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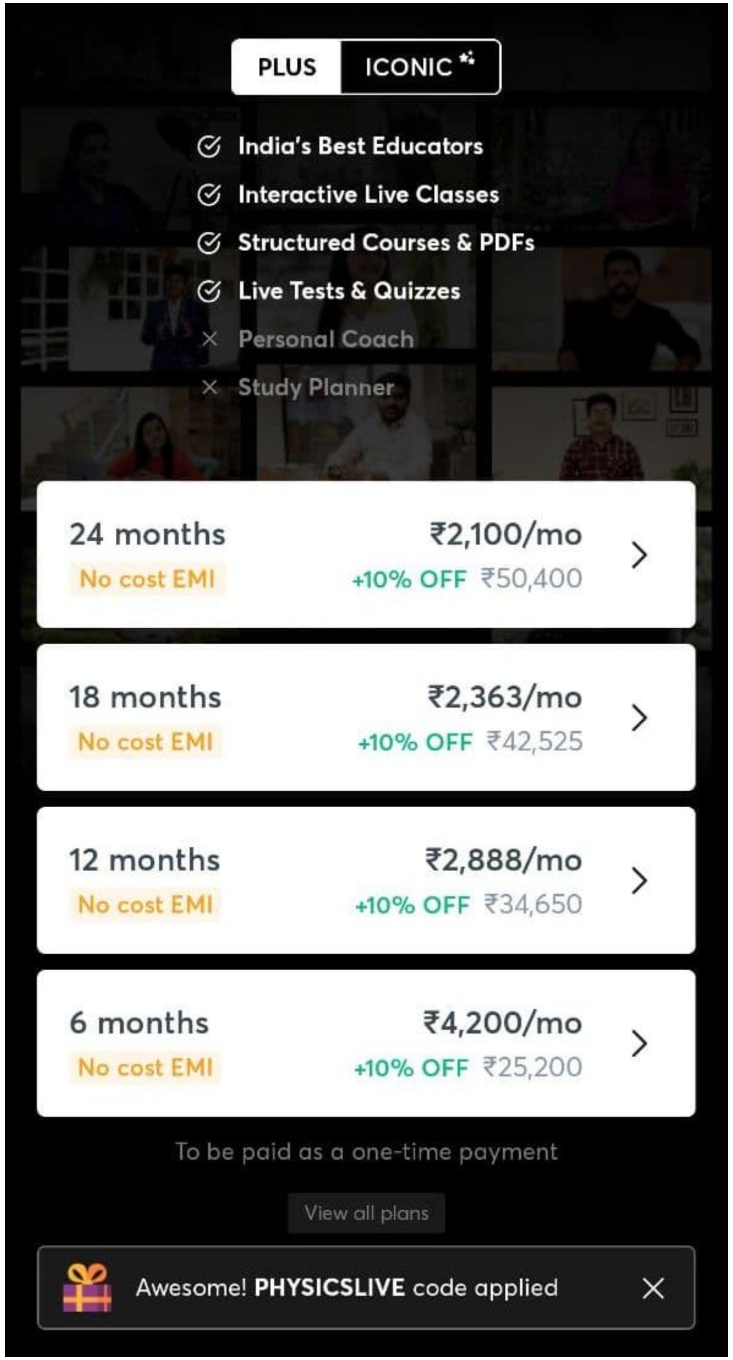

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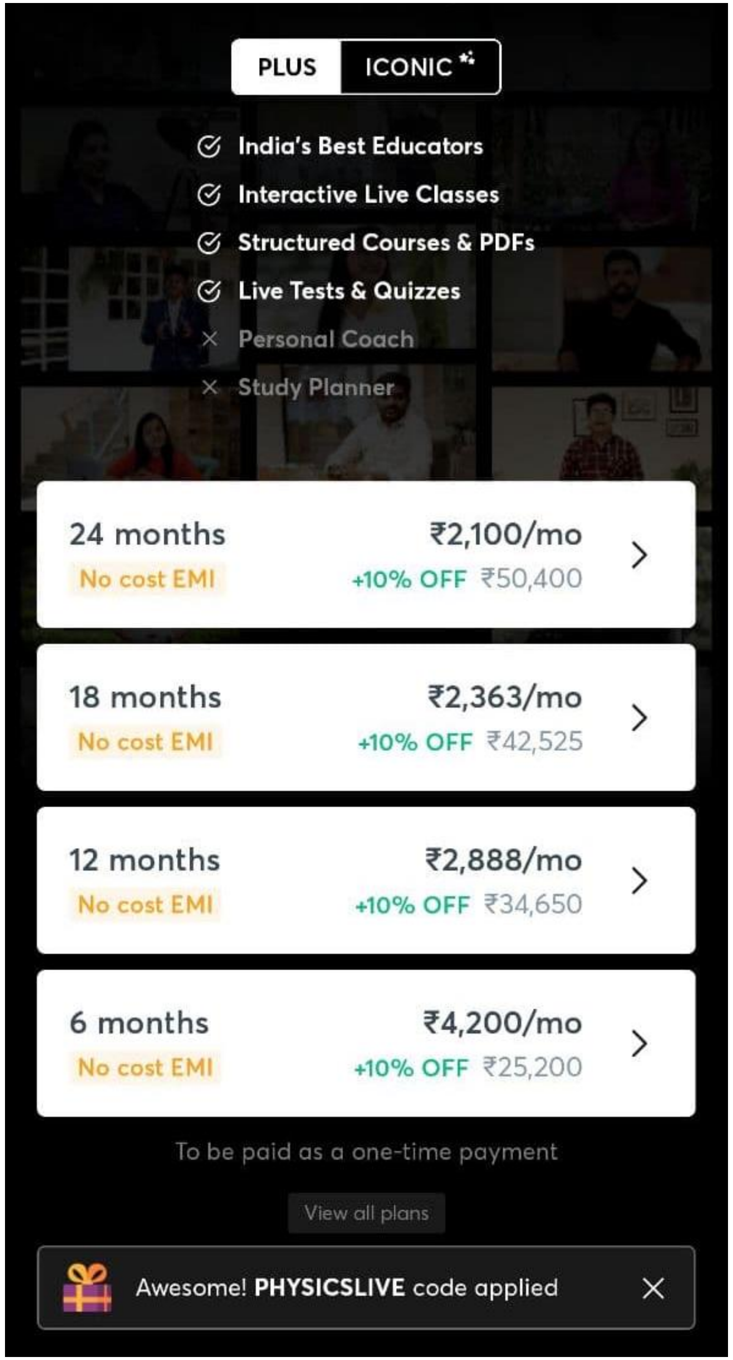

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JEE Advanced 2021
Paper - 2
Physics Answer Key & Solutions

By

PRATEEK JAIN SIR

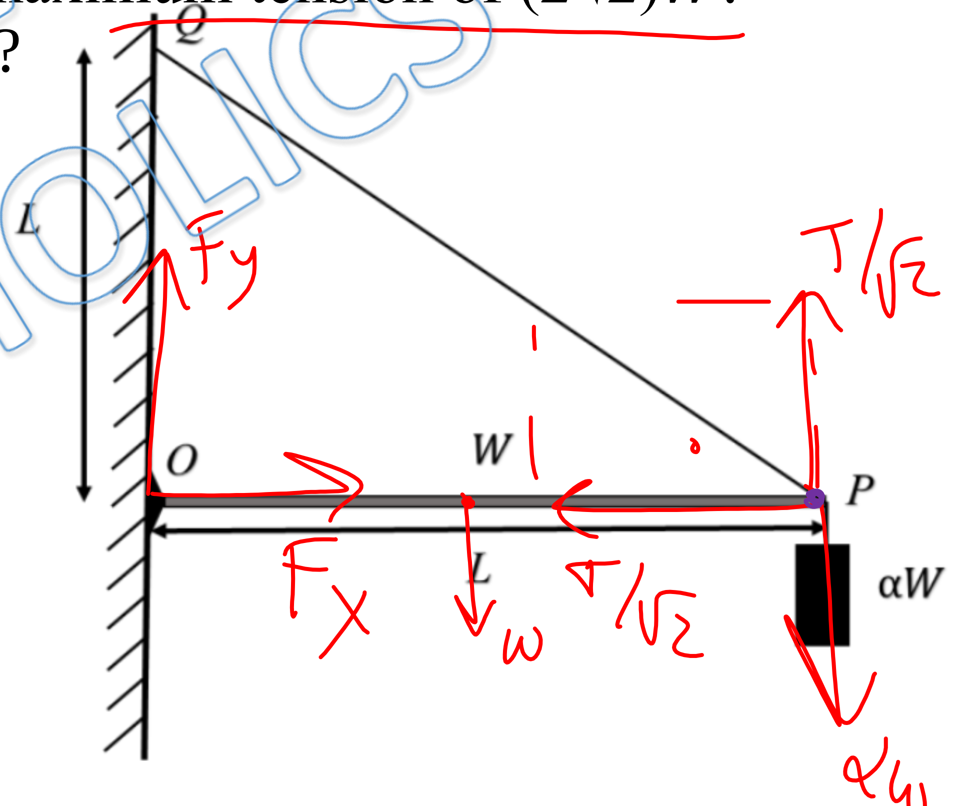
Q1) One end of a horizontal uniform beam of weight W and length L is hinged on a vertical wall at point O and its other end is supported by a light inextensible rope. The other end of the rope is fixed at point Q, at a height L above the hinge at point O. A block of weight αW is attached at the point P of the beam, as shown in the figure (not to scale). The rope can sustain a maximum tension of $(2\sqrt{2})W$. Which of the following statement(s) is(are) correct?

(A) The vertical component of reaction force at O does not depend on α

(B) The horizontal component of reaction force at O is equal to W for $\alpha = 0.5$

(C) The tension in the rope is $2W$ for $\alpha = 0.5$

(D) The rope breaks if $\alpha > 1.5$



$F_y + \frac{T}{\sqrt{2}} = w + \alpha w$

$F_x = \frac{T}{\sqrt{2}}$

$F_x = w\left(\alpha + \frac{1}{2}\right)$

Difficulty Level: Moderate

Ans. A, B, D

$T_P = 0$

$F_y \cancel{l} = \frac{w \cancel{l}}{2}$

$\boxed{F_y = \frac{w}{2}}$

$\frac{w}{2} + \frac{T}{\sqrt{2}} = w + \alpha w$

$T = \sqrt{2}\left(\frac{w}{2} + \alpha w\right) = \sqrt{2}\, w\left(\alpha + \frac{1}{2}\right)$

To break rope

$T > 2\sqrt{2}\, w$

$\cancel{\sqrt{2} w}\left(\alpha + \frac{1}{2}\right) > 2\cancel{\sqrt{2} w}$

$\alpha > \frac{3}{2}$

JEE Adv. 2021 (P-2)

Q2) A source, approaching with speed u towards the open end of a stationary pipe of length L, is emitting a sound of frequency f_s . The farther end of the pipe is closed. The speed of sound in air is v and f_0 is the fundamental frequency of the pipe. For which of the following combination(s) of u and f_s , will the sound reaching the pipe lead to a resonance?

$\nu = 5f_s$

$\nu = (2n+1)\nu_0$

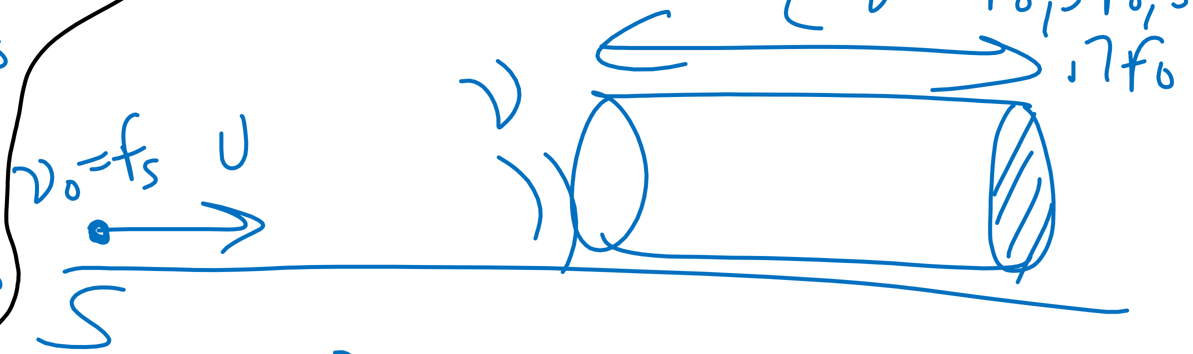
$\nu = f_0, 3f_0, 5f_0, 7f_0 \ldots$

(A) $u = 0.8v$ and $f_s = f_0$, $\nu = 5f_0$

~~(B)~~ $u = 0.8v$ and $f_s = 2f_0$ $\nu = 10f_0$

~~(C)~~ $u = 0.8v$ and $f_s = 0.5f_0$ $\nu = 2.5f_0$

(D) $u = 0.5v$ and $f_s = 1.5f_0$



$\nu_0 = f_s$

$$\nu = \frac{V + \cancel{V_0}}{V - V_s}\nu_0$$

$$\nu = \frac{V}{V - u} f_s$$

$\Rightarrow$ If $u = 0.8V$

$$\nu = \frac{V}{0.2V} f_s = 5f_s$$

$\Rightarrow$ If $u = 0.5V$

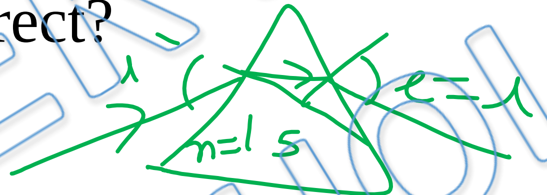
$$\nu = 2f_s = 3f_0$$

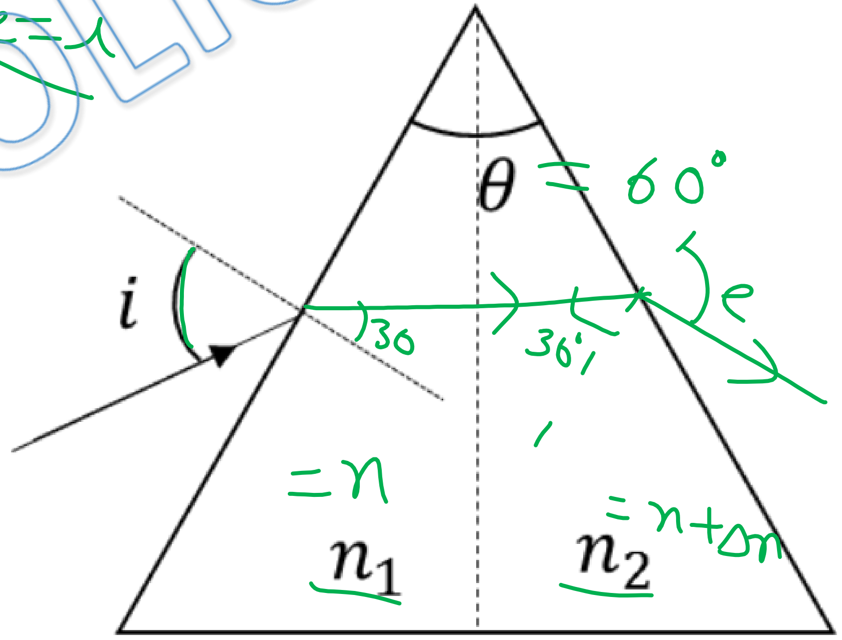
Difficulty Level: Moderate

Ans. A, D

Q3) For a prism of prism angle $\theta = 60°$, the refractive indices of the left half and the right half are, respectively, n_1 and n_2 ($n_2 \geq n_1$) as shown in the figure. The angle of incidence i is chosen such that the incident light rays will have minimum deviation if $n_1 = n_2 = n = 1.5$. For the case of unequal refractive indices, $n_1 = n$ and $n_2 = n + \Delta n$ (where $\Delta n \ll n$), the angle of emergence $e = i + \Delta e$. Which of the following statement(s) is(are) correct?

$\Delta e << i$





(A) The value of Δe (in radians) is greater than that of Δn

(B) Δe is proportional to Δn

(C) Δe lies between 2.0 and 3.0 milliradians, if $\Delta n = 2.8 \times 10^{-3}$

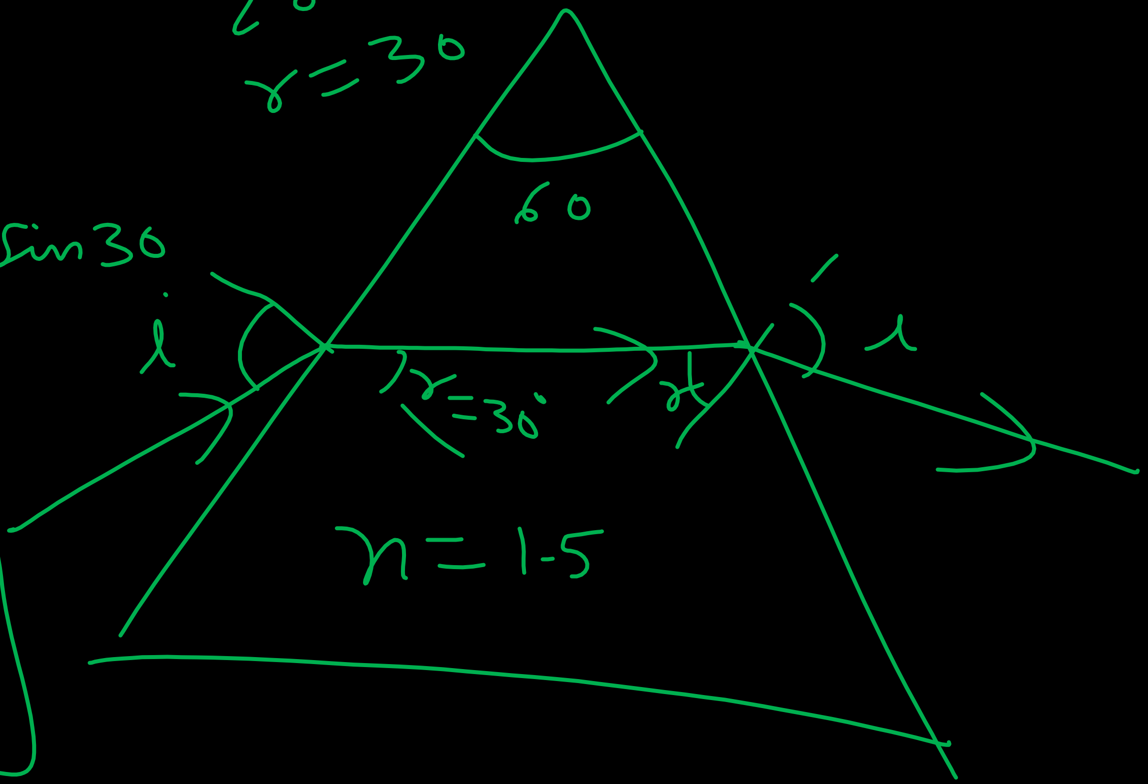
(D) Δe lies between 1.0 and 1.6 milliradians, if $\Delta n = 2.8 \times 10^{-3}$

Difficulty Level: Difficult

Ans. B, C

$$r_1 + r_2 = A$$
$$2r = 60$$
$$r = 30$$

$$1 \sin i = 1.5 \sin 30$$
$$\sin i = \frac{3}{2} \times \frac{1}{2}$$
$$\boxed{\sin i = \frac{3}{4}}$$



when x is very small

$\cos x \approx 1$

$\sin x \approx x$

$$n_2 \sin 30^\circ = 1 \sin(i + \Delta e)$$

$$(n + \Delta n)\frac{1}{2} = \sin i \cos \Delta e + \cos i \sin \Delta e$$

$$\left(\frac{3}{2} + \Delta n\right)\frac{1}{2} = \frac{3}{4} \times 1 + \sqrt{1 - \left(\frac{3}{4}\right)^2}\, \Delta e$$

$$\cancel{\frac{3}{4}} + \frac{\Delta n}{2} = \cancel{\frac{3}{4}} + \frac{\sqrt{7}}{4} \Delta e$$

$$\boxed{\Delta e = \frac{2 \Delta n}{\sqrt{7}}}$$

$$\frac{2}{2.6} \Delta n = \frac{2}{2.6} 2.8 \text{ mrad}$$

$$\left(\frac{2.8}{2.6}\right) 2 \text{ mrad}$$

$$\Delta e < \Delta n$$

JEE Adv. 2021 (P-2)

Poynting Vector (instantaneous intensity of EM wave)

Q4) A physical quantity $\vec{S}$ is defined as $\vec{S} = (\vec{E} \times \vec{B})/\mu_0$, where $\vec{E}$ is electric field, $\vec{B}$ is magnetic field and μ_0 is the permeability of free space. The dimensions of $\vec{S}$ are the same as the dimensions of which of the following quantity(ies) ?

(A) $\cancel{\dfrac{Energy}{charge \times Current}}$

(B) $\dfrac{Force}{Length \times Time}$

(C) $\cancel{\dfrac{Energy}{Volume}}$

(D) $\dfrac{Power}{Area}$

MHT

$$I = \frac{E}{At} = \frac{P}{A}$$

$$= \frac{J}{m^2 s}$$

$$= \frac{N\cancel{m}}{m^{\cancel{2}} s}$$

Difficulty Level: Easy

Ans. B, D

JEE Adv. 2021 (P-2)

mass defect (Δm)

$E = \Delta m c^2 = \delta c^2$

Q5) A heavy nucleus N, at rest, undergoes fission $N \rightarrow P + Q$, where P and Q are two lighter nuclei. Let $\delta = M_N - M_P - M_Q$, where M_P, M_Q and M_N are the masses of P, Q and N, respectively. E_P and E_Q are the kinetic energies of P and Q, respectively. The speeds of P and Q are v_P and v_Q, respectively. If c is the speed of light, which of the following statement(s) is(are) correct?

$E = E_P + E_Q = \delta c^2 \rightarrow (1)$

N rest $P_i = 0$

(A) $E_P + E_Q = c^2\delta$

(B) $E_P = \left(\frac{M_P}{M_P+M_Q}\right)c^2\delta$

(C) $\frac{v_P}{v_Q} = \frac{M_Q}{M_P}$

(D) The magnitude of momentum for P as well as Q is $c\sqrt{2\mu\delta}$, where $\mu = \left(\frac{M_P M_Q}{M_P+M_Q}\right)$

P_Q $\quad$ P_P $\quad$ $P_F = 0$

$V_Q \leftarrow Q \quad P \rightarrow V_P$

$E_Q \quad E_P$

$P_P = P_Q$

$m_P V_P = m_Q V_Q$

Difficulty Level: Easy

Ans. A, C, D

$p -$

$$p = \sqrt{2Km}$$

$$p_p = p_Q$$

$$\sqrt{2E_p m_p} = \sqrt{2E_Q m_Q}$$

$$E_p m_p = E_Q m_Q \longrightarrow (2)$$

$$E_p = \frac{m_Q(\delta c^2)}{m_p + m_Q}$$

$$p_p = \sqrt{2E_p m_p}$$

$$= \sqrt{\frac{2 m_Q \delta c^2 m_p}{m_p + m_Q}}$$

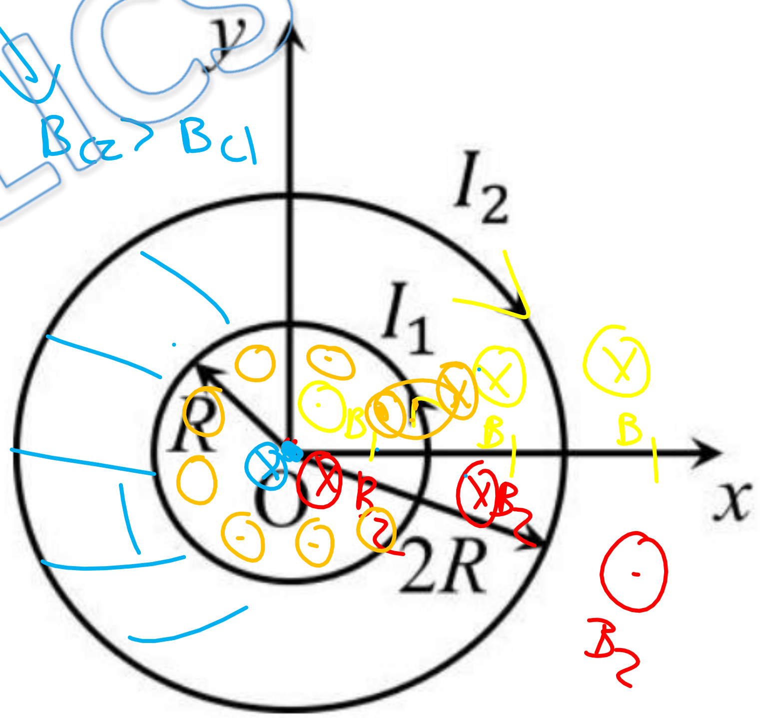
$$= c\sqrt{2\mu\delta}$$

Q6) Two concentric circular loops, one of radius R and the other of radius $2R$, lie in the xy-plane with the origin as their common center, as shown in the figure. The smaller loop carries current I_1 in the anti-clockwise direction and the larger loop carries current I_2 in the clockwise direction, with $I_2 > 2I_1$. $\vec{B}(x, y)$ denotes the magnetic field at a point (x, y) in the xy-plane. Which of the following statement(s) is(are) correct?

$B_{c1} = \frac{\mu_0 I_1}{2R}$

$B_{c2} = \frac{\mu_0 I_2}{2(2R)}$

$B_{c2} > B_{c1}$



(A) $\vec{B}(x, y)$ is perpendicular to the xy-plane at any point in the plane

(B) $|\vec{B}(x, y)|$ depends on x and y only through the radial distance $r = \sqrt{x^2 + y^2}$

(C) $|\vec{B}(x, y)|$ is non-zero at all points for $r < R$

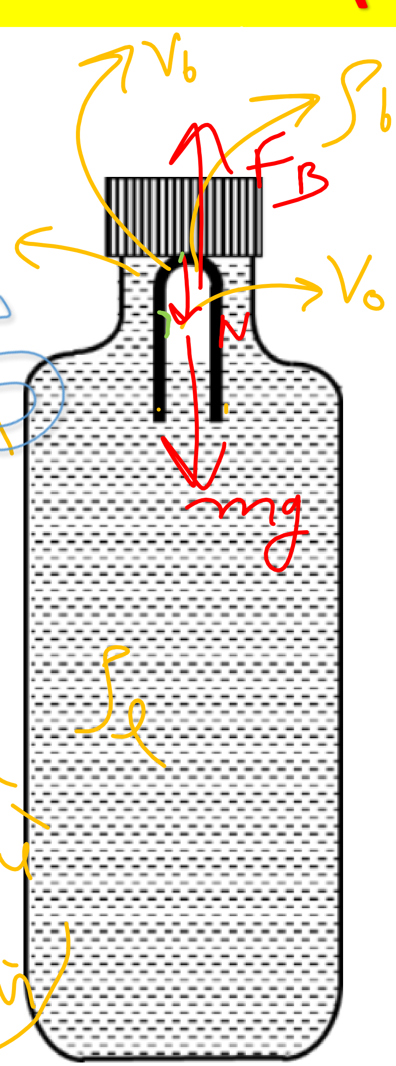
(D) $\vec{B}(x, y)$ points normally outward from the xy-plane for all the points between the two loops

Difficulty Level: Moderate

Ans. A, B

Question Stem for Question Nos. 7 and 8

A soft plastic bottle, filled with water of density 1 gm/cc, carries an inverted glass test-tube with some air (ideal gas) trapped as shown in the figure. The test-tube has a mass of 5 gm, and it is made of a thick glass of density 2.5 gm/cc. Initially the bottle is sealed at atmospheric pressure $p_0 = 10^5$ Pa so that the volume of the trapped air is $v_0 = 3.3$ cc. When the bottle is squeezed from outside at constant temperature, the pressure inside rises and the volume of the trapped air reduces. It is found that the test tube begins to sink at pressure $p_0 + \Delta p$ without changing its orientation. At this pressure, the volume of the trapped air is $v_0 - \Delta v$. Let $\Delta v = X$ cc and $\Delta p = Y \times 10^3$ Pa.



System: Test tube + trapped air

$mg + N = F_B$

$F_B = \rho_l V_d g$

Q7) The value of X is 0.30.

Q8) The value of Y is 10.00

Difficulty Level: Difficult

Ans 7: 0.30

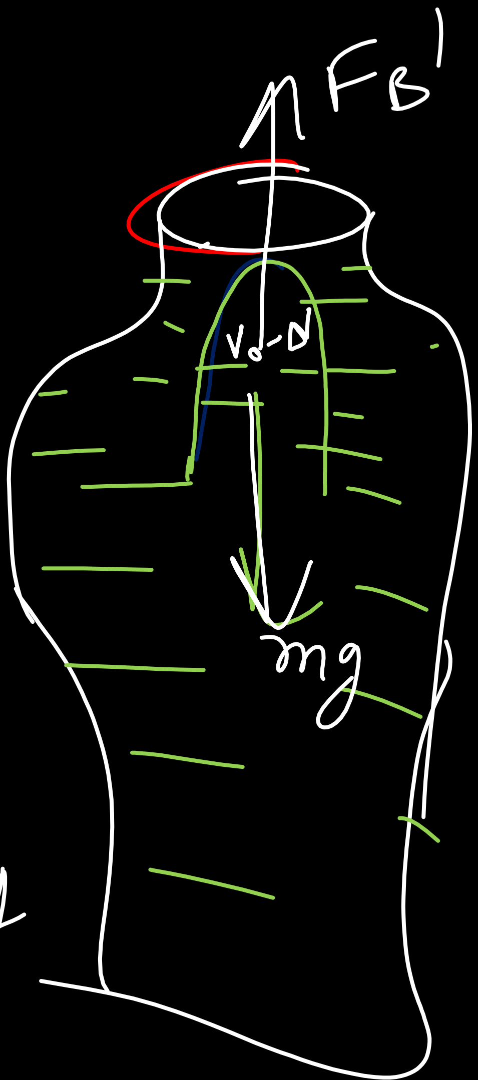
Ans 8: 10.00

when sinking just starts

$$mg + \cancel{N}^{\,0} = F_B'$$

$$5\,\cancel{gm}\,\cancel{g} = 1\,\cancel{gm}\,(53-\Delta V)\,\cancel{g}$$

$$\boxed{\Delta V = 0.30\,cc}$$



$$V_b = \frac{m}{\rho_b}$$

$$V_{ed}' = V_b + (V_0 - \Delta V)$$

$$F_B' = \rho_l V_{ed}' g$$

$$= 1\frac{gm}{cc}\left(\frac{m}{\rho_b} + V_0 - \Delta V\right) g$$

$$= 1\frac{gm\,\cancel{cc}}{\cancel{cc}}\left(\frac{5\,gm\,\cancel{cc}}{2.5\,\cancel{gm}} + 33 - \Delta V\right) g$$

$$= 1\,gm\,(53 - \Delta V)\,g$$

$$\cancel{P_1 V_1}$$

$$P_i V_i = P_f V_f$$

$$P_0 V_0 = (P_0 + \Delta P)(V_0 - \Delta V)$$

$$10^5 \times 3\;3\,\cancel{cc} = (10^5 + \Delta P)(3\;3 - 0.3)\cancel{cc}$$

$$1.1 \times 10^5 - 10^5 = \Delta P$$

$$0.1 \times 10^5 = \Delta P = 10 \times 10^3 P_0$$

JEE Adv. 2021 (P-2)

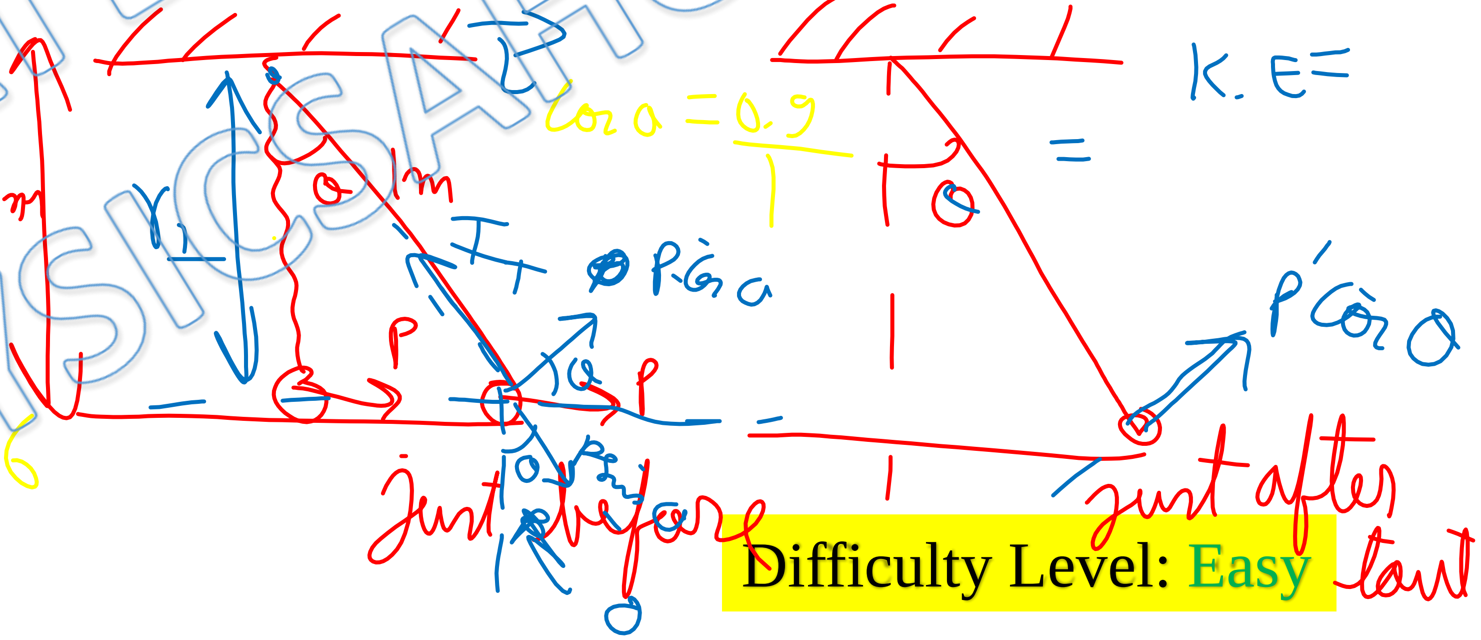
Question Stem for Question Nos. 9 and 10

$K = \frac{p^2}{2m}$

A pendulum consists of a bob of mass $m = 0.1$ kg and a massless inextensible string of length $L = 1.0$ m. It is suspended from a fixed point at height $H = 0.9$ m above a frictionless horizontal floor. Initially, the bob of the pendulum is lying on the floor at rest vertically below the point of suspension. A horizontal impulse $P = 0.2$ kg-m/s is imparted to the bob at some instant. After the bob slides for some distance, the string becomes taut and the bob lifts off the floor. The magnitude of the angular momentum of the pendulum about the point of suspension just before the bob lifts off is J kg-m^2/s. The kinetic energy of the pendulum just after the liftoff is K Joules

$L = P r_\perp$

$= 0.2 \times 0.9 = 0.18$



Q9) The value of J is 0.18 .

Q10) The value of K is 0.16 .

Difficulty Level: Easy

Ans 9: 0.18
Ans 10: 0.16

$$KE = \frac{(P\cos\theta)^2}{2m}$$

$$= \frac{P^2\cos^2\theta}{2m}$$

$$= \frac{\overset{0.2}{\cancel{0.04}} \times 0.81}{\cancel{2} \times 0.1} = 0.164$$

Question Stem for Question Nos. 11 and 12

JEE Adv. 2021 (P-2)

$V_{rms,R} = i_{rms} R$

In a circuit, a metal filament lamp is connected in series with a capacitor of capacitance C μF across a 200 V, 50 Hz supply. The power consumed by the lamp is 500 W while the voltage drop across it is 100 V. Assume that there is no inductive load in the circuit. Take rms values of the voltages. The magnitude of the phase-angle (in degrees) between the current and the supply voltage is φ. Assume, $\pi\sqrt{3} \approx 5$.

$V_{rms}^2 = V_{rms,C}^2 + V_{rms,R}^2$

$(200)^2 = V_{rms,C}^2 + 100^2$

$\boxed{V_{rms,C} = 100\sqrt{3}\text{ V}}$

$P = 500$

$P = i_{rms}^2 R$

$P = \left(\frac{V_{rms,R}}{R}\right)^2 R$

$P = \frac{V_{rms,R}^2}{R}$

Q11) The value of C is ____. 100.00

Q12) The value of φ is ____. 60.00

$R = \frac{\cancel{100}^{20} \times \cancel{100}}{\cancel{500}_{5}}$

$R = 20\Omega$

Difficulty Level: Moderate

Ans 11: 100.00

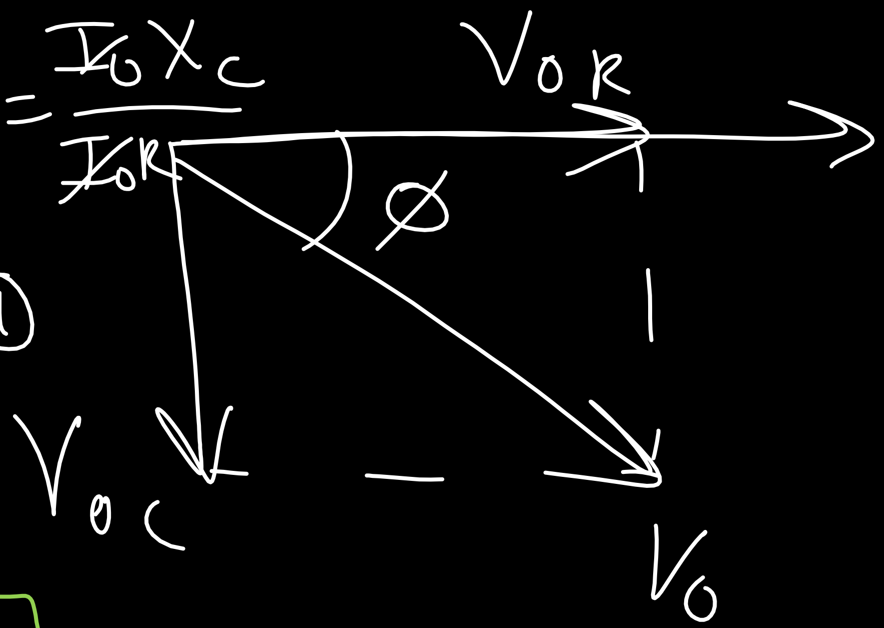
Ans 12: 60.00

$$X_c = \frac{1}{\omega C}$$

$$\omega = 2\pi f$$
$$\omega = 2\pi \times 50$$
$$\omega = 100\pi$$

$$\tan\phi = \frac{V_{oc}}{V_{oR}} = \frac{\cancel{I_o} X_c}{\cancel{I_o} R}$$

$$\tan\phi = \frac{X_c}{R} \rightarrow (1)$$



$$\tan\phi = \sqrt{3}$$

$$\boxed{\phi = 60^\circ}$$

$$V_{rms,c} = i_{rms} X_c$$
$$= \frac{V_{rms}}{Z} X_c$$
$$= \frac{V_{rms} X_c}{\sqrt{X_c^2 + R^2}}$$

$$V_{rms,c} = \frac{V_{rms}}{\sqrt{1 + \left(\frac{R}{X_c}\right)^2}}$$

$$100\sqrt{3} = \frac{200}{\sqrt{1+\left(\frac{R}{X_C}\right)^2}}$$

$$\left(\sqrt{1+\left(\frac{R}{X_C}\right)^2}\right)^2 = \left(\frac{2}{\sqrt{3}}\right)^2$$

$$1+\left(\frac{R}{X_C}\right)^2 = \frac{4}{3}$$

$$\frac{R}{X_C} = \frac{1}{\sqrt{3}}$$

$$\omega C R = \frac{1}{\sqrt{3}}$$

$$100\pi C \times 20 = \frac{1}{\sqrt{3}}$$

$$C = \frac{\cancel{10^6}\,10^3}{\cancel{2000}\,\pi\sqrt{3}}\ \mu F$$

$$C = \frac{10^3}{10}\ \mu F = 100\ \mu F$$

Paragraph (Q13to Q14)

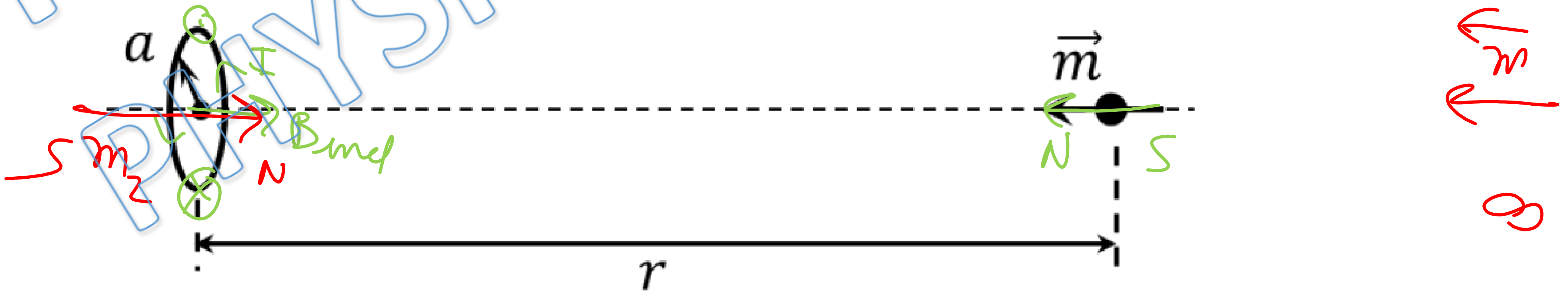
A special metal S conducts electricity without any resistance. A closed wire loop, made of S, does not allow any change in flux through itself by inducing a suitable current to generate a compensating flux. The induced current in the loop cannot decay due to its zero resistance. This current gives rise to a magnetic moment which in turn repels the source of magnetic field or flux. Consider such a loop, of radius a, with its center at the origin. A magnetic dipole of moment m is brought along the axis of this loop from infinity to a point at distance $r\ (\gg a)$ from the center of the loop with its north pole always facing the loop, as shown in the figure below.

$k' = \frac{\mu_0}{4\pi}$

$\vec{E} = \frac{2kP}{r^3}$ $\quad \vec{B} = \frac{2k'm}{r^3}$

$F = \frac{km_1m_2}{r^4}$

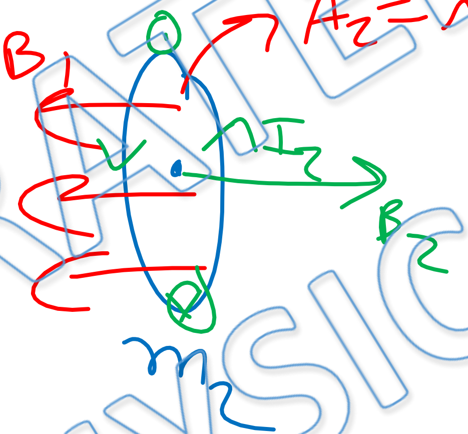
The magnitude of magnetic field of a dipole m, at a point on its axis at distance r, is $\frac{\mu_0}{2\pi}\frac{m}{r^3}$ where μ_0 is the permeability of free space. The magnitude of the force between two magnetic dipoles with moments, m_1 and m_2, separated by a distance r on the common axis, with their north poles facing each other, is $\frac{km_1m_2}{r^4}$, where k is a constant of appropriate dimensions. The direction of this force is along the line joining the two dipoles.



Q13) When the dipole m is placed at a distance r from the center of the loop (as shown in the figure), the current induced in the loop will be proportional to

(A) m/r^3 (B) m^2/r^2 (C) m/r^2 (D) m^2/r

$A_2 = \pi a^2$



$\phi_{21} = B_1 A_2$

$\phi_{22} = B_2 A_2$

$\phi_{21} = \phi_{22}$

$B_1 = B_2$

$\frac{\cancel{\mu_0}}{\cancel{2}\pi}\frac{m_1}{r^3} = \frac{\cancel{\mu_0} I_2}{\cancel{2}a} \Rightarrow I_2 = \frac{a}{\pi}\frac{m_1}{r^3}$

$F_{ext} \; dr$

$m_1 = m \quad F_{12} \propto$

$= \frac{k m m_2}{r^4}$

Difficulty Level: Difficult

Ans. A

$m_2 \longrightarrow$ not Constant

$m_2 = B_2 A_2$

$= \frac{\mu_0 I_2}{2r} \pi a^2$

$F_{ext} = F_{12}$

$dW_{ext} = -F_{ext}\, dr$

$= \frac{\mu_0 \cancel{\pi} a}{2} \frac{a}{\cancel{\pi}} \frac{m}{r^3}$

$W_{ext} = -\frac{\cancel{K} m^2 \mu_0 a^2}{2} \int_{\infty}^{r} \frac{dr}{r^7}$

$m_2 = \frac{\mu_0 a^2}{2} \frac{m}{r^3}$

$W_{ext} = \frac{-K m^2 \mu_0 a^2}{-6} \left[\frac{1}{r^6} \right]_{\infty}^{r}$

$F_{ext} = \frac{K m}{r^4} \frac{\mu_0 a^2}{2} \frac{m}{r^3}$

$= \frac{\cancel{+} K m^2 \mu_0 a^2}{\cancel{+} 6} \frac{1}{r^6} \propto \frac{m^2}{r^6}$

JEE Adv. 2021 (P-2)

Q14) The work done in bringing the dipole from infinity to a distance r from the center of the loop by the given process is proportional to

(A) m/r^5

(B) m^2/r^5

(C) m^2/r^6

(D) m^2/r^7

Difficulty Level: Difficult

Ans. C

Paragraph (Q15 to Q16)

JEE Adv. 2021 (P-2)

A thermally insulating cylinder has a thermally insulating and frictionless movable partition in the middle, as shown in the figure below. On each side of the partition, there is one mole of an ideal gas, with specific heat at constant volume, $C_V = 2R$. Here, R is the gas constant. Initially, each side has a volume V_0 and temperature T_0. The left side has an electric heater, which is turned on at very low power to transfer heat Q to the gas on the left side. As a result the partition moves slowly towards the right reducing the right side volume to $V_0/2$. Consequently, the gas temperatures on the left and the right sides become T_L and T_R, respectively. Ignore the changes in the temperatures of the cylinder, heater and the partition.

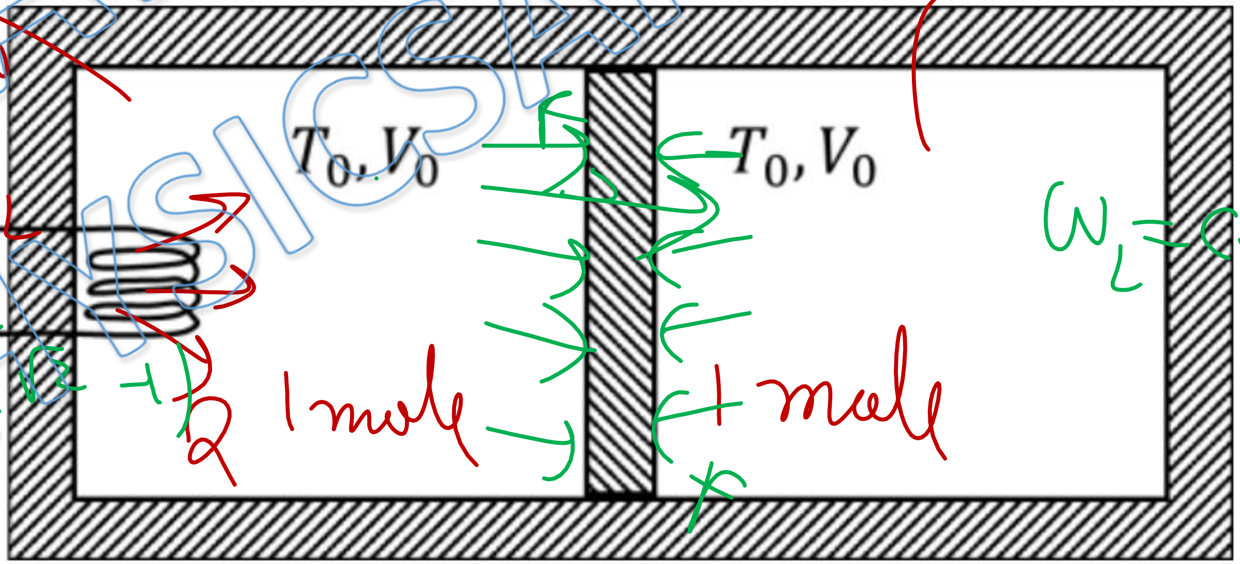
adiabatic

$\Delta Q = \Delta U + \Delta W$

$Q = 1\,C_v(T_L - T_0) + W_L$

$Q = C_v(3\sqrt{2}-1)T_0 + C_v T_0(\sqrt{2}-1)$

$\frac{Q}{C_v T_0} = 4\sqrt{2} - 2$



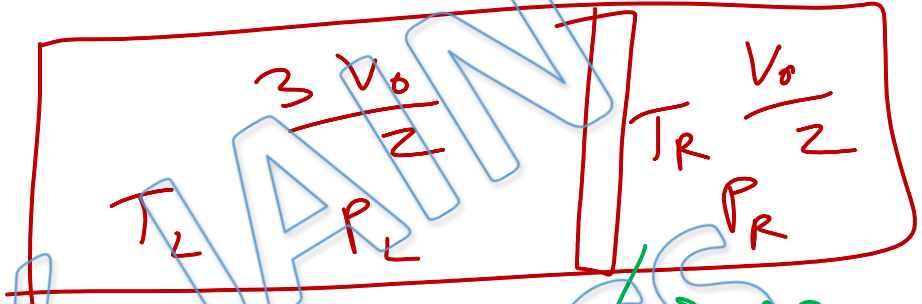
$W_L = -W_R$

$W_L = C_v(\sqrt{2}-1)T_0$

Q15) The value of $\frac{T_R}{T_0}$ is

$TV^{\gamma-1} = \text{Const}$

$T\sqrt{V} = \text{Const}$



(A) $\sqrt{2}$ (B) $\sqrt{3}$ (C) 2 (D) 3

$\Delta Q = \Delta U + \Delta W$

$0 = 1C_V(T_R - T_0) + W_R$

$W_R = -C_V(T_R - T_0) = -C_V(\sqrt{2}-1)T_0$

$C_V = 2R$

$C_P = C_V + R = 3R$

$\gamma = \frac{C_P}{C_V} = \frac{3}{2}$

$\gamma - 1 = 1/2$

$T_0\sqrt{V_0} = T_R\sqrt{\frac{V_0}{2}}$

$T_R = \sqrt{2}\,T_0$

Difficulty Level: Difficult

Ans. A

$P = \frac{nRT}{V}$

Since Partition is in eq^{bm}

~~P_R =~~

$P_R = P_L$

$\frac{1\,\cancel{R}\,T_R}{3\cancel{V_0}/2} = \frac{1\,\cancel{R}\,T_L}{\cancel{V_0}/2}$

$T_R = 3T_L = 3\sqrt{2}T_0$

JEE Adv. 2021 (P-2)

Q16) The value of $\frac{Q}{RT_0}$ is

(A) $4(2\sqrt{2} + 1)$ (B) $4(2\sqrt{2} - 1)$ (C) $(5\sqrt{2} + 1)$ (D) $(5\sqrt{2} - 1)$

$$\frac{Q}{C_v T_0} = 4\sqrt{2} - 2$$

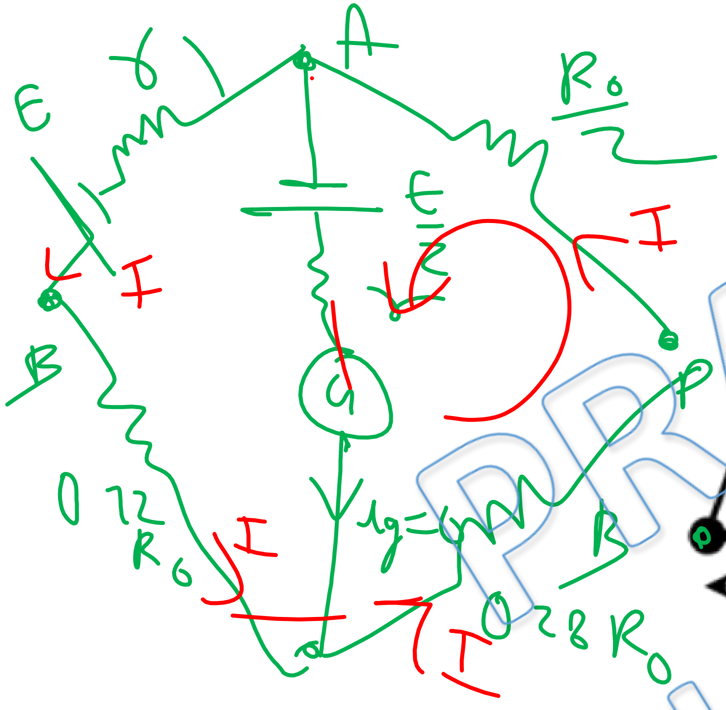
$$\frac{Q}{2RT_0} = 2(2\sqrt{2} - 1)$$

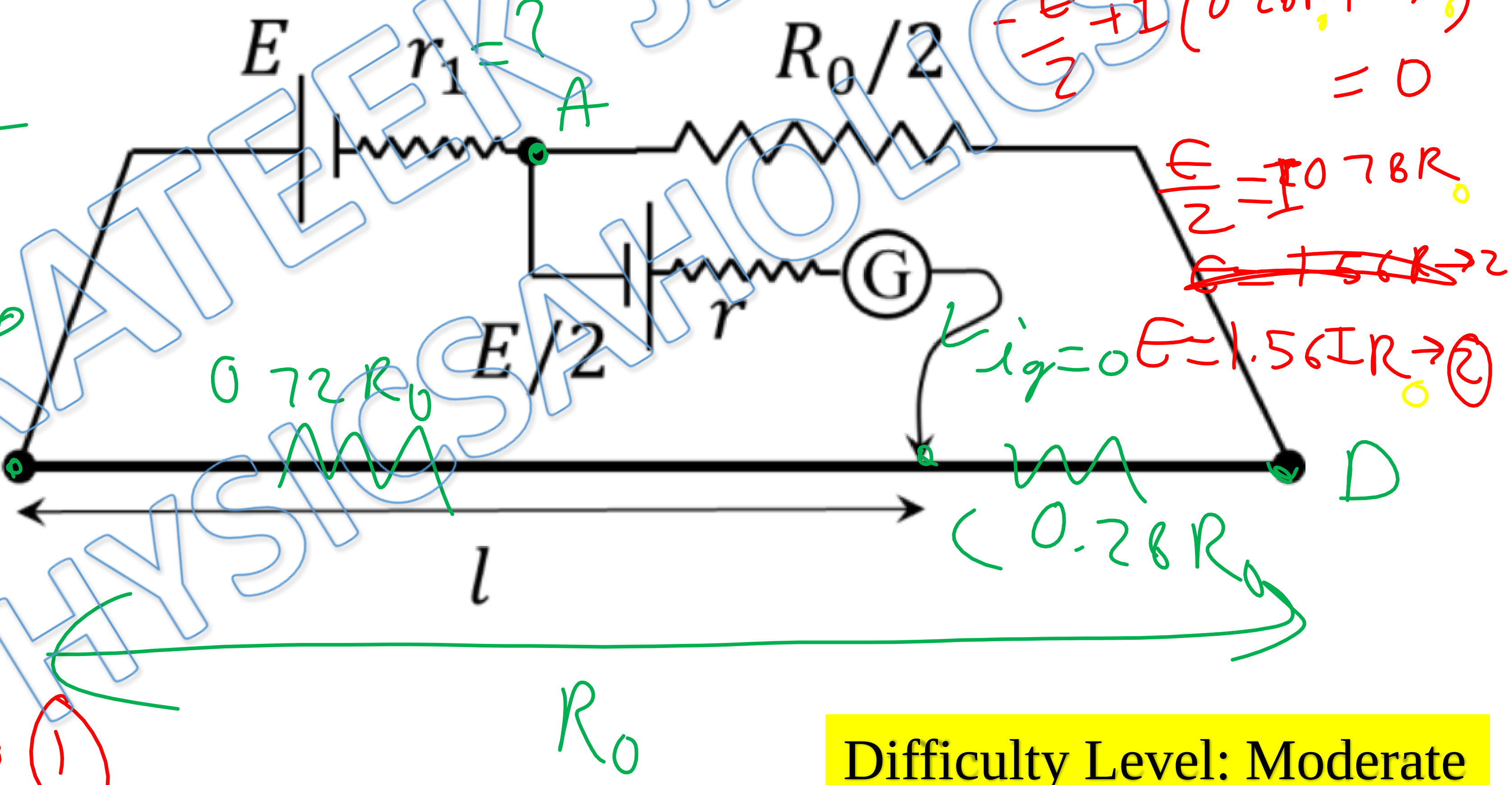
$$\frac{Q}{RT_0} = 4(2\sqrt{2} - 1)$$

Difficulty Level: Difficult

Ans. B

Q17) In order to measure the internal resistance r_1 of a cell of emf E, a meter bridge of wire resistance $R_0 = 50\ \Omega$, a resistance $R_0/2$, another cell of emf $E/2$ (internal resistance r) and a galvanometer G are used in a circuit, as shown in the figure. If the null point is found at l =72 cm, then the value of r_1 = 3 ___ Ω.





$$-\frac{E}{2} + I(0.28R_0 + 0.5R_0) = 0$$

$$\frac{E}{2} = I\,0.78R_0$$

$$\cancel{E = 1.56 R_0} \rightarrow 2$$

$$E = 1.56 I R_0 \rightarrow (2)$$

$$I = \frac{E}{1.5R_0 + r_1} \rightarrow (1)$$

Difficulty Level: Moderate

Ans. 3

$$\cancel{I} = \frac{156\,\cancel{I}\,R_0}{15R_0 + r_1}$$

$$15R_0 + r_1 = 1.56R_0$$

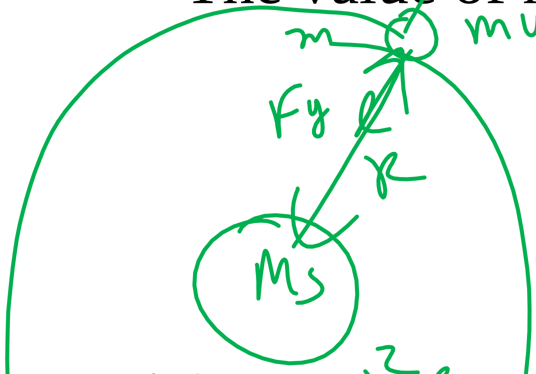
$$r_1 = 0.06R_0$$

$$r_1 = 0.06 \times 50 = 3\,\Omega$$

JEE Adv. 2021 (P-2)

Binary Star System

Q18) The distance between two stars of masses $3M_S$ and $6M_S$ is $9R$. Here R is the mean distance between the centers of the Earth and the Sun, and M_S is the mass of the Sun. The two stars orbit around their common center of mass in circular orbits with period nT, where T is the period of Earth's revolution around the Sun. The value of n is $\underline{\ 9\ }$.



$$\frac{GmM_S}{R^2} = m\omega^2 R$$

$$\omega = \sqrt{\frac{GM_S}{R^3}}$$

$$T = 2\pi\sqrt{\frac{R^3}{GM_S}}$$

$d = 9R$

$$T' = \frac{2\pi}{\omega'}$$

$$nT = 2\pi \times 9\sqrt{\frac{R^3}{GM_S}}$$

$$nT = 9T$$

Difficulty Level: Moderate

Ans. 9

$$F_g = \frac{G m_1 m_2}{d^2}$$

$$F_{CF} = m_2 \omega'^2 (3R)$$

$$\omega' = \sqrt{\frac{G(m_1 + m_2)}{\cancel{R}\, d^3}}$$

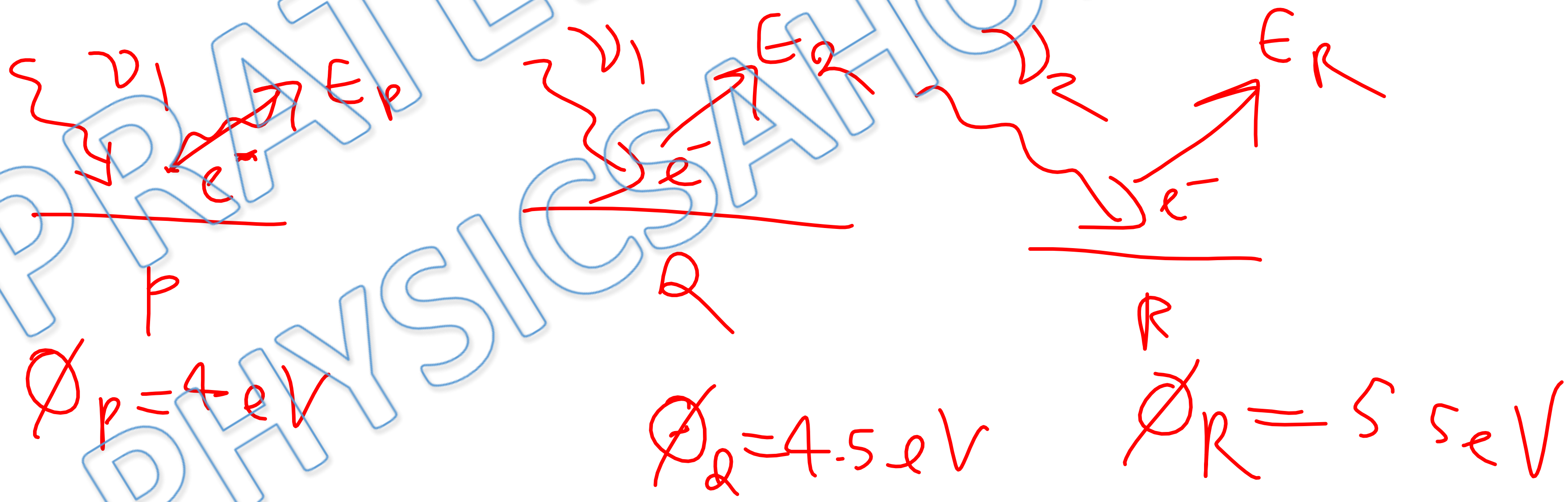
$$F_g = F_{CF}$$

$$\frac{G m_1 \cancel{m_2}}{d^2} = \cancel{m_2}\, \omega'^2 (3R)$$

$$\sqrt{\frac{G m_1}{81 R^2 \times 3R}} = \omega' = \sqrt{\frac{G\, \cancel{3} m_s}{81 R^3 \times \cancel{3}}} = \frac{1}{9}\sqrt{\frac{G m_s}{R^3}}$$

$h\nu_2 = ?$

Q19) In a photoemission experiment, the maximum kinetic energies of photoelectrons from metals P, Q and R are E_P, E_Q and E_R, respectively, and they are related by $E_P = 2E_Q = 2E_R$. In this experiment, the same source of monochromatic light is used for metals P and Q while a different source of monochromatic light is used for the metal R. The work functions for metals P, Q and R are 4.0 eV, 4.5 eV and 5.5 eV, respectively. The energy of the incident photon used for metal R, in eV, is __6__.



Difficulty Level: Easy

Ans. 6

$$K_{max} = h\nu - \phi$$

$$E_P = h\nu_1 - 4$$

$$E_Q = h\nu_1 - 4.5$$

$$E_R = h\nu_2 - 5.5$$

$$E_P = 2E_Q$$

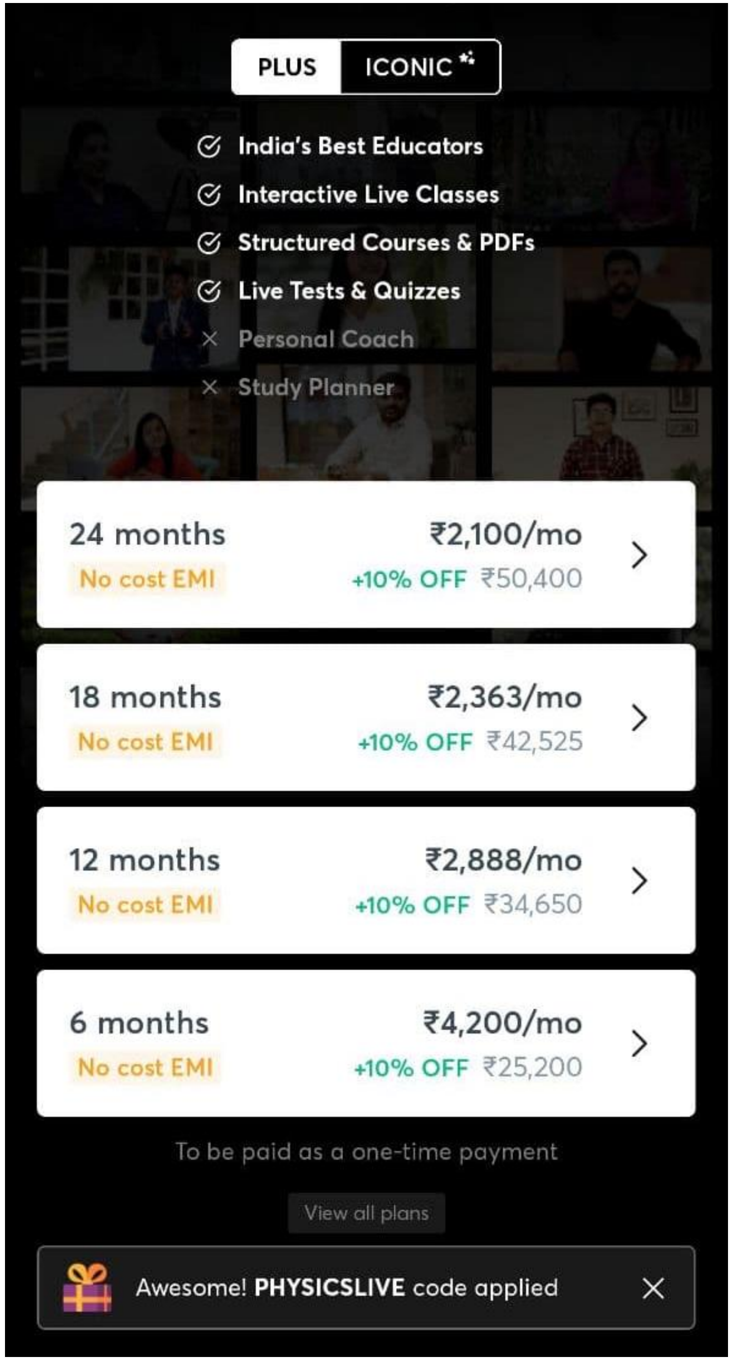
$$h\nu_1 - 4 = 2h\nu_1 - 9$$

$$5 = h\nu_1$$

$$h\nu_2 = E_R + 5.5 = E_Q + 5.5 = h\nu_1 - 4.5 + 5.5$$

$$h\nu_2 = h\nu_1 + 1$$

$$h\nu_2 = 5 + 1 = 6\,eV$$



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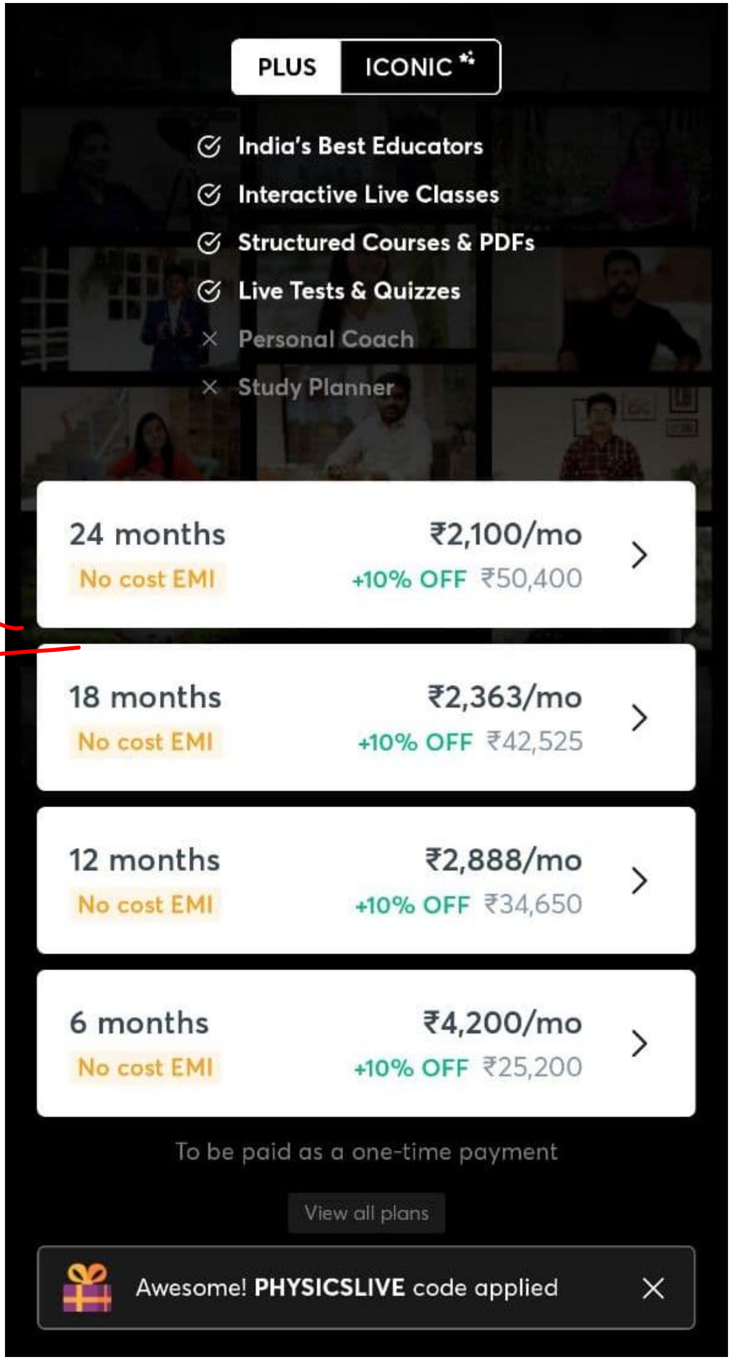

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