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XII HSC - BOARD - FEBRUARY - 2018

Date: 26.02.2018 **PHYSICS - (J 236) - QP + SOLUTIONS**

SECTION - I

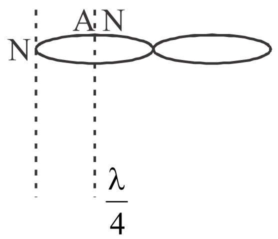
Q. 1 Select and write the most appropriate answer from the given alternative for each sub-question :

(i) In stationary wave, the distance between a node and its adjacent antinode is _______.

(a) λ (b) $\frac{\lambda}{4}$ (c) $\frac{\lambda}{2}$ (d) 2λ

Ans. (b)

$\frac{\lambda}{4}$



*Topic: Stationary wave; Sub-topic:Distance between Node & Antinode_ L- 1_* **XII-HSC Board Test__Physics**

(ii) If the source is moving away from the observer, then the apparent frequncy _____.

(a) will increase (b) will remain the same

(c) will be zero (d) will decrease

Ans (d)

Decrease, Doppler's effect.

*Topic: Wave theory; Sub-topic:Dopper's Effect; L- 1_* **XII-HSC Board Test__Physics**

(iii) A paricle of mass m performs vertical motion in a circle of radisu r. Its projectile energy at the highest point is _______. (g is acceleration due to gravity)

(a) 2 mgr (b) mgr (c) 0 (d) 3 mgr

Ans (A)

2 mgr

PE = mgh

*Topic:Circular Motion; Sub-topic:Vertical Circle; L- 1_* **XII-HSC Board Test__Physics**

(iv) The compressibility ofa substance is the reciprocal of _________.

(a) Young's modulus (b) bulk modulus

(c) modulus of rigidity (d) possion's ratio

Ans. (B)

Bulk modulus

$$\text{Comp} = \frac{1}{K}$$

*Topic: Elasticity; Sub-topic:Compressibility; L- 1_* **XII-HSC Board Test__Physics**

(v) If the particle starts its motion from mean position, the phase difference between displacement and acceleration is ______.

(a) 2π rad (b) $\frac{\pi}{2}$ rad (c) π rad (d) $\frac{\pi}{4}$ rad

Ans. (A) 2π

$y = a\sin wt$, $v = aw\cos wt$, $\text{accln} = -aw^2 \sin wt$

*Topic: SHM; Sub-topic:Acceleration of Particles; L-2_* **XII-HSC Board Test__Physics**

(vi) The kinetic energy per molecule of a gs at temperature T is ________.

(a) $\left(\frac{3}{2}\right)RT$ (b) $\left(\frac{3}{2}\right)K_BT$ (c) $\left(\frac{2}{3}\right)RT$ (d) $\left(\frac{3}{2}\right)\left(\frac{RT}{M}\right)$

Ans. (b) $\frac{3}{2}K_BT$

$$\text{ICE of 1 module} = \frac{3}{2}K_BT$$

*Topic: Kinetic theory of Gases & Radiation; Sub-topic:Kinetic Energy of Molecule; L-1_* **XII-HSC Board Test__Physics**

(vii) A thin ring has mass 0.25 kg and radius 0.5 m. Its moment of inertia about an axis passing through its centre and perpendicular to its plane is _______.

(a) 0. 0625 kg m^2 (b) 0.625 kg m^2 (c) 6. 25 kg m^2 (d) 62. 5 kg m^2

Ans. (A) 0.0625 kg m^2

$I = mr^2$

*Topic: Moment of inertia; Sub-topic:Ring Formula; L- 1_* **XII-HSC Board Test__Physics**

Q.2

(i) State Kepler's law of orbit and law of equal areas.

Ans. All planet revolves around sun in elleptical orbit, sun as one of its focus.

Line joining sun and planet sweeps equal area in equal time interval i.e. Aerial velocity is constant.

*Topic: Gravitation; Sub-topic:Kepper's law; L-1_* **XII-HSC Board Test__Physics**

(ii) State any 'four' assumptions of kinetic theory of gases.

Ans.
- Gas made up of small particle called molecule.
- They are very small, spherical, rigid and elastic.
- They move in random motion.
- They collide each other and container of wall, collision is perfectly elastic.

*Topic: Kinetic theory of Gases & Radiation; Sub-topic:Assumtption for gas molecule L- 1_* **XII-HSC Board Test__Physics**

(iii) Define moment of inertia. State its SI unit and dimensions.

Ans. It is sum of product of each point mass and square of its distance from axis of rotations.
S.I unit kg. m^2
Dim $[M^1 L^2 T^0]$

Topic: Momentof Inertia; Sub-topic:Definition; L- 1_ **XII-HSC Board Test__Physics**

(iv) Distinguish between centripetal and centrifugal force.

Ans.

Centripetal force	Centripetal force
It is real force	It is pseudo force
It acts from particle towards centre	it acts from centre to particle
e.g. Gravitation force, frictional force, Electro static force	e.g force experienced on person in marry go round (out wards), person pushed backward in accelerating train.

Topic: Circular Motion; Sub-topic:Centripetal Force; L-1_ **XII-HSC Board Test__Physics**

(v) In Melde's experiment, when tension in the string is 10 g wt then three loops are obtained. Determine the tension in the string required to obtain four loops, if all other conditions are constant.

Ans. $T_1P_1^{\ 2} = T_2P_2^{\ 2}$

$$10 \times 10^{-3} \times 9.8 \times 3^2 = T_2 \times 4^2$$

$$\boxed{T_2 = 0.06 \text{ N}}$$

Topic: Stationary waves; Sub-topic:Meldes experiment; L- 1_ **XII-HSC Board Test__Physics**

(vi) Calculate the work done in increasing the radius of a soap bubble in air from 1 cm to 2 cm. The surface tension of soap solution is 30 dyne/cm. $(\pi = 3.142)$

Ans. $T = \dfrac{E}{\Delta A}$

$$30 = \frac{E}{4\pi\left(r_2^{\ 2} - r_1^{\ 2}\right) \times 2}$$

$$E = 30 \times 4\pi \times \{2^2 - 1^2\} \times 2$$

$\boxed{E = 2260.8}$ dyne cm.

Topic: Surface Tension; Sub-topic:Surface Energy; L- 1_ **XII-HSC Board Test__Physics**

(vii) A falt curve on a highways has a radius of curvature 400 m. A car goes around a curve at a speed of 32 m/s. What is the minimum value of coefficient of friciton that will prevent the car from sliding? $\left(g = 9.8\ m/s^2\right)$

Ans. $v=\sqrt{\mu r g}$

$32^2=\mu \quad 400\times 9.8$

$\boxed{\mu=0.261}$

Topic: Circular Motion; Sub-topic:Banking of road; L- 1_ XII-HSC Board Test__Physics Sub-topic:Vibration in String_ L-1_ Target-2017__ XII-HSC Board Test___Physics

(viii) A particle performing linear S.H.M. has maximum velocity of 25 cm/s and maximum acceleration of 100 cm/m². Find the amplitude and period of oscillation. $(\pi=3.142)$

Ans. $wa=25$ ....(1)

$w^2a=100$ .....(2)

(2) dividing (1)

$w=4$

$\frac{2\pi}{T}=4$

$\boxed{T=1.575}$ S

from 1 $wa=25$

$a=\frac{25}{4}=\boxed{6.25}$ cm

Topic: SHM; Sub-topic:Acceleration of Particle; L-1_ XII-HSC Board Test__Physics

Q.3

(i) Derive Laplace's law for a spherical membrane.

Ans. Consider a small spherical liquid drop with a radius R. It has a convex surface, so that the pressure on the concave side (inside the liquid) is greater thean the pressure p_0 on the convex side (outside the liquid). The surfacxe area ofthe drop is

$A=4\pi R^2$ ....(1)

Imagine an increase in radius by an infinitesimal amount dR from the equilibrium value R. Then, the differential increase in surface are would be

$dA=8\pi R\bullet dR$ .....(2)

The increase insurface energy would be equal to the work required to increase the surface area :

$dW=T\bullet dA=8\pi TRdR$ .....(3)

We assume that dR is so small that the pressure inside remains the same , equal to p. All parts of the surface of the drop experience an outward force per unit area equal to $P-P_0$. Therefore, the work done by this outward pressure - developed force aginst the surface tension force during the increase in raduis dR is

dW = (excess pressure × surface area) . dR

$=(p-p_0)\times 4\pi R^2\bullet dr$ ......(4)

From equation (3) and (4)

$(p-p_0)\times 4\pi R^2\bullet dR=8\pi TRdR$

$\therefore \ p - p_0 = \frac{2T}{R}$ ......(5)

Which is called Laplace's law for a spherical membrane (or Young - Laplace equation is spherical form).

*Topic: Surface Tension; Sub-topic:Pressure change L-2_* **XII-HSC Board Test__Physics**

(ii) State and prove principle of conservation of angular momentum.

Ans. Principle (or law) of conservation of a body is conserved if the resultatnt external torque on the body is zero.

Proof : Consider a particle of mass m whose position vector with respect to the origin at any instant is $\vec{r}$.

Then, at this instant, the linear velocoity of this particle is $\vec{v} = \frac{\vec{dr}}{dt}$, its linear momentum is $\vec{p} = m\vec{v}$ and its angular momentum about an axis through the origin is $\vec{l} = \vec{r} \times \vec{p}$.

Its angular momentum $\vec{l}$ may change with time due to a torque on the particle.

$$\frac{d\vec{l}}{dt} = \frac{d}{dt}\left(\vec{r} \times \vec{p}\right)$$

$$= \frac{d\vec{r}}{dt} \times \vec{p} + \vec{r} \times \frac{d\vec{p}}{dt}$$

$$= \vec{v} \times \overrightarrow{mv} + \vec{r} \times \vec{F}$$

$$= \vec{r} \times \vec{F} \qquad \left(\because \vec{v} \times \vec{v} = 0\right)$$

$$= \vec{\tau}$$

Where $= \frac{d\vec{p}}{dt} == \vec{F}$, the force on the particle.

Hence, if $\vec{\tau} = 0$, $\frac{d\vec{l}}{dt} = 0$

$\therefore \vec{l}$ = constant, i.e., $\vec{l}$ is conserved. This proives the principle (or law) of conservation of angular mometnum.

*Topic: Rotational Motion; Sub-topic:Angular momentum L-2_* **XII-HSC Board Test__Physics**

(iii) Calculate the strain energy per unit voume is a brass wire of length 3 m and area of cross - section 0.6 mm^2 when it is stretched by 3 mm and a force of 6 kgwt is applied to its free end.

Ans. Date : L = 3m

A = 0.6 mm^2 = 0.6 × 10^{-6} m^2

l = 3 mm = 3 × 10^{-3} m

F = 6 kg-wt = 6 × 9.8 N

Formula :

$$\frac{\text{Strain Energy}}{\text{Volume}} = \frac{1}{2}\left(\frac{F}{A}\right) \times \left(\frac{l}{L}\right); \qquad = \frac{1}{2}\left(\frac{6 \times 9.8}{0.6 \times 10^{-6}}\right) \times \left(\frac{3 \times 10^{-3}}{3}\right)$$

$$= 4.9 \times 10^{-4}\, J/m^3$$

*Topic: Elasticity; Sub-topic:Strain, Energy per Volume_ L-2_* **XII-HSC Board Test__Physics**

(iv) What is the decrease in weight of a body of mass 500 kg when it is taken into a mine of depth 1000 km? (Radius of earth R = 6400 km, g = 9.8 m/s^2)

Ans. Date : m = 500kg

d = 1000 km

R = 6400 km

g = 9.8 m/s^2

Formula :

$$Wd = m \times gd = mg\frac{(R-d)}{R}$$

$$gd = g\frac{(R-d)}{d}$$

$$= \frac{9.8(6400-1000)}{6400}$$

$$= 9.8 \times 0.843$$

$$gd = 8.268 \ \ m/s$$

$$Wd = m \times gd$$

$$= 500 \times 8.268$$

$$Wd = 4134.3 \text{ N}$$

***Topic: Gravitation; Sub-topic:Variation of 'g'_ L-2_* XII-HSC Board Test__Physics**

Q.4 State the differential equationof linear simple harmonic motion. Hence obtain the expression for acceleration, velocity and displacemetn of a particle performing linear S.H.M.

A body cools from 80^o C to 70^o C in 5 minutes and to 62^o C in the next 5 minutes. Calculate the temperature of the surroundings.

Ans. State the differential equation of linear S.H.M.

When a particle perfoms linear SHM. the force acting on the particle is always directed towards the mean position. The magnitude of the force is directly proportional to the magnitude of the displacement of the particle from the mean position. Thus, if $\vec{F}$ is the force acting on the particle when its displacement from the mean position is $\vec{x}$,

$$\therefore \vec{F} = -k\vec{x} \qquad .....(1),$$

where the constant k, the force per unit displacement, is called the force constant. The minus sign indicates that the force and the displacement are oppositely directed.

The velocity of the particle is $\frac{d\vec{x}}{dt}$ and its acceleration is $\frac{d^2\vec{x}}{dt^2}$.

Let m be the mass of the particle.

Force = mass × acceleration

$$\therefore \quad \vec{F} = m\frac{d^2\vec{x}}{dt^2}$$

Hence, from Eq. (1) , $m\frac{d^2\vec{x}}{dt^2} = -k\vec{x}$

$$\therefore \frac{d^2\vec{x}}{dt^2} + \frac{k}{m}\vec{x} = 0 \qquad \text{........(2)}$$

This is the differential equation of linear S.H.M.

Hence obtain the expression for acceleration, velocity and displacement of a particle performing linear S.H.M.

The differential equationof linear SHM is $\frac{d^2\vec{x}}{dt^2} + \frac{k}{m}\vec{x} = 0$

where m = mass of the particle performing SHM,

$\frac{d^2\vec{x}}{dt^2}$ = acceleration of the particle when its displacement from the mean position is $\vec{x}$ and k = force constant. For linear motion, we can write the differential equation in scalar form :

$$\frac{d^2x}{dt^2} + \frac{k}{m}x = 0$$

Let $\frac{k}{m} = \omega^2$, a constant.

$$\therefore \frac{d^2x}{dt^2} + \omega^2 x = 0$$

$$\therefore \text{ Acceleration, } a = \frac{d^2x}{dt^2} = -\omega^2 x \qquad \text{.....(1)}$$

The minus sign shows that the acceleration and the displacement have opposite directions. Writing $v = \frac{dx}{dt}$ as the velocity of the particle.

$$a = \frac{d^2x}{dt^2} = \frac{dv}{dt} = \frac{dv}{dx} \bullet \frac{dx}{dt} = \frac{dv}{dx} = v = v\frac{dv}{dx}$$

Hence, Eq. (1) can be written as

$$v\frac{dv}{dx} = -\omega^2 x$$

$$\therefore \quad v\,dv = -\omega^2 x$$

Integrating this expression, we get

$$\frac{v^2}{2} = \frac{-\omega^2 x^2}{2} + C$$

where the constant of integration C is found from a boundary condition.

At an extreme posotion (a turning point of the motion), the velocity of the particle is zero. Thus, $v = 0$ when $x = \pm A,$ where A is the amplitude.

$$\therefore \quad 0 = \frac{-\omega^2 A^2}{2} + C \qquad \therefore \quad C = \frac{\omega^2 A^2}{2}$$

$\therefore \quad \dfrac{v^2}{2} = \dfrac{-\omega^2 x^2}{2} + \dfrac{\omega^2 A^2}{2}$

$\therefore \quad v^2 = \omega^2 \left(A^2 - x^2\right)$

$\therefore \quad v = \pm\omega\sqrt{A^2 - x^2}$ ......(2)

This equation gives the velocity of the particle in terms of the displacement, x. The velocity towards right is taken to be positive and towards left as negative.

Since, $v = dx/dt$, we can write Eq. (2) as follows :

$\dfrac{dx}{dt} = \omega\sqrt{A^2 - x^2}$ (considering only the plus sign)

$\therefore \quad \dfrac{dx}{\sqrt{A^2 - x^2}} = \omega \;\; dt$

Integrating the expression, we get,

$\sin^{-1}\left(\dfrac{x}{A}\right) = \omega t + x$ .....(3)

where the constant of integration, x , is found from the initial conditions, i.e., the displacement and the velocioty of the particle at time t = 0.

Frolm Eq. (3). we have

$\dfrac{x}{A} = \sin\left(\omega t + x\right)$

$\therefore$ Displacement as a function of time is, $x = A\sin\left(\omega t + x\right)$

Topic: Oscillation; Sub-topic:Linear SHM; L-3_ XII-HSC Board Test__Physics

$\dfrac{80-70}{5} = k\left(\dfrac{80+70}{2} - \theta_0\right)$ and $\dfrac{70-62}{5} = k\left(\dfrac{70+62}{2} - \theta_0\right)$

$\therefore$ The temperature of the surroundings , $\theta_0 = 30^\circ C$

Topic: KTG & Radiation; Sub-topic:Newton's Laws of Cooling; L-2_ XII-HSC Board Test__Physics

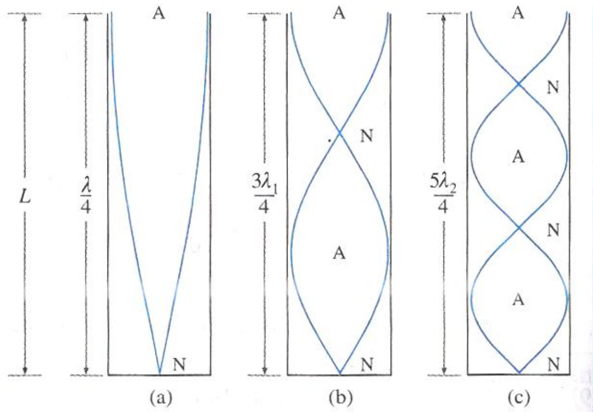
OR

What is meant by hamonics? Show that only odd hamonics are present as overtones in the case of an air column vibrating in a pipe closed at one end.

The wavelengths of two sound waves in air are $\dfrac{81}{173} m$ and $\dfrac{81}{170} m$. They produce 10 beats per second. Calculate the velocity of sound in air.

Ans. The lowest allowed frequency of vibration (fundamental) of a bounded medium and all its integral multiples are called harmonics.

The stationary waves in the air column in this case are subject to two boundary conditions that there mus tbe a node at the closed end and an antinode at the open end. In what follows, we shall ignore the end correction.



L = Length of the air column, N = node, A = antinode

Let *v* be the speed of sound in air. In the simplest mode of vibration, as shown in the figure, there is a node at the closed end and an antinode at the open end. The distance between a node and a constructive antinode is $\frac{\lambda}{4}$, where λ is the wavelength of sound. The corresponding wavelength λ and frequency *n* are

$\lambda = 4L$ and $n = \frac{v}{\lambda} = \frac{v}{4L}$ ......(1)

This gives the fundamental frequency of vibration and the mode of vibration is called the fundamental mode or first harmonic.

In the next higher mode of vibration, the first overtune , two nodes and two antinodes are formed as shown in the figure. The corresponding wavelength λ_1 and frequency λ_1 are

$\lambda_1 = \frac{4L}{3}$ and $n_1 = \frac{v}{\lambda_1} = \frac{3v}{4L} = 3n$ .....(2)

Therefore, the frequency in the first overtone is three times the fundamental frequency , i.e., the first overtone is the third hamonic.

In the second overtone, three nodes and three antinodes are formed as shown in the figure. The corresponding wavelength λ_2 and frequency n_2 are $\lambda_2 = \frac{4L}{5}$ and $n_2 = \frac{v}{\lambda_2} = \frac{5v}{4L} = 5n$ .....(3)

which is the fifth harmonic.

Therefore, in general, the frequency of the pth overtone (p = 1, 2, 3, ...) is

$n_p = (2p+1)n$ ......(4)

i.e., the pth overtone is the $(2p+1)$ the harmonic.

Equations (1), (2) and (3) show that allowed frequencies in an air column is a pipe clsoed at one end and n, 3n, 5n, ... That is, only odd harmonics are present as overtones.

*Topic: Stationary waves; Sub-topic: Vibrating column; L-3_* **XII-HSC Board Test__Physics**

Data : $\lambda_1 = \frac{81}{173}\text{m} = 0.468\text{ m}$

$$\lambda_2 = \frac{81}{170}\text{m} = 0.476\text{m}$$

$\Delta n = 10$ beats

Formula :

$$\Delta n = n_1 - n_2$$

$$= \frac{V}{\lambda_1} - \frac{V}{\lambda_2}$$

$$\Delta n = n_1 - n_2$$

$$= V\left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right]$$

$$10 = V\left[\frac{1}{0.468} - \frac{1}{0.476}\right]$$

$$10 = V\left[\frac{0.476 - 0.476}{0.468 \times 0.476}\right]$$

$$10 = \frac{V[0.008]}{0.2227}$$

$$V = \frac{10 \times 0.227}{0.008} = \frac{2.227}{0.008}$$

$$V = 278.46\text{ m/s}$$

*Topic: Wave motion; Sub-topic:Beat theory; L-2_* **XII-HSC Board Test__Physics**

SECTION - II

Q. 5 Select and write the most approprite answer from the given alternatives for each sub-question :

(i) The reflected waves from an ionosphere are ______.

(a) ground waves (b) sky waves (c) space waves (d) very high frequency waves

Ans (b) sky waves

Topic: Communication system; Sub-topic:___ L- 1_ XII-HSC Board Test__Physics

(ii) In interference pattern, using two coherent sources of light; the fringe width is _________

(a) directly proportional to wavelength.

(b) inversely proportional to square of the wavelength.

(c) inversely proportional to wavelength.

(d) directly proportional to square of the wavelength.

Ans (a) directly proportional to wavelength.

Topic: Interfernce and diffraction; Sub-topic:Interference_ L- 1_ XII-HSC Board Test__Physics

(iii) Electric intensity outside a charged cylinder havirtg the charge per unit length 'λ' at a distance from its axis is ________.

(a) $E = \frac{2\pi \in_0 \lambda}{Kr^2}$ (b) $E = \frac{\in_0 \lambda}{2\pi Kr^2}$ (c) $E = \frac{\lambda}{2\pi \in_0 Kr}$ (d) $E = \frac{4\pi \in_0 \lambda}{Kr^2}$

Ans (c) $E = \frac{\lambda}{2\pi \in_0 Kr}$

Topic: Electrostatics; Sub-topic:Gauss theorem_ L- 1_ XII-HSC Board Test__Physics

(iv) SI unit of potential gradient is _______.

(a) $V\ cm$ (b) $\frac{V}{cm}$ (c) $V\ m$ (d) $\frac{V}{m}$

Ans (d) $\frac{V}{m}$

Topic: Current Electricity; Sub-topic: Potentiometre_ L- 1_ XII-HSC Board Test__Physics

(v) The momentum associated with photon is given by_______.

(a) $h\upsilon$ (b) $\frac{h\upsilon}{c}$ (c) $h\,E$ (d) $h\lambda$

Ans (b) $\frac{h\upsilon}{c}$

Topic: Electrons and Photons; Sub-topic:De-broglie_ L- 2_XII-HSC Board Test__Physics

(vi) A pure semiconductor is ________.

(a) an extrinsic semiconductor (b) an intrinsic semiconductor

(c) p-type semiconductor (d) n-type semiconductor

Ans (b) an intrinsic semiconductor

Topic: Semi-conductor; Sub-topic:Semi-conductor_ L- 1_XII-HSC Board Test__Physics

(vii) Glass plate of refractive index 1.732 is to be used as a polariser, its polarising angle is _______.

(a) 30° (b) 45° (c) 60° (d) 90°

Ans (c) 60°

Topic: Wave theory of light; Sub-topic:Brewster law_ L- 2_ XII-HSC Board Test__Physics

Q.6 Attempt any SIX:

(i) State the conditions to get constructive and destructive interference of light.

Ans For constructive interference the path difference should be even multiple of $\frac{\lambda}{2}$ or phase difference should be $2\pi n$. Where $n = 0, 1, 2....$

For distructive interference the path difference should be odd multiple of $\frac{\lambda}{2}$

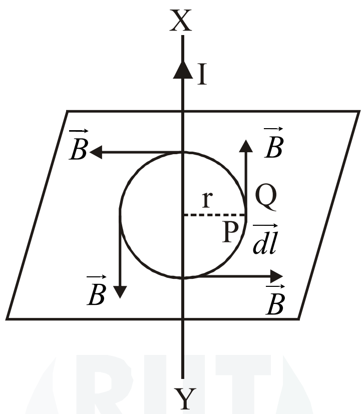
or $(2n-1)\frac{\lambda}{2}$ or phase difference should be odd multiple of π i.e., $(2n-1)\pi$

Topic: Interference and diffraction; Sub-topic:Interference_ L- 2_ XII-HSC Board Test__Physics

(ii) State and explain Ampere's circuital law.

Ans The line integral of magnetic field of induction $\vec{B}$ around any closed path in free space is equal to absolute permeability of free space (μ_0) times the total current flowing through area bounded by the path. Mathematically Ampere's law can be expressed as, $\oint \vec{B}.\vec{dl} = \mu_0 I$

Ampere's law is generalisation of Biot-Savart's law and is used to determine magnetic field at any point due to distribution of current. Consider a long straight current carrying conductor XY, placed in vacuum. A steady current 'I' flows through it from the end Y to X as shown in the figure.



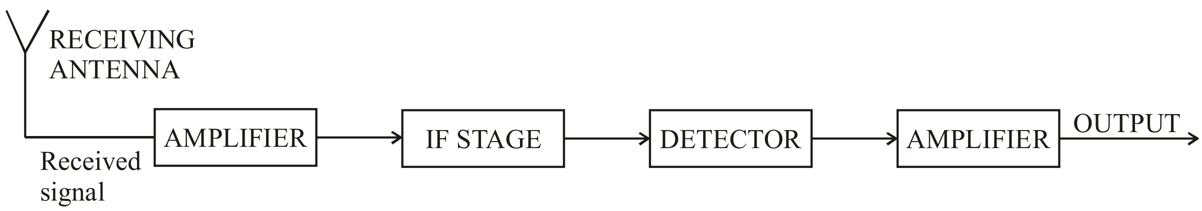
Imagine a closed curve (amperian loop) around the conductor having radius 'r'. The loop is assumed to be made of large number of small elements each of length $\vec{dl}$. Its direction is along the direction of traced loop. Let $\vec{B}$ be the strength of magnetic field around the conductor. All the scalar products of $\vec{B}$ and $\vec{dl}$ give the product of μ_0 and I. It is given by $\oint \vec{B}.\vec{dl} = \oint B\,dl\cos\theta$

where, θ = angle between $\vec{B}$ and $\vec{dl}$

Topic: Magnetic effect of electric current; Sub-topic:Ampere's law_ L- 1_ XII-HSC Board Test__Physics

(iii) Draw a neat and labelled block diagram of a receiver.

Ans



Block Diagram of a receiver

Topic: Communication system; Sub-topic:Receiver_L-1_ XII-HSC Board Test__Physics

(iv) Define magnetization. Write its SI unit and dimensions.

Ans The net magnetic dipole moment per unit volume is called as the magnetization $(\vec{M_Z})$ of the sample.

$$Magnetization = \frac{Net\ magnetic\ moment}{Volume}$$

$$\vec{M_Z} = \frac{M_{net}}{Volume}$$

Unit (A/m) and dimensions $\left[L^{-1}\ M^0T^0I^1\right]$

Topic: Magnetism; Sub-topic:Magnetism_L- 1_ XII-HSC Board Test__Physics

(v) The electron in the hydrogen atom is moving with a speed of 2.3×10^6 m/s in an orbit of radius $0.53\ \mathring{A}$. Calculate the period of revolution of electron. $(\pi=3.142)$

Ans $v=2.3\times10^6\ m$

$r=0.53\ \mathring{A}=0.53\times10^{-10}\ m$

$$v=r\omega=r\times\frac{2\pi}{T}$$

$$T=\frac{2\pi r}{v}=\frac{2\times3.14\times0.53\times10^{-10}}{2.3\times10^6}$$

$\therefore T=1.44\times10^{-16}$ sec

$$f=\frac{1}{T}=6.9\times10^{15}\ Hz$$

Topic: Magnetism; Sub-topic: Magnetic dipole_ L- 2_ XII-HSC Board Test__Physics

(vi) A capacitor of capacitance $0.5\ \mu F$ is connected to a source of alternating e.m.f. of frequency 100 Hz. What is the capacitive reactance? $(\pi=3.142)$

Ans $C=0.5\times10^{-6}$

$f=100\ Hz$

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

$$=\frac{1}{2\pi f\times C}$$

$$=\frac{1}{2\times3.14\times100\times0.5\times10^{-6}}$$

$=3184.7\Omega$

Topic: Electromagnetic induction; Sub-topic:Impedence_ L- 2_ XII-HSC Board Test__Physics

(vii) Calculate the de-Broglie wavelength of an electron moving with one fifth of the speed of light. Neglect relativistic effects. ($h=6.63\times10^{-34}\ J.s., c=3\times10^8$ m/s, mass of electron $=9\times10^{-31}\ kg$)

Ans $v=\frac{1}{5}\times3\times10^8\ \ m/s$

$$\lambda=\frac{h}{mv}$$

$$= \frac{6.63 \times 10^{-34}}{9 \times 10^{-31} \times \frac{3}{5} \times 10^{8}}$$

$$= 1.22 \times 10^{-11}\ m$$

$$= 0.122\ \mathring{A}$$

Topic: Atom, Molecule and Nuclei; Sub-topic: de-Broglie_ L- 2_ XII-HSC Board Test__Physics

(viii) In a cyclotron, magnetic field of 1.4 Wb/m² is used. To accelerate protons, how rapidly should the electric field between the Dees be reversed? $(\pi = 3.142, Mp = 1.67 \times 10^{-27}\ kg, e = 1.6 \times 10^{-19}\ C)$

Ans $B = 1.4\ wb/m^2$

$t = ?$

$$= \frac{\pi m}{q \cdot B}$$

$$= \frac{3.14 \times 1.67 \times 10^{-27}}{1.6 \times 10^{-19} \times 1.4}$$

$$= 2.3 \times 10^{-8}\ \text{sec}$$

Topic: Magnetic effect of electric current; Sub-topic: Cyclotron_ L- 2_XII-HSC Board Test__Physics

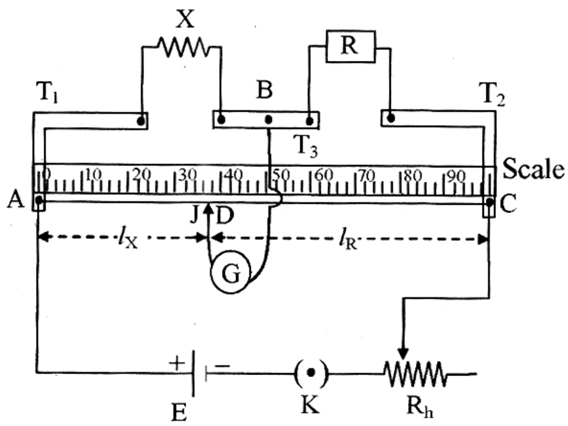
Q.7 Attempt any THREE:

(i) Explain with a neat circuit diagram how will you determine unknown resistance 'X' by using meter bridge.

Ans It consists of a 1 metre long wire of uniform cross section area made of magnetism stretched on a wooden board.

There are two L-shaped strips T_1 and T_2 which are also fitted from the ends of the wire on the top side. These strips are made up of copper. There is another straight strip T_3 fitted in between T_1 and T_2. This gives rise to formation of two gaps, a left gap and a right gap.

A metre scale is fitted along the wire which measures the length of the wire.



AC	:	One metre long uniform wire
X	:	Unknown resistance
R	:	Resistance from resistance box
G	:	Galvanometer
T_1, T_2, T_3	:	Metal strips

D : Null point
J : Sliding key (jockey)
R_h : Rheostat

Determination of unknown resistance:

Unknown resistance X is connected in the left gap and a resistance box R in right gap. A galvanometer is connected between point B and D through a Jockey (J). A battery is connected between A and C. A suitable resistance is introduced in the circuit from the resistance box and the jockey is tapped on the wire till apoint D is located such that the galvanometer deflection is zero. The distance of the point D from A is measured on the scale say l_X. The distance of the point D from C is measured on the scale l_R. By adjusting the value of R, the neutral point is obtained in the middle of the wire. In the balanced condition of bridge.

$$\frac{X}{R}=\frac{\text{Resistance of length } l_X}{\text{Resistance of length } l_R}$$

Since, $R=\rho\frac{l}{A}$

where, ρ is specific resistance of the material of wire

$$\therefore \quad \frac{X}{R}=\frac{\frac{\rho l_X}{A}}{\frac{\rho l_R}{A}}=\frac{l_X}{l_R}$$

$$\because \quad l_X+l_R=100\,cm$$

$$\therefore \quad l_R=100-l_X$$

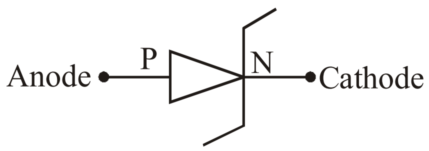
$$\therefore \quad X=R\left(\frac{l_X}{100-l_X}\right)$$

Hence the value of unknown resistance 'X' can be determined.

Topic: Current electricity; Sub-topic: Wheatstone metre bridge_ L- 2_XII-HSC Board Test__Physics

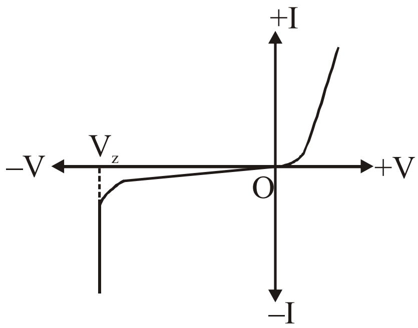
(ii) What is Zener diode? How is it used as a voltage regulator?

Ans Zener diode: A zener diode is a P-N junction diode intentionally manufactured to operate in breakdown region. It is symbolically represented as shown in figure.

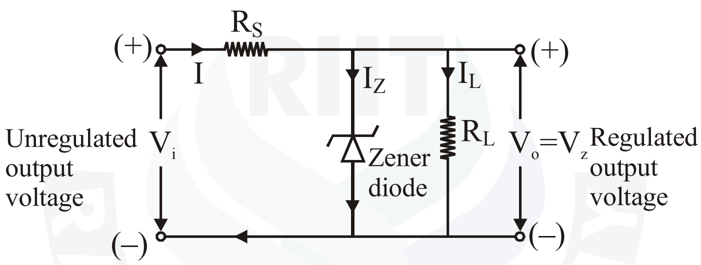


Breakdown for a given zener diode depends upon doping level of P and N regions.

I-V characteristic of a zener diode is as shown in figure.



In breakdown region, voltage across zener diode remains constant even when current through it changes by large amount.
In a zener diode, when reverse bias reaches a particular value, the current increases suddenly. This voltage is called zener voltage or zener breakdown voltage.
Zener voltage ranging from 2V to 200 V can be manufactured by controlling doping levels.
Zener diode as voltage regulator :



When voltage is applied to the circuit current I flows throug it. I is divided into I_Z and I_L, where, I_Z = current flowing zener diode and I_L = current flowing through load resistance.

From the figure, $I = I_Z + I_Z$

$\therefore\ V_i = IR_S + V_Z \qquad [\because V = IR]$

But, $I = I_Z + I_L$

$\therefore\ V_i = (I_Z + I_L)R_S + V_Z$

$\therefore\ V_i = (I_Z + I_L)R_S + V_O \qquad [\because V_O = V_Z]$

If input voltage V_i is increased beyond zener voltage, I increases such that current I_Z through zener diode increases but current I_L through load resistance remains same.
Therefore, output voltage V_O across load resistance remains the same.

Topic: Semi-conductor; Sub-topic:Zener diode_ L- 2_ XII-HSC Board Test__Physics

(iii) In a biprism experiment, light of wavelength 5200Å is used to get an interference pattern on the screen. The fringe width changes by $1\cdot3$ mm when the screen is moved towards biprism by 50 cm. Find the distance between two virtual images of the slit.

Ans $\lambda = 5200\ \text{Å} = 5.2\times10^{-7}\,\text{m}$

$X_1 - X_2 = 1.3\text{mm} = 1.3\times10^{-3}\,\text{m}$

$D_1 - D_2 = 50\text{cm} = 0.5\text{m}$

$$X_1 - X_2 = \frac{\lambda D_1}{d} - \frac{\lambda D_2}{d}$$

$$= \frac{\lambda}{d}(D_1 - D_2)$$

$$\therefore \quad d = \frac{\lambda(D_1 - D_2)}{X_1 - X_2}$$

$$= \frac{5.2 \times 10^{-7} \times 0.5}{1.3 \times 10^{-3}}$$

$$= 2 \times 10^{-4} \text{m}$$

$$= 0.2 \text{mm}$$

Topic: Interference and diffraction; Sub-topic:Interference_ L- 2_ XII-HSC Board Test__Physics

(iv) The refractive indices of water and diamond are $\frac{4}{3}$ and 2.42 respectively. Find the speed of light in water and diamond. $(c = 3 \times 10^8 \text{ m/s})$

Ans $\quad {}^a\mu_w = \frac{4}{3}$

$${}^a\mu_d = 2.42$$

$${}^a\mu_w = \frac{4}{3} = \frac{V_a}{V_w}$$

$$\therefore \quad V_w = \frac{3 \times 10^8}{\frac{4}{3}} = 3 \times 10^8 \times \frac{3}{4} = 2.25 \times 10^8 \, m/s$$

$${}^a\mu_d = 2.42 = \frac{V_a}{V_d} = \frac{3 \times 10^8}{V_d}$$

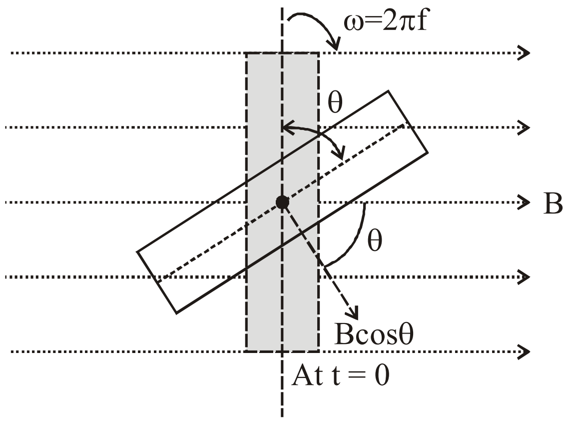
$$V_d = \frac{3 \times 10^8}{2.42} = 1.23 \times 10^8 \, m/s$$

Topic: Wave theory of light; Sub-topic:Huygen's theory_ L- 1_ XII-HSC Board Test__Physics

Q.8 Prove theoretically the relation between e.m.f. induced in a coil and rate of change of magnetic flux in electromagnetic induction. A parallel plate air condenser has a capacity of 20 μF. What will be the new capacity if:

(a) the distance between the two plates is doubled?

Ans



Magnetic flux $\phi = NAB\cos\omega t$

$N \to$ No.s of turns

$A \to$ Area of coil

$B \to$ Magnetic field {external}

$\omega \to$ Angular speed of coil

$\therefore$ max $\phi_0 = NAB,\ \omega t \to 0$

$\therefore\ \boxed{\phi = \phi_0 \cos\omega t}$

induce EMF (e)

$$e = -\frac{d\phi}{dt} = +\omega NAB\sin\omega t$$

$e_0 = \omega NAB,\ \ \omega t \to 90$

$\therefore\ \boxed{e = e_0 \sin\omega t}$

Topic: Electromagnetic induction / Electrostatics; Sub-topic: AC generator / Capacitor_ L- 2_ XII-HSC Board Test__Physics

So there is phase difference of $\frac{\pi}{2}$ with ϕ and e.

$$C = \frac{A \in_0}{d} = 20\,\mu F$$

If $d' \to 2d \quad \therefore\ C' \to \frac{C}{2} = 10\,\mu F$

(b) a marble slab of dielectric constant 8 is introduced between the two plates?

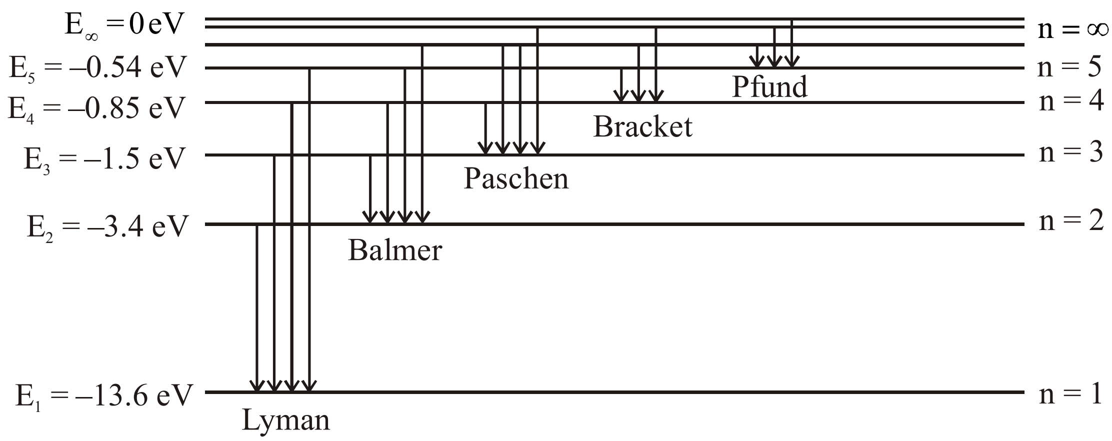
Ans If $k = 8$ introduce

$$C'' = \frac{A \in_0}{d} \times k = 20 \times 8 = 160\,\mu F$$

Topic: Electrostatics; Sub-topic:Capacitor_ L- 2_ XII-HSC Board Test__Physics

OR

Draw a neat and labelled energy level diagram and explain Balmer series and Brackett series of spectral lines for hydrogen atom.



Ans **Energy level diagram for hydrogen atom**

Balmer series: The spectral lines of this series correpond to the transition of an electron from some higher energy state to 2nd orbit. For Balmer series, p = 2 and n = 3, 4, 5. The wave numbers and the wavelengths of spectral lines constituting the Balmer series are given by,

$$\bar{v} = \frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$$

This series lies in the visible region.

Bracket series : The spectral lines of this series corresponds to the transition of an electron from a higher energy state to the 4th orbit.

For this series, p = 4 and n = 5, 6, 7, ...

The wave numbers and the wavelengths of the spectral lines constituting the Bracket series are given by,

$$\bar{v} = \frac{1}{\lambda} = R\left(\frac{1}{4^2} - \frac{1}{n^2}\right)$$

This series lie in the near infrared region of the spectrum.

Topic: Atom, Molecule and Nuclei; Sub-topic: Hydrogen spectrum_ L- 2_ XII-HSC Board Test__Physics

The work function for a metal surface is 2.2eV. If light of wavelength 5000Å is incident on the surface of the metal, find the threshold frequency and incident frequency. Will there be an emission of photoelectrons or not? $(c = 3\times10^8\ m/s,\ 1eV = 1.6\times10^{-19}\ J, h = 6.63\times10^{-34}\ J.s.)$

Ans For incident radiation

$$E = h\upsilon$$

$$= \frac{h.c}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^{8}}{5000\times10^{-10}\times1.6\times10^{-19}} = 2.4\ eV$$

Emission is possible.

Topic: Einstein photoelectric effect; Sub-topic:Photoelectric function_ L- 2_ XII-HSC Board Test__Physics