MODEL SET-2

SECTION-II (NON-OBJECTIVE TYPE QUESTIONS)

Question Nos. 1 to 11 are of short answer type. Each question carries 2 marks. 11 × 2 = 22

SHORT QUESTIONS

1. Define electric field intensity and write its SI unit with dimension also.

Ans.—The electric field intensity due to a source charge at any point in its electric field is defined as the force experienced by a unit positive charge placed at that point.

Mathematically, it can be expressed as

$$\vec{E} = \frac{\vec{F}}{q_o}$$

The S.I. unit of electric field intensity is newton/coulomb

it NC^{-1} or volt/ metre

The Dimesion of electric field intensity is,

$$[E] = \frac{[F]}{[q]} = \frac{[F]}{[It]} = \frac{[MLT^{-2}]}{[AT]} = [MLT^{-3}A^{-1}]$$

2. What is the function of 'moderator' and 'Controlling rods' in a nuclear reactor ?

Ans.—Function of moderator is nuclear reactor—

It slows down the speed of neutrons to make them useful for further fission.

Function on controlling rods is nuclear reactor—

It absorbs the excess no. of neutrons which are produced in reactor.

3. Welders wear special goggles or face masks with glass windows to protect their eyes from electromagnetic radiations. Name the radiations and write the range of their wavelength.

Ans.—ultraviolet rays.

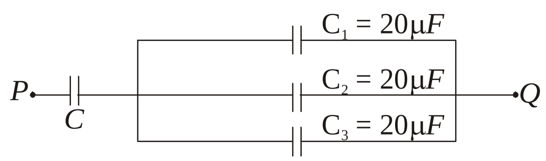
The wavelength of UV rays is 400 nm to 1 nm.

4. Define the activity of a given radioactive substance. Write its S.I. unit.

Ans.—The total decay rate of a radioactive sample is called the activity of the sample.

The S.I. unit of activity is 'becquerel'.

5. Calculate the capacitance of the capacitor C. The equivalent capacitance of a combination between P and Q is 30 μF.



Ans.—Capacitors C_1, C_2 and C_3 are in parallel, so the equivalent capacitance of these capacitors are

$$C' = C_1 + C_2 + C_3$$
$$= 20 + 20 + 20$$

= 60μF

Then, C and C' are is series, so equivalent capacitance, C" is given by—

$$\frac{1}{C''} = \frac{1}{C} + \frac{1}{C'}$$ But C" = 30μF

$$\therefore \quad \frac{1}{30} = \frac{1}{C} + \frac{1}{60}$$

or, $$\frac{1}{C} = \frac{1}{30} + \frac{1}{60} = \frac{2-1}{60} = \frac{1}{60}$$

$$\therefore \quad \boxed{\therefore C = 60\mu F}$$

6. Why the core of a transformer is laminated ?

Ans.—The core of a transformer is laminated to reduce the energy loss due to eddy currents. Laminations break the path of eddy currents. The energy loss due to eddy current also results in unnecessary heating of the transformer which may be harmful for the winding of the transformer.

7. The radius of curvature of the forces of a double convex lens are 10 c.m. and 15 c.m. If focal length of the lens is 12 c.m., field the refractive index of the material of the lens.

Ans.—Given that,

R_1 = 10 c.m.

R_2 = –15c.m.

f = 12 cm.

As we have from, Lens Maker's formula

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

or, $$\frac{1}{12} = (\mu - 1)\left(\frac{1}{10} - \frac{1}{-15}\right)$$

or, $$\frac{1}{12} = (\mu - 1)\left(\frac{3+2}{30}\right)$$

or, $$\frac{1}{12} = (\mu - 1)\frac{8}{30}$$

or, $$\frac{1}{12} = \frac{\mu - 1}{6}$$

or, 12 (μ –1) = 6 or, 12μ – 12 = 6

or, 12μ = 6 + 12

or, 12μ = 18

$$\therefore \quad \mu = \frac{18}{12} = \frac{3}{2}$$

$$\boxed{\mu = 1.5}$$

8. What is the lens of Presbyopia and Astingmatism ?

Ans.—Case of Presbyopia—It arises due to the gradual weakening of the ciliary muscles and diminishing flexibility of the eye lens.

Case of Astingmatism—It arises due to the irregularities in the surface of Cornea.

9. What do you mean by conductivity of a material ? Give its SI units.

Ans.—Conductivity is the reciprocal of the resistivity.

It can be expressed as—

$$\boxed{\sigma = \frac{1}{P}}$$

Its S.I. unit is siemen metre^{-1} (Sm^{-1}) or ohm^{-1} m^{-1}.

10. What is Photoelectric effect ? Write Einstein's photoelectric equation.

Ans.—Photoelectric effect—Photoelectric effect is the phenomenon of emission of electrons from the surface of metal when exposed to the radiation of suitable frequency.

Einstein's photoelectric equation can be expressed as—

$$\boxed{\frac{1}{2}mv^2 = h\nu - h\nu_o}$$

11. Write the functions of the following in communication system :

(a) Transducer

(b) Repeater

Ans.—(a) Transducer—A transducer is a device which converts one form of energy into another form of energy.

(b) Repeater—A repeater is a combination of a receiver and a transmitter. A reapeter, picks up the signal from the transmitter, amplifies and retransmits it to the receiver sometimes with a change in carrier frequency. They are used to extend the range of a communication system.

SECTION-II (NON-OBJECTIVE TYPE QUESTIONS)

Question Nos. 12 to 15 are of long answer type. Answer must be explantory and in your own language. Each question carries 5 marks. 4 × 5 = 20

LONG QUESTIONS

12. With the help of mean and labelled diagram explain the construction, working principle and sensitivity of a moving coil galvanometer ? Mention its conversion into ammeter & voltmeter.

Ans.— **Moving Coil Galvanometer (MCG)**

Moving coil Galvanometer is a device used to detect or measure the small electric current flowing in the circuit.

Principle

Moving coil Galvanometer is based on the result that when a current carrying loop or wire is placed in a uniform magnetic field it experiences a torque.

Theory

Let

N = No. of turns
l = length of the coil
b = breath of the coil
B = Strength of magnetic field
A = Area of the coil

For equilibrium, deflecting torque must be equal to resorting torque.

Deflecting Torque = Restoring Torque …(1)

N B I A sin = Kα …(2)

Where K = Restoring Torque per unit twist
α = Deflection

$$I = \left(\frac{K}{NBA\sin\theta}\right)\propto \quad \ldots(3)$$

For normal component, θ = 90º

$$I = \left(\frac{K}{NBA\sin 90^o}\right)\propto \quad \ldots(4)$$

$$I = \left(\frac{K}{NBA}\right)\propto \quad \ldots(5)$$

Where, $\left(\frac{K}{NBA}\right)G$ …(6)

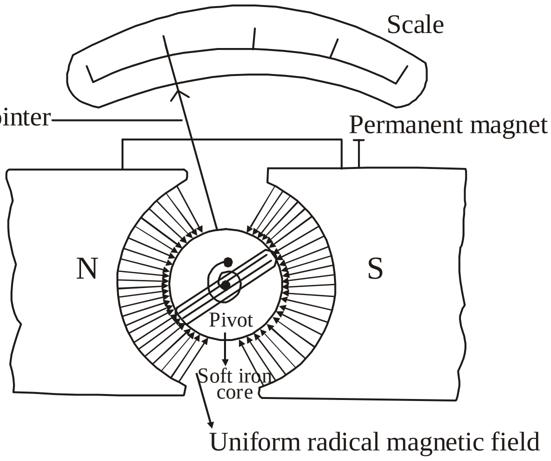
G is called Galvanometer's constant

I = G ∝ …(7)

Hence I ∝ α

The deflectioin produced in the coilof MCG is directly proportional to the electric current.

Construction



Sensitivity of a Galvanometer

A galvanometer is said to be sensitive if small current or voltage change produces large deflection in current.

There are two types of sensitivity :

(1) Current Senstivity

(2) Voltage Senstivity

Current Sensitivity—The current sensitivity of a galvanometer is defined as the deflection produced in the galvanometer per current flowing through it

$$\text{Current Sensitivity} = \frac{\propto}{I} \qquad \ldots(9)$$

$$I = \left(\frac{K}{NBA}\right)\propto \qquad \ldots(10)$$

$$\frac{\propto}{I} = \frac{NBA}{K}$$

$$\text{Current Sensitivity} = \frac{NBA}{K} \qquad \ldots(11)$$

Hence sensitivity of a MCG can be increased by increasing no. of turns, area of cross-section and strength of magnetic field but by decreasing restoring torque per unit twist—

Voltage Sensitivity—Voltage sensitivity of a galvanometer is defined as the deflection produced in the galvanometer per unit voltage applied to it.

$$\text{Voltage Sensitivity} = \frac{\propto}{V} \qquad \ldots(12)$$

But $V = IR$ …(13)

$$\text{Voltage Sensitivity} = \frac{\propto}{IR}$$

$$= \left(\frac{\propto}{I}\right)\times\frac{1}{R}$$

$$= \text{Current Sensitivity} \times\frac{1}{R}$$

$$\text{Voltage Sensitivity} = \frac{\text{Current Sensitivity}}{R}$$

Hence voltage sensitivity can be defined as the ratio of current sensitivity and resistance of the wire.

Using eq^n (11)

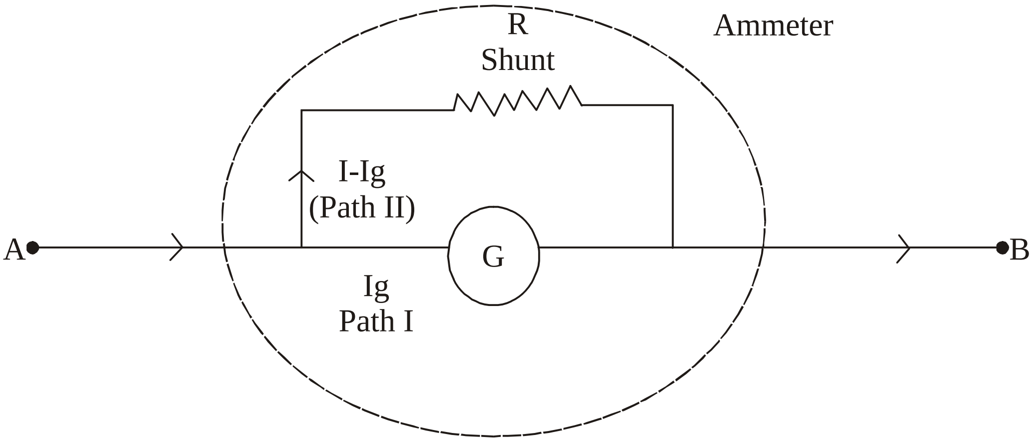
$$\text{Voltage Sensitivity} = \frac{\text{NBA}}{KR} \qquad \ldots(15)$$

Hence voltage sensitivity of a MCG can be increased by increasing no. of turns, strength of magnetic field, area of cross section but by decreasing restoring torque per unit twist and resistance of the wire.

Conversion of MCG into Ammeter

An ammeter is a device that measure current in the electric circuit. For an ideal ammeter, resistance is almost zero.

A MCG can be converted into an ammeter by connecting a low resistance called 'Shunt Resistance' connected in parallel with MCG.



In parallel grouping of resistance, potential must be equal

$V_{pathI} = V_{pathII}$ …(16)

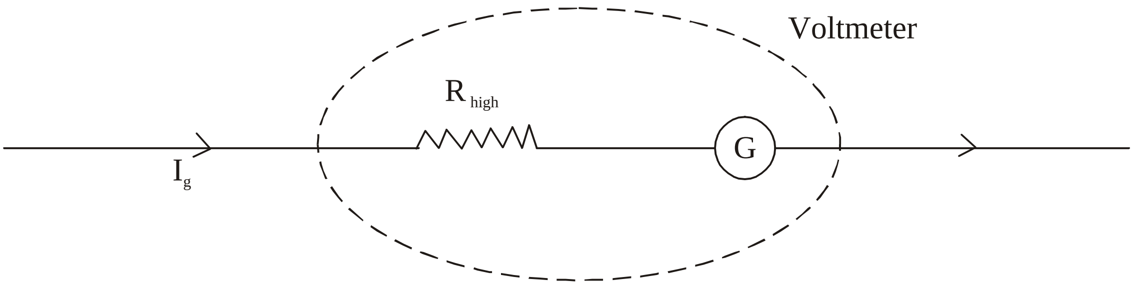
Ig G = (I – Ig) R shunt

$$\boxed{\text{R shunt} = \left(\frac{I_g}{I - I_g}\right) G} \qquad \ldots(17)$$

Conversion of MCG into Voltmeter

A voltmeter is a device that measure potential difference between two terminals of the wire. For ideal voltmeter, it's resistance is inifinite.

A moving coil galvanometer can be converted into a voltmeter by connecting a very high resistance in series.



$V = I_g R_n + I_g G$ …(18)

$V = Ig (R_n + G)$

$$\frac{V}{I_g} = R_n + G$$

$$\boxed{R_n = \frac{V}{I_g} - G}$$

Advantages of MCG

(i) It's sensitivity is very high

(ii) It behaves like linear scale because electric current is directly proportional to deflection produced in the coil.

(iii) A MCG can be converted into an meter or a voltmeter.

13. Define parallel palte capacitor. Explain its construction and working principle of parallel plate capacitor. Derive an expression for its capacitance ?

Ans.—PARALLEL PLATE CAPACITOR (PPC)—

An arrangement of two plates one plate is positive and other plate is negative placed parallely separated by dielectrics to store large amount of electric charge in small space is called parallel plate capacitor. It is the simplest form of any kind of capacitor.

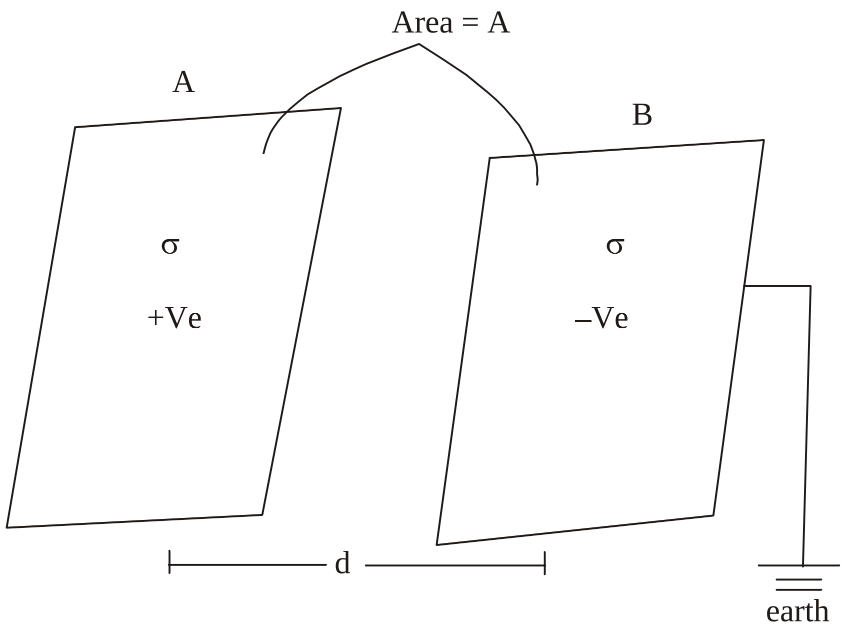
PRINCIPLE—It works on the principle that electric change stored on the plate is directly proportional to the potential difference between two plates.

i.e. $q \; V$ …(1)

$\therefore$ $q = CV$

$\therefore$ $\boxed{C = \frac{q}{V}}$ …(2)

CONSTRUCTION:—



Expression For Capacitance—

Let us consider two plates A and B having equal Area separated by a small distance. The surface change density of plate is ‘σ’

As we know that electric field is negative gradient of potential.

$$\therefore \quad E = \frac{-dv}{dr} \qquad \ldots(3)$$

Taking magnitude only.

$$E = \frac{dv}{dr} \qquad \ldots(4)$$

If electric field is uniform

dv = V

dr = r = d …(5)

$$\therefore \quad E = \frac{V}{d}$$

V = E d …(6)

Now, calculation of electric field,

$$E = E_1 + E_2 \qquad \ldots(7)$$

Where, E_1 is electric field of +ve plate.

E_2 is electric of –ve plate.

$$E = \frac{\sigma}{2 \in_0} + \frac{\sigma}{2 \in_0}$$

$$E = \frac{\sigma + \sigma}{2 \in_0} = \frac{2\sigma}{2 \in_0}$$

$$E = \frac{\sigma}{\in_0} \qquad \ldots(8)$$

But, $\sigma = \frac{q}{A}$ …(9)

$$\therefore \quad \boxed{E = \frac{q}{E_0 A}} \qquad \ldots(10)$$

Putting the value of E in eq^n …(6)

$$V = \frac{qd}{E_0 A} \qquad \ldots(11)$$

By def^n of capacitance of P.P.C.

$$C = \frac{q}{V} = \frac{q}{\frac{qd}{E_0 A}}$$

$$\therefore \quad \boxed{C = \frac{E_0 A}{d}} \qquad \ldots(12)$$

Eq^n—(12) is the general expression for capacitance of a parallel plate capacitor.

Conclusion—Capacitance of a parallel plate capacitor is—

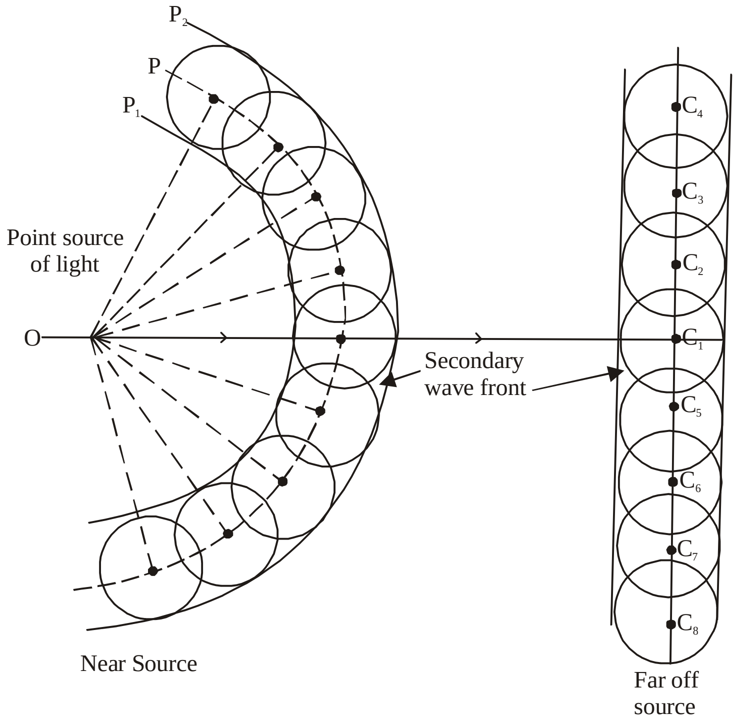
(i) Directly proportional to the area of the plate.

(ii) Inversly proportional to the distance between the plates.

14. Verify laws of reflection or laws of refraction on the basis of Huygen's wave theory ?

Ans.—Huygen's Principle

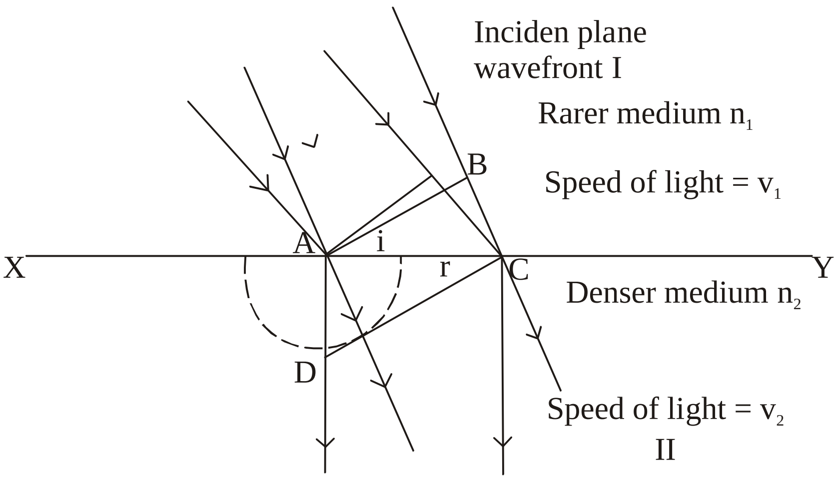
Huygen's principle gives the geometrical details of travelling of a wave. This principle is used to find the position of the given wavelength at any instant of time.



Following are the important assumption made by Huygen's—

1. Each source of light is the centre of disturbance from which waves spread in all direction.
2. Every point on a wavefront is a source of new disturbance which produces secondary wavelength.
3. Only forward envelope enclosing the tangent at the secondary wavelength at any instant gives the new position of wavefront.

Laws of Refraction by Using Huygen's Principle



Let us consider a plane wavelength AB. According to Huygen each and every point on the plane wavefront is the source of secondary disturbance which propagates in all the direction XY is the refracting surface. When a ray of light passes from Rarer to denser medium it bends toward the normal.

Medium-I is rarer medium whose refractive index in n_1. The speed of light in medium I is V_1 and speed of light in medium-II is V_2. Refractive index of medium-II is $n_2 \cdot n_2$ is denser medium.

Distance = Speed × time …(1)

$BC = V_1 t$ …(2)

$AD = V_2 t$ …(3)

Dividing eq^n (2) by (3)

$$\frac{BC}{AD} = \frac{V_1 t}{V_2 t}$$

$$\frac{BC}{AD} = \frac{V_1}{V_2} \quad \ldots(4)$$

In ΔABC

$$\sin i = \frac{BC}{AC} \quad \ldots(5)$$

$BC = AC \sin i$ …(6)

In ΔADC,

$$\sin r = \frac{AD}{AC} \quad \ldots(7)$$

$AD = AC \sin r$ …(8)

Using in eq^n (4)

$$\frac{AC \sin i}{AC \sin r} = \frac{V_1}{V_2}$$

$$\frac{\sin i}{\sin r} = \frac{V_1}{V_2} \quad \ldots(9)$$

By definition of refractive index of medium,

$$n_2 = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$$

$$n_2 = \frac{C}{V_2} \quad \ldots(10)$$

and $$n_1 = \frac{C}{V_1} \quad \ldots(11)$$

Dividing eq^n (10) by (11)

$$\frac{n_2}{n_1} = \frac{C}{V_2} \times \frac{V_1}{C}$$

$$\therefore \quad \frac{n_2}{n_1} = \frac{V_1}{V_2} \quad \ldots(12)$$

Using in eq^n (9)

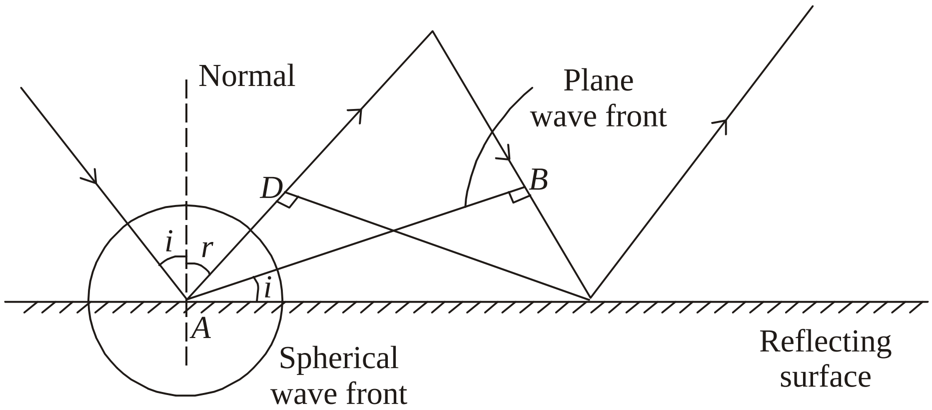
$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$$

$$\boxed{n_1 \cdot \sin i = n_2 \sin r} \quad \ldots(13)$$

eq^n is Snell's law. Hence, law of reflection can be easily derived by using Huygen's principle.

Laws of Reflection by Using Huygen's Principle

According to huygen each and every point of the plane wavefront is the source of secondary wavefront which propagates in all the direction. Let us consider a plane wavefront AB. By definition of wavefront distance couvered from A to B must be equal to distance covered from B to C.



$AD = BC$ ...(1)

In ΔADC,

$$\sin r = \frac{AD}{AC}$$

$\therefore$ $AD = AC$ sinr ...(2)

In ΔABC,

$$\sin i = \frac{BC}{AC}$$

$\therefore$ BC = AC sin i ...(3)

Using in eqn (1)

AC sin r = AC sin i

sin i = sin r ...(4)

For smaller angles,

sin i ~ i ...(5)

sin r ~ r

Using in eq^n (4)

$$\boxed{i = r} \quad \ldots(6)$$

$\therefore$ $\boxed{\text{Angle of incidence = Angle of reflection}}$

eq^n (7) is law of refraction

Hence by using huygen's priciple law of reflection can be easily derived.

15. Give postulates of Bohr's theory. Explain hydrogen spectrum on the basis of Bohr's theory.

Ans.—Bohr's theory—

Following are the improtant assumptions made by bohr—

1. All electrons revolves around the nucleus in the circular orbits.
2. The orbits in which electron revolve is stationary and disturb.
3. Only those orbits are said to be stationary and diserete for which angular momentum of electron is an integral multiple of $\frac{h}{2\pi}$.

Mathematically, it can be written

as, $L = \frac{nh}{2\pi}$ ...(1)

But, L = mvr ...(2)

$\therefore \quad \boxed{mvr = \frac{nh}{2\pi}}$ ...(3)

4. An electron / atom can jump from higher orbit/ energy state to lower energy state by releasing energy and released energy appears as only one photon.

Then is called Bohr's frequency condition.

$E = E_m - E_n$ ...(4)

$h\nu = E_m - E_n$

$$h \cdot \frac{c}{\lambda} = E_m - E_n$$

$\therefore \quad \boxed{\frac{1}{\lambda} = \frac{E_m - E_n}{h_c}}$ ...(5)

Bohr's explanation of spectral liner series of hydrogen atom

According to Bohr's frequency condition when an electron/ atom jumps from higher orbit / energy state to lower orbit/ energy stat, it release the corresponding electron is called spectral series.

1. Lyman series—The spectral due to the transion of an electron from any outer orbit, n_i to the first orbit (n_f = 1) from spectral series is called Lyman series.

It lies in "U V region"

n_i = 2, 3, 4, 5...... ∞

n_f = 1

$$\frac{1}{\lambda} = R\left[\frac{1}{nf^2} - \frac{1}{ni^2}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{1}{(1)^2} - \frac{1}{ni^2}\right] = 2\left[1 - \frac{1}{ni^2}\right]$$

For longest wavelengt

n_i = 2

$$\frac{1}{\lambda\,\text{longest}} = R\left[1 - \frac{1}{(2)^2}\right] = R \times \frac{3}{4}$$

$$\boxed{\lambda\,\text{longest} = \frac{4}{3R}}$$

For Shortest Wavelength

$n_i = \propto$

$$\frac{1}{\lambda \text{shortest}} = R\left[1 - \frac{1}{\infty}\right]$$

$$\lambda \text{ shortest} = \frac{1}{R}$$

$$\boxed{\frac{1}{R} = 911\mathring{A}}$$

2. Balmer series—The spectral liner emitted due to the transition of an electron from any outer orbit (n_i) to the second orbit ($n_f = 2$) from a spectral series is called Balmer series.

It lies in the "Visible region"

$n_i = 3, 4, 5 \ldots\ldots \infty$

$n_f = 2$

$$\frac{1}{\lambda} = R\left[\frac{1}{(2)^2} - \frac{1}{n_i^2}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{n_i^2}\right]$$

For maximum wavelength $n_i = 3$

$$\frac{1}{\lambda_{\max}} = R\left[\frac{1}{4} - \frac{1}{9}\right]$$

$$\frac{1}{\lambda_{\max}} = R\left[\frac{9-4}{36}\right] = \frac{5}{36}R$$

$$\boxed{\frac{1}{\lambda_{\max}} = \frac{36}{5}R}$$

For minimum wavelength, $n_i = \infty$

$$\frac{1}{\lambda_{\min}} = R\left[\frac{1}{4} - \frac{1}{\infty}\right]$$

$$\frac{1}{\lambda_{\min}} = \frac{R}{4} \quad \lambda_{\min} = \frac{R}{4}$$

3. Paschen series—The spectral liner emitted due to the transition of an electron from any outer (n_i) to the third orbit ($n_f = 3$) from a spectral series is called paschen series.

It lier in infra red region

ni = 4, 5, 6 …… ∞

$n_f = 3$

$$\frac{1}{\lambda} = R\left[\frac{1}{nF^2} - \frac{1}{ni^2}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{1}{9} - \frac{1}{ni^2}\right]$$

For maximum wavelength $n_i = 4$

$$\frac{1}{\lambda_{max}} = R\left[\frac{1}{9} - \frac{1}{16}\right] = \frac{7R}{144}$$

$$\boxed{\lambda_{max} = \frac{144}{7R}}$$

For minimum wavelength $n_i = \infty$

$$\frac{1}{\lambda_{min}} = R\left[\frac{1}{9} - \frac{1}{\infty}\right]$$

$$\frac{1}{\lambda_{min}} = \frac{R}{9}$$

$$\lambda_{min} = \frac{9}{R}$$

4. Bracket series—The spectral liner emitted due to the transition of an electron from any outer orbit (n_i) to the fourth orbit ($n_f = 4$) from spectral liner is called Bracket series.

It lies in "far infrared red" region

$n_i = 5, 6, 7, 8, 9 \ldots\ldots \infty$

$n_f = 4$

$$\frac{1}{\lambda} = R\left[\frac{1}{n_f^{\,2}} - \frac{1}{n_i^2}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{1}{16} - \frac{1}{n_i^2}\right]$$

For maximum wavelength $n_i = 5$

$$\frac{1}{\lambda_{max}} = R\left[\frac{1}{16} - \frac{1}{25}\right]$$

$$\frac{1}{\lambda_{max}} = \frac{9R}{400}$$

$$\boxed{\lambda_{max} = \frac{400}{9R}}$$

For minimum wavelength, $n_i = \infty$

$$\lambda_{min} = R\left[\frac{1}{16} - \frac{1}{\infty}\right]$$

$$\boxed{\lambda_{min} = \frac{16}{R}}$$

5. Pfund series—The spectral liner emitted due to the transition of an electron from any outer orbit (n_i) to the fifth orbit ($n_f = 5$) from a spectral series is called Pfund series.

It also lies in far infra-red region

$n_i = 6, 7, 8 \ldots \ldots \ldots \infty$

$n_f = 5$

$$\frac{1}{\lambda} = R\left[\frac{1}{n_f^{\,2}} - \frac{1}{n_i^2}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{1}{25} - \frac{1}{ni^2}\right]$$

For maximum wavelength, $n_i = 6$

$$\frac{1}{\lambda\, \text{max}} = R\left[\frac{1}{25} - \frac{1}{36}\right]$$

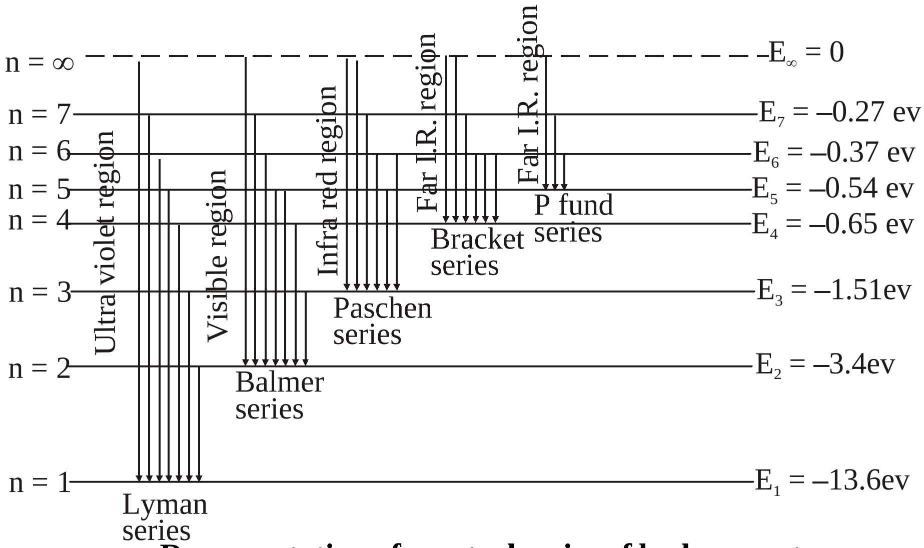
$$\lambda_{max} = \frac{900}{11R}$$

For minimum wavelength, $n_i = \infty$

$$\frac{1}{\lambda_{min}} = R\left[\frac{1}{25} - \frac{1}{\infty}\right]$$

$$\lambda_{min} = \frac{25}{R}$$

Energy distribution in Spectral liner



Representation of spectral series of hydrogen atom