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JEE (Main)

PAPER-1 (B.E./B. TECH.)

2023

COMPUTER BASED TEST (CBT)

Questions & Solutions

Date: 25 January, 2023 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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PART : PHYSICS

1. In Young's double slits experiment, the position of 5th bright fringe from the central maximum is 5 cm. The distance between slits and screen is 1 m and wavelength of used monochromatic light is 600 nm. The separation between the slits is :

(1) 12 μm (2) 60 μm (3) 36 μm (4) 48 μm

Ans. **(2)**

Sol. For bright fringe $x = \frac{n\lambda D}{d}$

$5 \times 10^{-2} = \frac{5\times600\times10^{-9}\times1}{d}$

$d = 600 \times 10^{-7}$

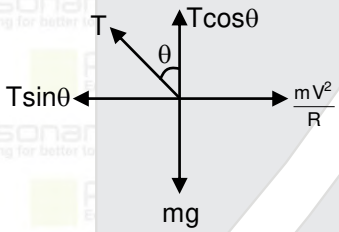
$d = 60 \times 10^{-6} = 60\mu m$

2. A car is moving with a constant speed of 20 m/s in a circular horizontal track of radius 40m. A bob is suspended from the roof of the car by a massless string. The angle made by the string with the vertical will be ; (Take g = 10m/s^2)

(1) $\frac{\pi}{6}$ (2) $\frac{\pi}{2}$ (3) $\frac{\pi}{4}$ (4) $\frac{\pi}{3}$

Ans. **(3)**

Sol.



$T\sin\theta = \frac{mV^2}{R}$ .....(i)

$T\cos\theta = mg$ .....(ii)

(i) & (ii) $\Rightarrow \tan\theta = \frac{V^2}{Rg}$

$\theta = \tan^{-1}\left(\frac{V^2}{Rg}\right)$

$\theta = \tan^{-1}\left(\frac{(20)^2}{40\times10}\right) = \tan^{-1}(1)$

$\theta = \frac{\pi}{4}$

3. An electromagnetic wave is transporting energy in the negative z direction. At certain point and certain time the direction of electric field of the wave is along positive y direction. What will be the direction of the magnetic field of the wave at that point and instant?

(1) Positive direction of z (2) Negative direction of y

(3) Positive direction of x (4) Negative direction of x

Ans. **(3)**

Sol. As K (propagation constant), E (Electric field) & B (Magnetic field) are mutually for to each other.

$\hat{B} = \hat{k} \times \hat{E}$ or right hand thumb rule

$\hat{B} = -\hat{z} \times \hat{y}$

$\hat{B} = -(-\hat{x}) = \hat{x}$

direction of $\vec{B}$ is along x-axis.

4. The root mean square velocity of molecules of gas is

(1) Inversely proportional to square root of temperature $\left(\sqrt{\frac{1}{T}}\right)$

(2) Proportional to square root of temperature $\left(\sqrt{T}\right)$

(3) Proportional to square of temperature (T^2)

(4) Proportional to temperature (T)

Ans. **(2)**

Sol. $V_{rms} = \sqrt{\frac{3RT}{m}}$

$V_{rms} \propto T^{1/2}$

5. Electron beam used in an electron microscope. When accelerated by a voltage of 20 kV, has a de-Broglie wavelength of λ_0. If the voltage is increased 40kV, then the de-Broglie wavelength associated with the electron beam would be :

(1) $\frac{\lambda_0}{2}$ (2) $3\lambda_0$ (3) $\frac{\lambda_0}{\sqrt{2}}$ (4) λ_0

Ans. **(3)**

Sol. $\lambda_0 = \frac{h}{\sqrt{2m \times E}} = \frac{h}{\sqrt{2m \times 20}}$

$\lambda_2 = \frac{h}{\sqrt{2m \times 40}}$

$\lambda_2 = \frac{\lambda_0}{\sqrt{2}}$

6. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R

Assertion A : Photodiodes are used in forward bias usually for measuring the light intensity.

Reason R : For a p-n junction diode, at applied voltage V rthe current in the forward bias is more than the current in the reverse bias for $|V_z| > \pm V \geq |V_0|$ where V_0 is the threshold voltage and V_z is the breakdown voltage.

In the light of the above statements, choose the correct answer from the option given below

(1) A is true but R is false

(2) A is false but R is true

(3) Both A and R are true but R is NOT the correct explanation A

(4) Both A and R are true and R is correct explanation A

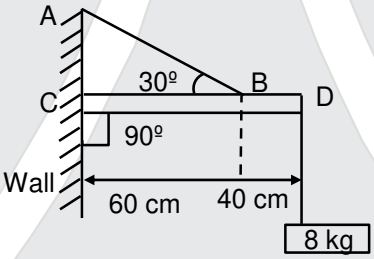
Ans. **(2)**

7. The ratio of the density of oxygen nucleus ($^{16}_{8}O$) and helium nucleus $\left(^{4}_{2}He\right)$ is

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

Ans. **(2)**

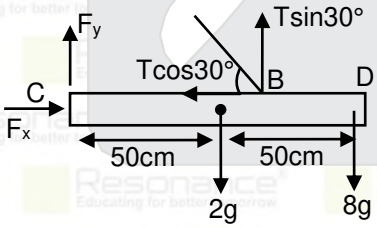
8. An object of mass 8 kg is hanging from one and of a uniform rod CD of mass 2 kg and length 1m pivoted at its end C on a vertical wall as shown in figure. It is supported by a cable AB such that the system is in equilibrium. The tension in the cable is : (Take g = 10 m/s^2)



(1) 240 N (2) 30 N (3) 300 N (4) 90 N

Ans. **(3)**

Sol. FBD of ROD CD



As system is in equilibrium. net torque about point C = 0

$T\sin\frac{\pi}{6} \times 60 - 8g \times 100 - 2g \times 50 = 0$

T = 300 N

9. A uniform metallic wire carries a current 2 A, when 3.4 V battery is connected across it. The mass of uniform metallic wire is 8.92×10^{-3} kg, density is 8.92×10^3 kg / m^3 and resistivity is $1.7 \times 10^{-8}\ \Omega$ – m. The length of wire is :

(1) ℓ = 10 m (2) ℓ = 100 m (3) ℓ = 5 m (4) ℓ = 6.8 m

Ans. **(1)**

Sol. Given m = 8.92×10^{-3} kg, I = 2A, V = 3.4 Volt, $\rho' = 8.92 \times 10^3$ kg/m^3 and $\rho = 1.7 \times 10^{-8}\ \Omega$–m

$$R = \frac{V}{i} = \frac{3.4}{2}$$

$$R = \rho\frac{\ell}{A} \qquad \therefore \quad m = \rho'(\text{Volume})$$

$$= \rho' \times A \times \ell$$

$$A = \frac{m}{\rho'\ell} \qquad ....(1)$$

From equation (1)

$$R = \rho\frac{\rho'\ell^2}{m}$$

$$\frac{3.4}{2} = \frac{1.7\times10^{-8}\times8.92\times10^3\times\ell^2}{8.92\times10^{-3}}$$

$$\ell^2 = 100 \Rightarrow \ell = 10$$

10. A message signal of frequency 5 kHz is used to modulate a carrier signal of frequency 2 MHz.. The bandwidth for amplitude modulation is :

(1) 10 kHz (2) 2.5 kHz (3) 20 kHz (4) 5 kHz

Ans. **(1)**

Sol. $\Delta\omega = 2\omega_m$

$\Delta f = 2f_m = 2 \times 5$ KHz

$\Delta f = 10$ KHz

11. T is the time period of simple pendulum on the earth's surface. Its time period becomes x T when taken to a height R (equal to earth's radius) above the earth's surface. Then, the value of x will be :

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

Ans. **(4)**

Sol. $T = 2\pi\sqrt{\frac{\ell}{g}}$

When pendulum at height R

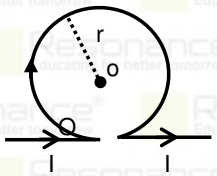
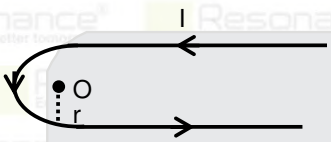
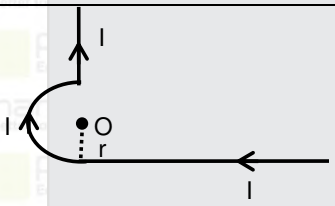
$$T' = 2\pi\sqrt{\frac{\ell}{g'}}$$

$$g' = \frac{g}{\left(1+\frac{h}{R}\right)^2} = \frac{g}{\left(1+\frac{R}{R}\right)^2} = \frac{g}{2^2} = \frac{g}{4}$$

$$T' = 2\pi\sqrt{\frac{\ell}{g/4}} = 2\pi\sqrt{\frac{4\ell}{g}} = 4\pi\sqrt{\frac{\ell}{g}} \ ; \quad \frac{T'}{T} = 4\pi\sqrt{\frac{\ell}{g}}\times\frac{1}{2\pi}\sqrt{\frac{g}{\ell}} = 2 \quad ; \ T' = 2T.$$

x = 2

12. Match List - I with List -II

List-I (Current configuration)	List- II (Magnitude of Magnetic Field at point O)
A. 	I. $B_0 = \frac{\mu_0 I}{4\pi r}[\pi + 2]$
B. 	II. $B_0 = \frac{\mu_0}{4}\frac{I}{r}$
C. 	III. $B_0 = \frac{\mu_0 I}{2\pi r}[\pi - 1]$
D. 	IV. $B_0 = \frac{\mu_0 I}{4\pi r}[\pi + 1]$

(1) A – I , B– III, C– IV, D– II (2) A – III, B– IV, C– I, D– II

(3) A – II , B– I, C– IV, D– III (4) A – III , B– I, C– IV, D– II

Ans. **(4)**

13. A Carnot engine with efficiency 50% takes heat from a source at 600 K, In order to increase the efficiency to 70 %, keeping the temperature of sink same, the new temperature of the source will be.

(1) 900 K (2) 300 K (3) 1000 K (4) 360 K

Ans. **(3)**

Sol. $\eta = 1 - \frac{T_{sink}}{T_{source}}$

$$\frac{50}{100} = 1 - \frac{T_{sink}}{600}$$

$$\Rightarrow T_{sink} = 300$$

$$\frac{70}{100} = 1 - \frac{300}{T'}$$

$$\frac{300}{T'} = \frac{7}{10} - 1 = \frac{3}{10}$$

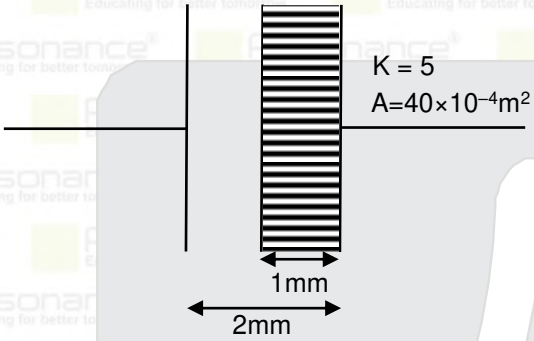
$$T' = 1000K$$

14. A parallel plate capacitor has plate area 40 cm^2 and plates separation 2mm. The space between the plates is filled with a dielectric medium of a thickness 1 mm and dielectric constant 5. The capacitance of the system is :

(1) $\frac{10}{3}\varepsilon_0 F$ (2) $\frac{3}{10}\varepsilon_0 F$ (3) $24\ \varepsilon_0$ F (4) $10\varepsilon_0$ F

Ans. **(1)**

Sol. Let us C_1 is capacitance due to dielectric



$$C_1 = \frac{\varepsilon_0 \times K \times 40 \times 10^{-4}}{1 \times 10^{-3}} = 20\varepsilon_0$$

C_2 due to remaining

$$C_2 = \frac{\varepsilon_0 \times 40 \times 10^{-4}}{1 \times 10^{-3}} = 4\varepsilon_0$$

Here C_1 and C_2 are in series.

So that $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{20\varepsilon_0} + \frac{1}{4\varepsilon_0}$

$$C_{eq} = \frac{20}{6}\varepsilon_0 = \frac{10}{3}\varepsilon_0 F$$

15. A bowl filled with very hot soup cools from 98ºC to 86ºC in 2 minutes when the room temperature is 22ºC. How long it will take to cool from 75ºC to 69ºC ?

(1) 2 minutes (2) 1 minute (3) 1.4 minutes (4) 0.5 minute

Ans. **(3)**

Sol. Using Newton's law of cooling, Rate of change in temperature, $R = \frac{dT}{dt} = -k(T - T_S)$, $T = \frac{T_i + T_f}{2}$

Initially, $R_1 = \frac{dT}{dt} = \frac{(98 - 86)°C}{2\,min} = \frac{12}{2}$ °C / minute

$R_1 = 6°C/m = -K(92° - 22°C)$ .....(i)

$R_2 = \frac{(75°C - 69°C)}{t} = -k(72°C - 22°C)$ .....(ii)

Divide (i) & (ii)

$$\frac{6t}{6} = \frac{-k(70)}{-k(50)} \Rightarrow t = \frac{7}{5}\text{min ute} = 1.4 \text{ minute.}$$

16. Match List -I with List -II

List-	List-II
A. Surface tension	I. kg $m^{-1}s^{-1}$
B. Pressure	II. kg ms^{-1}
C. viscosity	III. kg m^{-1} s^{-2}
D. Impulse	IV. kg s^{-2}

Choose the correct answer from the options given below :

(1) A- III, B-IV, C-I, D-II (2) A- IV, B-III, C-II, D-I

(3) A- IV, B-III, C-I, D-II (4) A- II, B-I, C-III, D-IV

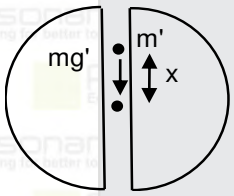
Ans. **(3)**

17. Assume that the earth is a solid sphere of uniform density and a tunnel is dug along its diameter throughout the earth. It is found that when a particle is released in this unnel, it executes a simple harmonic motion. The mass of the particle is 100 g. The time period of the motion of the particle will be (approximately) (Take g = 10 m s^{-2}, radius of earth = 6400 km)

(1) 1 hour 24 minutes (2) 1 hour 40 minutes (3) 12 hour (4) 24 hour

Ans. **(1)**

Sol.



mean position $F_{net} = 0$

$g = 0$

we know that $\left[g' = \frac{gx}{R}\right]$

$F_{net} = mg' = -mg\frac{x}{R}$

$T = 2\pi\sqrt{\frac{m}{k}}$ $\left[\because\ k = -\frac{mg}{R}\right]$

$T = 2\pi\sqrt{\frac{mR}{mg}}$

$T = 2\pi\sqrt{\frac{R}{g}} \approx 84$ min T = 1 hour 24 minutes

[R → Radius of earth 6.4×10^6 m, g → 9.81 m/s^2]

18. In an LC oscillator, if values of inductance and capacitance become twice and eight times, respectively, then the resonant frequency of oscillator becomes x times its initial resonant frequency ω_0. The value of x is.

(1) 1/4 (2) 4 (3) 16 (4) 1/16

Ans. **(1)**

Sol. $\omega_1 = \frac{1}{\sqrt{LC}}$ $\omega_2 = \frac{1}{\sqrt{2L \times 8C}} = \frac{1}{\sqrt{16LC}} = \frac{1}{4\sqrt{LC}} = \frac{\omega_1}{4}$

$\frac{\omega_2}{\omega_1} = \frac{1}{4}$

19. A solenoid of 1200 turns is wound uniformly in a single layer on a glass tube 2 m long and 0.2 m in diameter. The magnetic intensity at the centre of the solenoid when a current of 2 A flows through it is.

(1) 2.4×10^3 A m^{-1} (2) 1.2×10^3 A m^{-1} (3) 1 A m^{-1} (4) 2.4×10^{-3} A m^{-1}

Ans. **(2)**

Sol. Magnetic intensity equal

$B = \mu H = \mu ni$

$H = ni$

$= \left(\frac{N}{\ell}\right) \times i = \frac{1200}{2} \times 2$

$H = 1200$

$= 1.2 \times 10^3$ Am^{-1}

20. A car travels a distance of 'x' with speed v_1 and then same distance 'x' with speed v_2 in the same direction. The average speed of the car is :

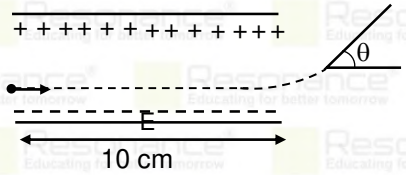
(1) $\frac{v_1 v_2}{2(v_1 + v_2)}$ (2) $\frac{2x}{v_1 + v_2}$ (3) $\frac{2v_1 v_2}{v_1 + v_2}$ (4) $\frac{v_1 + v_2}{2}$

Ans. **(3)**

Sol. Average Speed $= \frac{x + x}{\frac{x}{v_1} + \frac{x}{v_2}} = \frac{2x}{x\left(\frac{v_1 + v_2}{v_1 v_2}\right)}$

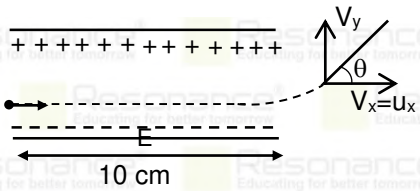
Average Speed $= \frac{2v_1 v_2}{v_1 + v_2}$

21. A uniform electric field of 10 N/C is created between two parallel charged plates (as shown in figure). An electron enters the field symmetrically between the plates with a kinetic energy 0.5 eV. The length of each plate is 10 cm. The angle (θ) of deviation of the path of electron as it comes out of the field is_____(in degree).



Ans. **45.00**

Sol.



acceleration due to electric field on electron

$a = \frac{eE}{m}$ ∴ Given $\frac{1}{2}mu_x^2 = \frac{1}{2}$

equation of motion in y direction $u_x^2 = \frac{1}{m}$

$V_y = U_y + a_y t$

$V_y = 0 + \frac{eE}{m}.t$ …(i)

equation of motion in x direction

$t \times u_x = 10 \times 10^{-2}$

$t = \frac{10\times10^{-2}}{u_x}$ …(ii)

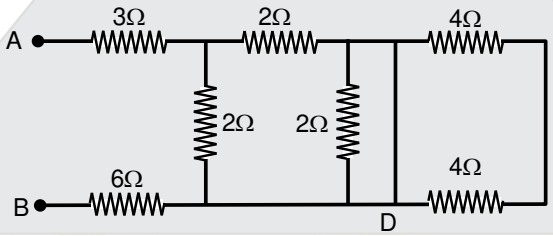
From equation (i) & (ii)

$V_y = \frac{eE}{m}\left(\frac{10\times10^{-2}}{u_x}\right)$

$\tan\theta = \frac{V_y}{V_x} = \frac{eE}{m}\left(\frac{10\times10^{-2}}{u_x^2}\right) = \frac{10\times10^{-1}}{m\times\frac{1}{m}}$

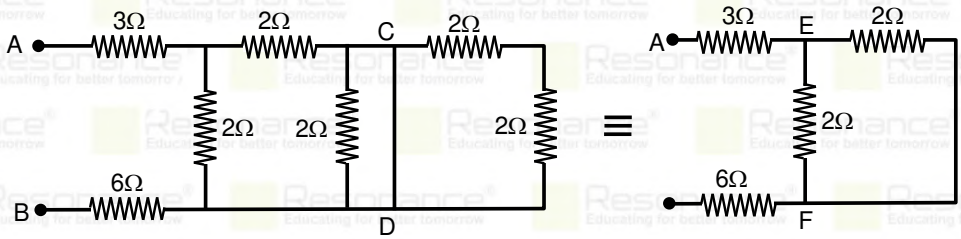
$\tan\theta = 1$, $\theta = 45°$

22. In the given circuit, the equivalent resistance between the terminal A and B is_____Ω.



Ans. **10**

Sol. Point C & D are short-circuited so 2Ω resistance an parallel to CD have no significance.



R_{EF} = 2Ω & 2Ω are parallel = 1Ω

R_{AB} = 3Ω + 1 Ω + 6Ω = 10 Ω

23. If $\vec{p} = 3\hat{i} + \sqrt{3}\hat{j} + 2\hat{k}$ and $\vec{Q} = 4\hat{i} + \sqrt{3}\hat{j} + 2.5\hat{k}$ then, the unit vector in the direction of $\vec{P} \times \vec{Q}$ is $\frac{1}{x}\left(\sqrt{3}i + \hat{j} - 2\sqrt{3}\hat{k}\right)$. The value of x is

Ans. **04**

Sol. $\vec{p} = 3\hat{i} + \sqrt{3}\hat{j} + 2\hat{k}$

$\vec{Q} = 4\hat{i} + \sqrt{3}\hat{j} + 2.5\hat{k}$

From Direction of unit vector is along $\vec{P} \times \vec{Q}$

then $\vec{P} \times \vec{Q} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & \sqrt{3} & 2 \\ 4 & \sqrt{3} & \frac{5}{2} \end{vmatrix}$

$\vec{a} = \vec{P} \times \vec{Q} = \hat{i}\left(\frac{5\sqrt{3}}{2} - 2\sqrt{3}\right) - \hat{j}\left(\frac{15}{2} - 8\right) + \hat{k}\left(3\sqrt{3} - 4\sqrt{3}\right)$

$\vec{P} \times \vec{Q} = \frac{\sqrt{3}}{2}\hat{i} + \frac{\hat{j}}{2} - \sqrt{3}\hat{k}$

$\vec{r} = \lambda(\vec{a})$ For parallel vector

$\vec{r} = \lambda\left(\frac{\sqrt{3}}{2}\hat{i} + \frac{\hat{j}}{2} - \sqrt{3}\hat{k}\right)$

$\vec{r}$ is a unit vector then

$|\vec{r}| = 1$

then $\lambda = \frac{1}{2}$

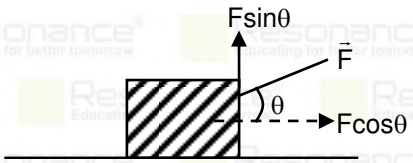
$\vec{r} = \frac{1}{2}\left(\frac{\sqrt{3}}{2}\hat{i} + \frac{\hat{j}}{2} - \sqrt{3}\hat{k}\right) \Rightarrow \frac{1}{4}\left(\sqrt{3}\hat{i} + \hat{j} - 2\sqrt{3}\hat{k}\right)$ then x = 4

24. An object of mass 'm' initially at rest on a smooth horizontal plane starts moving under the action of force F = 2N. In the process of its linear motion, the angle θ (as shown in figure) between the direction of force and horizontal varies as $\theta = kx$, where k is a constant and x is the distance covered by the object from its initial position. The expression of kinetic energy of the object will be $E = \frac{n}{k}\sin\theta$. The value of n is

Smooth horizontal surface

Ans. **0**

Sol. FBD



$$w = -\int F.dx$$

$$E = \frac{1}{2}mv^2 - 0 = \int_0^x F\cos\theta dx \Rightarrow E = 2\int_0^x F\cos(kx)dx$$

$$E = 2\left[\frac{\sin(kx)}{k}\right]_0^x = \frac{2}{k}\sin\theta$$

$$E = \frac{2}{k}\sin\theta \qquad \text{So } n = 2$$

25. An LCR series circuit of capacitance 62.5 nF and resistance of 50Ω, is connected to an A.C. source of frequency 2.0 kHz. For maximum value of amplitude of current in circuit, the value of inductance is _____ mH. (Take $\pi^2 = 10$)

Ans. **100**

Sol. For maximum current in LCR circuit at resonance

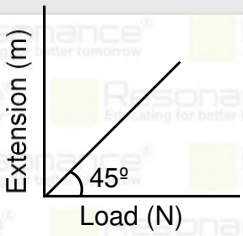
$$X_C = X_L$$

$$L = \frac{1}{\omega^2 C}$$

$$L = \frac{1}{(2\pi\times 2\times 1000)^2 \times 62.5\times 10^{-9}}$$

$$L = \frac{1}{4\pi^2\times 4\times 10^{-6}\times 62.5\times 10^{-9}} = \frac{100}{1000} = 100 \text{ mH}$$

26. Ass shown in the figure, in an experiment to determine Young's modulus of a wire, the extension-load curve is plotted. The curve is a straight line passing through the origin and makes an angle of 45º with the load axis. The length of wire is 62.8 cm and its diameter is 4 mm. The young's modulus is found to be x × 10^4 Nm^{-2}. The value of x is .....



Ans. **5**

Sol. We have

$$Y = \frac{F}{A}\frac{L}{\Delta L} \qquad ...(1)$$

$F = \left(\frac{YA}{L}\right)\Delta L$

By graph $\tan 45° = \frac{\Delta L}{F}$

$1 = \frac{\Delta L}{F} \Rightarrow \frac{F}{\Delta L} = 1$ ...(2)

$F = \Delta L$

Put in equation (1)

$Y \cdot \frac{A}{L} = 1 \Rightarrow Y = \frac{L}{A} = \frac{62.8\times10^{-2}}{\pi(2\times10^{-3})^2} = \frac{62.8\times10^{4}}{4\times\pi} = 5\times10^{4}\ Nm^{-2}$

27. The distance between two consecutive points with phase difference of 60º in a wave of frequency 500 Hz is 6.0 m. The velocity with which wave is a traveling is_____ km/s

Ans. **18**

Sol. Given Data $\Delta x = 6$ m, $\delta = 60 = \frac{\pi}{3}$, $\upsilon = 500$ Hz,

$\lambda = \frac{v}{\upsilon} = \frac{v}{500}$

$\Delta x = \frac{\lambda}{2\pi}\times\delta$

$6 = \frac{v/500}{2\times\pi}\times\frac{\pi}{3}$

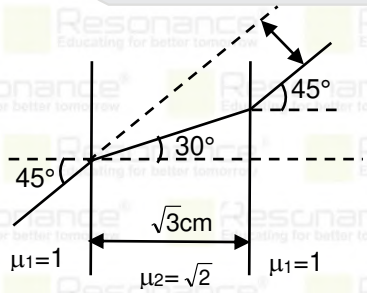
$v = 18 \times 1000$ m/sec.

$v = 18$ km/sec.

28. A ray of light is incident from air on a glass plate having thickness $\sqrt{3}$ cm and refractive index $\sqrt{2}$. The angle of incidence of a ray is equal to the cirtical angle for glass-air interface. The lateral displacement of the ray when it passes through the plate is -------- $\times 10^{-2}$ cm. (given sin 15º = 0.26)

Ans. **52**

Sol. Given incident angle $i_c = \sin^{-1}\left(\frac{1}{\mu}\right) \rightarrow$ (glass air interface)



$i_c = 45° = i$

From snell's law

$\mu_1\sin(i) = \mu_2\sin(r)$

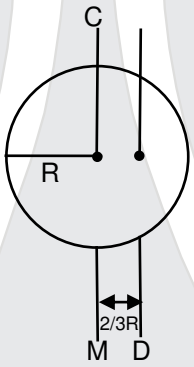
$1\sin(45) = \sqrt{2}\sin(r)$

$r = 30°$

Then lateral displacement $= \dfrac{t\sin(i-r)}{\cos(r)}$ $\quad\therefore$ Given $\sin(15°) = 0.26$

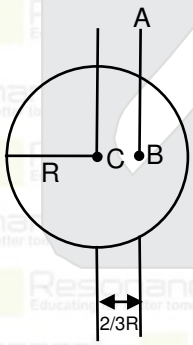
$$= \frac{\sqrt{3}\sin(45-30)}{\cos(30)} = 0.52 = 52 \times 10^{-2}\ \text{cm}$$

29. I_{CM} is the moment of inertia of a circular disc about an axis (CM) passing through its centre and perpendicular to the plane of disc. I_{AB}. is it's moment of inertia about an axis AB perpendicular to plane and parallel to axis CM at a distance $\dfrac{2}{3}$ R. from centre. Where R is the radius of the disc. The ratio of I_{AB} and I_{CM} is x : 9 . The value of x is ———.



Ans. **17**

Sol. I_{CM} of Disc $= \dfrac{1}{2}mR^2$



For I_{AB} using parallel axis therom

$$I_{AB} = I_{CM} + m\left(\frac{2R}{3}\right)^2 = \frac{17}{18}MR^2$$

$$\frac{I_{AB}}{I_{CM}} = \frac{17MR^2}{18 \times \frac{MR^2}{2}} = \frac{17}{9}$$

then x = 17

30. The wavelength of the radiation emitted is λ_0 when an electron jumps from the second excited state to the first excited state of hydrogen atom. If the electron jumps from the third excited state to the second orbit of the hydrogen atom, the wavelength of the radiation emitted will be $\frac{20}{x}\lambda_0$ The value of x is_____.

Ans. **27**

Sol. From question electron jumps from n = 3 to n = 2

$$\frac{1}{\lambda_0} = R_H\left(\frac{1}{4} - \frac{1}{9}\right)$$

$$\lambda_0 = \frac{36}{5R} \quad \ldots(i)$$

electron jumps from n = 4 to n = 2

$$\frac{1}{\lambda} = R_h\left[\frac{1}{4} - \frac{1}{16}\right]$$

$$\lambda = \frac{16}{3R}$$

$$\lambda = \frac{20}{x}\lambda_0 = \frac{16}{3R}$$

x = 27

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