

$$\Rightarrow \frac{q-q_1}{5\mu} = \frac{q_1}{2.5\mu} \Rightarrow q_1 = \frac{q}{3}$$

$$\Rightarrow U_i = \frac{q^2}{2\times 5\mu}$$

$$\Rightarrow U_f = \frac{(q-q_1)^2}{2\times 5\mu} + \frac{q_1^2}{2\times 2.5\mu} = \frac{4q^2}{90\mu} + \frac{q^2}{45\mu}$$

$$\Rightarrow U_f = q^2/15\mu$$

$$\Rightarrow \Delta U = \frac{q^2}{10\mu} - \frac{q^2}{15\mu} = \frac{q^2}{30\mu} = \frac{1100^2\,\mu}{30}$$

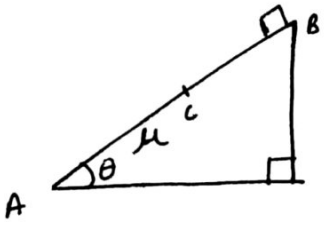
$$\Rightarrow \Delta U \times 100 = X = \frac{1100^2 \times 10^{-4}}{30} = 4.033$$

$$\Rightarrow \boxed{X \approx 4}$$

22

Q22) A small block start slipping down from point B on an inclined plane AB, which is making an angle θ with the horizontal. section BC is smooth and CA is rough with coefficient of friction μ. It is found that the block comes to rest as it reaches bottom (point A) of the inclined plane. If $BC = 2CA$, the coefficient of friction is given by $\mu = K\tan(\theta)$. The value of K is ___.

sol)



Let AC $= l \Rightarrow BC = 2l$

acceleration $= a = g\sin(\theta)$

friction $= f = \mu mg\cos(\theta)$

Let velocity at c be V.

$\Rightarrow v^2 = u^2 + 2a(l \times 2)$, $u = 0 \Rightarrow V = \sqrt{2g\sin(\theta)(l \times 2)}$

acceleration from C to A $= g\sin\theta - \mu g\cos(\theta)$

$\Rightarrow 0^2 = 2 \times 2gl\sin(\theta) + 2(g\sin(\theta) - \mu g\cos\theta)l$

$\Rightarrow 2\times\sin(\theta) = \mu\cos\theta - \sin\theta$

$\Rightarrow \boxed{\mu = 3\tan(\theta)}$

$\Rightarrow \boxed{K = 3}$

23

Q23> An engine takes in 5 moles of air at 20°C and 1 atm and compresses it adiabatically to 1/10 th of the original volume. Assuming air to be a diatomic ideal gas made up of rigid molecules. The change in internal energy during the process is X kJ. The value of X to nearest integer is:

sol> For an adiabatic process:

$$PV^{\gamma} = c \quad \Rightarrow \quad TV^{\gamma-1} = c$$

$$\Rightarrow \quad T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$\Rightarrow \quad T_1 = \left(\frac{1}{10}\right)^{\gamma-1} T_2$$

here $\gamma = 1 + \frac{2}{5} = 7/5$

$$\Rightarrow \quad T_1 = \frac{1}{10^{2/5}} T_2 \quad \Rightarrow \quad T_2 = 10^{2/5} T_1$$

Given $T_1 = 20°C = 293\ K$

$$\Rightarrow \Delta U = n C_v \Delta T = 5 \times \frac{5R}{2} \times 293 \left(10^{2/5} - 1\right)$$

$$\Rightarrow \Delta U = 5 \times \frac{5 \times 8.3}{2} \times 293 \left(2.5 - 1\right)$$

$$\Rightarrow \Delta U = 45598\ J = 45.598\ kJ$$

$$\Rightarrow \boxed{\Delta U \approx 46\ kJ}$$

24

Que 24) When radiation of wavelength A is used to illuminate a metallic surface, the stopping potential is V. for $\lambda = 3A$, the stopping potential is $\frac{V}{4}$. If the threshold wavelength of the surface is nA, find n.

Ans → By einstein's photoelectric equation

$$\frac{hc}{\lambda} = \phi + eV.$$

Given ⇒

$$\frac{hc}{A} = \phi + eV \rightarrow (1)$$

$$\frac{hc}{3A} = \phi + \frac{eV}{4} \rightarrow (2)$$

On solving, we get

$$\frac{2hc}{3A} = \frac{3eV}{4} \Rightarrow eV = \frac{8hc}{9A} \rightarrow (3)$$

Putting the value in (1) and using $\phi = \frac{hc}{nA}$ from the question.

$$\frac{hc}{A} = \frac{hc}{nA} + \frac{8hc}{9A}$$

$$\Rightarrow \frac{hc}{9A} = \frac{hc}{nA}$$

$$\Rightarrow \boxed{n = 9} \leftarrow \text{Ans}$$

25

Q25. A circular coil of radius 10cm is placed in a uniform magnetic field of 3.0×10^{-5} T with its plane perpendicular to the field initially. It is rotated at constant angular speed about an axis along the diameter of coil and perpendicular to magnetic field so that it undergoes half of rotation in 0.2 s. The maximum value of EMF induced (in μV) in the coil will be close to the integer...

Sol) Let the angle between $\vec{B}$ and $\vec{A}$ be θ

$\Rightarrow \theta = \omega t$

$\Rightarrow \phi = \vec{B} \cdot \vec{A} = BA\cos(\theta)$

$\Rightarrow \phi = BA\cos(\omega t)$

$\Rightarrow emf = -\frac{d\phi}{dt} = -BA\frac{d}{dt}(\cos \omega t)$

$\Rightarrow emf = -BA\omega(-\sin \omega t) = BA\omega \sin(\omega t)$

$\Rightarrow emf\ max = BA\omega$

$B = 3\times10^{-5}$ T, $A = \pi r^2 = \pi \times 0.1^2$

$\omega = \frac{\pi}{0.2}$

$\Rightarrow emf\ max = 3\times10^{-5} \times \pi \times 0.1^2 \times \frac{\pi}{0.2}$

$= 15\times10^{-6} = \boxed{15\,\mu V}$

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