PART TEST	HSC EXAMINATION SET – A PHYSICS	SOLUTIONS

Q.1 1. B. 2.B. 3.A. 4.A. 5.D. 6.B. 7.B.

Q.2 (1) (a) The substances that does not transmit any incident heat radiations are called athermanous substances

(b) The substances through which heat radiations can pass are called diathermanous substances

(2) Given: 54 waves in one minute, $\lambda = 10\ mts$

To find v = ?

Formula $v = n\lambda$

Solution :

$n = \frac{54\ waves}{1\ minute} = \frac{54}{60}\ sec^{-1}$

We have $v = n\lambda = \frac{54}{60} \times 10 = 9\ m/s$

(3) (a) The maximum distance between two molecules upto which intermolecular forces are effective is called range of molecular attraction

(b) The layer of surface liquid whose thickness is about the range of molecular attraction is called surface film.

(4) Given :

$\Delta\theta = 40 - 20 = 20^0C$

$A = 1mm^2 = 10^{-6}\ m^2$

$\alpha = 1.15 \times 10^{-5}\ /^0C$

$Y_{steel} = 2 \times 10^{11} N/m^2$

Formula :

$F = Y\ A\ \alpha\ \Delta\theta = 2 \times 10^{11} \times 10^{-6} \times 1.15 \times 10^{-5} \times 20 = 44N$

(5) (a) An ideal simple pendulum consists of a point mass suspended by a weightless inextensible string from a firm or rigid support.

(b) An practical simple pendulum consists of a small heavy spherical metallic bob suspended by a light inextensible string from a firm support.

(6) Given $K_0 = 10\ cm, r = 6\ cm, To\ find\ K_C$

Formula :

$I_0 = I_C + Mr^2$

${K_0}^2 = {K_C}^2 + r^2$

${K_C}^2 = {K_0}^2 - r^2$

${K_C}^2 = (10)^2 - (6)^2 = 64$

$\therefore K_C = 8\ cms$

(7) (a) The space surrounding the material body in which its attraction (gravitational) can be experienced is called gravitational field.

(b) The force experienced by unit mass placed at any point in the gravitational field is called intensity of gravitational field.

(8) Given $m = 0.4\ kg, r = 2\ m,\ n = 60\frac{rev}{min} = 1 rev/sec$

To find F = ?

Formula : F= $mr\omega^2$

Solution : We have

F= $mr\omega^2 =$ F $= mr(2\pi n)^2$

F = $0.4 \times 2 \times (2 \times 3.142 \times 1)^2 = 31.53N$

Q.3 (1) Let $v_1\ and\ v_2$ be the velocities of particles performing S.H.M. at distances of $x_1\ and\ x_2$ respectively.

$v_1 = \omega\sqrt{a^2 - {x_1}^2}$ ……………… (1) $v_1 = \omega\sqrt{a^2 - x_1^2}$

$v_2 = \omega\sqrt{a^2 - {x_2}^2}$ ……………… (2)

Squaring and subtracting (2) from (1), we get

${v_1}^2 - {v_2}^2 = \omega^2(a^2 - {x_1}^2) - \omega^2(a^2 - {x_2}^2)$

${v_1}^2 - {v_2}^2 = \omega^2(a^2 - {x_1}^2 - a^2 + {x_2}^2)$

${v_1}^2 - {v_2}^2 = \omega^2({x_2}^2 - {x_1}^2)$

$\omega^2 = \frac{{v_1}^2 - {v_2}^2}{{x_2}^2 - {x_1}^2}$

Taking square root of both sides we get

$\omega = \sqrt{\frac{{v_1}^2 - {v_2}^2}{{x_2}^2 - {x_1}^2}}$

Period of S.H.M is

$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{{v_1}^2 - {v_2}^2}{{x_2}^2 - {x_1}^2}}}$

$T = 2\pi \sqrt{\frac{x_2{}^2 - x_1{}^2}{v_1{}^2 - v_2{}^2}}$

(2) Let l_1 *and* l_2 be the lengths of closed and open organ pipes respectively. The frequency of the first overtone of the closed pipe.

$n_1 = 3\left(\frac{v}{4\, l_1}\right)$

The frequency of the third overtone of the open pipe is.

$n_2 = 4\left(\frac{v}{2\, l_2}\right)$

For resonance with a given fork

$n_1 = n_2$

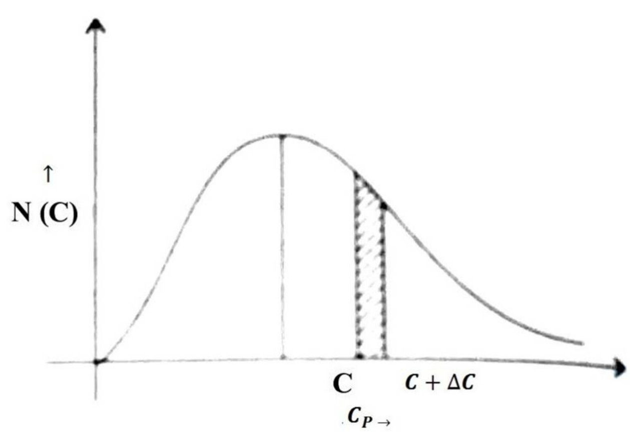
$\therefore 3\left(\frac{v}{4\, l_1}\right) = 4\left(\frac{v}{2\, l_2}\right) = \frac{2v}{l_2}$

$\therefore \left(\frac{l_1}{l_2}\right) = \left(\frac{3}{8}\right)$

(3) **Maxwell Distribution :**

For a given mass of gas, the velocities of all molecules are not the same, even when bulk parameters like pressure, volume and temperature are fixed. Collisions change the directions and speed of molecules, but in a state of equilibrium the distribution of speed is constant.

(1) Maxwell on purely statistical considerations shows that the distribution of molecular velocities in a gas takes place according to a definite law.
(2) This law is known as Maxwell's law of distribution of molecular velocities.
(3) The figure shows the curve representing the distribution of velocity in a gas.
(4) Conclusions from the graph.



(a) At C = 0, N (C) = 0 i.e. the molecules of zero velocity are not present in the gas.
(b) The velocity corresponding to the peak of the curve is known as most probable velocity (C_P)
(c) The curve is not symmetrical i.e. asymmetrical.

(d) The number of molecules having very high and very low velocities, is very low in the gas.

(e) The shaded region of the curve represents the number of molecules of the gas between the region C and $(C + \Delta C)$

(4) Moment of Inertia of a ring about its diameter

For uniform ring, the moment of inertia of the ring about any diameter is the same. We want to find the moment of inertia of a ring about a diameter as shown in the figure. If I_Z is the moment of inertia of a ring about Z axis passing through centre of mass of the ring and perpendicular to its plane then $I_Z = I_C$. Let I_X and I_y be the moment of inertia of the ring about the diameter along x and y axes respectively.

Using perpendicular axes theorem

$I_Z = I_X + I_y$ ……………………(1)

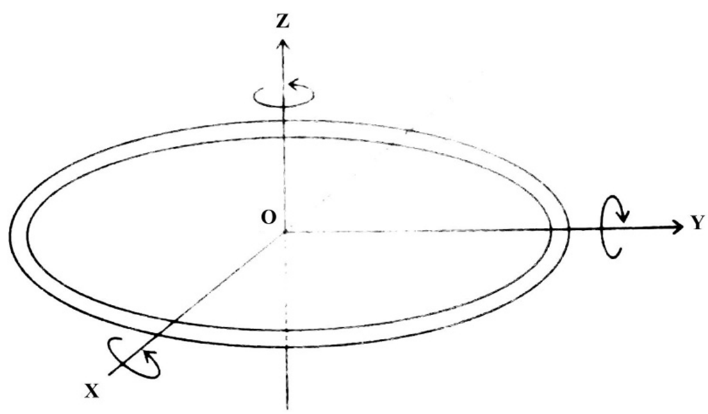
But $I_Z = I_C$. And for a ring $I_X = I_y$

Equation (1) becomes

$I_C = 2I_X = 2I_y$

$Let\ I_X = I_y = I_D\ where\ I_D$

Is the moment of inertia of a ring about its diameter



$\therefore I_C = 2I_D$

But $I_C = MR^2$

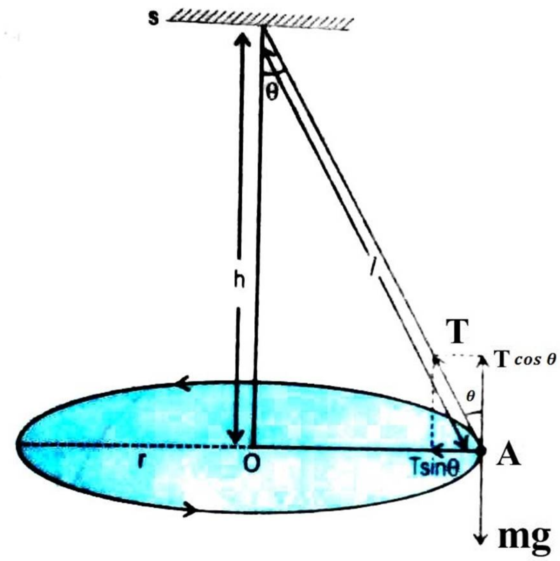
$\therefore I_D = \frac{1}{2}MR^2$

Hence the moment of inertia of a thin uniform ring about its diameter is given by

$I_D = \frac{1}{2}MR^2$

Q.4 (1) (a) Conical Pendulum

Conical Pendulum is a simple pendulum which is given such a motion that a bob describes a horizontal circle and the string describes a cone.



Conical pendulum

S ------ rigid support

T -------tension in the string

l---------length of the string

h--------axial height of the cone

v--------velocity

r---------radius of horizontal circle

θ--------semi vertical angle of cone

mg------weight of the sphere (bob)

Consider a bob of mass m revolving along a horizontal circle of radius r with velocity v. Let θ be semi vertical angle of cone. The forces acting on bob at position A are,

(1) Weight mg acting vertically downward.

(2) Tension T in upwards along the string. Tension (T) in the string can be resolved into,

(a) $T\ cos\theta$ vertically upward.

(b) $T\ sin\ \theta$ horizontal and directed towards the center of circle.

The weight mg is balanced by vertical component $T\ cos\theta$

$\therefore T\ cos\theta = mg \ldots\ldots\ldots..(1)$

The horizontal component $T\ sin\ \theta$ provides necessary centripetal force directed towards O for uniform circular motion of bob.

$T\ sin\ \theta\ = \frac{mv^2}{r}$...........(2)

Dividing (2) by (1) we get

$tan\ \theta\ = \frac{v^2}{rg}$

$\therefore v = \sqrt{rgtan\ \theta}$

This relation gives the speed of the bob of conical pendulum.

But $v = r\omega$

$\therefore r\omega = \sqrt{rgtan\ \theta}$

From the diagram $\tan\theta\ = \frac{r}{h}$

$r^{\ 2}\omega^2 = rg\left(\frac{r}{h}\right)$

$\omega^2 = \left(\frac{g}{h}\right)$

$\therefore \omega = \sqrt{\frac{g}{h}} \dots \dots \dots \dots (3)$

Equation (3) gives the angular speed of bob of a conical pendulum.

Periodic time of conical pendulum

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

$\therefore T\ = \frac{2\pi r}{\sqrt{rgtan\ \theta}}$

$\therefore T\ = 2\pi\sqrt{\frac{r}{gtan\ \theta}} \dots \dots \dots \dots \dots \dots \dots \dots \dots (4)$

From the diagram $sin\ \theta\ = \frac{r}{l}$

$\therefore r = l\ sin\ \theta$

Substituting this value in (4) we get

$\therefore T\ = 2\pi\sqrt{\frac{l\ sin\ \theta}{gtan\ \theta}}$

$\therefore T\ = 2\pi\sqrt{\frac{l\ cos\ \theta}{g}}$

1. b) Data : $g = 9.8\frac{m}{s^2}$, R = 6400 km $= 6.4\times10^6\ m$, d = 2000 km $= 2\ \times 10^6\ m$

Solution :

The acceleration due to gravity at a point at a depth d from the earth's surface is given by

$g_d = g\left[1 - \frac{d}{R}\right]$

$\therefore g_d\ = 9.8\left[1 - \frac{2\ \times10^6}{6.4\ \times10^6}\right]$

$\therefore g_d = \left[\frac{9.8\times4.4}{6.4}\right]$

$\therefore g_d = 6.737 m/s^2$

2. (a) Formation of Stationary waves on strings

When two identical progressive waves both (transverse or longitudinal) travelling along the same path in opposite directions, interfere with each other, by superposition of waves resultant wave is obtained in the form of loops, is called a stationary wave.

Consider two simple harmonic progressive waves of equal amplitude and frequency, propagating on a long uniform string in opposite directions.

If wave (frequency 'n' and wavelength λ) is travelling along positive direction of X-axis then

$$Y_1 = a\sin 2\pi\left(nt - \frac{x}{\lambda}\right) \dots\dots\dots (1)$$

If wave (frequency 'n' and wavelength λ) is travelling along negative direction of X-axis then

$$Y_2 = a\sin 2\pi\left(nt + \frac{x}{\lambda}\right) \dots\dots\dots (2)$$

These waves interfere to produce stationary wave. The resultant displacement of stationary wave is given by the principle of superposition of waves

$$Y = Y_2 + Y_1$$

$$Y = a\sin 2\pi\left(nt + \frac{x}{\lambda}\right) + a\sin 2\pi\left(nt - \frac{x}{\lambda}\right)$$

Using $sinC + sinD = 2sin\left(\frac{C+D}{2}\right)cos\left(\frac{C-D}{2}\right)$ and $\cos(-\theta) = cos\theta$ we get

$$Y = 2a\left[\sin(2\pi nt)cos\left(\frac{2\pi x}{\lambda}\right)\right]$$

$$Y = \left(2a\,cos\frac{2\pi x}{\lambda}\right)\sin(2\pi nt)$$

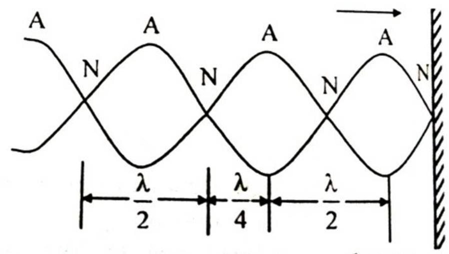
$$Y = A\sin(2\pi nt)$$

$$But\ \omega = (2\pi n)$$

$$Y = A\sin\omega t\ \ where\ A = \left(2a\,cos\frac{2\pi x}{\lambda}\right)$$

A is amplitude of resultant stationary wave, i.e. amplitude is periodic in space, hence we can see loops in case of transverse waves forming stationary wave on string.

Thus in stationary wave, frequency is same as that of progressive waves but amplitude varies with position of particle.



Position of nodes and antinodes on stationary wave

The above equation represents the resultant displacement of two simple harmonic progressive waves which is not moving because of absence of term x in the equation, therefore it is called stationary wave.

2. (b) Data :

$E = 5.67 \times 10^4 watt/m^2, \sigma = 5.67 \times 10^{-8} watt/m^2K^4$

T = ?

Solution

$E = \sigma T^4$

$\therefore T^4 = \frac{E}{\sigma}$

$\therefore T = \left[\frac{E}{\sigma}\right]^{1/4}$

$\therefore T = \left[\frac{5.67 \times 10^4}{5.67 \times 10^{-8}}\right]^{1/4}$

$\therefore T = [10^{12}]^{1/4}$

$\therefore T = [10^3]$

$\therefore T = 1000\ K$

Paper – II

Q.5 1. C. 2. B. 3. D. 4. D. 5.C. 6.D. 7.D.

Q.6 (1) Given $i_P = 56^0 40'$ Find the value of ${}_a\mu_g$

Formula $tan\ i_P = {}_a\mu_g$

Solution :

According to Brewster's law, if i_P the polarising angle then $tan\ i_P = {}_a\mu_g$

$tan\ (56^0 40') = {}_a\mu_g$

${}_a\mu_g = 1.5204$

(2) The various energy losses in a transformer are

- Flux losses
- Copper losses
- Iron losses
- Hysteresis losses

- Magnetostriction

(3) Half life period of a radioactive substance is defined as the time in which the half substance is disintegrated.

Expression for half life period :

From law of radio active decay.

$$N = N_0 e^{-\lambda y}$$

$$\text{At } t = T_{\frac{1}{2}},\ N = \frac{N_0}{2}$$

$$\therefore\ \frac{N_0}{2} = N_0 e^{-\lambda T_{\frac{1}{2}}}$$

$$\therefore\ \frac{1}{2} = e^{-\lambda T_{\frac{1}{2}}}$$

$$\therefore\ e^{\lambda T_{\frac{1}{2}}} = 2$$

$$\therefore\ \lambda T_{\frac{1}{2}} = \log_e^2 = 0.693$$

$$\therefore\ T_{\frac{1}{2}} = \frac{0.693}{\lambda}$$

This is required expression for half life period of radioactive substance.

(4) Solar cells

(a) It is semi conductor device that works on the phenomenon of photo electric effect.

(b) It coverts light energy from the sun (i.e. solar energy) into electric energy or electric current.

(c) Its working is based on photo voltaic effect (i.e when light falls on the open circuit of a p-n junction diode silicon or germanium, then e.m.f. is generated across its terminals).

Advantages of solar cells

(1) They are portable

(2) They require little maintainance

(3) No fuel or chemical is required for its operation.

Materials used in solar cells

(1) For solar cells Si and Ge are most widely used as semi conducting materials

(2) Gallium Arsenide (GaAs), Indium Arsenide (InAs) and Cadmium Arsenide (CdAs) are also used to prepare the solar cells.

(5) Since no current flows through the 5Ω the circuit represents a balanced Wheatstone's bridge.

$$\frac{X}{18} = \frac{2}{6}$$

$\therefore X = \frac{2\times18}{6} = 6\Omega$

(6) Given $r = 0.5\,\text{Å} = 0.5\times10^{-10}\,\text{m}$,

$f = 10^{10}\,\text{MHz} = 10^{10}\times10^{6} = 10^{16}\,\text{Hz}$

To find $M = ?$

Formula $M = IA$

Calculation Since, $I = \frac{1}{T}\cdot e = f.e$

From formula

$m = feA = fe\pi r^2$

$= 10^{16}\times1.6\times10^{-19}\times\pi\times\left(0.5\times10^{-10}\right)^2$

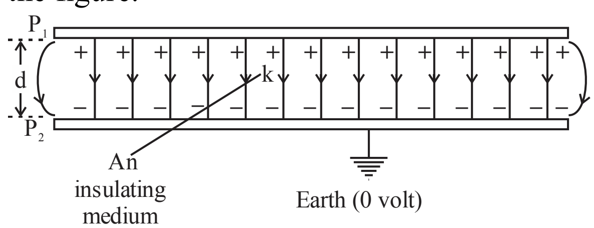
$= 1.6\times\pi\times0.25\times10^{-23}$

$\therefore \quad M = 1.256\times10^{-23}\,\text{Am}^2$

(7) Expression for capacity of a parallel plate capacitor :

(i) A parallel plate capacitor consists of two parallel metal plates P_1 and P_2 separated by a small distance d.

(ii) The space between the plate is filled with a medium of dielectric constant k as shown in the figure.



(iii) Plate P_1 is given a charge +Q white plate P_2 is earthed.

(iv) Positive charge +Q which is given to plate P_1, induces a negative charge –Q on the inner surface of plate P_2 will get earthed because of production of electrostatic repulsive force between two positive charge.

(v) As distance d between the two plates is very small as compared to the linear dimensions of the plates, the electric field is produced in the dielectric medium. This field is directed from P_1 and P_2.

(vi) According to Gauss theorem, magnitude of the electric intensity at a point in the dielectric medium is given by

$$E = \frac{\sigma}{k\varepsilon_0} \qquad ...(i)$$

Where σ is the magnitude of the surface charge density on either plate.

But $\sigma = \dfrac{Q}{A}$

$$E = \frac{Q}{k\varepsilon_0 A} \qquad \ldots(ii)$$

(vii) Since E is uniform between the plates

$\therefore \; E = \dfrac{V}{d}$

Where V = P. D between the plates

(viii) Comparing equation (ii) and (iii), we have

$$\frac{Q}{k\varepsilon_0 A} = \frac{V}{d}$$

$$\therefore \; \frac{Q}{V} = \frac{k\varepsilon_0 A}{d} \qquad \ldots(iv)$$

By definition $\dfrac{Q}{V} = C \qquad \ldots(v)$

(ix) From equation (iv) aned (v), we have

$$C = \frac{k\varepsilon_0 A}{d} \qquad \ldots(vi)$$

This is required expression for the capacity of a parallel plate capacitor.

(x) From equation (vi) it is concluded that capacity of a parallel plate capacitor depends on

a. area of plates $(C \propto A)$

b. dielectric constant of medium $(C \propto A)$ and

c. distance of separation between the two plates $\left(C \propto \dfrac{1}{d}\right)$

(8) Given $\lambda_1 = 2500^0 A,\ \lambda_2 = 3500^0 A$

To find $\frac{n_1}{n_2} = ?$

Formula $n\lambda = constant$

$n_1\lambda_1 = n_2\lambda_2$

$\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{3500}{2500} = \frac{7}{5}$

Thus the seventh order fringe of wave length $2500^0 A$ and fifth order fringe of wave length $3500^0 A$ will co-incide

Q.7 (1) Resolving power of a microscope

(1) It is defined as the reciprocal of the least separation between two close objects so that they appear just separated, when seen through the microscope

(2) Limit of resolution of the microscope $= d = \frac{\lambda}{2\mu\, sin\theta}$

(3) The resolving power of a microscope increases with the increase in the value of the medium between its objective and the object. For the reason, oil immersion objective microscopes are used to achieve high resolving power.

(4) The resolving power of a microscope increases with the decrease in the value of wavelength of the light used to illuminate the object.

(5) Since the wave length of ultra violet light is less than that of the visible light, the microscopes employing ultra violet light for illuminating the objects are used to achieve high resolving power. Such microscopes are called ultra microscopes.

(6) Still higher resolving power is obtained in electron microscope.

(7) The resolving power of an electron microscope is 1000 times greater than that of a microscope using visible light.

(2) Data k = 5

E = 500 V /m

l = 1 cm = $10^{-2}\ m$

$v = (1\ cm)^3 = 10^{-6}\ m^3$

Energy stored per unit volume

$U = \frac{1}{2} k\ \epsilon_0 E^2$

$U = \frac{1}{2} \times 5\ \times\ 8.85\ \times 10^{-12}\ \times\ (500)^2$

$U = 553.1\ \times 10^{-8}\ J\ /m^3$

Energy contained in the cube

$= U \times V$

$= 553.1\ \times 10^{-8}\ \times 10^{-6}$

$= 553.1\ \times 10^{-14}\ J$

(3) Resonant Frequency

A given A.C. circuit with constant value of inductance (L) and capacitance (C) can be in resonance only for a particular frequency.

The frequency of A.C. for which resonance takes place and maximum current (r.m.s.) flows through the circuit, is called resonant frequency (f_r).

The condition for resonance is $(Z = Z_{MIN})$

$X_L = X_C$

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

$\therefore \omega^2 = LC$

$\therefore \omega = \frac{1}{\sqrt{LC}}$

$But\ \omega = 2\ \pi f_r$

$\therefore 2\pi f_r = \frac{1}{\sqrt{LC}}$

$\therefore f_r = \frac{1}{2\pi\sqrt{LC}}$..........................(1)

The variation of r.m.s. current with frequency of A.C. is as shown in the figure. The curve is called the series resonance curve. At resonance the r.m.s. current becomes maximum.

This circuit at resonant condition is very useful in radio receivers T.V. receives for tuning the signal from a desired transmitting channel or station.

We, know that when alternating current of different frequencies are sent through series resonant circuit it offers minimum impedance to the current of resonant frequency and high impedance to the other frequencies current. In other words the circuit only accepts only current of the resonant frequency and rejects current of other frequencies. For this reason it is called an acceptor circuit.

(4) Data

$m = 9 \times 10^{-31}\, kg$

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

$h = 6.63 \times 10^{-34} Js, \epsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$

Solution

For the first orbit

n = 1

$r_1 = \left(\frac{h^2\epsilon_0}{\pi m e^2}\right)$

$r_1 = \frac{(6.63 \times 10^{-34})^2 \times 8.85 \times 10^{-12}}{3.142 \times 9 \times 10^{-31} \times (1.6 \times 10^{-19})^2}$

$r_1 = 5.34 \times 10^{-11}\ m$

$r_1 = 0.5374^0 A$

In general $r_n = r_1 n^2$

$r_3 = r_1 \times (3)^2$

$r_3 = 0.537 \times 9$

$r_3 = 4.837^0 A$

Q.8 (1) Space Communication

(a) (a) The process of transfer of information (speech, pictures or both) from source to large distances without wires (i.e. through space as communication channel) is called space communication.

Examples : Radio communication, Television communication and Satellite communication

(b) Messages are in the form of sound waves

(c) Waves can be send from one place to another by superimposing it on undamped electromagnetic waves.

(d) The radio waves can propagate from transmitting antenna to the receiving antenna by three types of propagation, which are as follows.

(1) Ground wave propagation
(2) Sky wave propagation
(3) Space wave propagation.

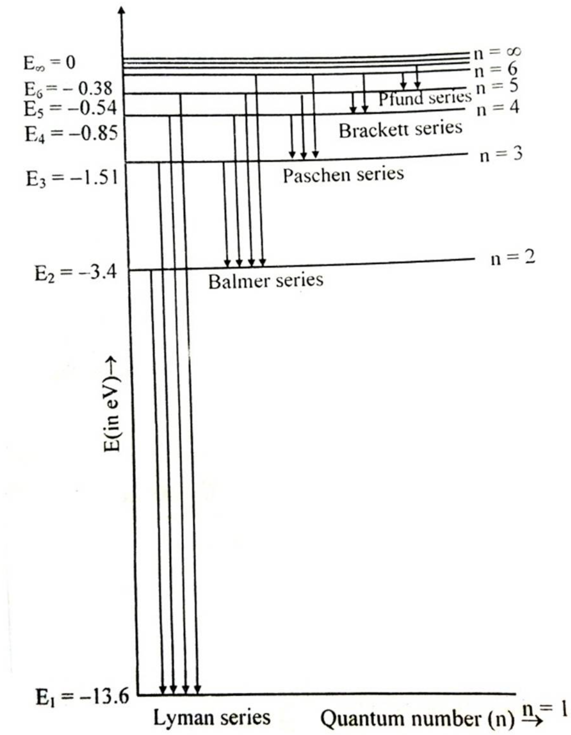
(b) (a) Inductive reactance (X_L)

(1) The non-ohmic or non-resistive opposition offered by an inductor coil to the flow of varying current or A.C. current through it is called as Inductive reactance (X_L)
(2) Inductive reactance can also be defined as the ratio of effective (r.m.s.) voltage across the inductance to the effective (r.m.s.) current through it.
(3) Note that the inductor coil produces leading of applied A.C. voltage with the resulting A.C. current. So it is always taken as + X_L
(4) S.I. unit of (X_L) is ohms
(5) It is given by $(X_L) = \omega L = 2\pi f L$

(b) Capacitive reactance (X_C)

(1) The non- ohmic or non-resistive opposition offered by a capacitor to the flow of varying current or A.C. current through it is called as Capacitive reactance (X_C)
(2) Capacitive reactance can also be defined as the ratio of effective (r.m.s.) voltage across the capacitance to the effective (r.m.s.) current through it.
(3) Note that the capacitor produces leading of the resulting A.C. current with the applied A.C. voltage. So it is always taken as + X_C
(4) S.I. unit of (X_C) is ohms
(5) It is given by $(X_C) = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

(2) (a)



Note :

Energy of electron in the infinite energy level is maximum i.e. 0 eV because below this value energy energy level has negative value.

(b) Diffraction of light

(1) The phenomenon of bending of light waves around corners and their spreading into the regions of the geometrical shadow of an object is called diffraction

(2) There are two kinds of diffraction. They are (a) Frensel's diffractions and (b) Fraunhofer diffraction

(3) Frensel's diffractions : In this case either the source or the screen or both are at finite distances from the diffracting aperture or the obstacle. No lenses are used to make the rays parallel or convergent. The wave fronts are either spherical or cylindrical.

(4) Fraunhofer diffraction : In this case either the source and the screen are at infinite distances from the diffracting aperture. This is achieved by placing the source and the screen in the focal planes of the two lenses.

(a) The diffraction is readily observed in case of radio waves and sound waves.

(b) Diffraction effect is observed in principle of all types of wave motion of which is due to interference of secondary wavelets.

(5) Wavefront obtained due to this may be either spherical or cylindrical.