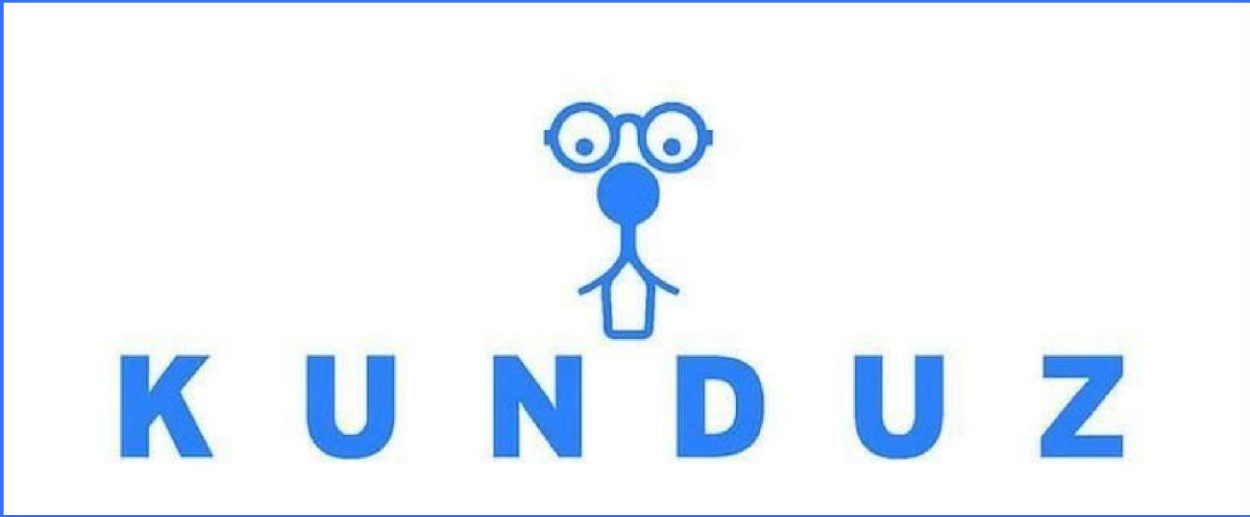


JEE Mains 2nd September 2020 shift 2 Physics solutions prepared by KUNDUZ tutors

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Question number

Question and Answers

1

1 Two disc having moment of inertia of inertia I_1 and I_2 and angle velocities ω_1, ω_2 are placed coaxially find total KE when they have same angular velocity

$I_1 = 0.10\ kg\text{-}m^2$ $\quad I_2 = 0.20\ kg\text{-}m^2$

$\omega_1 = 10\ Rad\,s^{-1}$ $\quad \omega_2 = 5\ Rad\,s^{-1}$

(I) 0 J (II) 5 J (III) 10 J (IV) $\frac{20}{3}$ J

Ans → By conservation of angular momentum

$$\underbrace{(I_1 + I_2)\,\omega}_{\text{Final } \vec{L}} = \underbrace{I_1\omega_1 + I_2\omega_2}_{\text{Initial } \vec{L}}$$

$$\omega = \quad = \frac{1+1}{0.3} = \frac{20}{3}\ Rad\,s^{-1}$$

$$K_f = \frac{1}{2} I_1\omega^2 + \frac{1}{2} I_2\omega^2$$

$$= \frac{\omega^2}{2}(I_1 + I_2)$$

$$= \left(\frac{20}{3}\right)^2 \times \frac{1}{2} \times \frac{3}{10}$$

$$= \frac{20}{3}\ J$$

2

2 A rod is heated from 0 to 10°C its length changes by 0.02%. What is its change in mass density?

(1) 0.02 (2) 0.04 (3) 0.06 (4) 0.08

Sol 1) By expansion law in 1-D

$$\ell = \ell_0 (1 + \alpha \Delta\theta)$$

α → Coeff. of Thermal expansion; $\Delta\ell$ → Change in length

Sol i.e. $\Delta L = L \alpha \Delta\theta$

$$\Rightarrow \alpha = \frac{\Delta L}{L \Delta\theta}$$

Given $\frac{\Delta L}{L} = 0.02\% = \frac{0.02}{100}$

$\Delta\theta = 10^\circ C$

$$\alpha = \frac{0.02}{100 \times 10} = 2 \times 10^{-5}$$

$$\eta = 3\alpha = 6 \times 10^{-5}$$

η → Coeff. of volumetric expansion

We have $\frac{\Delta V}{V} = \eta \cdot \Delta\theta$

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

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

% increase in volume = 0.06%

Since mass is unchanged, change in mass density will be 0.06%. (C)

3

3 A capillary of radius 0.15 mm is dipped in a liquid of density $\rho = 667\ Kg/m^3$. If surface tension of liquid is $0.05\ N m^{-1}$, find the height up to which liquid rises in capillary. Angle of contact between liquid and capillary tube is 60°. ($g = 10\ ms^{-2}$)

Ans → By the formula

$$h = \frac{2T\cos\theta}{\rho g r}$$

$\theta = 60°$

$\rho = 667\ Kg/m^3$

$T = \frac{1}{20}\ N m^{-1}$

$r = 0.15 \times 10^{-3}$

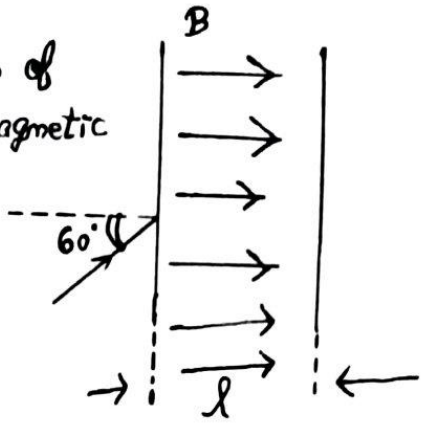
$$= \frac{2 \times \frac{1}{20} \times \frac{1}{2}}{667 \times 10 \times 0.15 \times 10^{-3}}$$

$$= \frac{1000 \times 100 \times 1}{667 \times 10 \times 15 \times 2}$$

$$= 0.05\ m = 5\ cm$$

4

Q4 The figure shows the region of length 'l' with a uniform magnetic field of 0.3T in it and a proton entering the region with velocity $4\times10^{5}\ ms^{-1}$ making an angle of 60° with the field. If the proton completes 10 revolution by the time it cross the region shown, 'l' is close to (mass of proton = 1.67×10^{-27} kg charge of the proton = 1.6×10^{-19} C)



(1) 0.22m (2) 0.88m (3) 0.44m (4) 0.11m

Sol)

$$\text{pitch} = t \times V\cos(60^\circ)$$

Also $$R = \frac{mV\sin(60^\circ)}{qB}$$

$$\Rightarrow t = \frac{2\pi R}{V\sin(60^\circ)} = \frac{2\pi m}{qB}$$

$$\Rightarrow \text{pitch} = \frac{2\pi}{qB} mV\cos(60^\circ)$$

Given that $l = 10 \times \text{pitch}$

$$\Rightarrow l = 10 \times \frac{2\pi}{qB} mV\cos(60^\circ)$$

$$\Rightarrow \boxed{l = 0.44\ m}$$

Thus, option 3 is correct.

5

5 A closed box contains an ideal gas if temperature of gas increased which:

(A) Mean free path remain same
(B) Relaxation time remains same
(C) Relaxation time decreases.
(D) Mean path decreases.

Ans → By definition,

$$\lambda = \frac{1}{\sqrt{2}\left(\frac{N}{V}\right)\pi d^2}$$

λ: Mean free path; d: diameter of molecule; N: No. of molecules; V: volume of container

Since velocity constant and no. of molecules are unchanged

so mean path remains same.
With temperature, the collision frequency will increase and relaxation time decreases.

6

6 In H-atom electron jumps from $(n+1)^{th}$ state to n^{th} state the frequency of emitted photon is directly proportional to $(n >>> 1)$

Ans → We know that Energy at state n, E_n

$$E_n \propto -\frac{1}{n^2}$$

i.e. $$E_n = \frac{-K}{n^2} \rightarrow \text{constant}$$

So, $$E_{n+1} = \frac{-K}{(n+1)^2}$$

$$\Rightarrow \Delta E = E_{n+1} - E_n$$

$$\Rightarrow \Delta E = K\left[\frac{1}{n^2} - \frac{1}{(n+1)^2}\right]$$

$$= K\left[\frac{(n+1)^2 - n^2}{n^2(n+1)^2}\right]$$

$$= K\left[\frac{1+2n}{n^2(n+1)^2}\right]$$

Since $n >>> 1$, $1+2n \approx 2n$

$n+1 \approx n$

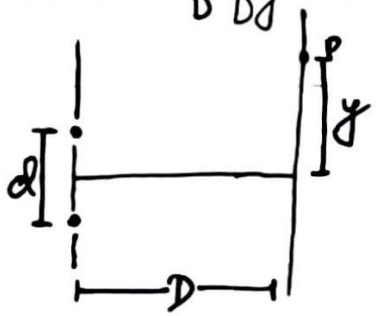
$$\Rightarrow \Delta E = K \times \frac{2n}{n^4}$$

$$= \frac{2K}{n^3}$$

$$\Rightarrow \boxed{\Delta E \propto \frac{1}{n^3}} \rightarrow \text{Answer}$$

7

7 In YDSE when $\lambda = 700$ nm then total number of figure b/w O and P is 16. When $\lambda = 400$ nm then total number of figure between O and P is



(I) 14 (II) 28 (III) 7 (IV) 12

Ans → By formula

$$\frac{y}{D} = \frac{m_1\lambda_1}{d} = \frac{m_2\lambda_2}{d}$$

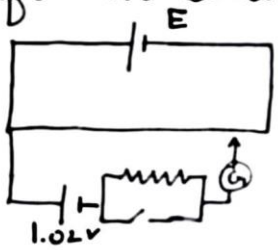
$$\Rightarrow \frac{m_2}{m_1} = \frac{\lambda_1}{\lambda_2}$$

$$\Rightarrow m_2 = \frac{700}{400} \times 16 = 28$$

Ans → 28 (B)

8

8 In given potentiometer 1.02 V is balanced at 51 cm from A. Find potential gradient of wire AB.

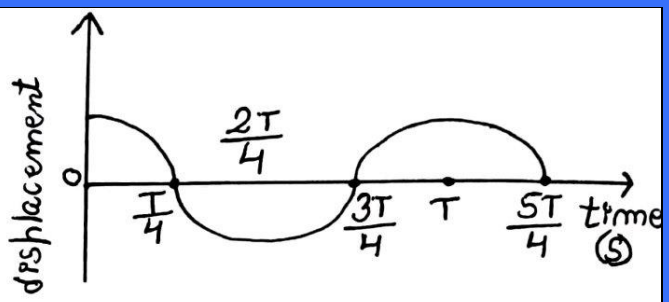


Ans→ By defition, $X = \frac{V}{\ell} = \frac{1.02\,V}{51\,cm} = 0.2\ V/cm$

(X: potential gradient)

9

Eg. The displacement time graph of a particle executing SHM is given in figure: (sketch is schematic and not to scale).



Which of the following statements is/are true for this motion?

(A) The force is zero at $t = \frac{3T}{4}$

(B) The acceleration is maximum at $t = T$

(C) The speed is maximum at $t = \frac{T}{4}$

(D) The P.E. is equal to K.E. of the oscillation at $t = \frac{T}{2}$

(1) (B), (C) and (D)
(2) (A) and (D)
(3) (A), (B) and (D)
(4) (A), (B) and (C)

Sol) From graph we can say that $x = A\cos(\omega t)$

A) At $t = \frac{3T}{4}$, it is mean position $\Rightarrow$ force = 0

B) At $t = T$, It is extreme position $\Rightarrow$ a = maximum.

C) At $t = T/4$, it is mean position $\Rightarrow$ V = maximum.

D) $PE = \frac{1}{2}Kx^2$, $KE = \frac{1}{2}KA^2 - \frac{1}{2}Kx^2$

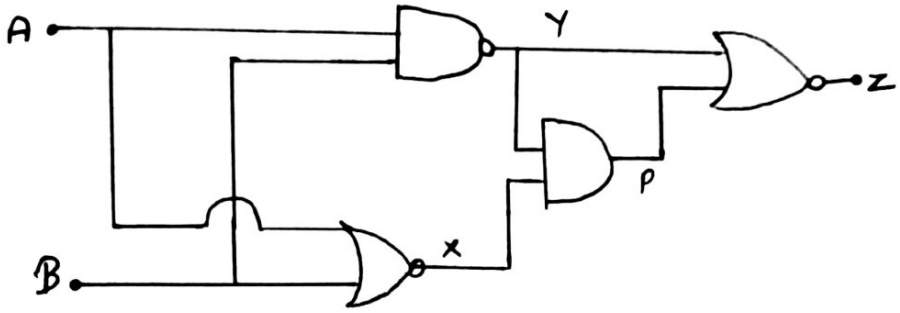
$\Rightarrow PE = KE \Rightarrow \frac{1}{2}KA^2 = Kx^2 \Rightarrow x = \pm A/\sqrt{2}$

$\Rightarrow$ at $t = T/8$

Thus, option 4 is correct.

10

Q10. In the following, digital circuit, what will be the output a 'Z', when the input (A, B) are (1,0), (0,0), (1,1), (0,1)



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

Sol> $X = \overline{A+B} = \overline{A} + \overline{B} = \bar{A} \cdot \bar{B}$

$Y = \overline{A \cdot B} = \bar{A} + \bar{B}$

$\Rightarrow P = X \cdot Y = (\bar{A} \cdot \bar{B}) \cdot (\bar{A} + \bar{B})$

$= \bar{A} \cdot \bar{B} + \bar{A} \cdot \bar{B} = \bar{A} \cdot \bar{B}$

$\Rightarrow Z = \overline{Y + P} = \overline{((\bar{A} \cdot \bar{B}) + \bar{A} + \bar{B})}$

$\Rightarrow Z = \overline{\bar{A} + \bar{B}} = A \cdot B$

Truth table

A	B	Z = A·B
1	0	0
0	0	0
1	1	1
0	1	0

Thus, option 4 is correct.

11

11 If area (A), time (T) and momentum (P) is assumed as fundamental quantities, then dimensional formula of energy will be.

Sol 3) let Energy in dimension of A, T and P be

$$E = A^x T^y P^z$$

since $A = L^2$ $P = MLT^{-1}$

and $E = ML^2T^{-2}$

so, we have

$$ML^2T^{-2} = L^{2x+z} M^z T^{y-z}$$

Equating the powers

$z = 1$ (M) $\quad 2x + z = 2$ (L) $\quad y - z = -2$ (T)

we get

$2x = 1 \Rightarrow x = 1/2$

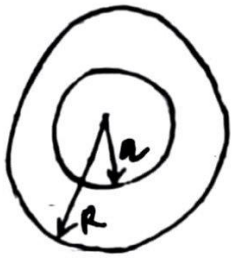
and $y = -1$

so

$$E = P A^{1/2} T^{-1}$$ (option 3)

12

12 Charge Q is distributed on two concentric spheres of radius r and R respectively. If charge density of both spheres is same then electric potential at the center will be.



Ans → By definition

$Q_2 = \sigma \cdot 4\pi R^2$

$Q_1 = \sigma \cdot 4\pi r^2$

$Q = Q_1 + Q_2$

$= \sigma \cdot 4\pi (R^2 + r^2)$ ---;

$\Rightarrow \sigma = \frac{Q}{4\pi(R^2+r^2)}$

Potential at center $= \frac{KQ_1}{r} + \frac{KQ_2}{R}$

$= K\left(4\pi r\sigma + 4\pi R\sigma\right)$

$= K \times 4\pi\sigma\ (r+R)$

$= K \times 4\pi \times \frac{Q}{4\pi(R^2+r^2)}(R+r)$

$= \frac{KQ(R+r)}{(R^2+r^2)}$

Ans → $V_C = \frac{KQ(R+r)}{R^2+r^2}$

13

13 $\vec{E}$ and $\vec{B}$ in an electronic wave oscillate along the directions having unit vectors $\hat{k}$ and $\hat{i}-\hat{j}$. Find unit vector along direction of propagation.

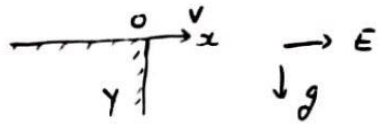
Ans → The direc^{n} of propagation can be found out using the cross product of $\vec{E}$ and $\vec{B}$

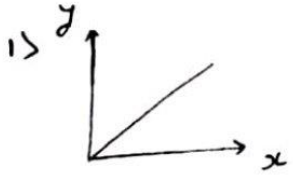
$$\vec{E} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 1 \\ 1 & -1 & 0 \end{vmatrix} = \hat{i}+\hat{j}$$

unit vector $= \dfrac{\hat{i}+\hat{j}}{\sqrt{2}}$

14

14 A particle having mass m and charge q is Projected horizontally from point O. charge correct from:



1) 

2) 

3) 

4) 

Sol) Given $\vec{E} = E\hat{i}$, $\vec{g} = g\hat{j}$

Acceleration in x direction = $\vec{a_x} = \frac{qE}{m}\hat{i}$

Acceleration in y direction = $\vec{a_y} = g\hat{j}$

$x = u_x t + \frac{1}{2}a_x t^2$, $y = u_y t + \frac{1}{2}a_y t^2$

$u_x = v$, $u_y = 0$

$\Rightarrow y = \frac{gt^2}{2}$ $\Rightarrow t = \sqrt{\frac{2y}{g}}$

$\Rightarrow x = v\sqrt{\frac{2y}{g}} + \frac{1}{2}\frac{qE}{m}\left[\sqrt{\frac{2y}{g}}\right]^2$ $\Rightarrow x = c_1\sqrt{y} + c_2 y$

$\Rightarrow \frac{dx}{dy} = \frac{c_1}{2\sqrt{y}} + c_2$ $\Rightarrow \frac{d^2x}{dy^2} = -\frac{c_1}{4y^{3/2}}$

$\Rightarrow \frac{d^2x}{dy^2} < 0$

Thus, graph is downward curve with respect to y axis.

Thus, option 3 is correct.

15

15 A closed box contains an ideal gas if temperature of gas increased which:

(A) Mean free path remain same
(B) Relaxation time remains same
(C) Relaxation time decreases.
(D) Mean path decreases.

Ans → By definition,

$$\lambda = \frac{1}{\sqrt{2}\left(\frac{N}{V}\right)\pi d^2}$$

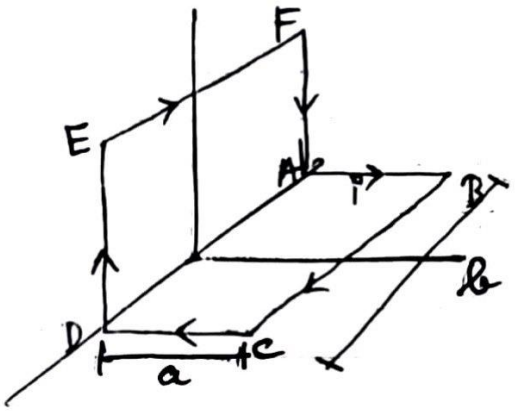
λ: Mean free path; d: diameter of molecule; N: No. of molecules; V: volume of container

Since velocity constant and no. of molecules are unchanged

so, mean path remains same.
With temperature, the collision frequency will increase and relaxation time decreases.

16

16



Find the magneti
moment of loop

Ans → Using right hand rule to find $\vec{M}$

For ABCD

$$\vec{M_1} = (ab.\,i)\,(-\hat{j})$$

↓ ↓

Area Current

For EFAD

$$\vec{M_2} = (ab.\,i)\,(-\hat{i})$$

$$\vec{M} = \vec{M_1} + \vec{M_2} = -(ab.\,i)\,(\hat{i}+\hat{j})$$

17

817. A particle is moving 5 times as fast as an electron. The ratio of the de-Broglie wavelength of the particle of that of the electron is 1.878×10^{-4}. The mass of the particle is close to:

(1) 1.2×10^{-28} kg (2) 9.7×10^{-28} kg

(3) 9.1×10^{-31} kg (4) 4.8×10^{-27} kg

Sol) V_p = velocity of particle

Given that $V_p = 5V_e$

$$\lambda_p = \frac{h}{m_p V_p}, \quad \lambda_e = \frac{h}{m_e V_e}$$

$$\frac{\lambda_p}{\lambda_e} = 1.878 \times 10^{-4} = \frac{m_e V_e}{m_p V_p}$$

$$\Rightarrow m_e V_e = 1.878 \times 10^{-4} m_p V_p$$

$$\Rightarrow \Rightarrow m_p = \frac{9.1 \times 10^{-31} \times V_e}{1.878 \times 10^{-4} \times 5V_e}$$

$$\Rightarrow \boxed{m_p = 9.7 \times 10^{-28} \text{ kg}}$$

Thus, option 2 is correct.

18

18 Accelaration due to gravity is same at height h from surface, then find h

(I) $\frac{(\sqrt{5}-1)R}{2}$ (II) $\frac{\sqrt{5}\cdot R}{2}-1$ (III) $\frac{R}{\sqrt{2}}$ (IV) $\frac{R(\sqrt{5}+1)}{2}$

Ans → using By Given conditions of question

$$\frac{GM}{(R+h)^2} = \frac{GM}{R^3}(R-h)$$

↓ At height h above surface

↳ h below the surface

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

$$\Rightarrow R^3 = R^3 - Rh^2 + hR^2 - h^3$$

$$\Rightarrow h^3 + h^2R - hR^2 = 0$$

since $h \neq 0$

$$h^2 + hR - R^2 = 0$$

By quadratic formula

$$h = \frac{-R \pm \sqrt{R^2 + 4(1)R^2}}{2}$$

$$= \cdot R\left(\frac{-1 \pm \sqrt{5}}{2}\right)$$

since R isn't -ve

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

19

Q19. A 10μF capacitor is fully to a potential of 50V. After removing the source voltage it is connected to an uncharged capacitor in parallel. Now the potential difference across them becomes 20V. The capacitance of the second capacitor is:

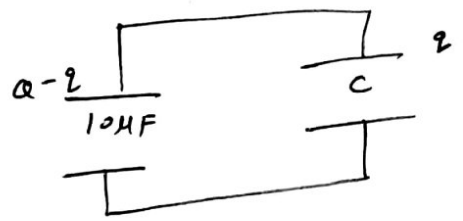
(1) 10μF (2) 20μF (3) 30μF (4) 15μF

Sol>

$Q = CV$

$\Rightarrow Q = 10\mu F \times 50V$

$= 500\mu C$



Let q charge move from first capacitor to second.

$\Rightarrow \frac{Q-q}{10\mu} = \frac{q}{C} \Rightarrow \frac{500\mu - q}{10\mu} = \frac{q}{C}$

$\Rightarrow 500\mu C - qC = 10\mu q$

$\Rightarrow q = \frac{500\mu C}{10\mu + C}$

Given that $20 = \frac{q}{C} = \frac{500\mu}{10\mu + C}$

$\Rightarrow 200\mu + 20C = 500\mu \Rightarrow \boxed{C = 15\mu F}$

Thus, option 4 is correct.

20

20 Impedance of a L-R circuit is 100 Ω and phase difference between source voltage and source current is 45° if frequency of source 1000 Hz then find inductance of coil.

(1) $25\sqrt{2}$ mH (11) $\frac{50\sqrt{2}}{\pi}$ mH (111) $\frac{25\sqrt{2}}{\pi}$ mH

(4) $\frac{20\sqrt{2}}{\pi}$ mH

Ans → $\tan\theta = \frac{X_L}{R} = \tan 45°$

$Z = \sqrt{R^2 + X_L^2}$

$Z = 100$, $R = X_L$

$\Rightarrow 100 = R\sqrt{2}$

$\Rightarrow R = 50\sqrt{2}\ \Omega$

$X_L = 50\sqrt{2}\ \Omega$

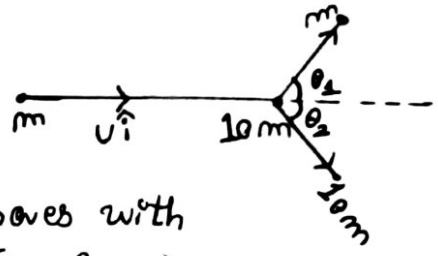
$\omega L = 50\sqrt{2}\ \Omega$

$L = \frac{50\sqrt{2}}{1000 \times 2\pi} = \frac{25\sqrt{2}}{\pi}$ mH

21

Q21.

A particle of mass m is moving along the x-axis with initial velocity $v\hat{i}$. It collides elastically with a particle of mass 10m at rest and then moves with half its initial kinetic energy (see figure). If $\sin\theta_1 = \sqrt{n}\sin\theta_2$ then the value of n is ____.



Sol) $KE_{initial} = \frac{1}{2}mv^2$

$KE_{(1m)} = \frac{1}{2} KE_{initial}$

$\Rightarrow \frac{1}{2} \times m \times V_1^2 = \frac{1}{2} \times \frac{1}{2} mv^2$

$\Rightarrow V_1 = \frac{v}{\sqrt{2}}$ { V_1 is final velocity of m }

By conservation of momentum:

$10m\, V_2 \sin(\theta_2) = m V_1 \sin(\theta_1)$

half of KE goes to 10m

$\Rightarrow V_2 = \frac{v}{\sqrt{20}}$

$\Rightarrow 10 \times \frac{v}{\sqrt{20}} \sin\theta_2 = \frac{v}{\sqrt{2}} \times \sin(\theta_1)$

$\Rightarrow \sin(\theta_1) = \sqrt{10}\sin\theta_2 \Rightarrow \boxed{n = 10}$

22

22 Young's modulus of a string of length 1m and density 900 kg/m³ is 9×10^9 N/m². Find min^m resonance frequency (in Hz) can be produced in the string if strain in it is 4.9×10^{-4}

Ans→ By definition,

$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}} = \frac{1}{2l}\sqrt{\frac{T}{\rho A}} = \frac{1}{2l}\times\frac{\sqrt{Y\Delta l}}{\sqrt{\rho l}}$$

$$f = \frac{1}{2l}\sqrt{\frac{Y\Delta l}{\rho l}} \quad \left(\text{given } \frac{\Delta l}{l} = 4.9\times10^{-4}\right)$$

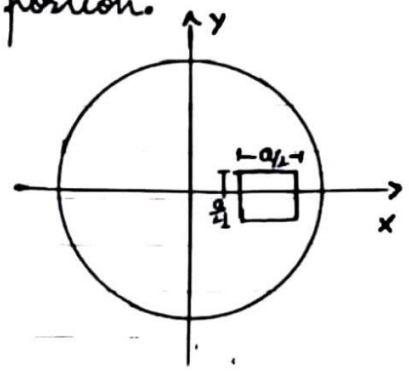
$$= \frac{1}{2\times1}\sqrt{\frac{9\times10^9\times4.9\times10^{-4}}{100}}$$

$$= \frac{1}{2}\sqrt{49\times10^{9-4-2}}$$

$$= \frac{1}{2}\times70 = 35 \text{ Hz}$$

23

23 A square of side $\frac{a}{2}$ is removed from a disc having radius a. Find center of mass of remaining portion.



(i) $x = \frac{-2a}{\pi}$ (ii) $\frac{-a}{8\pi-2}$ (iii) $\frac{-4a}{3\pi}$ (iv) $\frac{-a}{3\pi-4}$

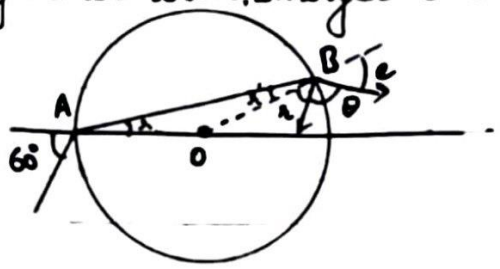
Ans → CoM of square is at $\frac{a}{2}$

$$X_a = \frac{A.x - A_1 x_1}{A - A_1} = \frac{\pi a^2 \times 0 - \frac{a^2}{4} \times \frac{a}{2}}{\pi a^2 - \frac{a^2}{4}}$$

$$= \frac{-a/8}{\pi - \frac{1}{4}} = \frac{-a}{8\pi - 2}$$

24

Q24 Light incident on a slhoe of refractive index $\sqrt{3}$ fleced in air as shown in figure. Find the angle (θ) in degree between emergent and reflected ray.



Ans→ Applying snell's law at A

$$1 \sin 60^\circ = \sqrt{3} \sin r$$
$$r = 30^\circ$$

By geometry, $r' = r = 30^\circ$

By snell's law at B

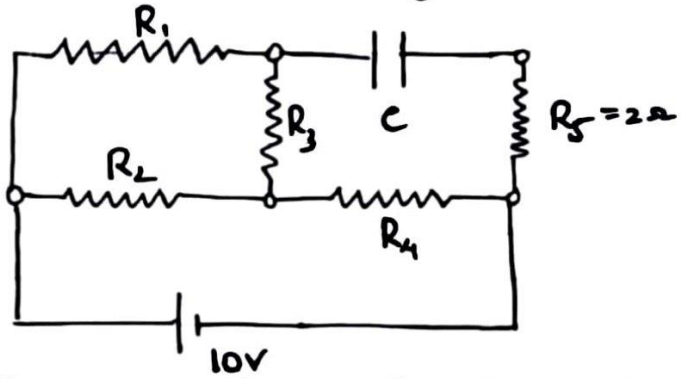
$$\sqrt{3} \sin 30^\circ = 1 \cdot \sin e$$
$$e = 60^\circ$$

By geometry, $r + \theta + e = 180^\circ$

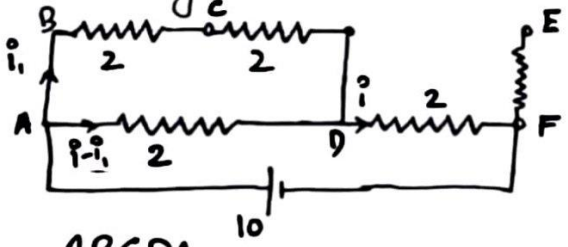
$$\theta = 180^\circ - 60^\circ - 30^\circ$$
$$= 90^\circ$$

25

Q25 $R_1 = R_2 = R_3 = R_4 = 2\,\Omega$. Find voltage across capacitor at steady state.



Sol) The current through the capacitor branch will be zero. (steady state). The circuit can be redrawn as



In ABCDA

$$4i_1 - 2(i - i_1) = 0$$

$$6i_1 = 2i \Rightarrow i_1 = i/3$$

Also, $i = \dfrac{10}{\frac{4}{3} + 2} = 3A \Rightarrow i_1 = 1A$

$$V_{CE} = 2(i_1) + 2(i)$$

$$= 2 + 2 \times 3$$

$$= 8V$$

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