Rao IIT Academy
Symbol of Excellence and Perfection
JEE | MEDICAL-UG | BOARDS | KVPY | NTSE | OLYMPIADS

XII HSC - BOARD - MARCH - 2017

Date: 04.03.2017 **PHYSICS (54) - SET [E]- SOLUTIONS**

SECTION - I

Q. 1

(i) (d)

$pv = nRT$ (i)

$0.9\ v' = nRT$ (ii)

$(1) \div (2)$

$v' = \dfrac{v}{0.9} = \boxed{1.11v}$

Topic: Kinetic Theory of Gases and Radiation; Sub-topic:Thermodynamics_ L- 1_ Target-2017__ **XII-HSC Board Test___Physics**

(ii) (c)

Since work has been done.

Topic:Elasticity; Sub-topic:Elastic Energy L-1 _ Target-2017__ **XII-HSC Board Test___Physics**

(iii) (c)

$\tau = I\alpha$

$\because \alpha = 0$

$\tau = 0$

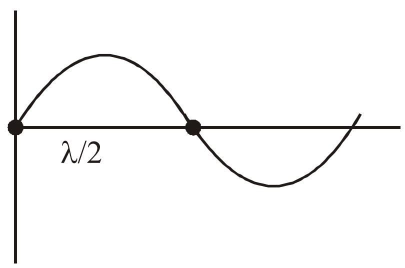
Topic: Rotational Motion; Sub-topic:Torque_L- 1_ Target-2017__ **XII-HSC Board Test___Physics**

(iv) (d)

Amplitude decreases with respect to time.

Topic: Oscillation; Sub-topic:Damped Oscillation_ L-1 _ Target-2017__ **XII-HSC Board Test___Physics**

(v) (b)



Topic: Wave motion; Sub-topic:Velocity of a Transverse wave in a String_ L-1 _ Target-2017__ **XII-HSC Board Test___Physics**

(vi) (a)

$$v = \sqrt{\frac{T}{m}}$$

Topic: Wave Motion; Sub-topic:Velocity of a Transverse wave in a String_ L- 1 _ Target-2017__ **XII-HSC Board Test___Physics**

(vii) (b)

$$\lambda T = b$$

$$\lambda = \frac{2.898 \times 10^{-3}}{700}$$

$$\lambda = 4.14 \times 10^{-6} m$$

Topic: Kinetic Theory of Gases and Radiation; Sub-topic:Wein's Law_ L- 1_ Target-2017__ **XII-HSC Board Test___Physics**

Q.2

(i) When body moves in UCM, its speed is same but direction changes and particle experience centripetal acceleration $a_c = \frac{v_2}{r}$. **[1 M]**

As per Newton's Law of Motion, if particle has accleration it experiences force called centripetal force $f_c = m\frac{v^2}{r}$, $m \rightarrow$ mass of particle f_c acts from particle to centre. **[1 M]**

Topic:Circular Motion; Sub-topic:Centripital Force_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(ii) $\because p = \frac{1}{3}\rho\overline{v}^2$

$$p = \frac{1}{3}\frac{M}{V}\overline{v}^2$$

$$pv = \frac{1}{3}M\overline{v}^2$$

$$\because pv = nRT$$

$$\therefore \frac{1}{3}M\,\overline{v}^2 = nRT$$

$$\frac{1}{3}M\,\overline{v}^2 = \frac{M}{M_m}RT$$

$$\overline{v}^2 = \frac{3RT}{M_m}$$

$\therefore \overline{v} \propto \sqrt{T}$ **[2 M]**

Topic: Kinetic Theory of Gases and Radiation; Sub-topic:RMS Velocity_ L- 1_ Target-2017__ **XII-HSC Board Test___Physics**

(iii) $\because F \propto x$

$F = -kx \; (k \to \text{force constant})$

$$\frac{md^2x}{dt^2} = -kx$$

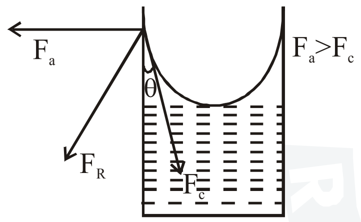
$$\frac{d^2x}{dt^2} = -\frac{k}{m}x$$

Let $\frac{k}{m} = w^2$

$$\therefore \boxed{\frac{d^2m}{dt^2} + w^2x = 0}$$ **[2 M]**

Topic: Oscillation; Sub-topic:Differential Equation of SHM_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(iv)



[1 M]

$F_a \to$ Adhesive force

$F_c \to$ Cohesive force

$F_R \to$ Net force **[1 M]**

Topic: Surface Tension_ Sub-topic:Angle of Contact_ L- 1_ Target-2017__ **XII-HSC Board Test___Physics**

(v) $mg = 350$ (1) an earth surface **[1/2 M]**

At depth $\left(\frac{R}{2}\right)$

$mg\left(1-\frac{d}{R}\right) = x$ (2) **[1/2 M]**

$(1) \div (2)$

$$\frac{1}{\left(1-\frac{R}{2R}\right)} = \frac{350}{x}$$ **[1/2 M]**

$$2 = \frac{350}{x}$$

$\boxed{x = 175\,N}$ **[1/2 M]**

Topic: Gravitation_ Sub-topic:Gravity at Depth_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(vi) $TE = \frac{1}{2}mv^2\left(1+\frac{k^2}{R^2}\right)$ **[1 M]**

$\frac{1}{2}(1)(2)^2\left(1+\frac{2}{5}\frac{R^2}{R^2}\right)$

$\frac{1}{2}\times 4\times\left(\frac{7}{5}\right)$

$= \boxed{2.8\,J}$ **[1 M]**

Topic: Rotational Motion; Sub-topic:Rolling Motion_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(vii) $n = \left(\frac{v}{2l}\right)\times 2$ **[1 M]**

$324 = \frac{v}{0.9}$

$\boxed{v = 291.6\ m/s.}$ **[1 M]**

Topic: Stationary Wave;Sub-topic:Vibration in String_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(viii) $\theta\,\alpha\,T^4$

$\theta'\alpha\,T^4$ **[1/2 M]**

$\frac{0.5}{\theta'} = \frac{(25+273)^4}{(15+273)^4}$

$\frac{0.5}{\theta'} = \left(\frac{298}{288}\right)^4$

$\frac{0.5}{\theta'} = (1.034)^4$ **[1 M]**

$\frac{0.5}{\theta'} = 1.143$

$\theta' = \frac{0.5}{1.143}$

$= 0.437\ c/\min$ **[1/2 M]**

Topic: Kinetic Theory of Gases and Radiation; Sub-topic:Stefan's Law_ L- 1_ Target-2017__ XII-HSC Board Test___Physics

Q.3

(i) The speed of the satellite revolving around the earth in an orbit of radius r is equal to cirtical speed v_c.

$$\therefore \text{ speed} = v_c = \sqrt{\frac{GM}{r}} \qquad \text{......(i)}$$ **[1/2 M]**

where M is mass of Earth and G is universal gravitational constant.

Now, time period of revolution, is

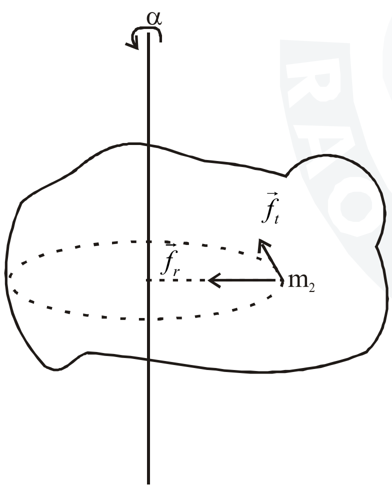
$$T = \frac{2\pi}{v_c} = \frac{2\pi r}{\sqrt{GM/r}} = \frac{2\pi r\sqrt{r}}{\sqrt{GM}}$$ **[2 M]**

$$\text{or, } T = 2\pi\sqrt{\frac{r^3}{Gm}}$$ **[1/2 M]**

Thus, the period of satellite revolving around the Earth depends upon mass 'M' of Earth.

Topic: Gravitation;Sub-topic:Time Period of Satellite_L- 1_ Target-2017__ XII-HSC Board Test___Physics

(ii) We consider the rigid body as a system of n particles of masses m_1, m_2, m_3, ..., m_4 and having perpendicular distances r_1, r_2, r_3, ... , r_n from the axis of rotation.



[1/2 M]

$\therefore$ Moment of inertia of the rigid body about the axis is

$$I = m_1r_1^2 + m_2r_2^2 + m_3r_3^2 + ...+ m_nr_n^2 = \sum_{i=1}^{n} m_ir_i^2 \qquad \text{.......(i)}$$ **[1/2 M]**

Let α be the angular acceleration of the rotating body. Considering the general i^{th} particle of the body, it is in circular motion in a circle of radius r_i, with angular acceleration α.

Let $\left(\vec{f}_t\right)_i$ and $\left(\vec{f}_r\right)_i$ be the tangential and radial forces respectively on the i^{th} particle. The radial force intersects the axis, so its torque about the axis is zero. So the net torque is the torque of tangential force.

$\therefore$ net torque on i^{th} particle about the axis is

$$\vec{\tau}_i = \vec{r}_i \times \left(\vec{f}_t\right)_i$$ **[1/2 M]**

$\therefore$ magnitude of this torque is

$\tau_i = r_i (f_t)_i$ $\qquad\qquad \{\because \vec{r}_i \perp (\vec{f}_t)_i\}$

$\Rightarrow \tau_i = r_i \ \{m_i (a_t)_i\}$

{Where $(a_t)_i$ is magnitude of tangential acceleration of i[th] particle}

$\Rightarrow \tau_i = m_i r_i (\alpha r_i)$ $\qquad\qquad \{\because (a_t)_i = \alpha r_i\}$ **[1/2 M]**

$\Rightarrow \tau_i = m_i r_i^2 \alpha$

$\therefore$ Total torque acting on the rigid body, is

$$\tau = \sum_{i=1}^{n} \tau_i = \sum_{i=1}^{n} m_i r_i^2 \alpha = \left(\sum_{i=1}^{n} m_i r_i^2\right) \alpha$$

$\Rightarrow \boxed{\tau = I\alpha}$ $\qquad\qquad \left\{\because \text{from equation } (i),\ I = \sum_{i=1}^{n} m_i r_i^2\right\}$

Dimension of torque : $\left[L^2 M^1 T^{-2}\right]$

SI Unit of torque is newton metre (N–m) **[1 M]**

Topic:Rotational Motion; Sub-topic:Torque Acting on a Rotating Body_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(iii) Let D be the diameter of the liquid drop.

$\therefore$ surface area of the drop, $A = \pi D^2$ **[1/2 M]**

$\therefore$ If T be the surface tension, the surface energy

U = T.A. or $U = T\left(\pi D^2\right)$ .....(1) **[1 M]**

Now, from the question,

$U = 2\pi \cdot T$ ......(2) **[1 M]**

From eq.(1) & (2), $T \cdot \left(\pi D^2\right) = 2\pi \cdot T$

$\Rightarrow D^2 = 2$ $\qquad \Rightarrow D = \sqrt{2}$ (in S.I. units)

$\therefore D = \sqrt{2}\, m = 1.414\, m$ **[1/2 M]**

Topic: Surface Tension_ Sub-topic:Surface Energy_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(iv) Given, angle of banking, $\theta = 10^0$

Optimum speed, $v_0 = 36\, km/hr = 36 \times \frac{5}{18} m/s$

or, $v_0 = 10$ m/s **[1/2 M]**

Let R be the radius of the circular track

we have,

$v_0 = \sqrt{gR\tan\theta}$

$\Rightarrow v_0^2 = gR\tan\theta$ **[1 M]**

$\Rightarrow R = \dfrac{v_0^2}{g\tan\theta} = \dfrac{(10m/s)^2}{(9.8m/s^2)\times\tan 10^0} = \dfrac{100m}{9.8\times 0.1763}$ **[1 M]**

$\Rightarrow R = 57.88m$

$\therefore$ Length of the circular track $= 2\pi R =$

$2\times 3.142\times 57.88m = 363.72m$ **[1/2 M]**

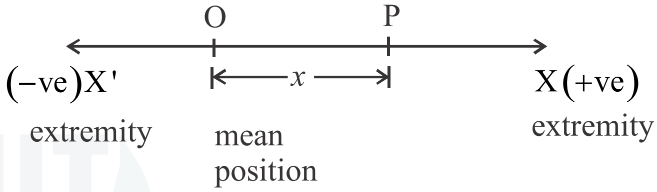
Topic:Circular Motion; Sub-topic:Banking of Road_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

Q.4 Conservation of energy for particle in S.H.M.

Suppose a particle of mass m performing linear S.H.M. is at point 'P' which is at a distance X from the mean position 'O' is shown in figure.

K.E. of particle at point 'P' is $K.E. = \frac{1}{2}m\omega^2\left(A^2 - x^2\right)$

P.E. of particle at point 'P' is $P.E. = \frac{1}{2}m\omega^2 x^2$



$T.E. = K.E. + P.E.$

$= \frac{1}{2}m\omega^2\left(A^2 - x^2\right) + \frac{1}{2}m\omega^2 x^2$

$T.E. = \frac{1}{2}m\omega^2 A^2 ......(i)$ **[1 M]**

If particle is at mean position $x = 0$

$\therefore K.E. = \frac{1}{2}m\omega^2 A^2$

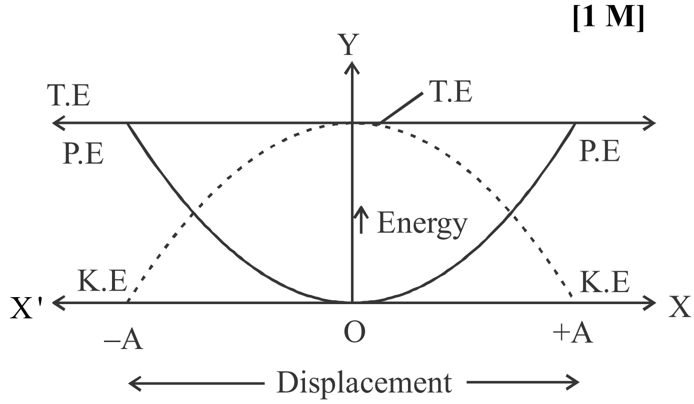
$P.E. = 0$

$T.E. = \frac{1}{2}m\omega^2 A^2 .....(ii)$ **[1 M]**

If particle is at extreme position $x = A$

$K.E. = \frac{1}{2}m\omega^2\left(A^2 - A^2\right) = 0$

$P.E. = \frac{1}{2}m\omega^2 A^2$ **[1 M]**



$T.E. = \frac{1}{2}m\omega^2 A^2 .....(iii)$ **[1 M]**

from equation (i) , (ii) & (iii) it is observed that total energy or a particle performing linear S.H.M. at any point in path is constant.

Topic: Oscillation_ Sub-topic:Total Energy_ L-1 _ Target-2017__ **XII-HSC Board Test___Physics**

Given : $\lambda_1 = \frac{83m}{170}$ **[1 M]**

$\lambda_2 = \frac{83}{172}m$

$N = 8$ beats per second.

To find : $V = ?$; $n_1 = ?$; $n_2 = ?$

$V = n_1\lambda_1$ and $V = n_2\lambda_2$

$n_1 = \frac{V}{\lambda_1}$ and $n_2 = \frac{V}{\lambda_2}$

$\lambda_1 > \lambda_2$ hence $n_2 > n_1$

$N = n_2 - n_1$

$8 = \frac{V}{\lambda_2} - \frac{V}{\lambda_1} = V\left[\frac{172}{83} - \frac{170}{83}\right]$ **[1 M]**

$8 = \frac{V \times 2}{83}$

$V = 332\,m/s$

$n_1 = \frac{V}{\lambda_1} = \frac{332}{\frac{83}{170}} = \frac{332 \times 170}{83} = 680Hz$

$n_2 = \frac{V}{\lambda_2} = \frac{332}{\frac{83}{172}} = \frac{332 \times 172}{83} = 688Hz$ **[1 M]**

Topic: Wave Motion_ Sub-topic:Beat Theory_ L-1 _ Target-2017__ **XII-HSC Board Test___Physics**

OR

Consider two identical progressive waves travelling along X axis in opposite direction. They are given by

$y_1 = A\sin\frac{2\pi}{\lambda}(vt - x)$ along positive X - axis ....(i)

$y_2 = A\sin\frac{2\pi}{\lambda}(vt + x)$ along negative X - axis ....(ii)

The resultant displacement 'y' is given by the principle of superposition of waves.

$y = y_1 + y_2 .....(iii)$ **[1 M]**

$y = A\sin\frac{2\pi}{\lambda}(vt - x) + A\sin\frac{2\pi}{\lambda}(vt + x)$

By using $\sin C + \sin D$

$= 2\sin\left[\frac{C+D}{2}\right]\cos\left[\frac{C-D}{2}\right]$

we get

$y = 2A\sin\left[\frac{2\pi}{\lambda}\left(\frac{vt - x + vt + x}{2}\right)\right]$ **[1 M]**

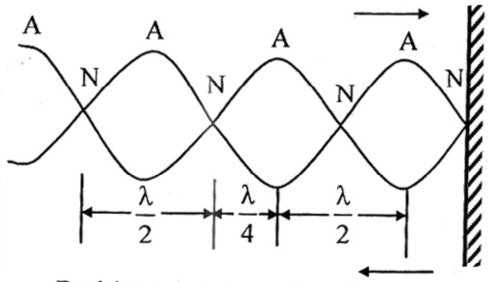
$\cos\left[\frac{2\pi}{\lambda}\left(\frac{vt - x - vt - x}{2}\right)\right]$

$= 2A\sin\left(\frac{2\pi vt}{\lambda}\right)\cos\left(\frac{2\pi}{\lambda}(-x)\right)$

$\therefore y = 2A\sin 2\pi nt\cos\left(\frac{2\pi x}{\lambda}\right)\left(\because n = \frac{v}{\lambda}\right)$

$\left[\because \cos(-\theta) = \cos\theta\right]$

$\therefore y = 2A\cos\left(\frac{2\pi x}{\lambda}\right)\sin 2\pi nt$



Position of nodes and antinodes on stationary wave

Let $R = 2A\cos\left(\frac{2\pi x}{\lambda}\right)$

$\therefore y = R\sin(2\pi nt)....(iv)$

But $\omega = 2\pi n$

$\therefore y = R\sin\omega t.....(v)$

Equation (v) represents the equation of S.H.M. hence, the resultant wave is a S.H.M. of amplitude R which varies with X.

The absence of x in equation (v) shows that the resultant wave is neither travelling forward nor backward. Therefore it is called stationary waves.

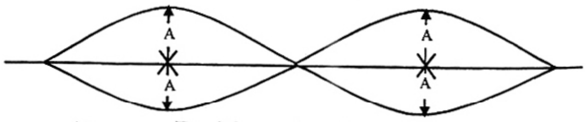
Position of antinodes : **[1 M]**

The points of a medium, which vibrate with maximum amplitude are called antinodes.

since $R = 2A\cos\left(\frac{2\pi x}{\lambda}\right)$

At antinode : $R = \pm 2A$

$\therefore \cos\left(\frac{2\pi x}{\lambda}\right) = \pm 1$



Position of antinodes

$\left(\frac{2\pi x}{\lambda}\right) = 0, \pi, 2\pi, 3\pi, ...n\pi$

$\therefore x = 0, \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2} .....$

$\therefore$ Distance between two consecutive

antinodes $= x_1 - x_0 = \frac{\lambda}{2}, x_2 - x_1$

$= \lambda - \frac{\lambda}{2} = \frac{\lambda}{2}$ and so on.

Thus distance between two successive antinodes is $\frac{\lambda}{2}$

Nodes : The points of medium, which vibrate with minimum amplitude are called nodes.
Amplitude at node is minimum i.e. 0. **[1 M]**

$\therefore R_{\min} = 0$

since, $R = 2A\cos\left(\frac{2\pi x}{\lambda}\right)$

$\therefore \cos\left(\frac{2\pi x}{\lambda}\right) = 0$

$\therefore \frac{2\pi x}{\lambda} = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, ...$

$\therefore x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4}, ...$

Distance between two consecutive nodes,

$x_1 - x_0 = \frac{3\lambda}{4} - \frac{\lambda}{4} = \frac{\lambda}{2}$

$x_2 - x_1 = \frac{5\lambda}{4} - \frac{3\lambda}{4} = \frac{\lambda}{2}$ and so on.

Thus distance between two successive nodes is $\frac{\lambda}{2}$

Hence nodes and antinodes are equispaced. The distance between node and adjacent antinode is $\frac{\lambda}{4}$.

Topic: Stationary Waves; Sub-topic:Stationary Waves_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

Given : $m = 1kg$ **[1 M]**

$r = 0.5mm = 5\times10^{-4}m$

$L = 4m$

$y = 20\times10^{10}N/m^2$

$g = 9.8\times m/s^2$

To find : $l = ?$

$$l = \frac{mgL}{y\times\pi r^2}$$

$$l = \frac{1\times9.8\times4}{20\times10^{10}\times3.14\times\left(5\times10^{-4}\right)^2}$$ **[1 M]**

$$= \frac{39.2}{2\times10^{11}\times3.14\times25\times10^{-8}}$$

$$= \frac{39.2}{50\times3.14\times10^{3}}$$

$$= 0.249\times10^{-3}m$$

$$l = 0.249mm$$

$$\text{Elastic limit} = \frac{\text{Tension}}{\text{Area}}$$

$$\text{Area} = \frac{\text{Tension}}{\text{Elastic limit}} = \frac{mg}{\text{Elastic limit}}$$

$$= \frac{1\times9.8}{2.4\times10^{8}}$$

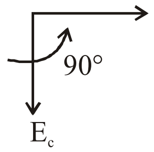
Area $= 4.08\times10^{-8}m^2$ **[1 M]**

Topic: Elasticity; Sub-topic:Young's Modulus_ L-1 _ Target-2017__ **XII-HSC Board Test___Physics**

SECTION - II

Q. 5

(i) (c)



Topic: Electromagnetic Induction; Sub-topic:Alternatig Current_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(ii) (b)

Application of doppler's effect.

Topic: Wave theory of light;Sub-topic:Doppler's Effect_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(iii) (a)

Concept of diamagnetic substance.

Topic: Magnetism; Sub-topic:Diamagnetic substance_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(iv) (b)

Transducer converts one form of energy into another.

Topic: Communication system; Sub-topic:Transducer_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(v) (c)

In saturation state, the collector – emitter voltage drops to such an extent that the collector–base p–n junction becomes forward biased. The emitter base junction however remains as usual (i.e. foward biased).

Topic: Semi-conductors_ Sub-topic:Transistro_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(vi) (c)

Concept of photon and its properties.

Topic: Atom, Molecule and Nuclei Sub-topic:Property of Photon_ L- 1_ Target-2017__ XII-HSC Board Test___Physics

(vii) (d)

$$E = \frac{q^2}{2c}$$

$$E' = \frac{(2q)^2}{2c} = 4\left(\frac{q^2}{2c}\right)$$

$$= 4E$$

Topic: Electrostatics_ Sub-topic:energy of Capacitors_ L-1_ Target-2017__ XII-HSC Board Test___Physics

Q.6

(i) Interference pattern is obtained as the result of interaction of light coming from two different wavefronts from two coherent sources while diffraction pattern is obtained as the result of interaction of light coming from different parts of the same wavefront. **[1/2 M]**

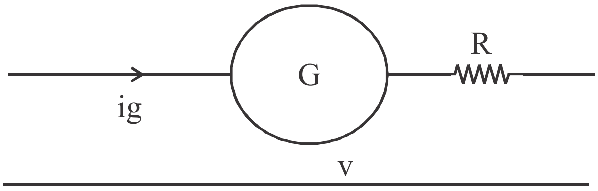
Interference fringes are of the same width while diffractiong fringes are not of the same width. **[1/2 M]**

In interference patternall bright bands are of same intensity while in diffraction pattern all bright bands are not of same intensity. Intensity is maximum for central maximum in diffraction pattern. **[1/2 M]**

The dark fringes are perfectly dark in interference pattern but in diffraction pattern they are not perfectly dark. **[1/2 M]**

Topic: Interference and Diffraction_ Sub-topic:difference bewtween Interference and diffraction L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(ii)



[1 M]

When high resistance in series is connected with MCG, it becomes voltmeter.

i.$_g$, $G + i_g \ R = V$

$i_g \ R = V - i_g.G$

$$\boxed{R = \frac{V}{ig} - G}$$

[1 M]

Topic:Magnetic Effect of Electric Current_ Sub-topic:Volt Metre L-1 _ Target-2017__ **XII-HSC Board Test___Physics**

(iii) 1) Accurancy and sensativity is more. **[1/2 M]**

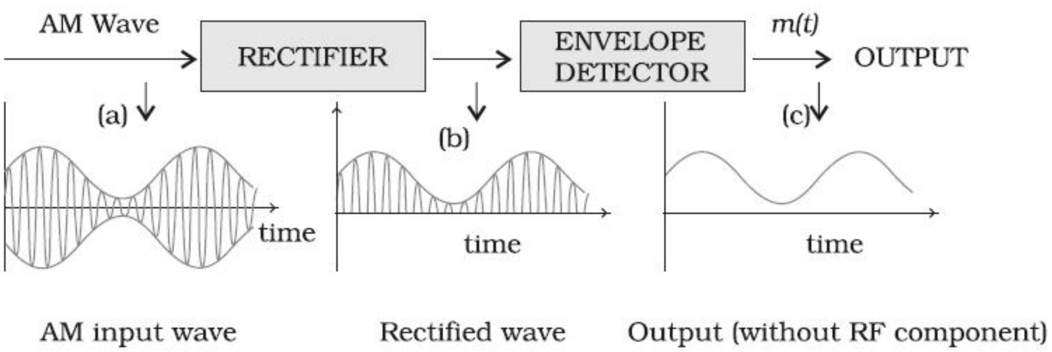
2) It can compare EMF of 2 cells. **[1/2 M]**

3) It can measure internal resistance of cell also . **[1/2 M]**

4) It can measure EMF of a cell. **[1/2 M]**

Topic: Current electricity; Sub-topic:Potentiometer_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(iv)



[1 + 1 M]

Topic: Communication System; Sub-topic:Amplitude Modulation (Detection) L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(v) $C_S = \dfrac{NAB}{C}$ **[1 M]**

$$\frac{100 \times 15 \times 10^{-4} \times 0.03}{15 \times 10^{-10}}$$

$$\boxed{C_S = 0.03 \times 10^{8} \text{ deg}/\ Amp}$$

[1 M]

Topic: Magnetic Effect of Current Electricity; Sub-topic:MCG Sensitivity_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(vi) $\phi = 6t^2 + 7t + 1$ **[1 M]**

$$e = -\frac{dt}{dt} = -(12t + 7)$$

e at t = 2

$\boxed{e = -31\,mV}$ **[1 M]**

Topic: Electro Magnetic Induction; Sub-topic:Induce EMF_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(vii) $\frac{x}{50} = \frac{40}{60}$ **[1 M]**

$\boxed{x = 33.34\Omega}$ **[1 M]**

Topic: Current Electricity_ Sub-topic:Meter Bridge_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(viii) $T = \frac{2\pi r}{V}$ **[1 M]**

$$f = \frac{V}{2\pi r}$$

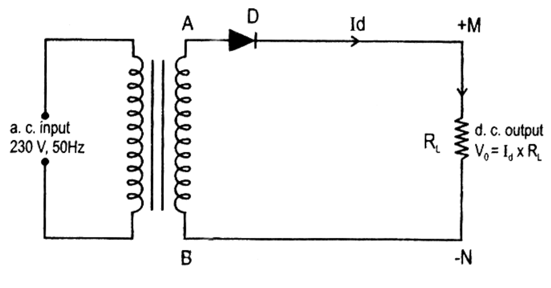
$$f = \frac{1.09 \times 10^6}{2 \times 3.14 \times 2.14 \times 10^{-10}}$$

$\boxed{f = 8.11 \times 10^{14}\,Hz}$ **[1 M]**

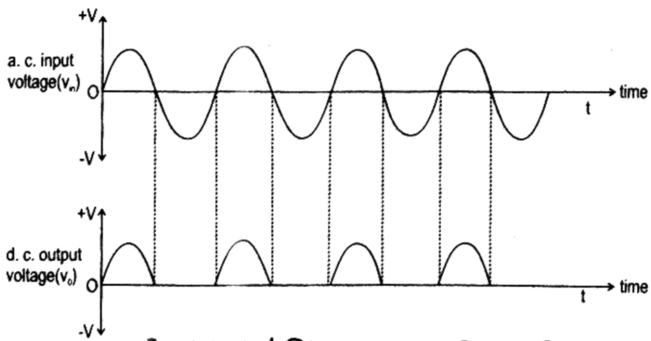
Topic: Atoms, Molecules and Nuclei; Sub-topic:Orbital Frequency of Electron_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

Q.7

(i)



Circuit diagram for half wave rectifier



Input and Output waveforms for half wave rectifier

[1 M]

The above figure shows circuit diagram for half wave rectifier. The transformer provides suitable ac voltage across secondary windings. The diode is connected in series with load resistance R_L.

During every positive half cycle of the ac input, point A becomes '+' ve w.r.t. point B, and diode becomes forward biased. When forward voltage crosses barrier potential, the diode works as closed switch and large current I_d flows through R_L from point M to N. This current produces voltage $\left(V_{dc} = I_d \times R_L\right)$ across the load R_L.

During every negative half cycle of the ac input, point A becomes negative w.r.t. point B and diode gets reverse biased. So, it works as an open switch and no current flows through R_L hence no voltage is developed across load R_L.

In this way, current always flows from point M to point N and thus is always unidirectional. So the voltage of point M is always positive w.r.t. point N. Since current flows through R_L only for half cycle of the applied ac voltage, it is called half wave rectifier. **[2 M]**

Topic: Semi Conductors ; Sub-topic:Half wave rectifier_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(ii) **Sefl Induction:**

When a current is established in a closed conducting loop, it produces a magnetic field. This magnetic field has its flux through the area bounded by the loop. If the current changes with time, the flux through the loop changes and hence an emf is induced in the loop. This process is called self induction. **[1/2 M]**

The magnetic flux (ϕ) is directly proportional to magnetic field (B) and field is directly proportional to the current(I)

$$\therefore \phi \propto I$$

$$\therefore \phi = LI$$

Here L is called self-inductance of the loop.

By Faraday's law of electromagnetic induction, the emf induced, $\varepsilon = -\dfrac{d\phi}{dt}$ **[1/2 M]**

or , $\varepsilon = -L\dfrac{di}{dt}$

S.I. unit of L is weber per ampere called henry (H). **[1/2 M]**

Mutual Induction:

Suppose two cosed conducting loops are placeed close to each other and a current I is passed in one. It produces a magnetic field and this field has a flux ϕ through the area bounded by the other loop. As the magnetic field at a point is directly proportional to the current producing it and the flux is directly proportional to the magnetic field, hence ϕ will be directly proportional to the current I. **[1/2 M]**

$$\therefore \phi = MI$$

where M is a constant depending on the geometrical shapes of the two conducting loops and their placing. This constant is called mutual inductance of the given pair of circuits.

So, if the current changes in one loop, the flux of the magnetic field, through the other loop also changes and hence emf is induced in that loop. This phenomenon is known as mutual induction. **[1/2 M]**

By Faraday's law, the emf induced is given by

$$\varepsilon = -\frac{d\phi}{dt} = -M\frac{dI}{dt}$$

S.I. unit of M is henry (H) **[1/2 M]**

Topic: Electro Magnetic Induction; Sub-topic:Self and Mutual Induction_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(iii) **Given:**

Side of cube, $a = 1cm = 1 \times 10^{-2}\, m$

electric field intensity, $E = 300\ V/m$

dielectric constant, $k = 8$

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N-m^2$ **[1/2 M]**

$\therefore$ energy density

$u = \frac{1}{2} k\varepsilon_0 E^2$ **[1/2 M]**

$\therefore$ The energy contained in the cube = energy density $\times$ volume

$\therefore U = \frac{1}{2}\varepsilon_0 E^2\ .V$ **[1/2 M]**

$= \frac{1}{2} k\varepsilon_0 E^2 \times a^3$

$= \frac{1}{2} \times 8 \times 8.85 \times 10^{-12} \times (300)^2 \times \left(1 \times 10^{-2}\right)^3\ J$ **[1 M]**

$= 3.186 \times 10^{-12}\ J$ **[1/2 M]**

Topic: Electrostaics; Sub-topic:Energy Density_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

(iv) **Given:**

$r = 0.53\ \mathring{A} = 0.53 \times 10^{-10} m$

$f = 9 \times 10^9\ M\ Hz = 9 \times 10^{15}\ Hz$

$e = 1.6 \times 10^{-19}\, C$

$\frac{e}{2m_e} = 8.8 \times 10^{10}\ C/kg$ and $\pi = 3.142$ **[1/2 M]**

Orbital angular momentum,

$l = m_e vr = \left(\frac{2m_e}{e}\right)\cdot\left(\frac{evr}{2}\right)$ ......(i) **[1/2 M]**

Now, $f = \frac{v}{2\pi r}$

$\therefore v = 2\pi r f$ .....(ii) **[1/2 M]**

$\therefore$ from equation (i) and (ii)

$l = \left(\frac{2m_e}{e}\right)\cdot\left(\frac{er}{2} \times 2\pi rf\right)$

or, $l = \left(\frac{2m_e}{e}\right)\cdot(fe)\cdot\left(\pi r^2\right)$

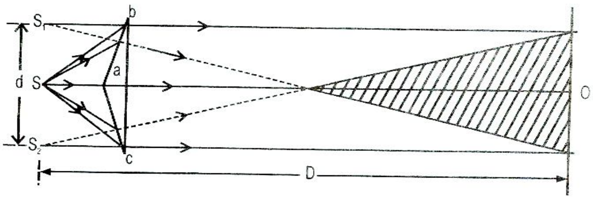
or, $l = \frac{1}{8.8 \times 10^{10}} \times 9 \times 10^{15} \times 1.6 \times 10^{-19} \times 3.142 \times \left(0.53 \times 10^{-10}\right)^2\ kg-m^2/s$ **[1 M]**

or $l = 1.444 \times 10^{-34}\ kg.m^2/s$ **[1/2 M]**

Topic: Magnetism_ Sub-topic:Magnetic Moment of a Revolving Electron_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**

Q.8

Fresnel's biprism experiment can be used to determine the wavelength of a monochromatic light. The fig. shows the experimental arrangement and ray diagram.



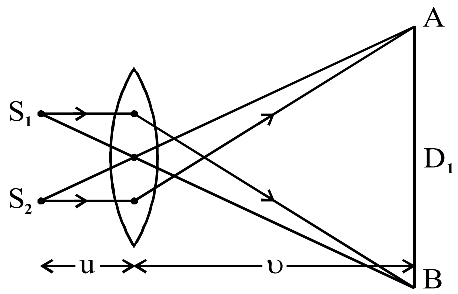
[1/2 M]

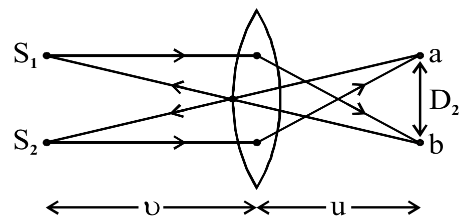
Apparatus : An optical bench is used in the biprism experiment. It consists of a heavy metal platform about 2m in length and carrying four vertical stands to a slits, the biprism, the lens and eyepiece. The stands can be moved along the bench as well as perpendicular to the bench.

Adjustment : The slit S is adjusted to be vertical and narrow. It is illuminated by light from a monochromatic source placed behind it. The light emerging from the slit is made incident on the biprism. The eyepiece stand is arranged at about 1 m from the slit. The refracting edge of the biprism and the vertical cross-wire of the eyepiece are arranged parallel to the slit and along a straight line. The slit is observed through the eyepiece and the biprism is slowly rotated about the horizontal axis. When its refracting edge becomes exactly parallel to the slit, the interference pattern consisting of alternate bright and dark bands is seen through the eyepiece. The slit must be suffciently narrow so that the bands are sharp and clear. **[1 M]**

Measurement : The wavelength of a monochromatic light is given by $\lambda = \frac{\overline{X}d}{D}$, where $\overline{X}$ is the band width or the fringe width d is the distance between the coherent sources and D is the distance between the sources and the eyepiece. The distance D can be measured directly with the help of the scale marked on the optical bench. To measure the band width $\overline{X}$, the micrometer screw fitted to the eyepiece is adjusted such that the vertical cross-wire is made coincide with one of the bright bands. The micrometer reading X_1 is noted By rotating the screw in the same sense, the vertical cross-wire is made coincide with successive bright bands and the corresponding reading X_2,X_3, X_4.....etc. are noted. The mean value of $(X_2–X_1),(X_3–X_2),(X_4–X_3)$... etc are noted. The mean value of $(X_2–X_1),(X_3–X_2),(X_4–X_3)$.... etc gives the mean band width $\overline{X}$. To measured the distance between two coherent sources, a convex lens is mounted on the stand between the biprism and the eyepiece. Without disturbing the slit and the biprism, the eyepiece stand is moved along the bench so that the distance the slit and the eyepiece is more than four times the focal length of the lens. The lens stand is moved towards the biprism and its position (L_1) is so adjusted that the two magnified images of the slit are seen through the eyepiece by rotating the micrometer screw. The vertical cross-wire in the eyepiece is made to coincide with each image and the corresponding reading is noted. The difference between these two reading gives the distance d_1 between the two magnified images. The lens is moved towards the eyepiece and its position (L_2) is so adjusted that two diminished images of the slit are seen through the eyepiece. The distance d_2 between these images is measure as in case of d_1 Then the distance between the two coherent sources is given by $d = \sqrt{d_1 d_2}$ **[1 M]**

The wavelength of the monochromatic light is determined by formula i.e $\lambda = \frac{\bar{X}d}{D}$. $\lambda = \frac{\overline{X}\sqrt{d_1 d_2}}{D}$ **[1/2 M]**





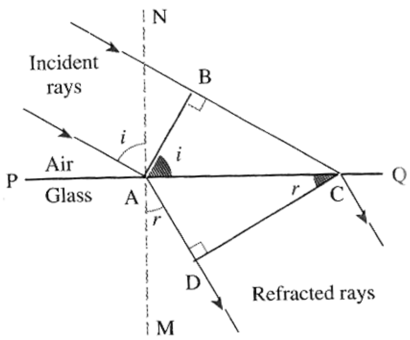
[1 M]

Topic: Interference and Diffraction; Sub-topic:Bi-prism_ L-1_ Target-2017__ XII-HSC Board Test___Physics

Given: $i = 65°$

$$\frac{CD}{AB} = 2$$ [1/2 M]

$$\frac{\cos r}{\cos i} = \frac{CD}{AB} = 2$$



$$\cos r = 2\cos 65°$$

$$= 2 \times 0.4226$$

$$\cos r = 0.845$$ [1/2 M]

$$= 2 \times 0.4226$$

$$\cos r = 0.845$$

$$r = \cos^{-1}(0.845)$$ [1 M]

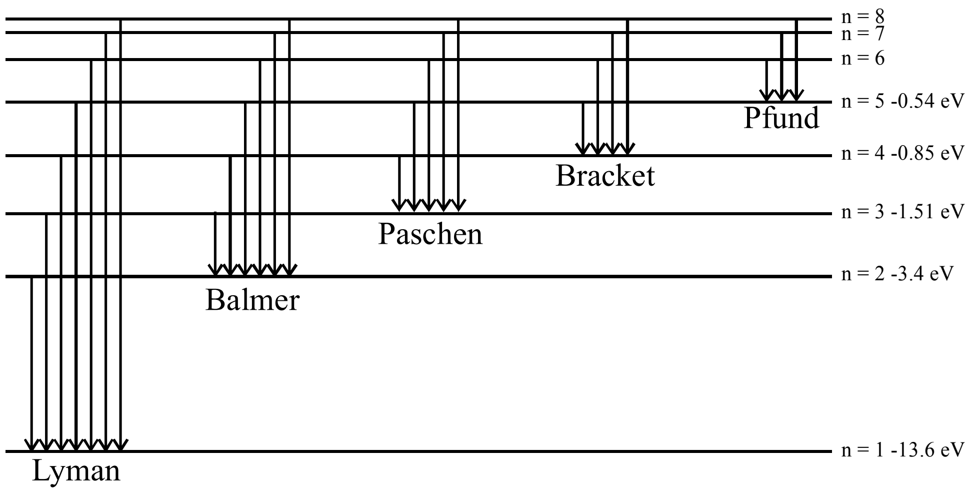
$$r = 32°20'$$

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin 65}{\sin 32°20'} = \frac{0.9063}{0.5328}$$

$$\mu = 1.701$$ [1 M]

Topic: Wave Theory of Light_ Sub-topic:Refractive Index_ L- 1_ Target-2017__ XII-HSC Board Test___Physics

OR



[2 M]

Topic:Atom, Molecules and Nuclei; Sub-topic:Hydrogen spectrum_ L- 1_ Target-2017__XII-HSC Board Test___Physics

Paschen series:

$$\frac{1}{\lambda} = R\left(\frac{1}{3^2} - \frac{1}{n^2}\right) \text{ where } n = 4, 5, 6, 7$$ **[1 M]**

$\lambda \to 18750\ \mathring{A}, 12820\ \mathring{A}$

This series lies in infrared region.

Brackett Series:

$$\frac{1}{\lambda} = R\left(\frac{1}{4^2} - \frac{1}{n^2}\right) \text{ where } n = 5, 6, 7, 8$$ **[1 M]**

$\lambda \to 40518\ \mathring{A},\ 26253\ \mathring{A}$ near infrared region.

Topic:Atom, Molecules and Nuclei; Sub-topic:Hydrogen spectrum_ L- 1_ Target-2017__ **XII-HSC Board Test___Physics**

Given:

$\phi = 2.25\,eV \ \to$ potassium

$\phi = 2.14\ eV \ \to$ Caesium

$\lambda = 5180\mathring{A} = 5.180 \times 10^{-7}\,m$ **[1/2 M]**

$h = 6.63 \times 10^{-34}\ Js$

$c = 3 \times 10^{8}\ m/s.$ **[1/2 M]**

$$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3\ 5\ 10^{8}}{5.180 \times 10^{-7}}$$ **[1 M]**

$E = 3.84 \times 10^{-19}\ J$

This is greatger than ϕ for potassium and Caesium. Hence, photoelectric effect will occur in botht he cases.

[1 M]

Topic: Electrons and Photons; Sub-topic:Einstein's Equation_ L-1_ Target-2017__ **XII-HSC Board Test___Physics**