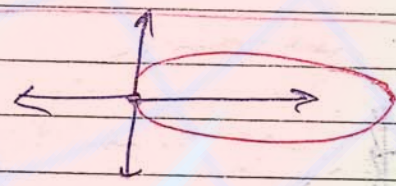
Optics

① light :→
It is the form of energy by which we feel saturation of eye due to which we are able to see the objects.

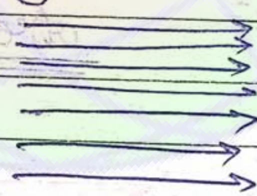
[wavelength of visible light 3600 A° to 7000 A°]

② Ray's :→ light always travells in straight line path any such straight line is called ray



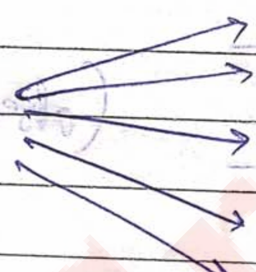
③ Beam of light →

(a)



[Parellel beam of light]

(b)

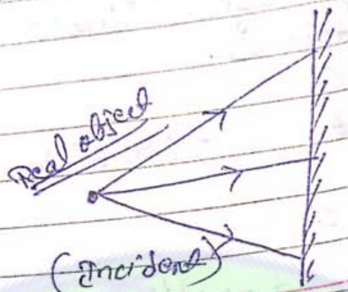


[Diverging beam of light]

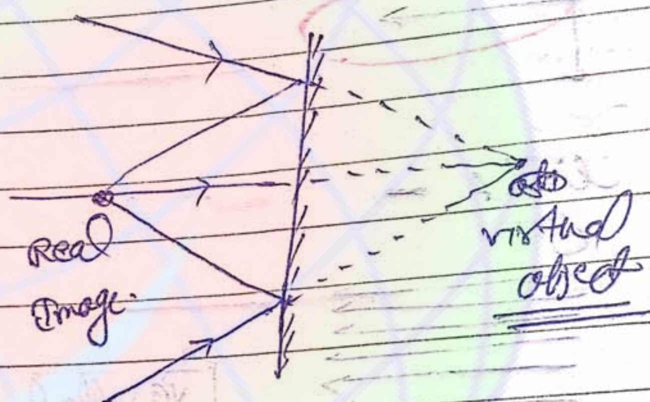
(c)

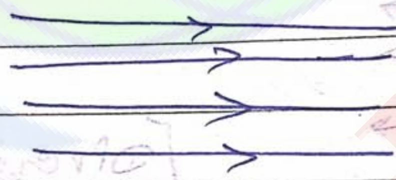
[converging beam of light]

④ object :→



It is the Intersection point of Incident rays.



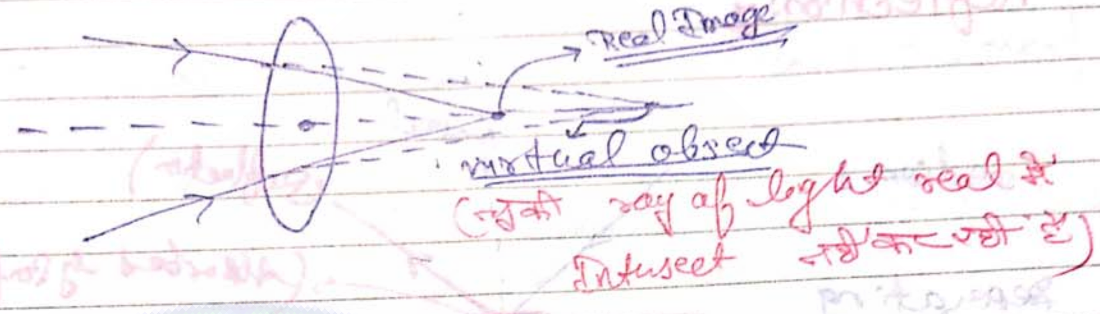


i) If Incident rays Intersects each other then
then object will be real

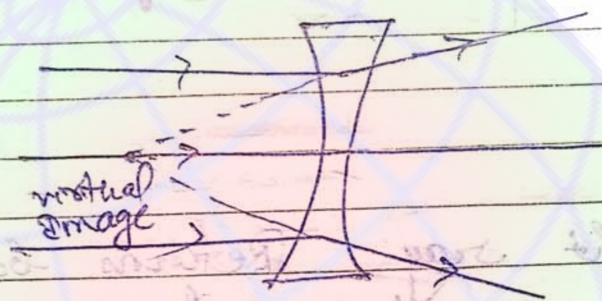
and

If Incident rays just appears to be Intersect than object will be virtual.

Example

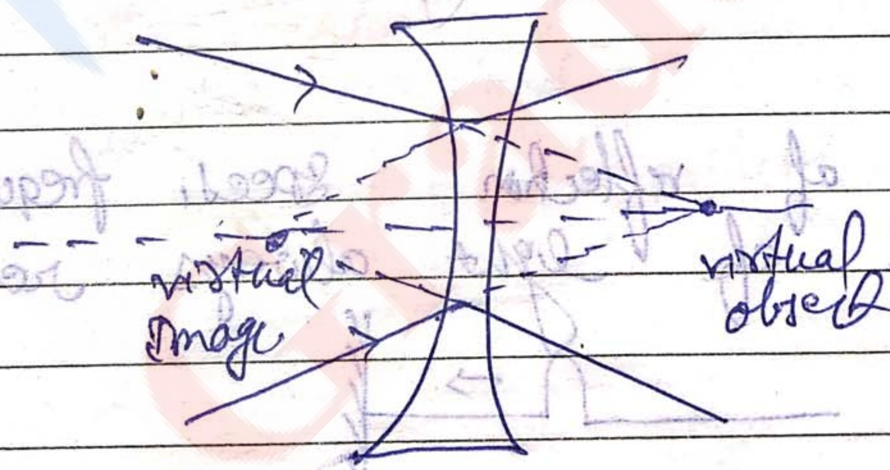


eg 2)

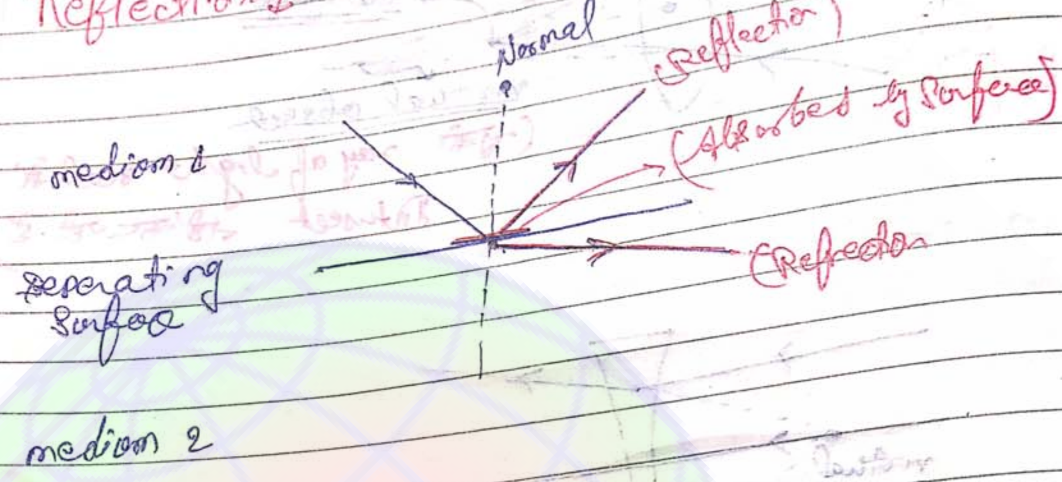


(5) Images

Image is the Intersection point of reflected rays or refracted rays



☆ Reflection:-



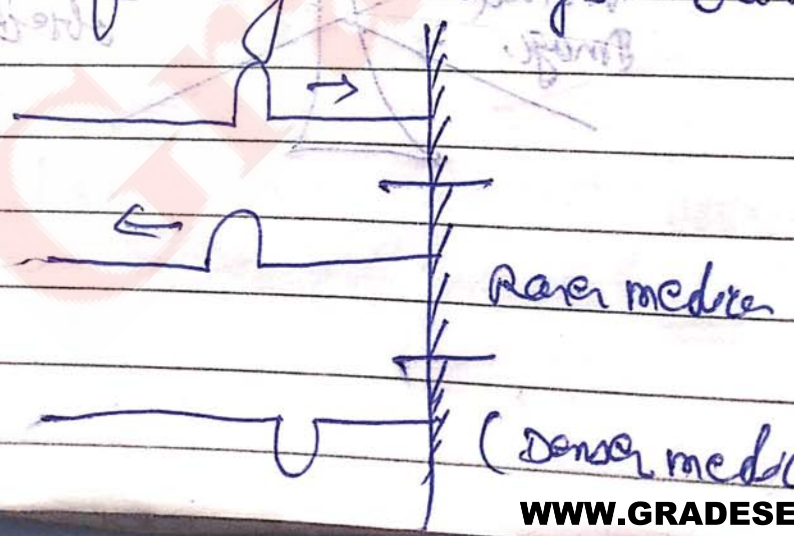
(i) when a light ray Incidence on a seperating surface Returns back after the phenomena is known as Reflection.

> Note :- frequency is the property of Source

So frequency of light not change in any medium.

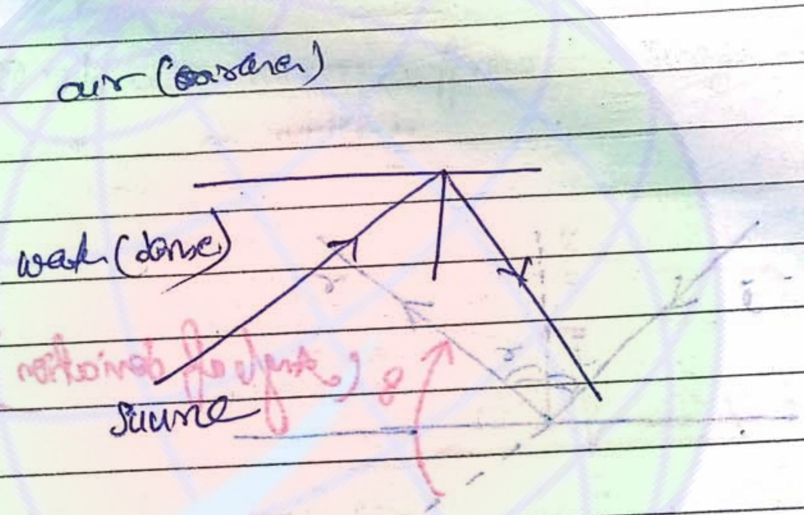
(ii) In case of reflection speed, frequency and wavelength of light always remain's unchang

(v)



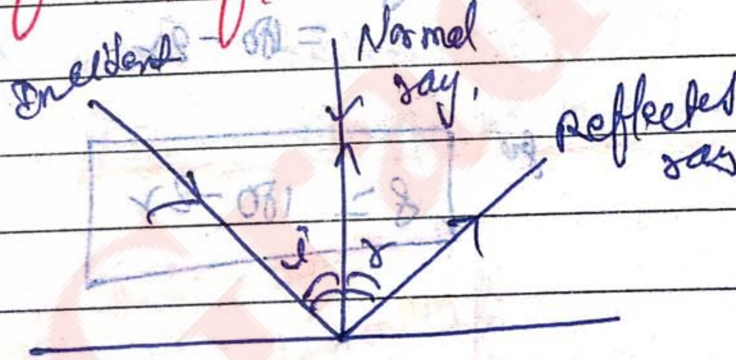
when light ray reflects back from a rarer medium its phase will not changes,
and
when a light ray reflects from a denser medium it's phase will got inverted.

a)



Here,
So, phase will not changed because light ray reflect in rarer medium.

★ Raw's of Reflection :

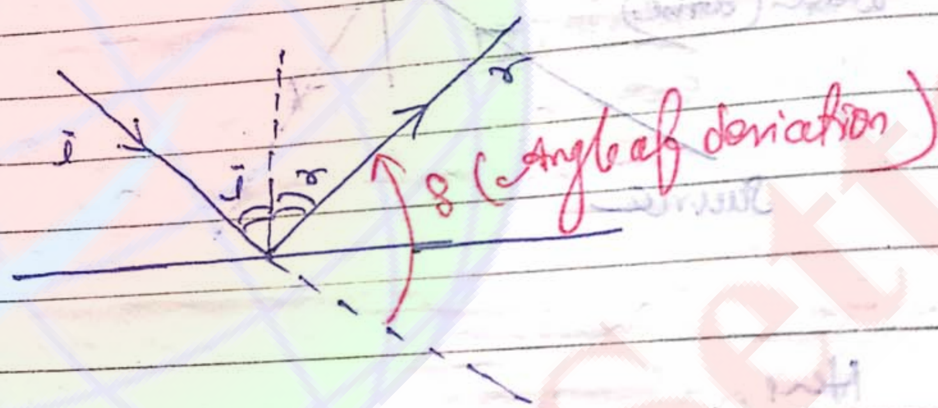


1) Incident ray, reflected ray and Normal all lies in the same plane

② $i \rightarrow$ angle of incidence
$r \rightarrow$ Angle of reflection

$\boxed{i = r}$ → In case of reflection always $i = r$

② Deviation:



$\angle i = \angle r$

$i + r + \delta = 180^\circ$

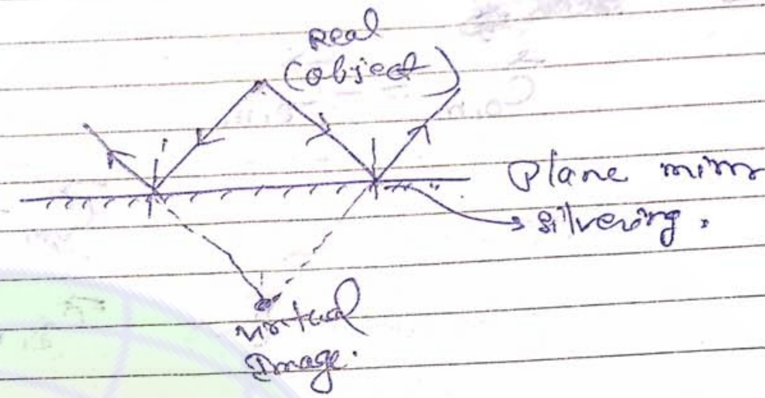
$\delta = 180 - i - r$

$= 180 - 2r$

so $\boxed{\delta = 180 - 2r}$

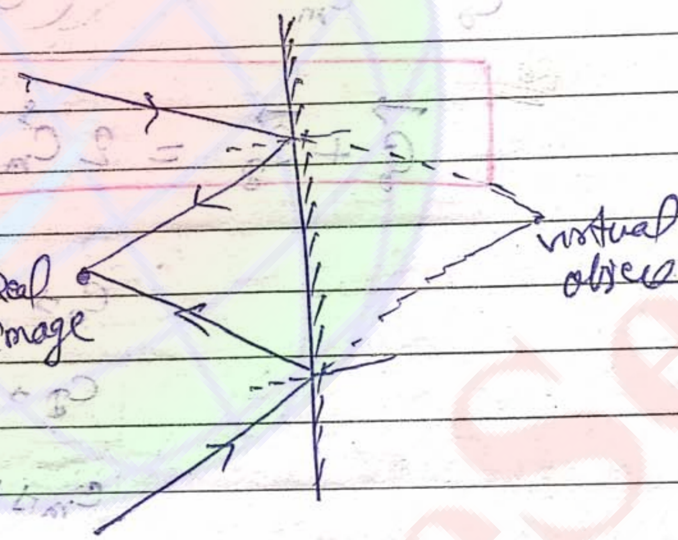
Nature of Image by plane mirror:

(1)



Plane mirror forms Image of same size and erect in nature

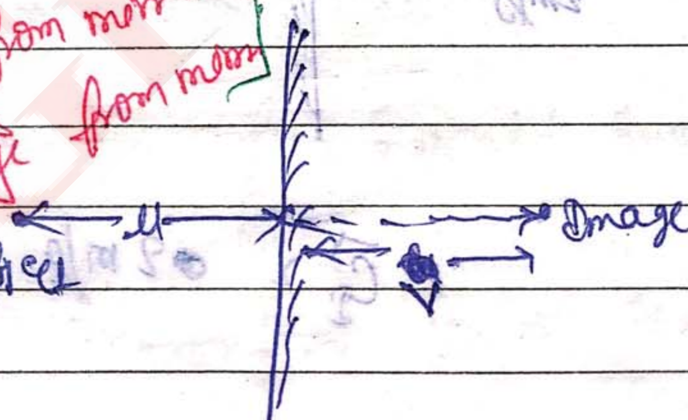
(2)



Plane mirror always forms virtual Image of real object and
Real Image of a virtual object

(3)

u → Distance of object from mirror
v → Distance of Image from mirror



$u = v$

In case plane mirror

(4)

$\vec{C}_{O,m} = -\vec{C}_{I,m}$

$\vec{C}_{O,m}$ → velocity of object w.r.t. mirror

$\vec{C}_{I,m}$ → velocity of Image w.r.t. mirror.

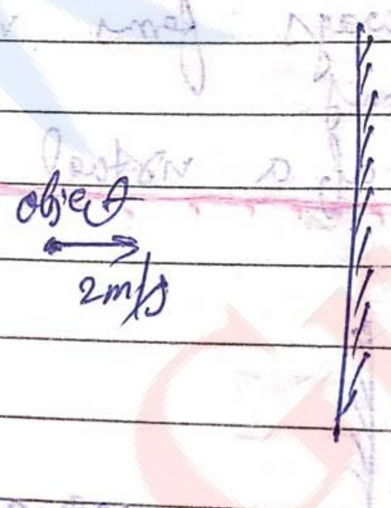
$\vec{C}_O - \vec{C}_m = -(\vec{C}_I - \vec{C}_m)$

$$\vec{C}_O + \vec{C}_I = 2\vec{C}_m$$

C_O → vel. of object

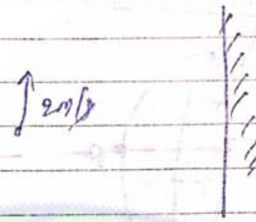
C_I → vel. of Image

C_m → vel. of mirror



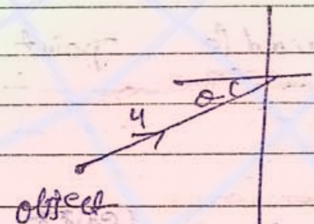
$\vec{C}_I$ = 2 m/s (towards mirror)

Q2)



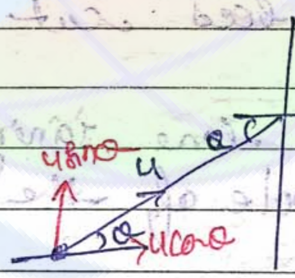
$\vec{C}_I \to$ 2m/s (upwards)

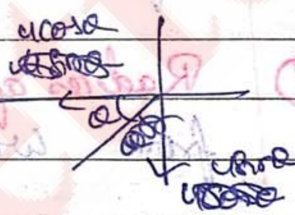
PQ
Q2)



Q/A

$\vec{C}_I \to u$

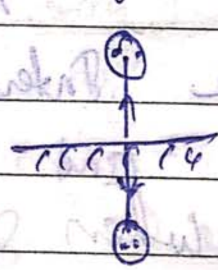




$\vec{C}_O \to u\cos\theta\,\hat{i} + u\sin\theta\,\hat{j}$

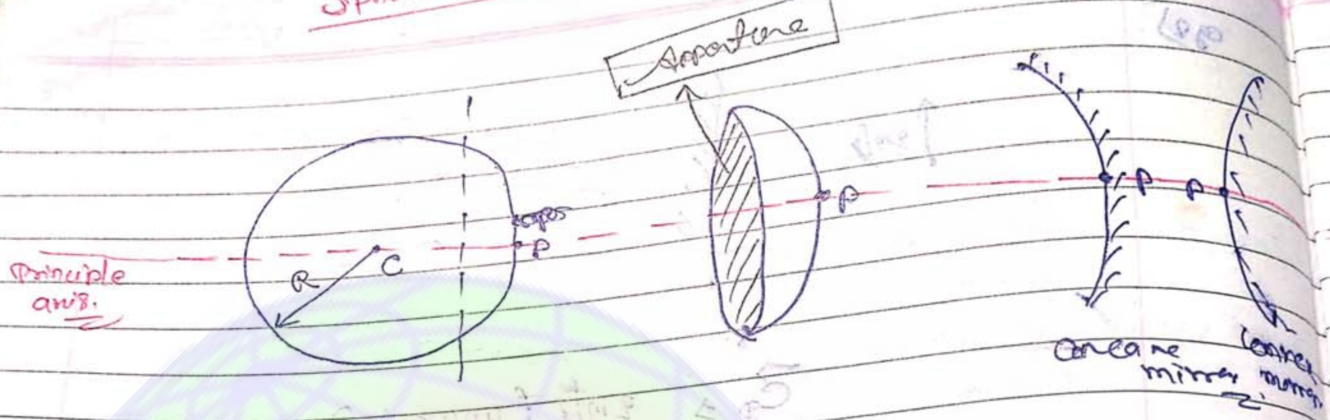
$\vec{C}_I \to -u\cos\theta\,\hat{i} + u\sin\theta\,\hat{j}$

(5) Plane mirror can also form Inverted Image.



(mirror is in ground and Person is on the mirror)

Spherical mirror



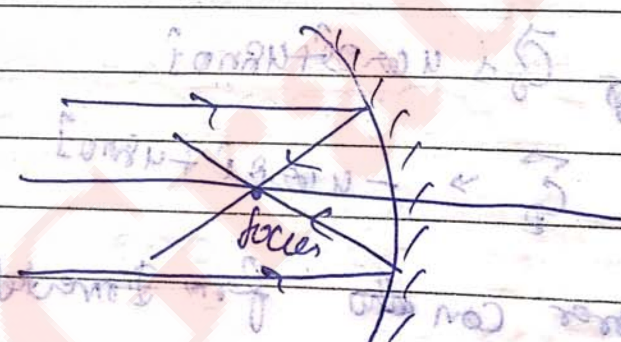
① Pole :→ It is the middle point of the cutting section

② Centre of curvature :→ It is the ~~circle~~ centre of sphere from where mirror has been cut.

③ Radius of curvature :→ It is the radius of sphere from which mirror has been cut

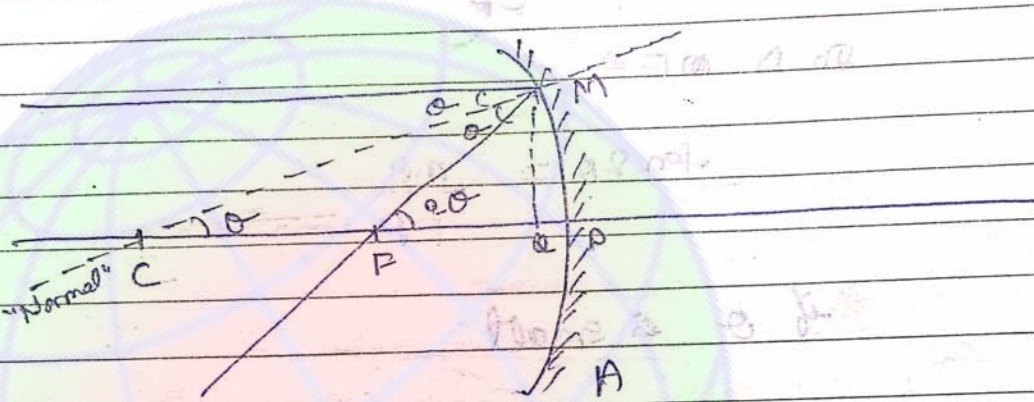
④ Principle axis :→ It is the line joining the centre of curvature and pole of the mirror

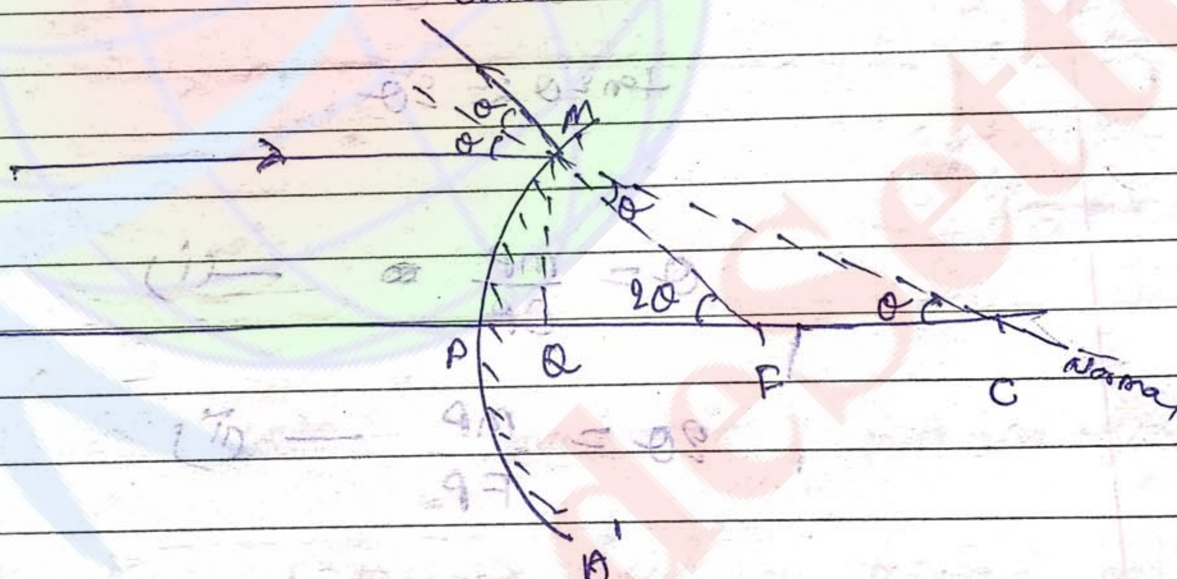
⑤ Focus :→



It is the Intersection point of reflected ray and principle axis when Incident ray is parallel to ~~the~~ the principle axis.

Relation b/w "f" (focal length) and "R" (radius of curvature)





A, A' is a given mirror its pole and centre of curvature are respectively representated as "P" and "C". A parallel ray is incident on the mirror at point M and after reflecting this ray cuts the principle axis. This intersection point is known as focus (F) of mirror

In Δ MCP

$$\tan\theta = \frac{MP}{CP}$$

In Δ MFP

$$\tan 2\theta = \frac{MP}{FP}$$

if θ is small

$$\tan\theta \approx \theta$$

$$\tan 2\theta \approx 2\theta$$

$$\theta = \frac{MP}{CP} \quad \text{—— (i)}$$

$$2\theta = \frac{MP}{FP} \quad \text{—— (ii)}$$

on solving (1) and (2)

$$\frac{2MP}{CP} = \frac{MP}{FP}$$

$$FP = \frac{CP}{2}$$

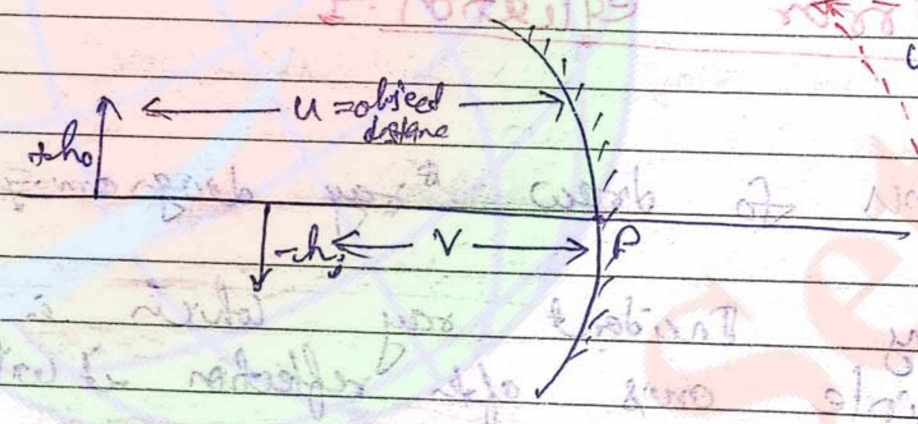
$\therefore \; CP = R$

$FP = f$

Hence

$$f = \frac{R}{2}$$

Sign Conventions



$u = -ve$

$v = -ve$

$h_o \Rightarrow +ve$

$h_i = -ve$

$R = -ve$

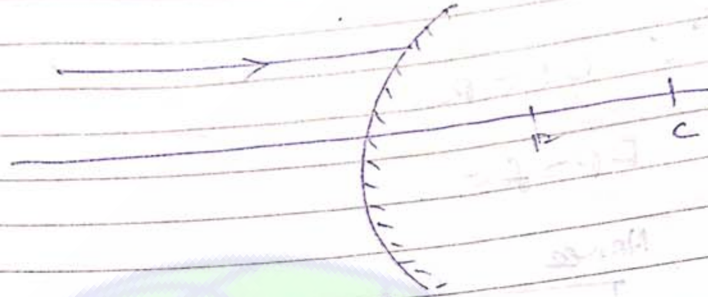
$f = -ve$

(1) All the distance must be measured from pole

(2) All the distance infront of mirror will be -ve and behind the mirror will be +ve.

(3) Height above the Principle axis will be taken as "+ve" and height below the principle axis will be taken as -ve

eg.)



$u = \infty$

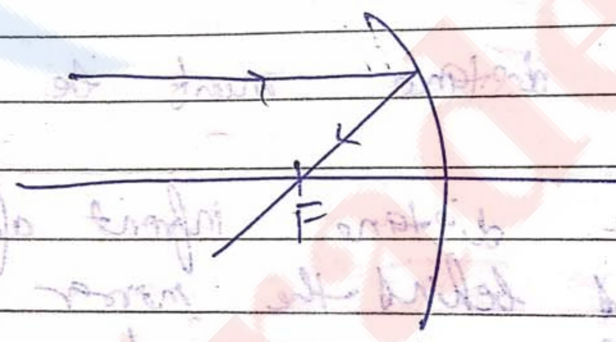
$f = +ve$

$v = +ve$

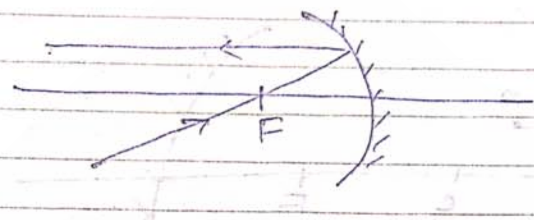
Mirror equation :-

(*) Steps to draw ray diagram :-

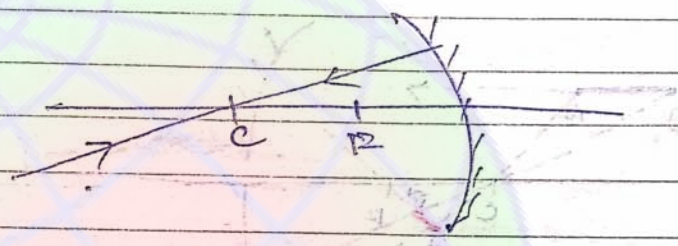
(1) Any incident ray which is parallel to principle axis after reflection it will pass through the focus



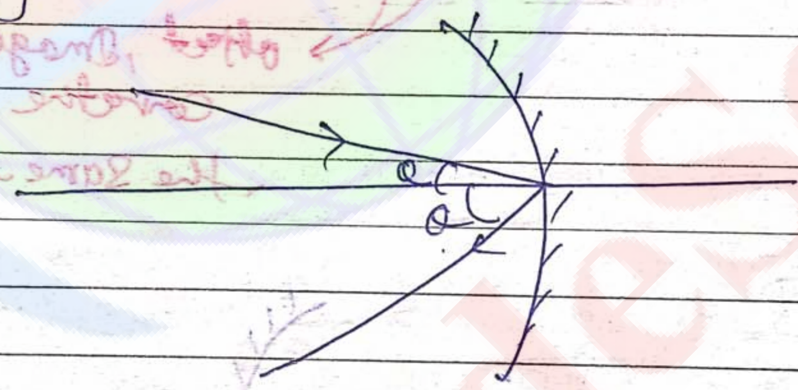
(2) Any light ray which passes through the focus after reflection becomes parallel to principle axis :-



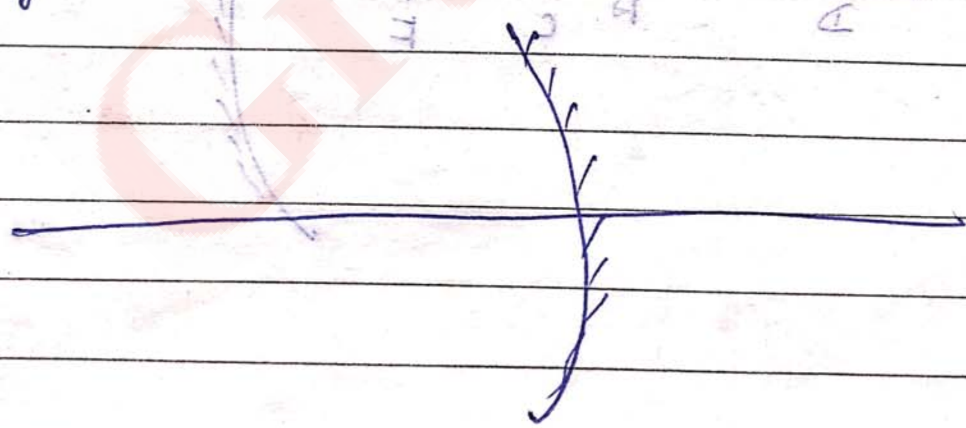
(3) Any light ray which passes through point "C" will retrace its own path after reflection.



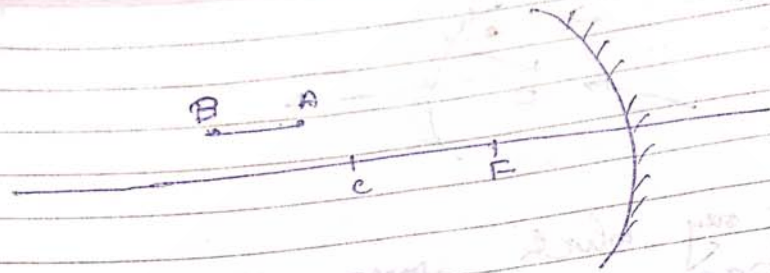
(4) Any ray incident on pole at an angle "θ" from principal axis will make again θ angle after reflection.



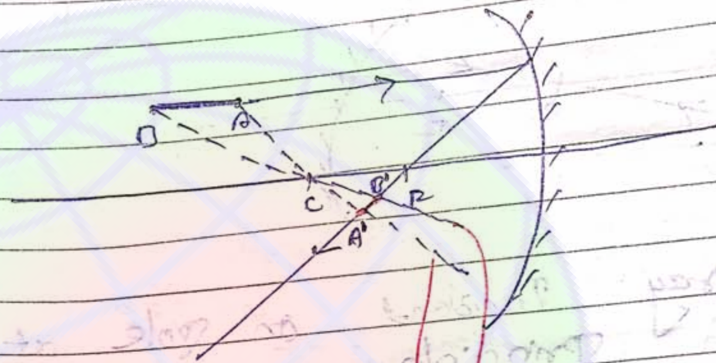
(5) Object, Image, and centre of curvature will always lie on the same line.



eg:-



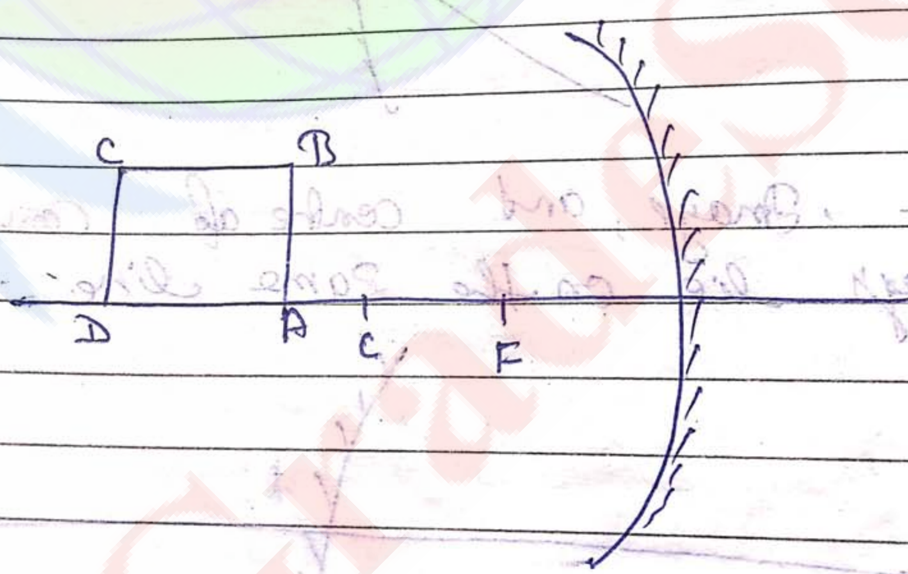
Sol^n



Mr. Rahul Sir

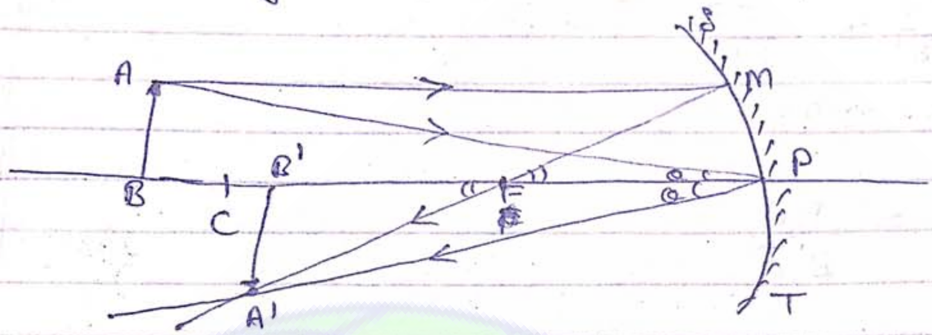
object, Image and centre of curvature all lie on the same line

(N.C.E.R.T)
Example



☆ Mirror Equation

~~ST is a given concave mirror, C and P resp. represent~~



ST is a given concave mirror, C and P resp. represents centre of curvature and pole of mirror. An object AB is placed ⊥r to principle axis. The parallel light ray from point "A" is incident on mirror at point "M" after reflection this light ray passes through the focus and another light ray is incident on the pole of mirror after reflection this light ray cut at point A'. Hence image A'B' is formed.

Here,

ΔABP and A'B'P are similar Δ,

$$\frac{AB}{BP} = \frac{A'B'}{B'P} \Rightarrow \frac{AB}{A'B'} = \frac{BP}{B'P} \quad -(1)$$

Δ A'B'F and ΔMFP are similar

$$\frac{A'B'}{B'F} = \frac{MP}{FP}$$

$$\frac{A'B'}{B'F} = \frac{AB}{FP} \quad \because (MP = AB)$$

$$\frac{\quad}{A'B'} = \frac{FP}{B'F}$$

from eq (i) and eq (iii)

$$\frac{BP}{B'P} = \frac{FP}{B'F}$$

By putting value

$$\frac{-u}{-v} = \frac{-f}{f-v}$$

$\Rightarrow uf - uv = -vf$

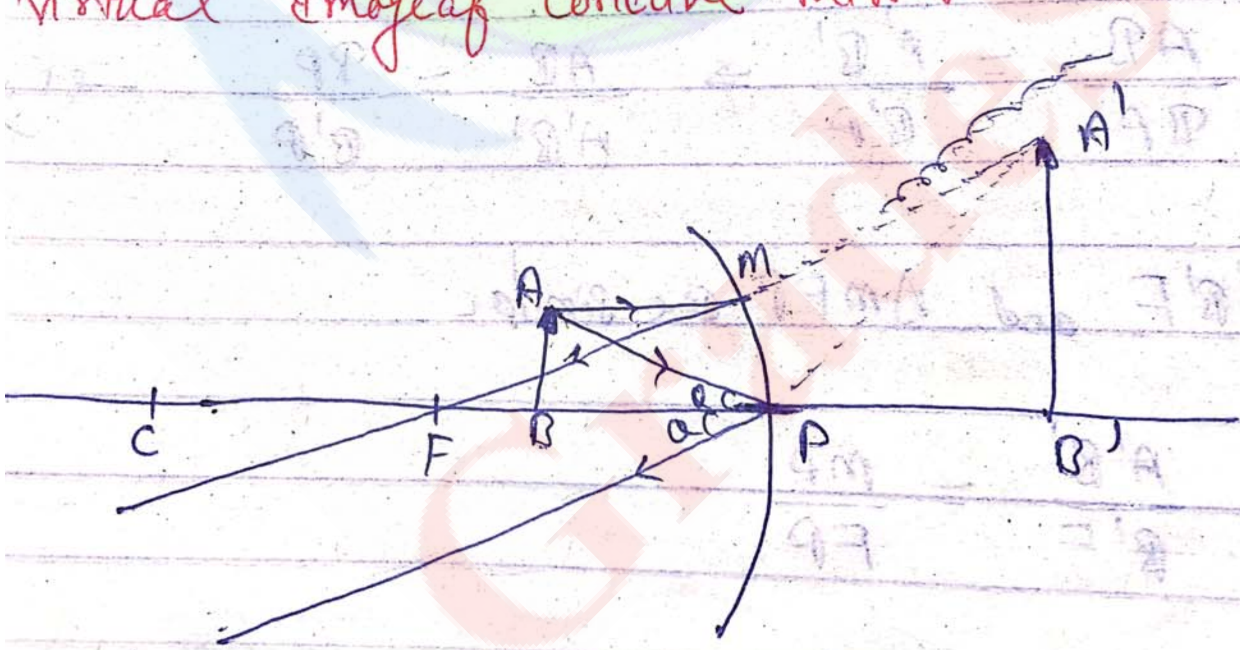
$\Rightarrow uf + vf = uv$

$\Rightarrow$ By dividing by uvf

$$\boxed{\frac{1}{v} + \frac{1}{u} = \frac{1}{f}}$$

and,
$BP = -u$
$B'P = -v$
$FP = -f$
$B'F = B'P - FP$
$= -v - (-f)$
$= f - v$

virtual Image of concave mirror $\Rightarrow$



$BP = -u$,
$B'P = +v$

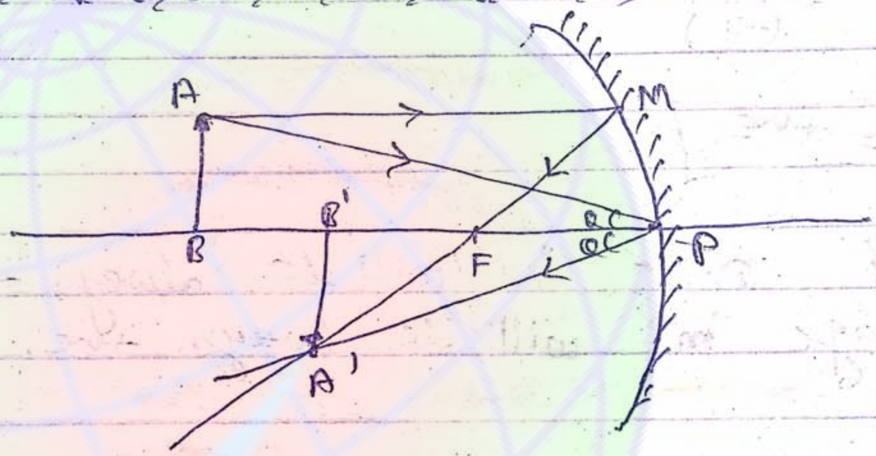
$FP = -f$
$B'F = B'P + FP$
$= -v + (-f) = -f - v$

Magnification in case of spherical mirrors

$$m = \frac{\text{height of Image}}{\text{height of object}}$$

i.e. $$\boxed{m = \frac{h_i}{h_o} = \frac{-v}{u}}$$

~~ΔABP and $\Delta A'B'P$ are Similar~~



ΔABP and $\Delta A'B'P$ are Similar

$$\frac{AB}{BP} = \frac{A'B'}{B'P}$$

$$\frac{A'B'}{AB} = \frac{B'P}{BP}$$

Let,

$A'B' = -h_i$

$AB = h_o$

$B'P = -v$

$BP = -u$.

$$\frac{-h_i}{h_o} = \frac{-v}{-u}$$

$$\boxed{\frac{h_i}{h_o} = \frac{-v}{u}}$$

1) For real Image →

$$m = -\frac{(-v)}{(-u)}$$

$$\boxed{m = -ve}$$

2) For virtual Image →

$$m = -\frac{(+v)}{(-u)}$$

$$\boxed{m = +ve}$$

Note (i) For real Image "m" will be always "-ve" and for virtual Image "m" will be always +ve.

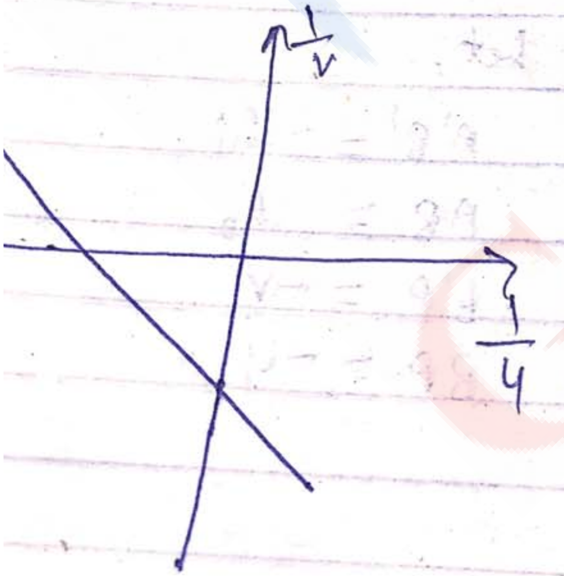
⇒ Graph

(a) Between $\frac{1}{u}$ and $\frac{1}{v}$

(1) for concave mirror

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

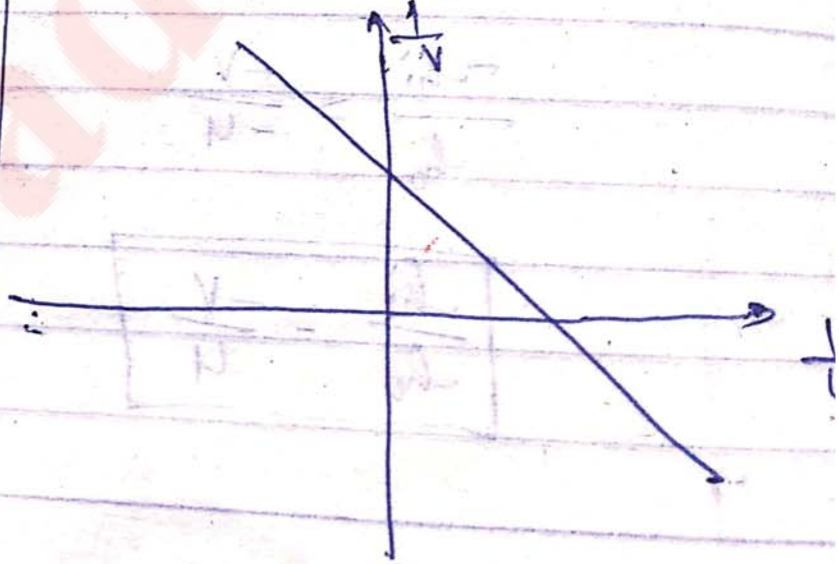
$$y + x = -c$$



for convex mirror

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$y + x = c$$

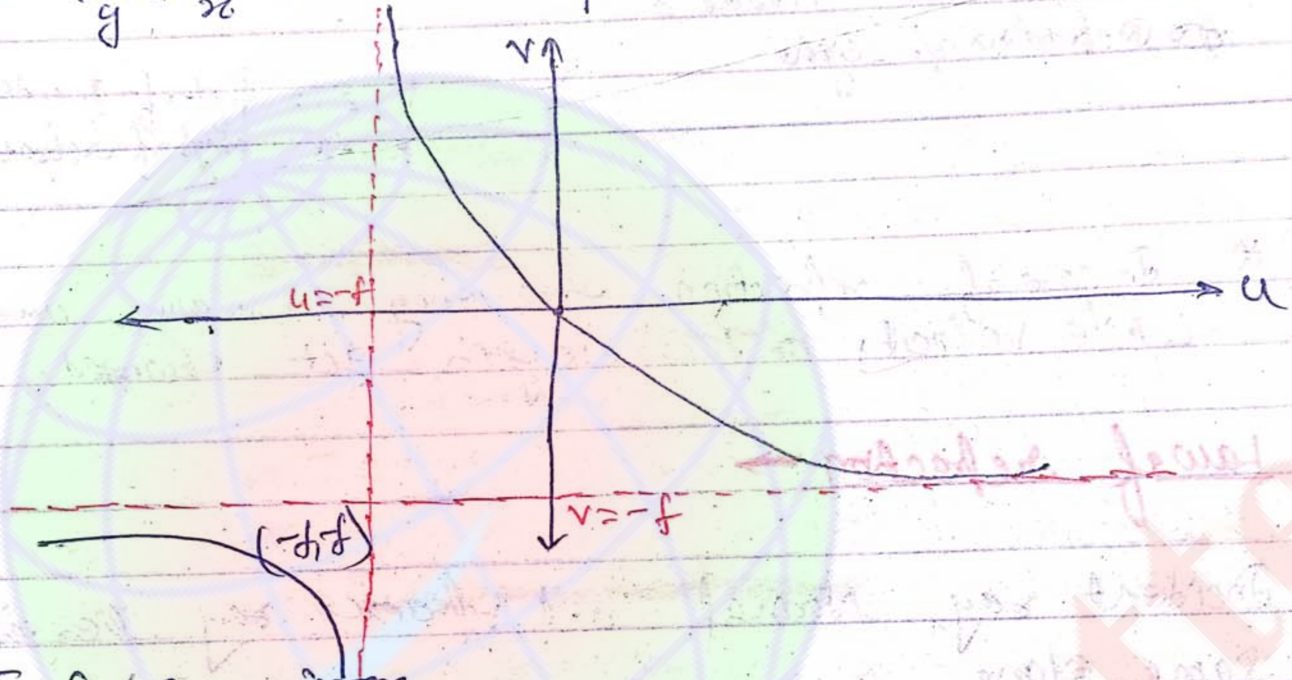


(6) Between "u" and "v"

(1) For concave mirror

$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ | $u=\infty$, $v=-f$; $u=-f$, $v=\infty$

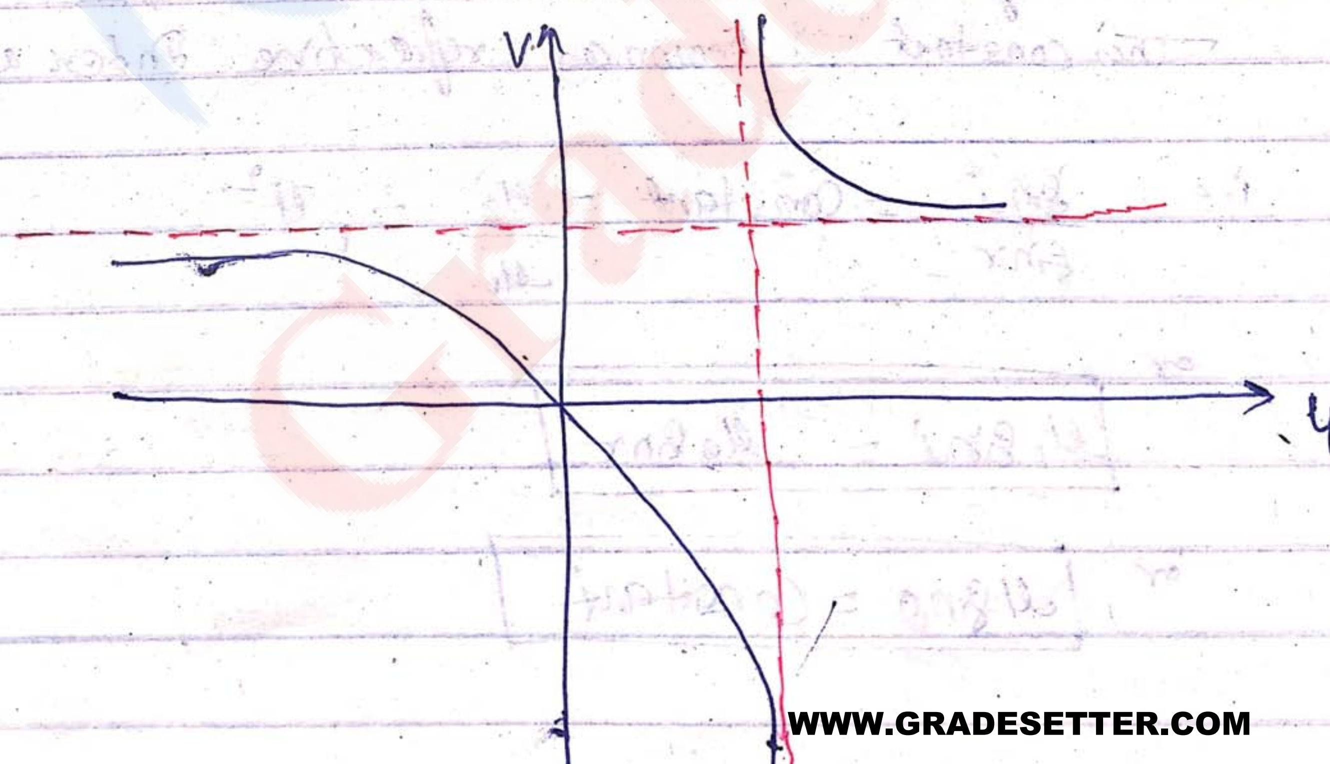
$\frac{1}{y}+\frac{1}{x}=-c$



(2) For convex mirror

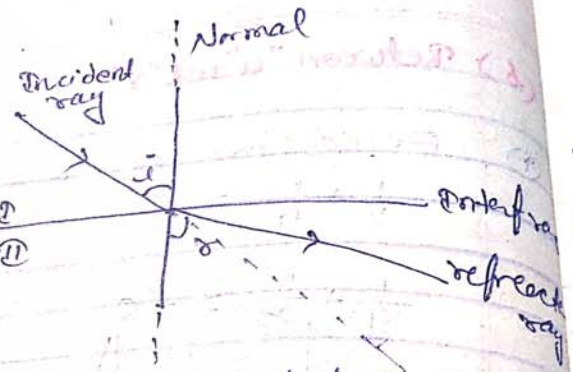
$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ | $u=\infty$, $v=f$; $u=f$, $v=\infty$

$\frac{1}{y}+\frac{1}{x}=c$



* Refraction of light →

When a light ray moves from one medium to another then it deviates from its original path towards normal or away from the normal, this phenomena is called as Refraction of light.



[∠i = Angle of Incidence
∠r = Angle of refraction]

* In case of refraction frequency remains unchanged while velocity and wavelength get changed.

* Law of refraction →

(1) Incident ray, Normal and refracted ray lies in the same plane.

(2) Snell's law ⇒
For a given pair of medium, the ratio of sin ∠i to the sin ∠r is always constant.
This constant is known as refractive index of the medium.

i.e. $\frac{\sin i}{\sin r} = \text{Constant} = \frac{\mu_2}{\mu_1} = {}_1\mu^2$

or

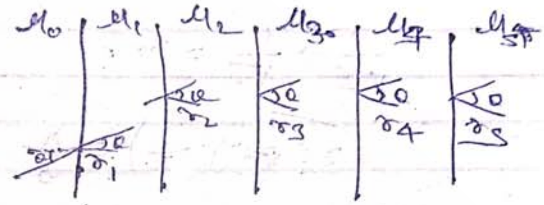
$$\boxed{\mu_1 \sin i = \mu_2 \sin r}$$

or

$$\boxed{\mu \sin\theta = \text{Constant}}$$

Q) Calculate r_1, r_2, r_3 and r_4

Sol) $\mu \sin\theta = \mu_1 \sin r_1$
$= \mu_2 \sin r_2$
$= \mu_3 \sin r_3$
$= \mu_4 \sin r_4$



$$r_1 = \sin^{-1}\left(\frac{\mu \sin\theta}{\mu_1}\right);$$

$$r_2 = \sin^{-1}\left(\frac{\mu \sin\theta}{\mu_2}\right)$$

$$r_3 = \sin^{-1}\left(\frac{\mu \sin\theta}{\mu_3}\right)$$

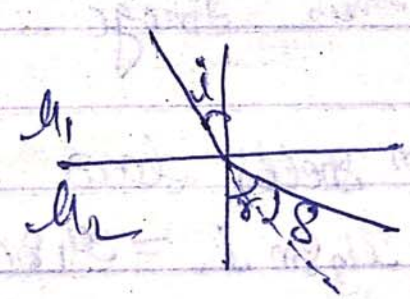
$$r_4 = \sin^{-1}\left(\frac{\mu \sin\theta}{\mu_4}\right)$$

* when a light ray moves from rarer to denser medium, it will shift towards normal and when a light ray moves from denser to rarer medium it will shift away from the normal.

* rarer to denser → $\mu \uparrow$ $\sin\theta \downarrow$
* Denser to rarer → $\mu \downarrow$ $\sin\theta \uparrow$

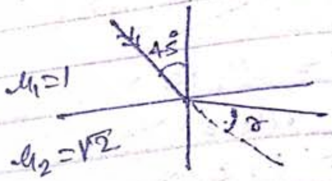
Angle of Deviation–

$$\delta = r - i$$



$\mu_1 > \mu_2$

eg) $\frac{\sin 45^\circ}{\sin r} = \frac{\sqrt{2}}{1}$



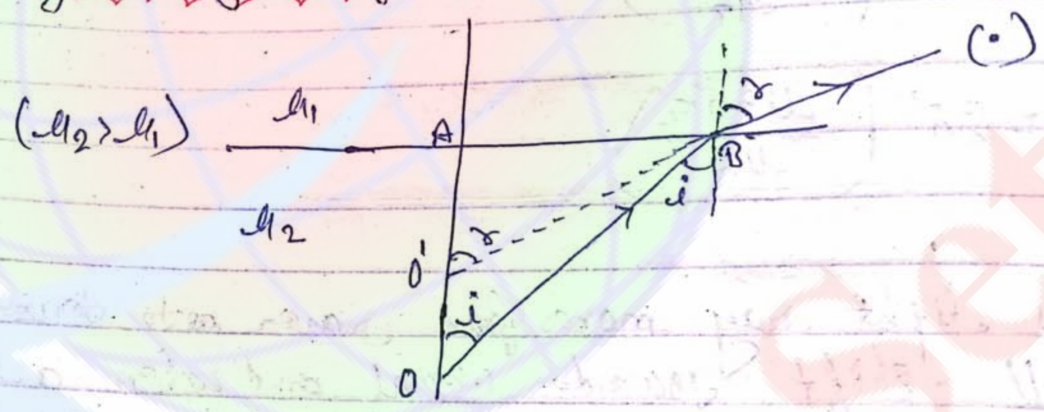
$\frac{1}{\sqrt{2}} \times \frac{1}{\sqrt{2}} = \sin r$

$r = \sin^{-1}\left(\frac{1}{2}\right) = \frac{\pi}{6}$

$\delta = (45 - 30)$
$= 15^\circ$ (clockwise)

☆ Apparent Depth or Apparent height of a object and shift

1) light ray going from denser to rarer media.



As shown in the fig. an object O is placed in a medium of refractive index μ_2 it is seen by an observer placed in medium μ_1 when a light ray starting from "O" is incident on interface at an angle "i" the after refraction it will move away from the normal, thus image of "O" is formed at "O'".
Now,

From Snell's law

$\mu_2 \sin i = \mu_1 \sin r$ — (i)

From geometry,
In ΔOAB,

$$\tan i = \frac{AB}{OA}$$

Since "i" is small
so
$\tan i \approx \sin i \approx i$

Again,
In $\Delta O'AB$
$$\tan r = \frac{AB}{O'A}$$

Since r is small
$\tan r \approx \sin r$

By putting the value in (1)

$$\mu_2 \frac{AB}{OA} = \mu_1 \frac{AB}{O'A}$$

$$\frac{\mu_2}{OA} = \frac{\mu_1}{O'A}$$

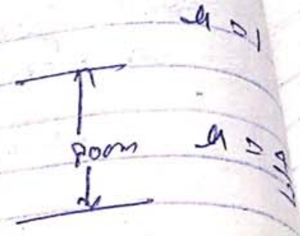
$$\Rightarrow O'A = \frac{\mu_1}{\mu_2} OA$$

Apparent depth = Real depth × $\frac{\text{R.I of observed media}}{\text{R.I of object media}}$

Shift $OO' = OA - O'A$
$$= OA - OA\frac{\mu_1}{\mu_2}$$

$$\boxed{S = OA\left(1 - \frac{\mu_1}{\mu_2}\right)}$$

Q) calculate apparent depth and shift



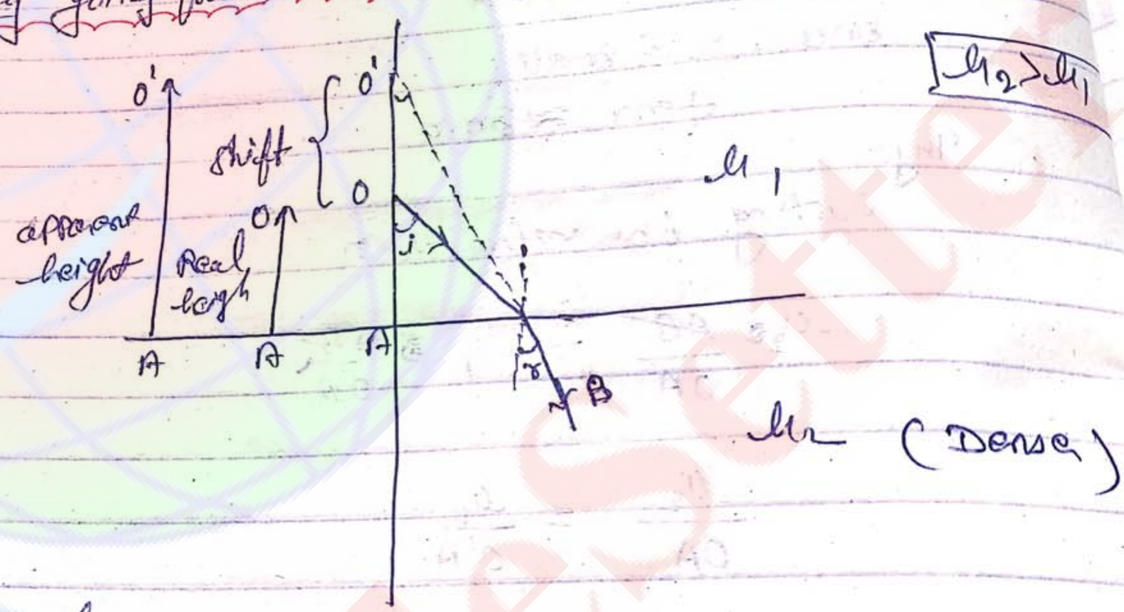
App depth $= \frac{1}{4} \times 3 \times 80^{20}$

$= 60$

$S = 80\left(1 - \frac{3}{4}\right)$

$= \frac{80}{4} = 20cm$ (towards interface) ↑

ii) Light ray going from rarer to denser media →



From Snell's law –

$\mu_1 \sin i = \mu_2 \sin r$

from geometry in ΔOAB

$\tan i = \frac{AB}{OA}$

$\tan i \approx \tan i \approx i$

and, In $\Delta O'AB$

$$\tan r = \frac{AB}{O'A}$$

$\therefore \sin r \approx \tan r \approx r$

Putting the value in (1)

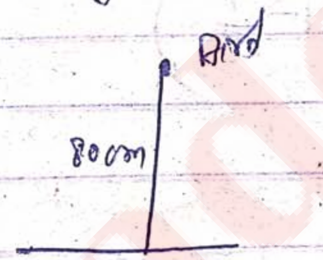
$$\mu_1 \frac{AB}{OA} = \mu_2 \frac{AB}{O'A}$$

$$\boxed{OA' = OA \frac{\mu_2}{\mu_1}}$$

$$\text{shift} = O'A - OA$$
$$= OA \frac{\mu_2}{\mu_1} - OA$$

$$\boxed{S = OA\left(\frac{\mu_2}{\mu_1} - 1\right)}$$

Q) calculate apparent height of the Bird As seen by observer



$\mu_1 = 1$

$\mu_2 = \frac{4}{3}$

$$A = 80 \times \frac{4/3}{1}$$

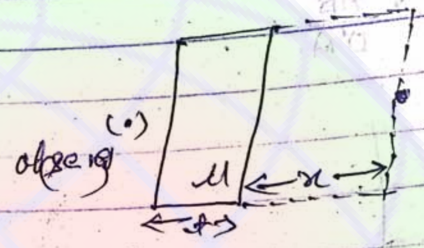
$$\text{App height} = 80 \times \frac{4}{3}$$
$$= \frac{320}{3}$$

$$\text{shift} = \frac{320}{3} - 80$$
$$= \frac{320 - 240}{3}$$
$$\text{shift} = \frac{80}{3}$$

Q) Prove that shift produced by a glass plate of thickness 't' and refractive index μ is independent from the position of object and its value will be

$$\boxed{S = t\left(1-\frac{1}{\mu}\right)}$$

A. Apparent depth by air $= \frac{x \cdot \mu_{air}}{\mu_{air}} = x$



App. depth by glass slab $= t \cdot \frac{1}{\mu}$

Total app. depth $= x + \frac{t}{\mu}$

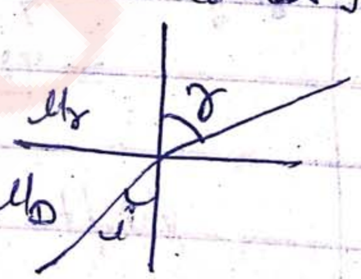
Total actual depth $= x + t$

Shift $= (x+t) - \left(x + \frac{t}{\mu}\right)$

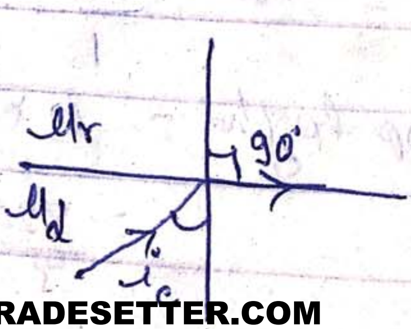
$= t\left(1 - \frac{1}{\mu}\right)$

Critical Angle ⇒

It is the value of angle of incidence for which angle of refraction becomes 90°



⇒



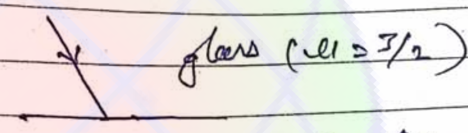
From snells law,

$$\mu_D \sin i_c = \mu_R \sin 90^\circ$$

$$\sin i_c = \frac{\mu_R}{\mu_D}$$

$$\boxed{i_c = \sin^{-1}\left(\frac{\mu_R}{\mu_D}\right)}$$ [i_c = critical angle]

eg.) Define the value of critical angle for the given interface



$$i_c = \sin^{-1}\left(\frac{4/3}{3/2}\right)$$

$$\boxed{i_c = \sin^{-1}\left(\frac{8}{9}\right)}$$

Total Internal reflection

If a light ray going from denser to rarer media is incident at an angle which is greater than critical angle then it will again return in the same medium and the phenomena is called total internal reflection.

⇒ Two Internal condition of T.I.R are→

(i) light ray goes from dense to rarer.

(ii) Angle of incidence greater than i_c.

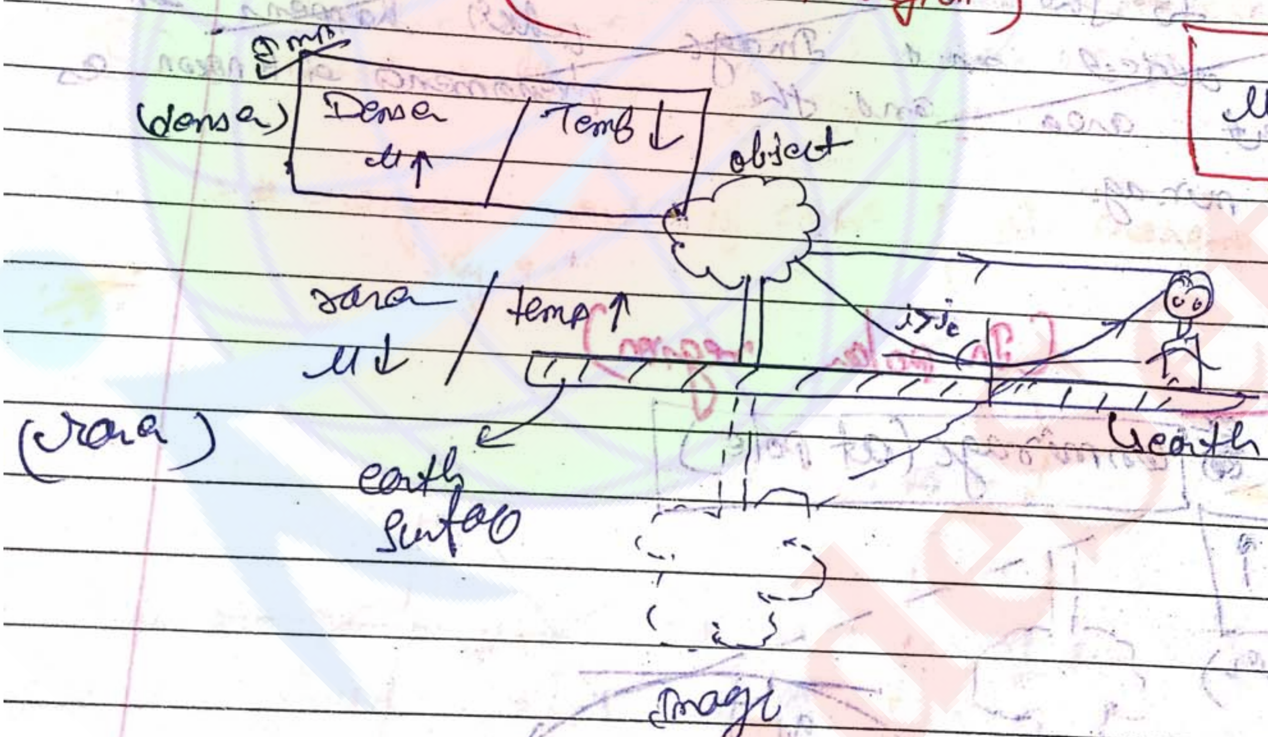
Note

Only Intensity will be reduced size and position of Image will not change when mirror is cut half.

Application of T.I.R

(1) mirage → (In summer region)

$\mu \propto \frac{1}{Temp}$



(2) ~~In the days of summer temp. of the ... which is closer to ground ... Hence refractive Index of the~~

In the summer day's, air becomes at high temp near the ground as we move upward temp. of air decreases, hence refractive Index of the air which is close to ground will be less. when a light ray starts to move towards ground, it will continiously shifts away from the normal, hence at some Instant, angle of Incidence ~~(ᵢ) when a light ray move~~ will be greate than critical angle. At this point phenomena of T.I.R will takes place and light ray will be reflected back. ~~it will continuously moves away from its~~

Therefore an observer will see both object and Image. ~~Here~~ This phenomena is known as **mirage**.

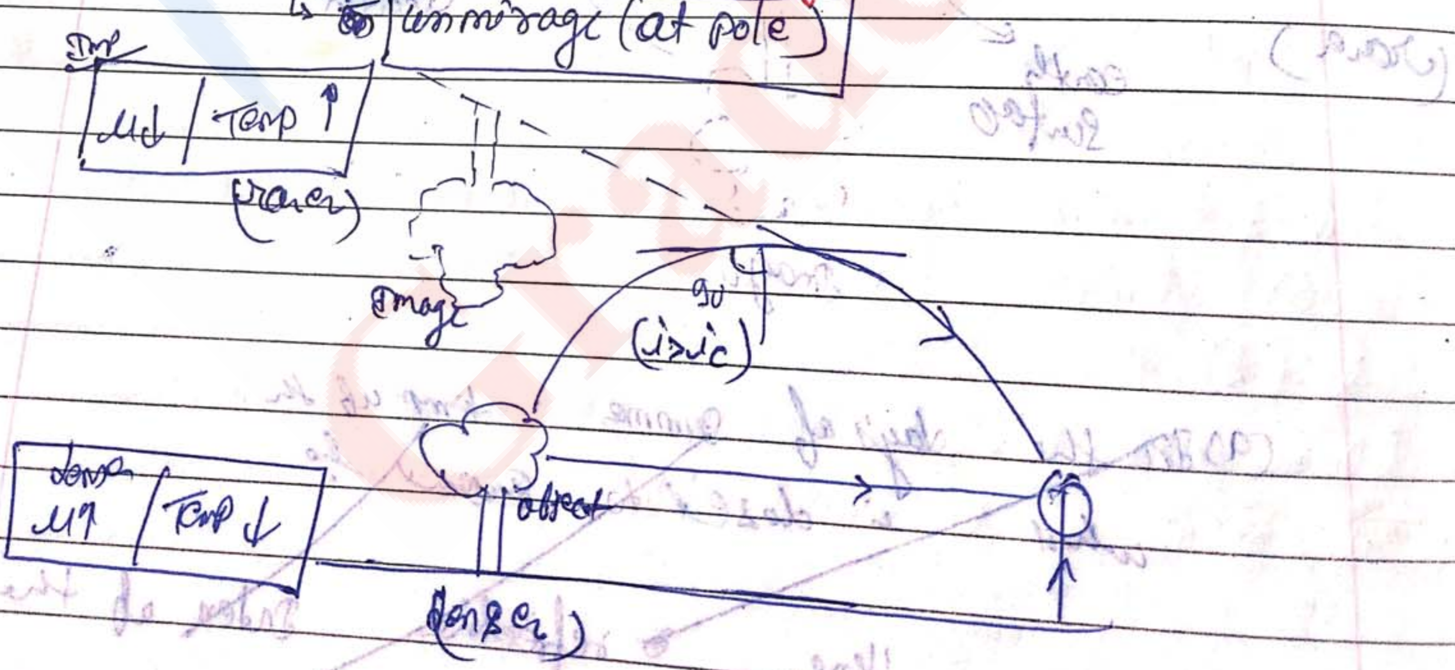
~~at far~~

~~becomes great tha cri~~

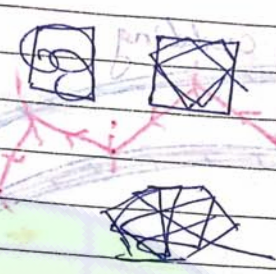
~~② Due to the (TIR) an observer can see both object and Image which happens in desert area. and the phenomena is known as mirage~~

II mirage (In polar region)

↳ or unmirage (at pole)



③ Sparkling of diamonds :-



$\mu = 2.42$

Sparking of diamonds is a based on principle of T.I.R.

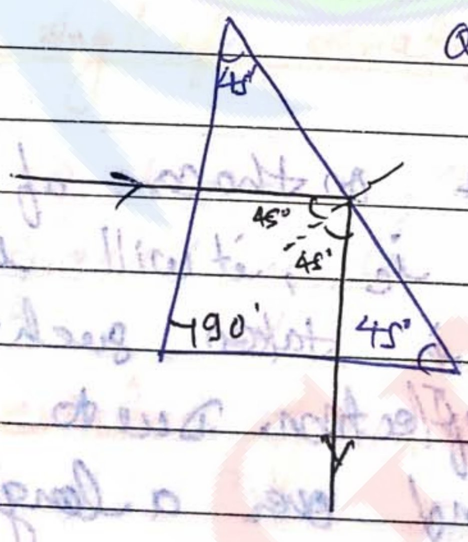
As the no. of faces increase brightness of diamond will get increase.

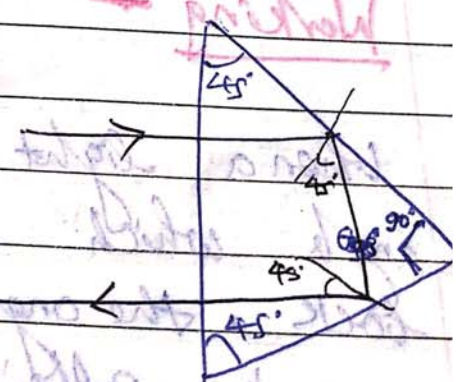
Note→ For diamond, quartz is used whose refractive index is 2.42 and critical angle is almost 23°. //

Ⓒ Total reflection by prism :-

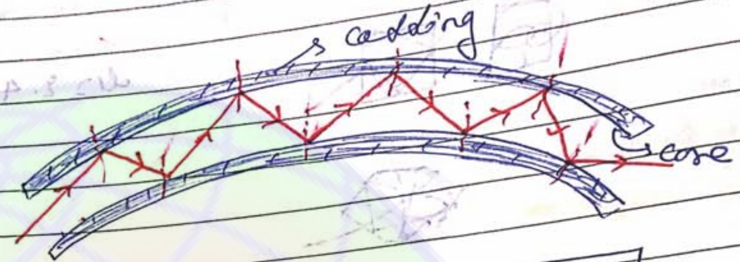
i) changing path of light say 90° | ii) changing path of light say 180°

Quatz K1 45





(5) optical fiber :-



$\mu_{core} > \mu_{cadding}$

This is based on principle of T.I.R.,

Construction →

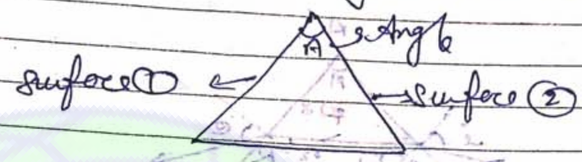
It is a hollow cylindrical pipe whose diameter is almost 0.1 mm. the inner part of the fiber is known as core of the fiber and its outerpart is known as cladding. Refractive index of the core is much higher than the cladding,

Working →

When a light ray is incident on the core of fiber at an angle which is greater than i_c, it will be reflected back, the angle of incidence is taken such that light rays suffer's multiple reflection. Due to multiple reflection signal can be send over a large distance

(6)→ Prism →

It is a crystal having two plane refracting surface.



(a)→ Prism angle →

It is the angle b/w two refracting surface.

(b)→ Angle of Incidence (i)

It is the angle made by incident ray with a normal with 1st refracting surface.

(c) Angle of emergence (e)

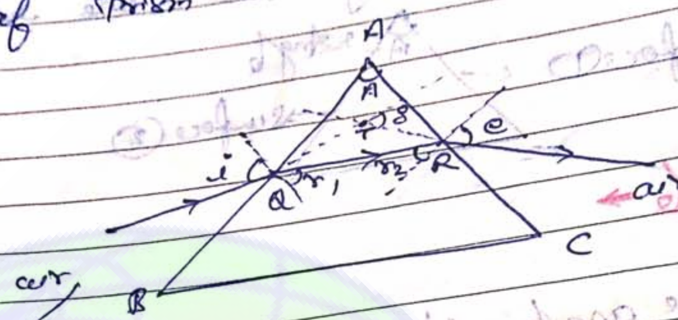
It is the angle made by emergent ray with a normal with 2nd refracting surface.

(d) Angle of deviation (δ)

It the angle b/w incident ray and finally refracted ray.

(e) Deviation for prism

In this Prism containing two plane refracting surface. A light ray incident on the surface "AB" at point "Q" and refracted on the surface AC at point "R" and angle made by incident ray and finally refracted ray is represented angle of deviation. μ is the refractive index of prism. A is angle b/w two refracting surface.

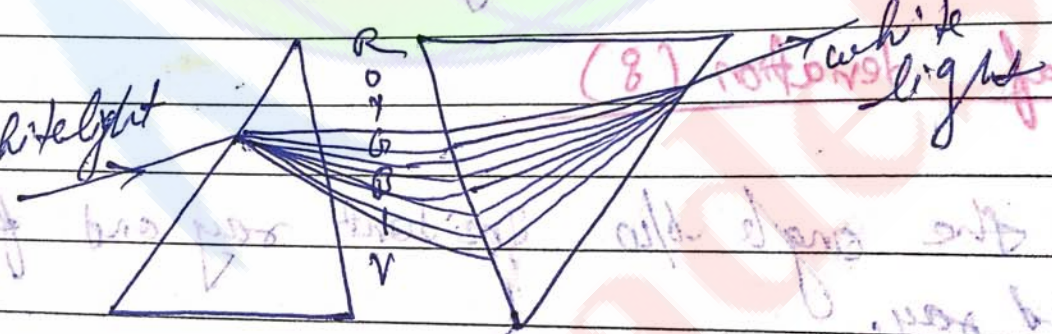


* Dispersion of light →

when white light is incident on a prism it get split into all seven colours, this phenomena is known as Dispersion of light.

Q) How you will use combination of prism to show that light ray does not create any dispersion? (white light)

An



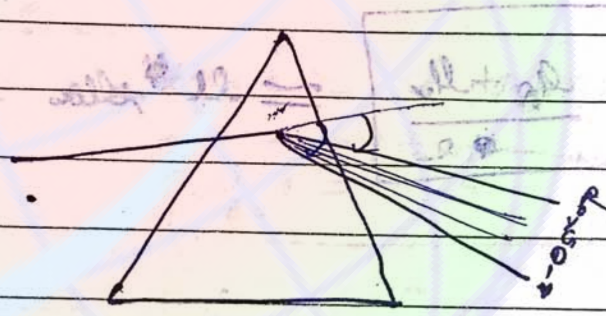
(Achromatic doublet)

(deviation without dispersion)

Angle of dispersion (θ)

$\delta = (\mu - 1)A$

$\mu_V > \mu_R$



$\delta_R = (\mu_R - 1)A$

$\delta_V = (\mu_V - 1)A$

Angle of dispersion $= \delta_V - \delta_R$

$$\theta = (\mu_V - \mu_R)A$$

✡ Dispersive power (ω) →

It is the ratio of angle of dispersion to the deviation of mean ~~Range~~. Range.

$$\omega = \frac{\theta}{\delta_{mean}}$$

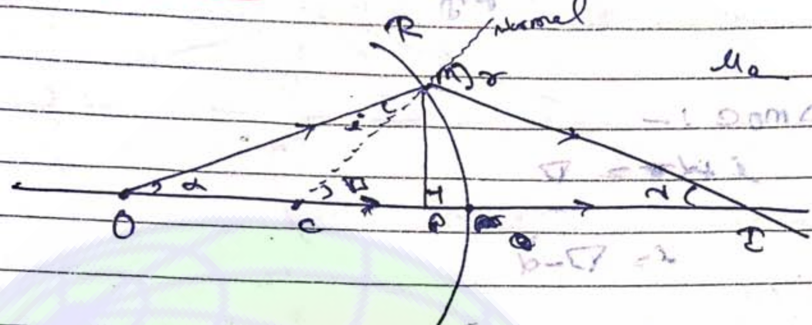
$$= \frac{(\mu_V - \mu_R)A}{(\mu_{mean} - 1)A}$$

$$\boxed{\omega = \frac{\mu_V - \mu_R}{\mu_{mean} - 1}}$$

$$\boxed{\mu_{mean} = \frac{\mu_R + \mu_V}{2}} \simeq \mu_{yellow}$$

Refraction through curve surface :-

① Concave surface :-



CP = −R
OP = −2R
PI = −V

from snells law :-

$$\mu_1 \sin i = \mu_2 \sin r$$

Since

i and r is small ($\sin i \simeq i$ and $\sin r \simeq r$)

$$\boxed{\mu_1 i = \mu_2 r} \quad \text{—(i)}$$

A given concave surface of radius "R" is placed as shown in the figure refractive index of the two sides are μ_1 and μ_2 and object is placed at "O" in medium μ_1.

A light is incident from "O" to "M" at angle "i" and after refraction it makes angle "r" with the normal.

The refracted light ray cuts principle axis at point "I" which is Image.

Now

from Geometry :-

$$\tan\alpha \simeq \alpha = \frac{MP}{OP}$$

$$\tan\beta \simeq \beta = \frac{MP}{CP}$$

In ΔMOC :-

$$i + \alpha = \beta$$

$$i = \beta - \alpha$$

$$i = \frac{MP}{CP} - \frac{MP}{OP}$$

In ΔMCI :

$$r = \beta + \alpha$$

$$r = \frac{MP}{CP} + \frac{MP}{PI}$$

By putting values in eq (1)

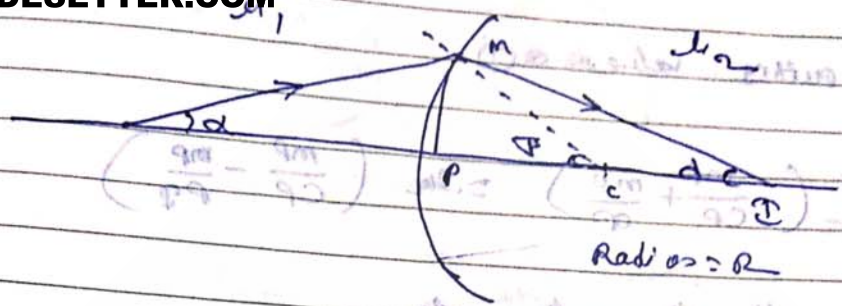
$$\mu_1 \left(\frac{MP}{CP} - \frac{MP}{OP}\right) = \mu_2 \left(\frac{MP}{CP} + \frac{MP}{PI}\right)$$

$$\frac{\mu_1}{CP} - \frac{\mu_1}{OP} = \frac{\mu_2}{CP} + \frac{\mu_2}{PI}$$

$$\frac{\mu_1}{-R} - \frac{\mu_1}{-V} = \frac{\mu_2}{-R} + \frac{\mu_2}{V}$$

$$-\frac{\mu_1}{R} + \frac{\mu_2}{R} = \frac{\mu_2}{V} - \frac{\mu_1}{u}$$

$$\boxed{\frac{\mu_2}{V} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}}$$



CP = +R

OP = −u

PI = +v

From Snell's law of

$\mu_1 \sin i = \mu_2 \sin r$

∴ i and r is very small

$$\mu_1 i = \mu_2 r \quad \text{—(i)}$$

From Geometry

$$\tan \alpha \approx \alpha = \frac{MP}{OP}$$

$$\tan \beta \approx \beta = \frac{MP}{CP}$$

$$\tan \gamma \approx \gamma = \frac{MP}{PI}$$

In ΔMOC

$$i = \beta + \alpha$$

$$i = \frac{MP}{CP} + \frac{MP}{OP}$$

In ΔMCI

$$r + \gamma = \beta$$

$$r = \frac{MP}{CP} - \frac{MP}{PI}$$

By putting value in eq (1)

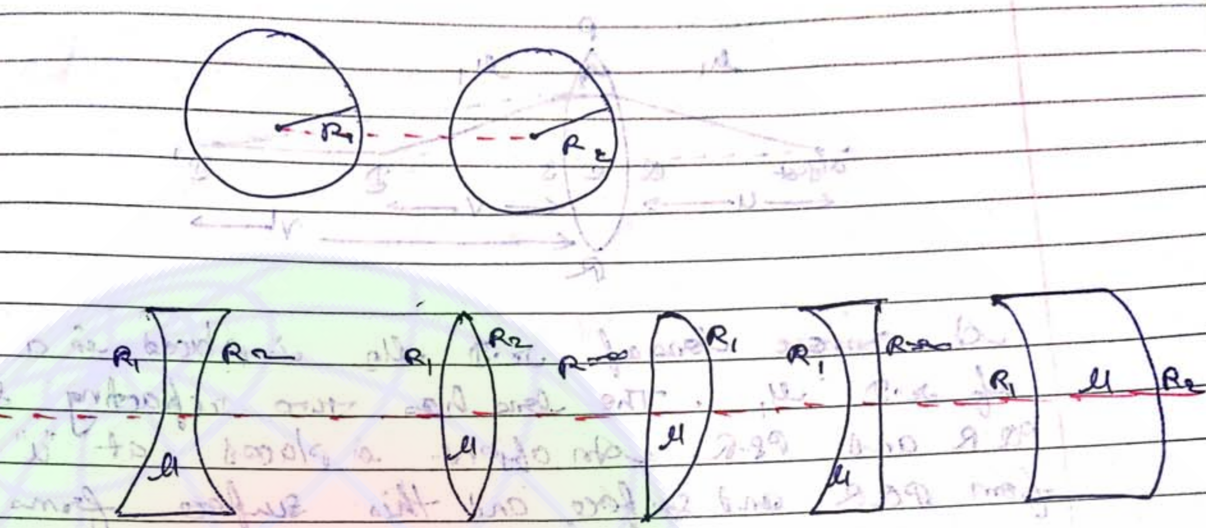
$$\mu_1 \left(\frac{MP}{CP} + \frac{MP}{OP} \right) = \mu_2 \left(\frac{MP}{CP} - \frac{MP}{PI} \right)$$

$$\frac{\mu_1}{CP} + \frac{\mu_1}{OP} = \frac{\mu_2}{CP} - \frac{\mu_2}{PI}$$

$$\frac{\mu_2}{R} - \frac{\mu_1}{-u} = \frac{\mu_2}{R} - \frac{\mu_2}{v}$$

$$\boxed{\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}}$$

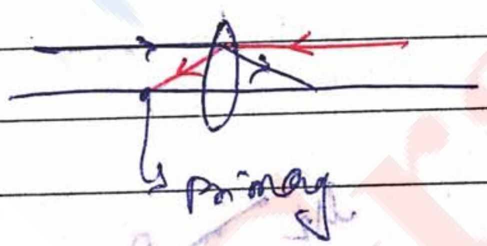
Lens and its application →



(1) Principle axis → It is the line joining C_1 and C_2

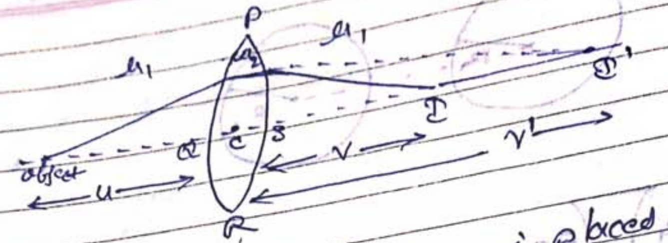
(2) optical centre :- Intersection point of the C_1, C_2 and lens.

3) Focus :- when parallel light is incident on lens then after refraction the point where it cuts the principle axis is known as focus.



Lens maker formula →

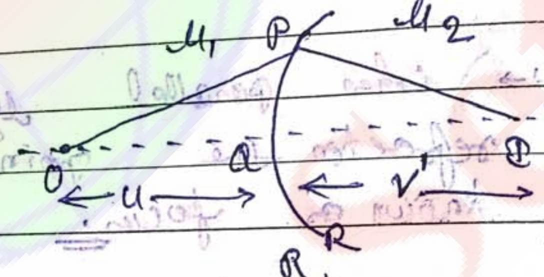
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad ; \quad \frac{1}{F} = (\mu - 1)\left\{\frac{1}{R_1} - \frac{1}{R_2}\right\}$$



A convex lens of r.I μ_2 is placed in a medium of r.I μ_1. The lens has two refracting surface PQR and PSR. An object is placed at "u" distance from PQR and surface and this surface forms Image at I'.

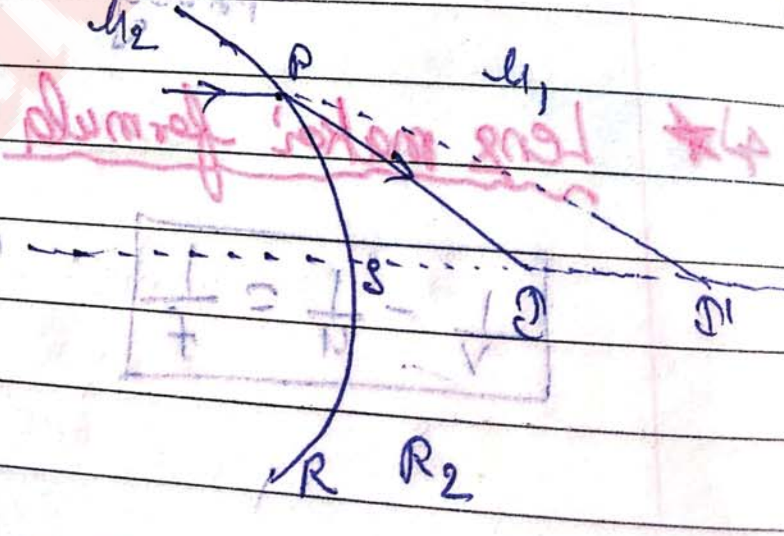
This Image I' will be object PSR surface and this surface finally will form Image at I. Hence from of formulae of refraction through curved surface we can prove the lens equation.

① From PQR Surface →



$$\frac{\mu_2}{v'} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R_1} \quad \text{—(i)}$$

② From PSR Surface →



$$\frac{\mu_1}{v} - \frac{\mu_2}{v'} = \frac{\mu_1 - \mu_2}{R_2} \quad \text{—(ii)}$$

Now,

Adding eq ① and eq ⑪

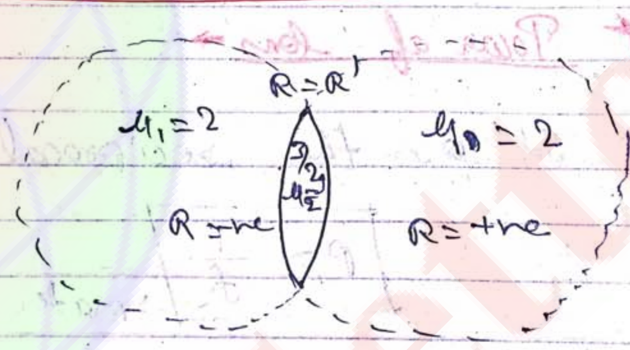
$$\frac{\mu_1}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R_1} + \frac{\mu_1 - \mu_2}{R_2}$$

$$\mu_1\left(\frac{1}{v} - \frac{1}{u}\right) = (\mu_2 - \mu_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow \boxed{\frac{1}{F} = \left(\frac{\mu_{lens}}{\mu_{med}} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$$

Q)



$$\frac{1}{F} = \left(\frac{3}{4} - 1\right)$$

$$\frac{1}{F} = \frac{-1}{4} \times \frac{2}{R}$$

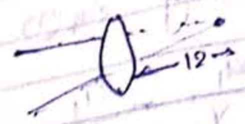
$$\frac{1}{F} = \frac{-1}{2R}$$

$$\therefore \boxed{F = -2R}$$

* If focus is -ve lens will be divergent and if focus is +ve lens will be convergent in nature

* If a lens is placed in air (rarer medium) then convex lens will be convergent and concave lens will be divergent.

Q) Calculate position of image—



s/n

$F = 20$

$u = +12$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} \Rightarrow \frac{1}{20} + \frac{1}{12}$

$\frac{3+5}{60} = v \Rightarrow \frac{60}{8}$

$v = 7.5$

★ **Power of lens** →

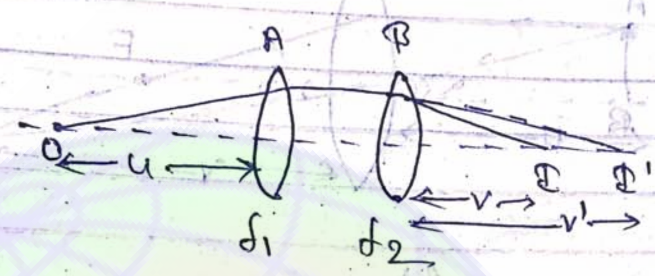
It is the reciprocal of the focal length.

$P = \frac{1}{f}$ (meter) or $P = \frac{100}{f\,cm}$

* To calculate power focal length must be put in "m".

* Unit of the power of lens is [illegible] Diopter (D)

☆ Equivalent power of two given lens placed very closed to each other →



For first lens,

$$\frac{1}{v'} - \frac{1}{u} = \frac{1}{f_1} \quad \text{—(i)}$$

For 2nd lens

$$\frac{1}{v} - \frac{1}{v'} = \frac{1}{f_2} \quad \text{—(ii)}$$

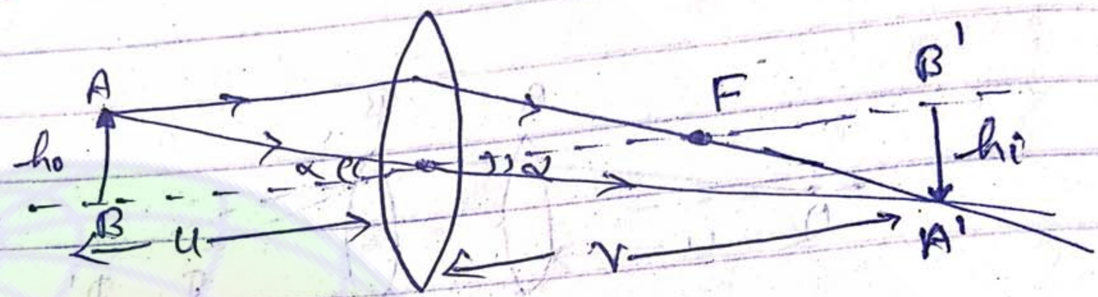
Add eq (i) and eq (ii)

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\boxed{\frac{1}{v} - \frac{1}{u} = \frac{1}{f_{eq}}}$$

$$\boxed{\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}}$$ and $$\boxed{P_{eq} = P_1 + P_2}$$

✡ Magnification produces by lens →



magnification, $m = \frac{h_i}{h_o}$

From geometry,

$$\tan\alpha = \frac{+AB}{-u} = \frac{-A'B'}{+v}$$

$$\Rightarrow \frac{A'B'}{AB} = \frac{v}{u}$$

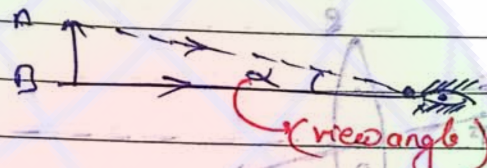
$$\boxed{m = \frac{h_i}{h_o} = \frac{v}{u}}$$

Optical devices :

They improve magnification field of view and view angle.

① **view angle :→** α

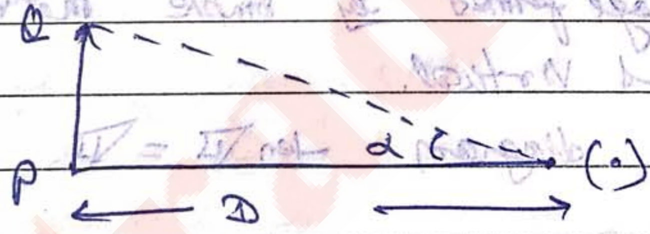
α is the angle made by an object on the human eye



② **magnification →**

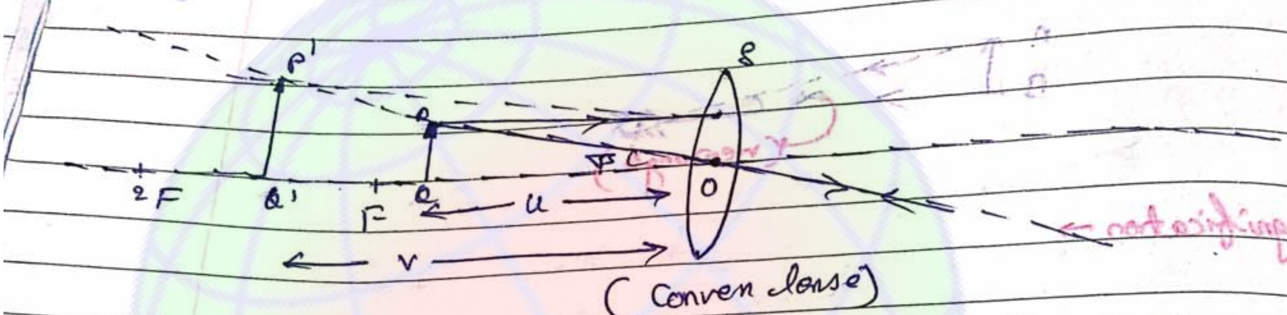
$$M = \frac{\text{View angle with instrument (Image)}}{\text{view angle without instrument when object is placed at "D"}}$$

$$= \frac{\tan \beta}{\tan \alpha} \simeq \frac{\beta}{\alpha}$$



$\tan \alpha = \frac{PQ}{D}$

(5) simple microscope



In the simple microscope a convex lens of focal length "F" is used and object "PQ" is placed somewhere focus and optical centre at u-distance the lens form's its Image P'Q' and distance of Image "v" from lens.

Image formed by simple microscope is enlarged erect and virtual.

From the diagram $\tan \beta = \beta$

So

$$\tan \beta = \beta = \frac{PQ}{u}$$

we know that $m = \frac{\beta}{\alpha}$

$$= \frac{PQ/u}{PQ/D}$$

So

Ra1, Ra2

$$\boxed{m = \frac{D}{u}}$$

Case 1st :-

When final image is form at "D".

$v = -D$

$f = +f$

$u = -u$

↳ (strained eye condition) ↳ (तनाव) Ra2

From lens equation

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$-\frac{1}{u} = \frac{1}{f} - \frac{1}{v}$$

By putting values with sign

$$-\frac{1}{-u} = \frac{1}{f} - \frac{1}{-V}$$

$$\frac{1}{u} = \frac{1}{f} + \frac{1}{D}$$

$$\frac{D}{u} = \frac{D}{f} + 1$$

$$\boxed{m = \left(\frac{D}{f} + 1\right)}$$

↳ Imp — put value without sign

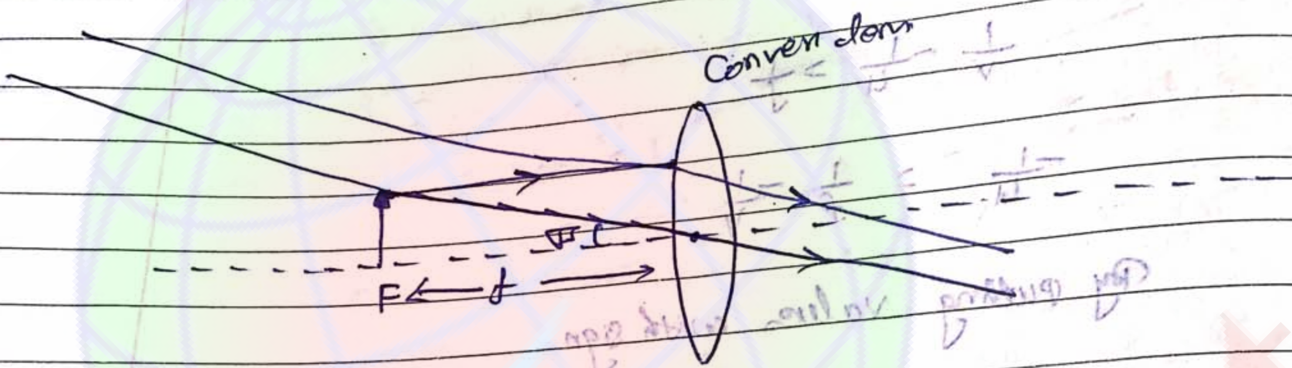
Ra1 → "m" is always in +ve.

Case and when final Image is formed at Infinity (Relaxed eye state)

$v = a$

$u = f$

$$m = \frac{D}{f}$$



$v = \infty$

$f = +f$

$u = -u$

Then lens equation

$$\frac{1}{\infty} - \frac{1}{-u} = \frac{1}{f}$$

$$-\frac{1}{u} = \frac{1}{f} - \frac{1}{\infty}$$

By putting value with

$$\frac{-1}{-u} = \frac{1}{f} - \frac{1}{\infty}$$

$$m = \frac{D}{f}$$

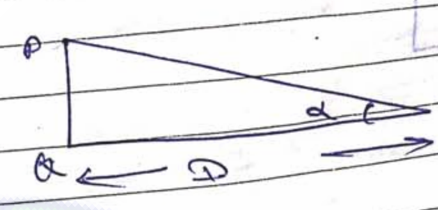
(3) $v = -D$

$$m = \frac{D}{f} + 1$$

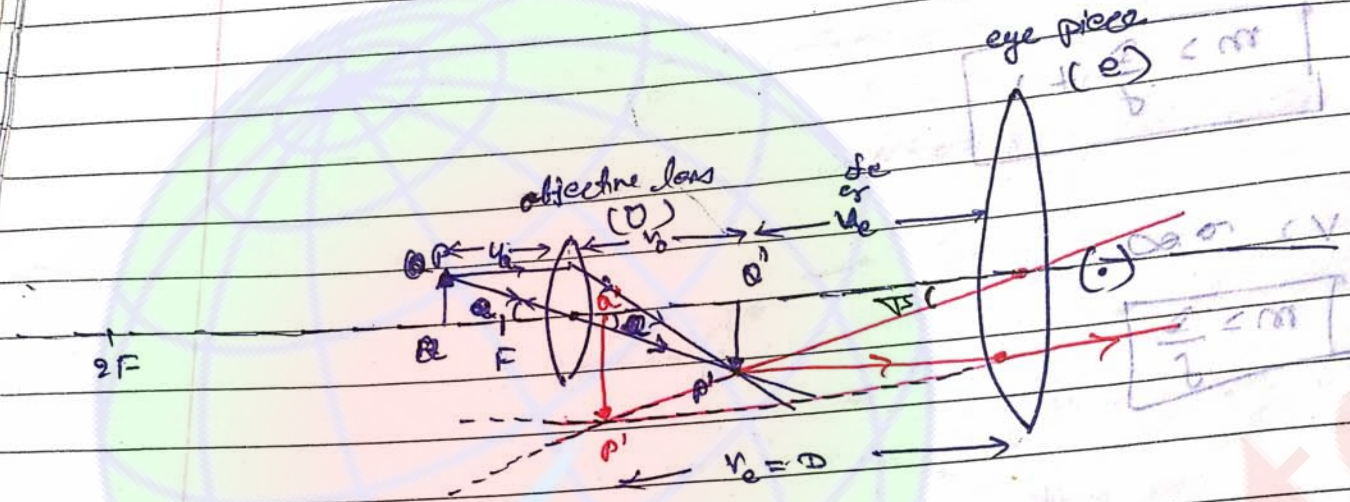
(4) $v = \infty$

$$m = \frac{D}{f}$$

(4) ★ Compound microscope



$$\tan\alpha = \frac{PQ}{D}$$



$$\tan\beta = \frac{P'Q'}{u_e}$$

$$\tan\alpha = \frac{PQ}{D}$$

$$m = \frac{\beta}{\alpha} = \frac{P'Q'/u_e}{PQ/D}$$

$$= \frac{P'Q'}{PQ} \cdot \frac{D}{u_e}$$

From geometry.

$$\tan\theta = \frac{P'Q'}{v_0} = \frac{PQ}{u_0}$$

$$= \frac{P'Q'}{PQ} = \frac{v_0}{u_0}$$

Hence

$$\text{magnification } (m) = \frac{v_0}{u_0} \cdot \frac{D}{u_e}$$

Case no 1:-
When final Image is formed at "D"
↳ (Standard eye condition)

$$V_e = -D$$

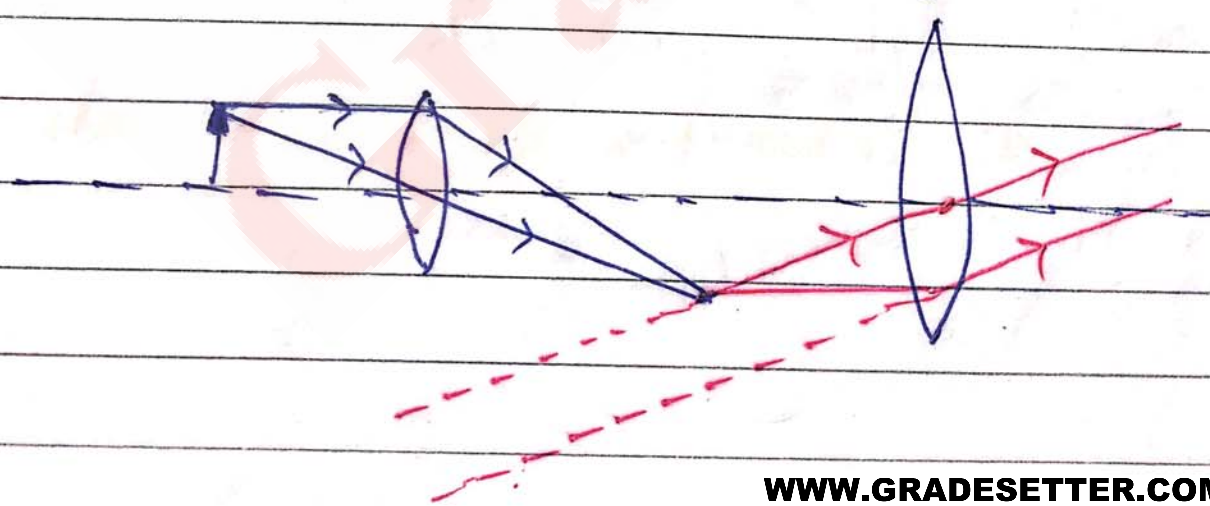
$$f = f_e$$

$$u = -u_e$$

$$\frac{D}{u_e} = \frac{D}{f_e} + 1$$

$$m = -\frac{v_0}{u_0}\left(\frac{D}{f_e} + 1\right)$$

Case 2nd :-
When final Image is formed at Infinity.
↳ (Relaxed eye state)



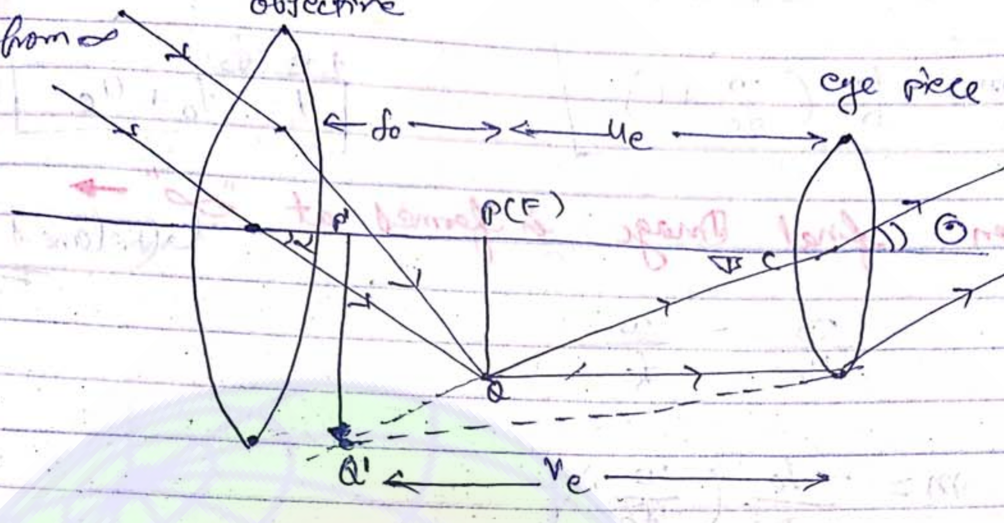
$v_e = \infty$

$f = f_e$

$u = -u_e$

$$\frac{D}{u_e} = \frac{D}{f_e}$$

$$m = -\left(\frac{v_0}{u_0} \times \frac{D}{f_e}\right)$$



$$\tan\beta = \frac{PQ}{u_e} = \frac{P'Q'}{v_e}$$

$$\tan\alpha = \frac{PQ}{f_o}$$

$$\text{Magnifying power } (m) = \frac{\beta}{\alpha} = \frac{\tan\beta}{\tan\alpha}$$

$$= \frac{PQ/u_e}{PQ/f_o}$$

$$\boxed{m = -\left(\frac{f_o}{u_e}\right)}$$

$$m = \frac{-F_o}{D}\cdot\frac{D}{u_e}$$

(strained eye)

(1) when final image is formed at "D"

$$\frac{D}{u_e} = \left(\frac{D}{f_e}+1\right)$$

$$m = -\frac{f_o}{D}\left(\frac{D}{f_e}+1\right)$$

$$L = f_o + u_e$$

(II) When final image is formed at "∞" → (Relaxed eye)

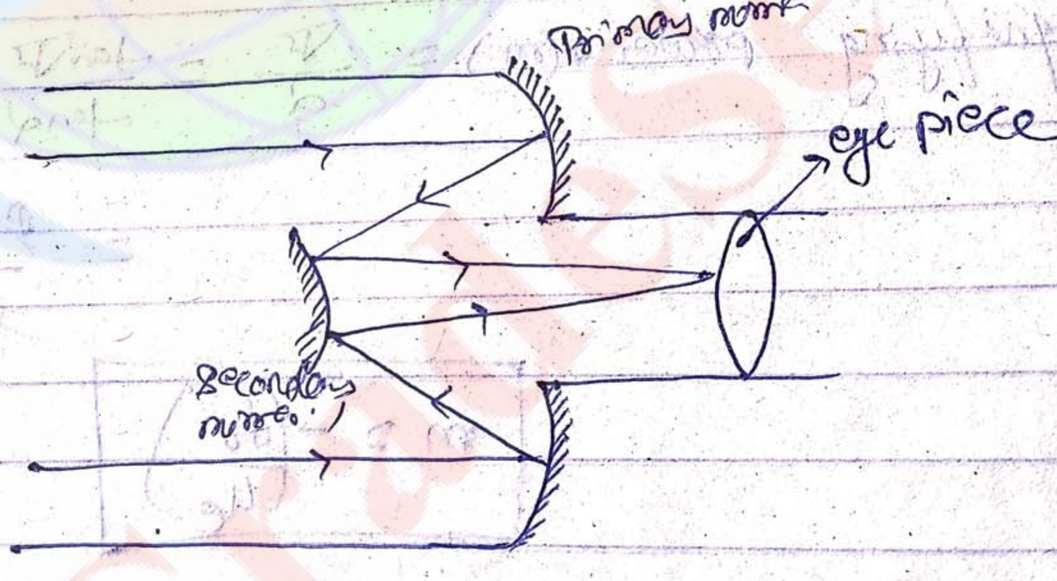
$$\frac{D}{u_e} = \frac{D}{f_e}$$

$$m = \frac{-f_o}{-D}\left(\frac{D}{f_e}\right)$$

$$m = -\frac{f_o}{f_e}$$

$$L = f_o + f_e$$

<6> Reflecting telescope →



Accomodation of human eye →

Human eye can change it's focus by expanding of contracting eye lens. this chemistry of eye is known as Accomodation of Human eye.

Defect of Vision →

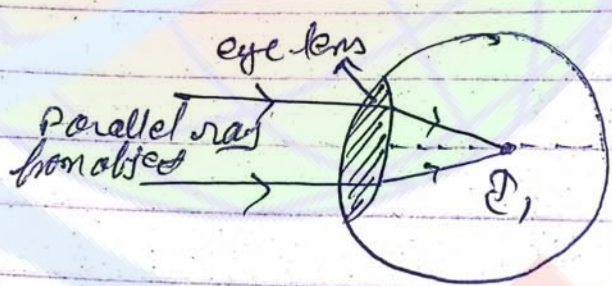
(1) myopia or short sightedness →

(नजदीक का दिखाई देगा)
(पास देखना)

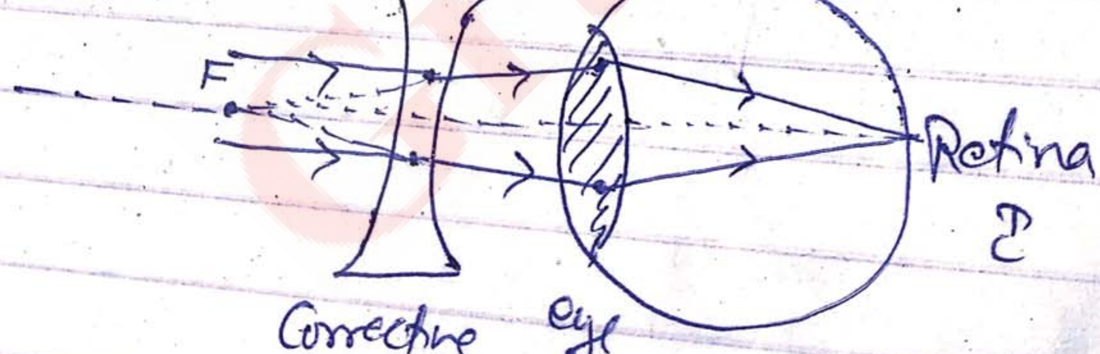
myopia is the defect of eye in which a person can see only nearby object's, but fails to see the far away objects distinctly.

Reason →

(i) decrease in focal length of eye lens
(ii) spreading of eye-sphere.



Removal

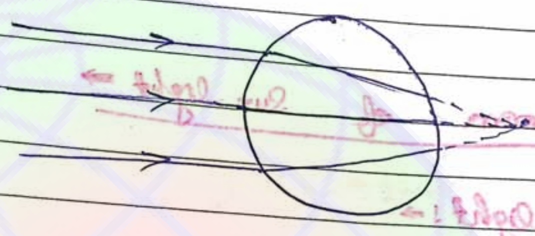


Near → नजदीक का दिखता है

[सिर्फ दूर का दिखता]

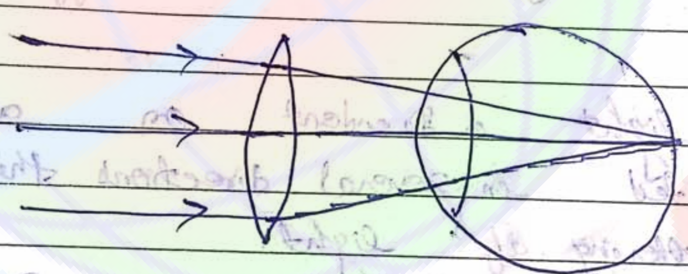
② Farsightness or hypermetropia:-

The person suffering from hypermetropia is not able to see the object's which are placed closed to them.

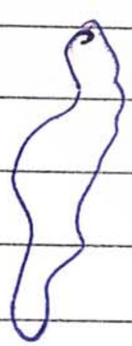


Removal:-

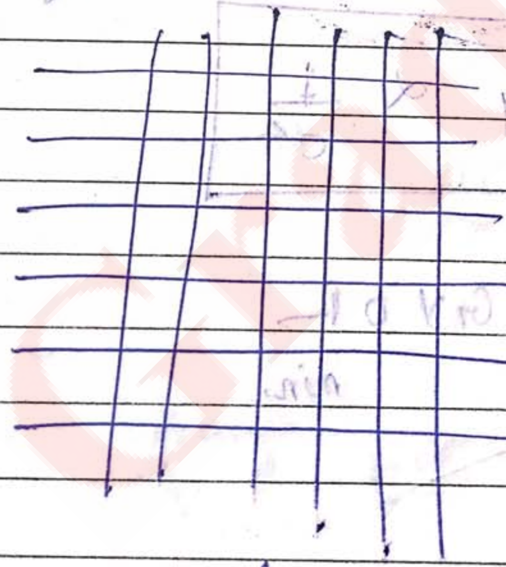
This can be removed using a converging lens of suitable focal length.



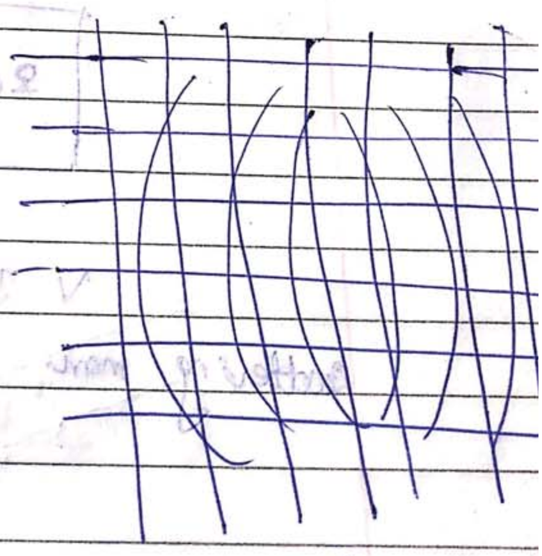
③ Astigmatism →



lens



Normal eye vision



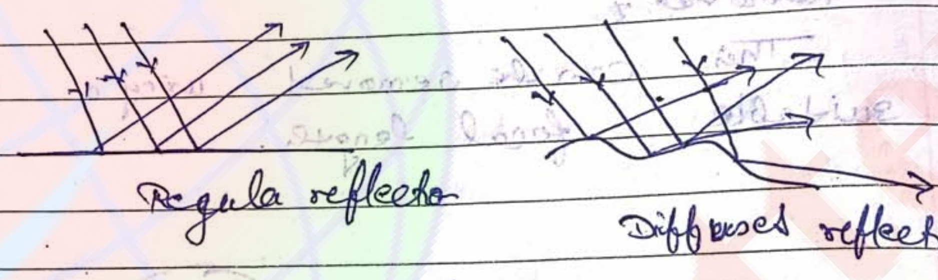
Astigmatism.

A person suffering from it can not differenciate b/w horizontal lines and vertical lines

Removal: →
This can be removed using cylindrical lenses.

★ Some phenomena of sun light →

① Scattering of light: →



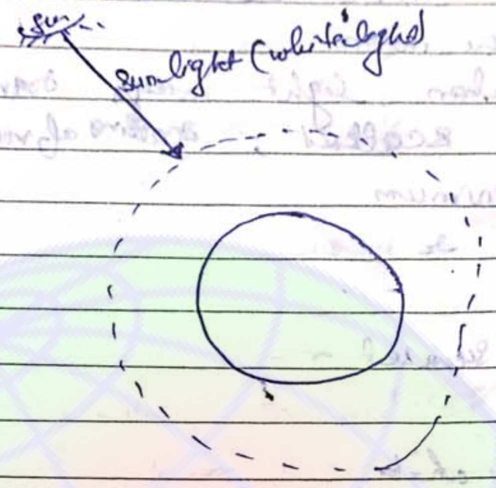
when which light is incident on a obstacle it get reflected in several directions this phenomena is known as scattering of light.
According to Rleigh scattering is Inversily proportion to the 4th power of wavelength

$$\text{Scattering} \propto \frac{1}{\lambda^4}$$

V I B G Y O R
Scattering max. min.

Applications:-

(1) Sky appears blue

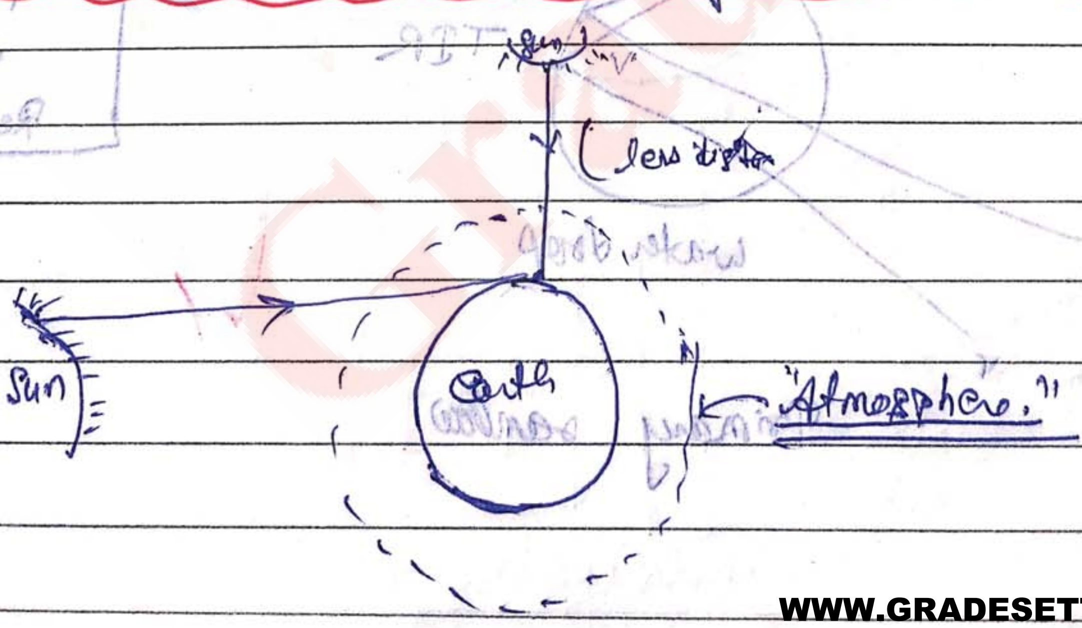


Rq. 1 — When white light from sun comes into atmosphere it get scattered. Scattering of violet colour is more in compare to blue colour but human eyes are more sensitive towards blue colour in compare to violet. Hence sky appears as blue to eyes.

V I (B) G Y O R

scatter हो जाता ज्यादा नहीं दिखता (less eye) — eye is more sensitive

(2) Sun appear reddish during sun set or sun rise



WWW.GRADESETTER.COM

light ray travells more distance in atmosphere in compare to the noon

when light rays travells in atmosphere it get scattered ; scattering of violet is maximum and for red it is minimum

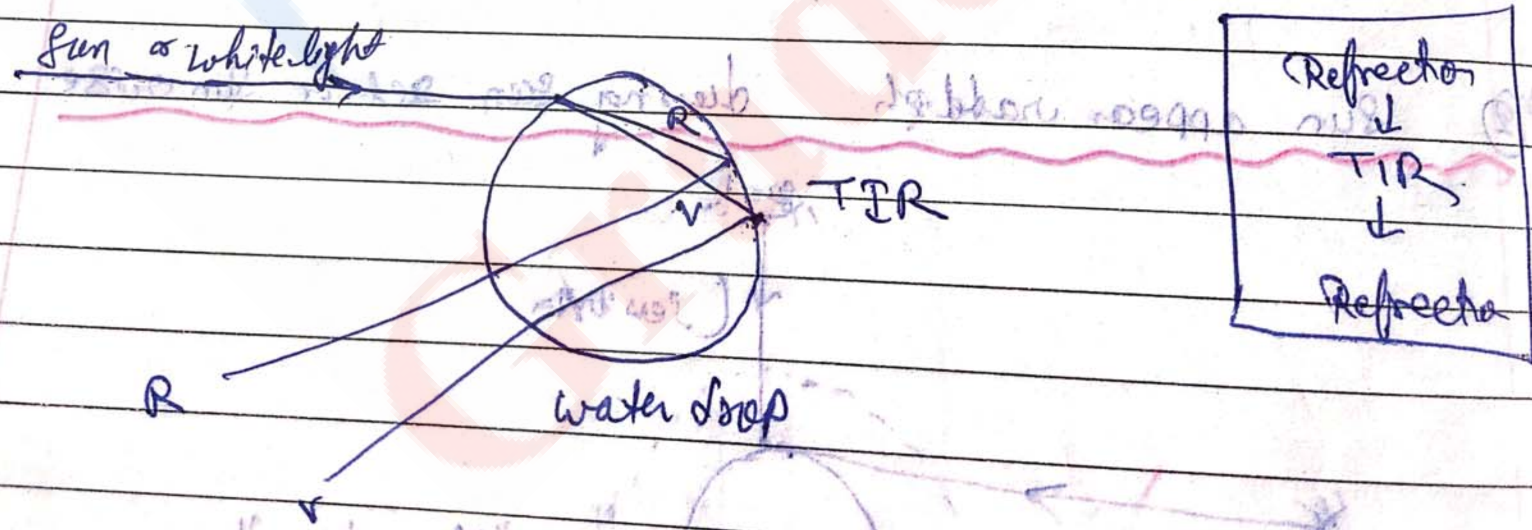
Therefore

Hence during sunset

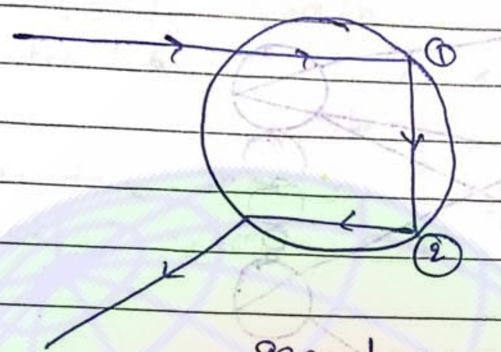
eg. cloud appears white

size of the water drops in clouds are very big compare to air molecules Hence when sunlight is incident on it, it doesn't get scattered therefore cloud appears white.

(4) Formation of Rainbow →



Primary rainbow

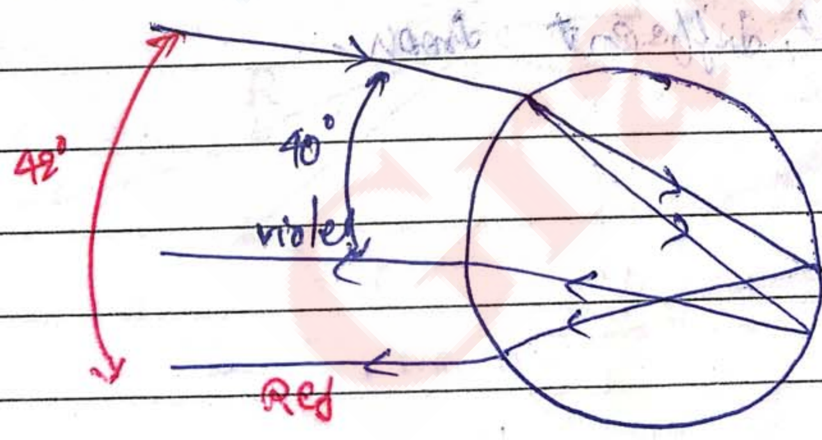


secondary ranbow

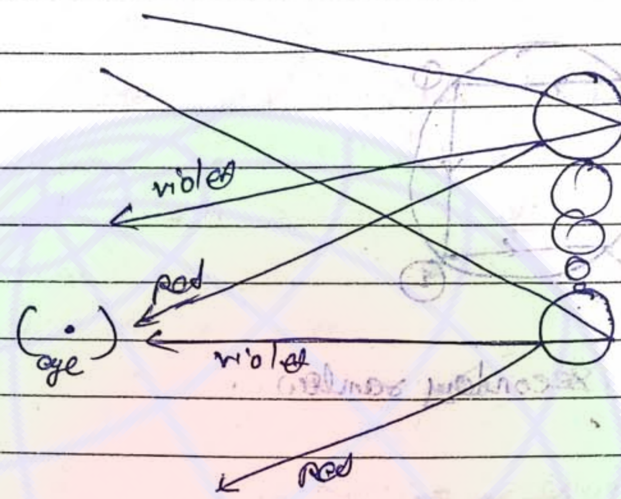
refrectn
↓
TIR 1st
↓
TIR 2nd
↓
refrectn

Ranbow is the example of dispersion of light ray produced by water drop's rainbow consist mainly three phenomena:-
1st refraction → 2nd Total Internal Reflection → and then again Refraction of light.
→ (Dispersion)

when Sunlight is incident on water drop's it get dispersed



Whole → N.C.E.R.T → Complete Discussion
+ D.P.P discussion

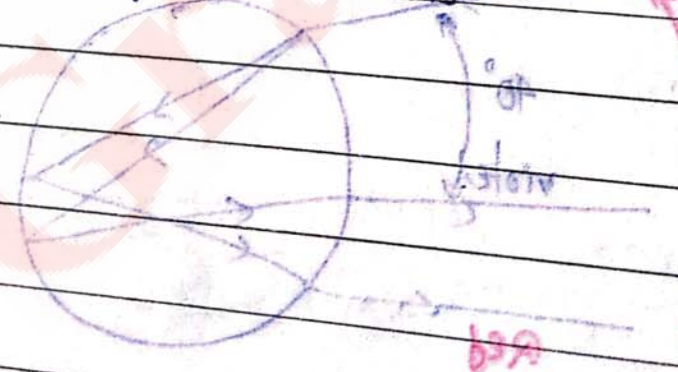


Primary rainbow

In the primary rainbow sun light reflected only ones inside the water drop due to the dispersion and Reflection it come out at complete spectrum. In the given figure two drops are available

violet colour from one an

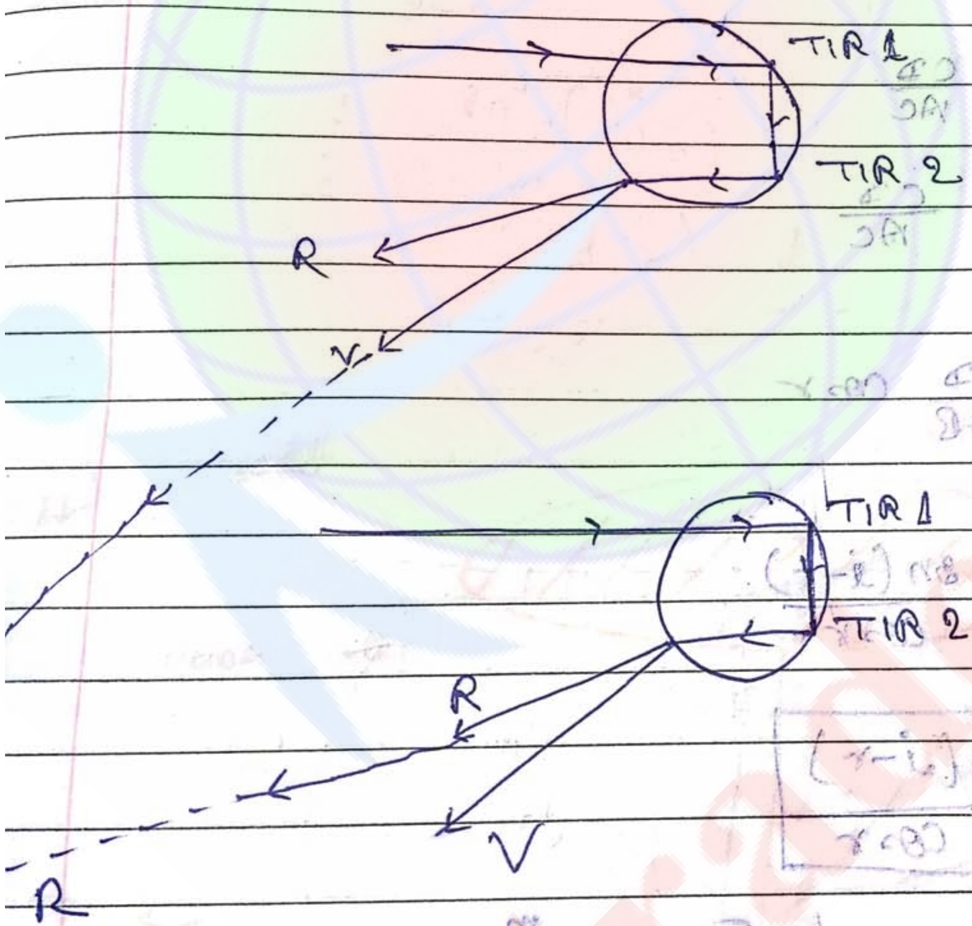
Hence observer can see red to violet all colours by different, different drops.



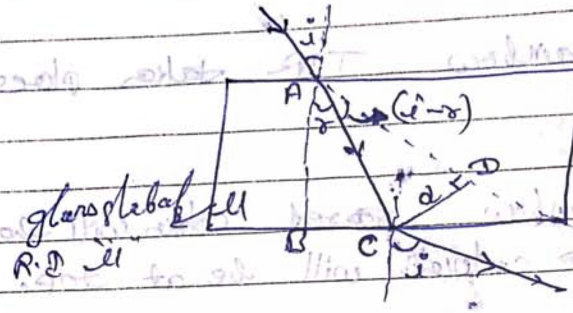
(i) In this type of rainbow TIR takes place twice inside the drop.

(ii) In secondary rainbow red colour will be at bottom and violet colour will be at top.

(iii) secondary rainbow is always created above a primary rainbow.



Lateral displacement ⇒



In ΔABC,

$$\cos r = \frac{AB}{AC} \Rightarrow AC = \frac{AB}{\cos r} \quad \text{---(1)}$$

In ΔACD,

$$\sin(i-r) = \frac{CD}{AC}$$

$$\sin(i-r) = \frac{CD}{AC}$$

$$\sin(i-r) = \frac{CD}{AB}\cos r$$

$$CD = \frac{AB \sin(i-r)}{\cos r}$$

$$\boxed{d = t\,\frac{\sin(i-r)}{\cos r}}$$

For min —

$i = 0$

$$d_{min} = t\,\frac{\sin 0^\circ}{\cos 0^\circ}$$

$$\boxed{d_{min} = 0}$$

For max^m —

$i = 90^\circ$

$$d_{max} = \frac{t \cdot \sin(90-r)}{\cos r}$$

$$\boxed{d_{max} = t}$$

DPPS-03

Q3) $C_m = 1.5\times10^8$ m/s

$C_{air} = 3\times10^8$ m/s

$\mu = \frac{C_{air}}{C_m} = \frac{3\times10^8}{1.5\times10^8}$

$\boxed{\mu = 2}$

$\mu = 1$

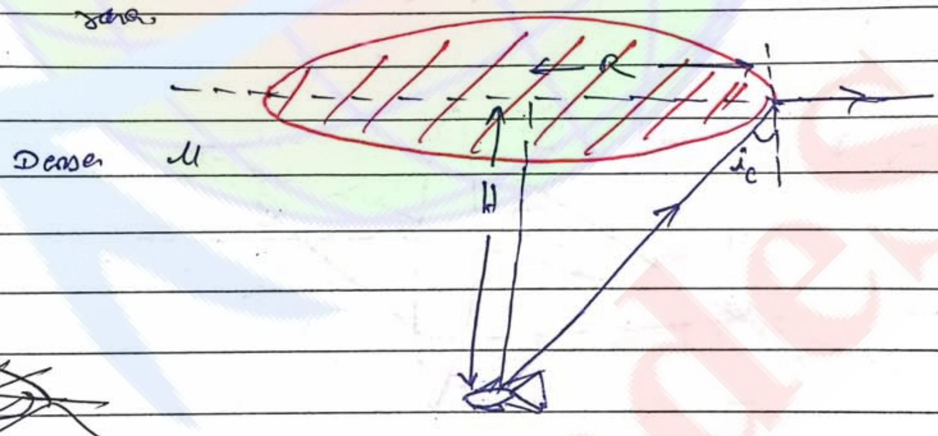
$\mu = 2$

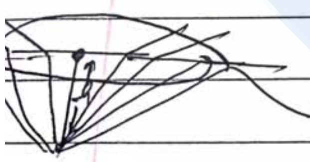
$C = \sin^{-1}\left(\frac{\mu_R}{\mu_D}\right)$

$= \sin^{-1}\left(\frac{1}{2}\right)$

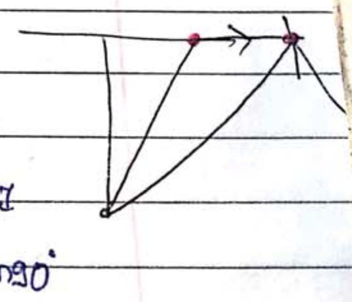
$\boxed{C = 30^\circ}$

Q4)





Note



$\tan i_c = \frac{R}{H}$

$R = H \tan i_c$

$\boxed{R = H \times \frac{1}{\sqrt{\mu^2 - 1}}}$

$= \pi r^2$

$\boxed{= \pi \times \frac{H^2}{\mu^2 - 1}}$

from snells law

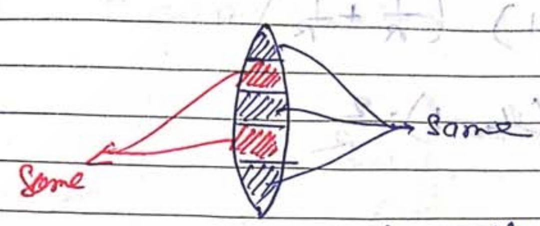
$\mu \sin i_c = 1 \times \sin 90^\circ$

$\sin i_c = \frac{1}{\mu}$

$\Rightarrow \tan i_c = \frac{1}{\sqrt{\mu^2 - 1}}$

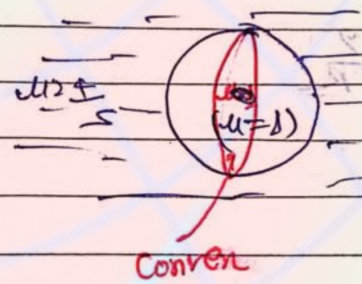
D.P.P.S - 9

Q6.)



two diff type of material so two Image is formed.

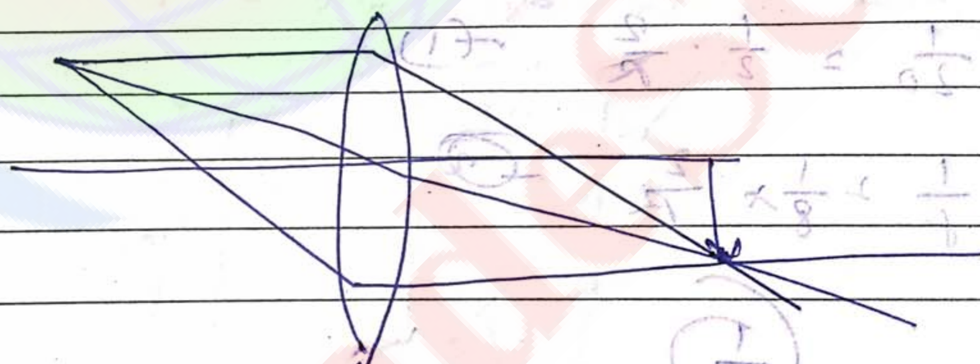
Q3.)



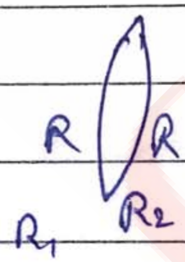
Here, lens is kept in

↳ Diverging lens

Q7.)



Q11.)



equi convex

$R_1 \rightarrow R$

$R_2 \rightarrow -R$

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

$$\frac{1}{f} = (\mu_{lens} - 1)\left(\frac{1}{R} + \frac{1}{R}\right)$$

$$\frac{1}{f} = (\mu_{lens} - 1)\cdot\frac{2}{R}$$

$$\frac{1}{20} = \left(\frac{3}{2} - 1\right)\cdot\left(\frac{2}{R}\right)$$

$$\frac{1}{f} = \left(\frac{\mu_{lens}}{\mu_{water}} - 1\right)\frac{2}{R}$$

$$\frac{1}{f} = \left(\frac{3/2}{4/3} - 1\right)\cdot\frac{2}{R}$$

$$\frac{1}{f} = \left(\frac{9}{8} - 1\right)\cdot\frac{2}{R}$$

$$\frac{1}{f} = \frac{1}{P} \times \frac{2}{R} \quad -(2)$$

$$\frac{1}{20} = \frac{1}{2}\cdot\frac{2}{R} \quad -(1)$$

$$\frac{1}{f} = \frac{1}{8} \times \frac{2}{R} \quad -(2)$$

$$\frac{1}{2}$$

$$\frac{1/20}{\frac{1}{8}} = \frac{1/2}{V_p}$$

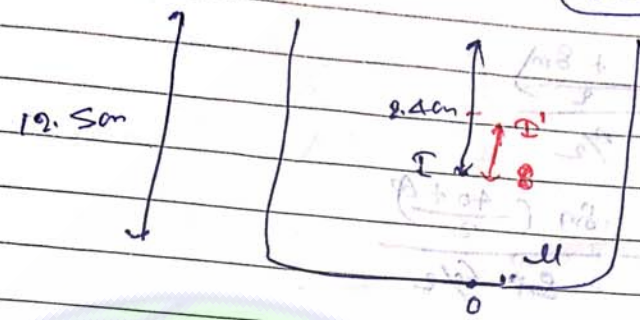
Convex

$$\frac{F}{20} = \frac{8}{2}$$

$$F = 4 \times 20 = 80$$

observer ($\mu = 1$)

9.3



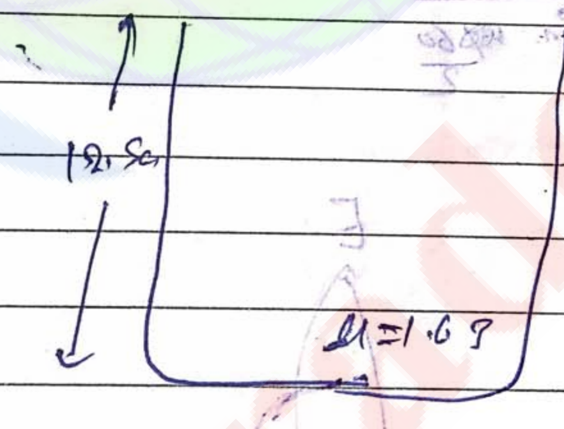
Real depth = 12.5cm

Appearant depth = 9.4cm

$$\text{App. depth} = \text{Real depth} \times \frac{\text{R.I of observer media}}{\text{R.I of object media}}$$

$$9.4 = 12.5 \times \frac{1}{\mu}$$

$$\mu_{wat} = \frac{12.5}{9.4} = \frac{4}{3} = 1.33$$



$$\text{Appearant depth} = 12.5 \times \frac{1}{1.63}$$

$$h' = \frac{12.5}{1.63}$$

$$\text{shift} = |h' - 9.4| =$$

06)

$\delta_m = 40$

$A = 60^\circ$

$$\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin A/2}$$

$$\mu_{prism} = \frac{\sin\left(\frac{40 + 60}{2}\right)}{\sin 60/2}$$

$$\mu_{prism} = \frac{\sin 50}{\sin 30}$$

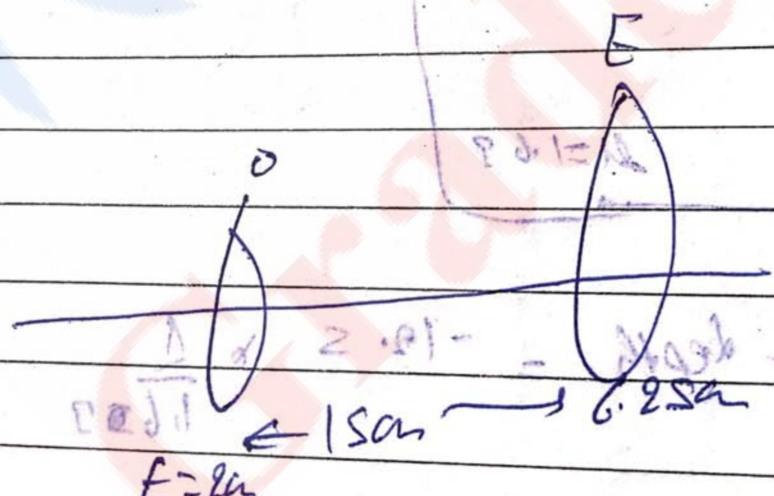
or

$$\frac{\mu_{prism}}{\mu_{water}} = \frac{\sin 50}{\sin 30}$$

$$\frac{\mu_{prism}}{\mu_{water}} = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin A/2}$$

$$\frac{\frac{\sin 50}{\sin 30}}{1.33} = \frac{\sin\left(\frac{60 + \delta_m}{2}\right)}{\sin \frac{60}{2}}$$

07)



$f = 2cm$

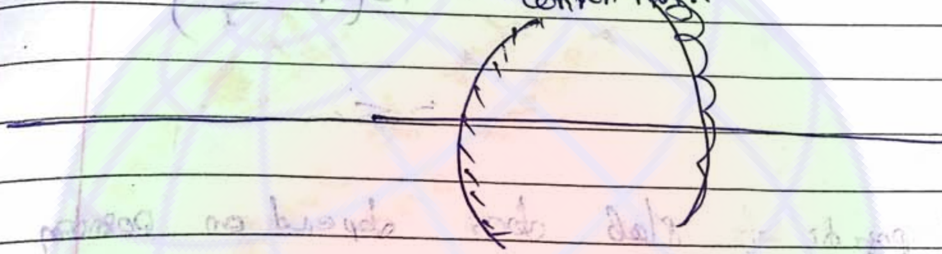
$$M = \frac{-v_0}{u_0}\left(1 + \frac{D}{f_e}\right)$$

Q14) $m = \frac{f_o}{f_e}$

Q15.

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\frac{1}{u} = \frac{1}{v} = \frac{1}{F} - \frac{1}{u}$



$\therefore f = +ve$

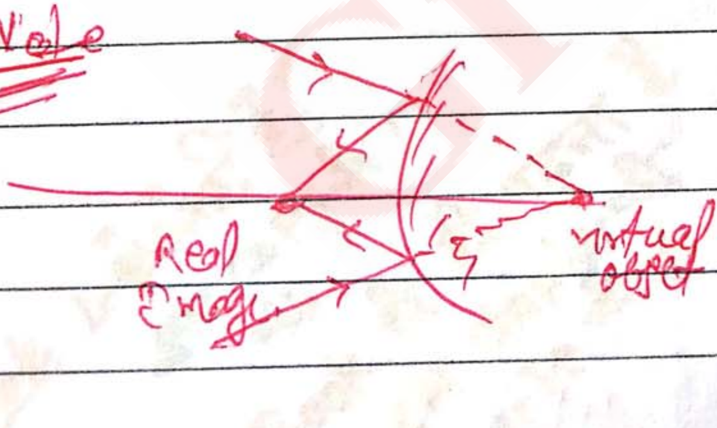
Real object $= -ve$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{-u}$$

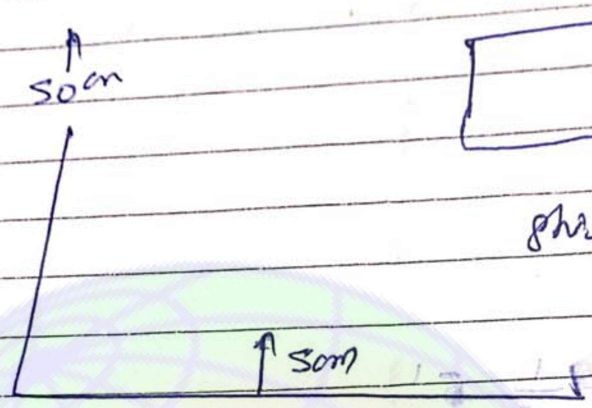
$$\boxed{\frac{1}{v} > 0}$$

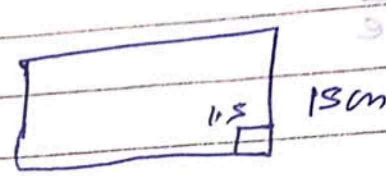
$\boxed{v > 0}$ Image form always behind the mirror.

Note



(16)





$$\text{shift} = t\left(1 - \frac{1}{\mu}\right)$$

$$= 15\left(1 - \frac{1}{1.5}\right)$$

$$= 15\left(1 - \frac{2}{3}\right)$$

$$= 5cm$$

R.I of posi. of slab does depend on position

Matter waves and Radioactivity → { matter wave and Photoelectric effect }

1) **Photon** → light energy travells in small packets or bundles these bundles are known as photon of light.

Energy of photon, $E = h\nu = \frac{hc}{\lambda}$

h = Plank constant $= 6.6\times10^{-34}$ J-sec
ν = frequency of light
c = speed of light $= 3\times10^{8}$ m/s
λ = Wavelength of light

V I B G Y O R

$\lambda_V < \lambda_R$ ⟶ Wavelength Increase.

$\nu_V > \nu_R$ ⟵ frequency Increases.

$E_V > E_R$ ⟵ Energy of photon

2) **mass of photon** →
According to einstine $E = mc^2$

✱ Dynamic mass $(m) = \frac{E}{c^2}$

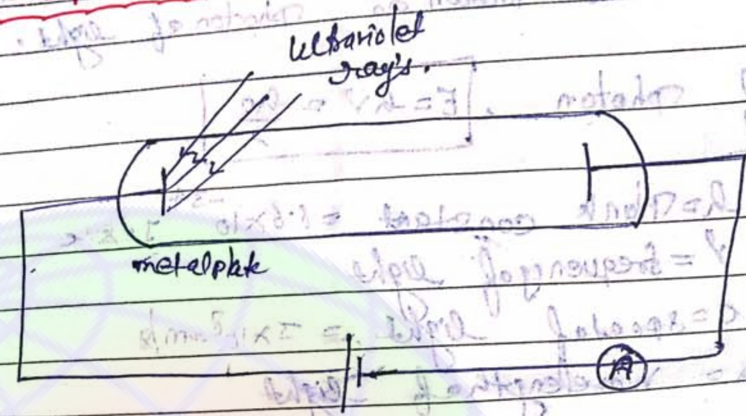
$$m = \frac{h\nu}{c^2} = \frac{h}{\lambda c}$$

✱ Rest mass of photon will be zero

3) Momentum of photon →

$$P = mv = mc = \frac{E}{c^2}\cdot c = \frac{E}{c} = \frac{h}{\lambda} = \frac{h\nu}{c}$$

(2) Hertz experiment →



In the Hertz experiment value of current is increases suddenly when this metal plate is exposed to the ultraviolet rays that means more no. of e^-'s are ejected from the metal surface when it is exposed to the light

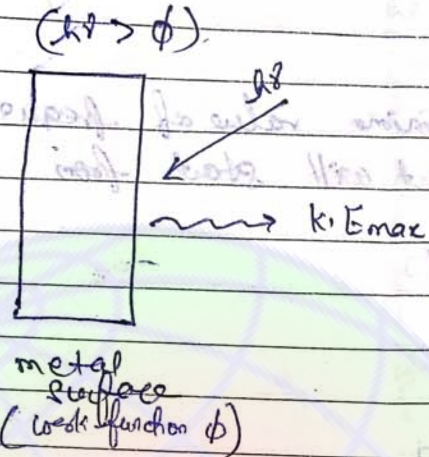
This phenomena is known as photo electric effect.

(3) Photoelectric effect →

When light energy is incident on a metal surface having suitable frequency then e^-'s are ejected from the metal surface and this phenomena is known as Photoelectric effect

These ejected e^-'s are known as photo electrons and current due to these e^-'s are known as photo current

<4> Einstein equation of photo electric effect →



$$h\nu = \phi + K.E$$

In the given figure light energy is incident on metal surface energy of a photon in the light is hν and work function of the metal surface

$$(h\nu > \phi)$$

Then e⁻'s of the metal will absorb photon's and will come out from the surface.

max. K.E of these e⁻'s is denoted by $K.E_{max}$

$$h\nu = \frac{1}{2}mv_{max}^2 + \phi$$

<5> Work function → It is the min. amount of energy of a photon to start the photoelectric effect.

$$E_{min} = \phi$$

$$h\nu_{min} = \phi$$

work function depends on the nature of target metal

(a) Threshold frequency

It is the minimum value of frequency on which photoelectric effect will start from a metal surface.

$$E_{min} = \phi$$

$$h\nu_{min} = \phi$$

$$\boxed{\nu_{min} = \frac{\phi}{h}}$$

$$\boxed{(\nu_0) \text{ Threshold frequency } \nu_{min} = \frac{\phi}{h}}$$

(b) Threshold wavelength →

It is the max. value of wavelength of light on which photo-electric effect will

$$E_{min} = \phi$$

$$h\nu_{min} = \phi$$

$$\frac{hc}{\lambda_{max}} = \phi$$

$$\boxed{\lambda_{max} = \frac{hc}{\phi}}$$ threshold wavelength

$E > \phi$

$h\nu > h\nu_{min}$

$\nu > \nu_{min}$

$c' < c_{max}$

☆ $\phi = E_{min} = h\nu_{min} = h\nu_0$

$\phi = E_{min} = \frac{hc}{\lambda_{max}} = \frac{hc}{\lambda_0}$

$h\nu = \phi + K.E_{max}$, $E = \phi + K.E_{max}$

$h\nu = h\nu_0 + K.E_{max}$, $\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + K.E_{max}$

$$\boxed{K.E_{max} = h\nu - h\nu_0}$$

$$\boxed{hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) = K.E_{max}}$$

where
ν_0 = Threshold frequency
λ_0 = Threshold wavelength.

Condition to start Photoelectric effect →

$h\nu - \phi = K.E_{max} \longrightarrow h\nu > \phi$ or $E > \phi$

$h(\nu - \nu_0) = K.E_{max} \longrightarrow \nu > \nu_0$

$hc\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right) = K.E_{max} \longrightarrow \lambda < \lambda_0$

Q ✱ If with green colour photoelectric effect just starts then name the colours with which it will not start.

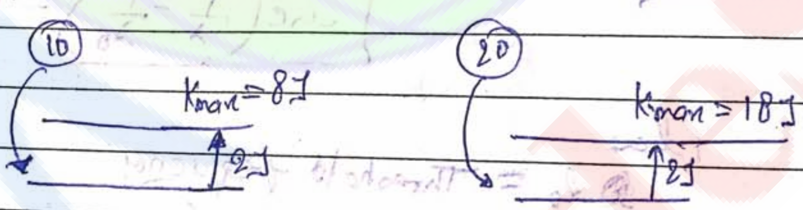
Sol/ V I B [G] Y O R
✓ ✓ ✓ ν_0 ✗ ✗ ✗
↓ λ_0
(high frequency)

✱ Conclusion of Einstein equation:-

① As the frequency increases energy of the photon will also increase hence max. K.E of electron will get increase and vice versa.

Q1) If energy of photon is doubled then how much time will be the K.E of e^- become?

Sol/



K.E = $h\nu - \phi$

K.E =

$$\boxed{K_2 > 2K_1}$$

② No. of e^-'s ejected in the photoelectric process are directly proportional to the intensity of light. Here if intensity is increased photoelectric current will increase.

No. of photo electron ∝ No. of photon

No. of photon ∝ Intensity

Photocurrent ∝ Intensity

* No. of photon's will be Independent from the K.E of photon.

K.E ∝̸ f(Intensity)

*i) For point source; **Intensity ∝ $\frac{1}{d^2}$**

ii) for line source; **Intensity ∝ $\frac{1}{d}$**

where, d = distance b/w source and surface

Q) If for a given point source distance b/w source and target surface is "x" and what will happen if the distance is doubled give the answer w.r.t photo electric current and K.E of e^-.

A) Intensity becomes $\frac{1}{4}$th

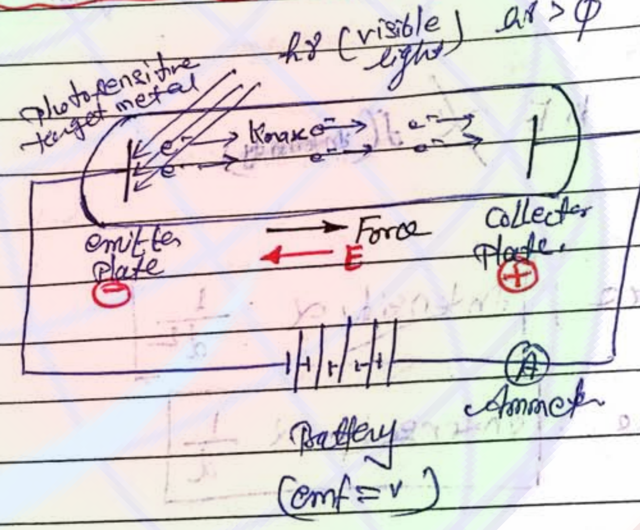
$I_1 = \frac{I}{4}$

current = $\frac{\text{current}}{4}$

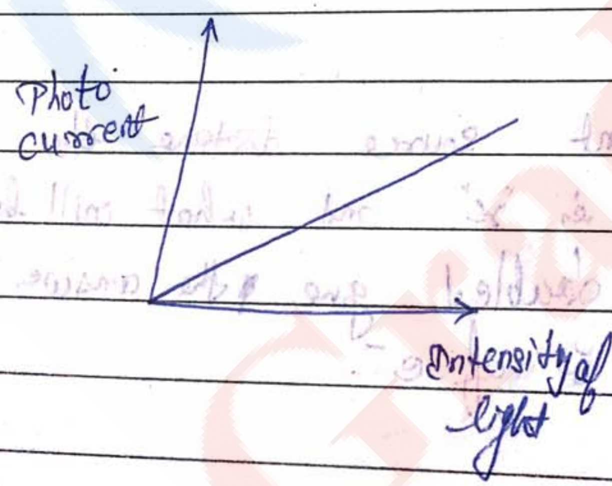
K.E = unchanged.

iii) There will no time lag b/w incident photon and ejected e^-'s.

Einstein experiment for photo electric effect →



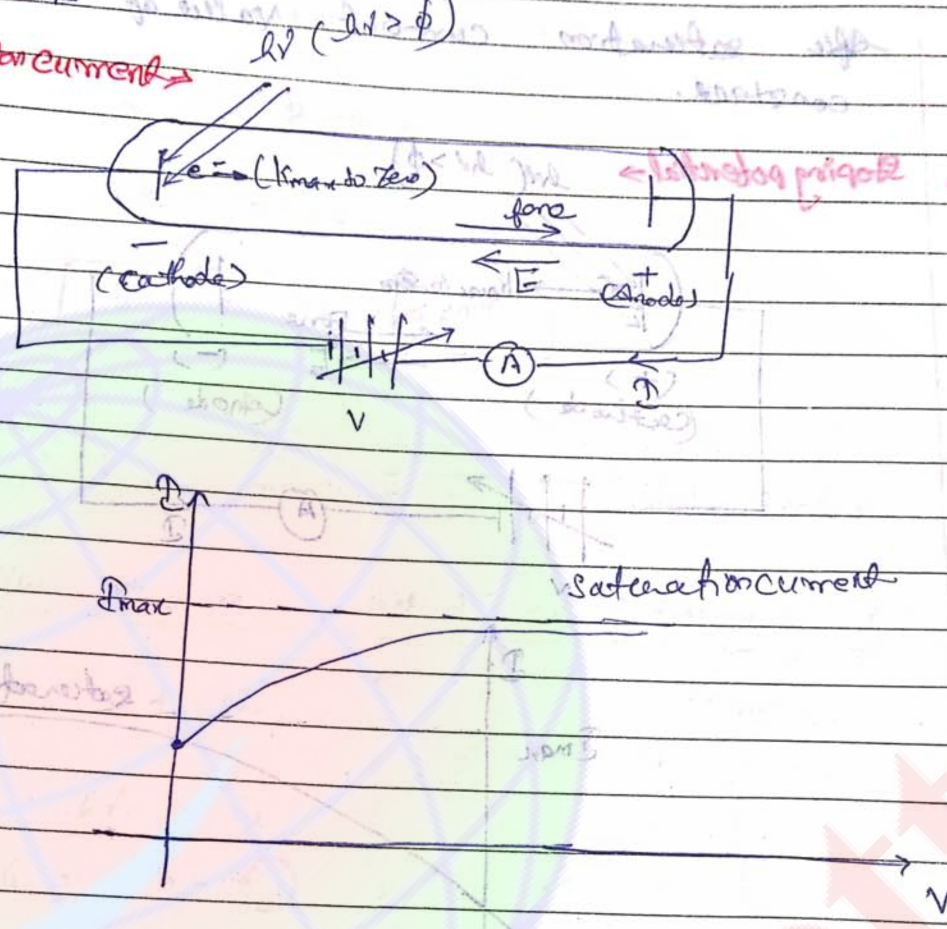
① Photocurrent v/s Intensity of light : →



That means As intensity increa current also increa

As the intensity of light is increases, value of photocurrent will increase.

<2> Saturation current →



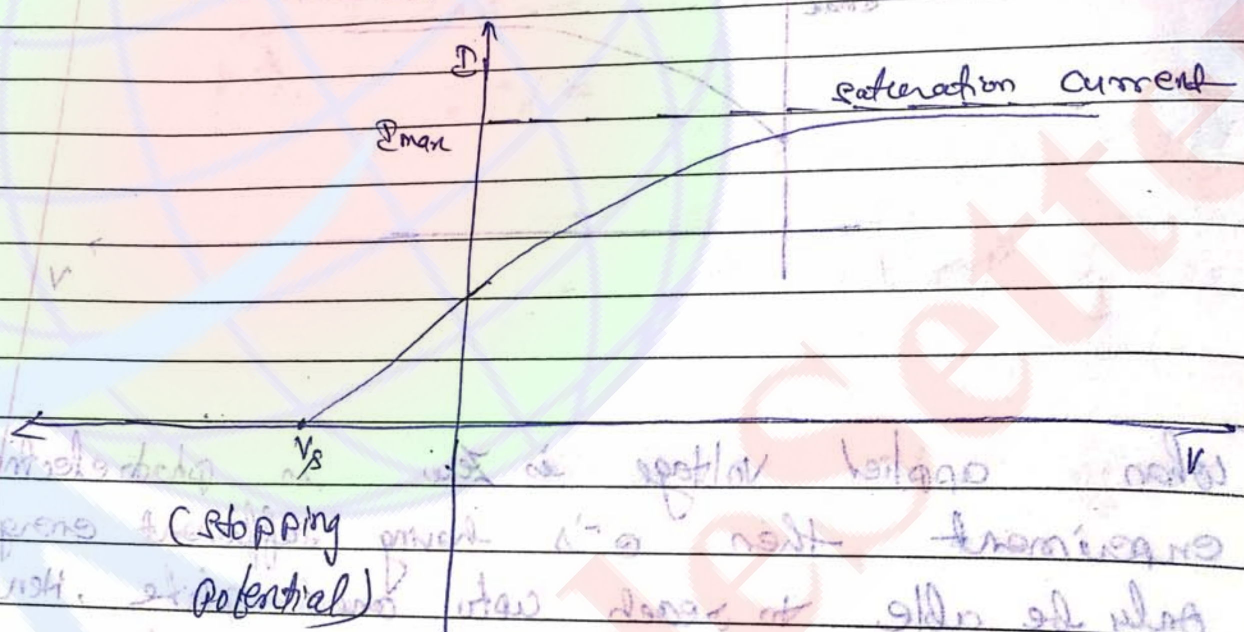
When applied voltage is zero in photoelectric experiment then e⁻'s having sufficient energy will only be able to reach upto anode plate, Hence there will be some current in the circuit.

If value of apparent voltage is increase then no. of e⁻'s reaching upto anode will also increase Hence current in the circuit will increase.

After a particular value of voltage current in the circuit will be maximum and this current is known as saturation current.

After saturation current value of current will be constant.

<3> Stoping potential >



If the polarity of batter is reverse (w.r.t. to emf) then on Increasing the potential value of the current in circuit will decrease.

the value of voltage at which Photocurrent becomes zero is known as stoping potential/

 potential

$$K_{max} - eV_s = 0$$

$$K_{max} = eV_s$$

V_s = stopping potential

e = charge of e^-

K_{max} = maximum K.E of photo electrons.

<4> Graph b/w stopping potential and frequency of photon →

$$E = \phi + K.E_{max}$$

$$E = h\nu_0 + eV_s$$

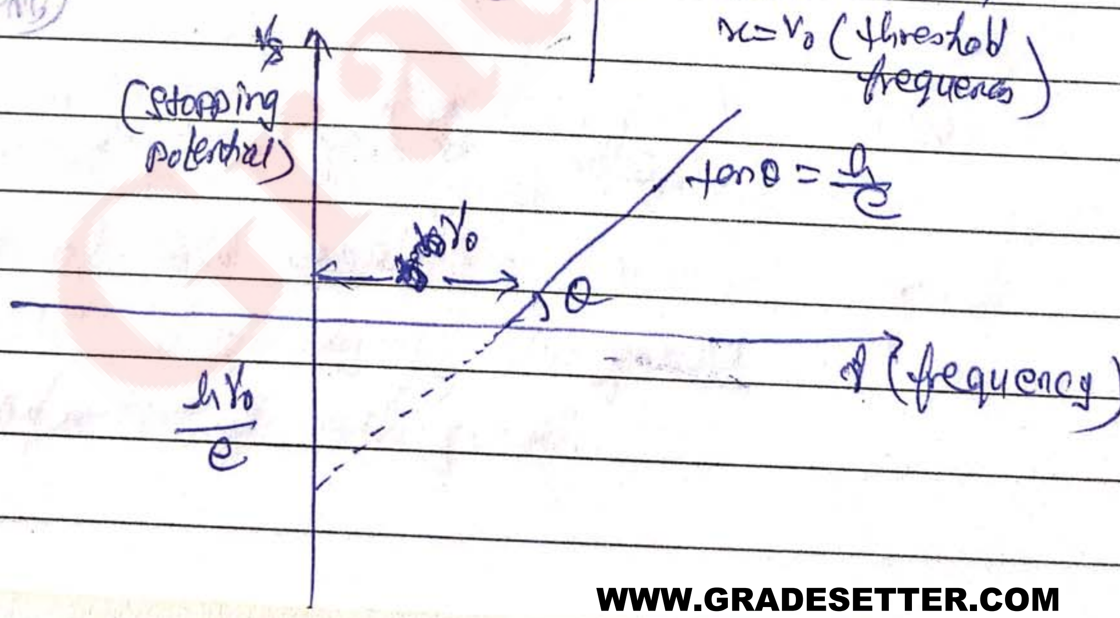
$$h\nu = h\nu_0 + eV_s$$

$$hx = h\nu_0 + ey$$

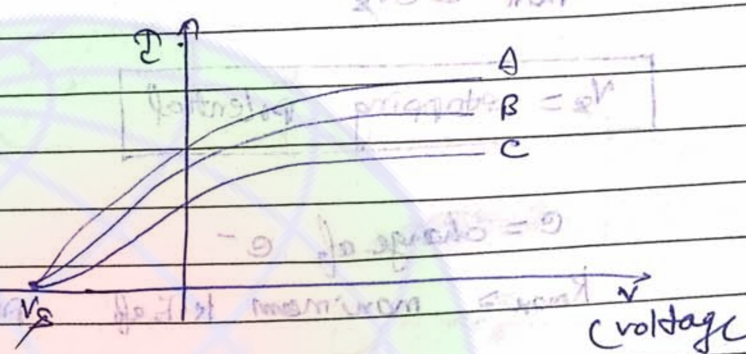
$$y = \frac{h}{e}x - \frac{h\nu_0}{e}$$

$$y = mx + c$$

slope of line (m) = $\frac{h}{e}$ | Intercept on x-axis $x = \nu_0$ (threshold frequency)



Q.1) a) what will be the ~~relation b/w~~ rate of stoping potent[ial] " " frequences of light
b) " " " " " wavelength of light
c) " " " " " Intensity of light
d) " " "



sol/n (a) Stopping potential same

$V_A = V_B = V_C$

(b) $E = \phi + eV_s$

E = Same

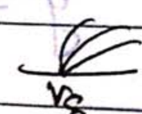
~~$V_A = V_B$~~

$\nu_A = \nu_B = \nu_C$

K.E max = $h\nu - h\nu_0$

$eV_s = h\nu - \frac{h\nu_0}{\text{const.}}$

Constant, cons, Const (given), Constan

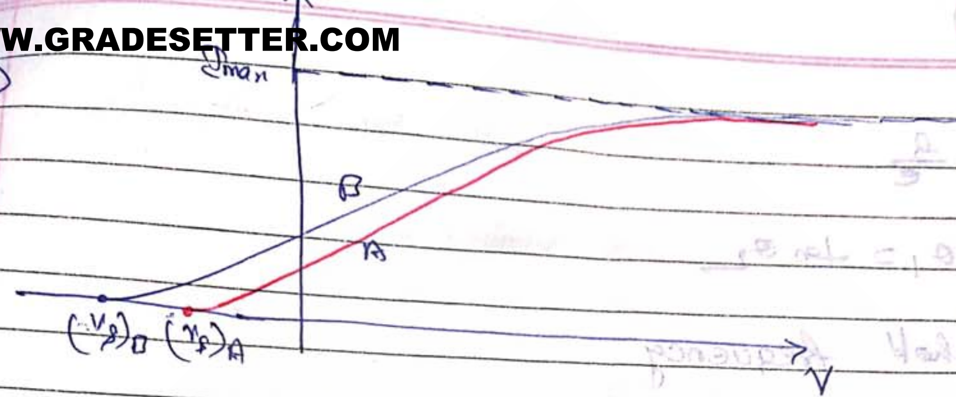


(c) $\lambda_A = \lambda_B = \lambda_C$

(d) $I_A > I_B > I_C$

(Intensity ∝ current)

eg2.)



(i) Intensity same

(ii) $(V_s)_A > (V_s)_B$

(iii) $\uparrow E = \phi + eV_s \uparrow$

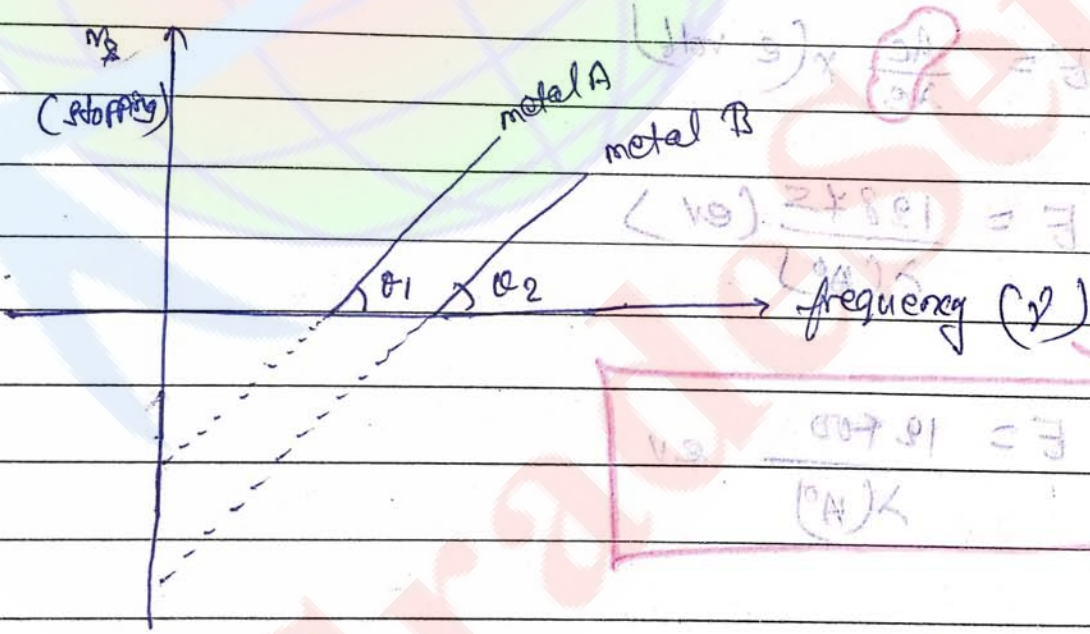
$\uparrow E = h\nu \uparrow$

$\nu_A > \nu_B$

(iv) $\lambda_A < \lambda_B$

(Blue) (Red)

eg3)



What will be the relation b/w :-

(a) slope of the graph

(b) threshold frequency of the graph

(c) Work-function of the graph.

Sol^n (1) slope = $\frac{h}{e}$

$\tan\theta_1 = \tan\theta_2$

(2) Threshold frequency

$(\nu_0)_B > (\nu_0)_A$

(3) $\phi_B > \phi_A$

Note (I) Energy of photon –

$E = h\nu$

(II) $E = \frac{hc}{\lambda}$ (joule)

(III) $E = \frac{hc}{\lambda e}$ (e volt)

(IV) $E = \frac{12875}{\lambda(A^0)}$ (eV)

Imp

$$E = \frac{12400}{\lambda(A^0)} \text{ eV}$$

Q. A light of wavelength 3000 A^0 is incident on a surface having work function 2 eV then what will be the max. K.E of e⁻'s?

$E = \phi + K.E_{max}$

$E = 2 + K.E_{max}$

$\therefore E = \frac{12400}{3000} = 4.1 eV$

so

$4.1 eV = 2 + K.E_{max}$

$\boxed{K.E_{max} = 2.1 eV}$ Ans

1) De-broglie hypothesis:-

According to de-broglie any moving particle shows particle nature aswell as wave nature.

This is known as dual nature of particle. Wavelength of any moving particle according to de-broglie is the following formula:-

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

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

λ = de-broglie wavelength

h = plank constant

P = momentum of particle

(1) For a particle of mass "m" and moving with speed "v",

$$P = mv$$

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

(2) For a particle of mass "m" and having kinetic energy (K.E)

$$\lambda = \frac{h}{P} = \frac{h}{\sqrt{2m(K.E)}}$$

(3) For any particle having charge "q" and Accⁿ with "V" volt

$$K.E = qV$$

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

(4) For any particle placed at room temperature

$$K.E = \frac{3}{2} KT$$

where, K = Boltzmann constant $= 1.38 \times 10^{-23}$
T = absolute temperate (in kelvin)

(5) For electron(e^-)

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

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

$$\lambda_e = \sqrt{\frac{150}{V}} = \frac{12.27}{\sqrt{V}} A^\circ$$

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

6) For proton :-

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

$m = m_p = 1.67 \times 10^{-27}$

$$\lambda_p = \frac{0.286}{\sqrt{V}} A^\circ$$

(7) For "α" particle

$q = +2e =$

$m = 4m_p$

$$\boxed{\lambda_\alpha = \frac{0.101}{\sqrt{V}} A^\circ}$$

<8> deutrium ($_1H^2$)

$q = 1e$

$m = 2m_p$

(9) For neutron

$$m = m_e = 1.67 \times 10^{-27}$$

$$\lambda = \frac{h}{\sqrt{2m \cdot \frac{3}{2}kT}} = \frac{h}{\sqrt{3mkT}}$$

$$\boxed{\lambda = \frac{30.86}{\sqrt{T}} A^{\circ}}$$

<10> How does the de-broglie postualate leads to the Bohr's atomic postualates/

According to de-broglie "e⁻" can be available in the certain orbit's whose circumference of the orbit is equal to the Integral multiple of the de-broglie wavelength of moving e⁻

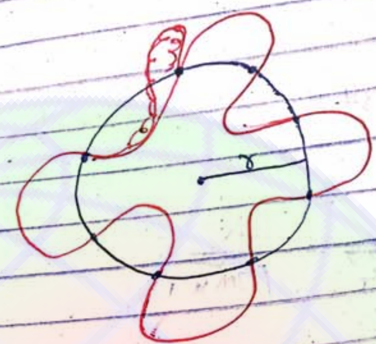
$$\boxed{2\pi r = N\lambda}$$

λ = de-broglie wavelength

$$2\pi r = N \cdot \frac{h}{p}$$

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

The equation is bohrs postulates of atomic structure./



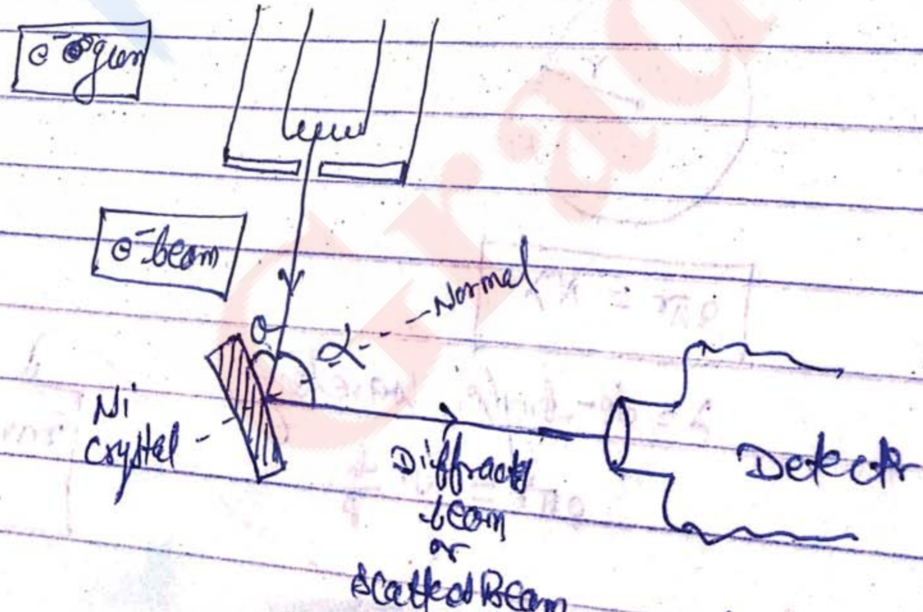
⇒ Deviation Germer experiment :→

With the experiment Deviation and germer prove that a moving e⁻ has wave nature and its wavelength can be used to show the wave nature of it.

Construction

It has mainly three parts –

(i) e⁻ gun
(ii) Ni crystal
(iii) Detector



i.e Angle of scattering./

(i) e^- gun : it is used to create a fine beam of e^-'s there e^-'s are acc^n from 44 volt to 68 volt's

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

(ii) Ni crystal : Ni crystal is used as diffraction grating it scatter's the incident e^- beam by angle "α".

∴ "α" is the angle b/w e^- beam and diffracted beam.

(iii) Detector :- The detector's detects intensity of e^- beam this can be put in an ionisation chamber with a sensitive galvanometer.

Working :-

When voltage provided by the e^- gun to the e^-'s is varied then the wavelength of the e^-'s will also changes. at a particular voltage of 54 volts intense of light becomes maximum.

The wavelength corresponding to this voltage is

$$\lambda = \frac{12.27}{\sqrt{54}} = 1.66 \, A^\circ$$

But, from Brag's equation, for maxima $2d\sin\theta$ is equals to $n\lambda$
for Ni crystal $d = 0.914\ A^\circ$ and $\theta = 65^\circ$

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

then

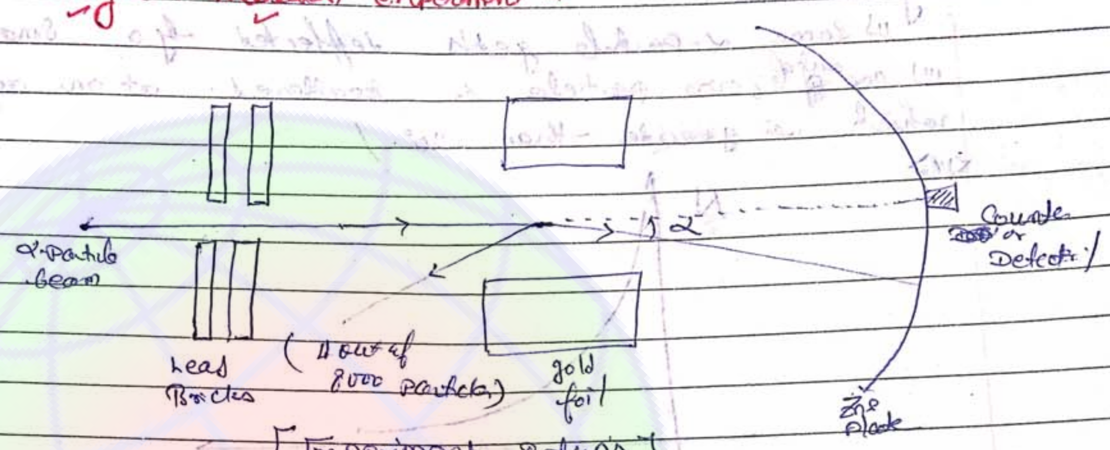
$$\lambda = \frac{2d\sin\theta}{N}$$

$$\lambda = 1.67\ A^\circ$$

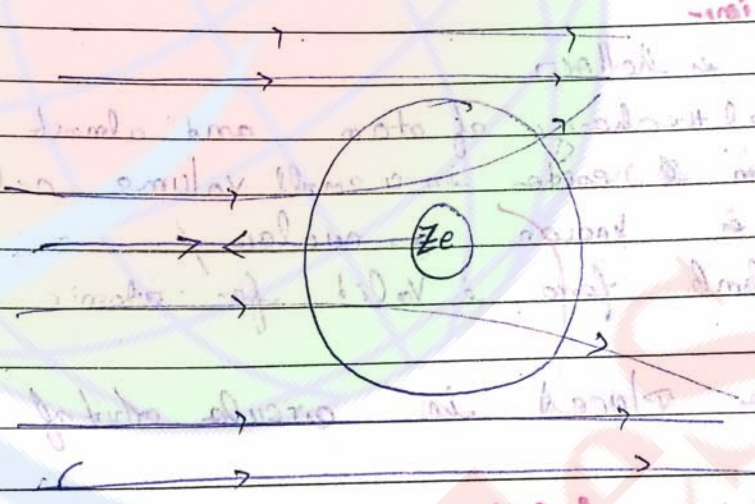
This results shows that wavelength calculated by the de-Broglie is correct and e^- shows particle Nature also.

Atomic structure

★ Rutherford's α-scattering experiment:→
or
Geiger – marsden experiment →



[Experiment setups]



[Trajectory of α-particles]

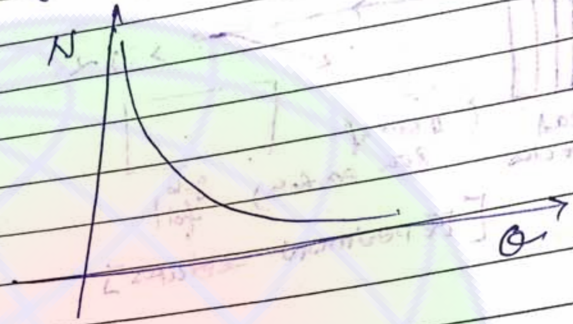
In α-scattering experiment, a beam of α-Particles are generated, this beam is Incident on a gold foil
when this beam is Incident on gold foil it get scatter's at an angle "α".
No of α-Particles scattered at a particular value of "α" is counted by a counter of detector which is made of Zinc sulphate plate./

observations → i) most of the α-particles move without any deviation.

ii) Some α-particle gets deflected by a small angle α.

iii) one out of 8000 particles is scattered at an angle of α which is greater than 90°.

(iv)



Conclusion:-

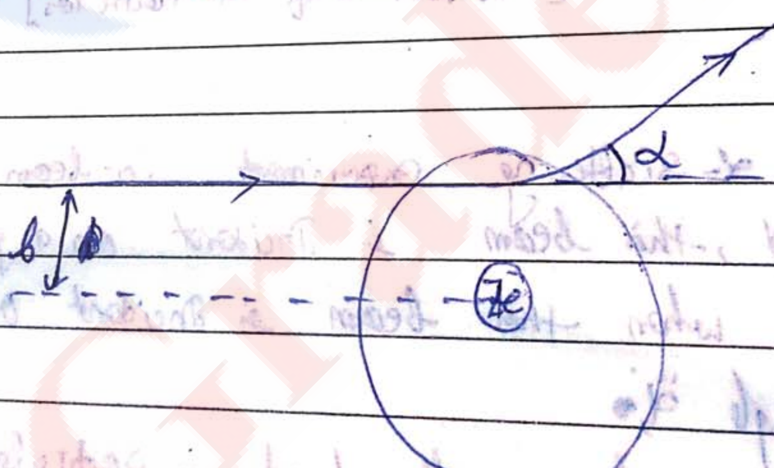
(i) Atom is hollow

ii) Total charge of atom and almost complete mass of atom resides in a small volume and this small volume is known as nucleus.

(iii) Coulomb force is valid for atomic distances.

(iv) e^- are placed in circular orbit of atom.

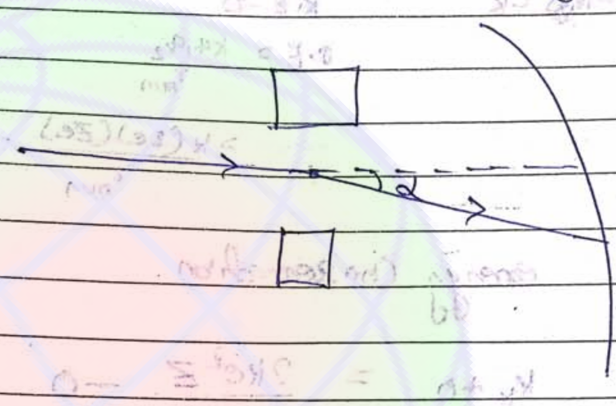
* Impact Parameter (b):-



The ⊥r distance of initial velocity vector of α-Particle from the nucleus when α-Particle is far away from the atom is known as Impact Parameter/

★ Angle of Scattering (α)

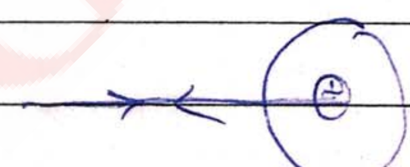
The angle by which α-particle is deviated from its Initial Velocity Vector is known as angle of Scattering/



Q.) Comment on the Impact Parameter in the following cases —
<1> when $\alpha = 0$
<11> when $\alpha = \pi$

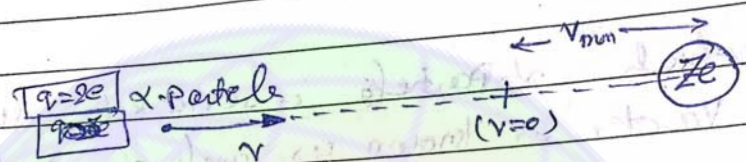
Sol^n 1) In the first case Imparameter (b) will be high

11) In case of head-on-collision Impact Parameter will be Zero.



($\alpha = \pi$)

★ Closest distance of approach of α-Particle:— (in Head-on- collision)



Kinetic energy = E_K $\qquad$ K.E = 0

P.E = 0 $\qquad$ $P.E = \frac{kq_1q_2}{r_{min}}$

$$= \frac{k(2e)(Ze)}{r_{min}}$$

From energy conservation

$$E_K + 0 = \frac{2ke^2Z}{r_{min}} \quad —(1)$$

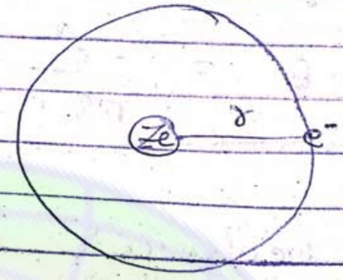
$$\boxed{r_{min} = \frac{2ke^2Z}{E_K}}$$

Z → atomic number

$$r_{min} = \frac{2 \times \frac{1}{4\pi\varepsilon_0} e^2 Z}{E_K}$$

$$\boxed{r_{min} = \frac{e^2 Z}{2\pi\varepsilon_0 E_K}}$$

* Radius of orbit and energy of an e^- in a orbit according to Rutherford →



* According to Rutherford e^- revolv's in circular orbit's and necessary centripetal force is provide by the coulomb's force.

For Hydrogen atom (Z = 1)

$$\frac{mv^2}{r} = \frac{K(Ze)(e)}{r^2}$$

$$mv^2 = \frac{1}{4\pi\epsilon_0}\frac{e^2}{r}$$

$$\boxed{r = \frac{e^2}{4\pi\epsilon_0 mv^2}}$$

* K.E of e^-

$$\boxed{K.E = \frac{1}{2}mv^2 = \frac{1}{8\pi\epsilon_0} \times \frac{1}{r}}$$

* P.E of e^-

$$\boxed{P.E = \frac{Kq_1q_2}{r} = \frac{-e^2}{4\pi\epsilon_0 r}}$$

Total mechanical energy of e^- →

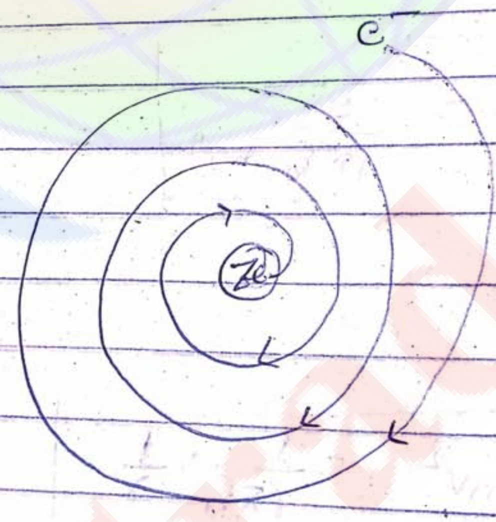
Total mech. energy = K.E + P.E

$$T.E = \frac{-e^2}{8\pi\epsilon_0 r}$$

Since total mechanical energy of e^- is "-ve"
Hence "e^-" will be stable in atom

★ Rutherford's drawback →

1) Since e^- is revolving in circular orbit's then it must have acc^n.
Any charge particle in acc^n motion will radiate electromagnetic radiation. Hence total energy of e^- will decrease and finally it should fall into the nucleus making spiral path.



2) Since e^- is radiating electromagnetic wave continously therefore spectrum generated by it must be continous.

1) According to bohr's theory when electron's moves in a circular orbit it's total mechanical energy will remain constant it will not radiate any electromagnetic waves.

<2> e^- will revolve only in circular orbit's where its angular momentum is Integral multiple of "$\frac{h}{2\pi}$", where h is planks constant.

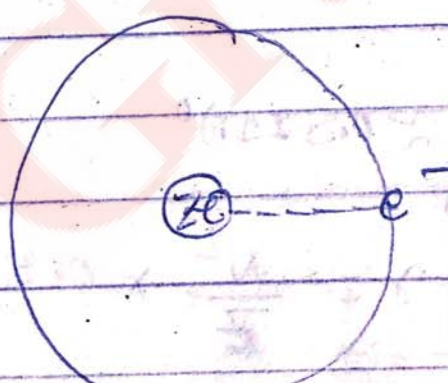
$$\text{Angular momentum, } mvr = \frac{nh}{2\pi}$$

n → Integer No. / (1, 2 ---)

(3) e^- will release or absorb the energy only when it moves from one orbit to another orbit

when it moves in higher orbit it will absorb one and when it jumbs into lower orbit it will release energy. this energy exchange will in terms of photons.

→ Radius and energy calculation of "e^-" moving in "n-th" bohr orbit —



According to bohr theory "e^-" revolves in circular path hence centripetal force will be provided by the coulomb force.

$$\frac{mv^2}{r} = \frac{K(Ze)e}{r^2} \quad \text{—(i)}$$

$$mvr = \frac{nh}{2\pi} \quad \text{—(ii)}$$

From eqn ②

$$v = \frac{nh}{2\pi mr}$$

By putting value of "v" in eq ①

$$\frac{m\, n^2 h^2}{4\pi^2 m^2 r^2} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze^2}{r}$$

$$\frac{n^2 h^2}{\pi m r} = \frac{Ze^2}{\varepsilon_0}$$

$$\frac{n^2 h^2 \varepsilon_0}{\pi m Ze^2} = r$$

$$\boxed{r = \left(\frac{n^2}{Z}\right)\left(\frac{1}{m}\right)\left(\frac{h^2\varepsilon_0}{\pi e^2}\right)}$$

Radius and energy "r_n" of electron moving in orbit

for electron

$$\frac{h^2\varepsilon_0}{m\pi e^2} \simeq 0.529\,A^0$$

so

$$\boxed{r = \frac{n^2}{Z} \times 0.529\,A^0}$$

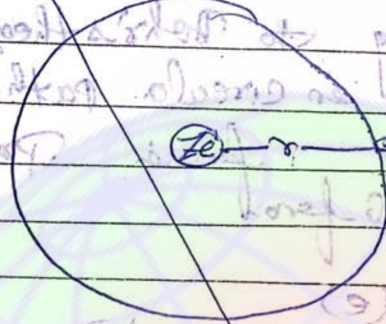
radius of first orbit of Hydrogen atom

$Z = 1 \quad , \quad N = 1$

$r_0 = 0.529 A^0$

$$r = \frac{N^2}{2} \times r_0$$

✱ Radius of orbit and Energy of electron in an orbit ⇒



A/c to Rutherford e⁻ revolves in circular orbits and necessary centripetal force provided by the coulomb force

for Hydrogen atom (Z=1)

So

$$\frac{mv^2}{r} = \frac{k(Ze)e}{r^2}$$

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

$$\boxed{r = \frac{1}{4\pi\epsilon_0}\frac{e^2}{mv^2}}$$

K.E of electron ⇒

$$K.E = \frac{1}{2}mv^2 \Rightarrow K.E = \frac{e^2}{8\pi\epsilon_0 r}$$

According to Bohr's theory, e^- revolves in circular path, Hence centripetal force is provided by coulomb force

$$\therefore \frac{mv^2}{r} = \frac{k(Ze)(e)}{r^2} \quad \text{—(1)}$$

Also

$$mvr = \frac{nh}{2\pi} \quad \text{—(11)}$$

from (2) →

$$v = \frac{nh}{2\pi r m}$$

By putting the value of v in eq (1)

$$\frac{m \cdot n^2 h^2}{4\pi^2 r^2 m^2} = \frac{1}{4\pi\varepsilon_0} \frac{Ze^2}{r}$$

$$\frac{n^2 h^2}{\pi r m} = \frac{Ze^2}{\varepsilon_0}$$

$$r = \frac{n^2 h^2 \varepsilon_0}{2\pi m e^2}$$

$$r = \frac{n^2}{Z}\left(\frac{h^2 \varepsilon_0}{\pi m e^2}\right)$$

for e^-,

$$\frac{n^2 \varepsilon_0}{\pi m e^2} \approx 0.529 A^\circ$$

So,

$$r = 0.529 \frac{n^2}{Z} A^\circ$$

* Radius of first orbit of H-atom →

$Z=1$, $n=1$, $r_0 = 0.529 A^\circ$

$$r = r_0 \frac{n^2}{Z}$$

* Energy of e^- in nth orbit According to Bohr →

K.E of e^- in any orbit, $K.E = \frac{1}{2}m$

But,

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

$$\Rightarrow mv^2 = \frac{Ze^2}{4\pi\varepsilon_0 r}$$

Hence,

$$K.E = \frac{1}{2}\left(\frac{Ze^2}{4\pi\varepsilon_0 r}\right)$$

$$P.E = \frac{k q_1 q_2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{(Ze)(-e)}{r}$$

$$\boxed{P.E = \frac{-Ze^2}{4\pi\varepsilon_0 r}}$$

Hence,

total mechanical energy of e^-.

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

$$= \frac{-Ze^2}{4\pi\varepsilon_0 r} + \frac{1}{2}\frac{(Ze^2)}{(4\pi\varepsilon_0 r)}$$

$$\boxed{T.E = \frac{-Ze^2}{8\pi\varepsilon_0 r}}$$

or

$$T.E = \frac{-Ze^2}{8\pi\varepsilon_0\left(\frac{n^2h^2\varepsilon_0}{Zm\pi e^2}\right)} = \frac{-Z^2me^4}{n^2 8\varepsilon_0^2 h^2}$$

for e^-,

$$\frac{me^4}{8\varepsilon_0^2 h^2} = 13.6\,eV$$

$$\boxed{T.E = -13.6 \times \frac{Z^2}{n^2}\,eV}$$

or,

$$\boxed{T.E = \frac{-Z^2}{n^2} RhC}$$

R → Rydberg const.

$$\therefore R = \frac{me^4}{8 h^3 \varepsilon_0^2 C}$$

Energy level of H-atom (Z=1)

0 ———————— n=∞ ; E=0

−0.34 eV ———————— n=6 ; E = −0.34 eV (5th excited state)

−0.54 eV ———————— n=5 ; E = −0.54 eV (4th excited state)

−0.85 eV ———————— n=4 ; E = −0.85 (3rd excited state)

−1.51 eV ———————— n=3 ; E = −1.51 eV (2nd excited state)

−3.4 eV ———————— n=2 ; E = −3.4 eV (1st excited state)

−13.6 eV ———————— n=1 ; E = −13.6 eV (Ground state)

Q) Calculate the first excited energy of one e^- placed in ground state for Li^{+2} atom

$$\Delta E = |E_2 - E_1|$$

$$= 10.2 \times 9$$

Q) Calculate IP of Na^{+10} atom, when e^- is in ground state.

A

E=0 ———————— n=∞

−13.6 ———————— n=1

$\Delta E = -13.6 \times (11)^2$ eV

Potential $= -13.6 \times (11)^2$

Q) what will be the amount of energy will be released or absorbed for H-atom if an e^- jumps from n=3 to n=2

Ans Energy released = -1.51
$+3.40$
1.89

Q) Calculate the energy released or absorbed by He^{+1} atom when e^- jumps from 3rd excited state to ground state.

Sol^n $E_4 = -0.85 \times 4 = -3.60$

$E_1 = -13.6 \times 4 = -54.4$

$\Delta E = -13.6 + 54.4$
(released) $= 50.8 eV$

$\Delta E = \frac{hc}{\lambda} = 50.8 = \frac{hc}{\lambda} \Rightarrow ?$

An e^- jumps from ∞ to ground state for H-atom then calculate "λ" of the photon emitted

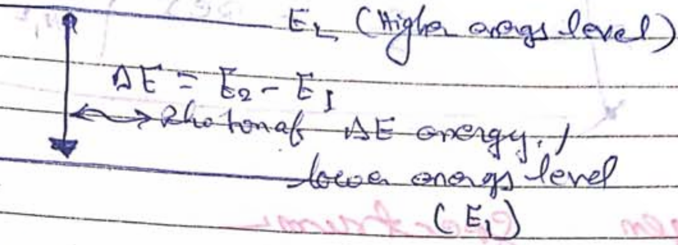
Energy released $= 13.6 eV$

$\lambda = \frac{12400}{13.6} A^0$

Q) What will be the amount of energy released or absorbed for H-atom, if one e^- jumps from n=3 to n=2

Sol/n Energy =

Wavelength and frequency of photon emitted →



Suppose an e⁻ jumps from a higher energy level to a lower energy level, energy of e⁻ in higher orbit is E_2 and energy of e⁻ in lower orbit is E_1. then energy released in this process

$$E_2 = -Rhc \frac{Z^2}{N_2^2}$$

$$E_1 = -Rhc \frac{Z^2}{N_1^2}$$

Energy released:-

$$\Delta E = E_2 - E_1$$

if wavelength of emitted photon is "λ"

$$\frac{hc}{\lambda} = \left(-Rhc \frac{Z^2}{N_2^2}\right) - \left(-Rhc \frac{Z^2}{N_1^2}\right)$$

$$\boxed{\frac{1}{\lambda} = RZ^2 \left\{\frac{1}{N_1^2} - \frac{1}{N_2^2}\right\}}$$

Now
frequency of emitted photon is -

$$\nu = \frac{c}{\lambda} = RcZ^2 \left\{ \frac{1}{N_1^2} - \frac{1}{N_2^2} \right\}$$

Hydrogen spectrum

1) Lyman series → when an e^- jumps from a higher orbit to ground state, then the wavelength emitted in this spectrum is known as Lyman series;

for hydrogen, $n_1 = 1$
$n_2 = 2, 3, 4, 5, 6 \ldots \infty$

$$\frac{1}{\lambda} = R \left\{ \frac{1}{1} - \frac{1}{N_2^2} \right\}$$

First line of lyman series →

$N_2 = 2$

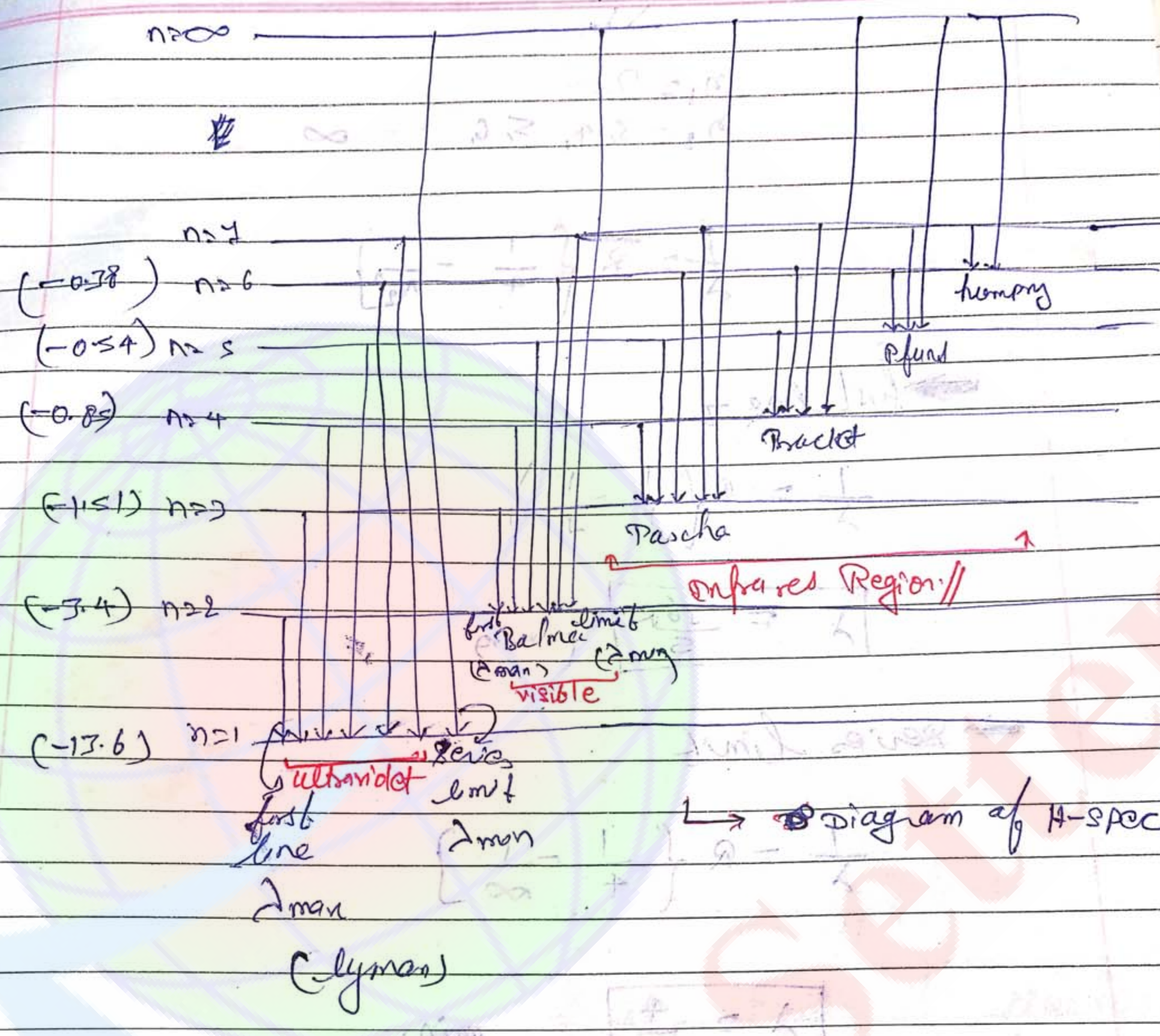
$$\frac{1}{\lambda} = R\left(\frac{1}{1} - \frac{1}{4} \right)$$

$$\boxed{\lambda = \frac{4}{3R}}$$

* Series limit of lyman series, $N_2 = \infty$

$$\frac{1}{\lambda} = R \left\{ \frac{1}{1} - \frac{1}{\infty} \right\}$$

$$\boxed{\lambda = \frac{1}{R}}$$



→ Diagram of H-spectra,

1) "lyman series" lies in the ultraviolet region.

$\lambda_{max} = 1216 A^0$

$\lambda_{min} = 912 A^0$

2) Balmer series → If an e⁻ jumbs in n=2 from any higher energy level, then the series generates a known as Balmer series./

$n_1 = 2$
$n_2 = 3, 4, 5, 6, \dots \infty$

$$\frac{1}{\lambda} = R\left\{\frac{1}{4} - \frac{1}{N_2^2}\right\}$$

→ first line :

$$\frac{1}{\lambda} = R\left(\frac{1}{4} - \frac{1}{9}\right)$$

$$\boxed{\lambda = \frac{36R}{5}} \text{ (max)}$$

→ series limit

$$\frac{1}{\lambda} = R\left\{\frac{1}{4} - \frac{1}{\infty}\right\}$$

$$\boxed{\lambda = \frac{4}{R}} \text{ (min)}$$

* Balmer series lies in the visible region

3) Paschen series :→

$N_1 = 3$
$N_2 = 4, 5, 6, 7, 8, \dots \infty$

$$\frac{1}{\lambda} = R\left\{\frac{1}{9} - \frac{1}{N_2^2}\right\}$$

(4) Bracket series →

$N_1 = 4$

$N_2 = 5, 6, \ldots \infty$

$$\frac{1}{\lambda} = R\left\{\frac{1}{16} - \frac{1}{N_2^2}\right\}$$

(5) Pfund series:—

$N_1 = 5$

$N_2 = 6, 7, 8 \ldots \infty$

$$\frac{1}{\lambda} = R\left\{\frac{1}{25} - \frac{1}{N_2^2}\right\}$$

Note → Paschen, Bracket, Pfund lies in Infrared region →

* Drawback →

(1) Bohr model can not explain the spectrum of atoms which have multiple e⁻'s

(2)

Lesson-13

"Nuclei"

Nucleus

1) * Nucleus was discovered by Rutherford in α-scattering experiment

2) * only Proton and Neutron resides ~~in the nuclei~~ Inside the nucleus, these two combinedly known as nucleons.

3.) Particle or nucleus ⇒

	(mass)	(charge)
Proton	$= 1.67 \times 10^{-27}$	$+e = 1.6 \times 10^{-19}$
Neutron	1.67×10^{-27}	0

$$M_N \geq M_P$$

4) Radius of Nucleus ⇒

It has be observed that radius of Nucleus directly proportional to the cubic root of the atomic mass no.

$$R \propto A^{1/3}$$, A = atomic no.

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

$$R_0 = 1.2 \times 10^{-15} \text{ meter}$$

$R_0 = 1.2$ Fm

☆ Symbol of a atom →

$$_{Z}X^{A}$$

X → element
Z → Atomic no = No. of Proton
A → mass no. = (No of Proton + No. of neutron)

$$_{3}Be^{7}$$

⟨4⟩ mass of Nucleus →

$$_{Z}X^{A}$$

$$\text{mass of Nucleus} = Zm_p + (A-Z)m_N$$

$$\text{mass of atom} = Zm_p + (A-Z)m_N + Zm_e$$

Density of Nucleus →

$$\text{Density} = \frac{\text{mass}}{\text{Volume}} = \frac{Zm_p + (A-Z)m_N}{\frac{4}{3}\pi R^3}$$

$$= \frac{Zm_p + (A-Z)m_n}{\frac{4}{3}\pi R_0^3 A}$$

$$d \approx \frac{Am_N}{\frac{4}{3}\pi R_0^3 A} \qquad d \approx \frac{A m_N}{\frac{4}{3}\pi R_0^3 A} \approx 3\times10^{17}\, kg/m^3$$

Nucleus is the most dens ——

→ Nucleus is most dense material and its density is of order of $3\times10^{17}\ kg/m^3$.

<6> Isotopes, Isobars and Isotones

(1) Isotopes → (समस्थानिक) → Place same (Z same)
[same Proton]

The atoms having same atomic number and different mass number are known as Isotopes.

$_{Z}X^{A_1}$ $_{Z}X^{A_2}$

Z = same (Proton same)

A_1, A_2 → No of neutron different

$_6C^{12}$, $_6C^{13}$, $_6C^{14}$

(2) Isobars → (समभारिक)

The atoms having same no of nucleons but different-different atomic no. are known as Isobars.

$_{Z_1}X^A$ $_{Z_2}Y^A$

$_6C^{14}$ $_7N^{14}$

(3) Isotones :- (same neutron)

The atom's having same no of neutron's but different "A" and "Z" are known as Isotones.

$X_{Z_1}^{A_1}$ $Y_{Z_2}^{A_2}$

$$A_1 - Z_1 = A_2 - Z_2$$

eg

$_3Li^7$, $_4Be^8$

★ Atomic mass unit :→

A a.m.u is numerically equal to the $\frac{1}{12}$th of the carbon ($_6C^{12}$) atom's mass.

$$1\ amu = \frac{1}{12}(\text{mass of } _6C^{12})$$

- It is symbollically represented by "u"
- According to Einstein equation 1 amu mass is equal to the $931\ \frac{MeV}{c^2}$ energy

$$1\ amu = 931\ MeV/c^2$$ where c = speed of light.

3) ★ Nuclear forces →

The force acting b/w Nucleons is called as Nuclear force.

it is strongest force in the nature but its range is smallest.

It's range is approx $10^{-15}\ m$.

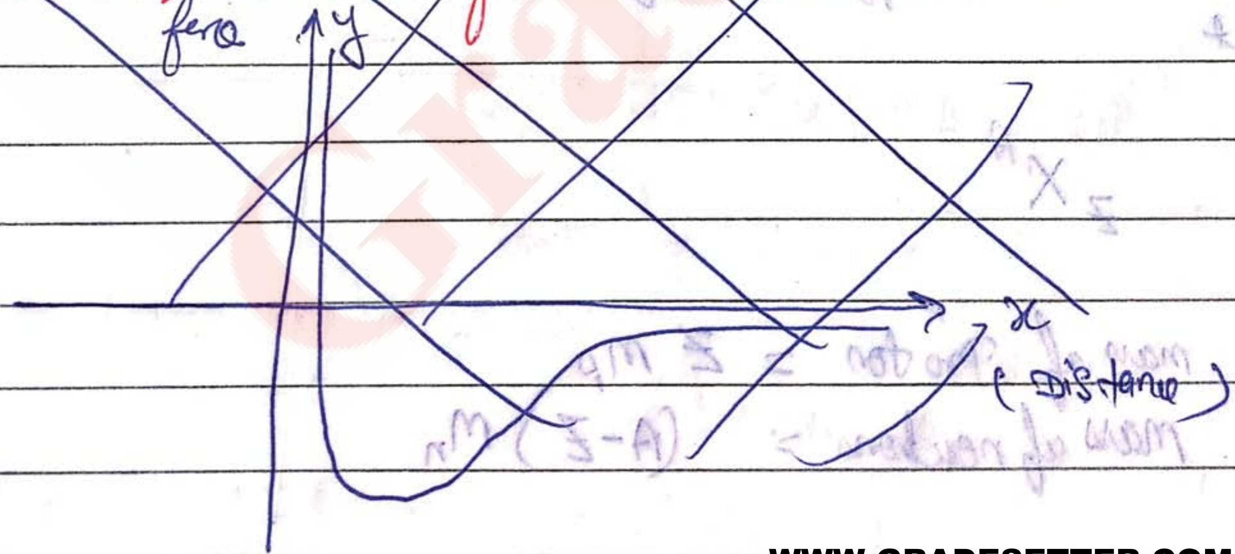
$$\text{Force b/w } p-p = \text{force b/w } p-n = \text{force b/w } n-n$$

- It does not follow the Inverse square law.

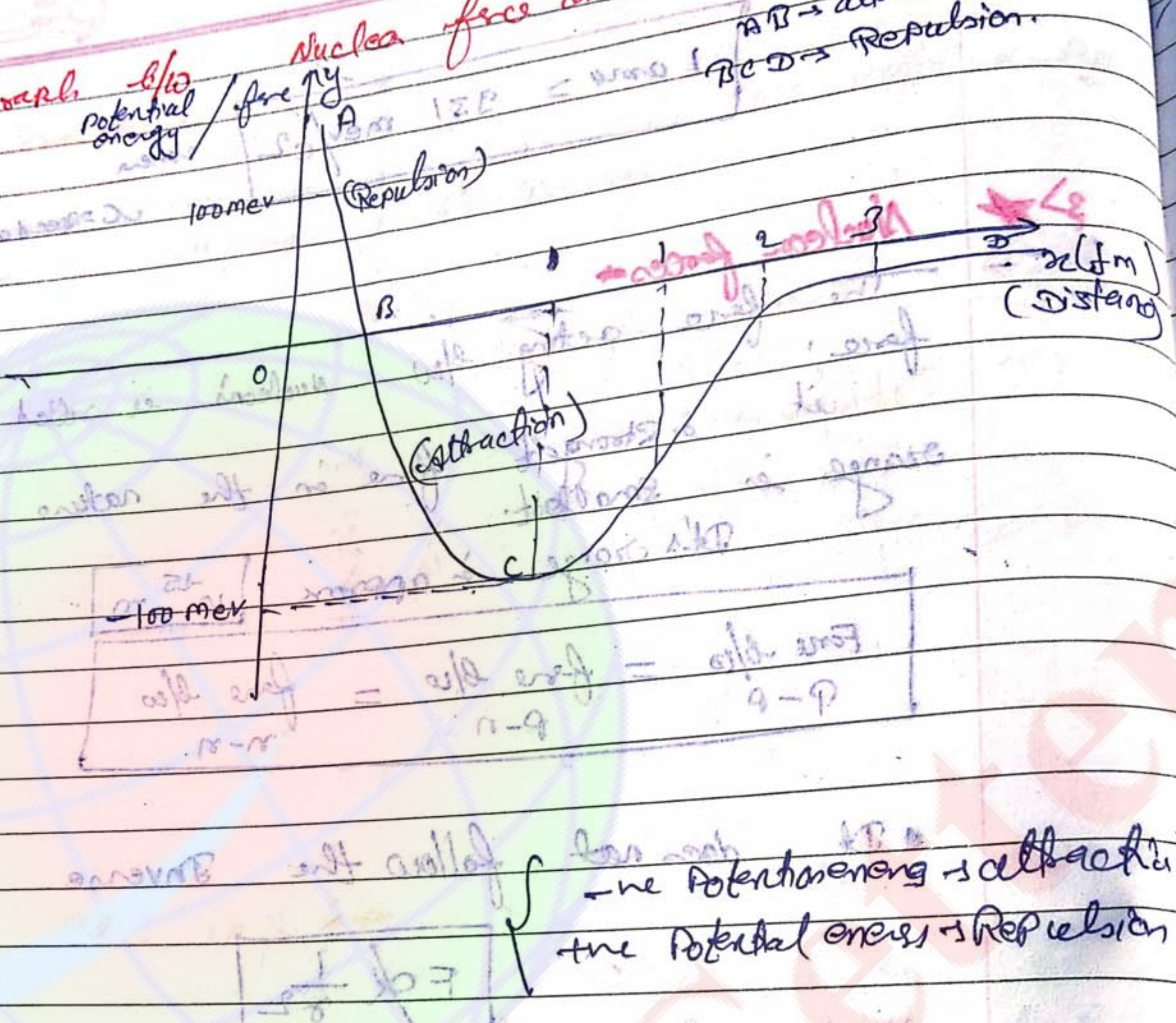
$$F \not\propto \frac{1}{r^2}$$

- It is attractive in nature, in general, but if the distance becomes very small it can be repulsive.

★ Graph b/w Nuclear force and distance →



Graph b/w Nuclear force and distance →



mass defect →

It is observed that mass of a nucleus is always less than the mass of constituent's elements (nucleons)

this difference of mass is known as mass defect.

Let

$_{Z}X^{A}$

mass of Proton = $Z\,m_p$

mass of neutrons = $(A-Z)\,m_n$

mass of ~~Particles~~ nucleon's = $Zm_p + (A-Z)m_n$

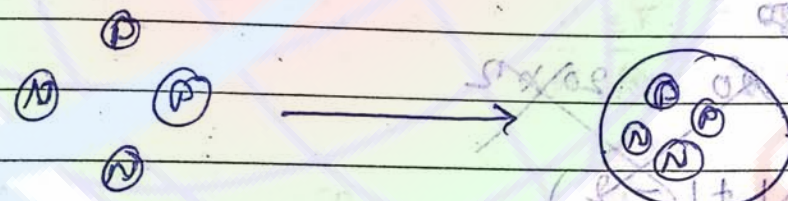
Measured mass of nucleus = m

mass defect = mass of nucleons − mass of nucleus

$$\Delta m = \{Zm_p + (A-Z)m_n\} - M_{nucleus}$$

Binding energy →

It is the amount of energy released when nucleon's come's together to form a ~~nucleus~~ nucleus.



B.E = energy released in process

$$B.E = \Delta m \cdot c^2$$

$$B.E = \Delta m \times 931.5 \text{ MeV}$$

(Δm in amu)

★ Calculate B.E of $_{20}Ca^{40}$ Nucleus

$m\left(^{40}_{20}Ca\right) = 39.962589\ u$

$m_N = 1.008665\ u$

$m_p = 1.007825\ u$

$1u = 931\ MeV/c^2$

Sol^n

$\Delta m = Zm_p + (A-Z)m_n - M_{nucle}$

$= 20 \times 1.007825 + (40-20)(1.008665) - M_{nucl}$

$= 20 \times 1.007825 + 20(1.008665) - 39.9625894$

$= 20\begin{pmatrix}1.007825 \\ 1.008665\end{pmatrix} - 39.625894$

2.016490

$= 40.3298 - 39.962589$

$= 0.36722$

$B.E = (\Delta m) \times 931.5\ MeV$

$= 0.36722 \times 931$

(given) ($1u = 931$)

$= 341.87\ MeV$

Now

B.E per nucleon $= \frac{B.E}{A} = \frac{341.87}{40} = 8.55$ MeV/nucleon

☆ Binding energy per nucleon →

$$\text{B.E per nucleon} = \frac{\text{B.E}}{A}$$

↳ this gives stability of nucleus greater value more stable.

★ which one is more stable and why

	B.E	A
atom x	100	10
atom y	200	50

Sol

$$\left(\frac{B.E}{A}\right)_x = \frac{100}{10} = 10 \frac{MeV}{nucleon}$$

$$\left(\frac{B.E}{A}\right)_y = \frac{200}{50} = 4$$

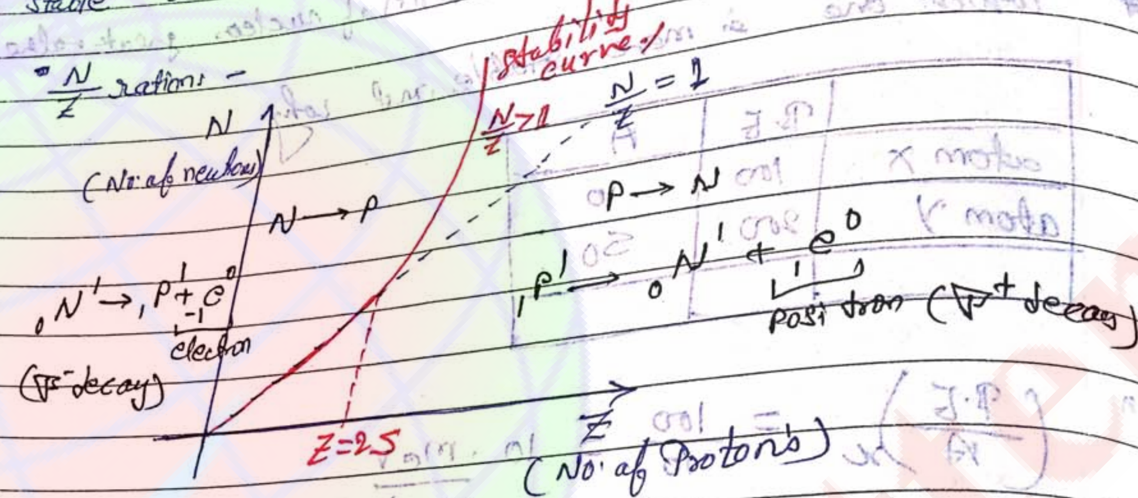
x is more stable

★ Stability of nucleus →

(1) Stability of a nucleus is directly proportional to the binding energy per nucleon.

(2) If a nucleus has even no. of proton's and even no. of neutron's then this nucleus will be more stable in compare to the surrounding atom's.

(3) $\frac{N}{Z}$ ratio :-



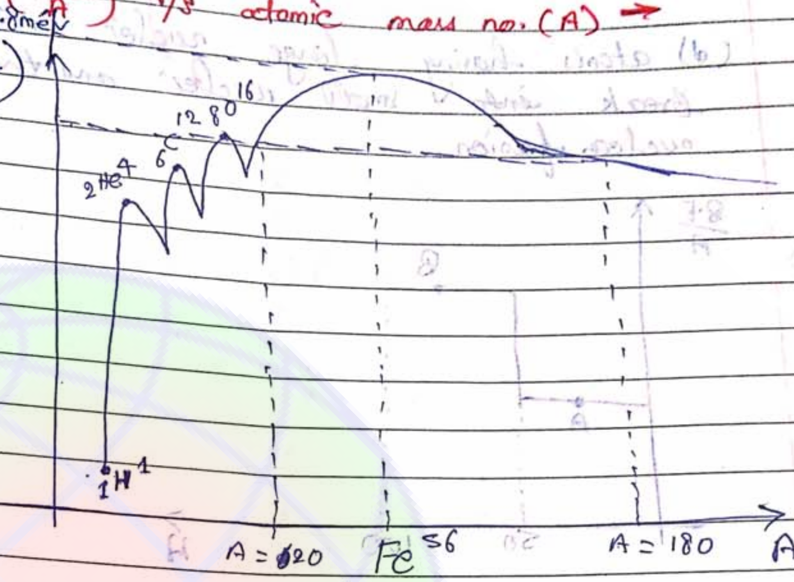
(i) The atom's which have "Z" less than 25, will be stable when $N = Z$.

The atom's which are having $Z > 25$, will be stable when No. of neutrons are more than No. of protons.

Reason → If no. of proton becomes more then repulsion force may increase hence stability of nucleus will decrease.

(ii) Element's which are on the left side of stability curve will show's β^- decay and element's which are on the right side of stability curve will show's β^+ decay

★ Graph b/w $\left(\frac{B.E}{A}\right)$ v/s atomic mass no. (A) →



(i) Binding energy per nucleon is almost constant b/w ~~A = 20 to~~ A = 30 to A = 170

(ii) Small nuclei and large nuclei has small binding energy per nucleon in compare to the medium nuclei.

(iii) Conclusion :-

(a) ~~B.E per nucleon~~ The force b/w nucleon's is attractive in nature and is sufficiently strong to produce a B.E of order of mega e⁻-volt.

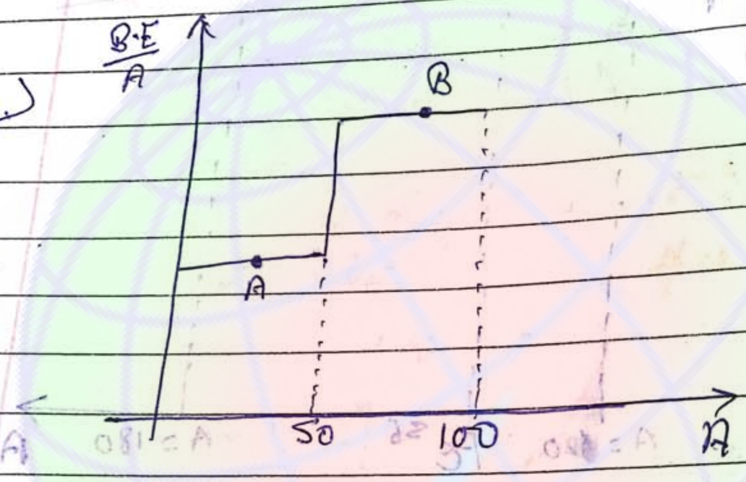
(b) As the size of nucleus increases no. of proton's will also increased. Hence repulsion force b/w nucleon's is get increased. Therefore after A = 56, B.E per nucleon get decreased.

(c) Atom's having A < 36, come's together to form a biger nuclei and the process is known as nuclear fusion.

4: 55 - 5:50

(d) atom's having large nuclei ~~A>180~~ A>180 will break into small nuclei and the process is known as nuclear fusion.

eg.)



2A ⟶ B + energy

A + B ⟶ C + D

100mev 20mev 40mev 30mev

energy released = (B.E of Product) − (B.E of reactant)

Radioactivity

Spontaneous emission of α, β or γ particles from a nucleus is called radioactivity.
It is a natural process and it cannot be controlled by any physical parameter such as temp, pressure, force.

Rutherford and Soddy law for radioactivity →

According to it rate of decay of radioactive nuclei is directly proportional to the no of active nuclei present in a sample.

Rate of decay ∝ No. of active nuclei

$$\left(\frac{-dN}{dt}\right) \propto N$$

	A →	B
t = 0	N_0	0
t = t	N_A	N_B

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

λ = decay constant

$$\int_{N_0}^{N_A} \frac{dN}{N} = \int_0^t -\lambda dt$$

$$\left[\log N\right]_{N_0}^{N_A} = -\lambda t$$

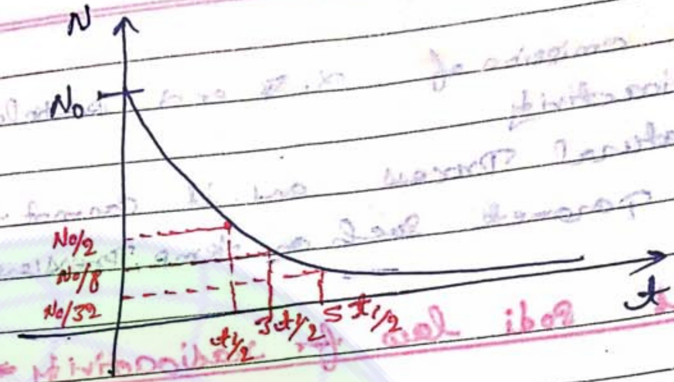
$$\log \frac{N_A}{N_0} = -\lambda t$$

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

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

~~$N_A = N_0 e^{-\lambda t}$~~

No of active nuclei or No of undecayed nuclei



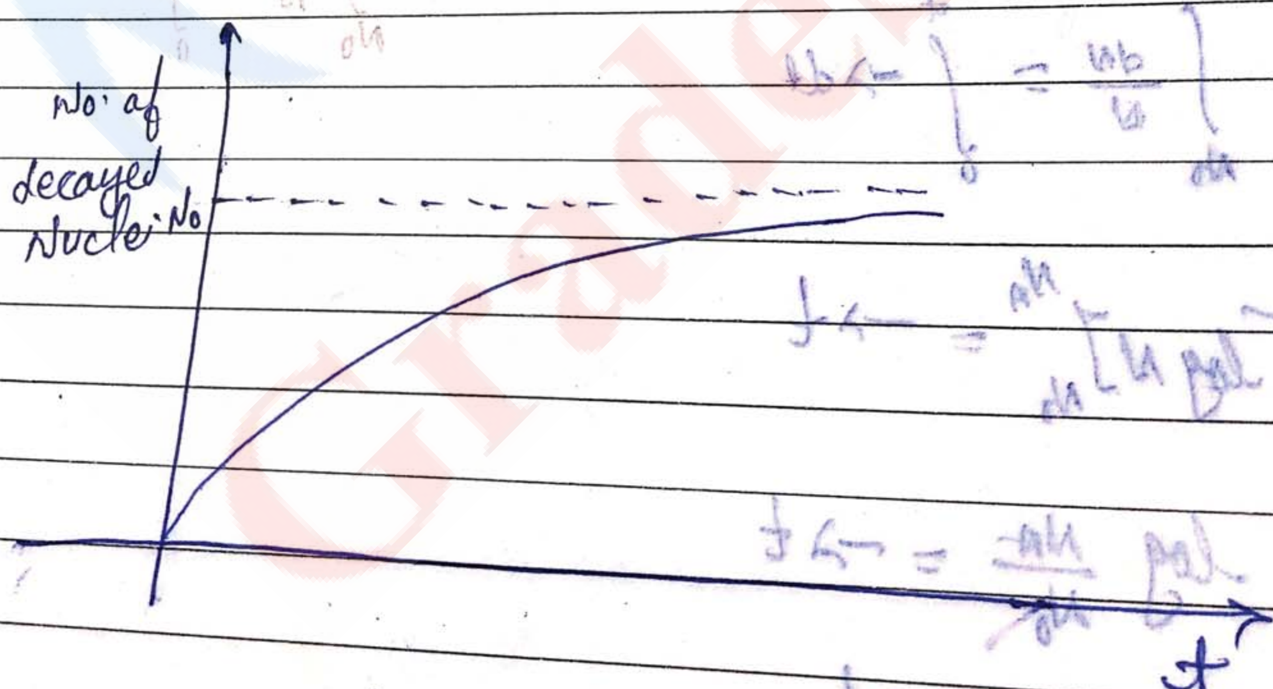
No. of decayed Nuclei-

$$N_A + N_B = N_0$$

$$N_B = N_0 - N_A$$

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

$$\boxed{N_B = N_0\left(1 - e^{-\lambda t}\right)}$$



1) Decay constant(λ) →

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

If

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

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

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

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

$$1 = \lambda t$$

$$\boxed{\lambda = \frac{1}{t}}$$

It is the reciprocal of the time in which no. of active nuclei becomes "$\frac{1}{e}$" times of the initial value of nuclei.

Its unit is sec^{-1}.

Note –
"λ" depends on material, it does not depend on rate of decay or No. of active nuclei.

2) Half life →
It is the time interval in which no. of active nuclei becomes half of the initial value.

$$A \longrightarrow B$$

	A	B
$t=0$	N_0	0
$t=T_{1/2}$	$\frac{N_0}{2}$	$\frac{N_0}{2}$

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

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

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

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

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

$$-\lambda T_{1/2} = -\ln 2$$

$$\boxed{T_{1/2} = \frac{\ln 2}{\lambda}} \text{ or } \boxed{T_{1/2} = \frac{0.693}{\lambda}}$$

eg(1) Half of life of a element's is 10 years then what will be the no. of active nuclei after 50 years. Initial no. of active nuclei 4000.

Sol^n $T_{1/2} = \frac{0.693}{\lambda} = 10$ $N_A = N_0 e^{-\lambda t}$

2400

$\lambda = \frac{0.693}{10}$ ~~$\times 50$~~

~~5.465~~

m^{-1} 2nd method

$A \longrightarrow B$

$t = 0$ $N_0 = 4000$ 0

$t = T_{1/2} =$ $\frac{N_0}{2} = 2000$ $\frac{N_0}{2}$

$t = 2T_{1/2}$ $\frac{N_0}{4} = 1000$ $\frac{3N_0}{4}$

$t = 3T_{1/2}$ $\frac{N_0}{8} = 500$ $\frac{7N_0}{8}$

$t = 4T_{1/2}$ $\frac{N_0}{16} = 250$ $\frac{15N_0}{16}$

$t = 5T_{1/2}$ $\frac{N_0}{32} = 125$ $\frac{31N_0}{32}$

$\hookrightarrow \frac{4000}{32} = 125$ Ans

or 2

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

$N_A = N_0 e^{-\frac{\ln 2}{T_{1/2}} \cdot t}$

$N_A = 4000 e^{-\frac{\log 2}{10} \times 50}$

$N_A = 4000 e^{-5\log 2}$

$N_A = 4000 e^{-\log 2^{-5}}$

$$\boxed{N_A = \frac{4000}{2^5}}$$

Q.) Half life ($T_{1/2}$) of element is 5 years after how much time total no. of active nuclei remains 3.125% of initial no. nuclei

Ans- own

$A \longrightarrow B$

$t = 0$ N_0 0

$t = T_{1/2}$ $\frac{N_0}{2} = 50\%$ $\frac{N_0}{2}$

$2T_{1/2}$ $\frac{N_0}{4} = 25\%$

$3T_{1/2}$ 12.5%

6.25%

$5T_{1/2}$ 3.125

25 year

m-1

$A \longrightarrow B$

$t=0 \quad N_0 = 100\% \quad 0 = 0\%$

$t = T_{1/2} \quad \frac{N_0}{2} = 50\% \quad \frac{N_0}{2} = 50\%$

$t = 2T_{\frac{1}{2}} \quad \frac{N_0}{4} = 25\% \quad \frac{3N_0}{4} = 75\%$

$t = 3T_{1/2} \quad \frac{N_0}{8} = 12.25\% \quad \frac{7N_0}{8}$

$t = 4T_{1/2} \quad \frac{N_0}{16} = 6.25\%$

$t = 5T_{1/2} \quad \frac{N_0}{32} = 3.125\%$

$\Rightarrow$ 25 years Ans //

m-2

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

$N_A = 3.125\%$ of N_0

$3.125 N_0 = 100 N_0 e^{-\lambda t}$

$\frac{3.125}{100} = e^{-\lambda t}$

$\log \frac{3.125}{100} = -\lambda t$

$t = -\frac{1}{\lambda} \log\left(\frac{3.125}{100}\right)$

$$\boxed{t = \frac{T_{1/2}}{0.693} \log\left(\frac{3.125}{100}\right)}$$

m-3

No. of active nuclei "N" half life
$N_A = \frac{N_0}{2^N}$

$$3.125 = \frac{100}{2^N}$$

$$2^N = \frac{100}{3.125}$$

$$2^N = 32$$

$$2^N = 2^5$$

$$N = 5$$

Total time

$$\boxed{t = N \times t_{1/2}}$$

$$t = 5 \times 5$$

$$= 25 \text{ years}$$

3) Average life →

It is the ratio of sum of life of all nuclei to the no. of nuclei in a given sample. ← (t)

$$T_{avg} = \frac{\text{Sum of life of all nuclei}}{\text{total no. of nuclei}}$$

$$T_{avg} = \frac{\int dN \cdot t}{N_0}$$

	A → B
	0
t=0 ,	N_0
t=t ,	N

But

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

$$dN = \lambda \cdot N \cdot dt$$

$$T_{avg} = \frac{\int_0^\infty (\lambda N_0 dt)\, t}{N_0}$$

But

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

$$T_{avg} = \frac{\int_0^\infty (\lambda N_0 e^{-\lambda t} dt)\, t}{N_0}$$

$$\boxed{T_{avg} = \frac{1}{\lambda} = \frac{T_{1/2}}{0.693}}$$

4} Activity →

It is numerically equal to the rate of decay of a radioactive sample.
It is represented by "A" and its unit Bq (Becquerel)

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

$A = \lambda N$

$$\boxed{A \propto N}$$

or

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

$$\boxed{A = A_0 e^{-\lambda t}}$$, activity at any time "t"

A_0 = Initial activity of sample.

$= \lambda N_0$

★ Specific activity →

It is defined as activity of a sample per unit gram o

$$\text{Specific activity} = \frac{A}{m} = \frac{\lambda N_0}{m_N}$$

m = mass in gram (gm)

$N_A = 6 \times 10^{23}$

m_w = molecular weight in gram (in gr

$A = \lambda N$

$$A = \lambda m \frac{N_A}{m_w}$$

* Specific activity depend's only on substance.

★ α, β and γ emissions →

(1) α-decay →

If a $_2He^4$ nucleus comes out from nucleus of any radioactive element then this process is known as α-decay.

this $_2He^4$ nucleus is known as α-particle./

$A = 4$

$Z = 2$

charge $= +2e$

$$_Z X^A \longrightarrow {}_{Z-2}Y^{A-4} + {}_2He^4 + \text{Energy}$$

or Q-value

$$_{92}U^{238} \longrightarrow {}_{90}Th^{234} + {}_2He^4 + Q\text{-value}$$

* Q-value -

It is the difference b/w kinetic energies of product and kinetic energy of reactant./

$$Q = (K_y + K_\alpha - K_x)$$

K_y = K.E of Y-nucleus

K_α = " " α- "

K_x = " " x - nucleus./

or

It is the difference b/w mass energy of reactant and mass energy of product./

Q = Initial mass energy − final mass energy

$= (m_x c^2 - m_y c^2 - m_\alpha c^2)$

$$Q = (m_x - m_y - m_\alpha) c^2$$

<i> If $Q > 0$; energy released

If Q is greater than zero, then any rexn will take pl[ace] automatically

<ii> If $Q < 0$, energy absorbed.

In such case rexn will never start automatically

eg 30.6

eg.) How does "$\frac{N}{Z}$" ratio changes in a α-emission?

$$_{92}U^{238} \longrightarrow {}_{90}Th^{234} + {}_{2}He^{4} + Q\text{-value}$$

$$\frac{N}{Z} \quad \frac{238-92}{92} \quad \frac{234-90}{90}$$

$$\frac{146}{92} < \frac{144}{90}$$

<2> β – decay :→

(a) β⁺ decay →

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

(neutrino)

or

$$_{1}p^{1} \longrightarrow {}_{0}N^{1} + {}_{1}e^{0} + \nu$$

or

$$_{11}Na^{22} \longrightarrow {}_{10}Ne^{22} + {}_{1}e^{0} + \nu$$

(b) β⁻ decay →

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

electron Antineutrino

or

$_0n^1 \longrightarrow {}_1p^1 + {}_{-1}e^0 + \bar{\nu}$

$_{15}P^{32} \longrightarrow {}_{16}S^{32} + {}_{-1}e^0 + \bar{\nu}$

β^- - decay

β^+ decay

- In these rexn kinetic energy (Q-value) of rexn shared b/w e^- and anti-neutrino randomly
- In these rexn K.E of e^- can have any value zero to Q hence its spectrum will be continuous.

Lesson - 15

Communication systems
(incomplete है)
⇓
Book से ही पढ़े.

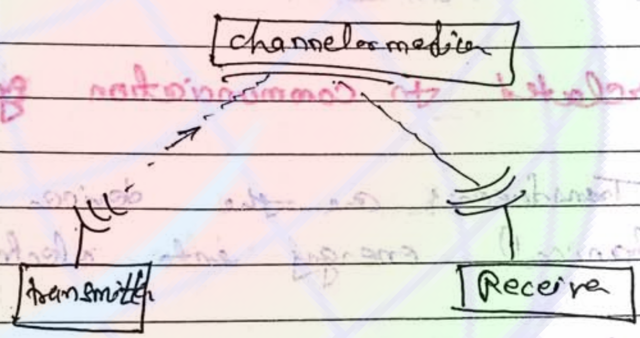
Note: - Lesson- 14, मिटा है।

Start

Communication system

1) Block diagram of communication system –

Note



⇒ Any communication system has 3 basic components

i) Transmitter
ii) channel or medium
iii) Receiver

⇒ In communication system transmitter is located at one place and Receiver is located at another place. The purpose of transmitter is to convert message signal into suitable form, so that they can be transmitted through the channel.

channel is the physical medium ... transmitter to receiver. channel may be ... or wireless.

Receiver has the task on operating or received signals it re-constructs the signal into suitable form so that message signal can be recognised by the user.

2) There are two basic modes of communication—
i) Point-to-Point communication—
ii) Broad cast communication—

3) Definition's related to communication system→

(1) Transducers → Transducers are the devices which converts mechanical energy into electrical signals.

(2) Signals → Information converted into electrical form and suitable for transmission are known as signals.
They are essentially single valued function of time.

Signal can be of two types—
1) Analogue Signals
(2) Digital Signals

1) Analogue Signals → The signal which changes continuously w.r.t time(t) are known as analogue signal.

eg→

$V = V_0 \sin \omega t$

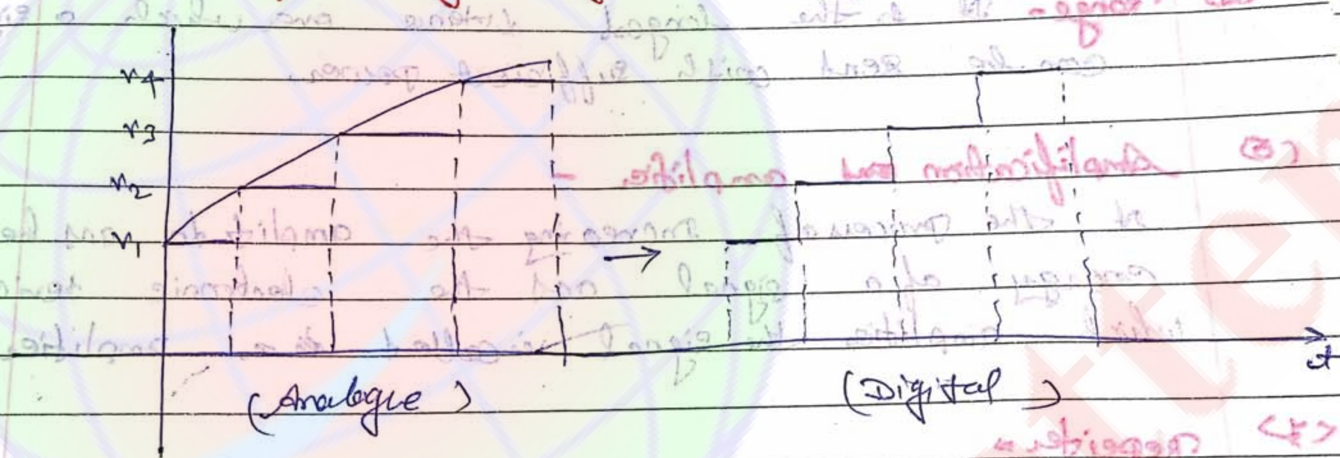
(Sine wave form)

<2> Digital signals → The signal's which have discret values of Quantity are called as digital signals. These are re-presented in term's of "0" and "1" these two term's respectively re-present's absence and Presence of signal.

0 ⟶ ✗ (absence of signal)

1 ⟶ ✓ (Presence of signal)

*Conversion of Analogue signal into digital signal →



Most of the signal in a communication system are analogue signal.

The process of converting analogue signal into digital signal are known as Quantization. in Quantization process the voltage signal is divided into steps. the analogue signal varies continously while the digital signal s have discret value of voltage V_1, V_2, V_3, V_4 with sudden jumbs from one value to the another

The Quality of digital signals can be Improved by reducing step size.

(3) Noise → Noise refers to the unwanted signals that tends to disturb the transmission and processing of a message signal in communication system.

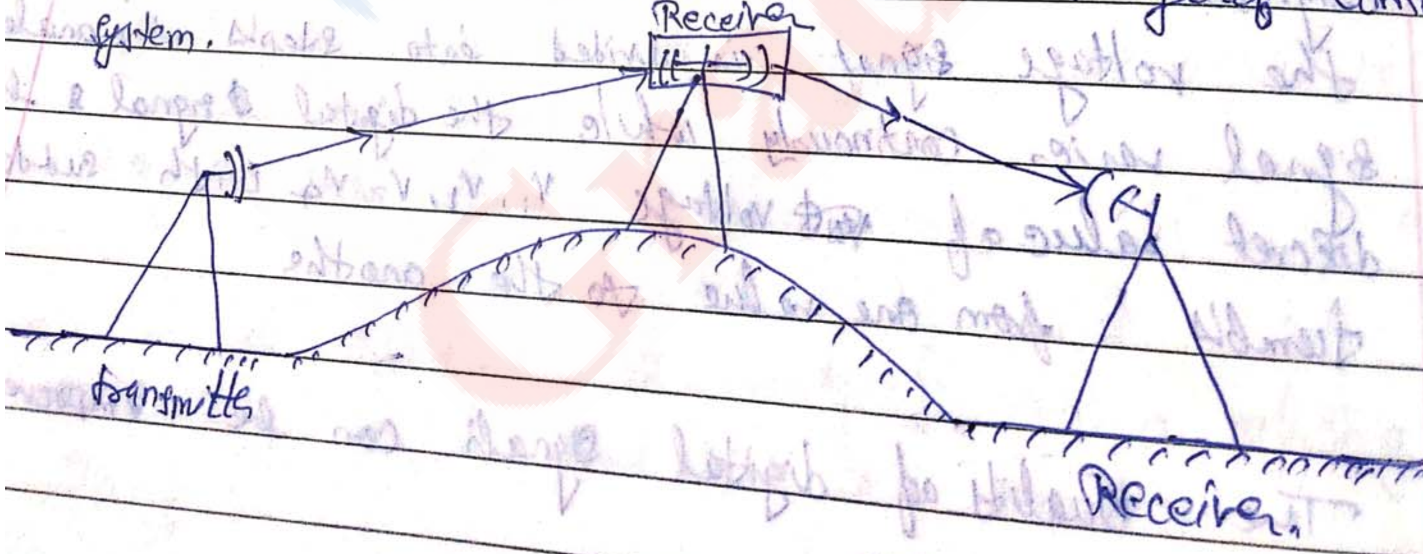
(4) Attenuation → The loss of strength of signal while propagating through a medium is known as attenuation.

(5) Range → It is the longest distance over which a signal can be sent with sufficient power.

(6) Amplification and amplifier → It the process of increasing the amplitude and hence energy of a signal and the electronic device which amplifies the signal is called as amplifier.

(7) Repeater →
Repeater is the ~~communication~~ combination of receiver and transmitter. a repeater receives the signal, amplifies it and send it to the another receiver.

Repeater are used to increases the Range of Communication system.



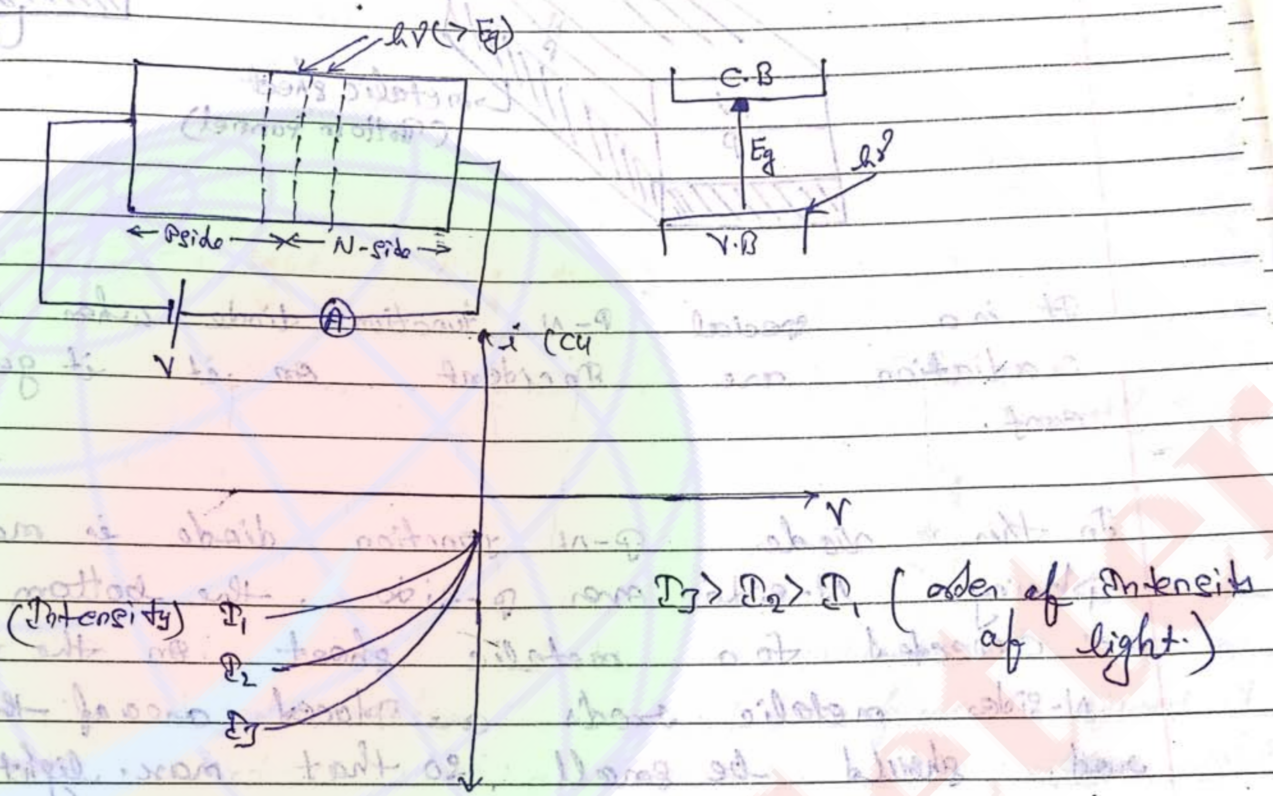
Lesson- 14

Semiconducter (incomplete)

Book से ही पढ़े।

Note! - Lesson 15, आगे से

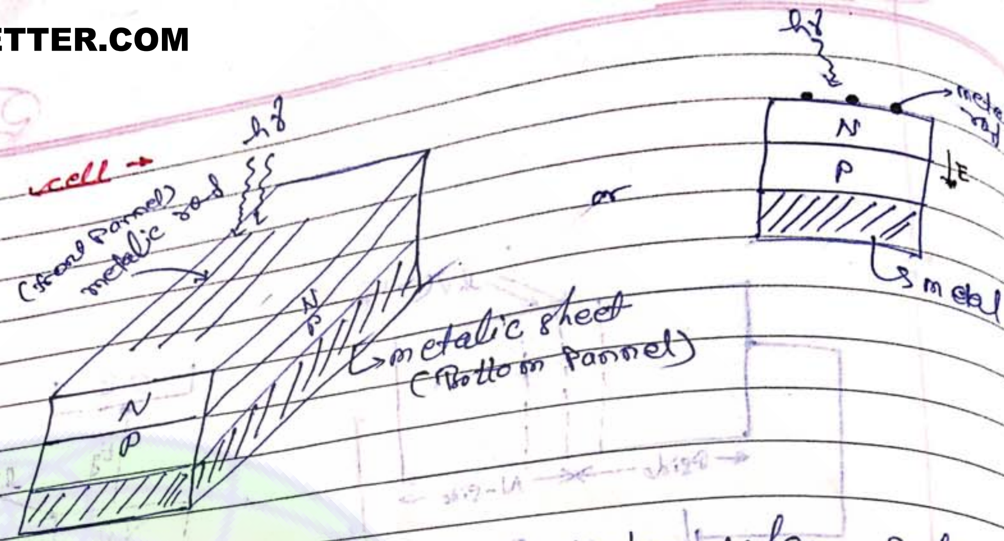
Photodiode: –



when light energy hν (> Eg) is Incident on the P-N junction then e⁻ may move from valence band to Conduction band in this case a e⁻ hole pair will be created the external electric field will exert for on this pair due to it force will accelerate towards p-side and e⁻ will accelerate towards N-S and current in the circuit will start to flow.

If Intentensity of light is Increased then value of current in the circuit will also Increase.

★ Solar cell →



It is a special P-N junction diode when solar radiation are incident on it it generates emf.

In this diode P-N junction diode is made by placing N-side over P-side, the bottom of P-side is connected to a metalic sheet on the top of N-sides metalic rod's are placed area of the metalic rod should be small so that max. light can be incident on N-side.//

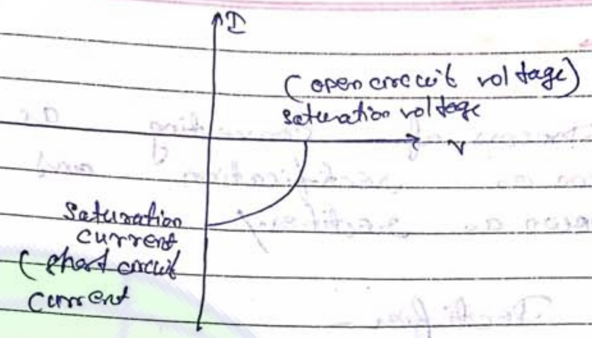
It works in 3-basic steps -

<1> When light is incident on it e^-, hole pairs are generated,

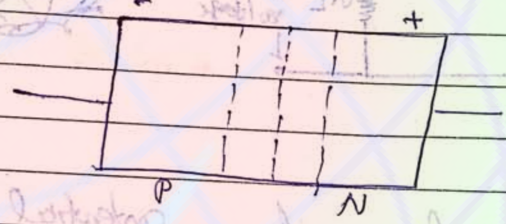
<2> electric field of depletion layer exert's force on the pair, so hole moves towards P-side and e^- moves towards N-side.

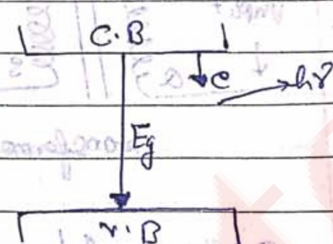
<3> The metalic bottom collects hole's and e^-'s are collected by the front pannel./

Therefore an emf will be induced on it.



<3> L-E-D → (light emitting diode)





L-E-D are special diode in which P-N junction heavily doped, when it is used in forward biased it emitts radiation which are converted into visible light by using sub-coding.

When a P-N junction diode is used in forward biased holes will move from P-side to N-side and e^- will moves from N-side to P-side.

Therefore at the junction conconcentration of e^-'s and whole will increase

In the P-side conc. of e^- will increase and to the N-side conc. of holes will increase.

Holes of N-side may absorb e^- from it, their by radiating a electromagnetic wave. This electromagnetic radiation is converted into suitable light by using fabrication.

<4> Rectifier →

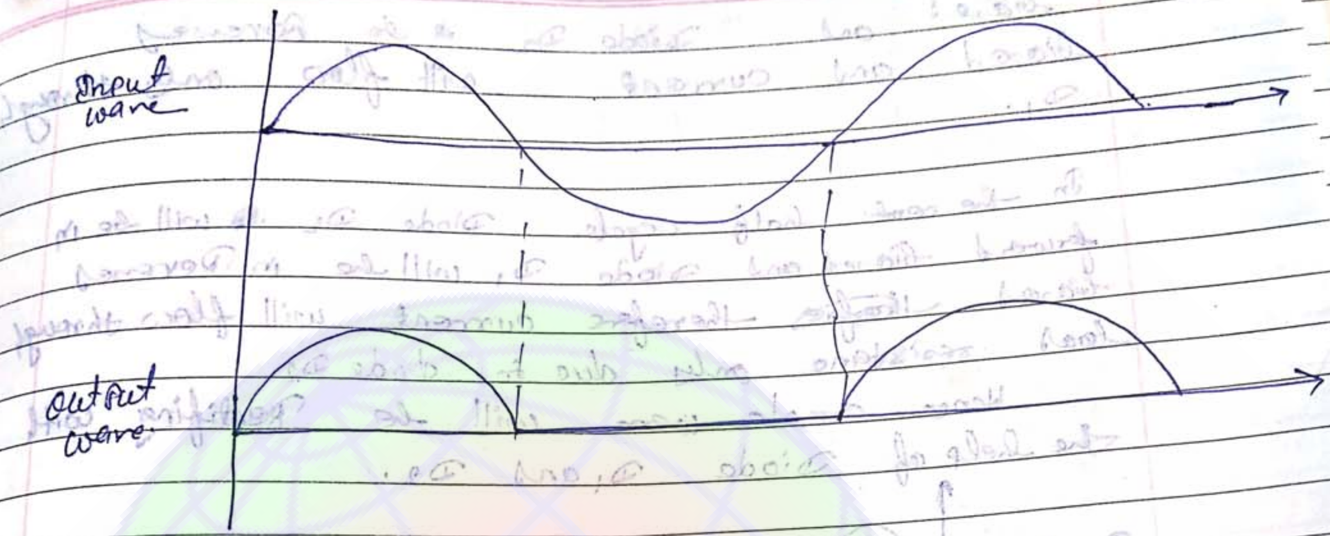
The process of converting ac-signal into dc-signal is known as rectification and the circuit used for it is known as rectifier./

Type of Rectifier –

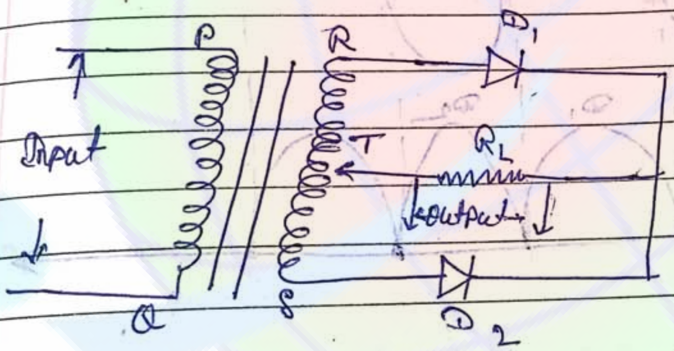
(1) Half wave rectifier –

In the 1st half cycle if potential of P is greater than potential of Q, then the value of potential at R will be more than potential at S. Then in this case diode "D" will be in forward biased and current will flow through it. therefore a voltage pulse will be available at load resistance./

In the 2nd (-ve) half cycle value of potential at point "S" will be more than value of potential at "R" Hence diode "D" will be in reversed biased and No current will flow through the load resistance./ Hence No voltage pulse will be available./



2> Full wave Rectifier :-



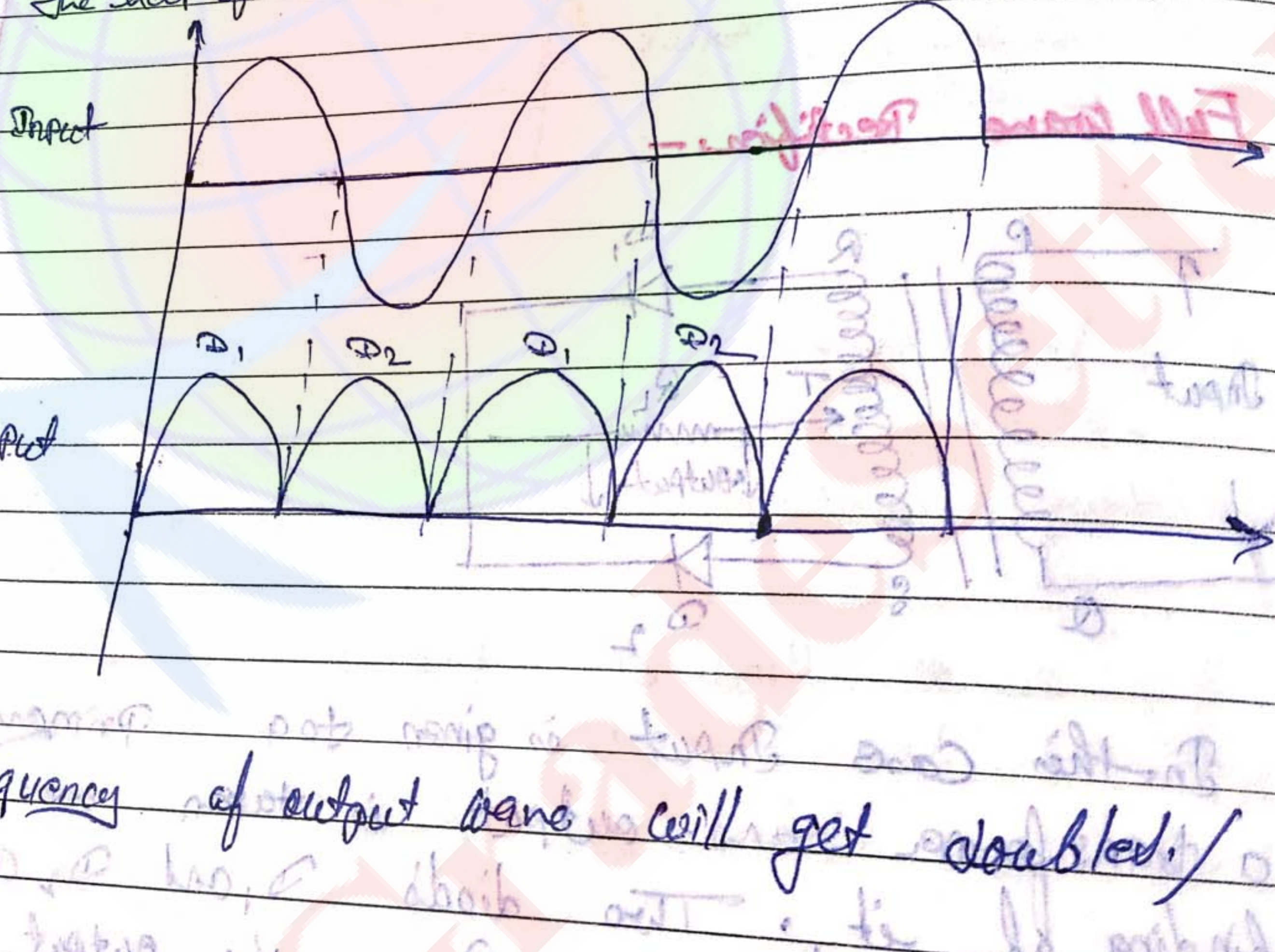
In this case Input is given to a Primary finding of a transformer and output is taken at the secondary finding of it. Two diods D_1 and D_2 are connected with load resistance R_L. The output is taken across the load resistance. This load resistance is connected b/w diods and point "T" from where transformer is centrally packed.

When the point "P" is at higher potential than Q (1st half cycle) then Point R will be at higher potential from point S.

In this case diode D_1 will be in froward biased and Diode D_2 is in Reverse biased and current will flow only through D_1.

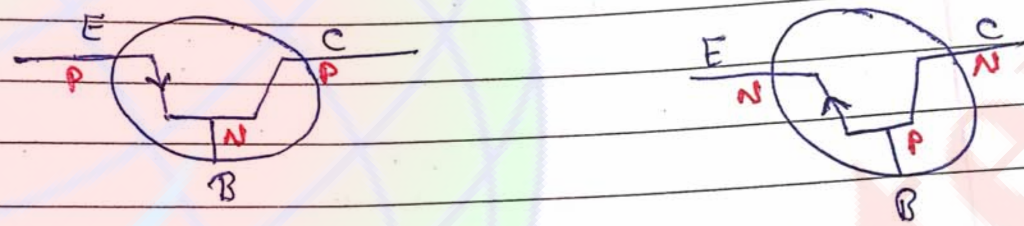
In the next half cycle Diode D_2 will be in forward biased and Diode D_1 will be in Reverse biased therefore current will flow through load resistance only due to diode D_2.

Hence complete wave will be Rectifying with the help of Diode D_1 and D_2.



* Frequency of output wave will get doubled.

Transistor →



Any transistor has 3 basic Parts.

(1) Emitter → It is medium in size