Q A slit of width a is alomenated by light of wave length 6000 Å for what value of a wild
i) 1st max^m fall at an angle of reflection at 30°
ii) 1st minimum fall at an angle of refflection at 30°

soln $d = a$

$\lambda = 6000 Å$

$= 6000 \times 10^{-10} = 6 \times 10^{-7} m$

i) $\theta = 30°$ $n = 1$

for first maximum

$$\sin 30° = \frac{(2n+1)\lambda}{2d}$$

$$\frac{1}{2} = \frac{(2\times1+1)\times 6\times10^{-7}}{2a}$$

$$a = 18\times10^{-7} m$$

ii) $\theta = 30°$, $n = 1$

$$\sin\theta = \frac{n\lambda}{d}$$

$$\sin 30° = \frac{1\times6\times10^{-7}}{a}$$

$$\frac{1}{2} = \frac{6\times10^{-7}}{a}$$

$$a = 12\times10^{-7} m$$

Q light of wave length 6500 Å passes through a slit 0·01 cm width and forms a differation pattern on a screen 1·8 m away what is the width of the central maximum also find the centre of the width of the central maximum when the apparatus is ~~energy~~ emerged in water of gratactive index $\frac{4}{3}$

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Soln Given that

$\lambda = 6500 \text{ Å}$

$= 6500 \times 10^{-10}$

$= 6.5 \times 10^{-7} m$

$d = 0.1 \, m = 0.1 \times 10^{-2} m$

$D = 1.8 m$

$x = \frac{2\lambda D}{d}$

$= \frac{2 \times 6.5 \times 10^{-7} \times 1.8 \times 10}{0.1 \times 10^{-2}}$

$= 3.6 \times 6.5 \times 10^{-4} cm$

$\mu = \frac{\lambda}{\lambda'}$

$\frac{4}{3} = \frac{6.5 \times 10^{-7}}{\lambda'}$

$\lambda' = \frac{6.5 \times 10^{-7} \times 3}{4}$

$x = \frac{2\lambda' D}{d}$

$= \frac{2 \times 6.5 \times 10^{-7} \times 3 \times 1.8}{4 \times 0.1 \times 10^{-2}} m$

A Fresnel distance ~~or~~ or varicty of ray optics

x

The distance of the screen from the slit or apperature when the spreading of ligh due to defraction from the centre of the screen is

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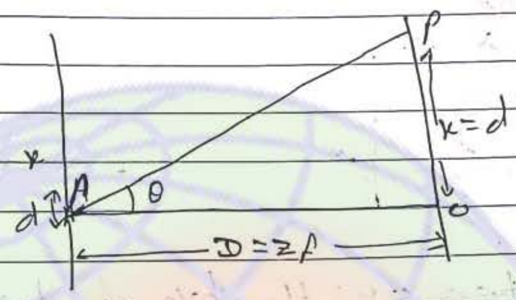
equal to the size of the slit
=> It is denoted by zf



let a screen is placed at distance of D from the slit which have width d

In △AOP

$$\tan\theta = \frac{x}{D}$$

for small angle of θ

$$\theta = \frac{x}{D} \quad \text{——— (1)}$$

for 1st minimum

$$\sin\theta = \frac{\lambda}{d}$$

for small angle of θ

$$\theta = \frac{\lambda}{d} \quad \text{——— (2)}$$

for eq^n (1) and (2)

$$\frac{x}{D} = \frac{\lambda}{d}$$

$$\boxed{x = \frac{\lambda D}{d}}$$

$$D = \frac{xd}{\lambda}$$

when $x = d$

$D = Z_F$

$$Z_F = \frac{d \times d}{\lambda}$$

$$\boxed{Z_F = \frac{d^2}{\lambda}}$$

10.17 Q. Two towers of two on the top of two hills are 40 km apart a ling joine them points 50 m above a hill. half ($\frac{1}{2}$) way b/w the powers what is the longest wavelength of the radion wave which can be and b/w the power without appreciable defferaction effect

Soln

$d = 50\ m$

$Z_F = 20\ km$

$\lambda = 20 \times 10^3\ m$

$\lambda = ?$

$$Z_F = \frac{d^2}{\lambda}$$

$$\lambda = \frac{d^2}{Z_F}$$

$$= \frac{50 \times 50}{20 \times 10^{3}}$$

$$= \frac{25}{2 \times 100} = \frac{1}{8}$$

* limit of resolution =>

The minimum distance ~~b/w the~~ of ~~sp~~ seperation b/w two points so that they can be saparate by an optical instrument is known as limit of resolution

* Resolving power =>

An ability of an optical instrument to form distinctly saparate images of the two closely placed point or object is called its resolving power. Which reciprocal of the limit of resolution

$$R.P. \propto \frac{1}{\text{lim of resolution}}$$

$$R.P \propto \frac{1}{\theta}$$

* Resolving power of ~~a~~ telescope and human eye

$$\theta = \frac{1.22\lambda}{D}$$

$$R.P = \frac{1}{\theta}$$

$$R.P = \frac{D}{1.22\lambda}$$

where d is diameter or abberation of objectly

* Resolving power of simple microscope

$$RP = \frac{2\mu \sin\theta}{1.22\lambda}$$

angle at the objective lens, μ is the refractive index

* ~~polarisation of light~~

* Comparision b/w the interference and diffraction of light ⇒

Interferance	Diffraction
1) It is due to the super-position of two wave fronts originating from two coherent source	1) It is due to the superposition of two secondary wave lets originating from the different point on the screen wave front.
2) In Interferance pattern all the maxima and minima that is dark and bright fringe are equal in intensity	2) If diffraction pattern it is vary
3) In interferance pattern the dark fringes are usually almost perfectaly dark.	3) In diffraction pattern the dark fringes are not perfectaly dark
4) In interferance pattern the width of the fringe is equal	4) In diffraction pattern the width of the fringes are not equal

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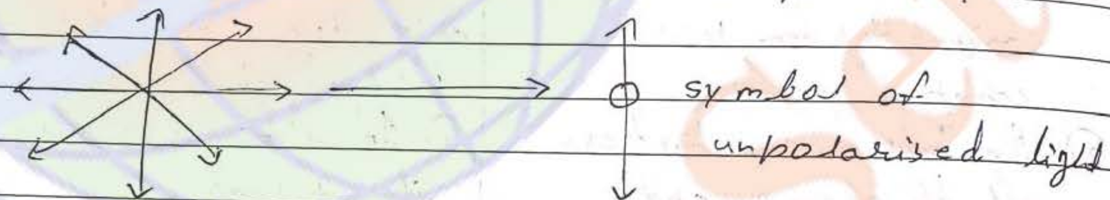
5) In interference bands are large in no.	5) In diffraction bands are few in no.
6) In interference bands are equally spaced	6) In diffraction bands are unequally spaced.

* Polarisation of light ⇒

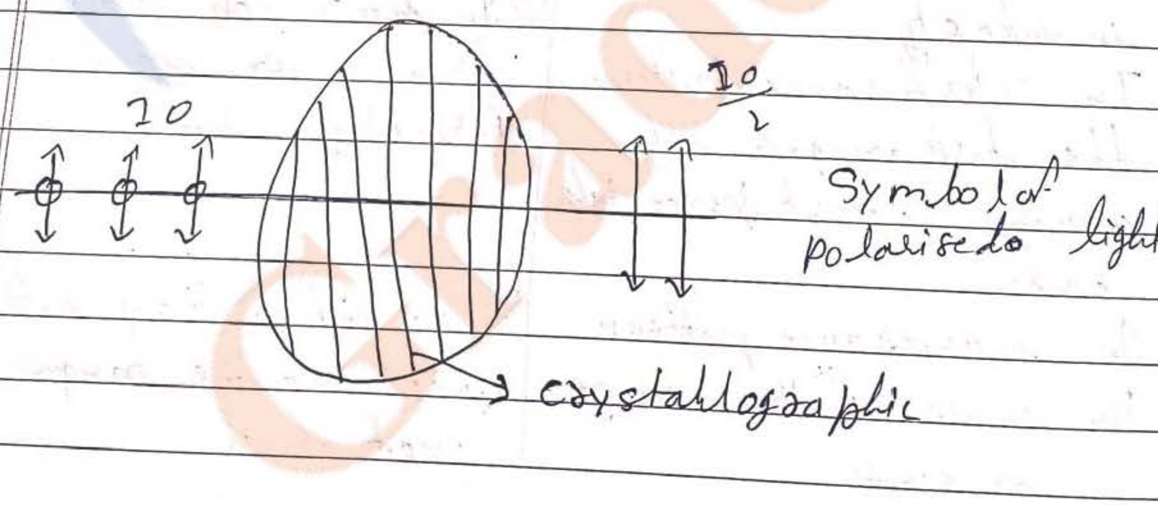
The Phenomenon of restriction the vibration of a light wave in a particular direction in a plane $\perp^{ar}$ to the direction of propagation is known as polarisation of light.

* Polariser ⇒ A device which is used to polarise the unpolarised beam of light

Tourmaline Crystal is used as a polariser



unpolarised light

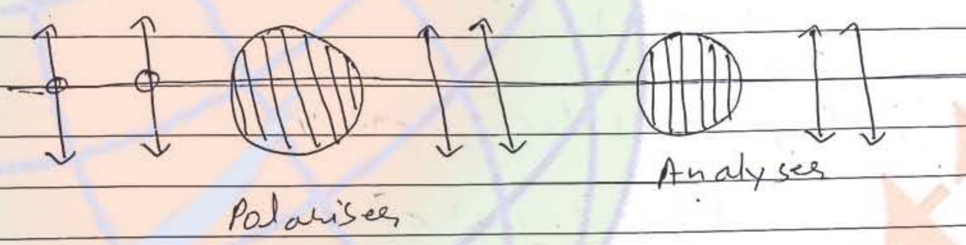


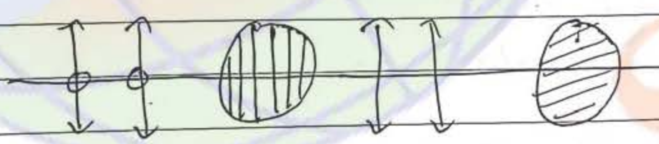
Note

In tourmaline crystal the ray of light parallelogram to the crystallographic axis passes through it and rest light get reflect back

Note Intensity of polarised light is half of the intensity of unpolarised light

* ~~Anar~~ Analyser ⇒ A device which is used to detect a given light is polarised or unpolarised



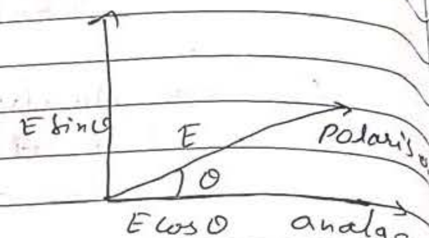


* Malus law ⇒ A/c to Malus law the intensity of the polarised light transmitted through the analyser varies as the square of the cosine of the angle b/w the plane of transmission of the analyser and the plane of the polariser.

$$I \propto \cos^2\theta$$

Let the polariser and analyser placed at angle θ

Polarised light of amplitude E have two components. E cos θ and E sin θ in which E sin θ is ⊥ar to the analyser that cannot pass through the analyser.
E cos θ component is Parallelogram to the analyser which pass through the analyser and resultant amplitude is E cos θ.



Intensity ∝ (amplitude)^2

$I \propto (E\cos\theta)^2$

$I = KE^2\cos^2\theta$ —— (1)

When maximum intensity

$\cos\theta = 1$

$I_0 = KE^2$

Putting this value in eq^n (1)

$$I = I_0\cos^2\theta$$

Where I_0 is constant

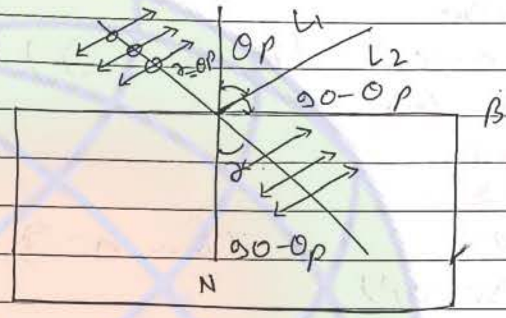
$$I \propto \cos^2\theta$$

This is malus law

* Polarisation by the Reflection ⇒
When unpolarised or ordinary light incident obtically in a glass slab then it get partically refracted and partically reflecated in such a way it get polarised.

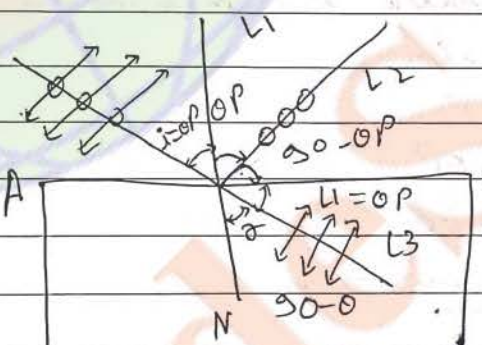
* Angle of Polarisation ⇒
An angle of incidence at which reflected ray is completely polarised is known as the angle of polarisation

It is denoted by θp or Ip



* Brewster's law
A/c to brewster's Law the refractive index of a medium is numerically equal to the tangent of angle of Polarisation

$\mu = \tan \theta p$



Let unpolarised light or ordinary light incident on the separating surface AB at angle of Polarisation θp. By laws of reflection ⇒

$\angle 1 = \theta p$

$\angle 1 + \angle 2 = 90^\circ$ (MN ⊥ AB)

$\theta p + \angle 2 = 90^\circ$

$\angle 2 = 90 - \theta p$ —— (1)

At angle of polarisation reflected or refracted ray is perpendicular to each other

$\angle 2 + \angle 3 = 90°$

$90 - \theta P + \angle 3 = 90°$ (from eq^n ①)

$\angle 3 = \theta P$ —— ②

$MN \perp AB$

$r + \angle 3 = 90$

$r = 90 - \theta P$ (from eq^n ②)

By snell's law

$\mu = \frac{\sin i}{\sin r}$

$\mu = \frac{\sin \theta P}{\sin(90 - \theta P)}$ (from eq^n ③)

$\mu = \frac{\sin \theta P}{\cos \theta P}$

$$\boxed{\mu = \tan \theta P}$$

Q Refractive index of a medium is $\sqrt{3}$ find the angle of polarisation.

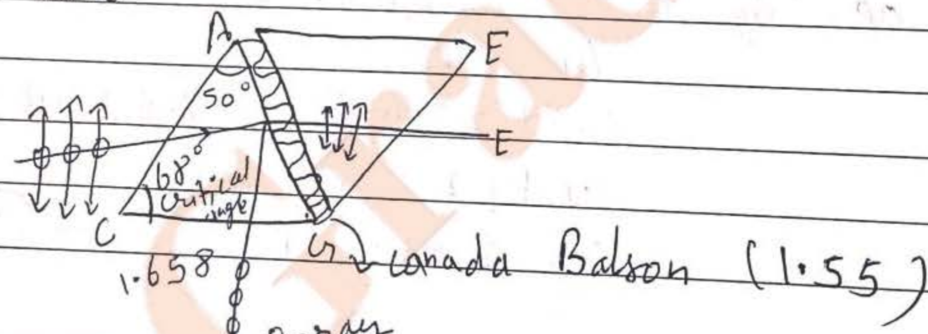
Soln $\mu = \tan \theta P$

$\sqrt{3} = \tan \theta P$

$\theta P = \sqrt{3} = 60°$

A <u>Nicol prism</u> ⟹

Nicol prism is an optical device which is used for producing plane polarised light and analysing the same



Nicol prism is consist of ~~cal~~ calcite crystal ACGE cut an angle of 68°, Join by the glue called canada Balson

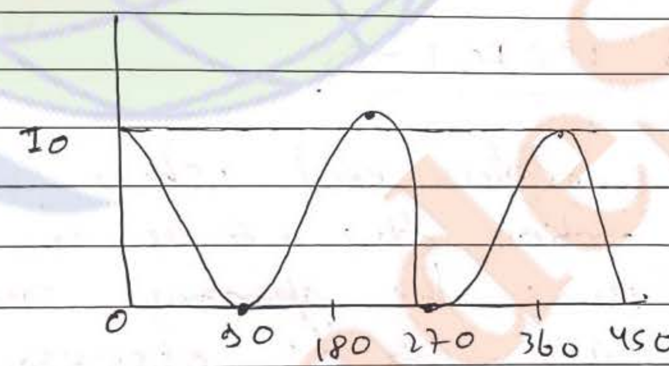
when beam of unpolarised light is passed through a calcite crystal it break into two rays i.e ordinary rays and extra ordinary rays as refractive index of calcite for o-ray is 1.658 and for E-ray is 1.486

therefore canada Balson acts as a ~~arror~~ rarer medium for O-rays and denser medium for E-rays, since O-rays incident greater than critical angle. So, O-ray is totally internally reflected.

Whereas E-ray is unaffected In such a way nical prism is polarise the light

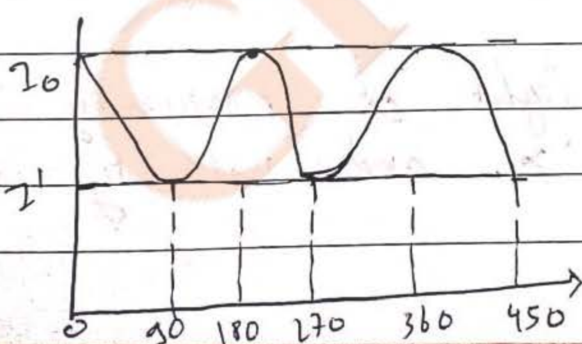
* Droplers Effect ⇒

* Graph of the Malus Law ⇒



Graph of the unpolarised beam of light

$$I = I' + I_0 \cos^2\theta$$

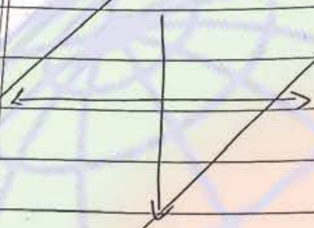


of the light wave in a plane perpendicular to the direction of propagation is known as polarisation of light

* Polarisation =>

A device which is used to polarise the unpolarised beam of light

Tourmaline crystal is used as a polariser



Q

Soln * DROPLERS EFFECT =>

* According to droplers effect whenever there is a relative motion b/w a source of light and the observer the apparent frequency of light received by the observer is different from the true frequency of light emitted by the source of light

Let a source of light of frequency 'ν' and wavelength 'λ' and velocity of light be 'c' then

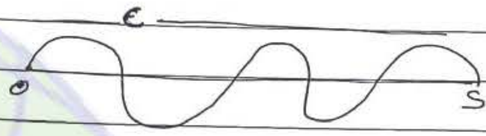
$$\lambda = \frac{c}{\nu} \quad \text{—— (1)}$$

If observer moves towards the source with velocity 'v'

$$\lambda' = \frac{c-v}{\nu} \quad \text{—— (2)}$$

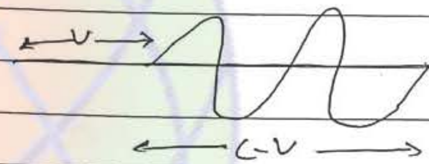
Apparant frequency of source

$$\nu' = \frac{c}{\lambda'}$$



$$\nu' = \frac{c\nu}{c-v}$$

$$\nu' = \frac{c\nu}{c\left(1-\frac{v}{c}\right)}$$



$$\nu' = \nu\left(1-\frac{v}{c}\right)^{-1}$$

By binomial theoram

$$\nu' = \nu\left(1+\frac{v}{c}\right) \quad \text{—— (3)}$$

When moves away from the source –

$$\nu' = \nu\left(1-\frac{v}{c}\right) \quad \text{—— (4)}$$

On combining eqn (3) and eqn (4)

$$\nu' = \nu\left(1 \pm \frac{v}{c}\right) \quad \text{—— (5)}$$

but $\frac{f}{c} = \frac{1}{\lambda}$

$$\Delta \gamma = \pm \gamma^{2} \times \frac{v}{c} \times \frac{1}{\lambda}$$

$$\boxed{\Delta \lambda = \mp \frac{v}{c} \lambda}$$

* There are two types of the Doppler's shift

i) Blue shift ⇒
When observer moves towards the source than change in frequency is positive or change in wavelength is negative i.e wavelength is decreases so spectrum shift from read to blue called blue shift

ii) Read Shift ⇒ when observes moves away from the source then change in frequency is negative and change in wavelength is positive i.e wavelength is increases so spectrum shift from blue to read called Read shift

* Application of doppler's effect ⇒
i) It is used measure the speed of stares and galaxes
ii) It is used to measure the temperature of Plasma in thermo nuclear
iii) It conform the hipothatic ~~thea~~ that the ~~uni~~ univers is spending

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iv) It is used in radar to estimate the speed of air ~~glass~~ craft there ~~@@~~ Precuen and distance from given

v) It is used in sonar to find the summerines and find the depth of the sea

Q what ~~should~~ speed should a galaxy move with respect to us so that the sodium line ~~at~~ at 589 nm λ you observed 589.6 nm

Soln

$\lambda = 589\,nm$

$= 589 \times 10^{-9}\,m$

$\lambda' = 589.6\,nm$

$c = 3 \times 10^{8}\,m/s$

$v = ?$

$\Delta\lambda = \lambda' - \lambda$

$= 589.6 - 589$

$= 0.6\,nm$

$= 0.6 \times 10^{-9}\,m$

$\Delta\lambda = \frac{v}{c}\lambda$

$v = \frac{\Delta\lambda \times c}{\lambda}$

$= \frac{0.6 \times 10^{-9} \times 3 \times 10^{8}}{589 \times 10^{-9}}$

$= \frac{1.8 \times 10^{8}}{589}\,m/s$

Ex 10.1

The 6563 A° H_2 line emited by hydrogen in a starks ~~and~~ is found to be red shift 15 A°

stimate the speed ~~with~~ of star is receding from earth

Soln $\lambda = 6563 A^\circ$

$\Delta\lambda = 15 A^\circ$

$\Delta\lambda = \frac{v}{c}\lambda$

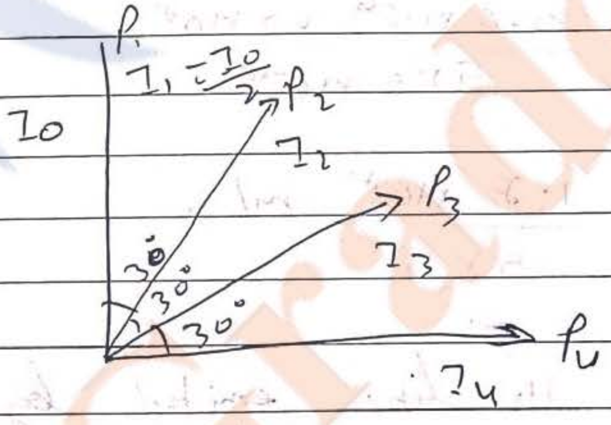
$v = \frac{\Delta\lambda \times c}{\lambda}$

$= \frac{15 \times 10^{-10} \times 3 \times 10^{8}}{6563 \times 10^{-10}}$

$= \frac{45 \times 10^{8}}{6563}$

$= 6.86 \times 10^{5}$ m/s

Q An unpolarised beam of light is incident on a group of four polarised shift which are arrange in such a way that the characteristic direction is ~~polarised~~ polarisation shift makes an angle of 30° ~~what~~ with that of the precedin light transmitted



Let, unpolarised light of intensity I_0 ~~intensity~~ incident on polarisation P_1
after polarisation P_1 is given by

$$I_1 = \frac{I_0}{2} \quad \text{--- (1)}$$

polarisation after P_2

$$I_2 = I_1 \cos^2 30^\circ$$
$$= \frac{I_0}{2} \times \frac{3}{4} = \frac{3I_0}{8} \quad \text{--- (2)} \quad (\text{from eq}^n \text{ (1)})$$

polarisation after P_3

$$I_3 = I_2 \cos^2 30^\circ$$
$$= \frac{3I_0}{8} \times \frac{3}{4} \quad (\text{from eq}^n \text{ (2)})$$
$$I_3 = \frac{9I_0}{32} \quad \text{--- (3)}$$

$$I_4 = I_3 \cos^2 30^\circ$$
$$= \frac{9I_0}{32} \times \frac{3}{4}$$

$$\boxed{I_4 = \frac{27}{128} I_0}$$

Ex 10.5 In young's double site experiment using monochromative light of wave length λ the intensity of light at a point on the screen where path diff is K what is the intensity of light at a point where path diff. is $\lambda/3$

Soln path diff $= \lambda$

$$\text{path diff} = \frac{\lambda\phi}{2\pi}$$

$$\therefore \frac{\lambda\phi}{2\pi} = \lambda$$

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$\phi = 2\pi$

$I_1 = I_2 = I_0$ (let)

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos 2\pi$

given $I = k$

$k = I_0 + I_0 + 2\sqrt{I_0^2} \times 1$

$k = 4I_0$ —— (1)

$I_0 = \frac{k}{4}$

$\frac{\lambda\phi}{2\pi} = \frac{\lambda}{3}$

$\phi = \frac{2\pi}{3}$

$I' = I_0 + I_0 + 2\sqrt{I_0^2}\cos\frac{2\pi}{3}$

$I' = 2I_0 + 2I_0 \times \frac{-1}{2}$

$I' = I_0 = \frac{k}{4}$ (from eqn (1))

EX→10.6

Solⁿ $\lambda_1 = 650\, nm$

$= 650\times10^{-9}\, m$

$\lambda_2 = 520\, nm$

$= 520\times10^{-9}\, m$

(a) $x = \frac{n\lambda D}{d}$

$n = 3$

$x = \frac{3\times650\times10^{-9} D}{d}$ Ans

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b) let length nth bright fringe of λ_1 coincides with the (n+1)th bright phase of λ_2

$$\frac{n \times \overset{5}{650}\, D}{d} = \frac{(n+1)\, \overset{4}{520}\, D}{d}$$

$$5n = 4n + 4$$

$$\boxed{n = 4}$$

$$n+1 = 4+1 = 5$$

Four bright fringe of the 650 wave length coincide with the 5th ~~520 of the~~ bright fringe of the 520

10.7) $\theta_1 = 0.2°$
$D = 1 m$
$\lambda = 600 nm$
$\mu = 4/3$

Soln $\frac{\theta_1}{\theta_2} = \mu$

$$\theta_2 = \frac{\theta_1}{\mu}$$

$$= \frac{0.2 \times 3}{4}$$

$$= \frac{0.6}{4}$$

$$= 0.15 \text{ Ans}$$

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Ch ⇒ 11

doual Nature of Matter and Radiation

* Surface barrier of electron ⇒
When electron tends to leave the metal surface as the as positive charge aquire the required metal surface that attract attract the negative charge of electron called surface barrier of electron

* Work function ⇒ The minimum energy required by the free electron to just leave metal surface is know as the work function
⇒ Its S.I unit is J (Joule)
another unit 1eV = 1.6×10^{-19} J
1MeV = 1.6×10^{-13} J

* Emition of electron ⇒ The phenomanen of emition of electron from the surface of metal is called electron emition

* Types of electron emition
i) Thermonice emition ⇒
An emition of electron in which free electrons are emitted from the metal surface by heating is know as the thermonice emition

ii) field emition ⇒
An emition of electron in which ele free electrons are mitted from the metal surface by appling external electric field

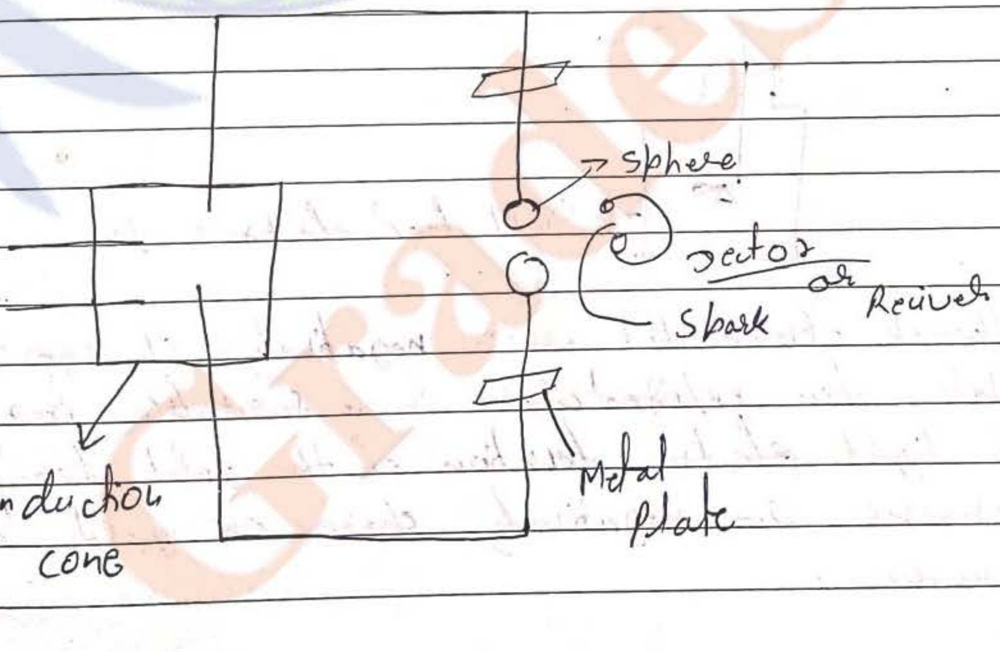
iii) Photo electric emition => An emition of electron in which free electron are emitted from the metal surface by applying the suitable frequency of light on it.

iv) Secondary emition =>
An emition of electron in which free electron are emitted from the metal surface by applying the bumbarding the fast moving electron is know as the secondary emition

* Photo electron => The free electron of a obtained during the photo electro emition is know as photo electron

* Photo electric current => electric Current constituent due to the photo electron is know as the photo electric current

* Photo electric effect =>
1) hertz experiment



henery hertz was observed during the electro magnetic radition experiment he used a reciver made of wire with metalic sphere on each in and band into a circuit to form a small gap b/w a sphere this reciver was used as a decator detector of electro magnetic radition radiation. electro magnetic radition induced a potential diff. across the gap this was evidence a spark jump across the gap. when exposs in a ultravoilet light this experiment so that emition of electron is possible in a when suitable frequancy of light incident on the metal

Hallwach Experiment ⇒

hallwach obrsve that when negatively charge zinc plate when exposed in a suitable frequancy of light electro devation of the gold leaf decreasses i.e negatively charge on gold leaf decreasses

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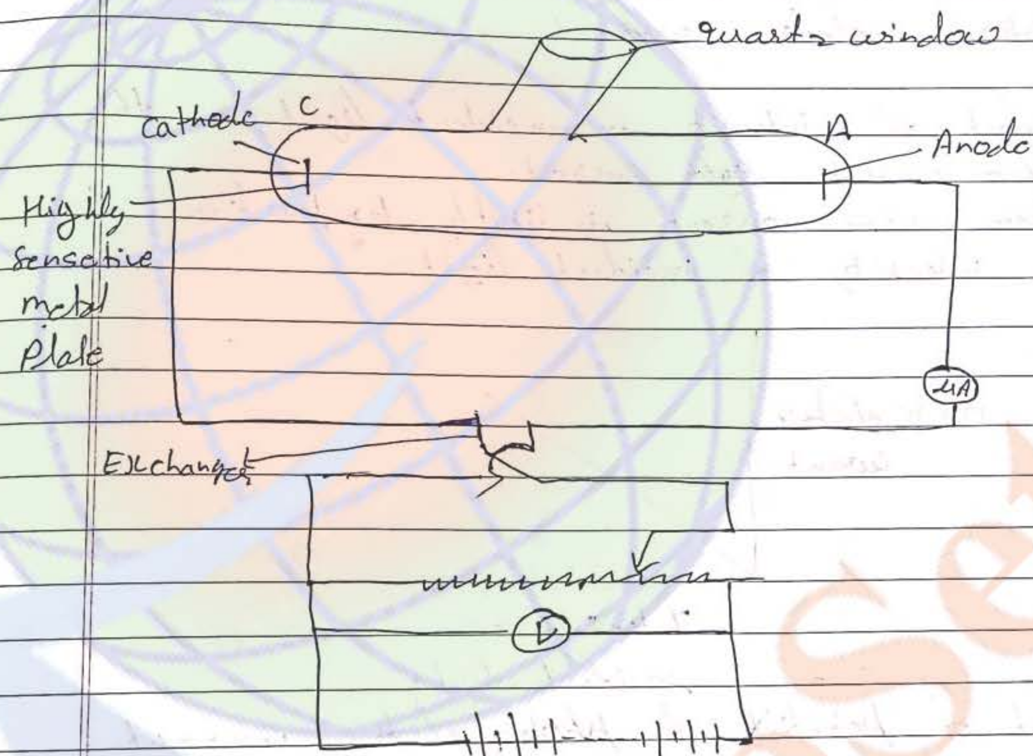
This show than negatively charge since palate expose and suitable frequency the electron emitted from the metal surface

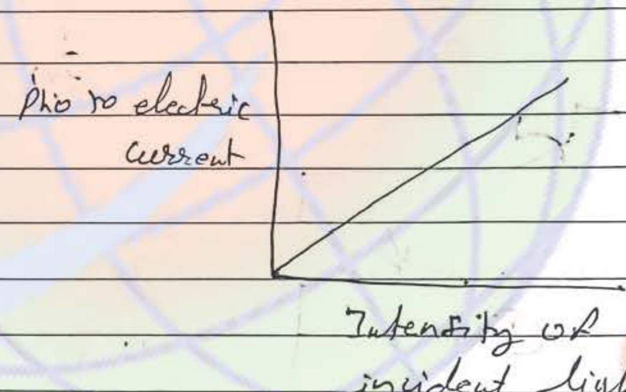
Experiment study of the photo electric effect



for the experimental study of the photo electric emission apparatus are arrange as show in the given figure it consists of the vacume tube having two electrode A and C the electrode C is a photo sensitive metal plate which emit electrons when expose to ultra violate radiation electrode a called the emitted electron the tube has a side window made up of the Phase through which the incident light inters the tube false

on the photo sensitive c electrode A and C are connected to a battery through a suitable exchanges
electrons are emitted when ultraviolet ~~or~~ radiation are made to fall on photo sensitive plate c these electron attracted towards electrode A constituent ~~connects~~ the photo electric current

i) effect of intensity of incident light on the photo electric ~~light~~ current.
ii) Photo electric current is directly proportional to the intensity of incident light



iii) Effect of potential of photo electric current

* stoping potential or cutup potential ⇒
The minimum negative potential applied across the plate for which photo electric current becomes zero is called cutup potential or stoping potential

Maximum kinetic energy ~~of the~~ acquired by the electron is given by

$$KE = \frac{1}{2} m v^2 \quad \text{--- (1)}$$

$$V = \frac{\omega}{q}$$

$$\omega = qV$$

for one electron

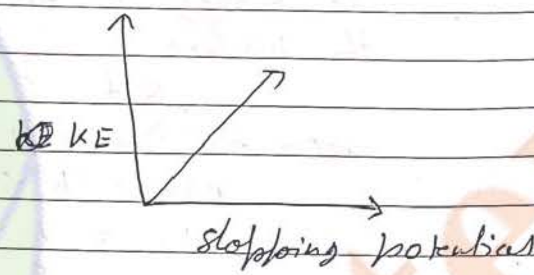
$q = e$ and $V = V_0$

$$\omega = eV_0 \quad \text{--- (2)}$$

from eqn (1) and (2)

$$eV_0 = \frac{1}{2} m v^2$$

$$KE \propto V_0$$



Effect of incident of light on the stopping potential

These no effect of the intensity of light on the stopping potential

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* Effect of frequency on stopping potential

Threshold frequency ⇒

The minimum frequency at which emition of electron is possible is known as the threshold frequency

Total work done to stope the electron

$W = eV_0$ —— (1)

The energy of incident light to incident on the surface

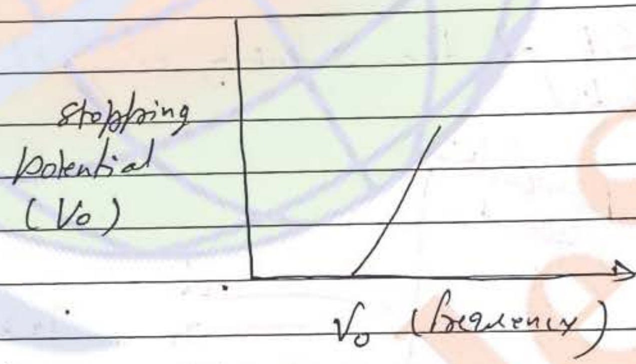
but $E = h\nu$ —— (2)

from eq^n (1) and (2)

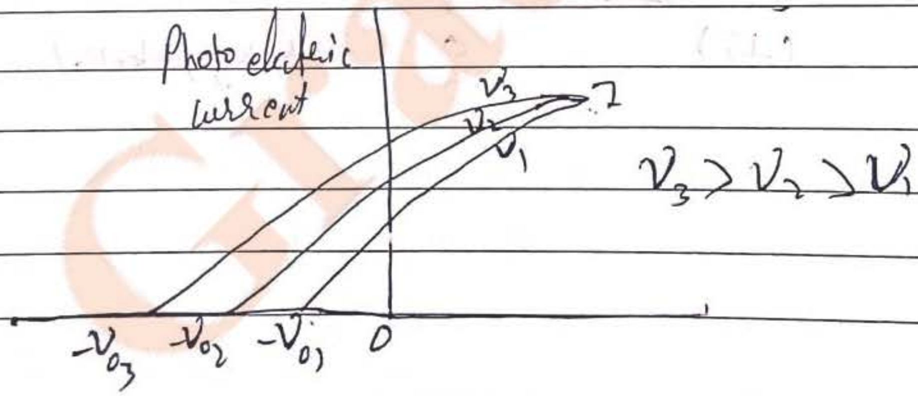
$eV_0 = h\nu$

$V_0 = \frac{h}{e}\nu$

$$\boxed{V_0 \propto \nu}$$



when intensity is same but frequency is different ⇒



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* law of Photo electric emition

i) for a given substance there is minimum frequency of incident light called threshold frequency below which no photo electric emition takes places

ii) the no. of electron ~~emitio~~ emitted per second i.e photo electric current of substance is directly proportional to the intensity of incident light of ~~sutable frequency~~ provided the frequency of light > threshold frequency
grater than

iii) the maximum k.E of a photo electrons is directly propoertion to the frequency of Incident light provided the frequency of incident light is grater than the threshold frequency An indebendent from the intensity of light

iv) the process of ~~photo electric~~ emition of electric electron in intenstentis

* Einstine equation of photo electic ⇒

A/C Einstine to
~~Planks~~ equ

fallse on a metal surface the energy of the photon is observed by the free electron in the metal this absorbe energy is utilised in two ways

1) A part of energy is used ~~to add~~ equal to the work function ϕ_0 of the metal surface.

ii) The remaining parts of the energy is used to provide the K.E of the free electron

$$h\nu = \phi_0 + \frac{1}{2}mv^2$$

case I when $\nu = \nu_0$

$$h\nu_0 = \phi_0 + 0$$

$$\therefore \phi_0 = h\nu_0$$

Putting this value in eqn ①

$$h\nu = h\nu_0 + \frac{1}{2}mv^2$$

$$h\nu - h\nu_0 = \frac{1}{2}mv^2$$

$$\boxed{\frac{1}{2}mv^2 = h(\nu - \nu_0)}$$

this is equation of einstine photo electric emission

* Veryfecation of the law of photo electric emission

i) If $\nu < \nu_0$

i.e from the emission equation K.E of free electrons is negative that is possible i.e below the threshold frequency emission of electron does not possible

ii) Since one photon can emit only one electron from the metal surface i.e the surface of Photo electrons per Second is directly proportional to the intensity of light.

KE or stopping potential of Photoelectric to

emition is directly proportional to the intensity of

collision b/w the free electrons and photon as such that they that is emission of electron is instantaneous processes.

Relation b/w the cutoff potential and frequency of incident light

from eysti einsteins equation of photo electric emission

$$\frac{1}{2}mv^2 = h(\nu - \nu_0) \quad \text{——} (1)$$

when K.E is given by

$$\frac{1}{2}mv^2 = eV_0 \quad \text{——} (2)$$

Where V_0 is the stopping potential

from eqn (1) and (2)

$$\boxed{\frac{1}{2}mv^2 = eV_0 = h(\nu - \nu_0)}$$

In wave length form

$$\nu = \frac{c}{\lambda}$$

$$\nu_0 = \frac{c}{\lambda_0}$$

$$\boxed{\frac{1}{2}mv^2 = eV_0 = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)}$$

Determination of the Planks constant ⇒

From the einestiest equation ——— ①

$\frac{1}{2}mv^2 = h(\nu - \nu_0)$ ——— ②

$\frac{1}{2}mv^2 = eV_0$

$eV_0 = h(\nu - \nu_0)$

V_0 is stopping potential

$eV_0 = h\nu - h\nu_0$

Dividing all terms by e

$V_0 = \frac{h\nu}{e} - \frac{h\nu_0}{e}$ ——— ③

$y = mx + c$ ——— ④

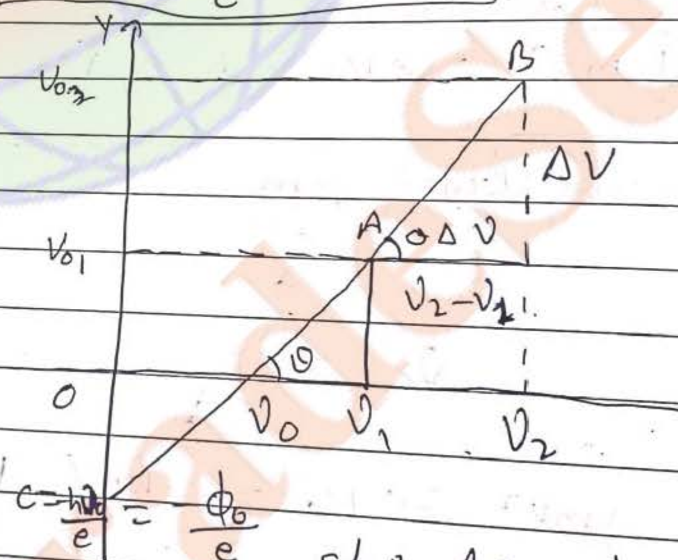
This is the equation of the straight line

The comparision equation ③ and ④

$y = V_0 \quad x = \nu$

$m = \frac{h}{e}$ ——— ⑤

$$c = -\frac{h\nu_0}{e} = \frac{\phi_0}{e}$$



slope AB $= \tan\theta = \frac{\Delta V}{\Delta \nu}$

$\tan\theta = m$

$\therefore m = \frac{\Delta V}{\Delta \nu}$ ——— ⑥

from eqn (5) and (6)

$$\frac{h}{e} = \frac{\Delta V}{\Delta \nu}$$

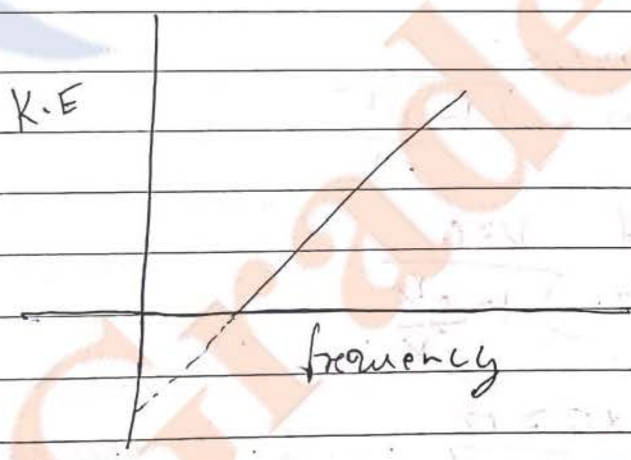
$$\boxed{h = \frac{\Delta V}{\Delta \nu} e}$$

frequency

* Graph b/w the frequency and stopping potential

Two or more metal substance have the same slope $\frac{h}{e}$ but different threshold frequency i.e all the graph b/w stopping potential and frequency are parallel

* graph b/w the K.E and frequency



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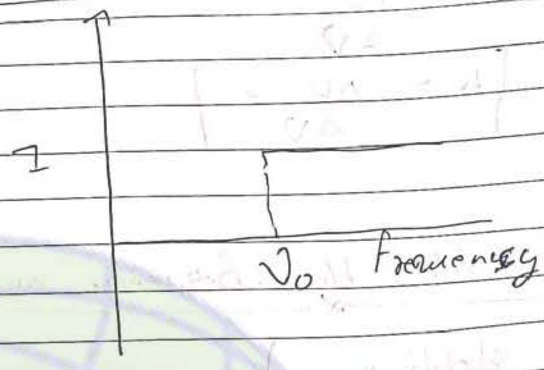
Frequency and photo electric current =>



Note that is photo electric current is depending frequency of incident light

Particle nature of light of Photon =>

i) A Photon travels at speed of light in vacuum
ii) A Photon has zero rest mass
iii)

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

where
m_0 is rest mass

$$m_0 = m\sqrt{1 - \frac{v^2}{c^2}}$$

but $v = c$

$$m_0 = m\sqrt{1 - \frac{c^2}{c^2}}$$

$$m \times 0 = 0$$

$$\boxed{m_0 = 0}$$

iii) ~~K-E~~ kenetice mass of Photone is $m = \frac{E}{c^2}$

$$m = \frac{h\nu}{c^2}$$

$$m = \frac{h\nu}{c \times c}$$

$$\boxed{m = \frac{h}{c\lambda}}$$

iv) The momentum of photone is

~~P = mc~~ $P = mc$

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

$$\boxed{P = \frac{h}{\lambda}}$$

v) Photon travels in a straight line

vi) wave length ~~of~~ the photon is changes in different medium so velocity of photon ~~is~~ in different medium

vii) Photon do not have any charge i.e not electricaly netreal

viii) photon may so the defelecation under the condition

ix) " are not deviated are electric and magnetic field

Failure of wave theory of light to explain the photo electric effect

1) A/c to wave theory K.E of the free electrons is directly proportional to intensity of light but in opposite ~~K-E does not depends~~ photo electric emission effect ~~bat~~ . experiment K.E does not depends on the intensity of light

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(5)

ii) A/c to waves theory emission of electron it is take place at any frequency of the incident light but photo electric experiment minimum frequency of incident light called threshold frequency is required

iii) A/c to waves theory free electrons of the metal take some time to observe the sufficient energy for the emition i.e it is time laging in processes but photo electric emission exp. it is a instantanious processes it take 10^{-9} second

Debrogally waves or matter waves

A/c to debrogally some phenomenan of light explain by using wave theory and some phenomenon explain quantum theory so then is sugies that light is duals in nature particles as well as wave nature on the following ajection

1) The inverse is made up particle and radiation and both entities most be symetricale

ii) The nature law of symetrice

2) Debrogally wave length or matter wave

A/c to debrogally the waves associated with the particles light protone, electron, netron etc it is known as the debrogally waves or matter waves

(3) debrogally wave length

A/c to debrogally a moving matterial particles some time acts as a wave and some time acts as a particle or wave is a associated with moving matterial particle which control particle in every respect the wave associated with moving particle is called matter wave or debrogally wave are which wavelength called debrogally wave length is given by $\boxed{\lambda = \frac{h}{mv}}$

derivation of debrogally wave length

A/c to planck's quantum theory

$$E = h\nu \quad \text{——— (1)}$$

A/c to einstein equation

$$E = mc^2 \quad \text{——— (2)}$$

from eqn (1) and (2)

$$mc^2 = h\nu$$

$$c = \frac{h\nu}{mc}$$

$$\nu\lambda = \frac{h\nu}{mc} \qquad (c = \nu\lambda)$$

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

where $mc = p$

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

$$\therefore \lambda = \frac{h}{p}$$

When mass and velocity associated with the particle be m and v then

$$\therefore \boxed{\lambda = \frac{h}{m}}$$

this is known as debrogally wave length

* debroglie wavelength ~~in form of~~ in terms of K.E

debroglie wavelength is given by

$$\lambda = \frac{h}{mv} \quad \text{——— (1)}$$

K.E of the moving particle is given by

$$K.E = \frac{1}{2}mv^2$$

multiplying both sides by m

$$2mKE = m^2v^2$$

$$\sqrt{2mKE} = mv$$

Putting this value in eqn (1)

$$\boxed{\lambda = \frac{h}{\sqrt{2mKE}}}$$

* debroglie wavelength in terms of absolute temp.

$$\lambda = \frac{h}{mv} \quad \text{——— (1)}$$

$$KE = \frac{3}{2}kT$$

$$\frac{1}{2}mv^2 = \frac{3}{2}kT$$

Multiplying both side by m

$$(mv)^2 = 3mkT$$

$$mv = \sqrt{3mkT}$$

Putting this value in eqn (1)

$$\boxed{\lambda = \frac{h}{\sqrt{3mkT}}}$$

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* de broglie wavelength in terms of electric potential
We know that de broglie wave length is given by

$$\lambda = \frac{h}{mv} \quad \text{--- (1)}$$

$$\frac{1}{2}mv^2 = eV$$

where v = velocity , V = electric potential

multiplying both side by m

$$(mv)^2 = 2meV$$

$$mv = \sqrt{2meV}$$

Putting this value in eqn (1)

$$\boxed{\lambda = \frac{h}{\sqrt{2meV}}}$$

=> wave length for electron

$$m = 9.1 \times 10^{-31}\ kg$$

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

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

$$\lambda = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19}\ V}}$$

$$\boxed{\lambda = \frac{12.27}{\sqrt{V}}\ A^{o}}$$

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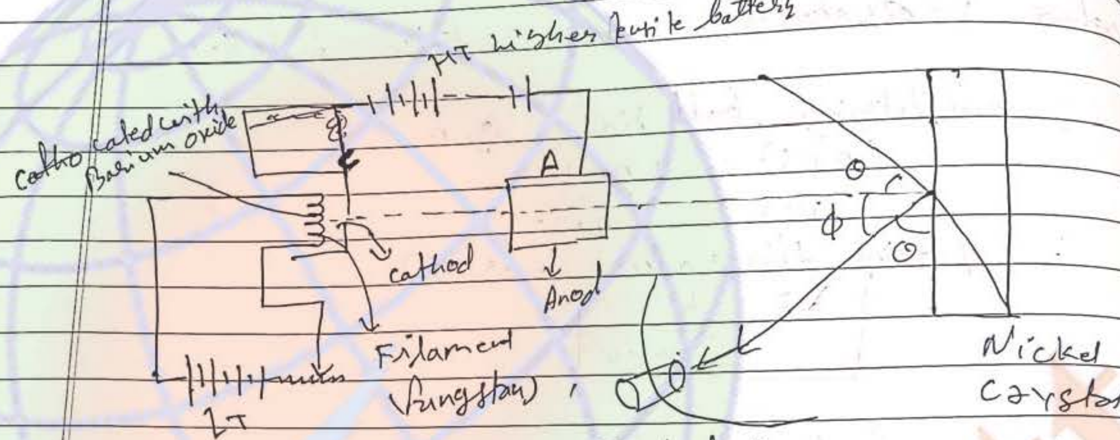
* ~~Deviation and~~
Davisson and Germer Experiment =>

✓ The wave nature of slow moving electron have been established davission and germer



for a davission Germer experiment apparatus are arrange as show in the given figure it consists of the filament usually made up of the tungustans coated with Barium oxide and conneckted to the low tensile battery filament is covered by the cathod having a very fine pole connected to the -ve terminal of the battery 'A' is a cylinder a fine hole along it axis called anode cathode an anode form electron gun electron which produce excalated electron that incidant on the nicale.

A decatore is placed inbound of the nicale cristal to decate the magnitude of electron emission

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Working

A fine beam of excited electron of an from of electron gun falls on the surface of nicale cristal ~~then~~ and found that when the incident beam of electron accelerated through a potential of 54 volt

was made to incident to the nicale cristal the intensity of scattered beam was maxm of an scattered angle 50°

$$\theta + \phi + \theta = 180°$$

$$2\theta = 180 - 50$$

$$2\theta = 130$$

$$\theta = \frac{130}{2}$$

$$= 65° \quad \text{—— (1)}$$

A/c to Braggs equation from the maximum and deflecation

$$2d \sin\theta = n\lambda$$

$$n = 1$$

$$\lambda = 2d\sin\theta$$

~~for nicale cristal~~

for nickle crystal $d = 0.91 A°$

$$\lambda = 2 \times 0.91 \sin 65° \quad (\text{from eq}^n (1))$$

$$= 1.65 A° \quad \text{—— (2)}$$

A/c to de Broglie hypothesis

$$\lambda = \frac{12.27}{\sqrt{V}} A°$$

$$V = 54 V$$

$$\lambda = \frac{12.27}{\sqrt{54}} A°$$

$$= 1.67 A° \quad \text{—— (3)}$$

Since the from eqn (2) and (3) wave length are very closed so davisson and germer shows experiment verify wave nature of the moving electron

Max born probability interpretation

A/c to born the probability of finding particle in the space is directly proportional to the square of the amplitude of matter wave associated with the particle at that point

let A is the amplitude of the matter wave or de brogally wave of particle at a point in the space then the probability of finding a particle at that point

$$Probability \propto A^2$$
$$Probability \propto I$$

consider small volume dv around electron space and A is the amplitude of matter waves the finding the particle in this small volume is given by :->

$$A^2 dv = I dv$$

Q The work function of c.s.m is 2.14 electron volt find

(a) threshold frequency for the csm

(b) The wave length of incident light of the photo ... is brought to zero by stopping potential

0.6
soln ϕ =
v

(b)

Q

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0.6V

soln $\phi = h\nu_0$

$\nu_0 = \frac{\phi_0}{h}$

$= \frac{2.14 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$

$= 5.16 \times 10^{14} Hz$

(b) $eV_0 = h\nu - h\nu_0$

$eV_0 = hc/\lambda - \phi_0$

$eV_0 + \phi_0 = \frac{hc}{\lambda}$

$\lambda = \frac{hc}{eV_0 + \phi_0}$

$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{1.6 \times 10^{-19} \times 0.6 + 5.16 \times 10^{14}}$ m

=

Q calculate the frequency associated with ~~the~~ a photon of energy 3.3×10^{-20} J

soln $E = 3.3 \times 10^{-20}$ J

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

$E = h\nu$

~~$E = \frac{hc}{\lambda}$~~, $\nu = \frac{E}{h}$

$= \frac{3.3 \times 10^{-20}}{6.63 \times 10^{-34}}$ Hz

Q Mono ~~chomo~~ chromatic ligh of frequency 6×10^{14} Hz is produce by a lager the power emitted is 2×10^{-3} W

(a) what is the energy of photon in the beam (b) how many photons per s on the average are emitted by the source

Soln
$P = 2\times10^{-3}$
$\nu = 6\times10^{14}\,Hz$

(a) $E = h\nu$
$= 6.63\times10^{-34}\times6\times10^{14}\,J$

(b) let, number of electrons emitted per second N is total no. of photons

$n = \frac{N}{t}$

$P = \frac{NE}{t}$

$P = nE$

$n = \frac{P}{E}$

$= \frac{2\times10^{-3}}{6.63\times10^{-34}\times6\times10^{14}}$

Q An Electron, An Alpha particle and a proton have the same K.E which of this particles has the shortest de Broglie wave length

Soln given

$KE_e = KE_\alpha = KE_p = K$ (let)

$m_e = 9.1\times10^{-31}\,kg$

$m_p = 6.67\times10^{-27}\,kg$

$m_\alpha = 4m_p = 4\times6.67\times10^{-27}\,kg$

$\lambda = \frac{h}{\sqrt{2mKE}}$

$\lambda_e : \lambda_\alpha : \lambda_p = \frac{h}{\sqrt{2m_e K}} : \frac{h}{\sqrt{2m_\alpha K}} = \frac{h}{\sqrt{2m_p K}}$

$= \frac{1}{\sqrt{m_e}} : \frac{1}{\sqrt{4m_p}} : \frac{1}{\sqrt{m_p}}$

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A ~~particle~~ wave length of the alphaparticle is shotest

Q A particle is moving three times as fast as electron the ratio of the de broglie wave length of the particle to that of the electron is 1.813×10^{-4} calculate the particles mass and ~~energy~~ & identify the particle

Soln Given

$V_p = 3V_e$

$\frac{\lambda_p}{\lambda_e} = 1.813 \times 10^{-4}$

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

$$\frac{\frac{h}{m_p V_p}}{\frac{h}{m_e V_e}} = 1.813 \times 10^{-4}$$

$$\frac{m_e V_e}{m_p V_p} = 1.813 \times 10^{-4}$$

$$\frac{m_e \times V_e}{m_p \times 3V_e} = 1.813 \times 10^{-4}$$

$$m_p = \frac{m_e}{3 \times 1.813 \times 10^{-4}}$$

$$= \frac{9.1 \times 10^{-31}}{3 \times 1.813 \times 10^{-4}}$$

$$m_p = 1.675 \times 10^{-27} \text{ Ans}$$

The particle is protone

Q. What is debrogally wavelength associated with an electron accelerated through a potential difference of 100V

Soln Given

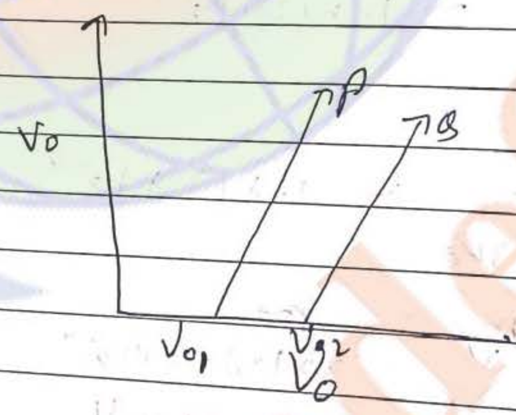
$V = 100V$

$\lambda = \frac{12.27}{\sqrt{V}} A^\circ$

$\lambda = \frac{12.27}{\sqrt{100}} A^\circ$

$\boxed{\lambda = 1.227 A^\circ}$

Q. In a given rafigare which metal P and Q have the greater work function



$V_{02} > V_{01}$

$\boxed{\phi_0 = h\nu_0}$

$\boxed{\phi_0 \propto \nu_0}$

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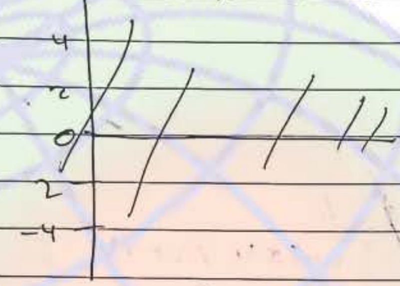
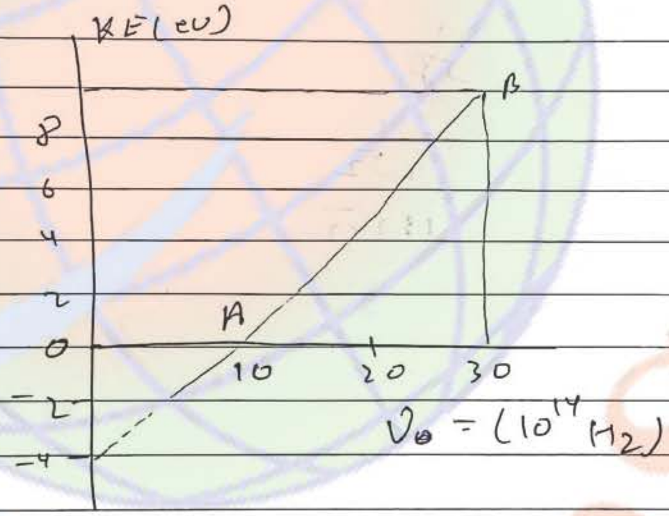
Work function of the metal ~~Q~~ is Q ~~...~~ is greater the the work function of the metal P

i) find 1st threshold frequency
ii) Work function from the following graph
iii) also find the value of plank's constant





(a) $\nu_0 = 10 \times 10^{14}$

(b) $\phi_0 = h\nu_0$

$= 6.63 \times 10^{-34} \times 10 \times 10^{14}$

$= 6.63 \times 10^{-19}\ J$

(c) $\frac{\Delta V}{\Delta \nu} = \frac{h}{e}$

$h = \frac{\Delta V e}{\Delta \nu}$

$= \frac{8 \times 1.6 \times 10^{-19}}{20 \times 10^{14} \times 10} = 6.4 \times 10^{-34}$

$\alpha = {}_4He^{+2}$

$p \to {}_1H^1$

Q. An α particle and proton are accelerated from rest through the same potential difference V find the ratio of de'broglie wavelength associated with them

Soln

$m_p = m$

$m_\alpha = 4m$

$$\lambda = \frac{h}{\sqrt{2meV}}$$

$$\lambda_p : \lambda_\alpha$$

$$\frac{h}{\sqrt{2meV}} \Big/ \frac{h}{\sqrt{2 \times 4 \times 2e \times V}}$$

$$= \frac{1}{\sqrt{8}}$$

$$= \frac{1}{2\sqrt{2}}$$

$1 : 2\sqrt{2}$

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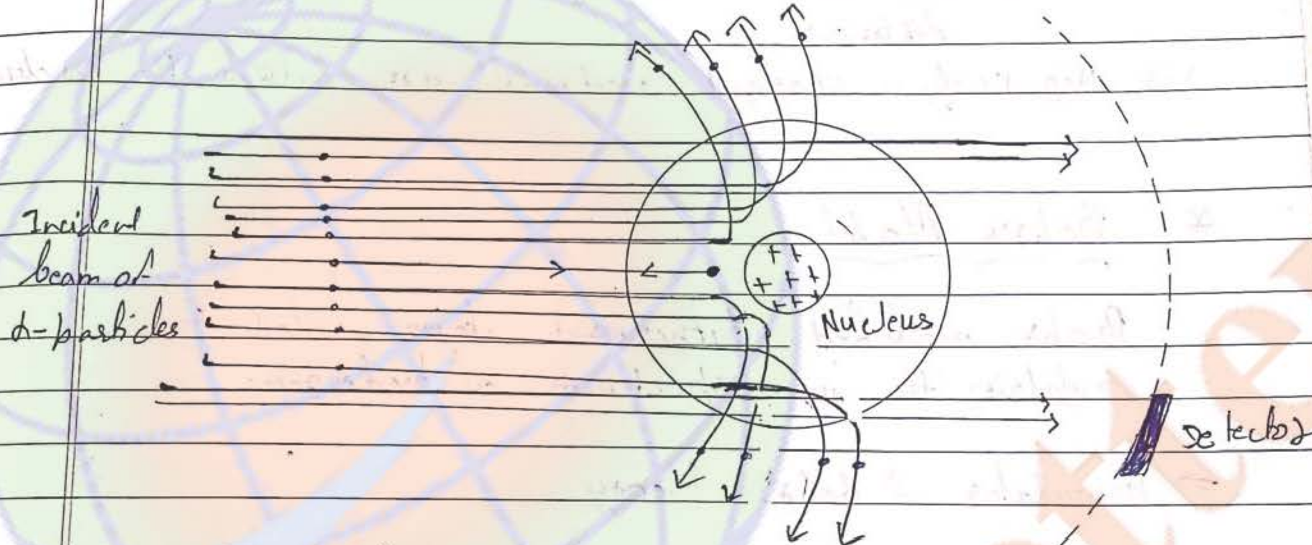
Atoms

* Rutherford α - Scattering experiment
or
Geiger - Marsden's α-particle scattering Experiment



Rutherford scattering experiment

On the suggestion of Rutherford, in 1911, his two associates, H. Geiger and E. Marsden performed an experiment by bombarding α-particles (Helium nuclei $Z=2, A=4$) on a gold foil.

Observations

i) Most of the α-particles pass through the gold foil undeflected

ii) A very small number of α-particles (1 in 8000) suffered large angle deflection; some of them retraced their path or suffered 180° deflection

Conclusion:

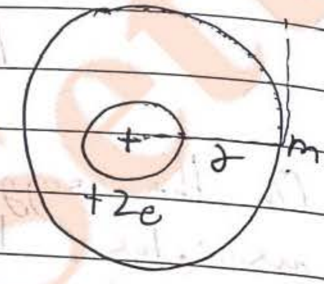
(i) Atom is hollow
(ii) Entire positive charge and nearly whole mass of atom is concentrated in a small centre called nucleus of atom.
(iii) coulombs law holds good for atomic distances
(iv) Negatively charged electrons are outside the nucleus

* Bohr's Model

Bohr modified Rutherford atom model to explain the line spectrum of hydrogen.

⇒ postulates of Bohr's theory

1) Stationary circular orbits ⇒
An atom consists of a central positively charged nucleus and negatively charged electrons revolve around the nucleus in certain obits called stationary orbits



The electrostatic coulomb force b/w the electrons and the nucleus provides the necessary centripetal force

i.e $$\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{(Ze)(e)}{r^2} \quad \text{--- (1)}$$

Where Z is the atomic number, m is the mass of electron, r_1 = radius of orbit

ii) Quantum condition ⇒ The stationary orbits are those in which angular momentum of electron is an integral multiple of $\frac{h}{2\pi}$ i.e.

$$mvr = n\frac{h}{2\pi} \qquad n = 1, 2, 3 \qquad \text{——— (ii)}$$

Integer n is called the principal quantum no. This equation is called Bohr's quantum condition.

iii) Heavy Nucleus ⇒ The nucleus is extremely massive than electron, so motion of nucleus can be neglected.

iv) Transitions ⇒ The electron does not radiate energy when in a stationary orbit. The quantum of energy (or photon) is emitted or ~~abso~~ absorbed when an electron jumps from one stationary orbit to the other. The frequency of emitted or absorbed ~~photon is~~ called photon is given by

$$h\nu = |E_i - E_f| \qquad \text{——— (iii)}$$

This is called Bohr's frequency condition

Radius of orbit and Energy of electron in orbit. Condition of Motion of ~~atom~~ electron in circular orbit is

$$\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{(Ze)(e)}{r^2} \qquad \text{——— (1)}$$

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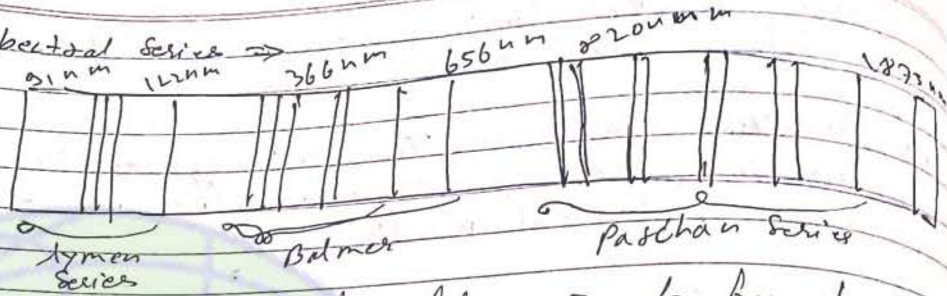
* Spectral Series =>



1) Lymen series => when electron Jump from higher energy orbit to first orbit

$n_1 = 1$ and $n_2 = 2, 3, 4$ ——

$\therefore \bar{\nu} = \frac{1}{\lambda} = R \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$\Rightarrow \bar{\nu} = R \left(\frac{1}{1^2} - \frac{1}{n_2^2}\right)$

It lies in UV region

2) Balmer series =>

$n_1 = 2$ and $n_2 = 3, 4, 5$

$\therefore \bar{\nu} = \frac{1}{\lambda} = R \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$= \bar{\nu} = R \left(\frac{1}{2^2} - \frac{1}{n_2^2}\right)$

It lies in visible region

3) Pashen series =>

$n_1 = 3$ and $n_2 = 4, 5, 6$ ——

$\therefore \bar{\nu} = \frac{1}{\lambda} = R \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$\Rightarrow \bar{\nu} = R\left(\frac{1}{3^2} - \frac{1}{n_2^2}\right)$

It lies in IR region

(4) Bracket series

$n_1 = 4$ and $n_2 = 5, 6, 7$

$\bar{\nu} = R\left(\frac{1}{4^2} - \frac{1}{n_2^2}\right)$

It lies in IR region

(5) P-fund series

$n_1 = 5$ and $n_2 = 6, 7, 8 - -$

$\therefore \bar{\nu} = \frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$= \bar{\nu} = R\left(\frac{1}{5^2} - \frac{1}{n_2^2}\right)$

It lies in a IR region.

* Distance of closest approached or ~~angle~~ size of nucleus

Ans The minimum distance up to which an energetic particle travelling directly towards the nucleus can be move before coming to rest and then retreating path is know as distance of closest approached

* Assumption ⇒

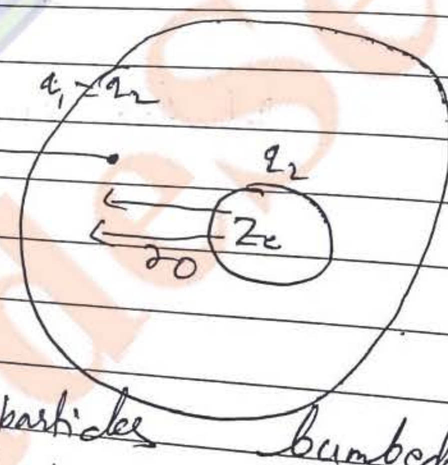
1) the scattering the because of collision b/w alpha particles and nucleus which is perfectly elastic.

2) Motion of the nucleus during embeet is not taken into consideration because it is havy

3) α-particles as well as nucleus are taken as a point charge

$\alpha = He^{+2}$

$\frac{1}{2}mv^2$



positive charge particles α-particles bumbeded towards the nucleus with velocity v and K.E is given by

$$KE = \frac{1}{2}mv^2 \quad \text{——— (1)}$$

due to electrostatics force of repulsion α-particles at rest at distance r_0 from the centre of the nucleus

$$U = \frac{k q_1 q_2}{r}$$

$$U = \frac{k \times 2e \times Ze}{r_0}$$

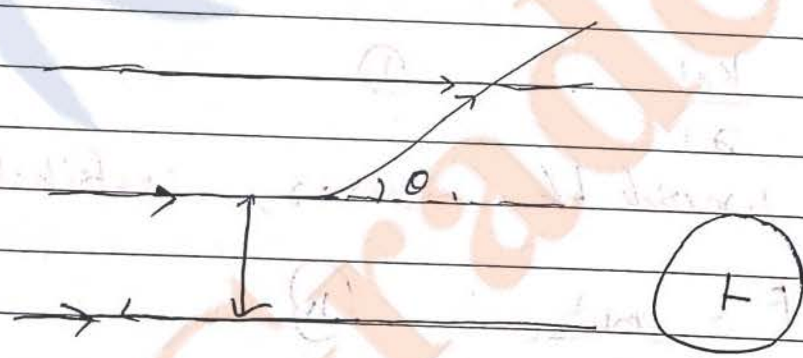
$$U = \frac{2kZe^2}{r_0}$$

This potential energy must be equal to the K.E

$$\frac{1}{2}mv^2 = \frac{2kZe^2}{r_0}$$

$$\boxed{r_0 = \frac{2kZe^2}{\frac{1}{2}mv^2}}$$

* Impact parameter ⇒ The perpendicular distance of the velocity vector of the α-particle from the centre of the nucleus when α-particle is not deflected is known as the Impact parameter
⇒ It is denoted by 'b'.



$$b = \frac{Z^2 e^2 \cot \theta/2}{4\pi\varepsilon_0 (\frac{1}{2}mv^2)}$$

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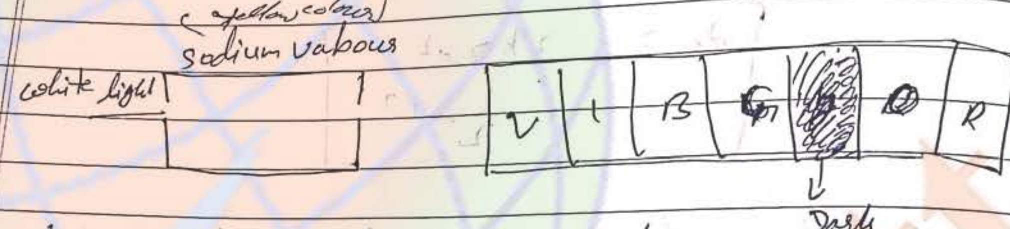
* Atomic spectrum ⇒

In each atom of the element electron jump from one energy level to another energy level produce (emites) radiation of different wave length so that produce the spectrum called atomic spectrum

* absorpation or line spectrum ⇒

when white light passes through gas or vapour the spectrum of transmitted light consists of few dark line with bright line called absorption line spectrum



* bore's theory of hydrogen atom

hydrogen atom is consist of the 1 electron and proton electron have mass m and moves with velocity v along with circular path. KE is given by

$KE = \frac{1}{2}mv^2$ electrostatics is given by

$$U = \frac{Ke^2}{r^2} \quad \text{——} \text{(I)}$$

this force provide the necessary centripetal force

$$F = \frac{mv^2}{r} \quad \text{——} \text{(II)}$$

from eq (I) and (II)

$$\frac{mv^2}{r} = \frac{ke^2}{r^2}$$

$$mv^2 = \frac{ke^2}{r} \quad \text{——— (iii)}$$

According to Bohr's atomic theory

$$mvr = \frac{nh}{2\pi}$$

where $n = 1, 2, ...$

$$v = \frac{nh}{2\pi mr} \quad \text{——— (4)}$$

Putting this value in eqn (3)

$$\frac{m n^2 h^2}{4\pi^2 m^2 r^2} = \frac{ke^2}{r}$$

$$\boxed{r = \frac{n^2 h^2}{4\pi^2 k m e^2}}$$

where $\frac{h^2}{4\pi^2 k m e^2}$ is constant

$$\boxed{r \propto n^2}$$

Radius of an orbit is directly proportional to the square of the principal quantum no.

i.e $n = 1, 2, 3$ - - - ~~so on~~

Hence ratio of radii is 1:4:

Putting the value in eqn (4)

$$v = \frac{nh \times 4\pi^2 k m e^2}{2\pi m n^2 h^2}$$

$$v = \frac{2\pi k e^2}{nh}$$

where $\frac{2\pi ke^2}{h}$ = constant

so $v \propto \frac{1}{n}$

A velocity of electron its orbit is inversely proportion to the principle quantum no.

Total energy of electron in its orbit

when electron revolved in orbit its posses both KE and potential energy

$$E = KE + PE \quad \text{——— (5)}$$

$$KE = \frac{1}{2}mv^2$$

$$KE = \frac{ke^2}{2r} \quad (\text{from eq}^n \text{ (3)})$$

electric potential energy

$$PE = \frac{ke \times -e}{r}$$

$$PE = \frac{-ke^2}{r}$$

Putting these value in eq^n (5)

$$E = \frac{ke^2}{2r} - \frac{ke^2}{r}$$

$$E = \frac{-ke^2}{2r}$$

$$E = \frac{-ke^2 \times 4\pi^2 kme^2}{2n^2 h^2}$$

$$E = \frac{-2\pi^2 k^2 me^4}{n^2 h^2}$$

$K = 9 \times 10^9 \; Nm^2/C^{-2}$

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

$m = 9.1 \times 10^{-31} kg$

$h = 6.63 \times 10^{-34} J/s$

$$E = \frac{-2\pi^2 k^2 m e^4}{n^2 h^2}$$

$$E = \frac{-2 \times (3.14)^2 \times (9 \times 10^9) \times 9.1 \times 10^{-31} \times (1.6 \times 10^{-19})^4}{n^2 (6.63 \times 10^{-34})^2}$$

$$E = \frac{-2.17 \times 10^{-18}}{n^2}$$

eV

$$E = \frac{-2.17 \times 10^{-18}}{n^2 \times 1.6 \times 10^{-19}} \; eV$$

$$E = \frac{-13.6}{n^2} \; eV$$

* energy level

$$E = \frac{-13.6}{n^2} \; eV$$

when $n = 1$ (ground state)

negative sign show that electron bounded with the nucleus.

$$E = \frac{-13.6}{1^2} \; eV$$

$E_1 = -13.6 \; eV$

when $n = 2$

$$E_2 = -\frac{13.6}{4} \; eV$$

$= -3.4 \; eV$

when $n = 3$

$$E_3 = \frac{-13.6}{9} \text{ eV}$$

$$E_3 = -1.51 \text{ eV}$$

when $n = 4$

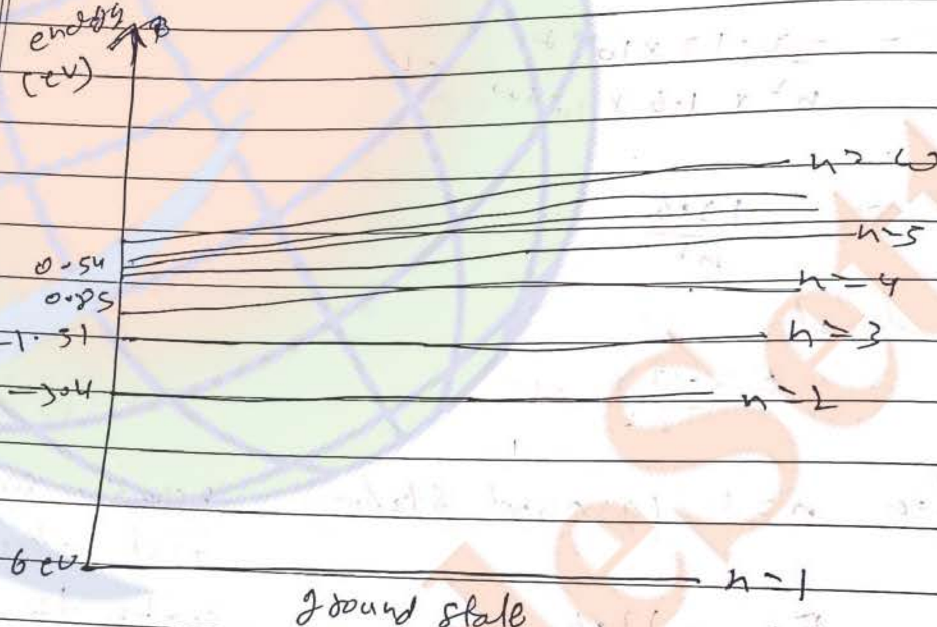
$$E_4 = \frac{13.6}{16}$$

$$= -0.850 \text{ eV}$$

when $n = 5$

$$E_5 = \frac{13.6}{25}$$

$$= -0.34 \text{ eV}$$



line spectrum of hydrogen atom

According to bohr's atomic theory when electron jump from high energy level to the lower energy level it is radiate energy

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in form of photon

$$h\nu = E_{nf} - E_{ni}$$

Where

$$E_{ni} = \frac{-2\pi^2 k^2 me^4}{n_i^2 h^2}$$

$$E_{nf} = \frac{-2\pi^2 k^2 me^4}{n_f^2 h^2} + \frac{2\pi^2 k^2 me^4}{n_i^2 h^2}$$

$$\frac{hc}{\lambda} = \frac{-2\pi^2 k^2 me^4}{h^2} \left[\frac{1}{n_i^2} - \frac{1}{n_f^2} \right.$$

$$\frac{1}{\lambda} = \frac{2\pi^2 k^2 me^4}{ch^3} \left[\frac{1}{n_i^2} - \frac{1}{n_f^2} \right.$$

where $\frac{2\pi^2 k^2 me^4}{ch^3} = R = 1.097 \times 10^7 m^{-1}$

called Rydberg constant

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

$$\bar{\nu} = R \left[\frac{1}{n_i^2} - \frac{1}{n_f^2} \right.$$

$\bar{\nu}$ = wave number.

* hydrogen spectrum and spectral =>
when electron jumps from high energy level to low energy level it emits the radiation of different wave length called spectral lines

1) Limen series ⇒
When the spectral line emitted due to the transition of an electron from any order orbit $n_i = 2, 3, 4$
2 first orbit
$n_f = 1$
from a spectral series called spectral lines called limen series

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

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

largest wave length

$$\frac{1}{\lambda_{max}} = R\left[1 - \frac{1}{2^2}\right]$$

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

$$\lambda_{max} = \frac{4}{3}R$$

$$\lambda_{max} = \frac{4}{3 \times 1.097 \times 10^7}$$

$= 1215 A^\circ$

Smallest wave length $n = \infty$

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

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

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

$$\lambda_{min} = \frac{1}{1.097 \times 10^{-7}}$$

$= 911 A^\circ$

liman Series lies in a ultra voilet ~~reg~~ resion

II) balmer Series ⇒ The spectral lines form due to transition of elatron from any ~~otor~~ outer orbit ~~or~~ $n_i = 3, 4$ — — to the second orbit $(n_f = 2)$ is know as balmer series

$$n_i = 3, 4 \text{ — —}$$
$$n_f = 2$$

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

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

$$\lambda_{max} = 6559\, A^o$$
$$\lambda_{min} = 3644\, A^o$$

Balmer Series lies in a Vesiable region

III) Paschen Series ⇒ The spectral lines form due to transition of electron from any oter orbit $n_i = 4, 5, 6$ — — to the third orbit is know as paschen series

$$n_i = 4, 5, 6 \text{ — —}$$
$$n_f = 3$$

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

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

$$\lambda_{min} = 1874\, A^o$$
$$\lambda_{max} = 8199\, A^o$$

Paschen series lies in a ~~in~~ intra-rayes region

iv) Brackett series ⟹ The spectral line from due to transition of electron from any outer orbit $n = 5, 6$ — to the forth orbit is know as brackett series

$n_i = 5, 6$ ——

$n_f = 4$

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

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

$\therefore \lambda_{max} = 40589 A^\circ$

$\lambda_{min} = 14576 A^\circ$

v) Pfund series ⟹ The spectral line from due to transition of electron from any outer orbit $n = 6, 7$ — to the fifth orbit is know as Pfund series

$n_i = 6, 7$ ——

$n_f = 5$

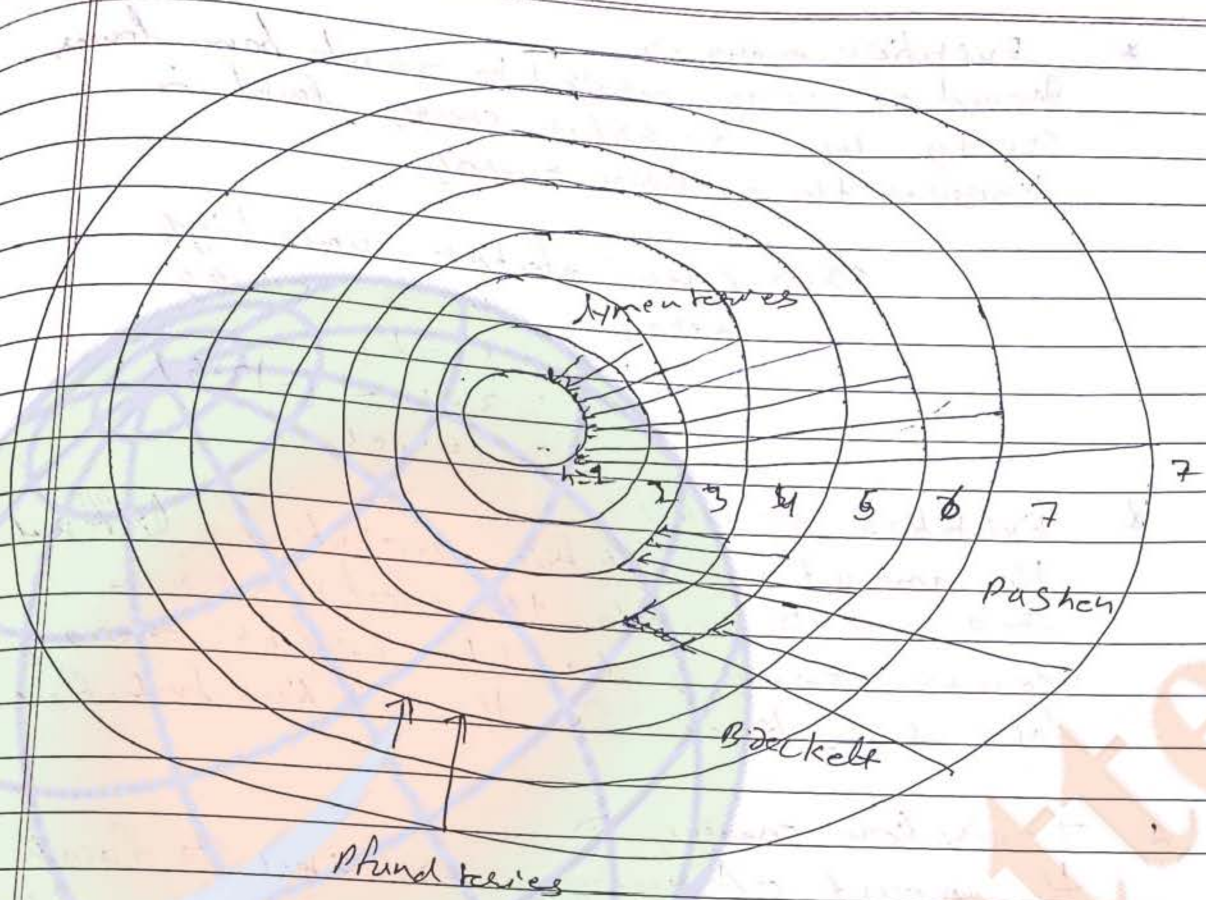
$$\frac{1}{\lambda} = R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

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

$\lambda_{max} = 74536 A^\circ$

$\lambda_{min} = 22775 A^\circ$

These line in a lare infraray region


Lymen series
n=1
2
3
4
5
6
7
7
Pashen
Brackett
Pfund series


n=7
n=6
n=5
n=4
n=3
Paschen
series
n=2
Balmer
series
n=1

* Exitation energy => required to jump from lower
Amount of energy required to jump from lower energy level to higher energy level is knows the exitation energy

eg => when electron jumps high energy to lower energy

$E = E_2 - E_1$
$= 3.4 - (-13.6)$
$= 10.2eV$

* Exitation potential
the amount of electric potential different required to jump the electron from lower energy level to higher energy level is know as the exitation potential

* Ionisation energy =>
the amount of energy required to decate the electron from the atom is know as the ionisation energy

* Ionisation potential =>
the potential difference required to decate the electron from the atom is know as the ionisation potential

* debrogally explanation to bore's second postulate of quantisation

The second posutate to bohr's atomic model is $mvr = \frac{nh}{2\pi}$ where $n = 1, 2$ ...

A/c to deBrogally the electron its orbit is particles in waves we know that when stringes fixed to end is plucked is large no. of waves are exicated. standing wave forms when total distance travel by a wave down and back is integrale multiple ~~hence~~ distance cover equal to

hence, distance covered = $2\pi r_n$

i.e $2\pi r_n = n\lambda$ ——— (1)

~~but~~ A/c to de Brogally

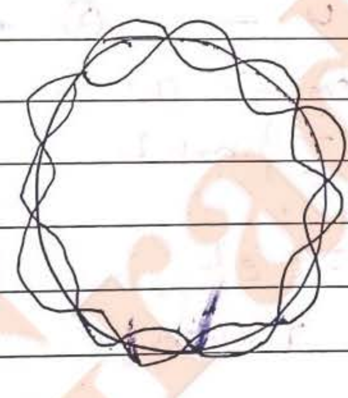
$$\lambda = \frac{h}{mv}$$

$$\therefore 2\pi r_n = \frac{nh}{mv_n}$$

$$mv_n r_n = \frac{nh}{2\pi}$$

Angular momentum at nth = $\frac{nh}{2\pi}$

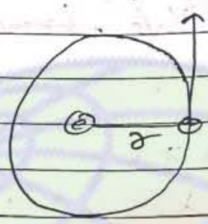
This is 2nd postulates of the Bor's



$$mvr = \frac{nh}{2\pi}$$

* Electron orbit ⇒

let an electron revolve with velocity v in its orbit that provide the electrostatics force of attraction necessary centripetal force



$$F_c = F_e$$

$$\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0} \times \frac{e \times e}{r^2}$$

$$mv^2 = \frac{e^2}{4\pi\varepsilon_0 r} \quad \text{—— (1)}$$

$$v = \sqrt{\frac{e^2}{4\pi\varepsilon_0 m r}}$$

$$r = \frac{e^2}{4\pi\varepsilon_0 m v^2}$$

When electron revolves in orbit possesses both K.E as well as potential energy

$$K = K.E + U \quad \text{—— (2)}$$

K.E of electron is given by

$$KE = \frac{1}{2}mv^2$$

$$KE = \frac{e^2}{2 \times 4\pi\varepsilon_0 r} \quad (\text{from eqn (1)})$$

$$KE = \frac{e^2}{8\pi\varepsilon_0 r} \quad \text{—— (3)}$$

Electric potential energy

$$U = \frac{1}{4\pi\varepsilon_0} \frac{q_1 \times q_2}{r}$$

$$U = \frac{e \times -e}{4\pi\varepsilon_0 r}$$

$$U = \frac{-e^2}{4\pi\varepsilon_0 r} \quad \text{——— (4)}$$

Putting value of KE and U in eqn (2)

$$E = \frac{e^2}{8\pi\varepsilon_0 r} - \frac{e^2}{4\pi\varepsilon_0 r}$$

$$E = \frac{e^2 - 2e^2}{8\pi\varepsilon_0 r}$$

$$\boxed{E = \frac{-e^2}{8\pi\varepsilon_0 r}} \quad \text{——— (5)}$$

A negative sign show that electron bonded with the nucleus

eqn (5) / eqn (3)

$$\frac{E}{KE} = \frac{\frac{-e^2}{8\pi\varepsilon_0 r}}{\frac{e^2}{8\pi\varepsilon_0 r}}$$

$$\boxed{E = -K.E}$$

eqn (5) / eqn (4)

$$\frac{E}{U} = \frac{\frac{-e^2}{2 \cdot 8\pi\varepsilon_0 r}}{\frac{-e^2}{4\pi\varepsilon_0 r}}$$

$$\frac{E}{U} = \frac{1}{2}$$

$$\boxed{E = \frac{1}{2} U}$$

Note

i) Total energy of an electron is equal to the negative of the K.E

ii) Total energy possess by in a electron in hydrogen atom its orbit is half of the electric potential energy

Q. It is formed experimentally that 13.6 eV energy is required to separated a hydrogen atom into a proton and electron. Compute the orbital radius and velocity of an electron in a hydrogen atom

Soln Given

$E = 13.6\ eV$

$= 13.6 \times 1.6 \times 10^{-19}\ J$

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

$r = ?$ $v = ?$

$$E = \frac{e^2}{8\pi\varepsilon_0 r}$$

$$r = \frac{e^2}{8\pi\varepsilon_0 E}$$

$$= \frac{(1.6 \times 10^{-19})^2 \times 9 \times 10^9}{2 \times 13.6 \times 1.6 \times 10^{-19}}$$

$$= \frac{1.6 \times 10^{-19} \times 9 \times 10^9}{2 \times 13.6}$$

$$= \frac{1.6 \times 9 \times 10^{-10}}{27.2}$$

$$= 5.3 \times 10^{-11} m$$

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$$v = \sqrt{\frac{e^2}{4\pi\varepsilon_0 m r}}$$

$$v = \frac{e}{4\pi\varepsilon_0 m r}$$

$$v^2 = \frac{e^2}{4\pi\varepsilon_0 m r}$$

$$= \frac{(1.6\times10^{-19})^2 \times 9\times10^{9}}{9\times10^{-31}\times5.3\times10^{-11}}$$

$$v = 2.2\times10^{6}\ m/s$$

Q A/c to classical electro magnetic theory comblete the initialfreauency of the light emitted by the electron revolving

$$T = \frac{\text{circumference}}{\text{speed}}$$

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

$$\frac{1}{T} = \frac{v}{2\pi r}$$

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

$$= \frac{2.2\times10^{6}}{2\times3.14\times5.3\times10^{-11}}\ Hz$$

$$= 3.6\times10^{15}\ Hz$$

Q A 10kg satalight circules or ones avery two hours in an orbit having a radius of 8000 km assuming that bore's angular momentum postulate - applying a sattelite it just as over electron in a hydrogen atom. find quantum no. orbit and the satalight

Soln

$m = 10kg$

$r = 8000km$

$= 8 \times 10^6 m$

$T = 2hr$

$= 2 \times 3600 sec$

$$mvr = \frac{nh}{2\pi}$$ ——— (1)

$$n = \frac{2\pi mvr}{h}$$

~~T =~~ circumference

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

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

Putting this value in eq^n (1)

$$n = \frac{2\pi mr}{h} \times \frac{2\pi r}{T}$$

$$n = \frac{(2 \times 3.14)^2 \times 10 \times (8 \times 10^6)^2}{6.63 \times 10^{-34} \times 2 \times 3600}$$

$$\simeq 5.3 \times 10^{45}$$

Q. Using the rydberg formula calculate the wave length of the 1st 4 spectral line in the lymen series in ~~of~~ the hydrogen spectrum

Soln Given

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

$n_f = 1$

$n_i = 2, 3, 4, 5$

$$\frac{1}{\lambda_1} = 1.097 \times 10^7 \left(\frac{1}{1} - \frac{1}{4}\right)$$

$$\frac{1}{\lambda_1} = \frac{1.097 \times 10^7 \times 3}{4}$$

$$= \frac{4}{3 \times 1.097 \times 10^7}$$

$$\lambda_1 = 1218 A^{\circ}$$

Q 12.5 the ground state of the hydrogen atom is -13.6 electron volt (ev) what are the kenetic and potential energy of the electron this

soln

$$E = -13.6 eV$$

$$KE = -E$$

$$= +13.6 eV$$

$$E = \frac{1}{2} U$$

$$U = 2E$$

$$U = 2 \times -13.6$$

$$= -27.2 eV$$

Ch → 13

Nuclei

* 1 amu ⇒ 1/12 part of the mass of an C_{12} carbon atom

⇒ 1 mole of C_{12} carbon atom = ~~equal to~~ 12 gram

⇒ 6.022×10^{23} C-12 atom = 12g

⇒ mass of 1 C-12 atom $= \frac{12}{6.022 \times 10^{23}}$ g

⇒ $1\ amu = \frac{1}{12} \times \frac{12}{6.022 \times 10^{23}}$

$= \frac{1}{6.022 \times 10^{23}}$

$= 1.66 \times 10^{-24}$ g

1.66×10^{-27} kg

* Mass energy equivalent ⇒

A/c to ~~Einsteins~~ einstein equation of mass energy

$E = mc^2$

$E = 1.66 \times 10^{-27} \times (3 \times 10^{8})^2$

$E = 1.66 \times 10^{-27} \times 9 \times 10^{16}$

$E = 1.494 \times 10^{-11}$ J

In electron volt (eV)

$E = \frac{1.494 \times 10^{-11}}{1.602 \times 10^{-19}}$

$= 931.25 \times 10^{6}$ eV

In MeV

$\boxed{E = 931.25\ MeV}$

Mass of proton $= 1.629 \times 10^{-27}$ kg
mass of Neutron is $= 1.6749 \times 10^{-27}$ kg

* ~~Nucleied~~ Nuclide ⇒ Atoms present of proton and neutron is nucleus is called Nuclide

* Isotopes ⇒ An Atoms of an element having same atomic number but different mass no. are called isotopes

eg ⇒ $_1H^1$, $_1H^2$, $_1H^3$

$_2He^3$, $_2He^4$

$_{17}Cl^{35}$ $_{17}C^{37}$

* Friction mass ⇒ Friction mass present an element due to the presence of the isotopes anatomes

let an element have an ~~no.~~ n no. of isotopse having mass no. ~~u, u~~ u_1, u_2 —— u_n present, k_1 %, k_2 % —— k_n %

$$\text{Friction mass} = (u) = \frac{u_1k_1 + u_2k_2 - - u_nk_n}{k_1 + k_2 - - + k_n}$$

$k_1 + k_2 + $ —— k_n

* Isobare ⇒ Atoms of ~~an de~~ different element have the same mass no. but different atomic no. are called isobar

eg => $_1H^3$, $_2He^3$
$_8O^{15}$, $_7N^{15}$

* Isotones => Atoms of different element have same no. of neutrone called isotone
eg => i) $_8O^{16}$, N^{15}
ii) $_1H^3$ $_2He^4$

Q Find the pair of isotopes, isobar and isotone in a following $_{39}X^{81}$ $_{39}X^{80}$ $_{40}Z^{82}$

Ans i) isotopes = $_{39}X^{81}$ $_{39}X^{80}$

2) isobar = $_{39}X^{81}$ $_{40}X^{81}$

3) Isotone = $_{39}X^{80}$ $_{40}Z^{81}$

Exercise 13.1

Solⁿ
$x_1 = 7.5\%$
$x_2 = 92.5\%$
$u_1 = 6.015$
$u_2 = 7.01000$

$$u = \frac{u_1 x_1 + u_2 x_2}{x_1 + x_2}$$

$$= \frac{6.01572 \times 7.5 + 7.01000 \times 92.5}{7.5 + 92.5}$$

$$= 6.941\ u$$

Size of Nucleus ⇒

A volume of the Nucleus is directly proportional to the mass no.

$V \propto A$

$\frac{4}{3}\pi R^3 \propto A$

$R^3 \propto A$

$$\boxed{R = R_0 A^{1/3}}$$

Where R_0 is know as empirical constant

$$\boxed{R_0 = 1.2 \times 10^{-15} m}$$

Q Calculate the Radius of nucleus of mass no. 8

$A = 8$

$R = R_0 A^{1/3}$

$R = 1.2 \times 10^{-15}\, 8^{1/3}$

$R = 2.4 \times 10^{-15} m$.

Nuclear Density ⇒ Mass of the nucleies present in nucleus per unit volume is know as the nuclear density

$$\rho = \frac{M}{V}$$

Mass of proton = Mass of ~~netron~~ neutron

M = Mass of proton + Mas of neutron

$= Zm + m(A - Z)$

$= Zm + mA - Zm$

$M = mA$

$$V = \frac{4}{3}\pi R^3 \quad [R = R_0 A^{1/3}]$$

$$V = \frac{4}{3}\pi R_0^3 A$$

$$\rho = \frac{mA}{\frac{4}{3}\pi R_0^3 A}$$

$$= \frac{3 \times 1.66 \times 10^{-27}}{4 \times 3.14 \times (1.2 \times 10^{-15})^3}$$

$$= 2.38 \times 10^{17}\ kg/m^3$$

Density of the nucleus of atom is constant A does not depends on the mass no.

* Mass Energy or law of conservation of mass energy

A/c to einstein

$$E = mc^2 \quad \text{--- (1)}$$

If Rest mass of the body be m_0 and K.E is 'T' then total energy is given by

$$E = m_0c^2 + T \quad \text{--- (2)}$$

from eqn (1) and (2)

$$m_0c^2 + T = mc^2$$

$$T = mc^2 - m_0c^2$$

$$T = (m - m_0)c^2$$

$$\boxed{T = \Delta mc^2}$$

change of mass is equal to the converted into the K.E

V.V.I
* Mass defect ⇒ The difference b/w the mass of the constituent nucleons of the nucleus in the free state and mass of the nucleus is know as mass defect
⇒ It is denoted by Δm

consider as an atom mass no. A and Atomic no. Z
no. of proton = Z
" " neutron = (A-Z)
if mass of the each proton and neutron be m_p and m_n

Total mass of constituent nucleons is given by
$Zm_p + (A-Z)m_n$
If mass of the nucleus be M then mass defect is given by

$$\Delta m = Zm_p + (A-Z)m_n - M \quad \text{——— (1)}$$

* Binding energy ⇒ Total energy the required to separate the nucleons at ~~inf~~ infinite distance apart from the nucleus so that they may not interact with each other is know as the binding energy
This binding energy is equivalent to the mass defect i.e is given by

$BE = \Delta mc^2$

$BE = [Zm_p + (A-Z) m_n - M) c^2$

Here Δm is in atomic mass unit so energy equival in mega electron valent is given by

$BE = (Zm_p + (A-Z) m_n - M) \times 931.25 MeV$

Binding energy per nucleon ⇒

The average energy required to relase a nucleon from the nucleus is called binding energy per nucleon.

$$\frac{\text{Binding energy (BE)}}{\text{Nucleon}} = \frac{\text{Binding energy}}{\text{Total no. of nucleon}}$$

Binding energy per neucleon determine the stability of the nucleus which is directly proportional to the binding energy per nucleon

Construction ⇒ The variation of binding energy per neucleon and mass no. of curves gives

1) Average binding energy of light nucleic likes ^1H, ^2H, ^3H is small average for mass numbers ranging from ~~2 20~~ 2 to 20 there are sharp define ~~peac~~ peaks corresponding to ~~He_{24}, C_{12}, O_{16}~~ ^{24}H, ^{12}C, ^{16}O

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this nucleus are more stable than naver nuclei

iii) binding energy per neuclon of the intermeadet neuclei range 30 to 120 corresponding to average binding energy per neuclon 8.5 maga electron volt (above the 8 MeV) in which iron nuclei has binding energy per nucleon is 8.8 MeV

iv) As the mass no. of increasses the binding energy per neuclon graguelly decrasses foals up to 7.6 MeV of ^{238}U neurdi nuclei

Conclusion ⇒

1) When havy unstable nuclei moves with the stable nuclei than they well gain binding energy and hence relase of energy this indicates that energy can be relase when havy nuclei brake into two or more nuclei called nuclear fission

When we move from lighter nuclei to heavier nuclei we gain find that there we well gain in the over all binding energy and hence relase of energy this indicates that energy can be relased when two or more lighter nuclei fuses together to form a heavier nuclei this processes is know as fission

Graph

* Packing fraction ⇒ mass defect per unit nucleon
Mass excess or mass defect fraction
is know as the packing fraction

$$\text{Packing fraction} = \frac{\text{Mass defect}}{\text{Mass number}} = \frac{M-A}{A}$$

Packing fraction so the stabily of the nucleus
it is universealy proportional to packing
fraction

* Nuclear force ⇒
an attractive force acts b/w the two nucleons
is know as the nuclear force

* Characterstatics of the nuclear force :→
i) It is undependent of charge
ii) It is strongest ~~force~~ force and nature its

π^+ - meason = electron
π^- - meason => Proton
π^0 - meason => Nutron

magnitude is 100 times of the electrostatic force and 10^{38} time than the gravitational force

iii) It is a short range force (10^{-15} m)

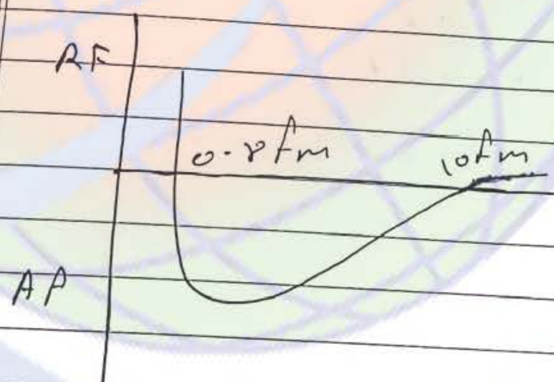
iv) Nuclear force is spin dependent - It has been observe that the nuclear force b/w the nucleons having parallel spin is grater than the force b/w nucleons having anti parallel spin thes they as spin dependent

v) Nuclear force is saturated force

vi) Nuclear force is non-central force

vii) Nuclear force is exchange force it arise due to the exchange of π meason b/w the nucleons

viii) Nuclear force has small component of repulsive force



Nuclear force arise due to π meason :->

1) π^+ - Meason it acts b/w the Proton
2) π^- - meason it acts b/w the electron
3) π^0 - meason it acts b/w the neutron

13.3) Obtained a binding energy in mega electron volt of nitrogen nucleus ($_7N^{14}$) also find the binding energy per nucleon

$m(_7N^{14}) = 14.003074$

Soln

$A = 14, \quad Z = 7$

$M = 14.003074$

$m_H = m_p = 1.0078254$

$m_n = 1.0086654$

$BE = [Zm_p + (A-Z)m_n - M] \times 931$

$= (7 \times 1.007825 + 7 \times 1.0086654 - 14.00307) \times 531$

$= 0.11243 \times 931$ MeV

$= 104.67$ MeV

$\frac{BE}{nucleon} = \frac{104.67}{14}$

$= \frac{104.67}{14}$

H.W Exs
13.4, 13.5

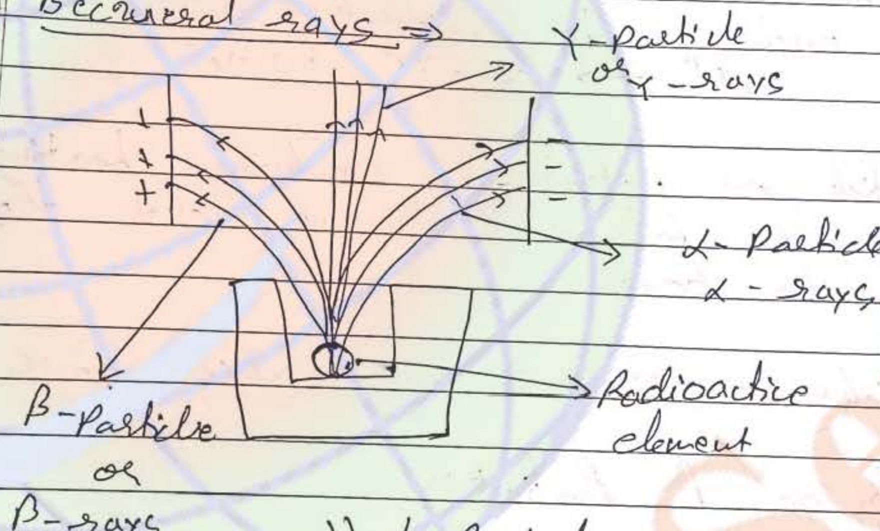
* Radio - activity

The Phenomeanen of contanies emesion of radiation by havy element is called radio activity

* Radio-active element ⇒

The element which shoes the Radio active element are called Radio-active element

* Beccurveral rays ⇒



1) α-Particle
2) β — ''
3) γ — ''

* Properties of α-Particle ⇒

An α-Particle is equivalent to the helium nucleus consists of two proton and two neutrons

He^{2+}

they have positive charge +2e
they are emitted with velocity ranging b/w 1.4×10^7 m/s to 2.2×10^7 m/s

They are deflecatice by electric and magnetic field

They cause fluorescence
They have low preatanting power
They have rest mass equal to four times
the mass of Proton.
they have high energing power
they have slightly effect the photographic plate
The emmision of α-Particle from a radio
active nucleus is represented by
$_ZX^A \rightarrow {}_{Z-2}Y^{A-4} + {}_2He^4$

α-Particle are capable of producing heating
effect when fale on a substance and they
cause skin bones

α-Particles are scated by matalice foils

2) Property of β-Particle :-
i) It is a fast moving electron
ii) It is a negatively charge equal to charge
on electron
iii) It rest mass is equal to the rest mass on
electron
iv) Its velocity is 2.97×10^8 m/s
v) It is deflecated in electric and magnetic
field
vi) It cause fluorescence
vii) It energing power is about 1/100 times
the energing power of α-Particle

viii) It ~~magre~~ piercing power is more than α-Particle

ix) It effect the photography of plate

x) The emission of β-Particle is given by

$$_{Z}X^{A} \longrightarrow _{Z+1}Y^{A} + _{-1}e^{0} + \bar{\nu}$$

3) ~~*~~ Property of γ-Particle ⇒

i) It is a packet of energy of electromagnetic radiation

ii) It have no charge

iii) It rest mass is zero

iv) It speed is 3×10^{8} m/s in vaccume

does not deflecative reflecative and magnetic field

vi) It ionising power is 1/100 by the β-particles

vii) Its ~~past~~ piercing power is 100 times in β-particle

viii) It effect at the photography

ix) It causes ~~does~~ fluorescence

emission of γ-rays is given by

$$_{Z}X^{A} \longrightarrow _{Z}X^{A} + \gamma\text{-ray}$$

~~*~~ laws of radio active ~~so~~ decay or dis radiation ⇒

i) Radio activy dica is espontanies processes and is not effected by the eternal condition such as temp, pressure etc.

ii) When a radio active elements decays by emiting an α-Particle the position of daugher element is down by two Placesses in a prodic table.

$_{Z}X^{A} \longrightarrow {}_{Z-2}Y^{A-4} + {}_{2}He$

Parent element — daughter element.

iii) when a radio active element decayed by emiting a β particle the possion of daughter element is rate by one position place in of periodic table.

$_{Z}X^{A} \longrightarrow {}_{Z+1}Y^{A} + {}_{-1}e^{0} + \bar{\nu}$

Parent element — daughter element

iv) When radio active element decayed by emiting a γ-rays it position remains same in a periodic table

$_{Z}X^{A} \longrightarrow {}_{Z}X^{A} + \gamma\text{-rays}$

P — ground state

v) The rate of this integration of a radio-active substance is directly proportional to the no. of atoms remains undecate in the substance this law is called radio active decay law or dice integration

* Mathematical form of decay law ⟹

Let radio active elements initially N_0 $(t=0)$ and N_0 after the time 't' elems remains un decate

a/c to law of dis-integration

$$\frac{dN}{dt} \propto N$$

$$\frac{dN}{dt} = -\lambda N \quad \text{—— (1)}$$

Where λ is know as decay decay constant ~~or~~ dice integration constant

~~do~~ Integrating

$$\frac{dN}{N} = -\lambda\, dt$$

Integrating both side

$$\int \frac{dN}{N} = -\lambda \int dt$$

$$\log_e N = -\lambda t + C \quad \text{—— (2)}$$

Where C is a integration constant

when $t = 0$ $N = N_0$

$$\log_e N_0 = -\lambda \times 0 + C$$

$$\therefore C = \log_e N_0$$

Putting this value in eqn (1)

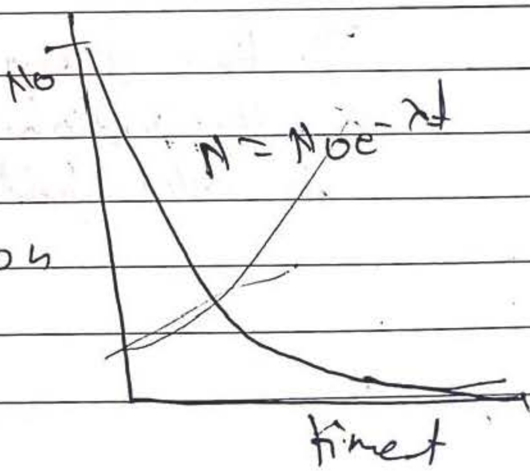
$$\log_e N = -\lambda t + \log_e N_0$$

$$\log_e N - \log_e N_0 = -\lambda t$$

$$\log_e \frac{N}{N_0} = -\lambda t$$

$$\boxed{\frac{N}{N_0} = e^{\lambda t}}$$

$$\boxed{N = N_0 e^{-\lambda t}}$$



This is know as

The exponential decay expression or ~~exp~~ equation

* decay constant ⇒ from exponential decay equation ⇒

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

when $t = \frac{1}{\lambda}$, $\lambda = \frac{1}{t}$

$N = N_0 e^{-\frac{1}{t} \times t}$

$N = N_0 e^{-1}$

$N = \frac{N_0}{e}$

$N = \frac{N_0}{2.718}$

$N = 0.36779\ N_0$

$N = 36.779\ \%$ of N_0

$\boxed{N = 36.8\ \% \text{ of } N_0}$

Radioactive decay constant is the reciprocal of the time during which no. of atmos in the radiactive substance reduces to 36.8 % of the original no. of atoms

Its SI unit is $= m^{-1}$
another unit = Day^{-1}, year^{-1}, min^{-1}, hour^{-1}

* half life radioactive Substance :⇒

The time during which half of the atoms of the radioactive substance is ~~dist~~ disintegrate is called half life of a radioactive substance

* From the exponential decay ~~expn~~ (eqation)

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

$$t = T_{\frac{1}{2}} = T$$

$$N = \frac{N_0}{2}$$

Putting these value in eqn (1)

$$\frac{N_0}{2} = N_0 e^{-\lambda t}$$

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

Taking $\log_e$ both side

$$\log_e \frac{1}{2} = \log_e e^{-\lambda t}$$

$$2.303 \log_{10} \frac{1}{2} = -\lambda T$$

$$2.303 \left[\log_{10} 1 - \log_{10} 2\right] = -\lambda T$$

$$2.303 \times -0.301 = -\lambda T$$

$$0.693 = \lambda T$$

$$T = \frac{0.693}{\lambda}$$

for first half life $= \frac{N_0}{2}$

for 2nd half life $= \frac{N_0}{2 \times 2} = N_0 \left(\frac{1}{2}\right)^2$

for 3rd half life $= N_0 \left(\frac{1}{2}\right)^3$

for nth half life $= N_0 \left(\frac{1}{2}\right)^n$

$$\boxed{N = N_0 \left(\frac{1}{2}\right)^n}$$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$$

$$n = \frac{t}{T}$$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T}$$

* activity of radioactive substance ⇒
The rate of dis integration of radioactive substance is known as activity of radioactive substance

from the exponential decay equation

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

diff w.r to t

$$\frac{dN}{dt} = -\lambda N_0 e^{-\lambda t}$$

$$A = \left|\frac{dN}{dt}\right|$$

$$A = \lambda N_0 e^{-\lambda t} \quad \text{——— (1)}$$

when $t = 0$ $A = A_0$

$$A_0 = \lambda N_0 \cdot e^0$$

$$A_0 = \lambda N_0$$

Putting this value in eqn (1)

$$A = A_0 e^{-\lambda t}$$

$$\frac{A}{A_0} = e^{-\lambda t} \quad \text{——— (2)}$$

~~N = No e^{-λt}~~

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

$$\boxed{\frac{N}{N_0} = e^{-\lambda t}} \quad \text{——— (3)}$$

from (2) and (3)

$$\frac{A}{A_0} = \frac{N}{N_0}$$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T}}$$

$$\boxed{\frac{A}{A_0} = \left(\frac{1}{2}\right)^{\frac{t}{T}}}$$

Note –

$$N = N_0 e^{-\lambda t}$$
$$A = A_0 e^{-\lambda t}$$
$$\frac{A}{A_0} = e^{-\lambda t}$$
$$\frac{N_1}{N_0} = e^{-\lambda t}$$

* <u>Average life or mean life ⇒</u>

The ratio of the sum of the live atom to the ~~total~~ total no. of atom is known as mean life or average life.

$$T_{av} = T_m = \frac{\text{Sum of lives atom}}{\text{total no. of atom}}$$

From the exponential decay equation

$w = No\, e^{-\lambda t}$

diff wr.t t

$\frac{dN}{dt} = -\lambda\, No\, e^{-\lambda T}$

$|dN| = -\lambda\, No\, e^{-\lambda t} \cdot dt$

Sum of lives atom $= \int_0^{No} t\, |dN|$

$= \int_0^{\infty} t\, \lambda\, No\, e^{-\lambda t}\, dt$

$= \lambda No \int_0^{1} t\, e^{-\lambda t}\, dt$

$\left[\int uv\, du = u \int v\, dx - \int \left[\frac{du}{dx} \int v\, dx \right] dx \right.$

$= \lambda No \left[t \int_0^{\infty} e^{-\lambda t}\, dt - \int_0^{\infty} \left[\frac{dt}{dt} \int e^{-\lambda t} dt \right] dt \right.$

$= \lambda No \left[\left(\frac{t\, e^{-\lambda t}}{-\lambda} \right)_0^{\infty} + \frac{1}{\lambda} \int_0^{\infty} e^{-\lambda t}\, dt \right.$

$= \frac{\lambda No}{\lambda} \left[0 - \frac{1}{\lambda} \left(e^{-\lambda t} \right)_0^{\infty} \right]$

$= No \left[-\frac{1}{\lambda} \left(e^{\infty} - e^{0} \right) \right]$

$= No \left[-\frac{1}{\lambda} \times (0 \cdot 1) \right]$

$$= \frac{N_0}{\lambda}$$

Sum of total lives atom $= \frac{N_0}{\lambda}$

$$T_{av} = \frac{\frac{N_0}{\lambda}}{N_0}$$

$$T_{av} = \frac{1}{\lambda}$$

* Relation b/w the half life and average life

$$T_{\frac{1}{2}} = \frac{0.6931}{\lambda}$$

$$T_{av} = \frac{1}{\lambda}$$

$$\frac{T_{\frac{1}{2}}}{T_{av}} = \frac{\frac{0.6931}{\lambda}}{\frac{1}{\lambda}}$$

$$\frac{T_{\frac{1}{2}}}{T_{av}} = 0.6931$$

$$\boxed{T_{\frac{1}{2}} = 0.6931\, T_{av}}$$

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13.8 Q

$A_0 = 15$ decay/min
$T = 5730$ yrs
$A = 9$ decay/min

$A = A_0 e^{-\lambda t}$

$\frac{A}{A_0} = e^{-\lambda t}$

$\frac{9}{15} = e^{-\lambda t}$

$0.6 = e^{-\lambda t}$

$\log_e 0.6 = -\lambda t$

$2.303 \log_{10} 0.6 = -\lambda t$

$2.303 \times 0.2218 = \lambda t$

$2.303 \times 0.228 = \frac{0.693}{T} t$

$t = \frac{2.303 \times 0.2218 \times 5730}{0.693}$ yrs

Q 13.9 obtain the amount of cobalt $_{27}Co^{60}$ necessary to provide a radio active source of 8 micro curie (8mci) strand half life of $_{27}Co^{60}$ is 5.3 yrs

Soln $A = 8$ mci $= 8 \times 3.7 \times 10^7$ decay / sec (Bq)

$T = 5.3$ yrs
$= 5.3 \times 365 \times 24 \times 3600$ sec
$= 1.67 \times 10^8$ sec

$A = \lambda N$

$N = \frac{A}{\lambda}$

$= \frac{8 \times 3.7 \times 10^7 \times 1.67 \times 10^8}{0.693}$ atom

Amount = $\frac{8\times3.7\times10^{7}\times1.67\times10^{8}\times60}{0.693\times6.022\times10^{23}}$ g

* α-decay ⇒ the phenomanan of emission of α-particles from the nucleus of an element is know as the α-decay

$$_{Z}X^{A} \longrightarrow {}_{Z-2}Y^{A-4} + {}_{2}He^{4} + Q$$

Parent nucleus — Daughter nucleus — α-Particle

$$Q = [m({}_{Z}X^{A}) - m({}_{Z-2}Y^{A-4}) - m({}_{2}He^{4})]c^2$$

$$= [m({}_{Z}X^{A}) + Zm_e - \{Zm_e + m({}_{Z-2}Y^{A-4}) + m({}_{2}He^{4})\}]c^2$$

$$= [M({}_{Z}X^{A}) - M({}_{Z-2}Y^{A-4}) - M({}_{2}He^{4})]c^2$$

* kinetic energy

$$KE_{\alpha} = \left(\frac{A-4}{A}\right)Q$$

* β-decay ⇒ the phenomanan of emission of β-decay β-particles is know as the β-decay

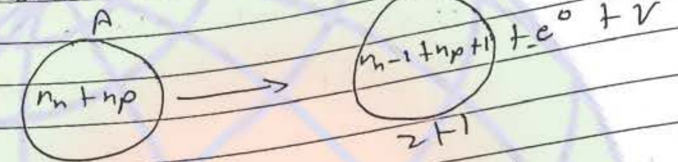
⇒ There are three types of β-decay

1) β^--decay
2) β^+-decay
3) electron capture

1) β^- – decay ⇒ Neutron of the nucleus converted into the proton, electron and antineutrino in which electron and antineutrino comes out from the nucleus only and proton remains in a nucleus

$n \rightarrow p + e^0 + \bar{\nu}$

neutron → proton + electron + antineutrino



$z = n_p$

$$ {}_{z}X^A \longrightarrow {}_{z+1}Y^A + {}_{-}e^0 + \bar{\nu} $$

Parent nucleus — Daughter nucleus — β particle — antineutrino

⇒ Q-value

$$ Q\text{-value} = \left[m\left({}_{z}X^A\right) - m\left({}_{z+1}Y^A\right) - m_e \right] c^2 $$

$$ = \left[m\left({}_{z}X^A\right) + zm_e - zm_e - m\left({}_{z+1}Y^A\right) - m_e \right] c^2 $$

$$ = \left[M\left({}_{z}X^A\right) - \left\{ (z-1)m_e + m\left({}_{z+1}Y^A\right) \right\} \right] c^2 $$

$$ Q\text{-value} = \left[M\left({}_{z}X^A\right) - M\left({}_{z+1}Y^A\right) \right] c^2 $$

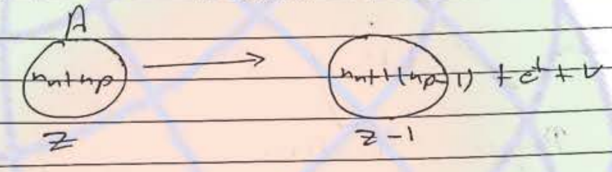
$$ Q\text{-value} = \left[M\left({}_{z}X^A\right) - M\left({}_{z+1}Y^A\right) \right] \times 931.5 $$

2) β^+ - decay $\Rightarrow$

In a β^+ - decay proton of the nucleus converted into the neutron, positron and neutrino in which neutron remains only positron and neutrino comes shot from the nucleus.

$$P \longrightarrow n + e^+ + \nu$$

Proton $\longrightarrow$ neutron + Positron + neutrino



$$_{Z}X^{A} \longrightarrow {}_{Z-1}Y^{A} + e^+ + \nu$$

Parent nucleus — Daughter nucleus — Positron — neutrino

$\Rightarrow$ Q-Value $\Rightarrow \left[m({}_{Z}X^{A}) - m({}_{Z-1}Y^{A}) - m_e \right] c^2$

$= \left[m({}_{Z}X^{A}) + Zm_e - Zm_e - m({}_{Z-1}Y^{A}) - m_e \right] c^2$

$= \left[M({}_{Z}X^{A}) - \{ Zm_e + m({}_{Z-1}Y^{A}) + m_e \} \right] c^2$

$= \left[M({}_{Z}X^{A}) - \{ M({}_{Z}Y^{A}) + 2m_e \} \right] c^2$

Q-Value $= \left[M({}_{Z}X^{A}) - M({}_{Z-1}Y^{A}) - 2m_e \right] c^2$

3) electron capture $\Rightarrow$ In a electron capture proton of the nucleus and electron of the innear most cell (k cell) are combind together to produce neutron and neutrino in which netron remain of nucleus only neutrino comes shoet from the

nucleus $p + e^- \longrightarrow n + \nu$

$$\underset{Z}{\overset{A}{(n_n + n_p)}} \longrightarrow \underset{Z-1}{\overset{A}{(n_{n+1} + n_{p-1})}} + \nu$$

$${}_{Z}X^{A} \longrightarrow {}_{Z-1}Y^{A} + \nu$$

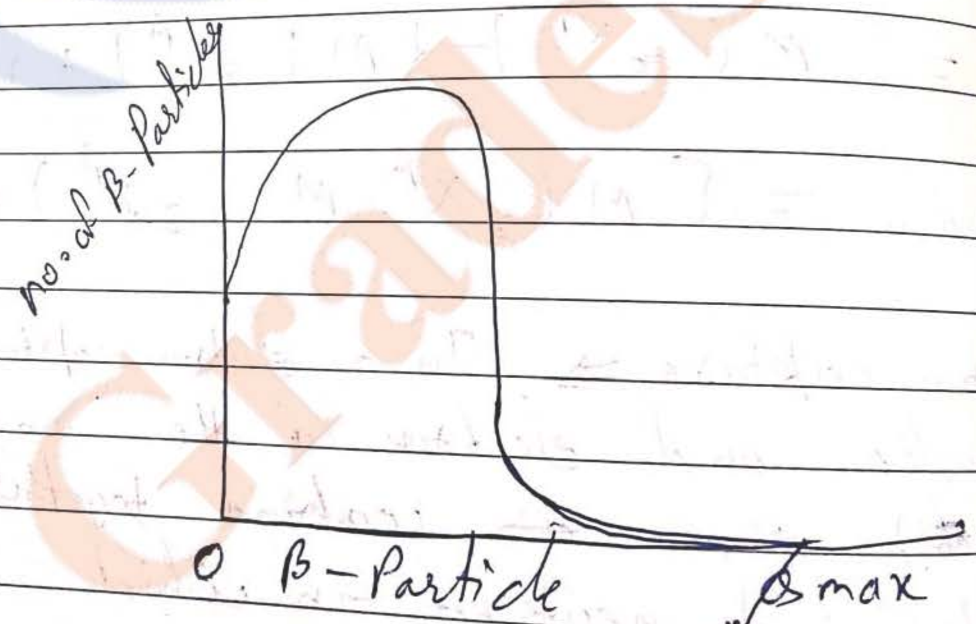
Parent nucleus — Daughter nucleus — neutrino

$$Q\text{-value} = \left[m\left({}_{Z}X^{A}\right) - m\left({}_{Z-1}Y^{A}\right)\right]c^2$$

$$= \left[m\left({}_{Z}X^{A}\right) + Zm_e - Zm_e - m\left({}_{Z-1}Y^{A}\right)\right]$$

$$Q\text{-value} = \left[M\left({}_{Z-1}Y^{A}\right) - m_e\right]c^2$$

✱ Graph between the number of Atoms β- Particles and Energy



observation
i) Most of
ii) only
iii) The e
β-p
this
iv) This
i) law
ii) law

✱ neutr

The
of e
is
due
two
cha
n

✱ γ-observation

i) Most of β- particle emitted carry small energy
ii) only very few β-particles carry maximum energy called end point energy
iii) The energy spectrum of the β-decay indicate that β-particles carries the energy zero to ∞- max this
iv) This voilet the
i) law of conservation of energy
ii) law of conservation of angular momentum

* neutrino hypotaties

The voliation of principle law of conservation of energy and law of angular momentum is resolve by pauli he was suggest that during the β-particle decay there are two particles whose rest mass is zero and charge is neutral called antineutrino and neutrino

* γ- decay => the Phenomenon of emission of γ-particles or photon is know as the γ-decay

$$ {}_{Z}X^{A} \longrightarrow {}_{Z}X^{A} + \gamma $$

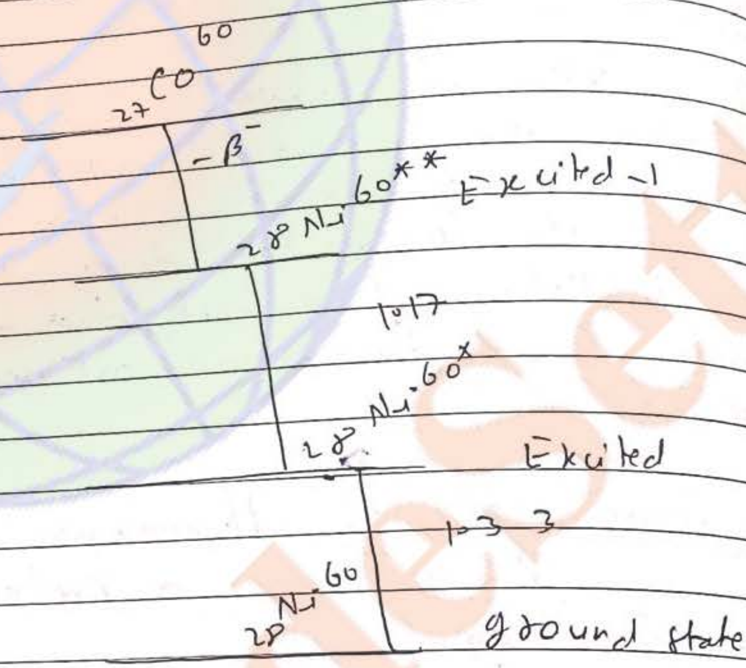
Excitted state   ground state

Note => γ-decay takes place after the emission of α or β decay

eg => $_{27}Co^{60} \longrightarrow _{28}Ni^{60} + _{-1}e^{0}$

$_{28}Ni^{60**} \longrightarrow _{28}Ni^{60*} + \gamma$ - rays (= 1.17 MeV)

$_{28}Ni^{60*} \longrightarrow _{28}Ni + \gamma$ - ray (= 1.33 ray)



1) α- decay

$$_{Z}X^{A} \longrightarrow _{Z-2}Y^{A-4} + _{2}He^{4} + Q\text{-value}$$

(2) β^- - decay

$${}_{Z}X^{A} \longrightarrow {}_{Z+1}Y^{A} + {}_{-1}e^{0} + \bar{\nu}$$

(3) β^+ - decay

$${}_{Z}X^{A} \longrightarrow {}_{Z-1}Y^{A} + e^{+} + \nu$$

(4) electron capture

$${}_{Z}X^{A} \longrightarrow {}_{Z-1}Y^{A} + \nu$$

(5) γ - decay

$${}_{Z}X^{A*} \longrightarrow {}_{Z}X^{A} + \gamma\text{-rays}$$

Q. Write the sequence of decay of radioactive nucleus is ${}_{80}A_1^{226} \xrightarrow{\alpha} A_2 \xrightarrow{\beta} A_3 \xrightarrow{\alpha} A_4$ find the atomic no. and mass no. of A_4

Sol.

$${}_{80}A_1^{226} \xrightarrow{\alpha} {}_{78}A_2^{222} \xrightarrow{\beta} {}_{79}A_3^{222} \xrightarrow{\alpha} {}_{77}A^{218}$$

$$A = 218$$
$$Z = 77$$

Q. The sequence of decay of radioactive nucleus is $D \xrightarrow{\alpha} D_1 \xrightarrow{\beta} D_2 \xrightarrow{\alpha} D_3 \xrightarrow{\alpha} D_4$ If nucleon number and atomic number of D_2 are 176 and 71 respectively what are there values for D and D four

Sol.

$${}_{72}D^{180} \xrightarrow{\alpha} {}_{70}D_1^{176} \xrightarrow{\beta} {}_{71}D_2^{176} \xrightarrow{\alpha} {}_{69}D_3^{172} \xrightarrow{\alpha} {}_{67}D_4^{168}$$

for D mass no. = A = 180
Atomic no. Z = 72
for D_4
A = 168
Z = 67

13.12 Q Find the Q value and K.E of emitted α-particles in the α-decay

1) $_{88}Ra^{226}$

$$_{88}Ra^{226} \longrightarrow {}_{86}Rn^{222} + {}_2He^4 + Q$$

$$Q\text{-value} \left[M\left({}_{88}Ra^{226}\right) - M\left({}_{86}Rn^{222}\right) - M\left({}_2He^4\right)\right]$$

$$= [226.02540 - 222.01750 - 4.00260)$$

$$Q\text{-value} = 4.94 \text{ MeV}$$

$$KE_\alpha = \frac{(A-4)}{A} Q$$

$$= \frac{(226-4)}{226} \times 4.94$$

$$= 4.85 \text{ MeV}$$

Q 13.13

$$_6C^{11} \longrightarrow {}_5B^{11} + e^+ + \nu$$

$$T = 20.3 \text{ min}$$

$$E = 0.960 \text{ MeV}$$

$$Q \text{ Value} = [m({}_6C^{11}) - m({}_5B^{11}) - m_e] \times 931.5$$

$$= [m({}_6C^{11}) + 6m_e - 6m_e - m({}_5B^{11}) - \ldots$$

931.5 MeV

$[M({}_6C^{11}) - M({}_5B^{11}) - 2m_e] \times 931.5\ MeV$

$= [11.011434 - 11.009305 - 2 \times 0.00033] \times 931.5$

$= 0.961\ MeV$

13.6 Write the nuclear reaction

i) α-decay of ${}_{88}Ra^{226}$

$${}_{88}Ra^{226} \longrightarrow {}_{86}X^{222} + {}_2He^4$$

iii) β^- - decay

$${}_{15}P^{32} \longrightarrow {}_{16}Y^{32} + e^- + \bar{\nu}$$

iii) β^+ - decay ${}_6C^{11}$

$${}_6C^{11} \longrightarrow {}_5X^{11} + e^+ + \bar{\nu}$$

* Nuclear reaction => A reaction in which nucleus of an atom in paticipate is know as the nuclear reaction

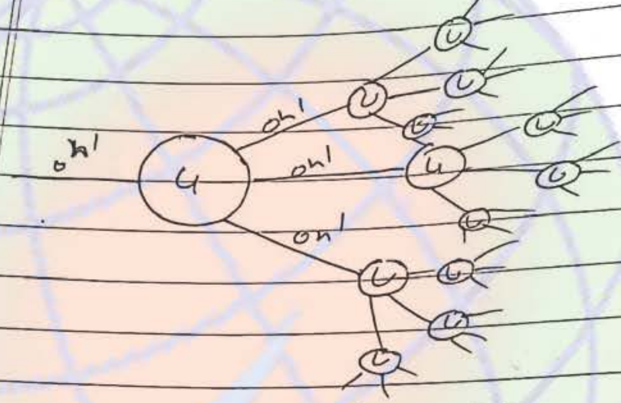
=> There are two types of nuclear reaction
i) Nuclear fission
ii) Nuclear fusion

i) Nuclear fission reaction =>
A Nuclear reaction in which havy unstable nucleus splits into two or more fragments and relase the tremeandous amount of energy is know as the nuclear fission reaction

There are two types of the nuclear fission

1) Nuclear chain reaction ⇒
A nuclear fission in which all the neutron are responsible for further ~~fiss~~ for further fission reaction is know as the nuclear chain reaction

$$_{92}U^{235} + {}_0n^1 \longrightarrow Ba^{141}_{58} + Kr^{92}_{36} + 3\,{}_0n^1 + Q\text{-value}$$



1, 3, 9, 27 ——

△ likage of nutron from the system ~~Some~~ ⇒
Some of secondary nuclear nutrone produce may escape out of the system and will not take part in further fission this

△ Absorbation of neutron by ⇒
the secondar neutron may be absarve by imburities which ar not fissible this loss may be raduced by having a fissinable matteral free from imburities

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* ~~Absorbation of~~
* Critical size ⇒
In order two have a sustend chain reaction in a sample of radium(U)235 it is required that the number of neutrons lost due to likage and absorbation called critical size.

* Neutron ~~de~~ reproduction factor all multiplication factor ⇒
The ratio of the rat of production of neutrons to the rate of loss of neutrons due to lekage and absorbation
⇒ It is denoted by k
k = rate of production of neutron ~~by~~ rate of loss of neutrons

Case I
When $k = 1$
The chain reaction well be ~~study~~ steady

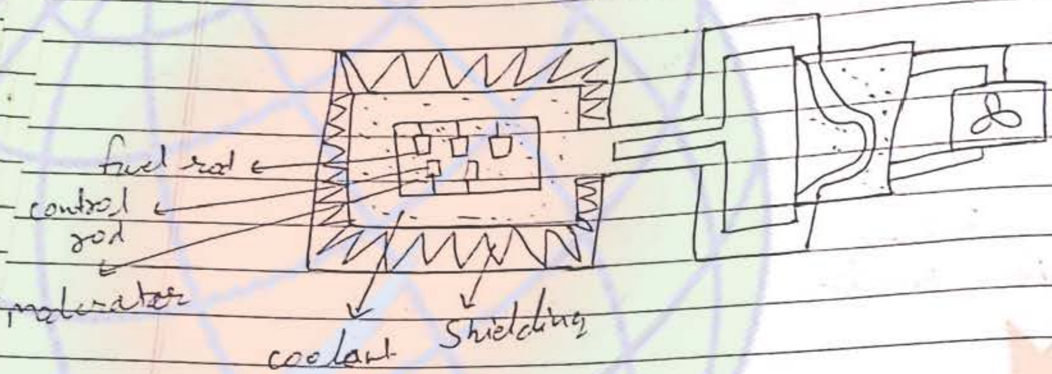
case II
k is grater than one $(k > 1)$
chain reaction accelerated.
~~the si~~ In this case the size of the atom/ material is called super critical

case III when $k < 1$
The chain reaction gradually comes to
the size of the matterial ~~a~~ used is called
Sub ~~sense~~ critical

* Control fission reaction ⇒ only one neutron in
A reaction in which only one neutron is provided for the further fission reaction is called control fission reaction.

* Nuclear reactor ⇒
A device where controlled fission reaction can take place is called Nuclear reactor.

* construction ⇒



* Nuclear reactor is consist of following :⇒
1) Nuclear fuel
It is a fissionable material to be used for the fission process to take place commonly used ~~fuel~~ fuel in a nuclear reaction reactor are U^{233}, U^{235}, U^{239} etc.

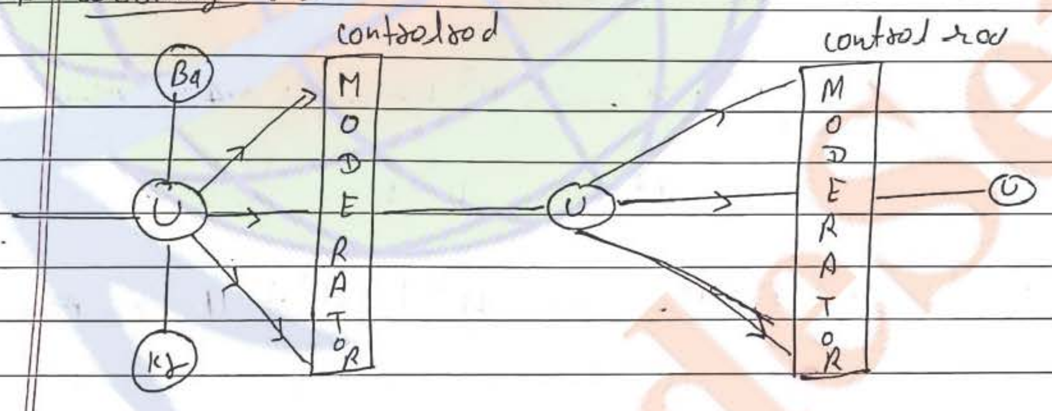
ii) Moderator ⇒ Moderator slow the speed of the neutrons produced during the fission reaction because moderate rate neutron can easily take ~~part~~ participate in a fission reaction so and control rod can easily absorbed the extra neutrons.

(iii) Control rod :->
the control rod have ability to capture the extra neutron produced during the fission reaction cadmeum, Boron etc. are used as a controller

(iv) Coolant => A substance which is used to transfer the heat energy from nuclear reactor to heat exchanger.

(v) Shielding =>
A concreate wall of few meter thick over the nuclear reaction that protect from the effect of radiation

Working :->



When slow moving neutrons strike on the uranium it produce the neutrons that passes through the moderator which retard the speed of the neutron the extra neutron produced during the fission reaction is absorbed by the control rod energy is transferred from the nuclear reactor to the heat exchange by the coolant

* Fast Breeder reactor =>

They use thorium or natural uranium as fuel element when fast neutrons strike uranium fuel in a reactor U^{238} absorbs α neutron and becomes U^{239} this is radioactive and ~~undey~~ undergoes β decay ~~the~~ twice to produce PU^{239}

$$_{92}U^{238} + {}_0n^1 \longrightarrow {}_{92}U^{239} \xrightarrow{\beta} {}_{93}U^{239} \xrightarrow{\beta} {}_{94}PU^{239} \xrightarrow{\alpha} {}_{92}U^{235}$$

2) * Nuclear fusion =>

Nuclear reaction in which two or more lighter nuclei ~~are~~ combined together to form stable nuclei and tremendous amount of energy is known as the nuclear fusion.

eg =>

$${}_1H^1 + {}_1H^1 \longrightarrow {}_1H^2 + e^- + \bar{\nu} + 0.42 \text{ MeV}$$

$${}_1H^2 + {}_1H^2 \longrightarrow {}_2He^3 + n + 3.27 \text{ MeV}$$

$${}_1H^2 + {}_1H^2 \longrightarrow {}_1H^3 + {}_1H^1 + 4.03 \text{ MeV}$$

* ~~Therf~~ thermonuclear fusion =>

A nuclear fission in which large amount of heat energy is provided to the lighter nuclei to overcome the electrostatic force of repulsion called thermonuclear fission

Note => Thermonuclear fission is the source of energy at the ~~seen~~ sun

* Controlled thermonuclear fusion =>

A controlled thermonuclear fusion the basses of ~~fusion~~ fussion reaction which is the furthier of source of unlimited and unpolluted energy more attractive reaction for terestial is

$$_1H^2 + _1H^2 \longrightarrow _2He^3 + n + 3.2\ MeV$$

$$_1H^2 + _1H^2 \longrightarrow _1H^3 + _1H^1 + 4.03\ MeV$$

$$_1H^2 + _1H^3 \longrightarrow _2He^4 + n + 17.59\ MeV$$

* nuclear Holocaust =>

Nuclear Holocost is the name given to the large scale distruction and devastation that would be be caused by use of nuclear weapons

Q 13.16

$$_{26}Fe^{56} \longrightarrow _{13}Al^{28} + _{13}Al^{28} + Q$$

$$Q\text{-value} = [m(_{26}Fe^{56}) - 2m(_{13}Al^{28})] \times 931.5\ MeV$$

$$= 55.93494 - 2 \times 27.98191$$

$$= -26.88\ MeV$$

Here -ve ~~sigh~~ sign show that the fussion reaction is not possible.

13.17

Soln: 1 mole = 239 g = 6.022×10^{23}

$1000 g = \frac{6.022 \times 10^{23} \times 1000}{239}$

$= 2.52 \times 10^{24}$ atom

Total energy released $= 2.52 \times 10^{24} \times 180$ MeV

Ch → 14

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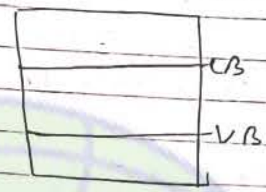
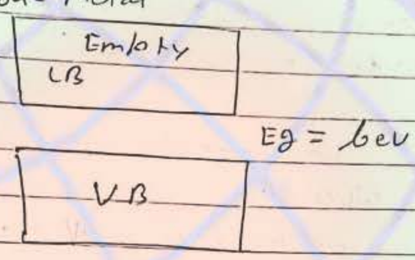
Semi - Conductor And devices

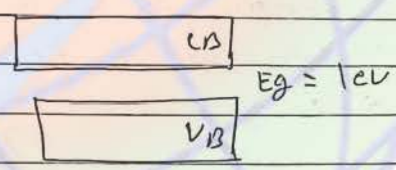
1) Metal ⇒ / conductor



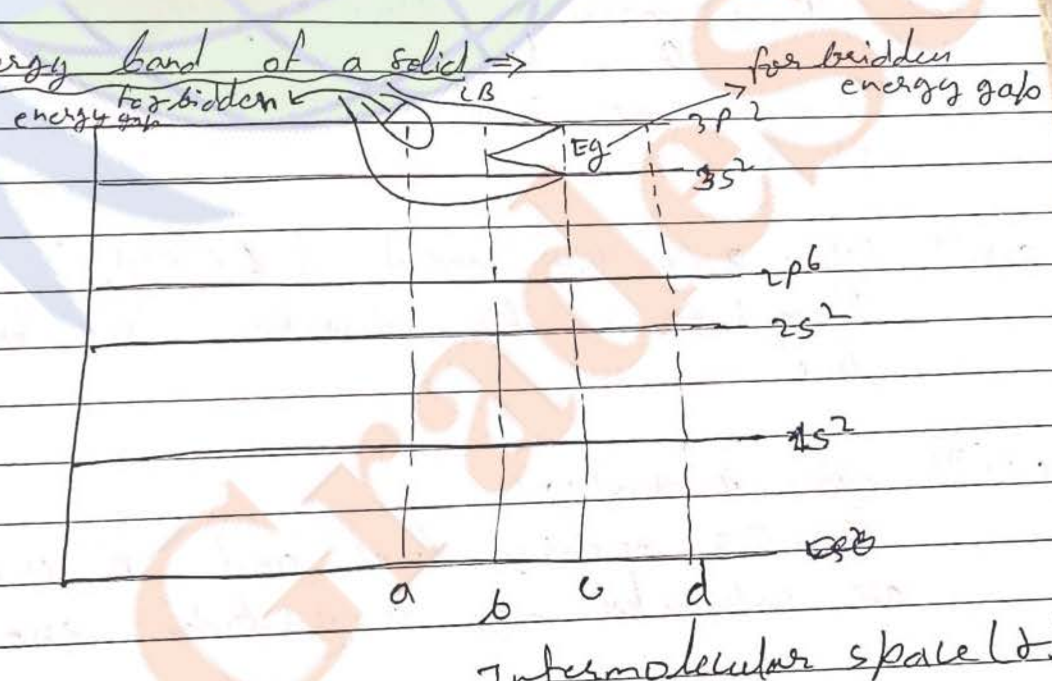
2) Insulator / Non- Metal



3) Semi- Conductor



* Energy band of a solid ⇒



Silicon (Si)
Atomic no. = 14
Electronic configuration
$1s^2, 2s^2, 2p^6 3s^2 3p^2$
no. of atoms = N
Total valence = 4N
no. of state of energy level = 8N
no. of filled state energy level = 4N
unfilled = 4N

The graph b/w intermolecular space (r) and energy as show in the given by
consider silicon a cristel havy N no. of silicon atoms

Total no. of valence electron be 4N
no. of state of energy level be 8N
In which 4N energy level is field and 4N energy leve is unfilled

case I — If intermolecular space is very-very large than the A (r = d >> a),
there is no intrecation b/w the atoms of the silicon

case II — When r lies b/w c and d (c < r < d)
There is no visiable saparation b/w the energy level

case III — when r equal to c
the 3s energy level and 3p energy level are saparated by a forbidden energy level
Eg

case IV
leve
con

case V
When
In t

The
ban
Valan

Int
Sem

Int
A
S

Ex

when $a < r < b$

case V In this case all the filled and unfilled energy level are over lap of each other they are can not be distangus each other

case VI

When r is less than a ($r < a$)
In this case filled and unfilled energy level are saparated by small energy gap and called for bidden energy gap

The upper unfilled energy level is called conduction band and lower filled energy level called Valance band

* Semi-conductor
  - Intrinsic Semiconductor
  - Extrinsic Semiconductor
    - p-type Semi-conductor
    - n-type semi-conductor

* Intrinsic semiconductor ⇒
A pure semi-conductor is know as the Intrinsic Semiconductor

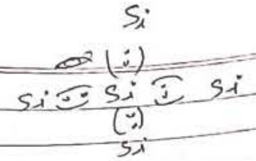
eg ⇒ garmanium, Silicon etc.

* behavier of intrinsic Semi-conductor ⇒

Si

Atomic no. - 14

$1s^2 2s^2 2p^6 3s^2 3p^2$



At zero calvin (0°K) all the covalent bond are exist there is noe current carriers avaible at 0K. it acts as a an insulator

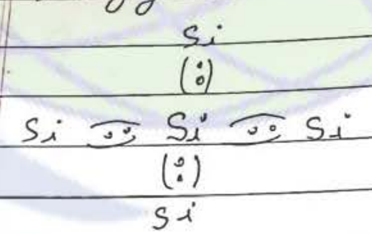
At room temperature there is a thermal aratuted electron jump from the valance band to conduction band and cricate the same no. of the holes in the valence bend that is the positive in nature which attract the never electron and constituent electric current

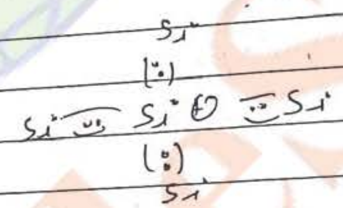
~~there are~~

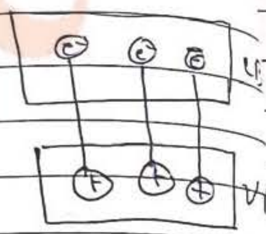
⇒ there are two types of current carries electrons and whols having same no. of density

$$n_e = n_h$$

⚝ Energy band of Intrinsic Semi-conductor







⇒ There are two types of Impurities

1) Penta-Valent ⇒ Phasphoros, arsenic, antimoni
This also know as donor imbrurities

11) Try-Valent ⇒ eg ⇒ Almunium, endium, boron

Doping ⇒
The processes of adding the impurities in a intrinsic semi-conductor is know as doping

Method of doping ⇒

i) By difusing
ii) By heating
iii) By bombading

Extrinsic Semi-conductor ⇒
extrinsic A semi-conductor which obtained by adding impurities in a intrinsic semi-conductor is know as the extrinsic semi-conductor

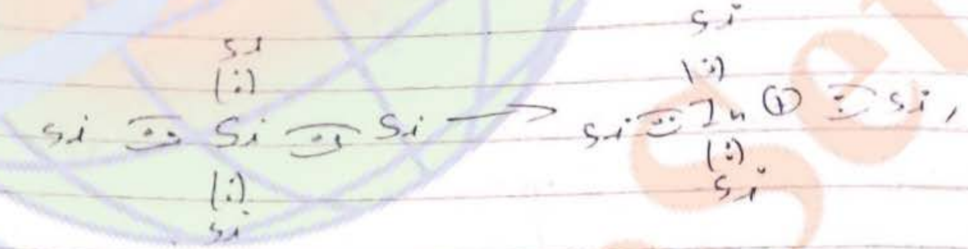
⇒ There are two type of extrinsic semi-conductor ⇒

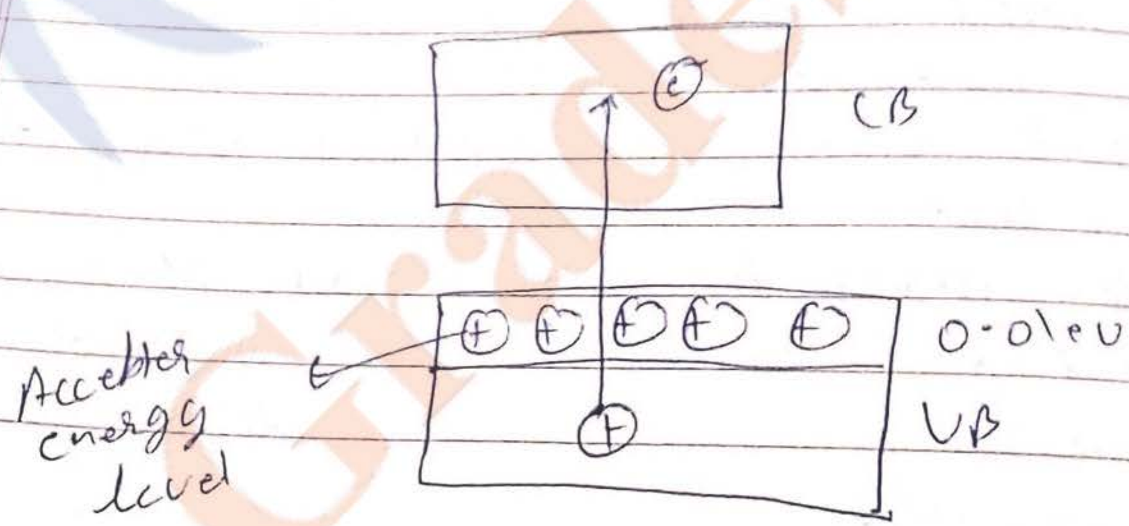
1) P-type extrinsic Semi-conductor ⇒
A semi-conductor which obtained by adding the try-valent impurities in extrinsic semi-conductor is know as the P-type Semi-Conductor.
eg ⇒ Consider a silicon having atomic no. 14 and valence electron 4 from the co-valent bond
⇒ when try-valent impurities added in a silicon atoms this atom replaces one silicon atom and satels is the ~~stations side the~~ lattice side of replace silicon atom. Indium from the three complete co-valent bond forth bond is remains unbonded.
It creat difficiency of electrons called hole which is positive in nature
this hole attracte the electrons from the naveary co-valent bond to fill it self more and more holes are criated by adding more and more impurities

In the holes majority current carrier and electrons are the minority current carrier

$n_h >> n_e$

In a p-type semi-conductor a new energy level form due to the holes called acceptor energy level which lies just above the valence band the energy gap between the acceptor energy level and valence band is very-very (0.01 eV) less than forbidden energy level so at room temperature easily jump in a accepter energy level and create the large no. of holes in a valence band in such a away holes are the majority current carrier and electron are the minority current carrier in a p-type semi-conductor





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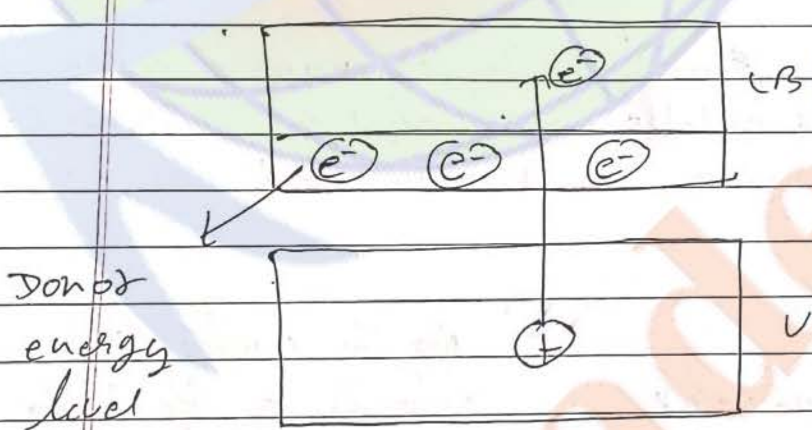
(2) n-type Semi-conductor =>
A Semi-conductor which obtained by adding the pentavalent impurities in a Intrinsic Semi-conductor is know as the n-type Semi-conductor or negative type semi-conductor

When penta-valent impurities ~~adding~~ added in a intrinsic semi-conductor it replace one silicon atoms and setal in a its lattice side of the silicon ~~sili~~ phosphores atom form the complete 4 covalent atom fifth electron of it remains unbonded as by adding more-more ~~penta valent~~ free electron are produce that is electrons are the majority current carrier and holes are ~~man~~ minority current carrier ~~also~~ in a n-types semi-conductor

$n_e >> n_h$



Energy band diagram of the n-type Semi-~~condo~~ conductor as show in the the given figure

Donor energy level corresponding to the electron like just below the conduction band the energy gap b/w the conduction band and donor energy level is very very small then the forbidden energy gap so it room temperature there are large no. of the three free electrons are available in the conduction band for the conduction of the current majority current carrier is holes and minority current carrier is electron.

* Difference b/w the Intrinsic and Extrinsic Semi-conductor

Intrinsic	Extrinsic
1) It is a pure Semi-conductor	1) It is the impure or doped with impurities Semi-conductor
2) Its conductivity is low	2) Its conductivity is high
3) In its density of current carrier of holes and electron are same	3) In its no. of density of electron and holes are different
4) Its conductivity is the only the function of the temperature	4) Its conductivity depends on the temperature and concentration of the hole and electron i.e. is current carrier

Differ...

P-ty...

1) It is o... by a... tri-va... intrin...

2) In ... carr... curre...

3) Its ... low

4) In P... the ... vale...

5)

Note → P-typ...

* Ele...

Let ...

A ...

n ...

* ele... holes:

* Difference b/w the P-type and N-type semi-conductor

P-type	N-type
1) It is obtained by adding the tri-valent impurities in the intrinsic semi-conductor	(1) It is obtained in a pentavalent adding the impurities in
(2) In p-type majority current carrier is hole and minority current carrier is electron $n_e > n_h$	(2) In N-type majority current carrier is electron and minority current carrier is hole. $n_e < n_h$
(3) Its conductivity is low	(3) Its conductivity is high
(4) In P-type acceptor energy level just above the valance band	(4) In N-type donar energy level just below the conduction band

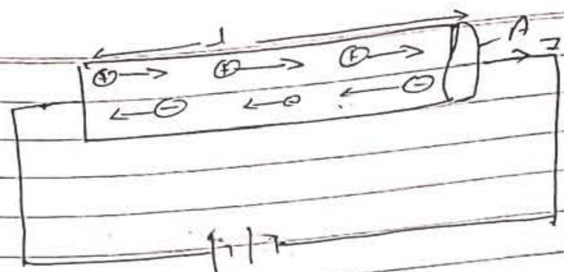
(5)

Note → P-type and N-type semiconductor are electrically neutral

* Electric Current through the semi-Conductor ⇒

Let a semi-Conductor of length l area of crossection A having density of electron and holes n_e and n_h respectively and drift velocity V_e and V_h

* electric current consistent due to the electron holes are given by ⇒



$I_h = I_e + I_h$

$I_e = Ane\, eV_e$

Total current in a semi conductor

$I = I_e + I_h$

$I = An_e eV_e + An_h eV_h$

$$I = Ae(n_e V_e + n_h V_h)$$

* conductivity of Semiconductor =>

$$\sigma = \frac{1}{\rho}$$

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

from ohm's law

$$R = \frac{V}{I}$$

$$\therefore \frac{V}{I} = \rho \frac{l}{A}$$

but $E = \frac{V}{l}$

$$V = El$$

$$\frac{El}{I} = \rho \frac{l}{A}$$

$$\frac{1}{\rho} = \frac{I}{El} \times \frac{l}{A}$$

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σ = Sigma
ρ = Rho

$$\frac{1}{\rho} = \frac{I}{EA}$$

Where $I = Ae\,(n_e v_e + n_h v_h)$

$$\sigma = Ae\,(n_e v_e + n_h v_h)$$

$$= e\left(n_e \frac{v_e}{E} + n_h \frac{v_h}{E}\right)$$

Where $\frac{v_e}{E} = \mu_e$ (Mobility of electron)

$\frac{v_h}{E} = \mu_h$ (Mobility of hole)

$$\boxed{\sigma = e\,(n_e \mu_e + n_h \mu_h)}$$

case I Mobility Conductivity of extrinsic semiconductor

$$n_e = n_h = n_i$$

$$\sigma = e\,(n_i v_e + n_i v_h)$$

$$\sigma = e n_i\,(\mu_e + \mu_h)$$

case II conductivity of P-types semiconductor

$$n_h \gg n_e$$

$$\boxed{\sigma_h = e\, n_h \mu_h}$$

case III Conductivity of N-types Semi-conductor

$$n_e \gg n_h$$

$$\boxed{\sigma_n = e\, n_e \mu_e}$$

* Number density of Majority and minority carrier in Intrinsic Semi-conductor or mass action law ⇒

A/c to this law n_i = density of Intrinsic semi-conductor current carrier carrier
n_e ⇒ density of no. of electron
n_h ⇒ " " " hole.

Q. A pure silicon at 300k has equal concentration of 1.5×10^{16} electron and hole increases the hole dropping by indium increases $10^{22}\ m^{-3}$ calculate the concentration to $4.5\times10^{22}\ m^{-3}$ in the dopt new electron concentration silicon

Sol-
$n_i = 1.5\times10^{16}\ m^{-3}$
$n_h = 4.5\times10^{22}\ m^{-3}$
$n_e = ?$
$\therefore n_h n_e = n_i^2$

$$n_e = \frac{n_i^2}{n_h}$$

$$= \frac{(1.5\times10^{16})^2}{4.5\times10^{22}}$$

Note the no. density of hole electron pair increases with the temp. A/c to following relation $n_i^2 = A_0 T^3 e^{-E_g/kT}$

E_g ⇒ forbidden energy gap
T = absolute temp
A_0 is constant
k is voltman constant

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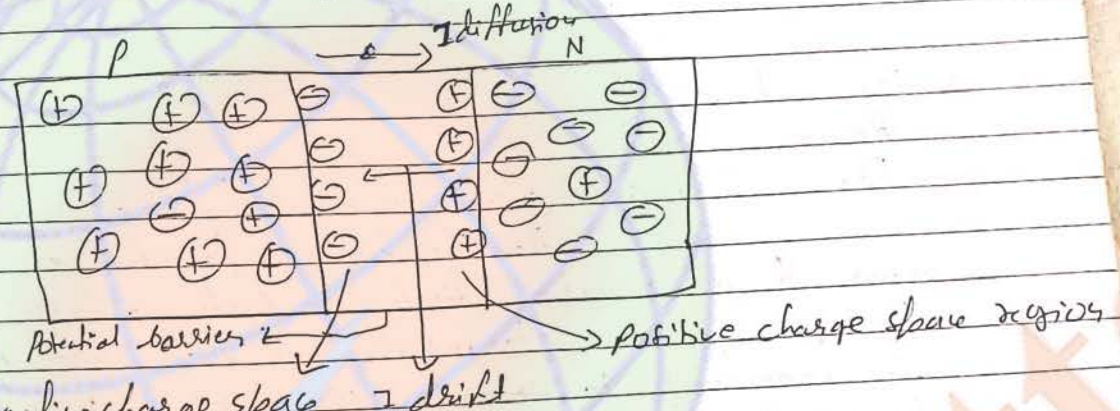
* Semi-Conductor device ⇒

1) PN - Junction ⇒ When P-types semiconductor cristeal is brought into closed contact with a n-type semiconductor cristal the resulting arrangement is PN-Junction called PN - Junction or PN diode

→ formation of P-type and or N-type Semiconductor

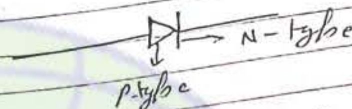


depletion

* A depletion layer or region ⇒
the space charge region on both the side side of PN - Junction which have e-mobile ions and e devotide devoide any charge carrier will from a region called depletion layer, or region

* Potential barrier →
due to the e-mobile positive and negative charge region an electric potential region critical at the Junction is know as potential barrier
⇒ It is denoted by V_b

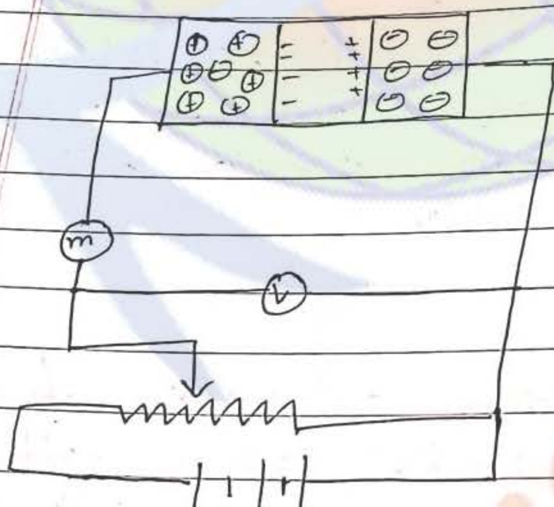
Symbole of PN-Junction diode

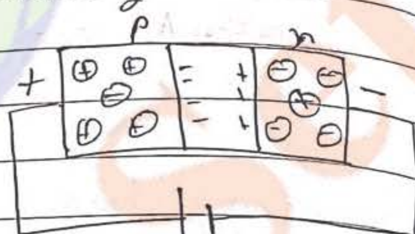


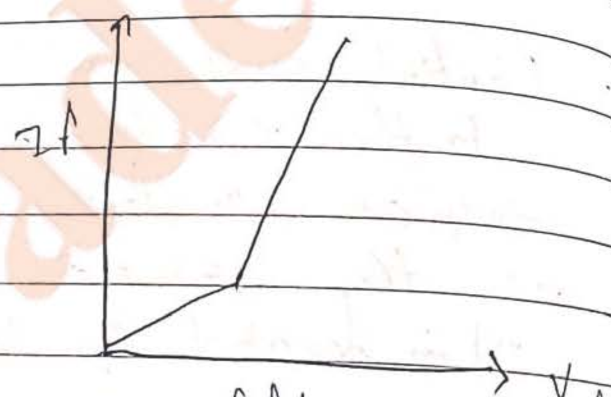
There are two type of Biasing =>

i) Forward biasing
ii) Reverse biasing

i) Forward wasing => When a battery of emf greater than the barrier potential is connected across a p-n junction diode in such a way that the ~~pos~~ positive terminal of the battery is connected to ~~program~~ p region and negative terminal of battery connected to the n-junction of diode called forward ~~as~~ biasing







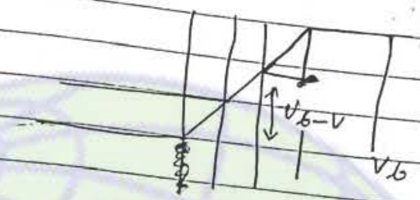
Knee Voltage

* Knee V... A batte... the J...

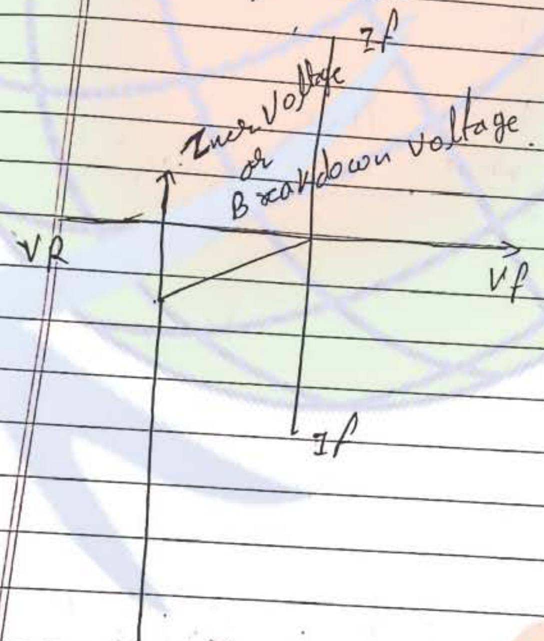
* Reve... When the...

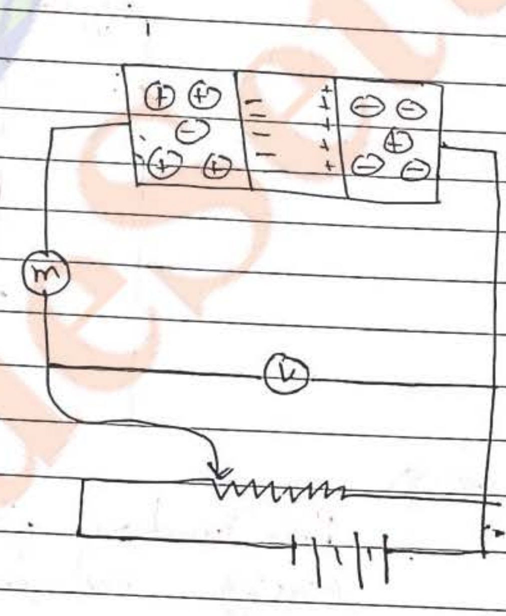
VR

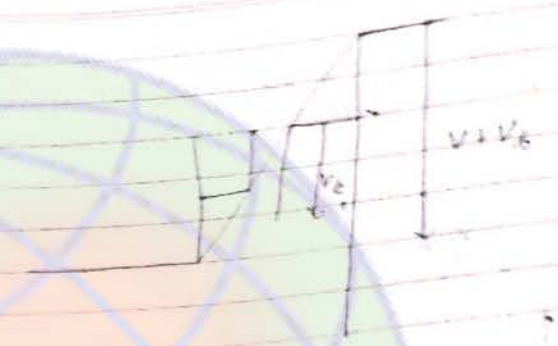
* Knee voltage ⇒
A battery voltage at which current flow through the Junction is increases repadily is called Knee voltage



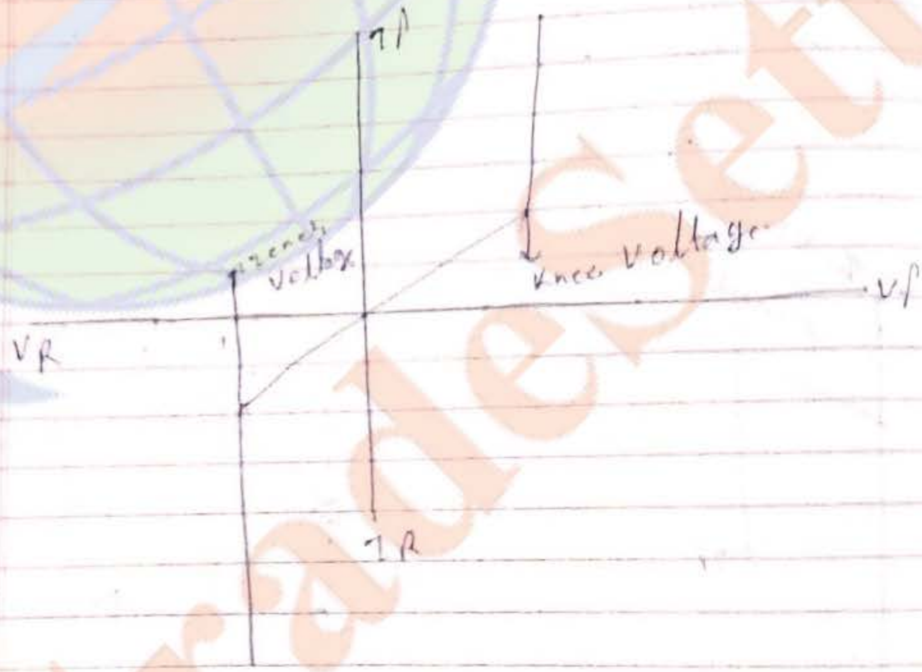
* Reverse biasing :->
When positive terminal of battery is connected to the 'P' region of the pn-junction diods is called reverse biasing







* A battery voltage at which reverse current get suddenly raised is known as the zener voltage or breakdown voltage.



Note ⇒

∴ Pn-Junction diode is conduct in forward biasing and does not conduct inverse bi

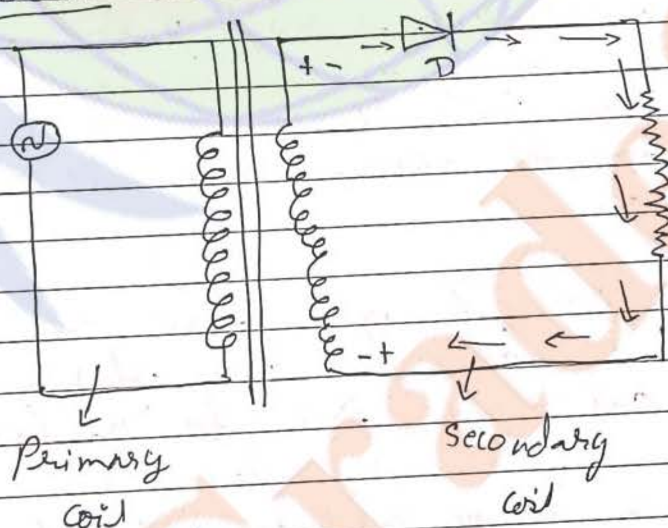
* PN-Junction diode as a rectifier ⇒
An electronic device which is used to convert the alternating A.C signal into D.C signal is know as the rectifier

Principle ⇒
It is best on the Principle of that in p-n junction diode conduct in forward bising and does not conduct in the reverse bising.

⇒ There are two types of the rectifier
1) half wave rectifier
2) Full wave rectifier

1) half wave rectifier ⇒ A rectifier which convert half cycle of A.C into D.C is know as the half wave rectifier

construction ⇒



half wave rectifier is consists of the two coils first coil called the primary coil connected to the A.C source. Second coil called secondary coil is connected to the low resistance through the diode 'D'

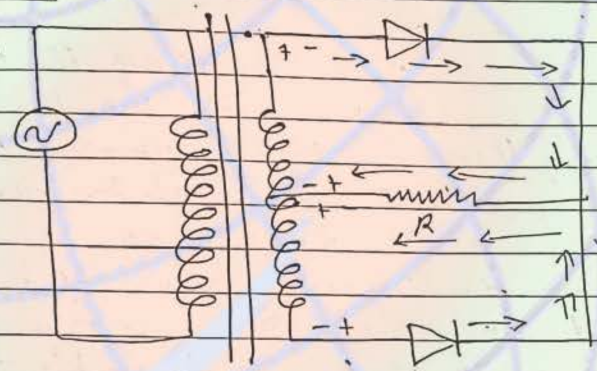
Working ⇒
When positive half cycle applied a cross the primary coil then emf induced in a secondary coil due to the mutual inductance whose polarity in such a way upper and lower parts of it becomes positive and negative polarities. as result p-n junction diode becomes in a forward biasing is connected and allow the follow of current and output of the obtained across the load resistance

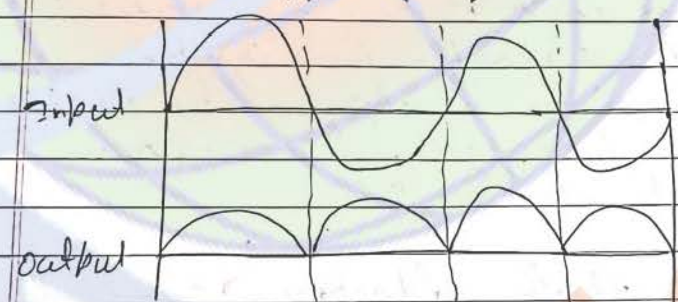
during the negative cycle again emf induced a cross the secondary coil whose polarity is such a way diode 'D' becomes in reverse biasing by does not conduct. There is no output obtained across the low resistance as a result in such a way half way rectifier the only convert the half cycle of A.C into DC

Disadvantage ⇒
1) It only convert the half cycle ~~into~~ of AC into DC
11) It lides the loss of energy
111) ~~full wave rectifier~~

* fullwave rectifier ⇒
rectifier which convert the full cycle of AC into DC

construction ⇒





A full wave rectifier is consistes of the two coil first coil across which input AC signal is applied Second coil called secondary coil is connecated to the two dioade ~~D1 and D2~~ through the D1 and D2 n-type of the diode are connecated ~~at~~ the common point ~~and~~ low resistance are connecated ~~in~~ the centre of the coil to the commont point of the n-type region classmate Date Page

Working
when positive half cycle AC source is input flow through the primary coil then due to mutual inductance emf induce across the coil whose polarity is in such a way for forward biasing and diode D_1 becomes biasing. D_2 in a reverse biasing but D_2 does not conduct but D_1 Diode D_1 is forward biasing and is conduct because resultant output obtained across the R during the negative half cycle flow through the primary coil again emf induce across the secondary coil whose polarity in such a way in reverse biasing that diode D_1 becomes does not conduct and diode D_2 is a forward biased that conduct to which output is obtained across the load resistance in the same direction of the previous current in such a way full wave AC input convert into the D.C

Draw back =>
It produce the actually fluctuating DC output

* Filter circuit =>
An electronic circuit that connected to the out of the rectifier which produce the smooth dc output called filter circuit

Variable DC output of amplifier due to super position of the Input AC signal on the output DC signal in a filter signal capacitor of inductor are

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and

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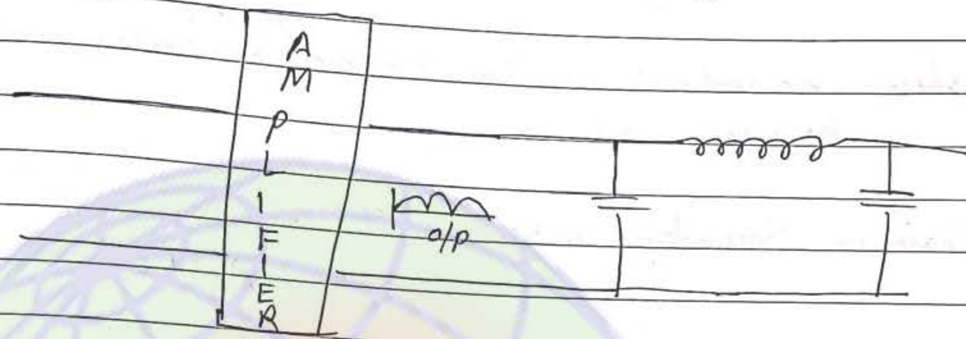
used because capacitor block of DC ~~o/p~~ output and inductor block the AC output



* Ripple factor of a rectifier ⇒
It is the ratio of the value ac component to the value dc component in a ~~volume~~ rectifier

$$\text{Ripple factor} = \frac{\text{Value of A.C component}}{\text{Value of DC component}}$$

$$= \frac{I_{ac}}{I_{dc}} = \frac{V_{ac}}{V_{dc}} = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$$

Ripple factor of the half wave rectifier is 1.21 and full wave rectifier is 0.48

Efficiency of — it is the ~~reciprocal~~ ratio of the output AC power to the ~~inde~~ input D.C power

$$\boxed{\eta = \frac{P_{dc}}{P_{ac}}}$$

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$V_{pm} = \sqrt{2}\, V_{rms}$

⇒ Maximum primary voltage $V_{pm} = \sqrt{2}\, V_{rms}$

⇒ Maximum Secondary Voltage $V_o = V_{pm} \times \frac{n_s}{n_p}$

where n_s and n_p are the no. of terms of secondary and primary coil

⇒ Maximum Secondary current $I_o = \frac{V_o}{R_i + R_L}$

⇒ Mean value of current in half wave rectifier $I_{dc} = \frac{I_o}{\pi}$

⇒ Output DC voltage in half wave rectifier $V_o = I_{dc} \times IR$

$$V_o = \frac{I_o}{\pi} \times IR$$

⇒ Mean value of current in full wave rectifier

$$I_{dc} = \frac{2I_o}{\pi}$$

⇒ Output DC voltage is given by

$$V_o = I_{dc} \times R_L$$

$$\boxed{V_o = \frac{2I_o}{\pi} R_L}$$

⇒ Current through the PN Junction diode

$$I = I_o \left(e^{\frac{eV}{kT}} - 1 \right)$$

where I_o is maximum current, e is the basic charge, V is the voltage and T is the absolute temperature

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In case of forward baising current is given by

$$I = I_0 \left(e^{\frac{eV}{KT}} - 1 \right)$$

Reverse baising

$$I =$$

~~Ideal~~ dc resistance the ratio of voltage through the current is know as dc resistance

$$r_{dc} = \frac{V}{I}$$

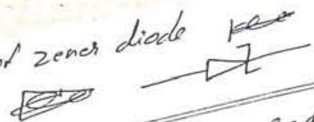
Statice or danamic resistance ⇒
the ratio of the small change in voltage current ~~ratio of the~~ is know as statice ~~or d~~ resistance

$$R_{ac} = \frac{\Delta V}{\Delta I}$$

* Some Impotant type of P-n Junction diode ⇒
1) zener diode
2) Photo diode
3) light ~~midding diode~~ emitting diode
4) Solar cell

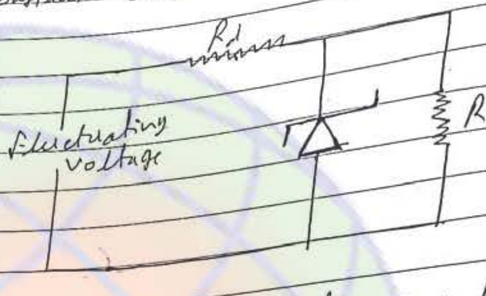
1) Zener diode ⇒
In havenly dopth reverse ~~by~~ baised p-n junction ~~is~~ diode is called zener diode
zener diode work in a ~~reversed baised~~ brackdown state

⇒ Symbol of zener diode



Zener diode is a voltage regulator ⇒

* An electronic device which is used to maintain the constant output voltage



Zener diode used as a voltage regulator is consistes of the zener diode that conta connecated to the load resistance and drooping resistance Rd as shown in the given figure

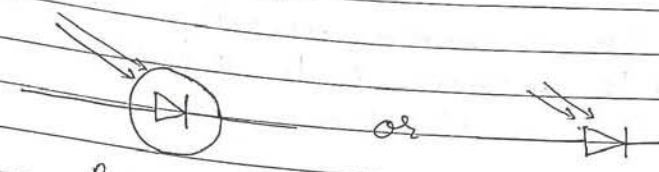
working ⇒

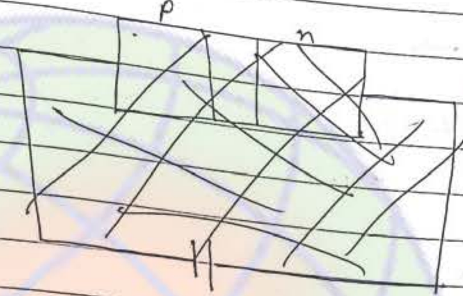
when the Input dc voltage increases beyound the sertain limit the voltage across the zener diode becomes constant equal to zener breakdown voltage but the current through the zener diode circuit arise sarplly as the dynamic resistance of ~~all most~~ be zener diode become allmost ~~zener~~ zero after after zener breakdown voltage due to which there is an increase in voltage across Rd and constant voltage obtained across R_L

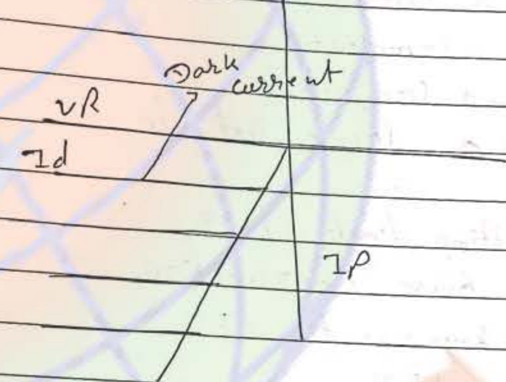
2) Photo diode ⇒

A Reverse bise Pn-Junction diode which emites the rediation of light in the presence of light is know as the photo diode

⇒ Symbol of Photo diode







contruction ⇒

A Photo diode is pn-Junction diode made up the photo sencecative semi-conductor mattecial it is coverd with the transparent material that allow the light falls on it. it is opperated under the reverse baise the given figure

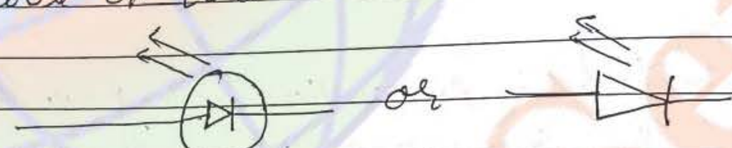
when visiable light of energy grater that the forbidden is incident on the Pn-Junction diode additional electron holes pair are created in the deplaction layer this charge carries will be seperated by junction field that easily flow the junction by the reverse biasing.

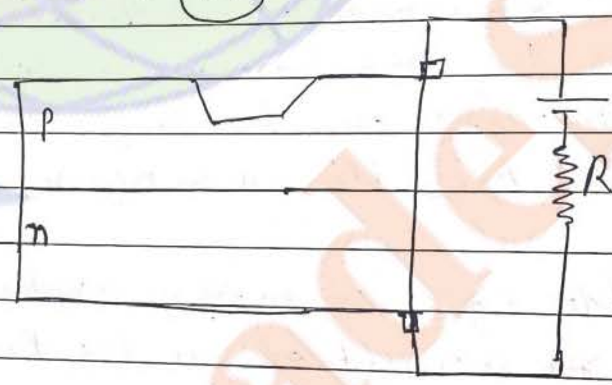
The flow of reverse saturation current increases with the increase in the intensity of light as show in the given figure.

* dark dark current =>
A current flow in a reverse bias P-n Junction, photodiode. in the absence of light ~~in the absence of~~ is known as the dark current

=> uses of Photo diode =>
It is use in a remode switch
It is use in a communication
It is use in a computer
It is use in a logic gat etc.

3) light emitting diode (LED) =>
A forward biase Pn-Junction diode which produce the light is known as the LED
=> Symbol of LED





construction =>
light emitting diode is consistes of the thin layer of ~~[illegible]~~ P type semi conductor and thick layer of n types semi-conductor

It is connecated to the load resitance R and forward baise by using the battery voltage.

working =>

when Pn-Junction is forward biase magurally current carries cross the junction the electron moves ~~fr~~ from n-region to P-region through the Junction and holes moves from P region to n-region through the Junction as a result of it the concentration of carrier increase repeadelly at the Junction bondary which combined with the majority current carrier and produce the heat and light

uses =>

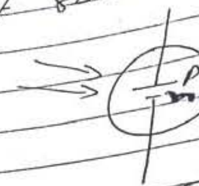
It is used in burglar alarm System.
It is use in calculator or digital watch
It is use in commication
It is use in a traffice light, remode control etc.

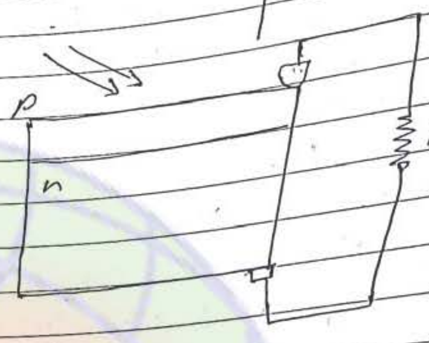
=> Advandage of LED =>

It has less power and low operational voltage
It has fast action and ~~require~~ required no warms ~~up~~ as time
It is cheat in eatily to handal
It can be used in varies ~~propers~~ purpers.

4) A Solar cell => Pn-Junction diode which convert solar energy into the ~~light ene~~ electrical energy is know as the solar cell

⇒ Symbole of solar cell





construction ⇒

A solar cell consists of the silicon or galium or arcenide pn-Junction diode which is cover with the glass window the upeerlayers is the p-type semi-conductor it is very thin show that the incident ligi liht photon may easily reach the pn-Junction on the p type fase of p-layer the metal finger electrodes are prepared which is the connecated to the output load resistance R

Working Photon of light falls at the Junction electron holes payer are generated in the diplolication layer near the Junction that moves in oposite opposite direction the photone generated electron moves forward n-type and holes moves towards p-region and rise the photo voltage b/w and bottom and electron electric current obtained across the load resistance R_L

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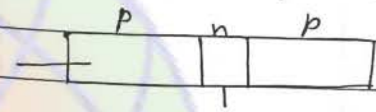
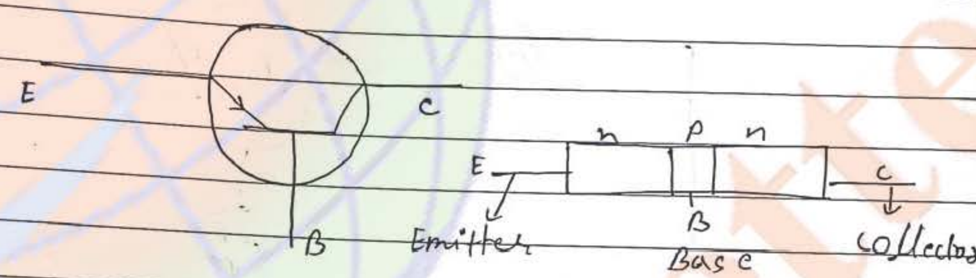
* Transistor :->
A transistor is formed by sandwich a thin layer of the semi-conductor b/w two thick layers of the same kind of the semiconductor.

=> There are two type of the transistor :->
1) PnP transistor obtained by sandwich of n-type of semiconductor between the thick layer of the semiconductor

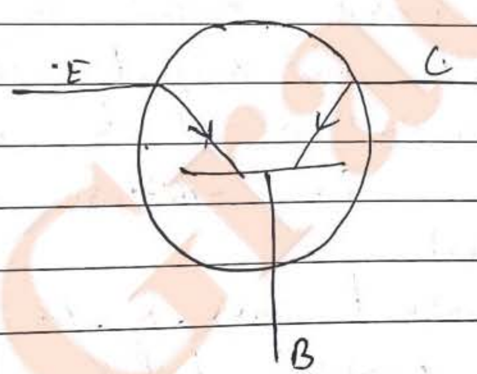


=> Symbol of p-n-p transistor :->

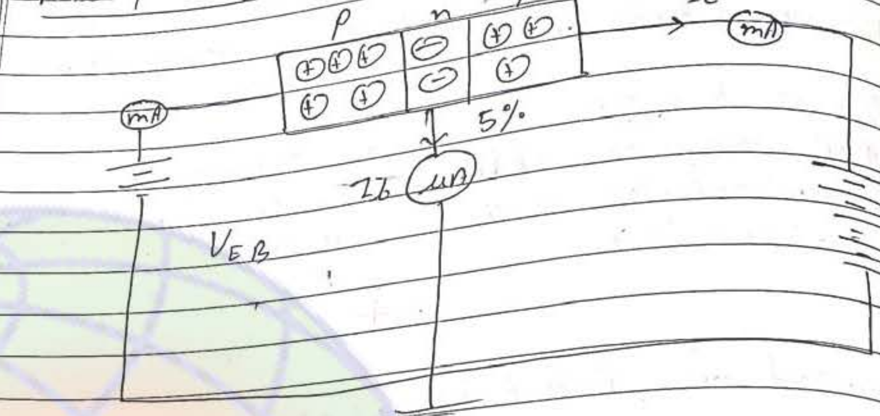


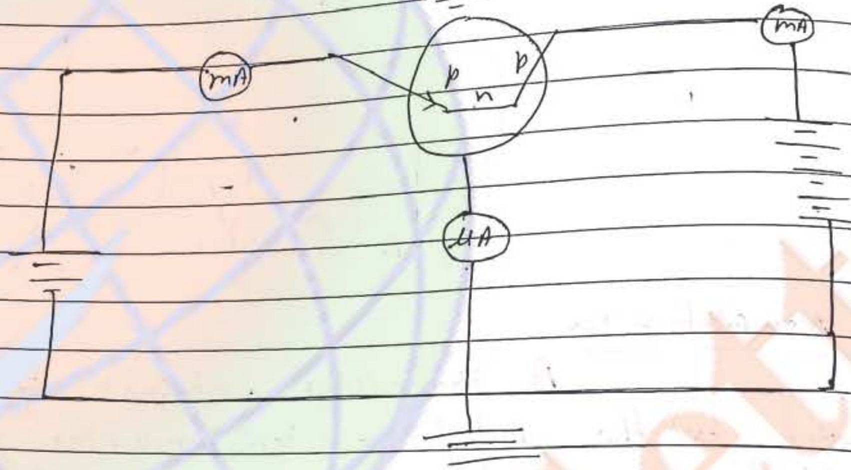
II) npn transistor :->
A transistor obtained by the sandwich of the p-type of semiconductor between the thick layer of n-type semiconductor

=> Symbol



* Action /working of PnP transistor =>





The schemetric and symbolic diagram as shown in the given figure. Emitter base input junction is forward baised by using Voltage i.e. 'V_{EB}' and output collector base junction is reversed baised by using voltage 'V...
Since emitter base junction is forward baised
so, majority current carrier holes repel towards current carrier holes inter to the base where 5% of the holes combine with the

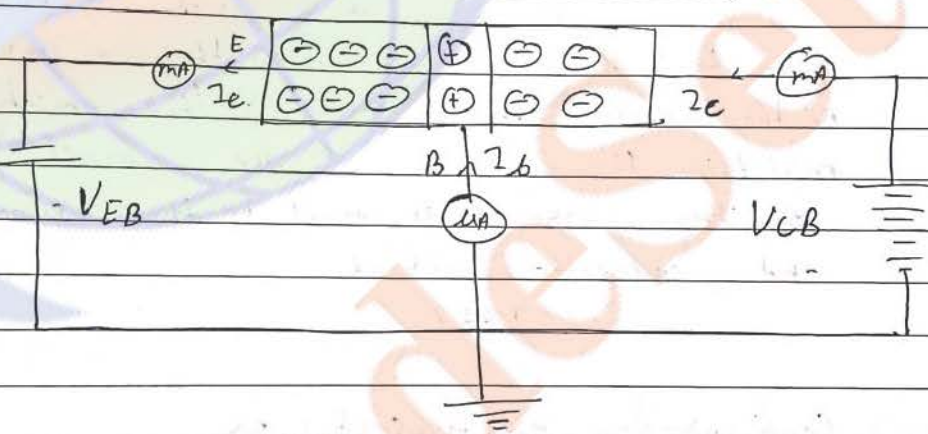
electrons and constituent base current I_B and remaining holes 95% holes attract towards the collector because it is connected to the negative terminal of the battery and constituent the collector current I_c.

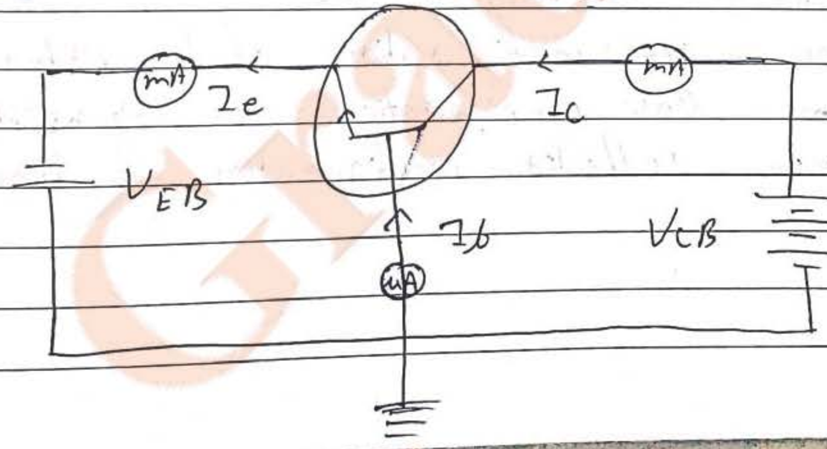
∴ A number of holes concentration decreases in a emitter then covalent bond is break imediately and produce the eeh electron and holes where electron moves (+ve) terminal of the battery V_{EB} and holes are repel towards the base and maintain the current in a circuit

According to junction law

$$I_e = I_b + I_c$$

* Action / working of the npn transistor ⇒





The symbolic and schematic diagram of npn transistor as shown in the figure. Emitter base junction is forward baised by using battery voltage V_{EB} and collector base junction is reverse baised by using batter voltage V_{CB}.

Since emitter base junction is forward baised so, majority current carries electrons moves towards the base and decreases its depletion layer and enter to the base where 5% of the electron combine with the holes and constitute the base current I_B. rest of the 95% of electron attract towards the collector because it is connected to the (Positive) terminal of the battery and constituent the collector current I_C.

As soon as 1 electron decreases in a emitter then electron from the -ve terminal of the battery moves towards the emitter and maintain the current in the circuit.

Emitter current is equal to the sum of base and collector current

$$I = I_b + I_c$$

=> Configuration of transistor :->

i) Common emitter configuration of transistor
ii) Common base configuration of transistor
iii) Common collector configuration of transistor

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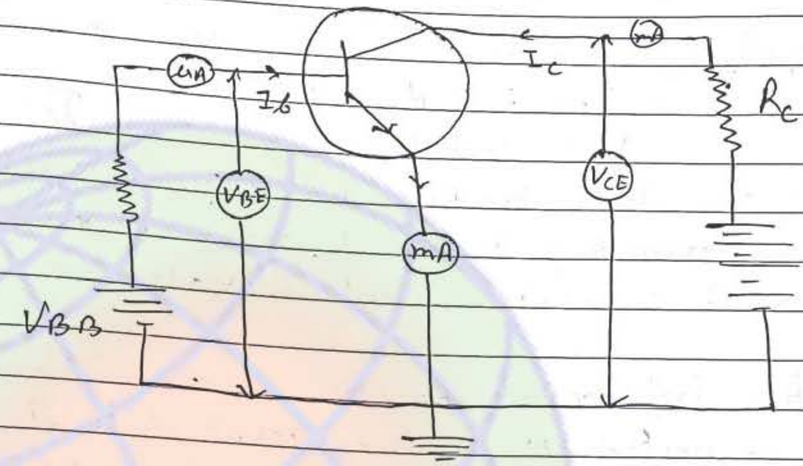
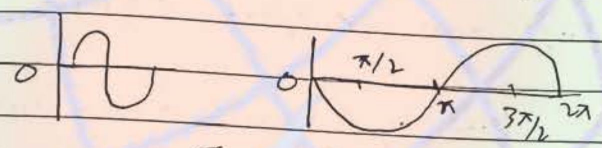
i) Common emitter configuration of transistor npn :-





$$I_e = I_b + I_c \quad \text{--- (1)}$$

from KVL

$$-V_{CC} + I_c R_c + V_{CE} = 0$$

$$V_{CE} = V_{CC} - I_c R_c \quad \text{--- (2)}$$

Common emitter npn transistor is used as a amplifier as shown in the given figure.

=> Input Junction base and emitter is formed baised by using battery voltage VBE and output collection emitter Junction is reverse baised by using battery voltage VCE.

=> A load resistance Rc connected in output across which output is taken out.

=> Capacitor C_1 and C_2 connected in input and output across which output is taken out

=> capacitor C_1 and C_2 connecated in input and output to provide pure a-c input and output.

by applying junction law

$I_e = I_b + I_c$ ——— ①

Applying kirchoff's voltage law in output circuit

$-V_{cc} + I_c R_c + V_{CE} = 0$

$V_{CE} = V_{cc} - I_c R_c$ ——— ②

During the positive half cycle input emitter base junction forward bais increased from eqⁿ ① collection current increases ⇒

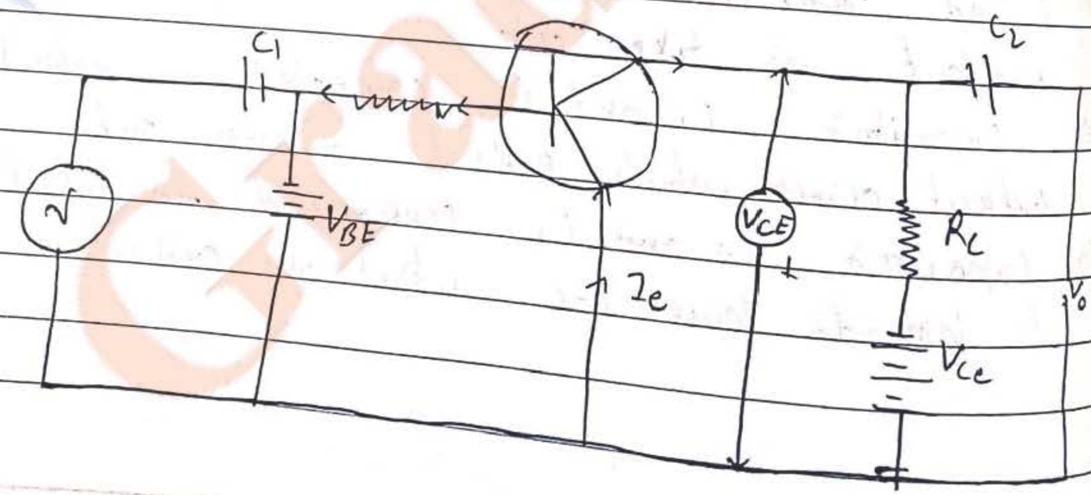
Voltage drop across R_c also increases since collector is connected to positive terminal to it produces more negative amplified output signal.

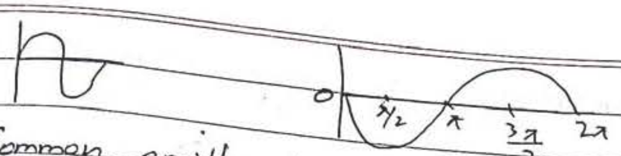
During the negative half cycle input forward baising decreases as a result collector current I_c decreases.

From eqⁿ ② voltage drop across R_c also decreases and produce more positive amplified output signal.

The phase difference b/w input and output signal is π

Common emitter pnp transistor is used as an amplifier





Common emitter pnp transistor is used as an amplifier whose configuration is shown in the given fig. Input base emitter junction is forward baised by using battery voltage V_{BE} and output junction collector and emitter is reverse baised by using battery voltage V_{CE}

In Input and output capacitor C_1 and C_2 are connected to provide the pure ac.
During the positive half cycle input emitter bas junction forward bais decreases from eq^n ① collector current I_C decreases and voltage drop across R_C also v and produce more negative output amplified signal

By applying junction law

$$I_e = I_b + I_c \quad \text{—— ①}$$

Applying KVL in output circuit

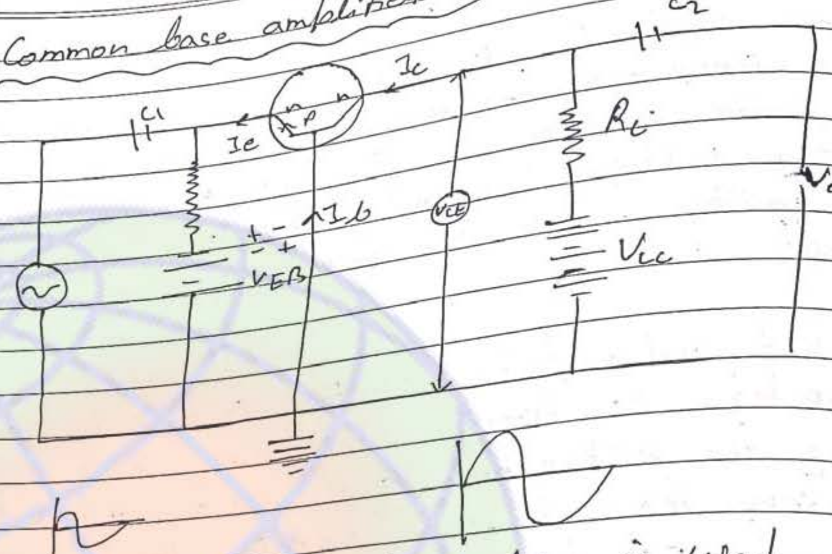
$$-V_{cc} + I_c R_c + V_{CE} = 0$$

$$V_{CE} = V_{cc} - I_c R_c \quad \text{—— ②}$$

During the negative half cycle input emitter junction forward bais increases. from eq^n ① collector current I_c increases and voltage drop across R_c also and produce more positive amplified output signal

The phase difference b/w input and output is 'π'

* Common base amplifier by using npn transistor



Common base npn transistor is used as an amplifier whose circuit diagram as shown in the given figure input emitter base junction is forward baised by using battery voltage V_{EB} output is taken across R_C by using voltage V_{CB}

In input and output capacitor C_1 and C_2 are connecated to provide a.c

applying kirchoff's junction law

$$I_e = I_b + I_c \quad \text{--- (1)}$$

Applying KVL in output circuit

$$-V_{cc} + I_C R_C + V_{CB} = 0$$

$$V_{CB} - V_0 = V_{cc} - I_C R_C$$

During the +ve positive halfe cycle input emitter base junction forward bais decreases from eq-(1) collector current I_c decreases. The voltage drop across R_C also decreates and produce more positive output amplified sig

The phase difference b/w input and output is 0

* Common base amplifier by using pnp transistor :=>

Transistor gain

Transistor gain of a common emitter amplifier :=>

1) AC current gain :=>

The ratio of the small change in output collector current I_c to the small change in input base current I_b at constant voltage V_{CE} is known as the current gain

$$B_{ac} = \left(\frac{\Delta I_c}{I_b} \right)_{V_{CE} = \text{constant}}$$

II) DC current gain =>

The ratio of the output current to the input current is known as the DC current gain

$$B_{dc} = \frac{I_c}{I_b}$$

III) Resistance gain (R gain) =>

The ratio of the output resistance to the input resistance is known as a resistance gain

$$R_{gain} = \frac{R_o}{R_i}$$

$$\alpha = \frac{\beta}{\beta+1}$$

from eq^n (1)

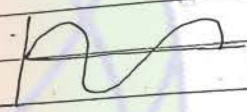
$$\frac{1}{\alpha} - 1 = \frac{1}{\beta}$$

$$\frac{1-\alpha}{\alpha} = \frac{1}{\beta}$$

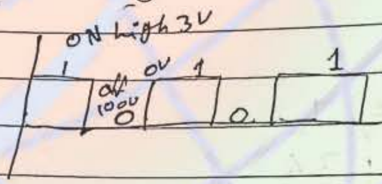
$$\beta = \frac{\alpha}{1-\alpha}$$

* LOGIC GATES =>

i) Analog Signal



ii) Digital Signal



i) Decimal system
$(0,1,2,--9)_{10}$

ii) Binary system :-
$(0,1)_2$

* Conversion of decimal to binary system

2	25	1 ⟶ least significant digit (LS
2	12	0
2	6	0
2	3	1
2	1 ⟶ most significant digit (MS	

* $(25)_{10} = (11001)_2$

2	17	1
2	8	0
2	4	0
2	2	0
	1	

* $(17)_{10} = (10001)_2$

If there is $(0)_{10} = (0)_2$

$(1)_{10} = (1)_2$

$(2)_{10} = 10$

$(3)_{10} = 11$

* logic gate

An electronic circuit which perform the Boolean algebric operation is known as the logic gates

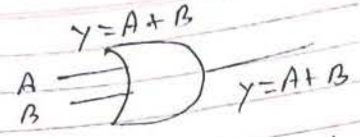
⇒ Types of logic gates

i) OR gate
ii) AND gate
iii) NOT gate
iv) NOR gate
v) NAND gate
vi) E-OR gate
vii) E-NOR gate

1) OR GATE

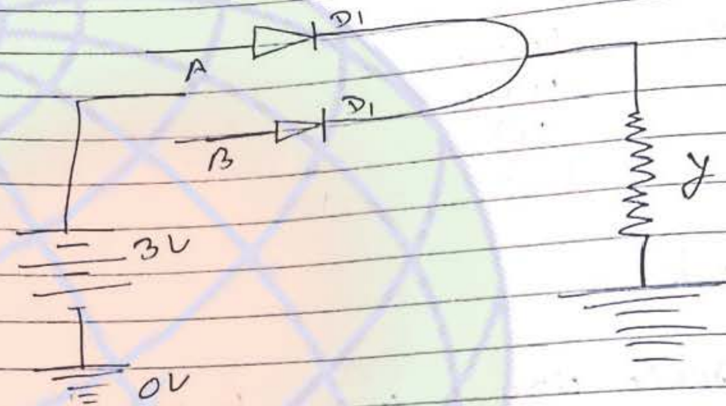
A Logic gat which perform the all operation is known as the OR Gate

OR means addition



It have two or more input but only one output

⇒ electronic circuit of OR gate:⇒



1) electronic circuit for two input is consist of the two diodes D_1 and D_2 as shown in given figure

operation

case I when A = 0 and B = 0
Both diode D_1 and D_2 are reversed biased that they do not conduct and there is no output

i.e y = 0

case II.

when A = 0 and B = 1
Diode D_1 is reversed biased that does not conduct and diode D_2 is forward biased that conduct output is high

case III – when $A=1$ and $B=1$ i.e $y=1$

Diode D_1 is forward biased and diode D_2 reversed biased due to diode. D_1 output is high
i.e $y=1$

case IV

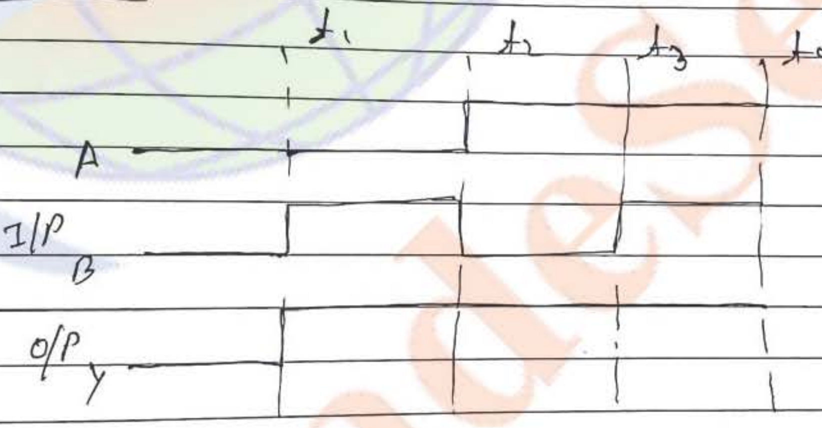
when $A=1$ and $B=1$

Both diode D_1 and D_2 are forward biased that conduct and output is high
i.e $y=1$

⇒ Truth table

Input A	Input B	output $Y=A+B$
0	0	0
0	1	1
1	0	1
1	1	1

⇒ wave form



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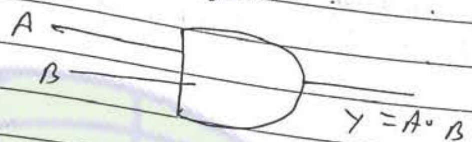
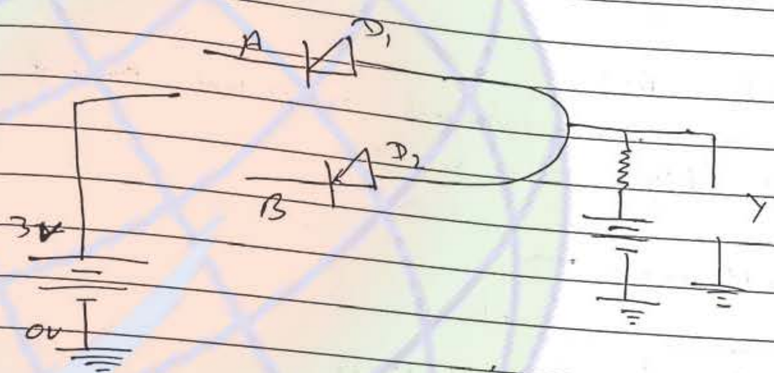
2) * And gate ⇒ A logic gate which is Performed the n- operation is knowas the And gate
$Y = A \cdot B$

⇒ Symbol of And gate



It have two or more input but only one output

⇒ electronic circuit of And



INPUT		OUTPUT
A	B	$Y = A \cdot B$
0	0	0
0	1	0
1	0	0
1	1	1

for And operation for two input diode D_1 and D_2 are connecated as show in the given figure

Case I ⇒

When $A = 0$, $B = 0$ both diode are becomes forward ~~diode~~ baised and they are conducate and all outputs are gate grounded as result output is ~~as result output is~~ low that is $y=0$

case II when $A=0$, $B=1$ diode D_1 conduct and Diode D_2 not conduct as result output is low that is $y=0$.

case III $A=1$, $B=0$ In this case diode D_1 is reverse biased and diode D_2 is forward biased due to which output is low i.e is $y=0$

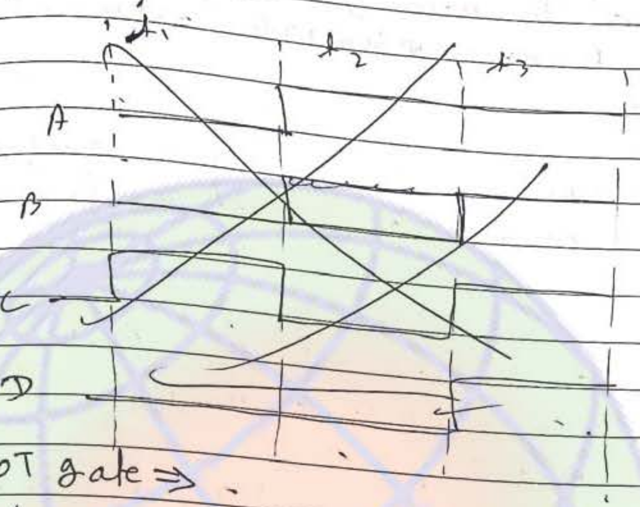
case IV when $A=1$, $B=1$ Both diode are ~~forward biased~~ reversed baised output is high i.e $y=1$

Truth table =>

Input A	Input B	Output $Y = A \cdot B$
0	0	0
0	1	0
1	0	0
1	1	0

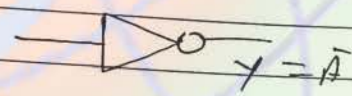
Wave form =>

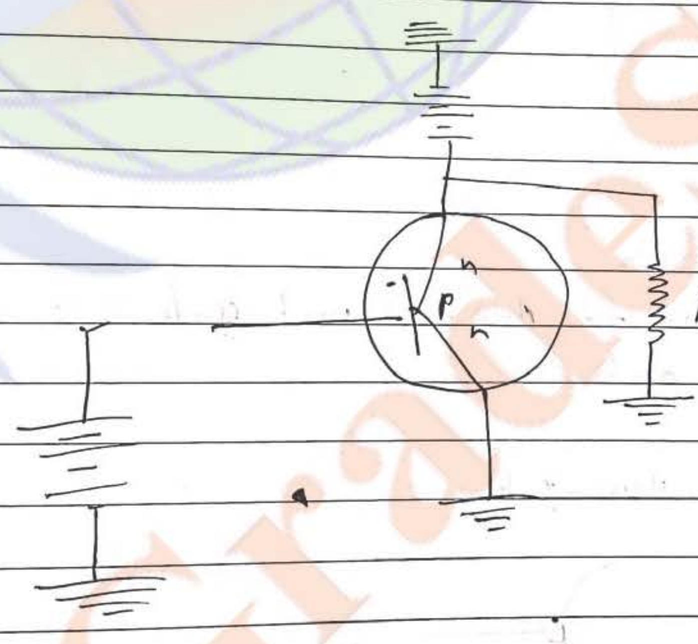
* Wave form ⇒



③ NOT gate ⇒

* A logic gate which Performed the not operation is know as NOT gate
It have only one input and output





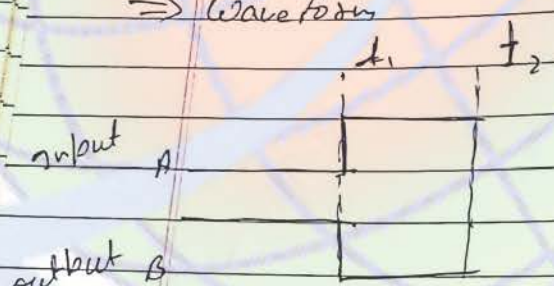
electronic circuit of the note gate by using the and transistor npn transistor as shown in the given figure

case I
when A = 0 transistor in a reversed baised that does not conduct as result output is high i.e. Y = 1

case II
A = 1 transistor (Q) is forward by baised that conduct. as a result output is low that is Y = 0

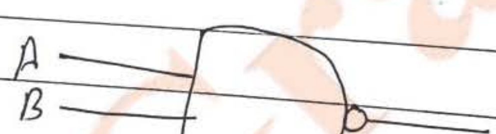
Input A	output Y = $\bar{A}$
0	1
1	0

⇒ Waveform



* Non- gate ⇒
A combination of And and not gate is know as the Non-gate

⇒ Symbol of Non-gate



$Y = \overline{A \cdot B}$

It has two or more input but one only-one output

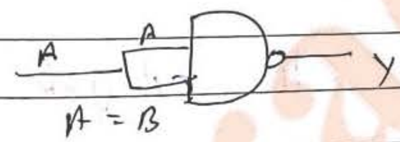
⇒ truth table

INPUT		Output
A	B	Y = A·B
0	0	1
0	1	1
1	0	1
1	1	0

wave form →

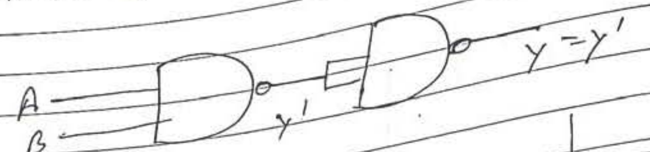
Non-gate is inversal logic gate that Perform the all basic operation

1) Nand-gate as a note gate



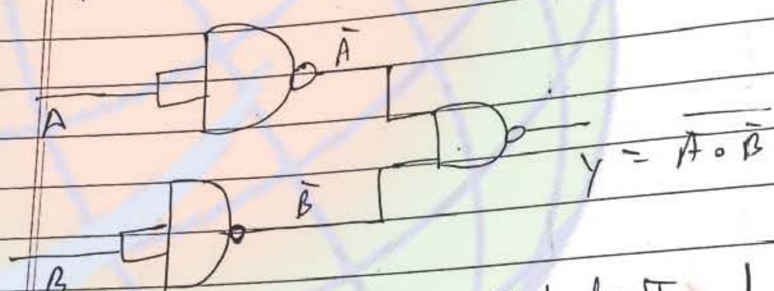
Input		output
A	A = B	Y = A·B
0	0	1
1	1	0

II) Nand gat as a AND gate



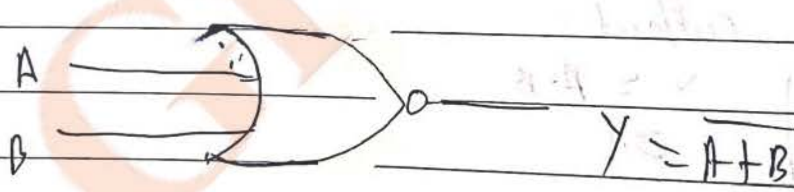
Input-1		Input-2	Output
A	B	$Y' = A \cdot B$	$Y = Y'$
0	0	1	0
0	1	1	0
1	0	1	0
1	1	0	1

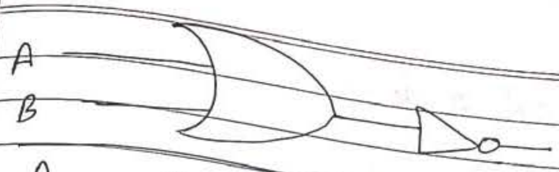
III) NAND gate as a OR gate



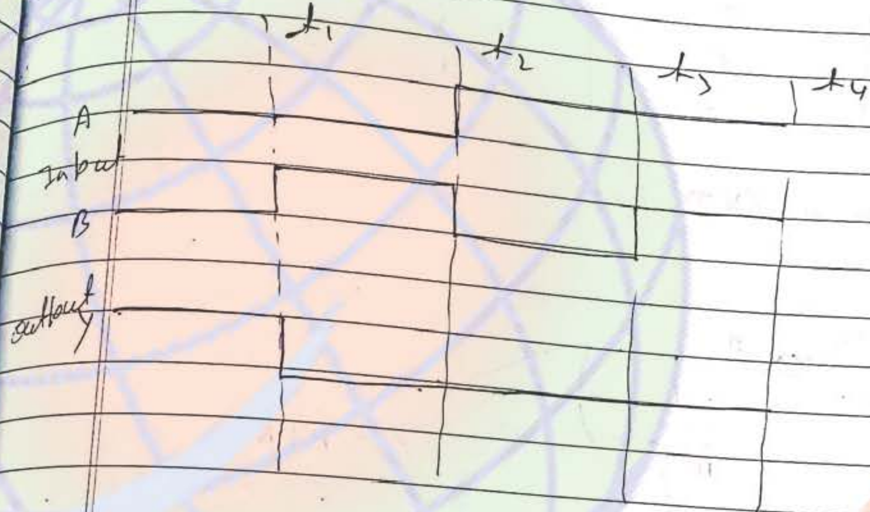
Input-1		Input-II		Output
A	B	$\bar{A}$	$\bar{B}$	$Y = \overline{\bar{A} \cdot \bar{B}}$
0	0	1	1	0
0	1	1	0	1
1	0	0	1	1
1	1	0	0	1

IV) NOR-gate => A combination of the OR gate and Not gate



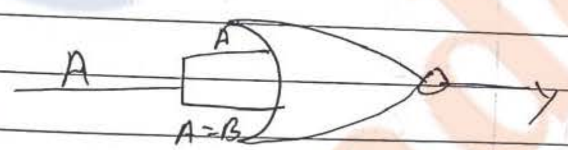


A	B	$Y = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0



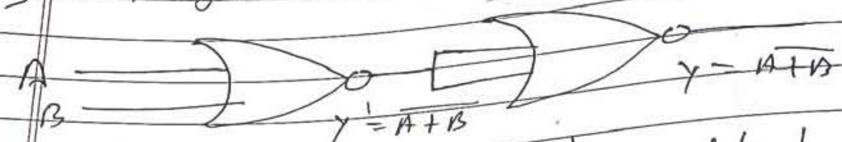
* NOR gate is universal gate ⇒ which Performed the all operation of the logic gate

1) NOR gate as a Not gate



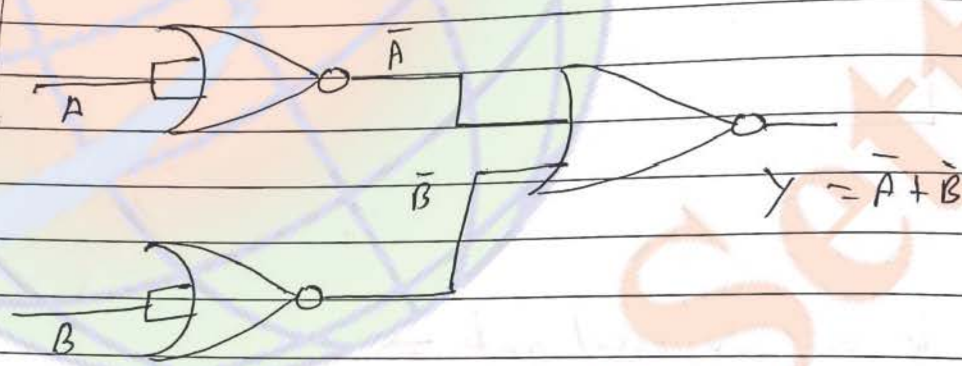
Input		Output
A	A = B	$Y = \overline{A+B}$
0	0	1
1	1	0

ii) NOR gate as a OR gate =>



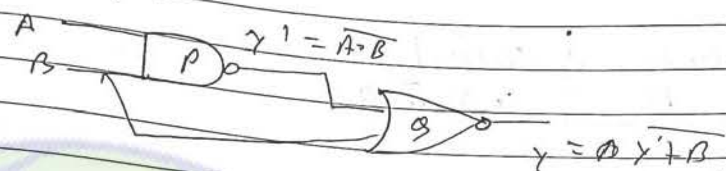
Input-I A	Input-I B	Input-II $Y' = \overline{A+B}$	Output $Y = A+B$
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	1

iii) NOR gate as a AND gate



Input-I A	Input-I B	Input-II $\bar{A}$	Input-II $\bar{B}$	Output $Y = \overline{\bar{A}+\bar{B}}$
0	0	1	1	0
0	1	1	0	0
1	0	0	1	0
1	1	0	0	1

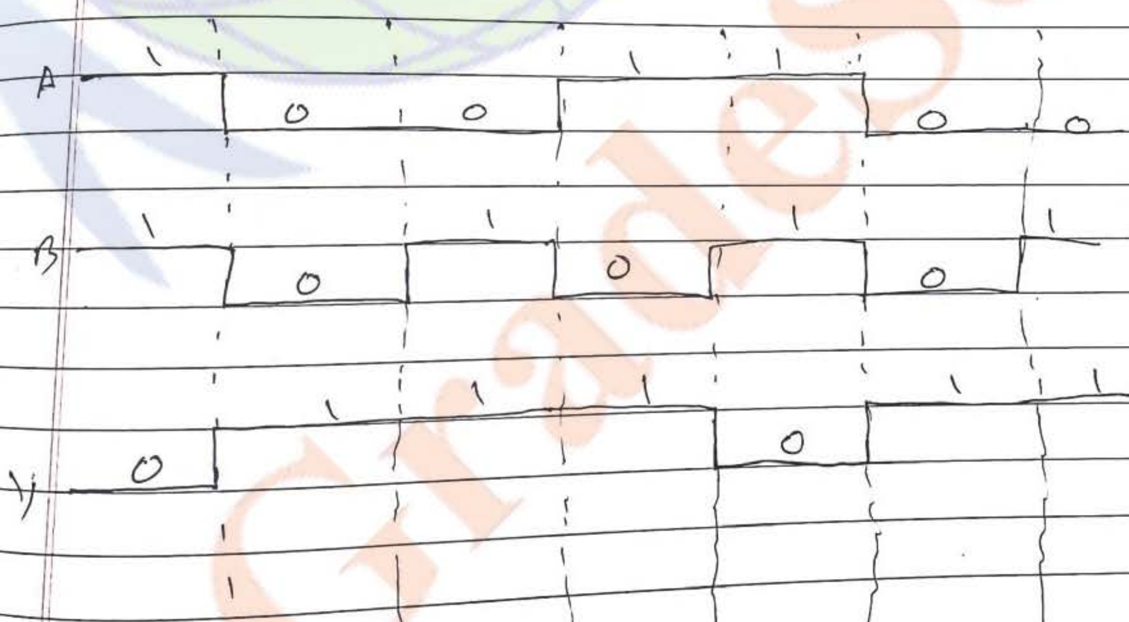
Q) Identifay the logic gat and write the truith table for two o input



P ⇒ NAND gate
Q → NOR gate

Input - 1		Input - 2		output
A	B	$Y' = \overline{A \cdot B}$	B	$Y = \overline{Y' + B}$
0	0	1	0	0
0	1	1	1	0
1	0	1	0	0
1	1	0	1	0

Q) The following figure shows the Input wave front A and B and output wave form Y of a logic gates intentifiy the gate and write the truth table



NAND gate

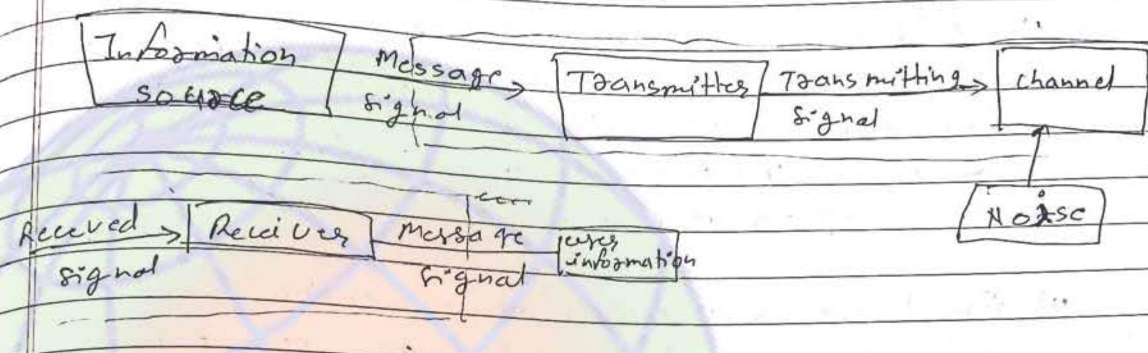
Input A	Input B	Output $Y = \overline{A \cdot B}$
1	1	0
0	0	1
0	1	1
1	0	1
1	1	0
0	0	1
0	1	1

Ch ⇒ 15

NCRT पढ़ना है इस chapter के लिए

Communication

* Communication system ⇒



In a communication system transducer convert the information source into the electrical form and this signal Provided the transmitter. transmitter convert the massage signal into the suitable transmitting signal before the transmitter low frequeny signal called modulating signal super impose on the high frequency signal called carrier wave signal this processes is know as modulation and obtained wave is called is know as modulated wave that is transmited by the transmitting antina in communication channel. As the transmitter signal probagate through the communication channel get distotated due to Noise and loss of the strength called attenuation this signal recived by the reciving antina that have a demodulator which saparate the low frequency audio signal from the modulated signal, and transmitter converted ie massage signal for the user.

They are following two mode of communication
1) Point to Point communication $\Rightarrow$ in which there is one signal transmitter and signal Reciver is know as the point to point communication. A mode of communication.
eg $\Rightarrow$ Mobile, Fax, Telephone, telegraph

11) Broad cast $\Rightarrow$ A mode of communication in which only - one transmitter and large no. of reciver is known as the broad cast
eg $\rightarrow$ Radio, T.V

$\Rightarrow$ Types of the transmitting medium and communication chainal
communication medium / chanal $\Rightarrow$
1) Guided transmitter medium or chainal
It is that communication which is used to point - point communication b/w a signal transmitter and reciver s
eg $\Rightarrow$ optical fibre / Telephone
This is used in line communication system

11) Un guidded transmitter median $\Rightarrow$
It is that communication medium in which there is no point to point contact b/w sign signal transmitter and a reciver this communication system used and ~~statstyle~~ ~~satalyte~~ Satellite.

Note
Page no $\Rightarrow$
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Antina ⇒ A metallic state structure is know as the antina
⇒ There are two types of antina
i) Herge antina ⇒ It is a straight conductor of length equal to halfe of the wave length of the transmitted or reived signal

length of antina = $\frac{\lambda}{2}$

ii) Markonic antina ⇒ It is straight conductor whose length is equal to the one fourth of the wave length of the transmitted or reived signal

length ~~size~~ of antina = $\frac{\lambda}{4}$

Modulation ⇒
The processes of ~~supes~~ imposition ~~imposince~~ of ~~high~~ of low frequency signal ~~of~~ called modulating signal over the high frequency signal called carrier wave two produce modulated wave is know as modulation

Needs of modulation ⇒
i) Size of antina ⇒ by the modulation modulated wave ~~also~~ obtained that's have high frequency and low wave length so its size becomes lower
for example ⇒ ~~size~~ low frequency signal of 20 KHz
$20 \times 10^3 Hz$

$$\lambda = \frac{c}{V} = \frac{3 \times 10^{8\,4}}{2\cancel{0} \times 10^{\cancel{3}}}$$

$$\frac{3 \times 10^4}{2} = 1.5 \times 10^4 m$$

Size of antina = $\frac{\lambda}{4}$ = $\frac{1.5 \times 10^4}{4}$
= 0.375×10^4
= 3750 m

when this signal super-impose over the high frequency carrier wave signal of frequency 1 MHz = 10^6 Hz
$\lambda = \frac{3 \times 10^8}{10^6}$ = 300 m

Size of antenna = $\frac{\lambda}{4}$
= $\frac{300}{4}$ = 75 m

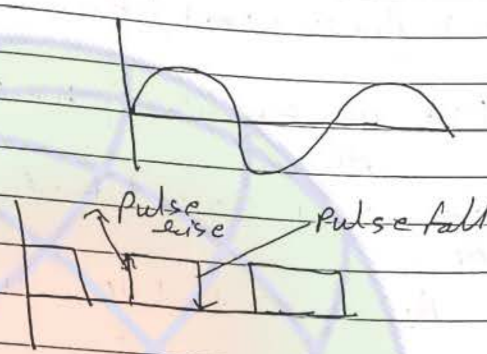
This shows that needs of modulation

ii) Effective power radiated by antina => Therotically experimentally is find that power of radiation is directly directly proportional to the square of the $\frac{1}{\lambda}$ $P \propto \left(\frac{1}{\lambda}\right)^2$

here power radiation increases by reducing the wavelength this is possible when modulation is take place

Mixing of signal from different transmitters there is imbossible to distinguish low frequency signal mixing there is less chance to mixing high frequency signals that way this is also needs of modulation

* Types of modulation
i) Amplitude modulation
ii) frequency modulation
iii) ~~pulse~~ phase modulation



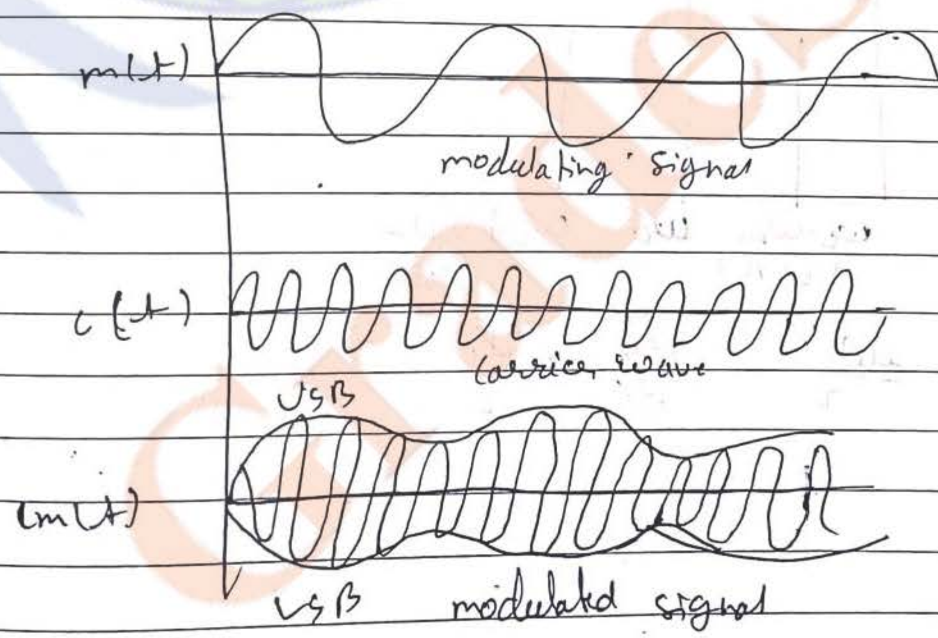
1) Amplitude modulation →

A modulation in which amplitude of the carrier waves varies according with the varation of modulating signal.

let modulating signal and carrier wave are

$m(t) = A_m \sin \omega_m t$ —— (1)

$c(t) = A_c \sin \omega_c t$ —— (2)



modulated signal is given by

$C_m(t) = [A_c + m(t)] \sin \omega_c t$

$= (A_c + A_m \sin \omega_m t) \sin \omega_c t$ (from eq. ①)

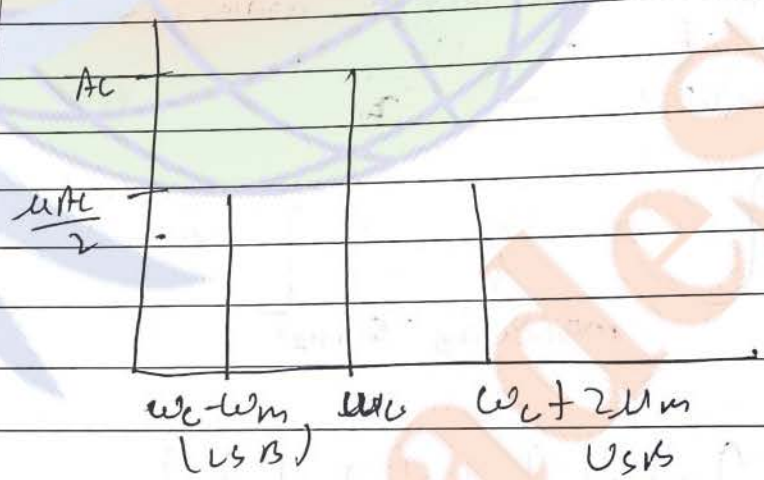
$= A_c \left(1 + \frac{A_m}{A_c} \sin \omega_m t\right) \sin \omega_c t$

where $\frac{A_m}{A_c} = \mu$ (called modulation index)

$C_m(t) = A_c \sin \omega_c t + \frac{A_c}{2} \mu\, 2 \sin \omega_m t \cdot \sin \omega_c t$

$= A_c \sin \omega_c t + \frac{A_c \mu}{2} \cos(\omega_c - \omega_m) t - \frac{A_c \mu}{2} \cos(\omega_c + \omega_m) t$

here three frequency $(\omega_c - \omega_m)$ called lower side band and $(\omega_c + \omega_m)$ called upper side band



$\frac{\mu A_c}{2} = \frac{A_m}{A_c} \times \frac{A_c}{2}$

* band width ⇒ upper side band − lower side band

USB − LSB

$= \omega_c + \omega_m - \omega_c + \omega_m$

$= 2\omega_m$

Note ⇒ Maximum amplitude and voltage of modulation signal $= A_c + A_c$

Minimum amplitude and voltage $= A_c - A_m$

* Power Average power per cycle in the unmodulated carrier wave

$$P_c = \frac{A_c^2}{2R}$$

Average power per cycle of modulated signal

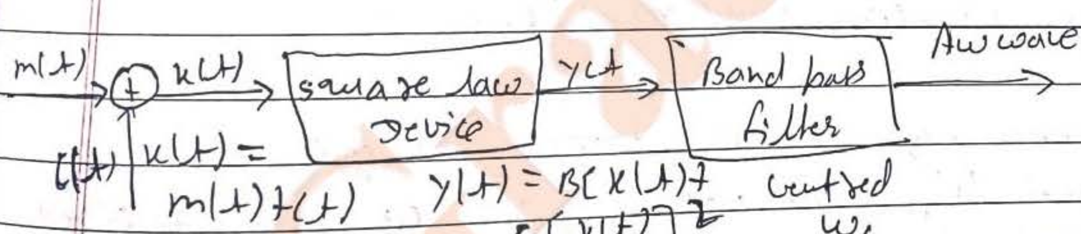
$$P_t = P_c\left(1 + \frac{\mu^2}{2}\right)$$

$$\frac{P_t}{P_c} = \left(1 + \frac{\mu^2}{2}\right)$$

$$\frac{I_t^2 R}{I_c^2 R} = \left(1 + \frac{\mu^2}{2}\right)$$

$$\boxed{\frac{I_t}{I_c} = \sqrt{1 + \frac{\mu^2}{2}}}$$

* Production of the amplitude modulated wave ⇒



Block of a simple modulator

$2\sin A \cdot \sin B = \cos(A-B) - \cos(A+B)$

$\sin^2 A = \frac{1-\cos 2A}{2}$

Modulating and carrier wave signal are given by

$m(t) = A_m \sin \omega_m t$

$c(t) = A_c \sin \omega_c t$

$x(t) = m(t) + c(t)$

$= A_m \sin \omega_m t + A_c \sin \omega_c t$ ——— (1)

This signal passes through the square law device.

$y(t) = [B x(t)] + c[x(t)]^2$

$= B[A_m \sin \omega_m t + A_c \sin \omega_c t] + c[A_m \sin \omega_m t + A_c \sin \omega_c t]^2$

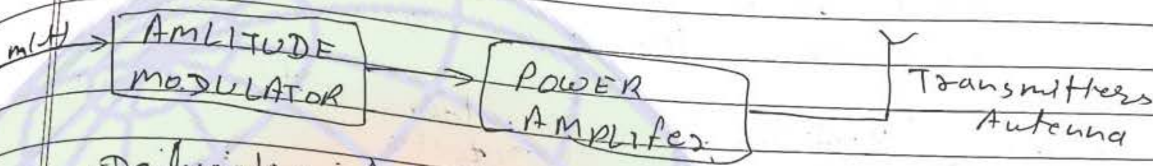
$= BA_m \sin \omega_m t + BA_c \sin \omega_c t + cA_m^2 \sin^2 \omega_m t + 2cA_m A_c \sin \omega_m t \sin \omega_c t + cA_c^2 \sin^2 \omega_c t$

$y(t) = BA_m \sin \omega_m t + BA_c \sin \omega_c t + \frac{cA_m^2}{2} - \frac{cA_m^2}{2} \cos 2\omega_m t + 2cA_m A_c \cos(\omega_c - \omega_m) t - 2cA_m A_c \cos(\omega_c + \omega_m) + \frac{cA_c^2}{2} - \frac{cA_c^2}{2} \cos 2\omega_c t$

there are ~~the they are~~ following frequency ω_c, ω_m, $2\omega_m$, $2\omega_c$, $\omega_c - \omega_m$ and $\omega_c + \omega_m$

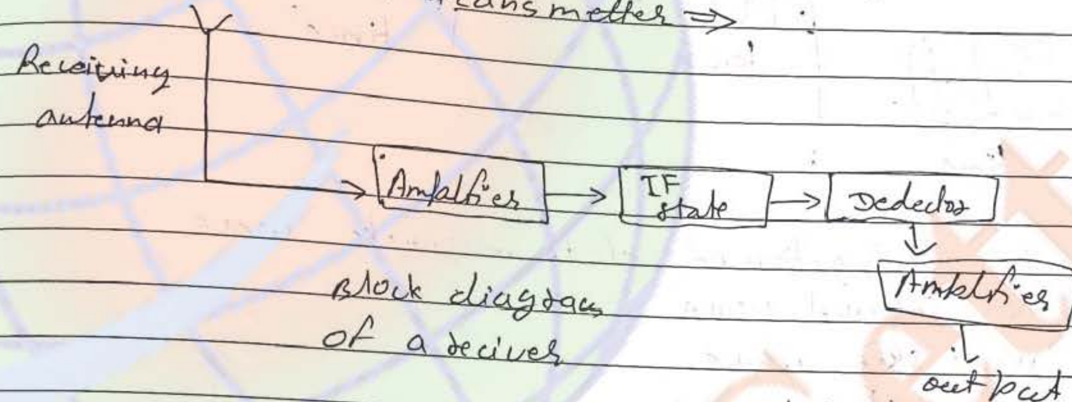
this frequency are passes ~~throu~~ through the band pass filter which produce the desired ~~direct~~ frequency $\omega_c - \omega_m$ and $\omega_c + \omega_m$

Before ~~transmission~~ transmission their signal are passes through the power amplifier and then radiated by the transmiting antenna in a communication channels.



Deducation of amplitude modulated wave =>

1) Block diagram of transmetter =>



Block diagram of a reciver

transmitted massage gate ~~atinuate~~ attenated in probagating through the chainal the reciving antuna to floude by an amplifier and a dector and addition it is connecated to the intermediated frequency state which conveet the carrier frequency in dired ~~as~~ low frequency output ~~to~~ of the IF state posses through the decator that produce the usual out put massage signal. Since during the decation signals is atinuated so again it posses through the amplifier whose Block diagram as show in the given figure.

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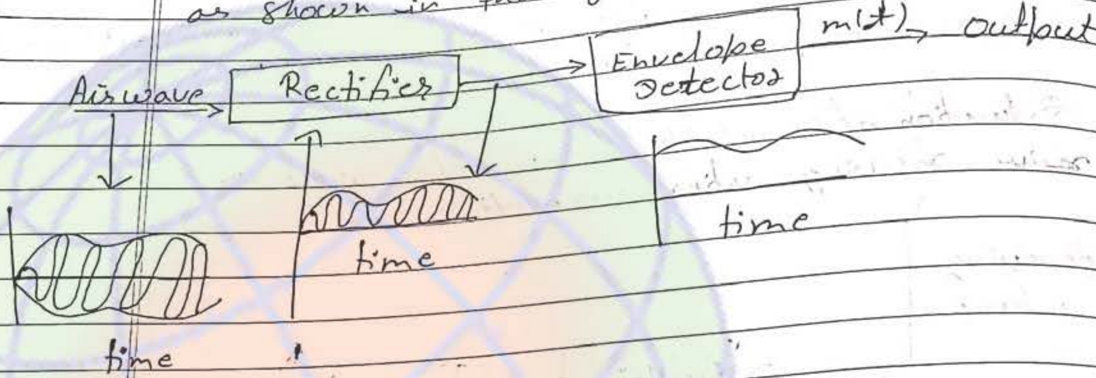
* deModulation or dedecation ⇒ the low frequency
The processes of removale of the high frequency signals signal from the high frequency signals
called demodulation or dedecation block diagram
as shown in the given figure.



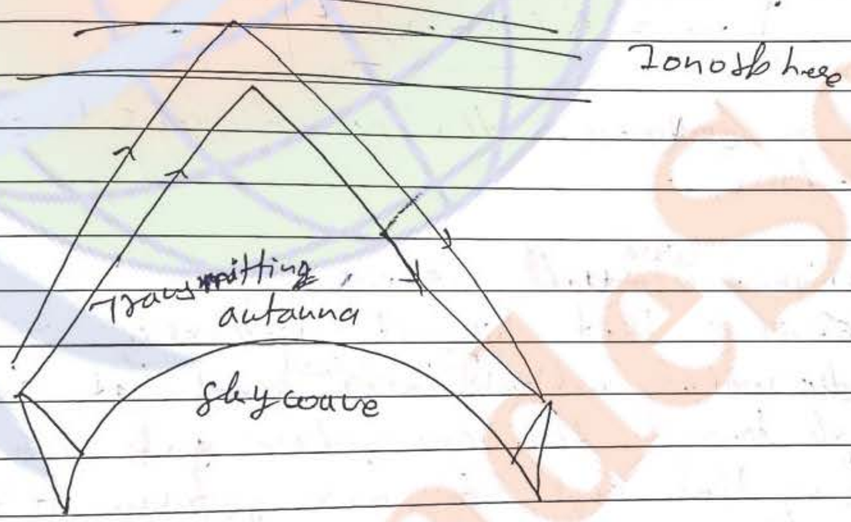
* Propagation of electromagnatic wave
1) Ground wave
11) sky wave
111) Space wave

1) Ground wave propagation ⇒
A mode of wave propagation in which the ground has stronge influance on the propagation of signals waves from the transmitting antenna to receiving antinna is know as the Ground wave propagation or surface wave propagation.
to radiate the signal with high efficiency the antinna length at list $\frac{\lambda}{4}$ the antinna haves large physical size and they are located or very near to the ground in standard Amplitude Modulated (Am) broad cast the ground best vertical towers are generally used

as transmitting antenna for such antenna ground has strong influence on the propagation of the signal the mode of propagation is called surface wave propagation and wave glides over the surface of the earth a wave induces current the ground over which it passes and it is attenuated as result of absorbation of energy by the earth the Attenuation of surface wave increases very rapidly with increase in frequency so it frequency is less than few maga Hertz (MHz)

III) Sky wave propagation ⇒

It is a mode of wave propagation in which the radio wave emmited from the transmitter antenna reach the receiving antenna after reflection by the ionosphere.



In the frequency range form few maga hertz upto 30 to 40 MHz can be activiated by the reflecation of the atmosphere that extanted from 65 km to 400 km above the earth surface.

Ionosphere occurs due to the absorption of ultraviolet and other high energy radiation coming from the sun the ionosphere divided in different layers on the variation of density of ionds
density of the atmosphere decreases at hight but concentration of ions increases each layers are act as reflector of the different frequency

Critical frequency ⇒
it is a highest frequency of radio wave which when sent straight that is normally towards the layer of ionosphere gates reflected from ionosphere and return to the earth

$$\nu_c = 9 (N_{max})^{1/2}$$

where N_{max} is the no. of density of the electrons

Maximum usual frequency ⇒
it is that highest frequency of radio waves which when sent at some angle towards the ionosphere gate reflected from that and becomes returns to the earth

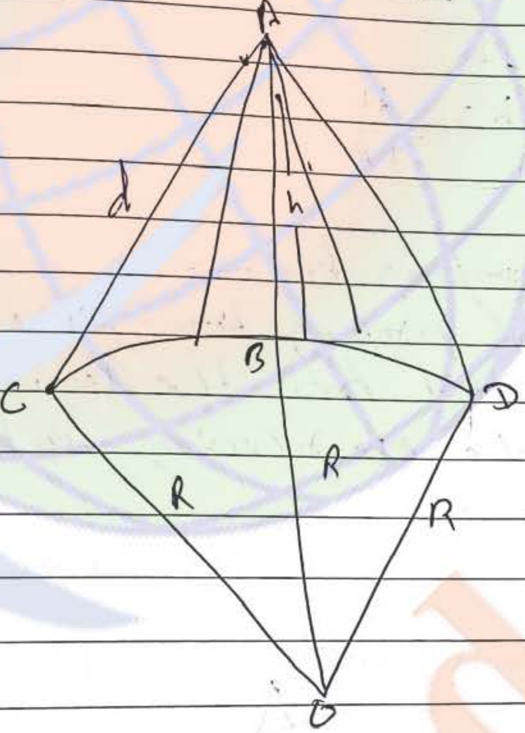
maximum usual frequency = $V_c \sec\theta$

$$MUF = V_c \sec\theta$$

* Skeep - distance ⇒
It is the smallest distance b/w the transmitting antinna and the receving antinna and the receiving antinna where the skys wave of fixed frequency but not more than the critical frequency is first received after reflection from the iono sphere.

* fading ⇒ It is the varation in the strength of a signal at a receiver due to interfarance of wave

* hight of antinna ⇒



let antinna AB at hight of h fixed on the ground surface which have radius R

$AO^2 = AC^2 + OC^2$
$(h+R)^2 = d^2 + R^2$
$h^2 + R^2 + 2hR = d^2 + R^2$

$h^2 << R$

$2hR = d^2$

$d = \sqrt{2hR}$

Area effected

$= \pi d^2$

$= \pi 2hR$

Area $= 2\pi hR$

population = Area × population density

population $= 2\pi hR \rho$

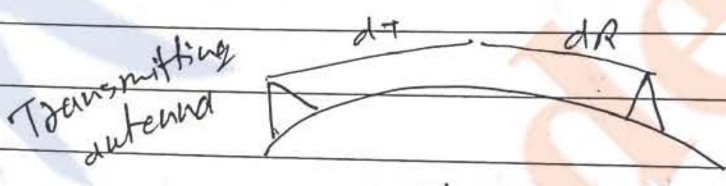
height

$2hR = d^2$

$$h = \frac{d^2}{2R}$$

3) Space wave propagation →

It is a mode of propagation in which the radio wave emitted from the transmitting antenna reach the receiving antenna through space.



$d_M = d_T + d_R$

$$d_M = \sqrt{2h_T R} + \sqrt{2h_R R}$$

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A space wave are used for line of sight communication as well as satellite communication at frequency of above the 40MHz communication is essentially ~~generally~~ limited ~~increases~~ to line of ~~side~~ sight paths. At this frequency the antenna are relatively smaller and can be placed at heights of many wave length above the ground because of line of sight nature of propagation direct wave gets blocked due to curvature of earth so total horizontal distance from the transmitting antenna to receiving antenna is given by

$$d_M = d_T + d_R$$

$$\boxed{d_M = \sqrt{2h_T R} + \sqrt{2h_R R}}$$

where h_T = height of transmitting antenna
h_R = height of receiving antenna

television broadcast microwave links and satellite ~~satelight communication can be used in space wave mode communication~~ can be used in spacewave mode.

Ex 15.1 $h_T = 32\,m$

$h_R = 50\,m$

$R = 6.4 \times 10^6\,m$

$$d_M = \sqrt{2h_T R} + \sqrt{2h_R R}$$

$$= \sqrt{2 \times 32 \times 6.4 \times 10^6}$$

$$= 45.5\,km$$

17.1.16

~~15.(d) $A_{sa} = 1 \times 4n$ $= 2 \times 3.14 \ldots$~~

15.5) $A_c = 12V$

$A_m = ?$

$\mu = 75\%$

$= \frac{75}{100} = \frac{3}{4}$

$\mu = \frac{A_m}{A_c}$

$\frac{3}{4} = \frac{A_m}{12}$

$A_m = \frac{3}{4} \times 12$

$= 9$

15.6) $c(t) = 2 \sin 8\pi t$ volts

$c(t) = A_c \sin \omega_c t$

comparing above eqn

$A_c = 2V$

$\omega_c = 8\pi$

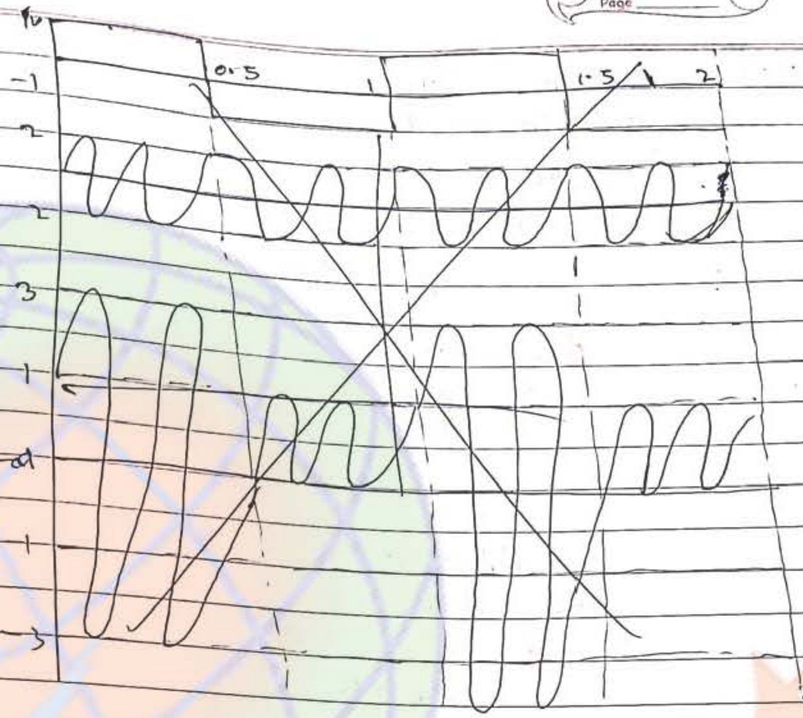
$2\pi \nu_c = 8\pi$

$\nu_c = 4$

$A_m = 1V$

$A_{max} = A_c + A_m = 2+1 = 3V$

$A_{min} = A_c - A_m = 2-1 = 1V$



(ii) $\mu = \frac{A_m}{A_c} = \frac{1}{2} = 0.5$

17.1

15.7

$A_c + A_m = 10V$

$A_c - A_m = 2V$

$2A_c = 12$

$A_c = \frac{12}{2} = 6$

$A_c = 6V$

$A_m = 10 - 6 = 4V$

$\mu = \frac{A_m}{A_c} = \frac{4}{6} = \frac{2}{3}$

$\mu = \frac{2}{3}$

$A_c + A_m = 10$

$A_c - A_m = 0$

$2A_c = 10$

$A_c = 5$

$A_m = 5$

$\mu = \frac{A_m}{A_c} = \frac{5}{5} = 1$

*

Ch ⇒ 8

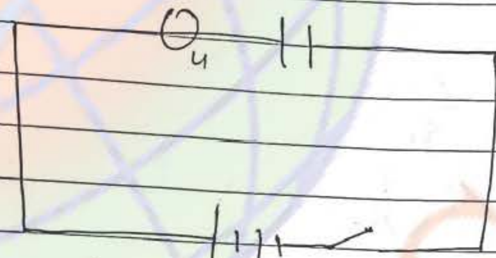
Electromagnatic Wave

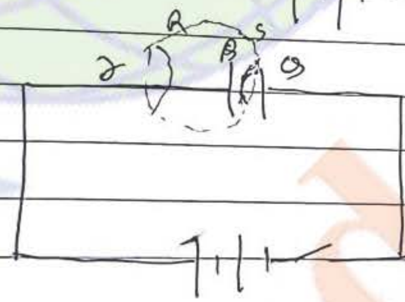
* Displacemant current ⇒
A/c to amfaire circuital law

$$\oint \vec{B}\cdot d\vec{l} = \mu_0 I \quad \text{—①}$$

maxwell satchedd that ~~som~~ abae euation is logicali in Constant consistant

for this verification maxwell arranged the apparatus than consists of a capacitor of two plate P and Q connected to the battery through taping switch. maxwell consider the taping switch - in which whore are one ends loop lies are at R and another ends lies b/w the plates at S.





Applying ACL at R

$$\oint_B \vec{\cdot}\, d\vec{l} = \mu_0 I$$

$$B\int dl \cos\theta = \mu_0 I$$

$$B \times 2\pi r = \mu_0 I \quad \text{--- (II)}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

applying ACL ats

$$\oint \vec{B} \cdot \vec{dl} = \mu \times 0 \quad \text{--- (III)}$$

$$\boxed{B = 0}$$

from eqn (II) and (III) ampiere circuital law is in consistent. maxewell suggested that some thing is missing in the amperian circuital law which is related to the electric field

Let capacitor plate has area A and charge q

$$E = \frac{\sigma}{\varepsilon_0}$$

$$\sigma = \frac{q}{A}$$

$$E = \frac{q}{\varepsilon_0 A}$$

$$q = \varepsilon_0 E A$$

$$q = \varepsilon_0 \phi_e$$

Diff w.r.t t.

$$\frac{dq}{dt} = \varepsilon_0 \frac{d\phi_e}{dt}$$

$$\boxed{I_d = \varepsilon_0 \frac{d\phi_e}{dt}}$$

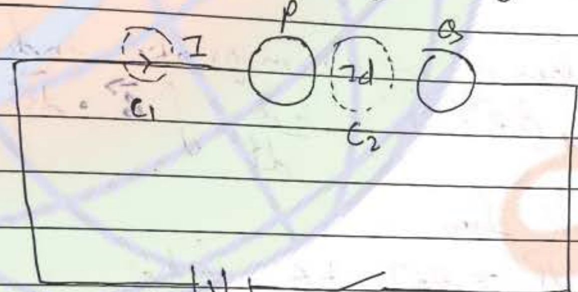
$$\oint \vec{B} \cdot \vec{dl} = \mu_0 (I + I_d)$$

It is the displacement current thus displacement current is that current which comes into play region in which electric field and electric flux changing with time

Maxwell modify the ampere circuital law called ampere Maxwell law ~~or equation~~ are given by

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 (I + I_d)$$
$$= \mu_0 I + \mu_0 \varepsilon_0 \frac{d\phi_e}{dt}$$

\# Continuity of current =>
According to continuity of current the sum of conduction current and displacement current has a important property of continuity along any closed path individually they may be continuous.



Consider a parallel plate capacitor P and Q connected to the battery through the switch
Consider two loop C_1 and C_2

$$I + I_D = I + \varepsilon_0 \frac{d\phi_e}{dt}$$

where, $\phi_e = 0$ —— (1)

$$I + I_D = I$$

for loop C_2

$$I + I_D = 0 + \varepsilon_0 \frac{d\phi_e}{dt}$$

$$= 0 + \frac{\epsilon_0 \, dI}{\epsilon_0 \, dt}$$

$$I + I_D = I \quad \text{——— (2)}$$

From eqn (1) and (2) we condu concluded that sum of conduction current and disfslacement current are continue

Equation of Maxwell :-

I) gauss law of electrostatics

$$\oint \vec{E} \cdot \vec{ds} = \frac{q}{\epsilon_0}$$

II) gauss law of electromagneto static

$$\oint \vec{B} \cdot \vec{ds} = 0$$

III) Faraday's law of electromagnetic inductor

$$\oint \vec{E} \cdot \vec{dl} = \frac{-d}{dt} \int \vec{B} \cdot \vec{ds}$$

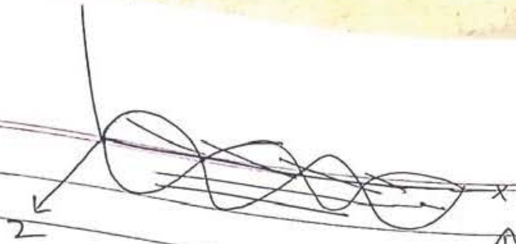
IV) Ampere Maxwell law

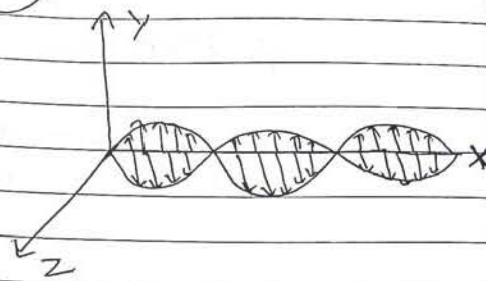
$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I + \epsilon_0 \frac{d\phi_e}{dt}$$

Electromagnetic waves :->

A/c to Maxwell the electromagnetic waves are those waves in which there are sinosuidal varation of electric and magnetic field vectors at right angle to each other,

As well as at right angle to the direction of wave propagation.





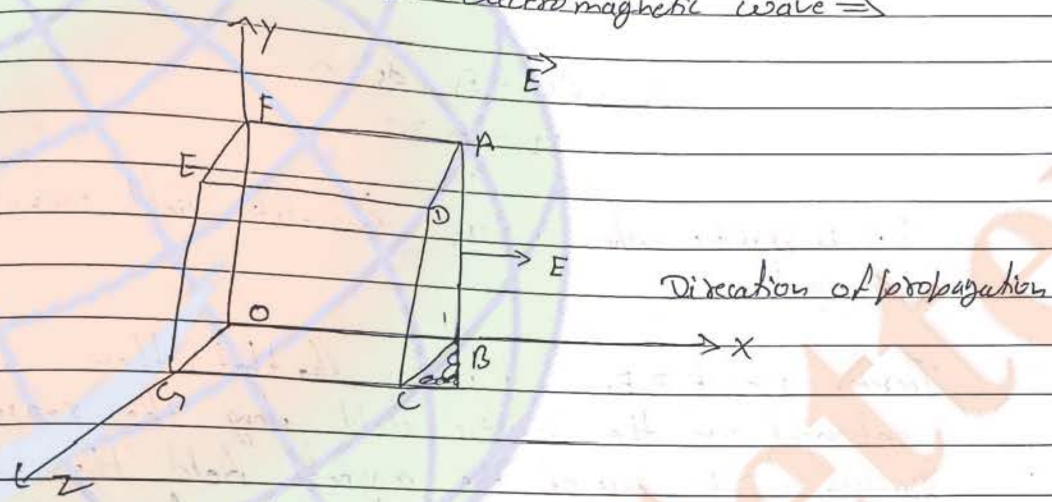
$E_y = E_0 \sin(kx - \omega t)$

$B_z = B_0 \sin(kx - \omega t)$

$k = \frac{2\pi}{\lambda}$

$\omega = 2\pi\nu$

* Transverse nature of the electromagnetic wave ⇒



A plane

consider x electromagnetic wave propagate in the direction of the x-axis in a consider parallelopide ABCDEFOG ABCD is the wave front of the electromagnetic wave at the any stand 't'

Electric and a magnetic field ⊥ to the direction of a magnetic ~~field~~ x-axis ~~suppor~~ suppose to zero

Since there is no charge inclosed in a parallelopide

Applying the gauss law :-

$$\oint \vec{E}\,\vec{ds} = \frac{1}{\epsilon_0}$$

$q = 0$

$\oint \vec{E} \cdot \vec{ds} = 0$

$\int_{ABCD} E_1 ds \cos 0^\circ + \int_{EFGH} E_2 ds \cos 180^\circ + \int_{ADEF} E ds \cos 90^\circ + \int_{BCGH} E ds \cos 90^\circ +$

$\int_{ABDF} E d \cos 90^\circ + \int_{CDEG} E ds \cos 90^\circ = 0$

$E_1 \int ds - E_2 \int ds = 0$

$E_1 - E_2 = 0$

This is possible when $u_1 = u_2$ but static field cannot be propagate

Therefor ~~$u_1 =$~~ $E_1 = E_2$ this so that there is no component of the electric field along the x-axis similarly, in case of the magnetic field there is no component of the magnetic field along the direction of propagation that is electric field and magnetic field are perpendicular to the direction of propagation of wave

⇒ characteristics of the electromagnetic wave ⇒

i) It is produce by the oslating charge

ii) It does not required any material medium for propagation

iii) Its speed in vaccume is 3×10^8 m/s which is given by

$$C = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

iv) speed of light in a dielectric medium

$$V = \frac{1}{\sqrt{\mu_0 \mu_r \epsilon_0 \epsilon_r}}$$

v) Speed of electromagnetic wave is the ratio of the amplitude of the electric field and magnetic field

$$C = \frac{E_0}{B_0}$$

vi) The velocity of electromagnetic waves depends interally on a electric and magnetic field

vii) The electromagnetic waves carry energy which is divided equally b/w electric field and magnetic field vectors

viii) Intensity of the static electric field and magnetic field are given by

$$u_e = \frac{1}{2} \epsilon_0 E_0^2$$

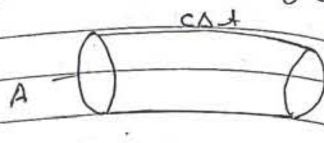
$$u_B = \frac{B_0^2}{2\mu_0}$$

Total energy density of
Total energy of electromagnetic wave

$$u_T = u_e + u_B$$

$$u_T = \frac{1}{2} \epsilon_0 E_0^2 + \frac{B_0^2}{2\mu_0}$$

* Intensity of electromagnetic waves ⇒
The energy passing per unit area per unit time perpendicular to the direction of propagation of wave



$$I = \frac{Energy}{Volume}$$

$$u_{av} = \frac{U_{av}}{Volume}$$

$$U_{av} = u_{av} \times Ac\Delta t$$

$$I = \frac{U_{av} \cancel{A} c \cancel{\Delta t}}{\cancel{A \Delta t}}$$

$$\boxed{I = U_{a} c}$$

* Momentum of electromagnetic wave ⇒

$$Momentum = \frac{Energy}{c}$$

$$\boxed{p = \frac{U}{c}}$$

* ~~Radiation pressure~~ Radiation pressure ⇒

$$Pressure = \frac{\text{change in momentum}}{\Delta t}$$

$$Pressure = \frac{D\,Energy}{c\Delta t}$$

unit time
gation

Pg no 278 Example 8.2 $= \frac{I}{C} = \frac{\text{Intensity}}{\text{Speed}}$

Q

Soln $\nu = 25\ \text{MHz}$

$= 25\times10^{6}\ \text{Hz}$

$E = 6.3\hat{j}\ \text{V/m}$

$\vec{B} = ?$

$C = \frac{E}{B}$

$B = \frac{E}{C}$

$= \frac{6.3}{3\times10^{8}}$ 2.1

$= 2.1\times10^{-8}$

$\vec{B} = 2.1\times10^{-8}\ \hat{k}\ T$

Example 8.3

Soln $B_y = 2\times10^{-7} \sin(0.5\times10^{3}x + 1.5\times10^{11}t)\ T$

$B = B_0 \sin(kx + \omega t)$

Comparing above eqn

$B_0 = 2\times10^{-7}\ T$

wave length

$k = 0.5\times10^{3}$

$\frac{2\pi}{\lambda} = 0.5\times10^{3}$

$\lambda = \frac{2\pi}{0.5\times10^{3}}$

frequency

$\omega = 1.5\times10^{11}$

$2\pi\nu = 1.5\times10^{11}$

$\nu = \frac{1.5 \times 10^{11}}{2\pi}$

(b) $c = \frac{E_0}{B_0}$

$E_0 = B_0 c$

$= 2 \times 10^{-7} \times 3 \times 10^{8}$

$= 60$

$E = E_0 \sin(kx + \omega t)$

$E = 60 \sin(10.5 \times 10^{3} x + 1.5 \times 10^{11} t)\ NC^{-1}$

Example no→ 8.4)

$\frac{P}{A} = 1800 / cm^2$

$A = 20\ cm^2$

$P = 18A = 18 \times 20$

$= 360 w$

$t = 30\ min$

$= 30 \times 60\ sec$

$U = P \times t$

$= 360 \times 30 \times 60$

$\text{Momentum} = \frac{U}{c}$

$\text{Force} = \frac{\text{momentum}}{t}$

$= \frac{U}{ct}$

$F = \frac{360 \times 30 \times 60}{3 \times 10^{8} \times 30 \times 60} = 120 \times 10^{-7} N$

Example 8.5)

$P_{in} = 100 w$

$r = 3m$

$\eta = 2.5\%$

$$\eta = \frac{P_o}{P_{in}}$$

$$P_o = \eta P_{in}$$

$$= \frac{7.5}{100} \times 100$$

$$P_o = 2.5 W$$

$$I = \frac{P_o}{A}$$

$$= \frac{2.5}{4\pi r^2}$$

$$= \frac{2.5}{4 \times 3.14 \times 9}$$

$$I = I_e + I_B$$

$$I_e = I_B$$

$$I_e = I_B = \frac{1}{2} I$$

$$I_e = \frac{1}{2} \epsilon_0 E^2_{rms}$$

$$\frac{I}{2} = \frac{1}{2} \epsilon_0 E^2_{rms}$$

$$E_{rms} = \sqrt{\frac{I}{\epsilon_0}}$$

$$= \sqrt{\frac{2.5}{4 \times 3.14 \times 9 \times 8.854 \times 10^{-12}}}$$

$$= 2.9 \; V/m$$

$$E_0 = I_{rms}\sqrt{2}$$

$$= \frac{2.9 \times 1.414}{4.07} \; V/m$$

$$c = \frac{E_0}{B_0}$$

$B_0 = \frac{E_0}{c}$

$= \frac{4.07}{3 \times 10^8} T$

Exercise => 8.1

$r = 12\ cm = 12 \times 10^{-2}\ m$

$d = 5\ cm = 5 \times 10^{-2}\ m$

$I = 0.15\ A$

$C = \frac{\epsilon_0 A}{d}$

$C = \frac{\epsilon_0 \pi r^2}{d}$

$= \frac{8.854 \times 10^{-12} \times 3.14 \times 144 \times 10^{-4}}{5 \times 10^{-2}}$

$= 80.1 \times 10^{-12}$

$q = CV$

$\frac{q}{t} = C\left(\frac{V}{t}\right)$

$\frac{I}{C} = \frac{V}{t}$

$\frac{0.15}{80.1 \times 10^{-12}} = \frac{V}{t}$

$\frac{V}{t} = 1.87 \times 10^9\ Vs^{-1}$

$I_0 = \epsilon_0 \frac{d\phi}{dt}$

$= \epsilon_0 \frac{dEA}{dt}$

$= \epsilon_0 A \frac{dE}{d\phi}$

E

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

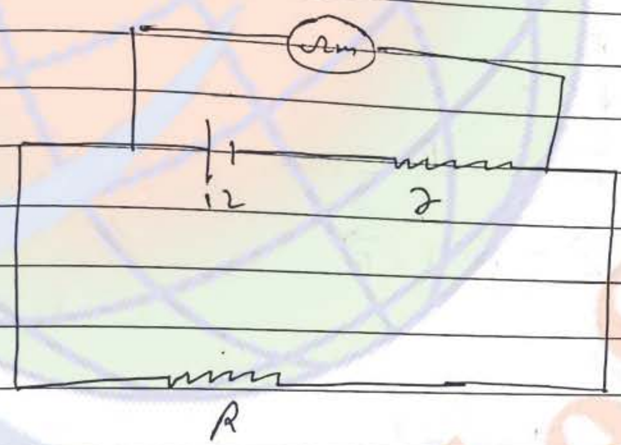
$$I_0 = \frac{\epsilon_0 A}{d} \frac{dv}{dt}$$

$$= C \frac{dv}{dt}$$

$$= 80.1 \times 10^{-2} \times 1.87 \times 10^{9} A$$

Q A storage battery of emf 12V and internal resistance 0.5 Ω is to be charged by a battery charge which supply 110V dc how much resistances must be connected in series with the battery to limit the changing current to 5 ampere what will be the potential difference across the terminal of the battery during changing what is the purpose having series resistor during charging

Sol:



$$R_{eq} = R + r$$

Remaining voltage

$$V = 110 - 12$$

$$= 98 V$$

$$I = \frac{V}{R_{eq}}$$

$$5 = \frac{98}{R + 0.5}$$

$$R + 0.5 = \frac{98}{5}$$

$$= 19.6$$

$$R = 19.6 - 0.5$$

$$R = 19.1\,\Omega$$

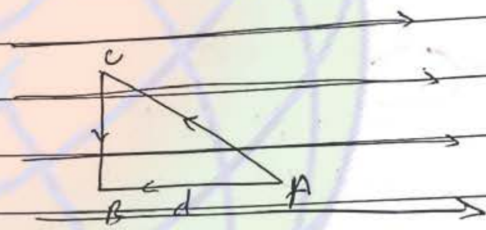
$$V = E + Ir$$

$$= 12 + 5 \times 0.5$$

$$= 12 + 2.5$$

$$= 14.5V$$

Q. A test charge q_0 is move without acceleration from point A to B along the path A → C → B as show in the given figure calculate the potential difference b/w A and B



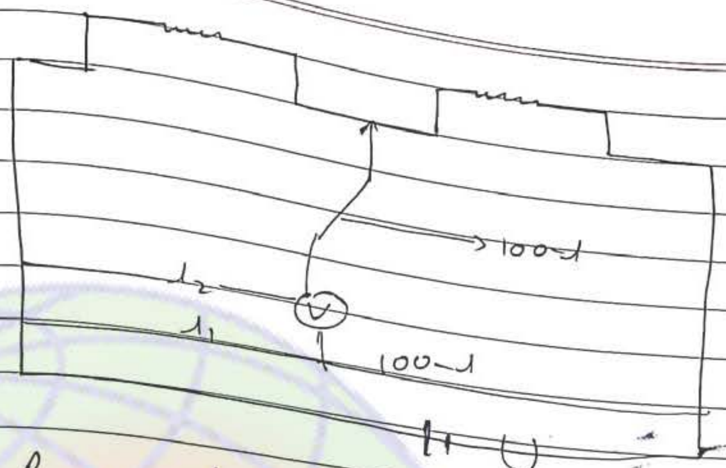
$$\vec{AB} = \vec{AC} + \vec{CB}$$

$$E = \frac{-dv}{dl}$$

$$E = \frac{-(V_B - V_A)}{d}$$

$$Ed = V_A - V_B$$

$$V_A - V_B = Ed$$



$$\frac{R}{S} = \frac{l_1}{100-l_1} \quad \text{--- (1)}$$

$$\frac{R}{R_{eq}} = \frac{l_2}{100-l_2}$$

$$R_{eq} = \frac{1}{x} + \frac{1}{5}$$

$$= \frac{5+x}{x5}$$

$$= \frac{R \times 5}{5+x} = \frac{l_2}{100-l_2} \quad \text{--- (2)}$$

eqn (2) / eqn (1)

$$\frac{\frac{R5x}{5+x}}{\frac{R}{S}} = \frac{\frac{l_2}{100-l_2}}{\frac{l_1}{100-l_1}}$$

$$\frac{5^2 x}{5+x} = \frac{l_2(100-l_1)}{l_1(100-l_2)}$$