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(Memory Based) JEE MAIN – 2020 September Session 04-09-2020 (Shift-I) (PHYSICS)

PART :: PHYSICS

1. Dimensional formula of thermal conductivity will be:

(1) $M^1L^1T^{-3}\theta^{-1}$ (2) $M^0L^1T^{-1}\theta^{-1}$ (3) $M^1L^0T^{-1}\theta^{-1}$ (4) $M^1L^1T^0\theta^{-1}$

Ans. (1)

Sol. $k = \dfrac{(Q/t)\Delta x}{A\Delta T}$

$= \dfrac{M^1L^2T^{-2}(L)}{L^2\theta(T)}$

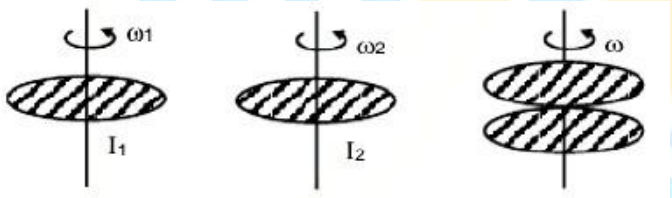
$= M^1L^1T^{-3}\theta^{-1}$

2. Two disc of radius R and $\dfrac{R}{2}$ are made with same material with same thickness. Disc of radius R rotates with speed of ω and disc of radius $\dfrac{R}{2}$ is at rest. Now both disc are placed coaxially. Find percentage loss of kinetic energy when they rotates with same angular velocity.

(1) 10 (2) 20 (3) 30 (4) 40

Ans. (2)

Sol.



Angular momentum conservation

$$\frac{MR^2}{2}\omega + U = \left(\frac{MR^2}{2} + \frac{MR^2}{8}\right)\omega_f$$

$$\omega_f = \frac{4}{5}\omega$$

Final K.E.

$$K_f = \frac{1}{2}\left(\frac{MR^2}{2} + \frac{MR^2}{8}\right)\frac{16}{25}\omega^2$$

$$K_f = \frac{MR^2\omega^2}{5}$$

$$K_i = \frac{1}{2}\left(\frac{MR^2}{2}\right)\omega^2 = \frac{MR^2\omega^2}{4}$$

Percentage loss in kinetic energy

$$\%\text{loss} = \frac{\frac{MR^2\omega^2}{4} - \frac{MR^2\omega^2}{5}}{\frac{MR^2\omega^2}{4}} 100 = 20\%$$

3. For Lyman series $\lambda_{max} - \lambda_{min} = 340\,\text{Å}$, Find the same for Paschen series ?

(1) $11,802\,\text{Å}$ (2) $13,802\,\text{Å}$ (3) $12,502\,\text{Å}$ (4) $10,000\,\text{Å}$

Ans. (1)

Sol. Lyman ; $\frac{1}{\lambda_{min}} = R(1) = R$; $n = \infty$ to 1

$$\frac{1}{\lambda_{max}} = R\left\{1 - \frac{1}{4}\right\} = \frac{3R}{4}; n = 2 \text{ to } 1$$

$$\Rightarrow \lambda_{max} - \lambda_{min} = \frac{4}{3R} - \frac{1}{R}$$

$$340 = \frac{1}{3R} .....(1)$$

Paschen : $Y_{\lambda'_{min}} = R\left(\frac{1}{9}\right)$ and $Y_{\lambda'_{max}} = R\left(\frac{1}{9} - \frac{1}{16}\right) = \frac{7R}{16\times 9}$

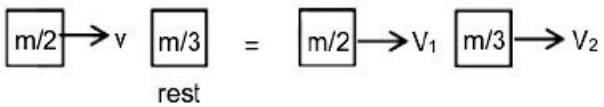
$$\lambda'_{max} - \lambda'_{min} = \frac{16\times 9}{7R} - \frac{9}{R} = \frac{81}{7R}(b)$$

$$\frac{(b)}{(a)} = \frac{x}{340} = \frac{81}{7} \Rightarrow x = 11,802.8$$

4. A Body of mass $\frac{m}{2}$ moving with velocity v_0 collides elastically with another mass of $\frac{m}{3}$. Find % change in KE of first body ?

(1) 32 % (2) 96 % (3) 34 % (4) 80 %

Ans. (2)

Sol. 

$$v_1 = \frac{2(m/30)0}{\left(\frac{m}{2} + \frac{m}{3}\right)} + \frac{\left(\frac{m}{2} - \frac{m}{3}\right)v}{\left(\frac{m}{2} + \frac{m}{3}\right)} = \frac{v}{5}$$

For body of m/2

$$K_i = \frac{1}{2}\left(\frac{M}{2}\right)V^2 = \frac{1}{4}mv2$$

$$K_f = \frac{1}{2}\left(\frac{m}{2}\right)\left(\frac{v}{5}\right)^2 = \frac{1}{100}mv^2$$

$$\%\ \text{Loss} = \frac{k_i - k_f}{k_i} \times 100 = \frac{\frac{mv^2}{4} - \frac{mv^2}{100}}{\frac{mv^2}{4}} = 100 = 96\%$$

5. A body of mass m moving with velocity 'v' collides with shown masses respectively. Find loss in KE after the last collision. Consider all collision completely in elastically ?

(1) 85.5 (2) 90.2 (3) 93.75 (4) 88.5

Ans. (3)

Sol.

inelastic collision

$$mv = 16\, mv^1$$

$$v^1 = \frac{v}{16}$$

$$\Delta K \text{ loss} = \frac{1}{2}mv^2 - \frac{1}{2}(16M)\left(\frac{v}{16}\right)^2$$

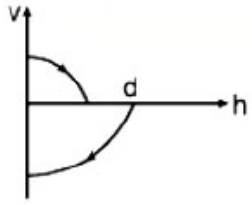
$$= \frac{1}{2}mv^2 - \frac{1}{2}M\frac{v^2}{16}$$

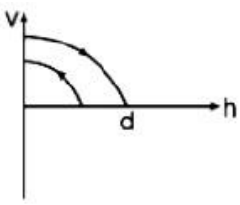
$$= \frac{1}{2}mv^2\left(\frac{15}{16}\right)$$

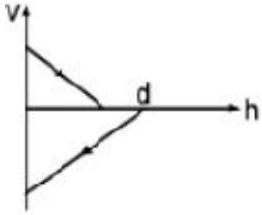
$$\%\Delta K \text{ loss} = \frac{\frac{1}{2}mv^2\left(\frac{15}{16}\right)}{\frac{1}{2}Mv^2} \times 100$$

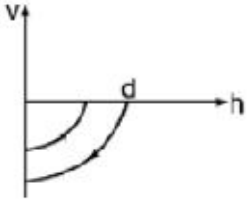
$$= \frac{15}{16} \times 100 = 93.75\%$$

6. A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height d/2. Neglecting subsequent motion and air resistance, its velocity v varies with the height h above the ground as

(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. (i) For uniformly accelerated/deaccelerated motion

$$v^2 = u^2 \pm 2gh$$

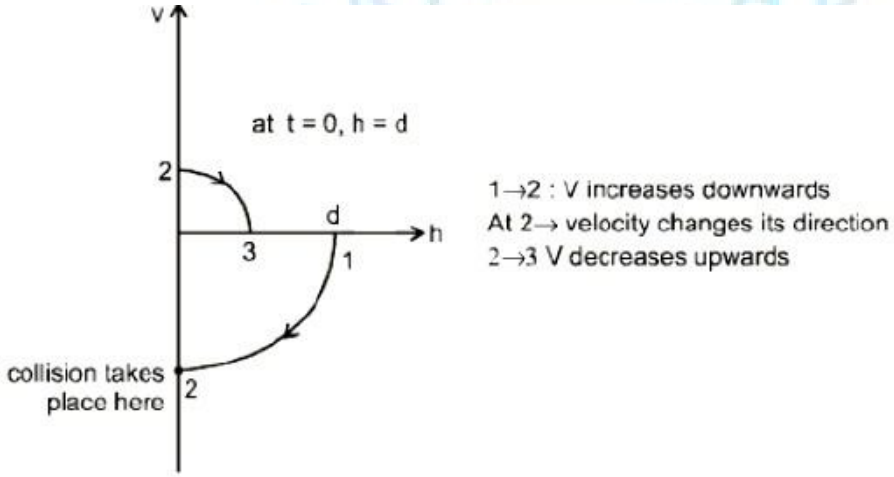
i.e. v – h graph will be a parabola (because equation is quadratic).

(ii) Initially velocity is downwards (-ve) and then after collision it reverses its direction with lesser magnitude. i.e. velocity is upwards (+ve). Graph (A) satisfies both these conditions.

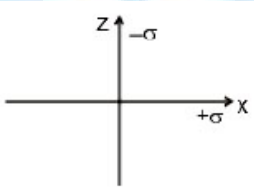
Therefore, correct answer is (A)

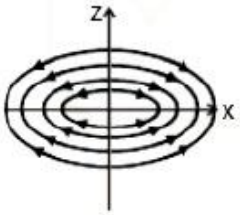
Note that time t = 0 corresponds to the point on the graph where h = d

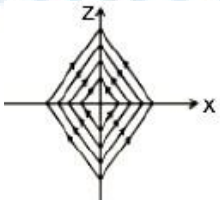
Next time collision takes place at 3.

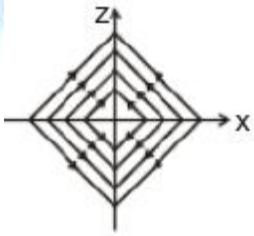


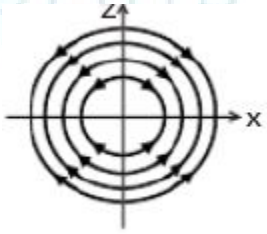
7. Two infinitely large charged planes having uniform surface charge density $+\sigma$ and $-\sigma$ are placed along x – y plane and yz plane respectively as shown in the figure. Then the nature of electric lines of forces in x – z plane is given by :



(1) 

(2) 

(3) 

(4) 

Ans. (3)

Sol. The electric field intensity due to each uniformly charged infinite plane is uniform. The electric field intensity at points A, B, C and D due to plane 1, plane 2 and both planes are given by E_1, E_2 and E as shown in figure 1. Hence the electric lines of forces are as given in figure ?

8. Gravitational field intensity is given by $E=\frac{Ax}{\left(A^2+x^2\right)^{3/2}}$, then find out potential at x.. (Assume potential at infinity = 0)

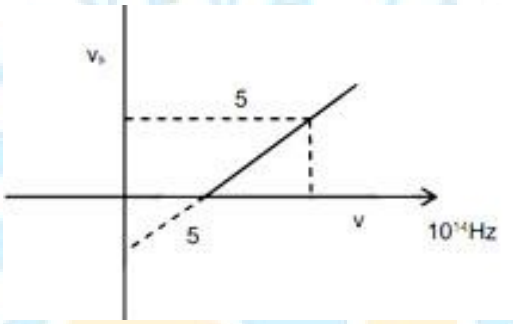
(1) $-\frac{2A}{\sqrt{A^2+x^2}}$ (2) $-\frac{A}{\sqrt{A^2+x^2}}$ (3) $-\frac{A}{3\sqrt{A^2+x^2}}$ (4) $-\frac{3A}{3\sqrt{A^2+x^2}}$

Ans. (2)

Sol. $V_x = -\int_{\infty}^{x} \frac{Ax}{\left(A^2+x^2\right)^{3/2}}(-dx)$

$V_x = -\frac{A}{\sqrt{A^2+x^2}}$

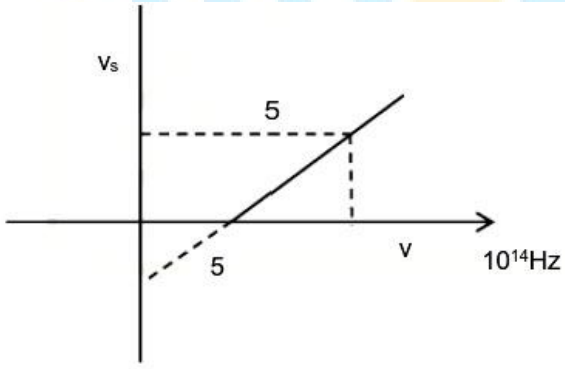
9. Graph between stopping potential and frequency of light as shown in figure.



(1) 4.01 (2) 2.01 (3) 5.01 (4) 2.04

Ans. (2)

Sol.



Threshold Energy = hv

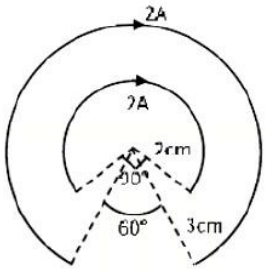
$= = 6.6\times10^{-34}\times5\times10^{14}\,J$

Work friction = $\frac{6.6\times5\times10^{-20}}{1.6\times10^{-19}}eV$

$=\frac{6.6\times5}{1.6}\times10^{-1}eV$

$=\frac{3.3}{1.6}\times2.01\,eV$

10. Two concentric circular current carrying arc of radius $R_1 = 3cm$ and $R_2 = 2cm$ and direction of current in both arc are shown in figure. Find the ratio of magnetic field $\left(\frac{B_1}{B_2}\right)$ at centre produced by both arc.



(1) $\frac{6}{5}$ (2) $\frac{5}{6}$ (3) $\frac{3}{4}$ (4) $\frac{4}{3}$

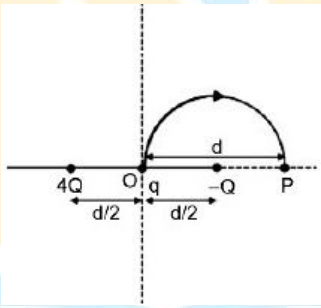
Ans. (1)

Sol. $B_c = \frac{\mu_0 I}{4\pi E}(\theta)$ $(\theta$ angle substance at centre$)$

$$\frac{B_{large}}{B_{small}} = \frac{i_1}{i_2} \times \frac{R_2}{R_1} \frac{(2\pi - \pi/2)}{(2\pi - \pi/3)}$$

$$= \frac{2}{2} \times \frac{2}{3} \times \frac{3\pi}{2} \times \frac{3}{5\pi} = \frac{6}{5}$$

11. Find change in potential energy from origin to point P of charge q moving on the path as shown in figure.



(1) $-\frac{10KQ}{3d}$ (2) $-\frac{13KQ}{3d}$ (3) $-\frac{13KQ}{d}$ (4) $-\frac{16KQ}{3d}$

Ans. (4)

Sol. Potential at O,

$$\Rightarrow V_0 = \frac{K4Q}{\frac{d}{2}} + \frac{K(-Q)}{\frac{d}{2}} = \frac{6KQ}{d}$$

Potential at P,

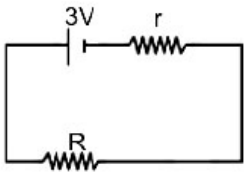
$$\Rightarrow V_p = \frac{K4Q}{\frac{3d}{2}} + \frac{K(-Q)}{\frac{d}{2}} = \frac{2KQ}{3d}$$

Change in potential energy of a charge $q = q\Delta V = q(V_f - V_i)$

$$= q(V_p - V_0)$$

$$q=\left(\frac{2KQ}{3d}-\frac{6KQ}{d}\right)=\frac{16KQ}{3d}$$

12. Terminal voltage of cell (emf = 3V & internal resistance = r) is equal to 2.5 V and heat loss is R is given by 0.5 watt. Then find power loss in internal resistance.



(1) 0.3 (2) 0.5 (3) 0.1 (4) 1

Ans. (3)

Sol. $E=3V$

$V_R=2.5V$

By KVL

$V_r+V_R=E$

$V_r+2.5=3$

$V_r=0.5$

$$\frac{V_R}{V_r}=\frac{IR}{Ir}=\frac{2.5}{0.5}=5\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$\frac{R}{r}=5$$

$$\frac{P_R}{P_r}=\frac{I^2R}{I^2r}=\frac{R}{r}$$

$$\frac{P_R}{P_r}=5$$

$$P_r=\frac{P_R}{5}=\frac{0.5}{5}=0.1\text{watt}$$

13. Correct order of wavelength will be:

(1) Radio waves > microwaves > visible rays > X-rays

(2) Microwaves > Radio waves > Visible rays > X-rays

(3) X-rays > Radio waves > Microwaves > Visible rays

(4) X-rays > Radio waves > Visible rays > Microwaves

Ans. (1)

Sol. Theory based

14. A particle at origin (0, 0) moving with initial velocity $u=5\,m/s\,\hat{j}$ and acceleration $10\hat{i}+4\hat{j}$. After t time it reaches at position (20, y) then find t and y :

Ans. (1)

Sol. Equation (1)

$$S_x = \frac{1}{2}a_x t^2$$

$$20 = \frac{1}{2}\times 10\times t^2$$

$$t = 2$$

Equation (2)

$$S_y = u_y t + \frac{1}{2}a_y t^2$$

$$y = 5(2) + \frac{1}{2}(4)(2)^2$$

$$y = 18$$

15. Distance between through and crest of a waves is 1.5m while distance between two through is 5m. Which of the following wavelength is possible.

(1) $\frac{1}{2},\frac{1}{4},\frac{1}{6},.....$ (2) $1,2,3,.....$ (3) $\frac{1}{1},\frac{1}{3},\frac{1}{5},.....$ (4) $1,3,5,.....$

Ans. (3)

Sol. Trough to crest distance

$$1.5 = (2n_1+1)\frac{\lambda}{2} \text{ ……..(1)}$$

Trough to trough distance

$$5 = (n_2\lambda) \text{ ……..(2)}$$

From (1) and (2)

$$\frac{1.5}{5} = \frac{2n_1+1}{2(n_2)}$$

$$3n_2 = 10n_1 + 5$$

n_1 and n_2 are integer

$(1)\, n_1 = 1, n_2 = 5, \lambda = 1$

(2) $n_1 = 4, n_2 = 15, \lambda = \frac{1}{3}$

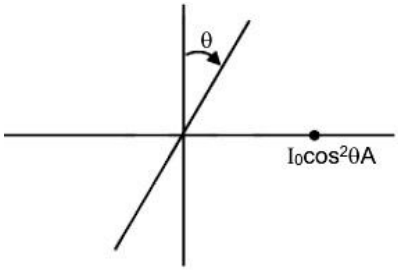
(3) $n_1 = 7, n_2 = 25, \lambda = \frac{1}{5}$

16. Intensity of plane polarized light is 3.3 W/m. Area of a plane $3\times10^{-4}m^2$ and polarizer rotates with 10π rad/sec. Energy transmsitted in 1 complete cycle:

(1) 4.95×10^{-4} (2) 3.95×10^{-4} (3) 2.95×10^{-4} (4) 6.95×10^{-4}

Ans. (1)

Sol.

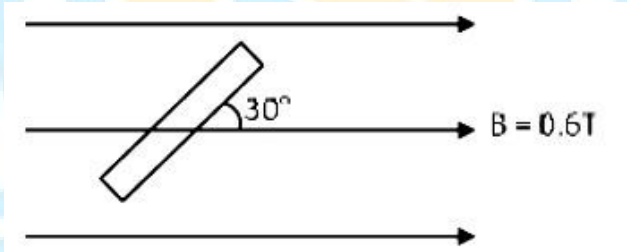


Average energy = $I_0A<\cos^2\theta>$

$=\dfrac{3.3\times3\times10^{-4}}{2}$

$=\dfrac{9.9}{2}\times10^{-4}=4.95\times10^{-4}$

17. A bar magnet experienced torque 0.018 N – m when placed in uniform magnetic field, B = 0.06 T and makes 30^0 angle with the magnetic field as shown in figure. Find out work done by external force if magnet rotates fro minimum potential energy to maximum potential energy.



(1) 0.036 J (2) 0.018 J (3) 0.072 J (4) 0.36 J

Ans. (3)

Sol. $\tau=MB\sin\theta=0.18$

$M=\dfrac{0.018}{B\sin\theta}=\dfrac{0.018}{0.06\times0.5}=0.6A-m^2$

$\omega=AU=U_f-U_i$

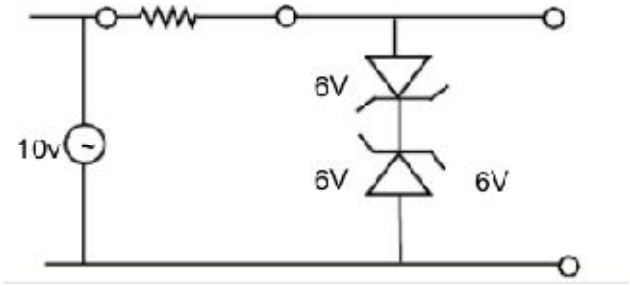
$=-MB\cos180^0-\left(-MB\cos0^0\right)$

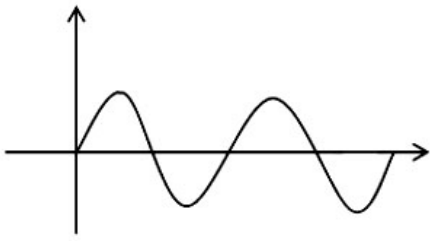
$=2MB$

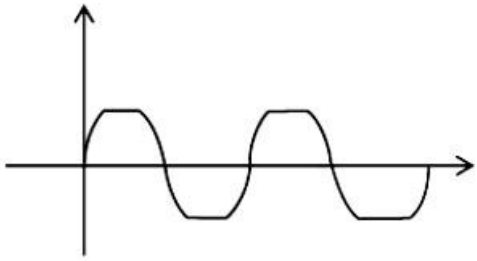
$=2\times0.6\times0.06$

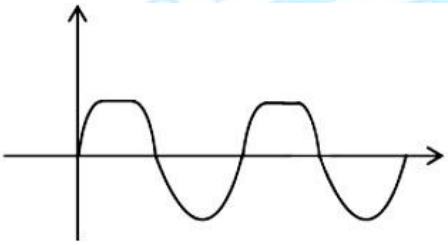
$0.072J$

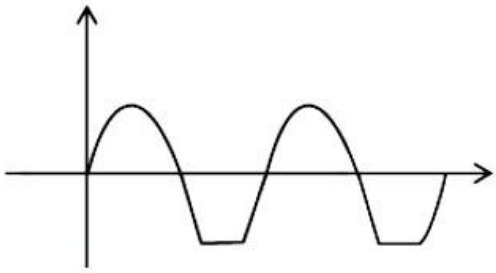
18. Correct graph of voltage across Zener diode will be



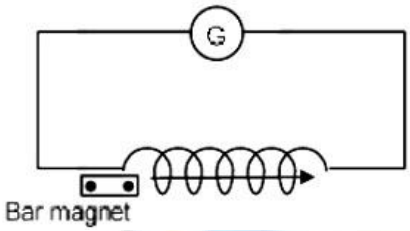
(1) 

(2) 

(3) 

(4) 

Ans. (2)

19. 

A bar magnet moves with constant velocity as shown in figure through a coil. Which of the following option is correctly represent the deflection of needle in Galvanometer.

(1) 

(2) 

(3) 

(4) 

Ans. (2)

20. In compound microscope final image formed at 25 cm from eyepiece lens. Length of tube is 20 cm. Given that $f_0 = 1cm, m = 100$. Find focal length of eyepiece lens

Ans. 6.25

Sol. $M = \frac{v_0}{u_0}\left(1+\frac{D}{f_e}\right)$

$$M = \frac{L}{f_0}\left(1+\frac{D}{f_e}\right)$$

$$100 = \frac{20}{(1)}\left(1+\frac{25}{f_e}\right)$$

$$5 = 1+\frac{25}{f_e}$$

$$4 = \frac{25}{f_e}$$

$$f_e = \frac{25}{4} = 6.25\,cm$$

21. 0.1 mole of a gas at 200 K is mixed with 0.05 mole of same gas at 400 K. If final temperature is equal to $10T_0$, then find the value of T_0.

Ans. 26.66

Sol. $(0.1)(200)+(0.05)(400)=(0.15)T$

$$T = \frac{20+20}{0.15} = \frac{800}{3} = 266.67$$

$$10T_0 = 266.67$$

$$T_0 = 26.66$$

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