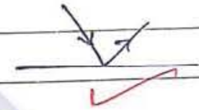
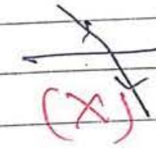
Optics

It is the branch of Physics which deal's with the study of different Phenomenon associated with light.

→ Newton theory :-





(X)

→ Huggen's theory :- mechanical wave (X)

→ Young's theory :- wave

→ maxwell's theory :- Non-mechanical wave (no-medium is required)

→ De Broglie's theory → Particle (Photoelectric effect)
→ wave (Interference)

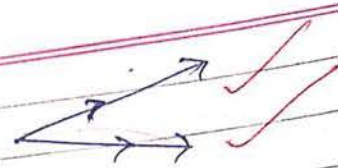
According to the theory given by De-broglie, light is having dual nature (Particle as well as wave nature)

The Phenomenon of light Photo-electric effect is explain using Particle nature of light.

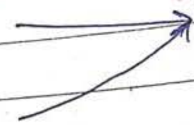
whereas the phenomenon of light Interference is explain using wave nature light.

Date / /

Diverging rays:-



Converging rays:-



	Object	Image
Real	Diverge	Converge.
virtual	coverge	Diverge.

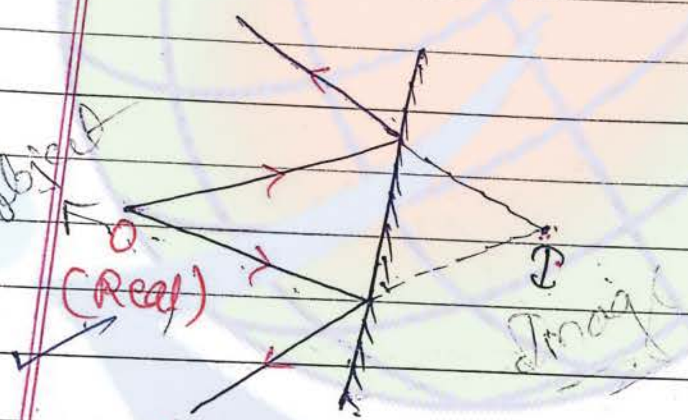
Object and Image :-

To define the position of an object Incident rays are required whereas to define the position of an Image Reflected / Refracted rays are required.

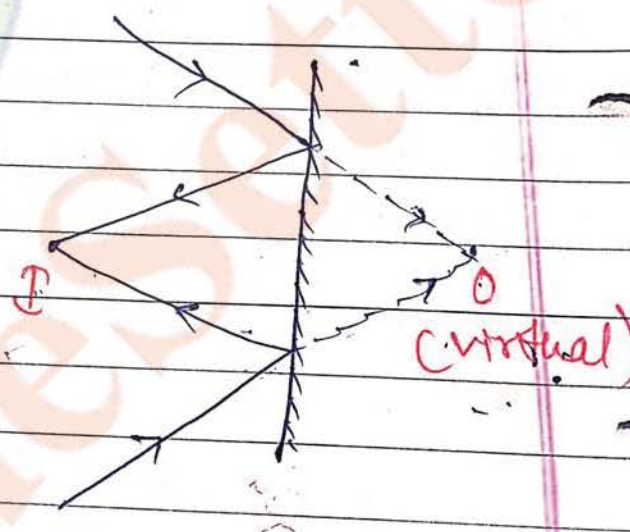
At least two rays are required to locate an object or Image.

objects:-

a) Real object



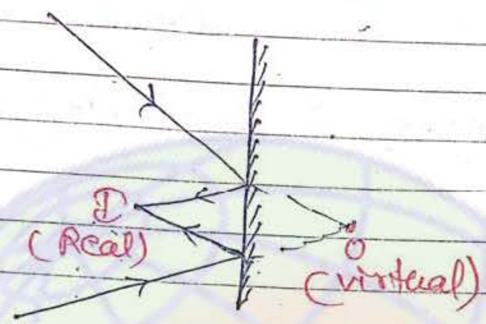
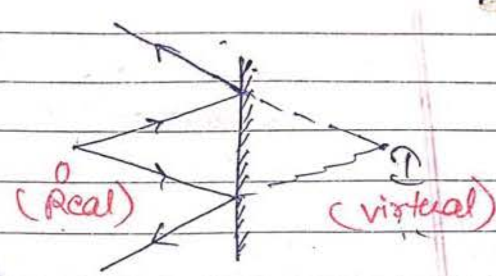
b) virtual object.



i) An object is said to be real if from the position of this object Incident ray's diverse

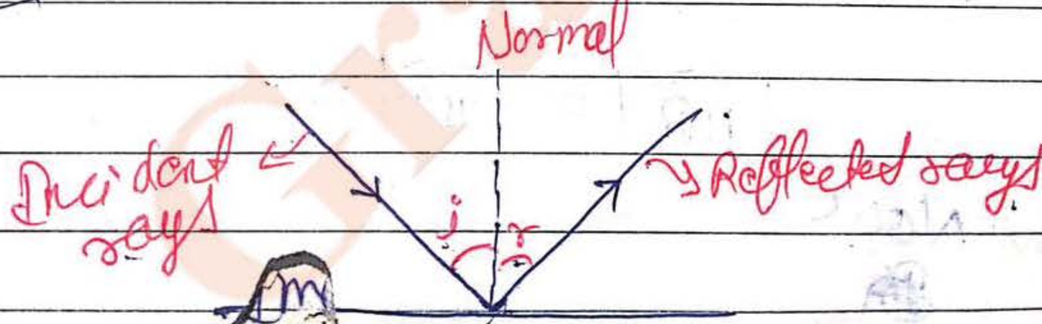
ii) A point where Incident ray's appear to converge called as virtual object

* Images–

Real Image	virtual Image–
a) 	a) 
b) A point where reflected or reafracted ray's actually converge is called as real Image.	b) A point from where reflected or refracted rays appear to diverse is called as virtual Image.

(*) Reflection of light :→

If the ray of light falling on a Surface return's back in the same medium then this phenomenon is called as reflection of light.



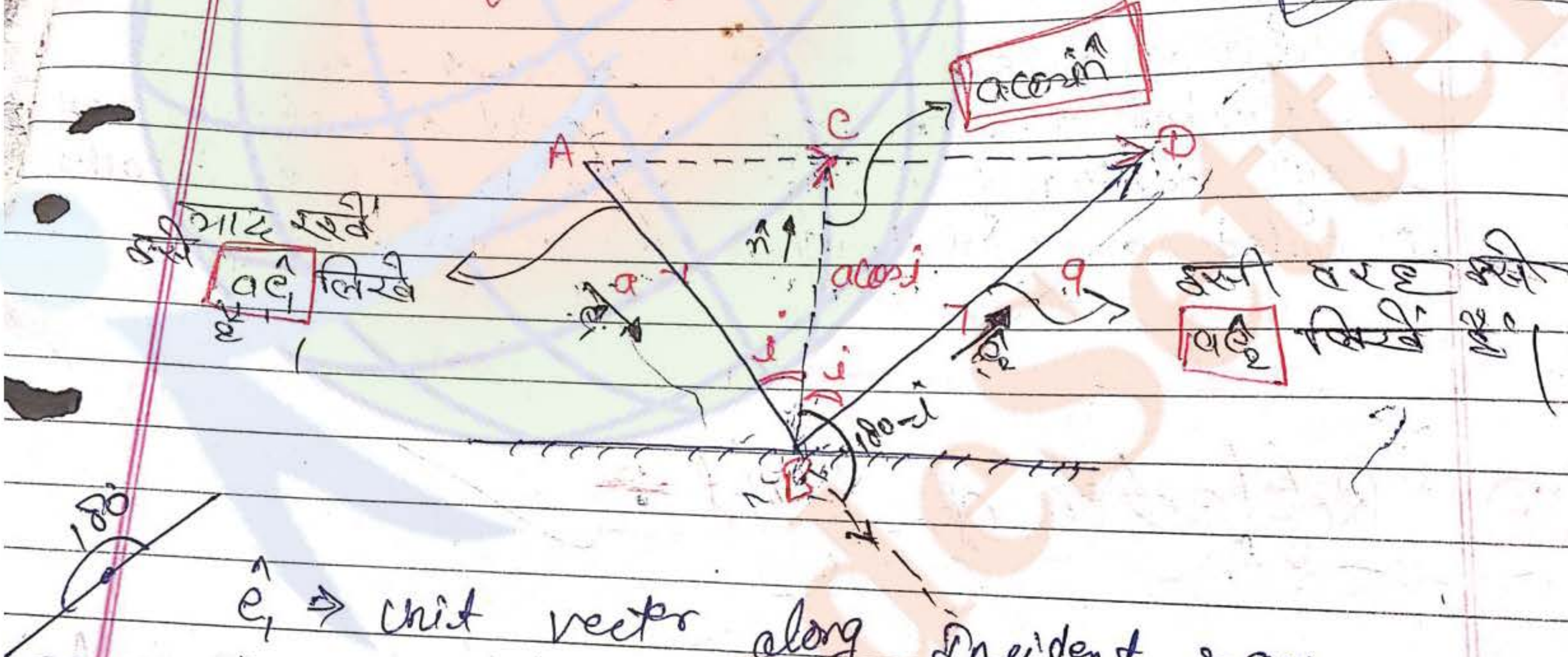
∠i = Angle of Incidence
∠r = Angle of reflection

* Law's of reflection →

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

2.) Angle of Incidence is equal to Angle of reflection.

* Vector form of the law of reflection →



$\hat{e}_1 \Rightarrow$ Unit vector along Incident ray

$\hat{n} \Rightarrow$ " " " Normal

$\hat{e}_2 \Rightarrow$ " " " Reflected ray

$$|\vec{AB}| = |\vec{BD}| = a$$

Now

In ΔABC

$\vec{AC} = \vec{AB} + \vec{BC}$

$\Rightarrow \vec{AC} = a\hat{e}_1 + a\cos i\,\hat{n}$ —— (1)

In $\Delta ABCD$

$\vec{BC} + \vec{CD} = \vec{BD}$

$\Rightarrow \vec{CD} = \vec{BD} - \vec{BC}$

$\Rightarrow \vec{CD} = a\hat{e}_2 - a\cos i\,\hat{n}$ —— (2)

Now

$\vec{AC} = \vec{CD}$ —— (3) → यह बात याद रखें equal ही आएगा।

from eq (1), (2) and (3)

$a\hat{e}_1 + a\cos i\,\hat{n} = a\hat{e}_2 - a\cos i\,\hat{n}$

$$\boxed{\hat{e}_2 = \hat{e}_1 + 2\cos i\,\hat{n}}$$ —— 4

बाद में जाकर "a" कट जाता है।

angle b/w $\hat{e}_1$ and $\hat{n}$ (180 − i)

Also,

$\hat{e}_1 \cdot \hat{n} = \cos(180 - i)$

$= -\cos i$

$\Rightarrow$ $\cos i = -\hat{e}_1 \cdot \hat{n}$

So,

$$\boxed{\hat{e}_2 = \hat{e}_1 - 2(\hat{e}_1 \cdot \hat{n})\hat{n}}$$

1st Choice

Q4) A ray of light is falling on a reflecting surface along the direction given by $\hat{i}+\hat{j}-\hat{k}$ and Normal to the surface is along the direction $\hat{i}+\hat{j}$ find out unit vector along the direction of reflected rays:-

Sol^n इस equation को हम पहले ही सिद्ध कर चुके हैं। $\hat{e}_1$ तथा $\hat{n}$ given है। इसकी सहायता से $\hat{e}_2$ निकाल लेंगे

$\hat{e}_2 = \hat{e}_1 - 2(\hat{e}_1\cdot\hat{n})\hat{n}$

$\hat{e}_2 = 1 -$

$\hat{e}_1 = \frac{1}{\sqrt{3}}(\hat{i}+\hat{j}-\hat{k})$ $\quad \because \hat{A} = \frac{\vec{A}}{|\vec{A}|}$

$\hat{n} = \frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$ $\quad \because \hat{A} = \frac{\vec{A}}{|\vec{A}|}$

$\hat{e}_2 = \frac{1}{\sqrt{3}}(\hat{i}+\hat{j}-\hat{k}) - \frac{2}{\sqrt{3}\sqrt{2}}(2)\frac{1}{(\sqrt{2})}(\hat{i}+\hat{j})$

$= \frac{1}{\sqrt{3}}(\hat{i}+\hat{j}-\hat{k}) - \frac{2}{\sqrt{3}}(\hat{i}+\hat{j})$

$= \frac{-1}{\sqrt{3}}(\hat{i}+\hat{j}+\hat{k})$

Q5) There are three reflecting surfaces which are mutually perpendicula to each other.

a ray of light is falling on one of the surface. [illegible] that after three reflection one through each surface) the final reflected ray is Parallel but opposite to the Incident rays.

Sol^n Let eq^n of Incident ray $= a\hat{i} + b\hat{j} + c\hat{k}$

when there ray's Incident on x-y plane

$r' = a\hat{i} + b\hat{j} - c\hat{k}$

Again when there light ray Incident on y-z Plane

then

$r'' = -a\hat{i} + b\hat{j} - c\hat{k}$

& when light rays Incident on x-z Plane

then

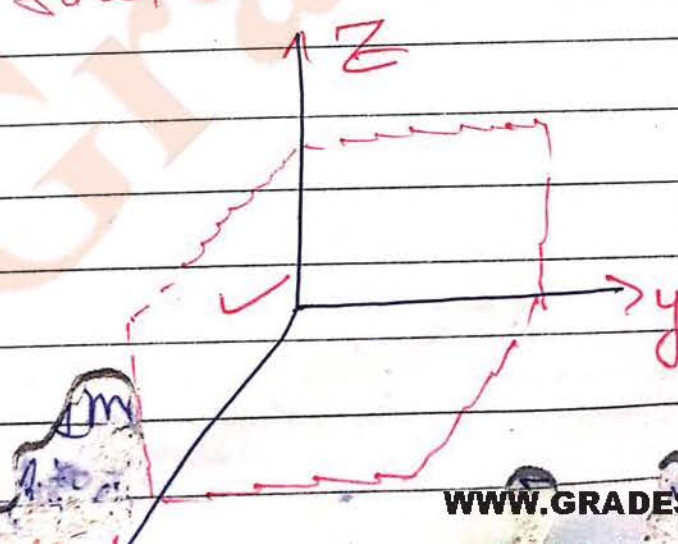
$r''' = -a\hat{i} - b\hat{j} - c\hat{k}$

&

$r''' = -(a\hat{i} + b\hat{j} + c\hat{k})$

Here we see that two vector Incident and reflected are opp. in sign, it means two vector is in opp. direction.

Teacher solution



$\hat{e}_1 = a\hat{i} + b\hat{j} + c\hat{k}$

$\hat{n}_1 = \hat{j}$

$\hat{e}_2 = \hat{e}_1 - 2(\hat{e}_1 \cdot \hat{n}_1)\hat{n}_1$

$= ?$

$\hat{n}_2 = \hat{k}$

$\hat{e}_3 = \hat{e}_2 - 2(\hat{e}_2 \cdot \hat{n}_2)\hat{n}_2$

$= ?$

$\hat{n}_3 = \hat{i}$

$\hat{e}_4 = \hat{e}_3 - 2(\hat{e}_3 \cdot \hat{n}_3)\hat{n}_3$

$= -(a\hat{i} + b\hat{j} + c\hat{k})$

1st Choice

Page No. 11

Date / /

Important key points-

1) ~~using~~ During the reflection of light the wavelength, frequency and speed remain unaffected.

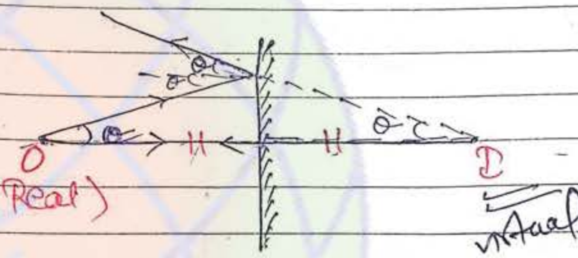
2) If the reflection is taking place from Rarer - Denser Interface then a phase difference of π is Introduced.

whereas If the reflection is taking place from denser rarer Interface then no phase difference is Introduced.

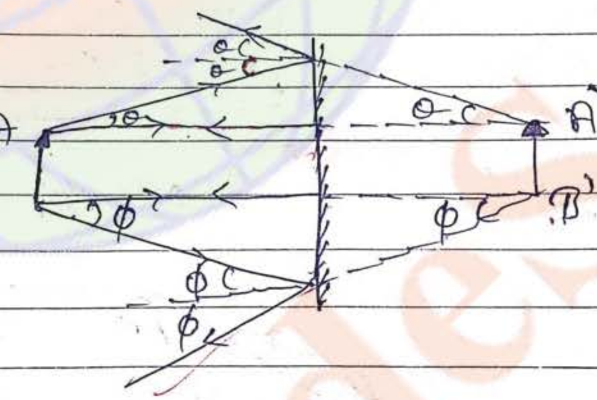
* Application of reflection of light through plane surface (plane mirror) →

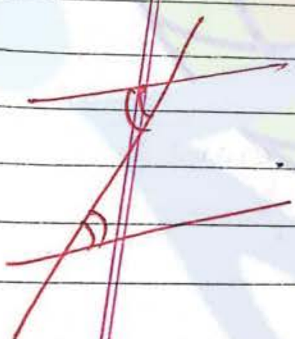
⇒ Image formation: ⇒

a) Point object -



b) For extended object: -





Some Point (Important) about Plane mirror

1) If the object is real then Image formed by the plane mirror is virtual and vice-ver

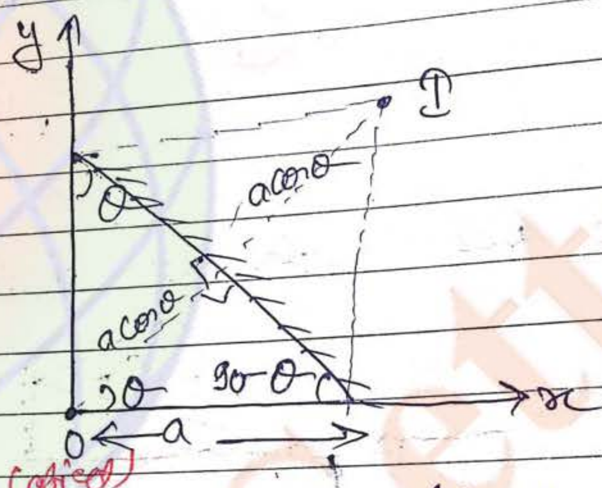
2) The ⊥ar separation of object from the plane mirror will ... same as the ⊥ar distance of

Image from the plane mirror

(ii) The height of the Image formed by the plane mirror is same as the height of the object.

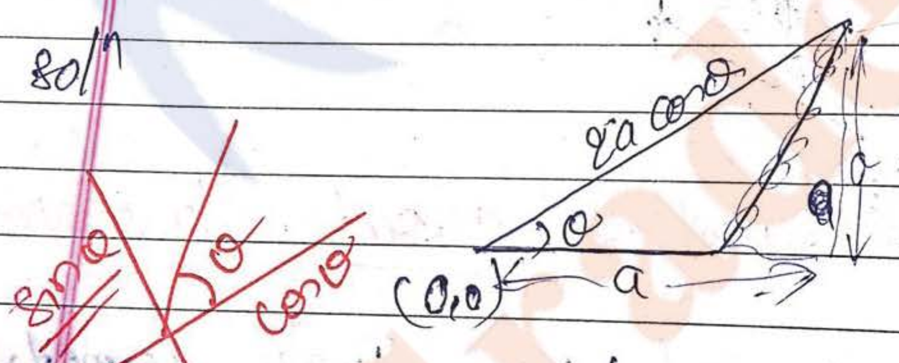
Linear magnification $(m) = \frac{\text{height of Image}}{\text{height of object}}$

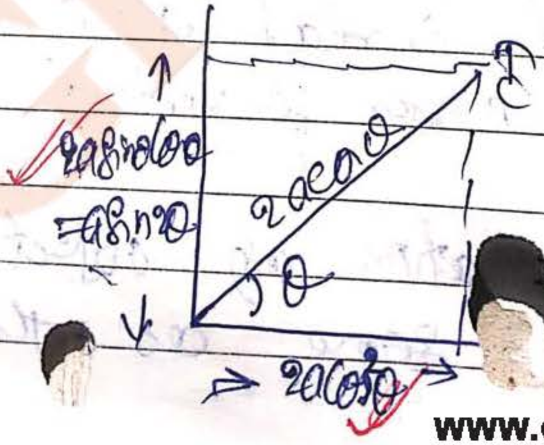
→ for plane mirror $m = 1$



find out the co-ordinate of object formed.

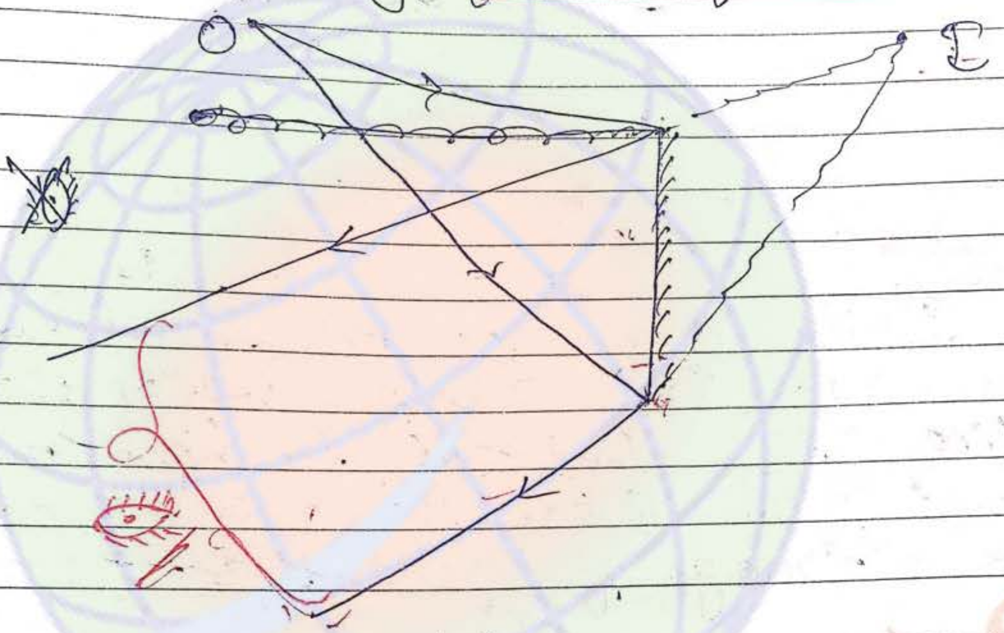
Sol^n



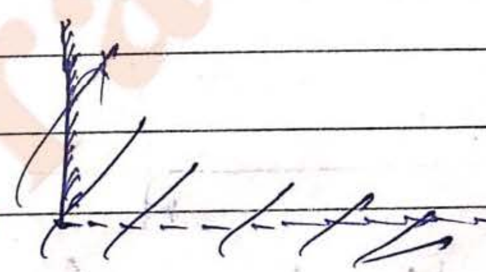


4) Field of View →

Even if the size of the object is very large and that of mirror is very small full Image of the object is still formed but whether an observer can see the ~~object or not~~ Image or not it is decided by field of view.

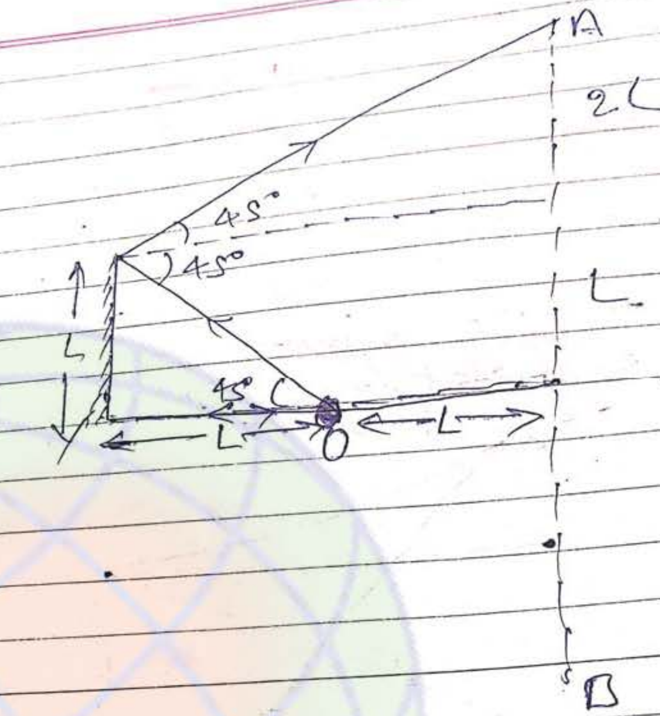


The field of view of any Image is the region which lies b/w two extremely reflected rays an observer can see the Image only if his eye lie in the field of view.



1st Choice

Q)

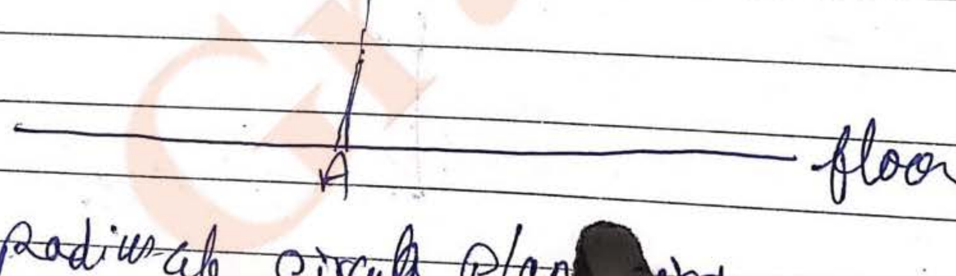


In the figure shown an observer is moving with constant vel. "v" along the line AB find out for how much duration of time the observer can see the Image of point object "O"

Sol^n

$t = \frac{3L}{V}$ (time = $\frac{\text{Displacement}}{\text{velocity}}$)

Q)

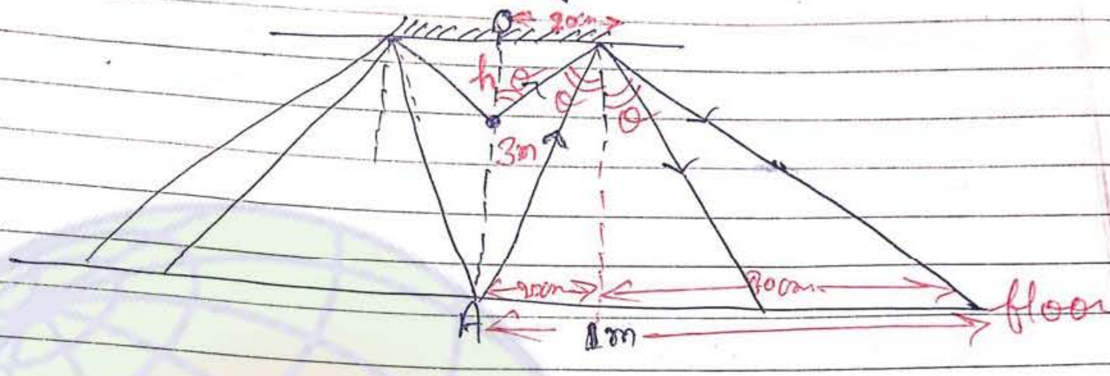


Radius of circula plane mirror = 20cm
Height of room = 3m

on the ceiling of a room a circula plane mirror of radius 20cm is fixed. find out on the line "OA" ... maximum ...

~~of light from point "O". show that after reflection a circular~~
area on the ground having radius "1m" can be elluminated.

Sol/n



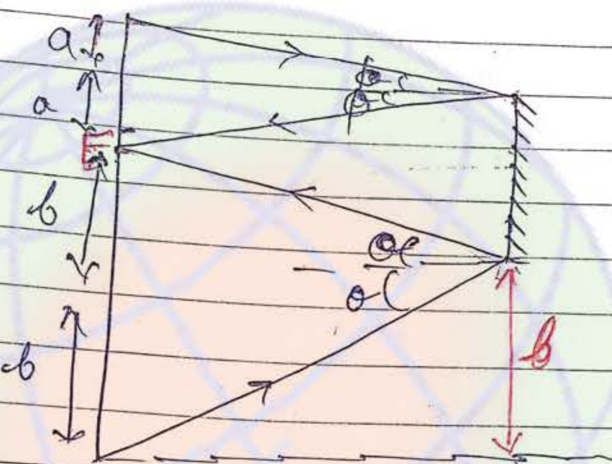
Radius of circular plane mirror = 20cm
Height of room = 3m

$$\tan\theta = \frac{20}{h} = \frac{80}{300}$$

$$\Rightarrow h = 75cm$$

5) Ans/m

5. minimum height of the plane mirror required to see the full image by the person himself.

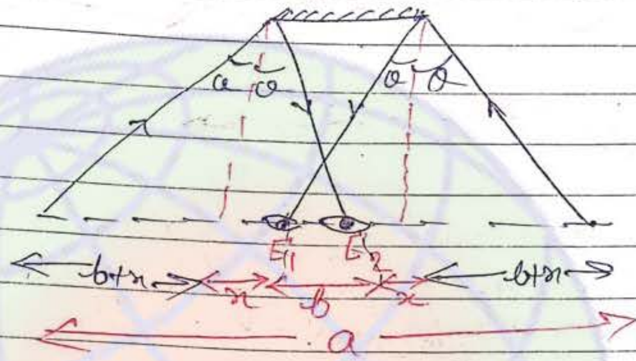


Height of man = 2(a+b)
height of mirror = (a+b)

$$\text{minimum length of mirror} = \frac{\text{height of man}}{2}$$

Under this condition a man can see the full image of the bottom most part of the plane mirror i.e. at the height half of the height of eyes from the ground surface.

6) minimum width of the plane mirror required to see the full image of the face by a person himself.



Person with two eye

a = width of face
b = separation b/w 2 eyes

$3b + 4x = a$

$4x = a - 3b$

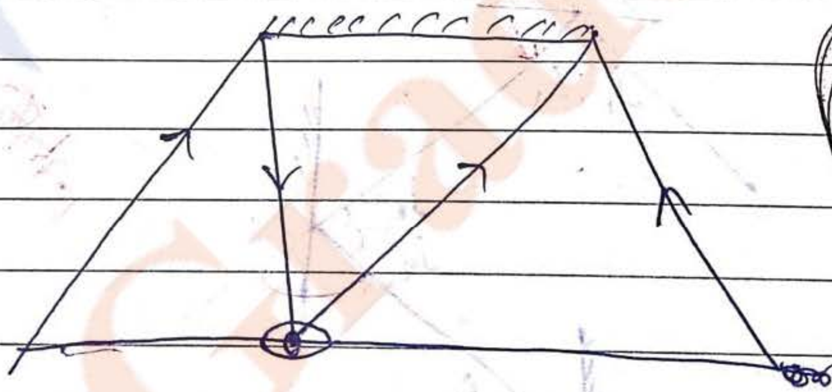
$$\boxed{x = \frac{a-3b}{4}}$$

width of mirror $= (b$

$\Rightarrow b + 2\left[\frac{a-3b}{4}\right]$

$$\boxed{\Rightarrow \frac{a-b}{2}}$$

Notes ->



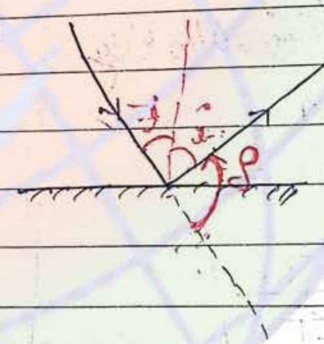
Person with only one eye

If a man can see with one eye only the minimum width of the plane mirror required should be half of the width of the face

7) Deviation Produced by Plane mirror →

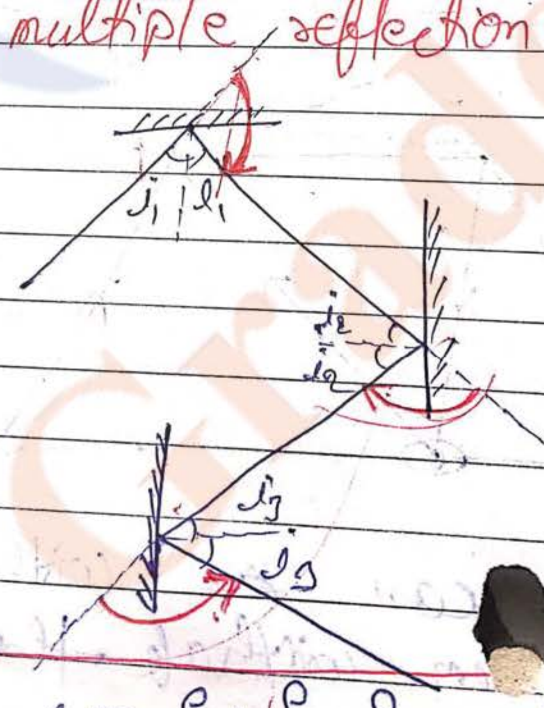
a) For Single reflection →

It is the angle through which the path of ray of light shift's during the reflection.



$$\boxed{\delta = 180 - 2i}$$

b) For multiple reflection →

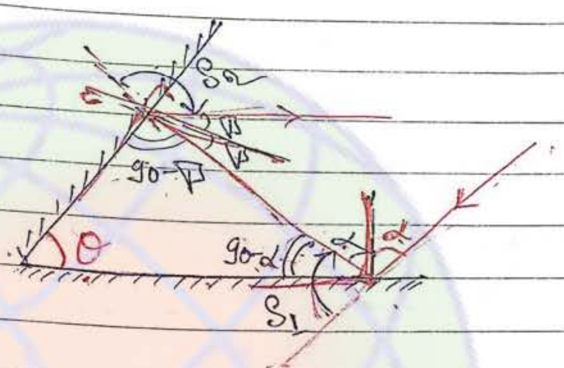


~~clock~~ clock = +ve
Anti clock = −ve

$$\boxed{\delta_{total} = \delta_1 + \delta_2 - \delta_3}$$

(5) The angle b/w two plane mirror's is "θ". A ray of light is incident on one of the plane mirror at an angle "α". Prove that after one reflection through each plane mirror the total deviation produced does not dependend on the angle "α".

Sol^n



$$\delta_1 = 180 - 2\alpha$$
$$\delta_2 = 180 - 2\beta$$

$$\boxed{\delta_{total} = 360 - 2(\alpha + \beta)} \quad \text{— (I)}$$

$$\theta + 90 - \alpha + 90 - \beta = 180$$
$$\boxed{\theta = \alpha + \beta} \quad \text{— (II)}$$

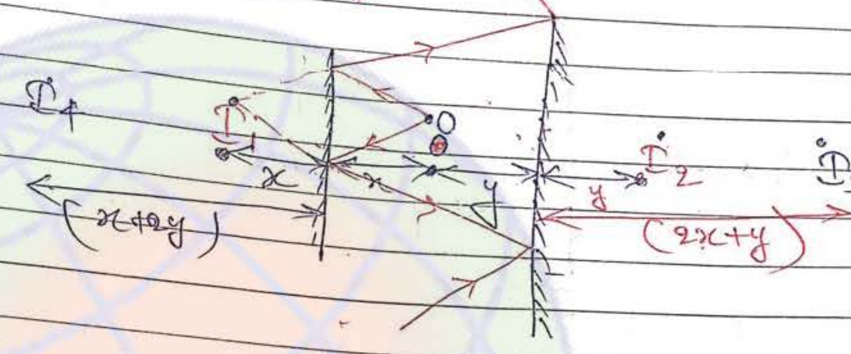
$$\delta_{total} = 360 - 2\theta$$

Result:- from the ~~above~~ above expression the total deviation depend's only upon the angle angle b/w two plane mirror's

Page No. 25
Date / /

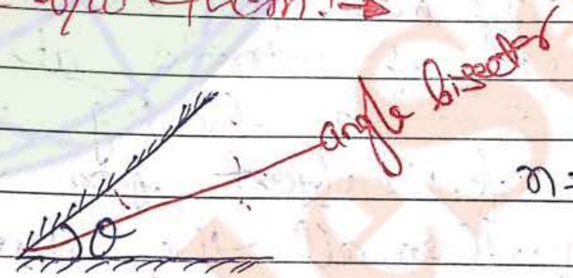
8. No. of Images formed by the two Plane mirror's

(a) If two Plane mirror are kept Parallel to each other →



No. of Images formed = ∞

(b) If two Plane mirror are kept at an angle θ/α then :→



$n = \frac{360}{\theta} = ?$

(i) If "n" is even Integer then No. of Images formed = (n − 1)

(ii) If "n" is odd Integer
→ If object is kept at angle bisector then no. Images formed = (n − 1)
→ If object is kept at any other angle bisector then no. of Images = "n"

याद रखें
समझने में अलग है
त odd है इसे
sector के अलावा नहीं
दीया है
रखे अधिक गलती
ा। (इसके अलावा कोई
case ही same है)

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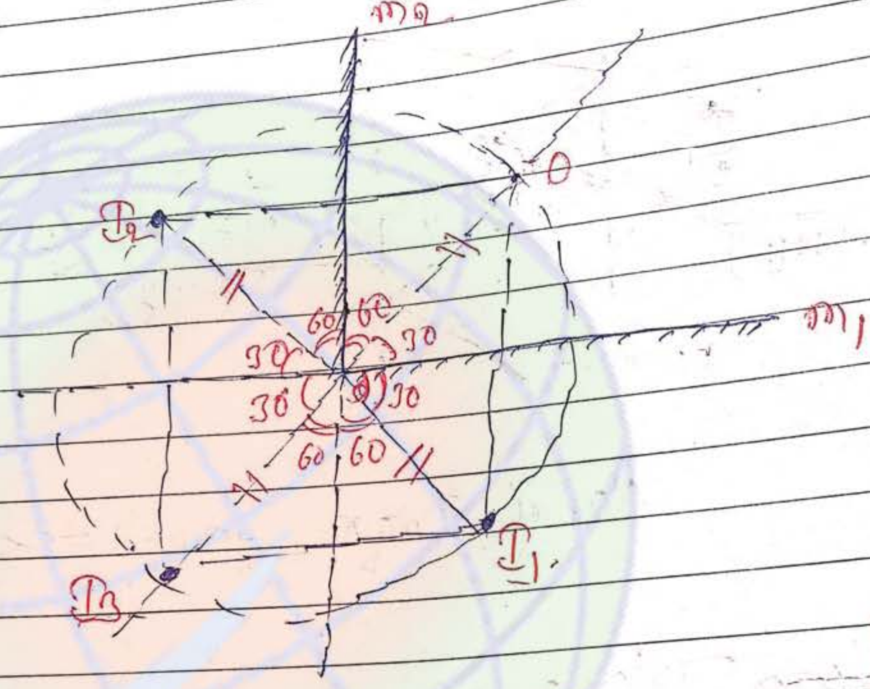
Q1.) If $\theta = 90°$

$n = \frac{360}{90} = 4$

No of Images = "3"



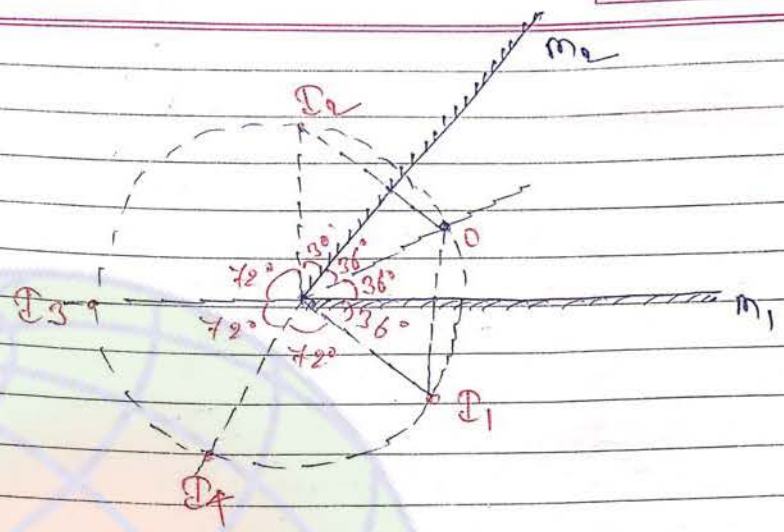
Note → If we consider the point of intersection of mirror's at a centre as a circle is drawn having radius equal to separation of the object from the point of intersection, then all the Images lie on circumference of the circle.

Q2.) If $\theta = 72°$ and object is kept at angle bisector.

$n = \frac{360}{72} = 5$

No of Images $= 5 - 1$

$= 4$



Ex 3.) If $\theta = 72°$ and object is not kept at bisector

Sol^n

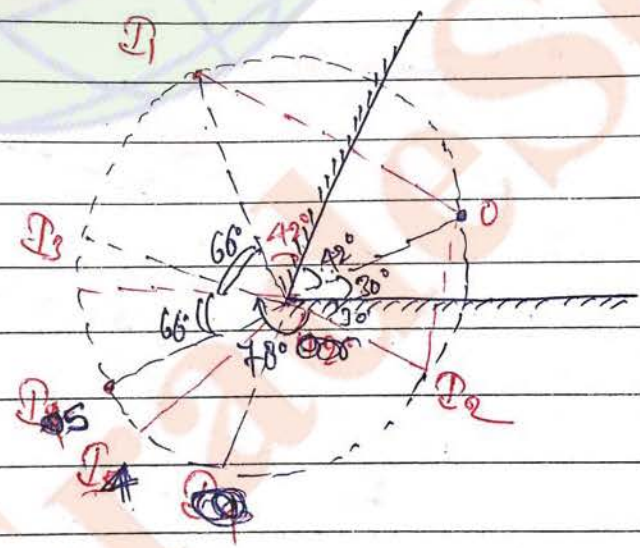
$$n = \frac{360}{72} = 5$$

No of Images = 5

30 — 112 — 170 — 100 — 180

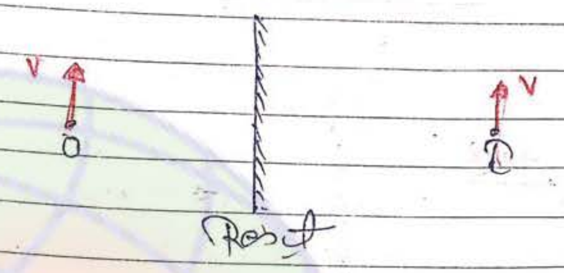
84
30
100
214

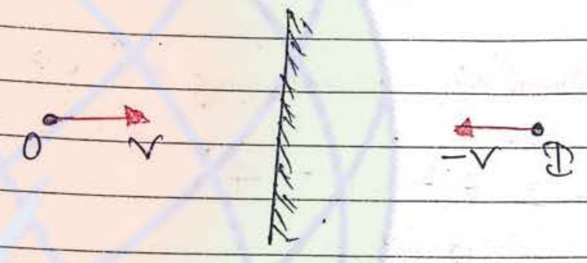
180
42
138



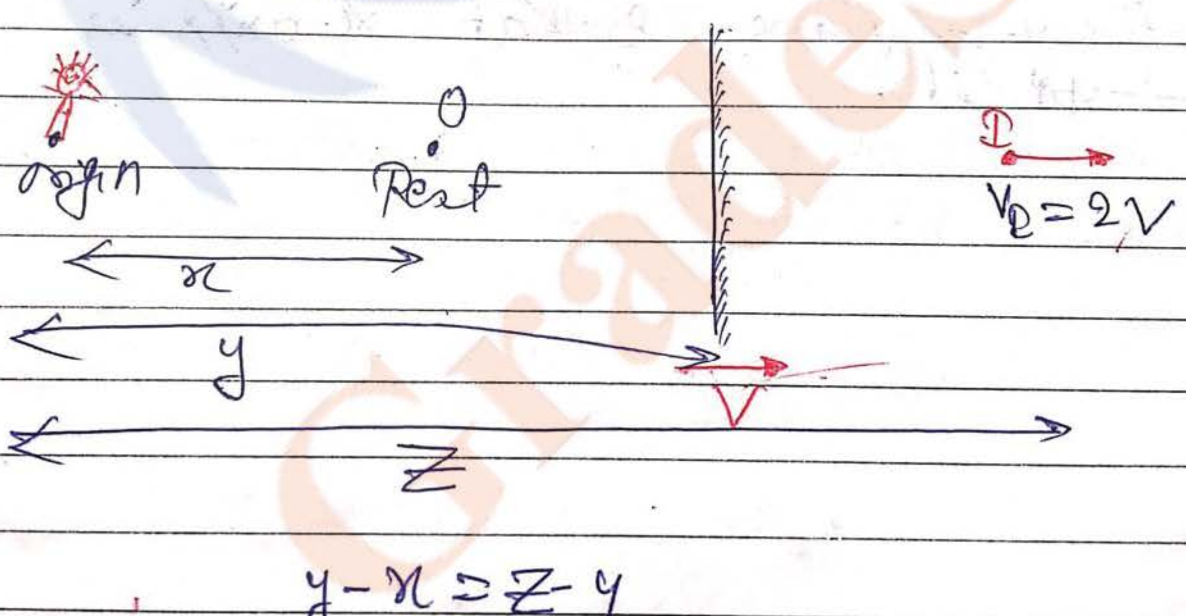
Motion of object and Plane mirror →

1) If Plane mirror is stationary and object and moving





2) If object is stationary but plane mirror is moving :->



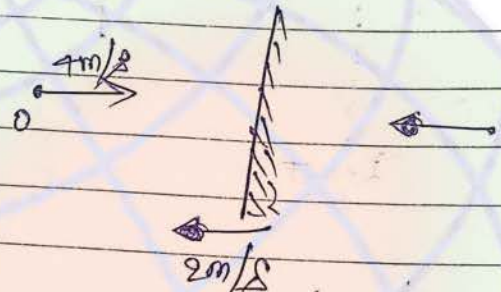
$$y - x = Z - y$$

$$Z = 2y - x$$

$$\frac{dZ}{dt} = 2\frac{dy}{dt} - \frac{dx}{dt}$$

$$\boxed{V_I = 2v}$$

So)



Find out velocity of Image

$$\frac{dZ}{dt} = 2(-2) - (4)$$
$$= -8 \text{ m/sec.}$$

$$\frac{dZ}{dt} = \cancel{2\frac{dy}{dt} - \frac{dx}{dt}}$$
$$= \cancel{2\frac{(-2)}{dt}} \cancel{-\frac{dx \times 4}{dt}}$$
$$=$$

Suppose the mirror is lying in the y-Z plane so that x-axis is ⊥ to it.

③ method of Relative velocity →

Suppose the mirror is lying in y-z plane so that x-axis is horizontal :-

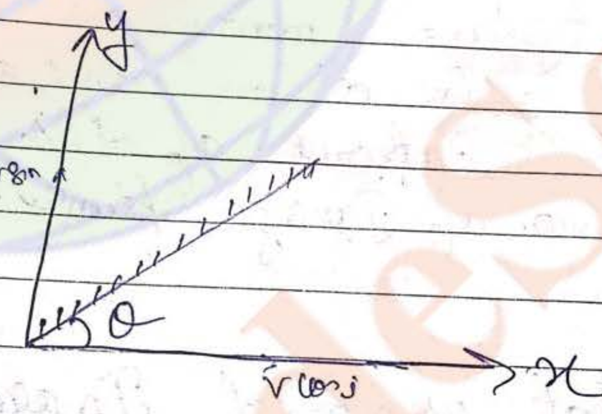
$$\vec{V}_{Im(y)} = \vec{V}_{om(y)}$$

$$\vec{V}_{Im(z)} = \vec{V}_{om(z)}$$

Along x-axis

$$\vec{V}_{Im(x)} = -\vec{V}_{om(x)}$$

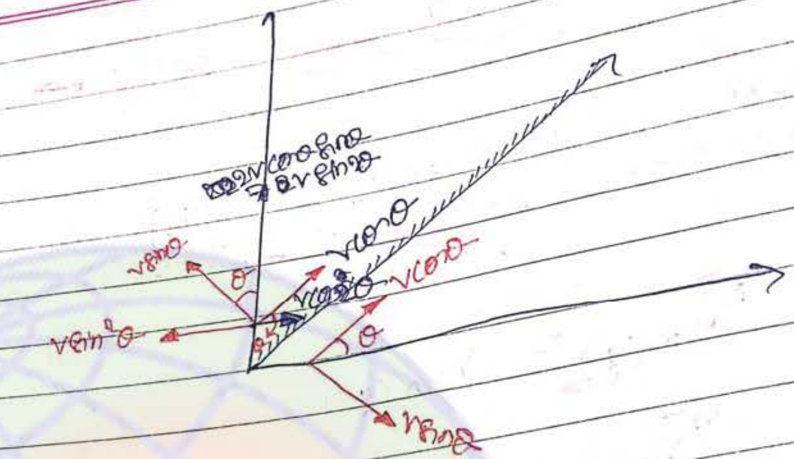
(1.) Question no ⇒ 11



A man is moving along x-axis with the constant vel. "v" find out velocity of his Image.

(a) $V\sin\theta\hat{i} + V\cos\hat{j}$
(b) $V\cos\theta\hat{i} + V\sin\theta\hat{j}$
(c) $V\sin2\theta\hat{i} + V\cos2\theta\hat{j}$
(d) $V\cos2\theta\hat{i} + V\sin2\theta\hat{j}$

Sol^n

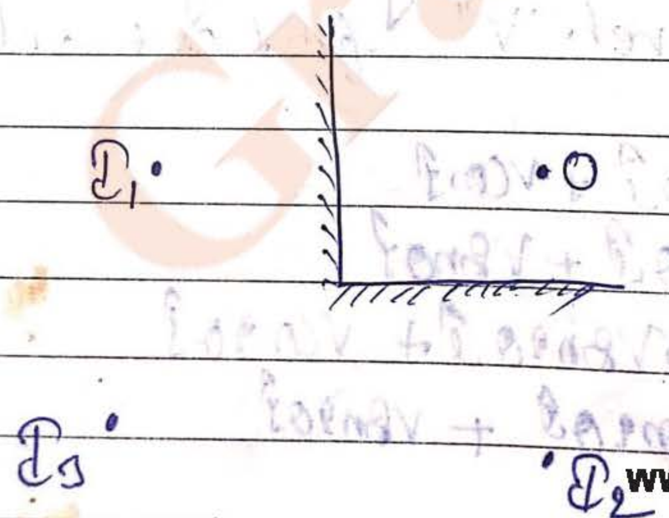


$$v\left[\cos^2\theta - \sin^2\theta\right]$$

$$= v\cos 2\theta\,\hat{i} + v\sin 2\theta\,\hat{i}$$

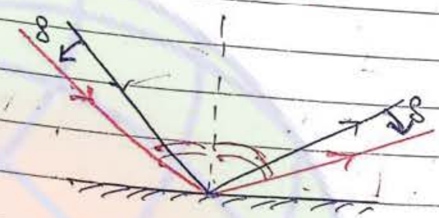
(10) Three plane mirrors are mutually ⊥ to each other and an object is kept infront of this system find out no. of Image formed.

Sol^n Total number of Image formed ⇒ "7"



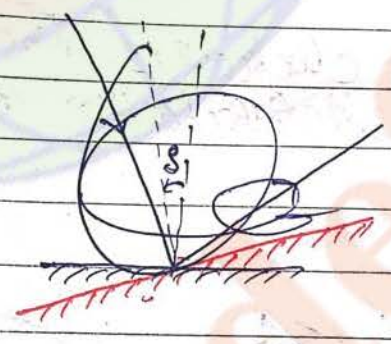
10) Effect of rotation of Incident ray on Plane mirror →

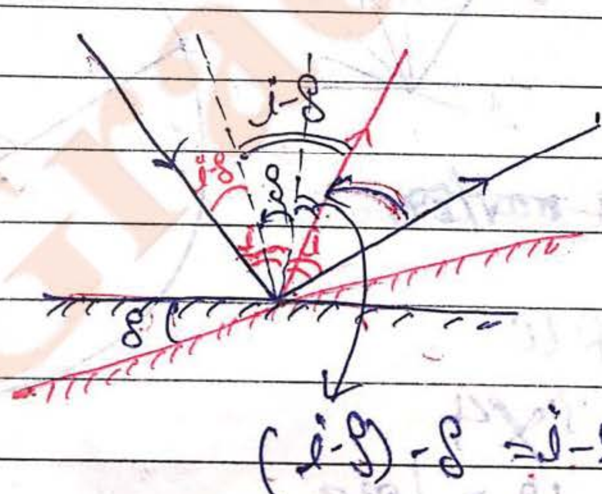
(a) If only Incident ray is rotated →



In this case the reflecting ray rotates through the same angle in opposite sense.

(b) If only Plane mirror is rotated →





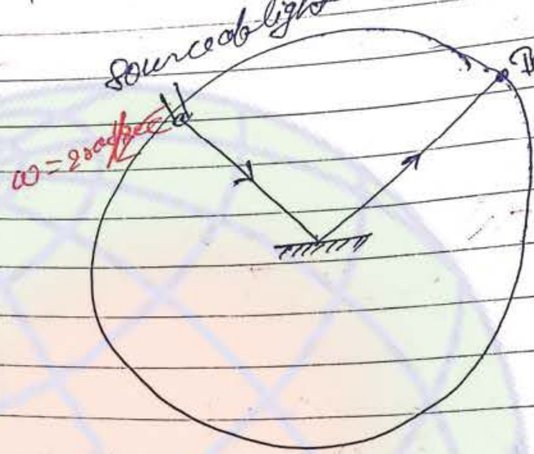
$(i-\delta)-\delta = i-2\delta$

Hence → Reflected ray rotate through $(i-2\delta)$

1st Choice

In this case the ~~reflect~~ reflected ray rotates through twice the angle of rotation of plane mirror in the same sense.

(a)



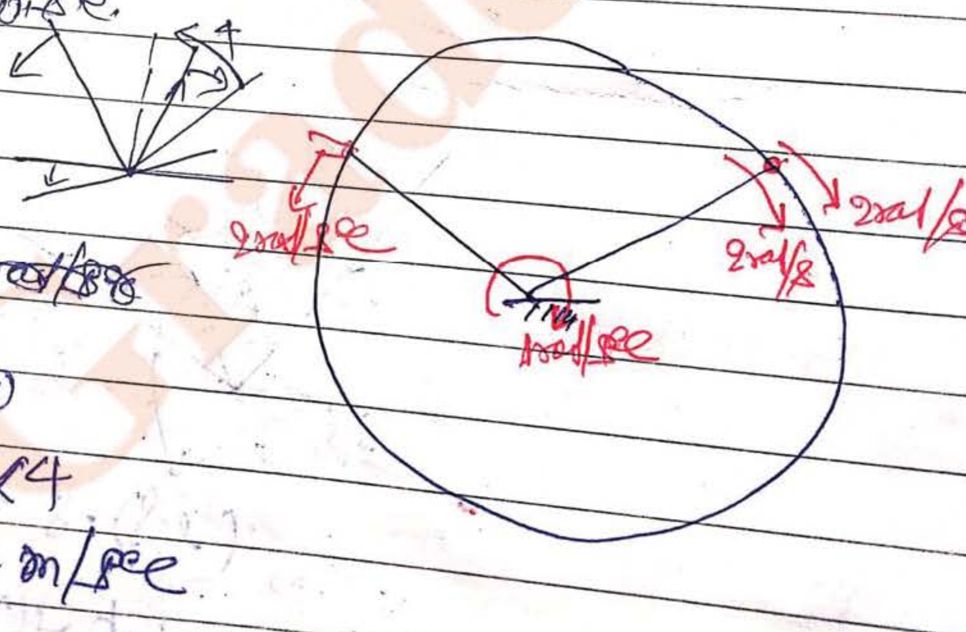
Radius of spherical

In the figure shown find out the linear velocity of Bright spot If the plane mirror kept at the centre is rotated with ang. vel 1 rad/sec

(a) To clockwise direction
(b) To Anticlockwise direction.

So/n

a) clockwise.



$\omega = 4$ ~~rad/sec~~

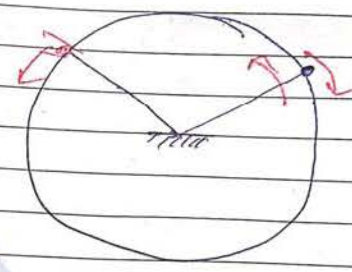
$V = R\omega$

$= 3 \times 4$

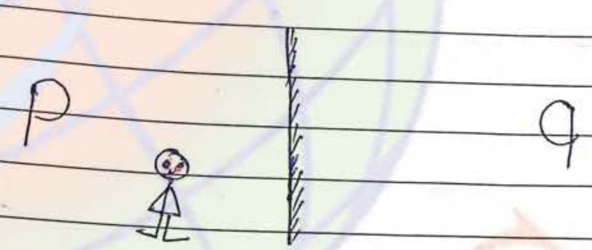
$= 12$ m/sec

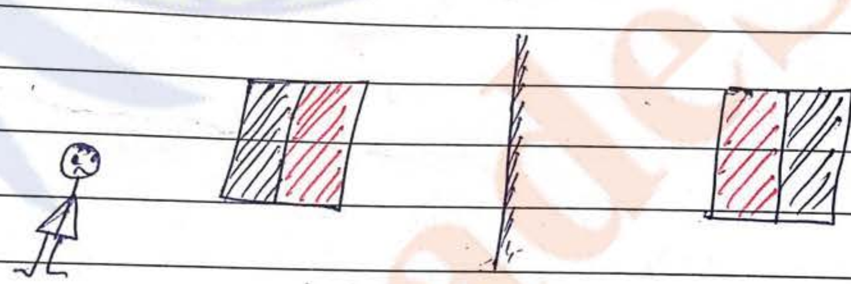
b) Anticlockwise

$\omega > 0$
$v > 0$



ii) Lateral Inversion ⇒





As shown in the figure If the observer is present b/w the object and mirror then right part is appear on the left and left is appeared on the right.

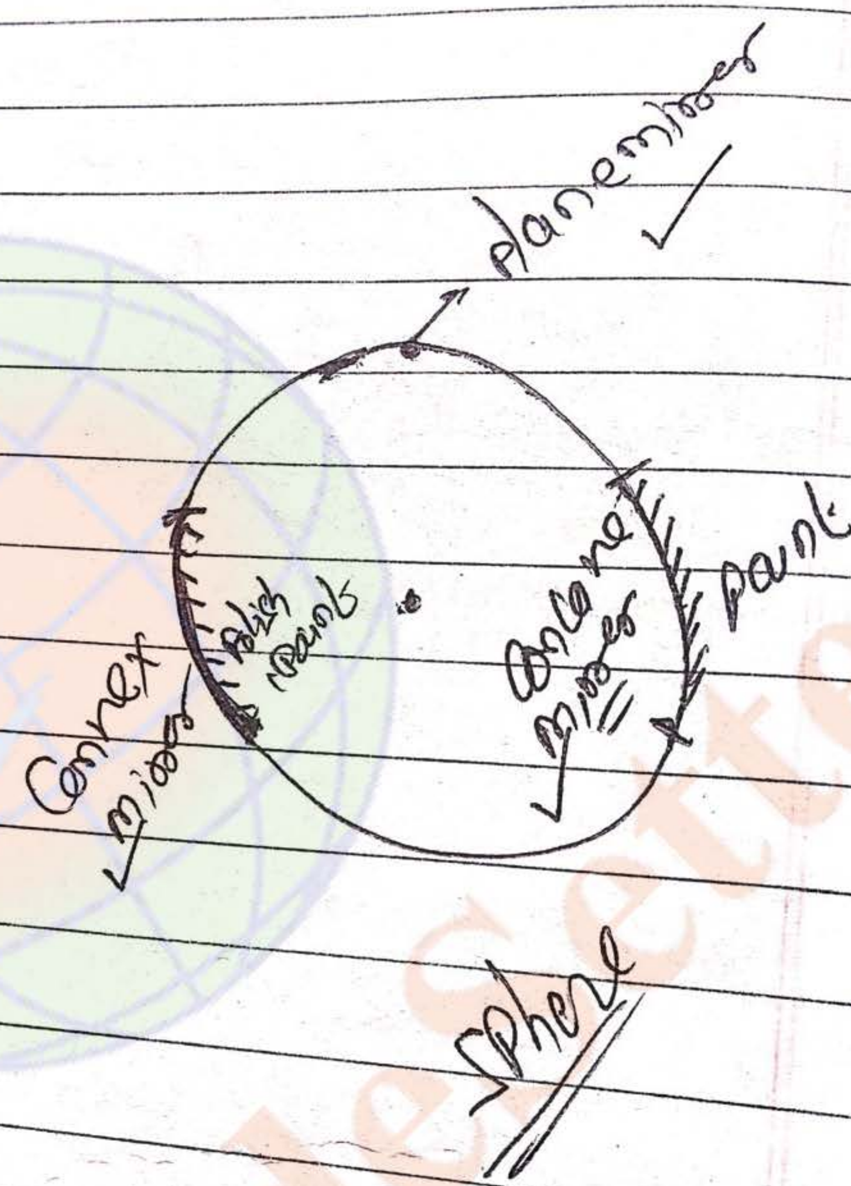
whereas If the observer is present

very good

Page No. 36
Date / /

1st Choice

behind then front is appeared on the back and back is appeared in front.

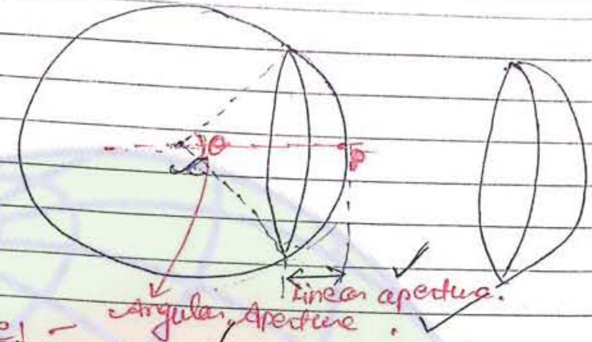

plane mirror
Convex mirror
Polish points
Concave mirror
paint
Sphere

Start

1st Choice

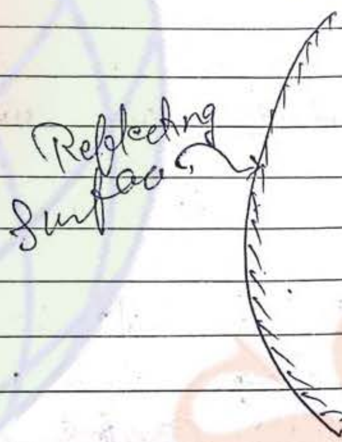
Spherical mirror

Page No. 39
Date / /



Types -

a) Concave mirror b) Convex mirror



(Concave उधर से दिखे)

Spherical mirror is a Part of holosphere whose one of the surface is reflecting surface.
If the reflecting surface is Inside than the mirror is concave.
and if outside the mirror is convex.

Some basic terms of spherical mirror:-

1) Centre of Curvature (C)   2.) Radius of Curvature (R)
3) Aperture   IV) Pole (P)
V) Principal axis   VI) Focus (F)
VII) Focal length (f)

1st Choice

1) Centre of Curvature(C) :- It is the centre of sphere from where mirror has been made.

2) Radius of curvature :- (R)
It is the radius of sphere from where mirror has been made

Aperture → (I) Linear Aperture
→ (II) Angular Aperture.

The aperture of spherical mirror give the Information about it's size.

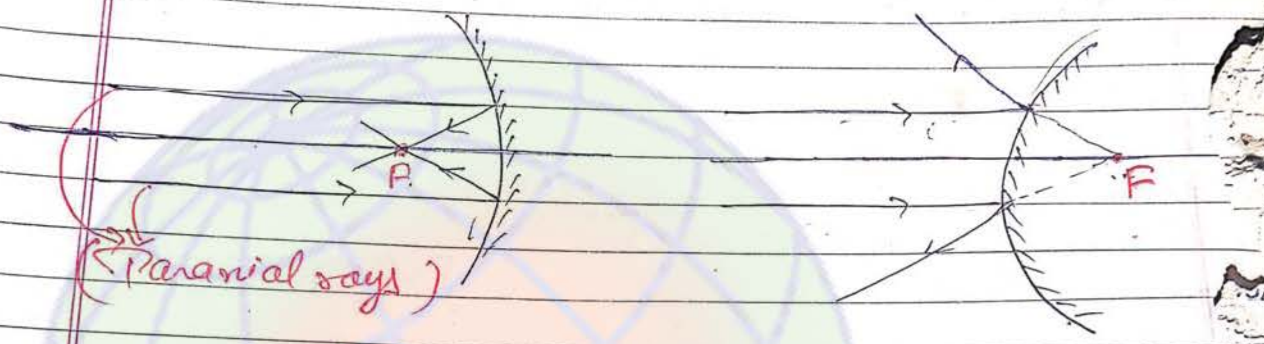
It is dimension of mirror

4) Pole → (P) ⇒ It is the Point on the Surface of spherical mirror where the line joining centre of Curvature and centre of circular section of spherical mirror Intercept.

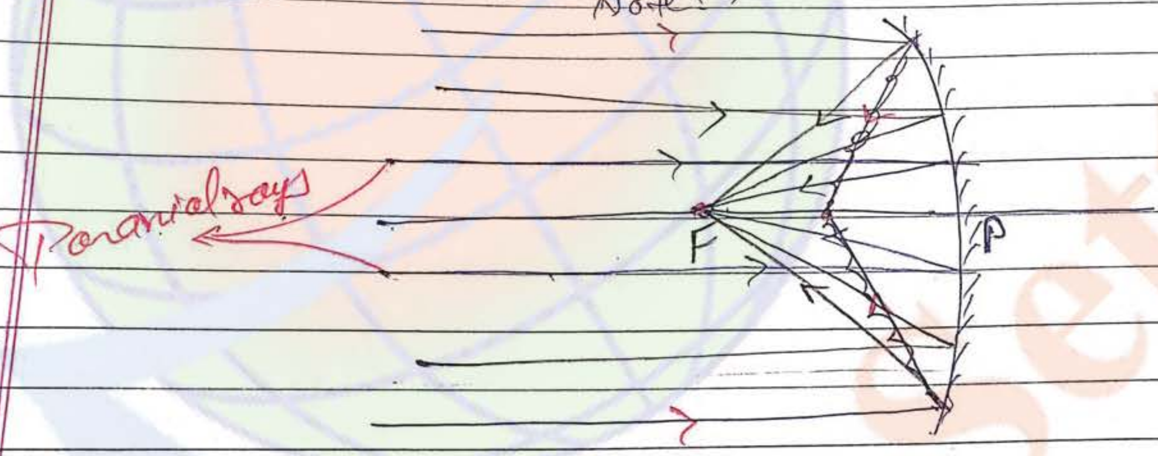
5) Principal axis →
It is the line joining centre of curvature and pole

6) Focus →

Concave mirror (Converging) (Diverging) Convex mirror.



Note :→



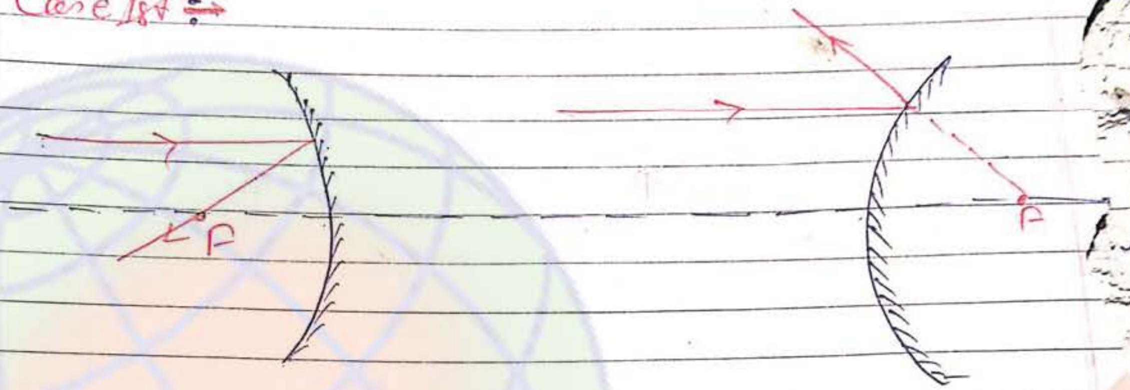
Definition:-

If the Incident rays are Parallel and closer to Principal axis (Paraxial rays) then after the reflection they either converse at a point on the Principal axis (Concave mirror) or appear to diverse from a point on the Principal axis (convex mirror). This point is called as focus.

VII) Focal length:-
It is the seperation b/w pole and focus

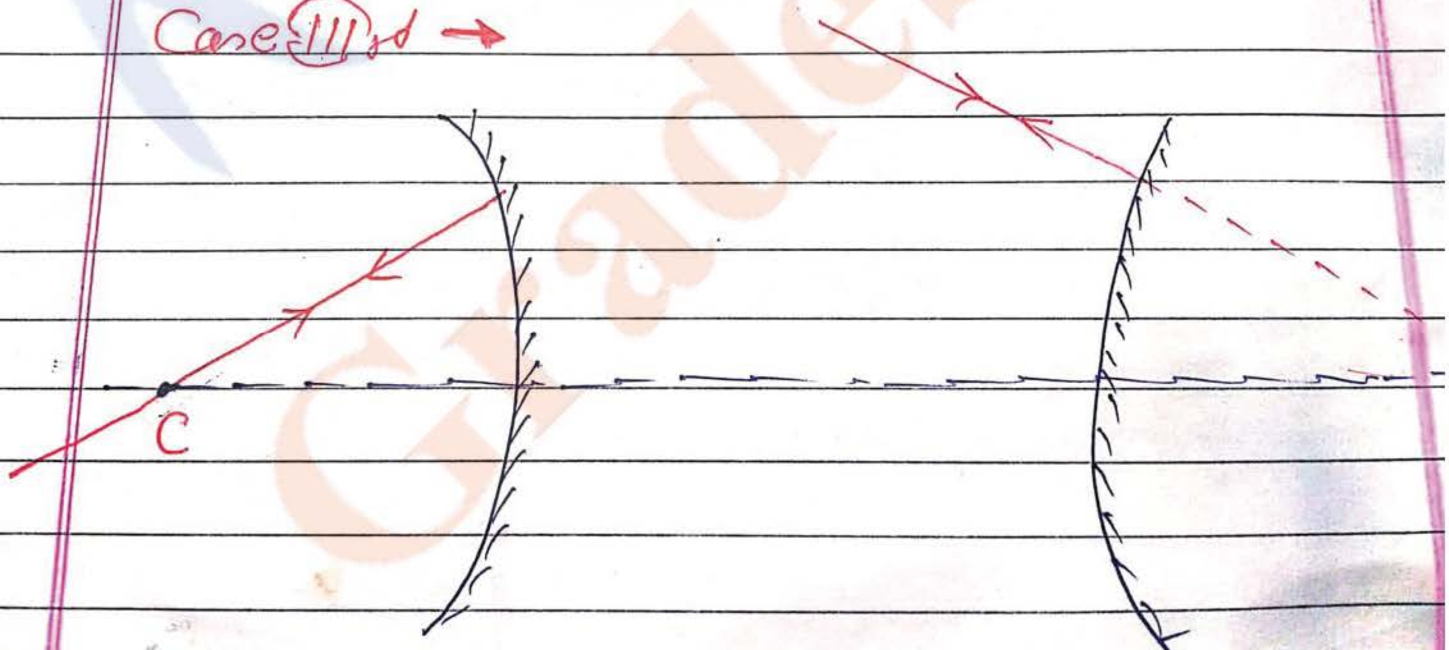
Fundamental rays for spherical mirror.

Case 1st :-

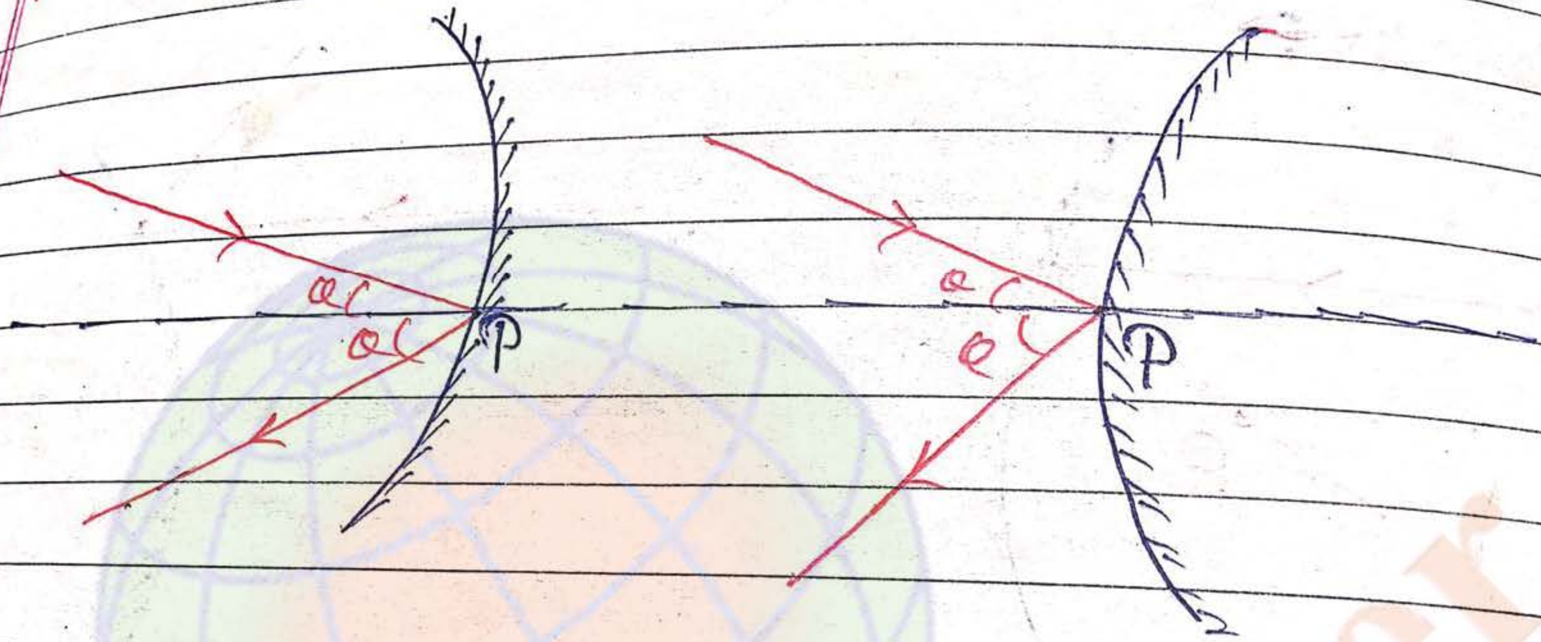


Case IInd →

Case IIIrd →

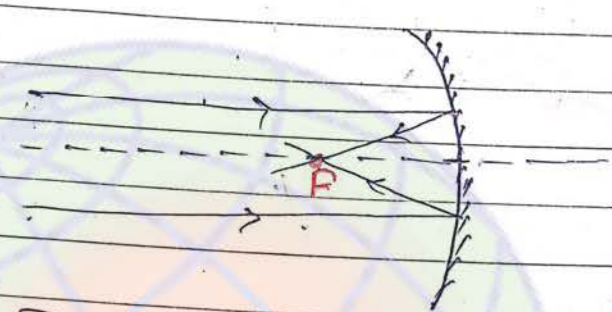


Case (IV) 10



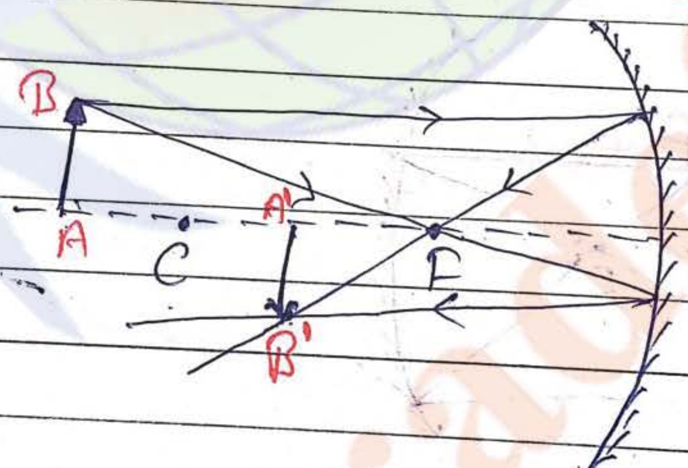
Ray diagram for concave mirror →

1.) If object is kept at "∞"



Position of Image :→ At F.
Nature ⇒ Real and Inverted
size ⇒ Highly diminished

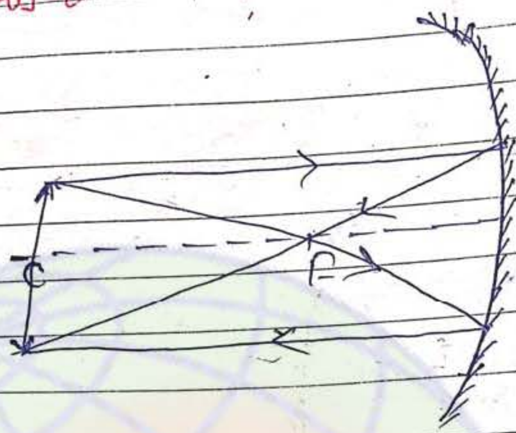
2.) when object is kept beyond "C".



Position of Image :→ B/w "F" and "C"
Nature :→ Real and Inverted
size :→ Smaller than object.

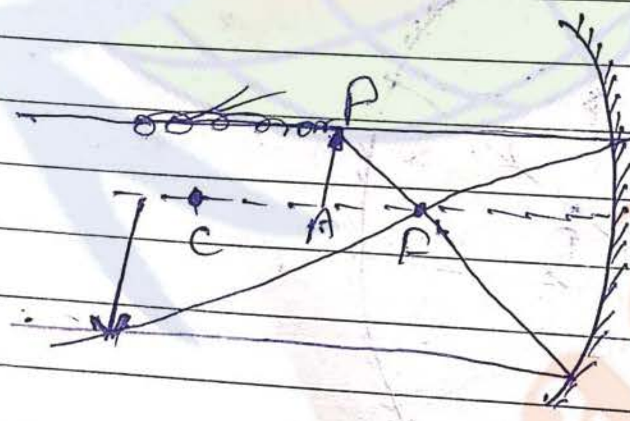
वास्तविक   छोटा

3.) If object is kept at "C".



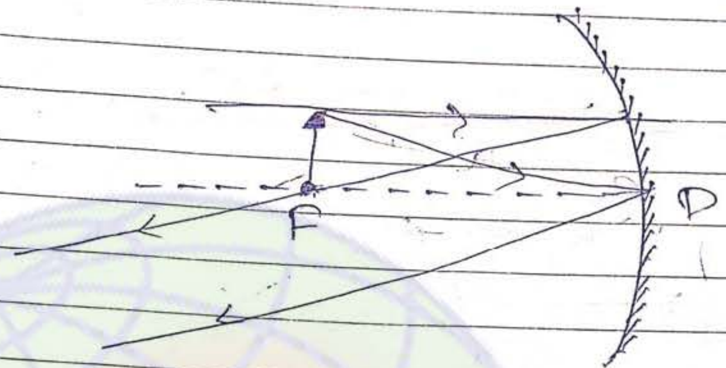
Position of Image :- At C itself
Nature of Image ⇒ Real and Inverted
Size :- Same as that of object.

4.) If object is kept b/w "C" and "F"



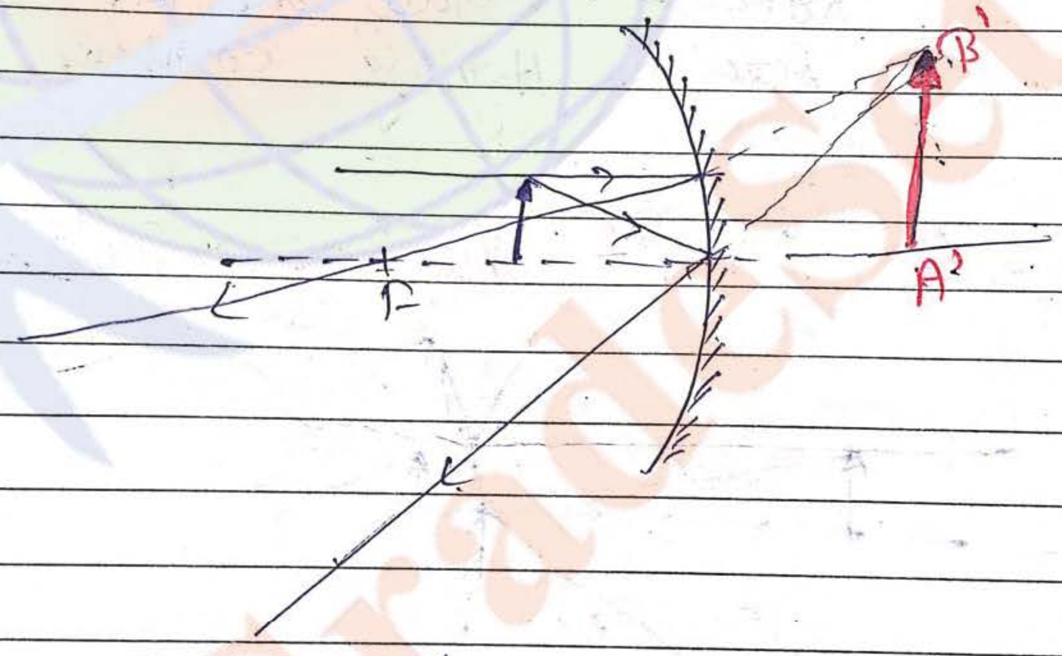
Position of Image Beyond C
Nature of Image :- Real and Inverted
Size :- large than object.

5.) If object is kept at "F"



Position of Image :- At ∞
Nature of :- Real and Inverted
Size :- Highly magnified.

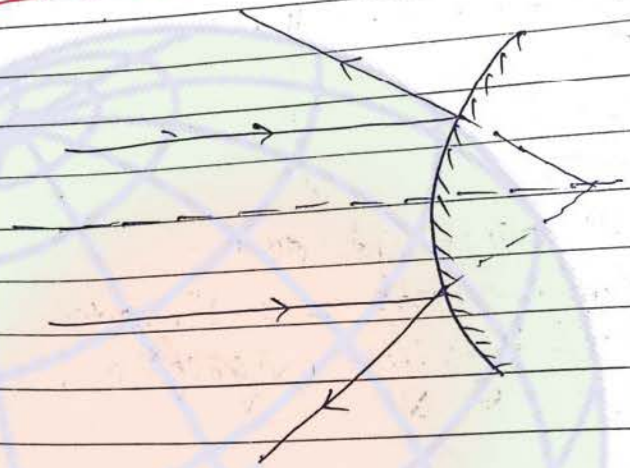
6.) If object is kept b/w "F" and Pole :-



Position of Image :- Behind the mirror
Size ⇒ large than object
Nature ⇒ virtual and erect

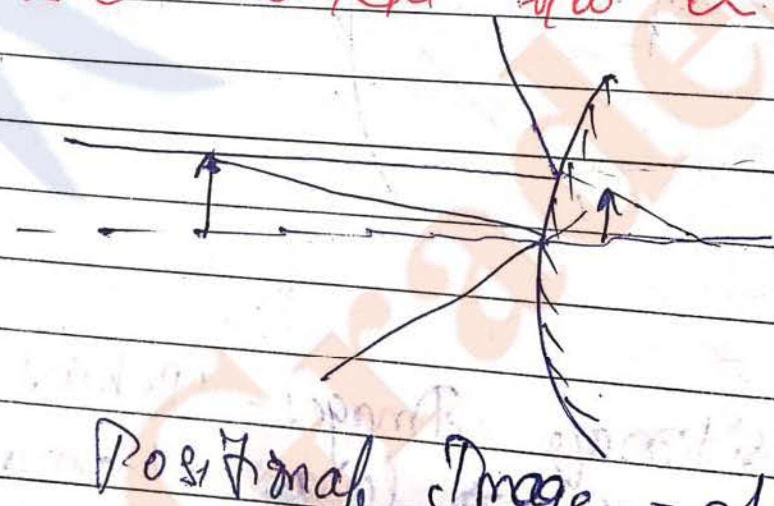
Ray diagram for convex mirrors –

1) If object is kept at "∞"



Position of Image :– F
Nature :– virtual and erect
Size :– Highly diminished

2) If object is kept b/w ∞ and Pole –



Position of Image = B/w F and pole.
Nature = virtual and erect
Size = smaller than object.

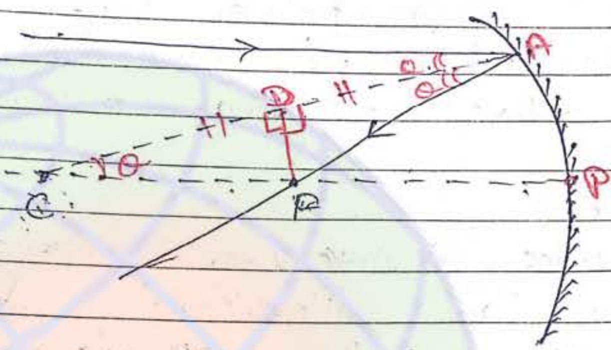
1st Choice

Page No. 49

Date / /

Board

Relation b/w focal length and Radius of curvature for the spherical mirror



$$CD = DA = \frac{R}{2}$$

In ΔCDF

$$\cos\theta = \frac{CD}{FC} = \frac{R}{2(FC)}$$

$$FC = \frac{R}{2}\sec\theta \quad —(1)$$

$$PF = PC - FC$$

$$f = R - \frac{R}{2}\sec\theta$$

$$\boxed{f = R\left(1 - \frac{\sec\theta}{2}\right)}$$

- For Paraxial rays, $\theta \rightarrow$ "0",

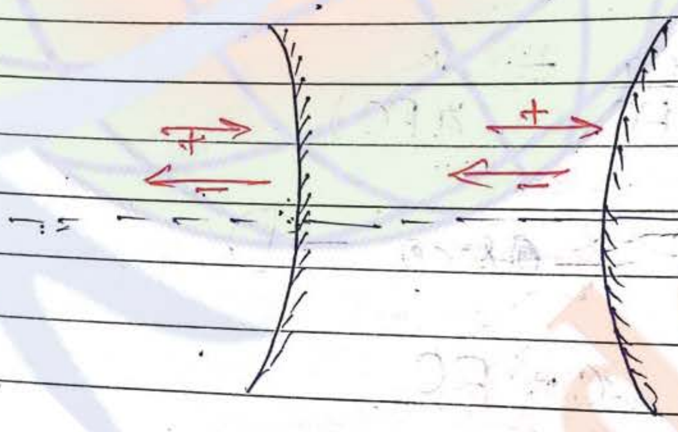
$$\boxed{f = \frac{R}{2}}$$

याद रखें

Sign Convension for spherical mirror's:-

All the seperation (of object, Image or focus) are measured from pole of the spherical mirror.

The distance is measured along the direction of Incident ray are taken with "+ve" sign and along the direction opp. to Incident ray distance are taken with -ve sign.

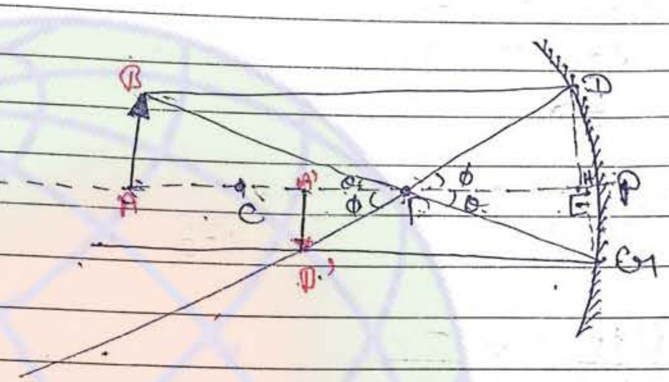


All the height's measured above the principal axis are taken with the "+ve" sign and height below the principal axis are taken with "-ve" sign.

1st Choice

→ नोट :- इस formula को, नहीं पढ़े छटे, तीन फेल्सों formula है। उसे पढ़ें।

Mirror formula for spherical mirror → (Concave mirror for)



$$\tan\theta = \frac{AB}{FA} = \frac{GH}{FH} \approx \frac{A'B'}{PF}$$

$$\Rightarrow \frac{AB}{A'B'} = \frac{FA}{PF} = \frac{PA-PF}{PF} \quad \text{—(1)}$$

$$\tan\phi = \frac{DE}{FE} = \frac{A'B'}{FA'}$$

$$\Rightarrow \frac{AB}{PF} = \frac{A'B'}{FA'}$$

$$\Rightarrow \frac{AB}{A'B'} = \frac{PF}{FA'} = \frac{PF}{PA'-PF} \quad \text{—(2)}$$

From eq(1) and (2)

$$\frac{PA-PF}{PF} = \frac{PF}{PA'-PF}$$

$PF = -f$

$PA = -u$

$PA' = -v$

from eq (iv)

$$\Rightarrow \frac{-u-(-f)}{-f} = \frac{-f}{-v-(-f)}$$

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

$$\Rightarrow -uv-uf-vf+f^2 = f^2$$

$$\Rightarrow uv = f(u+v)$$

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

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

$f \rightarrow$ focal length

$v \rightarrow$ ~~object~~ Image distance

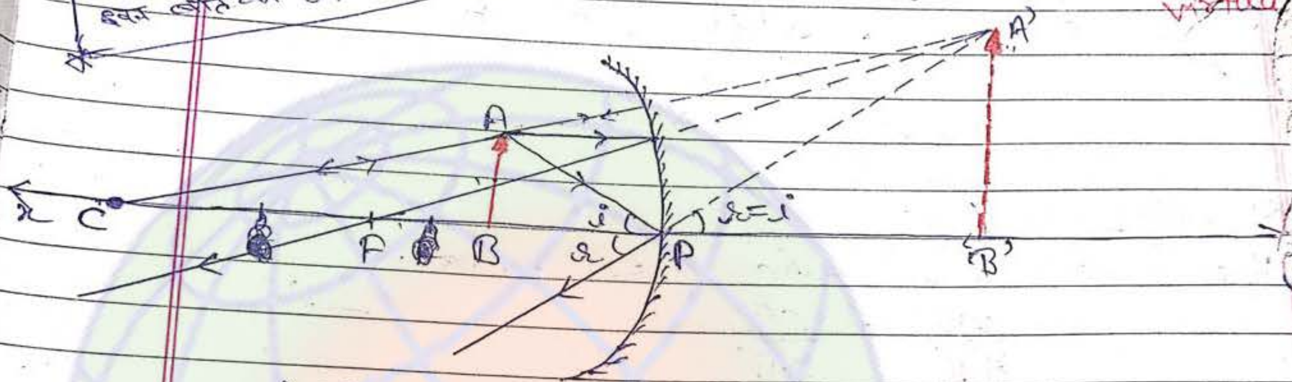
$u \rightarrow$ object distance

Notes ➡

This formula is used to find out Position of Image if the focal length of spherical mirror and the location of the object is given.

Mirror formula for Spherical mirror → (Concave mirror) virtual

नोट → किसी Ray की दिशा इंदु ... है इस बात का ध्यान रखें



ΔABC and $\Delta A'B'C$ are similar (एक बात Centre of curvature से)

$$\therefore \frac{AB}{A'B'} = \frac{CB}{CB'} \quad \text{--- (i)}$$

Again, ΔABP and $A'B'P$ are similar (एक बात Pole से Angle)

$$\frac{AB}{A'B'} = \frac{PB}{PB'} \quad \text{--- (ii)}$$

equating (i) and (ii),

$$\frac{CB}{CB'} = \frac{PB}{PB'}$$

But all distance along the principal axis be measured from pole of the mirror P,

$$\frac{PC - PB}{PC + PB'} = \frac{PB}{PB'}$$

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

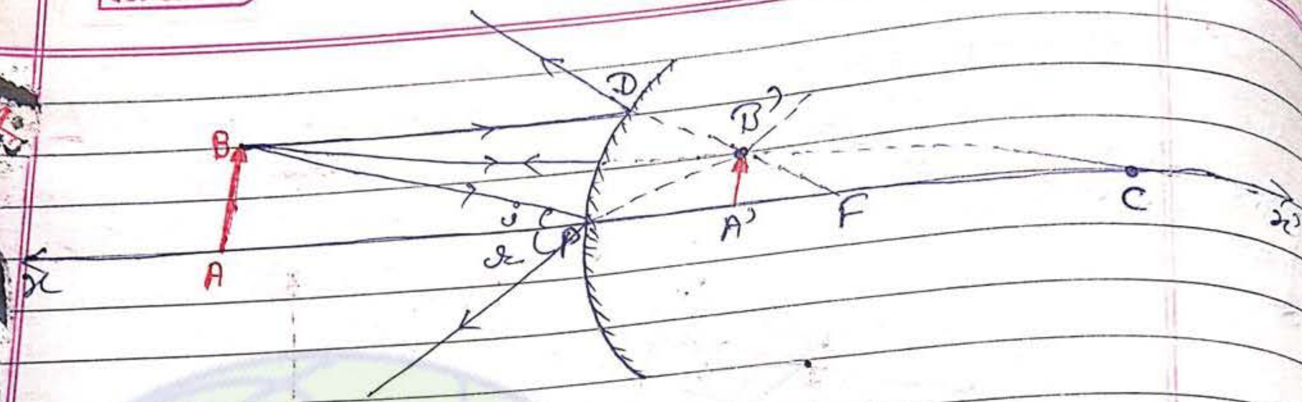
using new cartesian sign convention,

$$\frac{-R+u}{-R+v} = \frac{-u}{v}$$

$-vR + uv = uR - uv$ or $vR + uR = 2uv$

[illegible]ing by uvR,

$$\frac{1}{u} + \frac{1}{v} = \frac{2}{R} = \frac{2}{2f} \quad \text{or} \quad \frac{1}{v} + \frac{1}{u}$$



Proof:-

Here, ΔABC and $A'B'C$ are similar

$$\frac{AB}{A'B'} = \frac{CB}{CB'} \quad \text{—(i)}$$

Again, ΔABP and $A'B'P$ are similar.

$$\therefore \frac{AB}{A'B'} = \frac{PB}{PB'} \quad \text{—(ii)}$$

Now, from eq Ist and eq 2nd,

$$\frac{CB}{CB'} = \frac{PB}{PB'}$$

But all distances along the Principal axis should be measured from the pole of the mirror

$$\frac{PB + PC}{PC - PB'} = \frac{PB}{PB'}$$

using, new Cartesian sign convension.

$$\frac{-u+R}{R-v} = \frac{-v}{u}$$

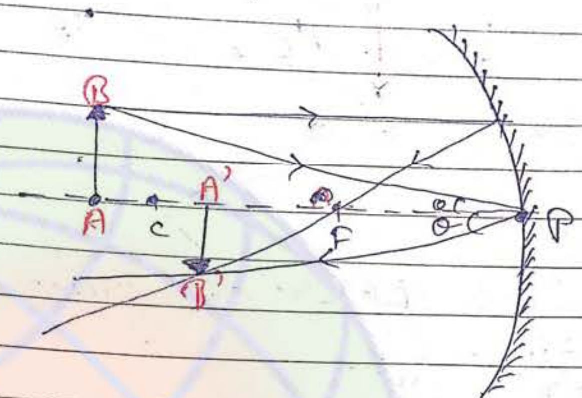
$$-uv + vR = -uR + uv \quad \text{or} \quad vR + uR = 2uv$$

Dividing by uvR,

we get

$$\frac{1}{u} + \frac{1}{v} = \frac{2}{R} = \frac{2}{2f} \quad \text{or} \quad \boxed{\frac{1}{u} + \frac{1}{v} = \frac{1}{f}}$$

linear magnification for Spherical m



$$\tan\theta = \frac{AB}{PA} = \frac{A'B'}{PA'}$$

$AB = H_o$

$A'B' = -H_I$

$PA = -u$

$PA' = -v$

$$\Rightarrow \frac{A'B'}{AB} = \frac{PA'}{PA}$$

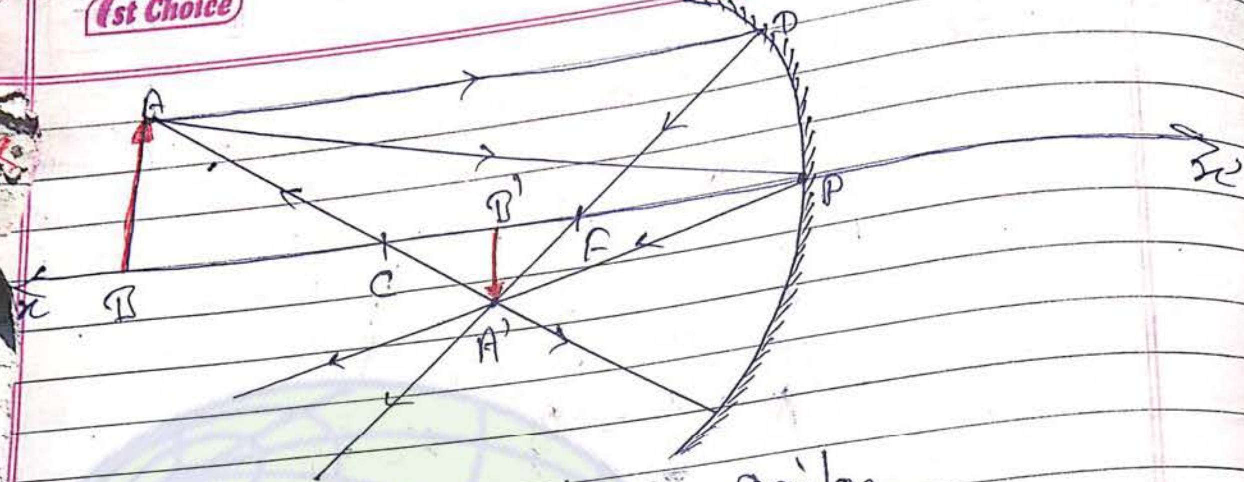
$$\Rightarrow \frac{-H_I}{H_o} = \frac{-v}{u}$$

$$\boxed{m = \frac{H_I}{H_o} = \frac{-v}{u}}$$

Image distance

object distance

$$m = \frac{H_I}{H_o} = \frac{-v}{u} = \frac{f}{f-u} = \frac{f-v}{f}$$



In $\triangle ABC$ and $\triangle A'B'C$ are similar

$$\frac{AB}{A'B'} = \frac{CB}{CB'}$$

Again, As $\triangle ABP$ and $A'B'P$ are similar;

$$\frac{AB}{A'B'} = \frac{PB}{PB'}$$

Equating (1) and (2), $\frac{CB}{CB'} = \frac{PB}{PB'}$

But all distances along the Principal axis should be measured from the Pole of the mirror.

$$\therefore \frac{PB - PC}{PC - PB'} = \frac{PB}{PB'}$$

using new cartesian sign convention,

PB(object distance) $= -u$; PF(focal length) $= -f$

PB' (Image distance) $= -v$; PC(radius of curvature) $= -R$

$$\frac{-u+R}{-R+v} = \frac{-u}{-v} = \frac{u}{v}$$

$uv + vR = -uR + uv$ or $vR + uR = 2uv$

$uR + vR = 2uv$

Dividing by uvR, $\frac{1}{u} + \frac{1}{v} = \frac{2}{R}$

But $R = 2f$

$$\frac{1}{v} = \frac{2}{2f} \text{ or } \boxed{\frac{1}{u} + \frac{1}{v} = \frac{1}{f}}$$

Q The radius of curvature of a concave mirror is 30cm, find out where the object has be placed so that Image is five times magnified.

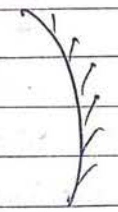
Sol

$f = 15cm$

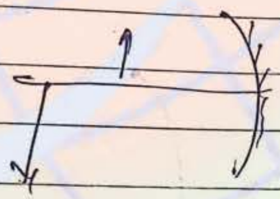
$v = ?$

$H_i = 5H$

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



If Image is real



$m = -5$

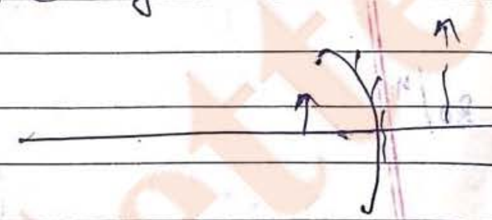
$R = -30$

$f = -15$

$m = -5 = \frac{-15}{-15-u}$

$u = -18cm$

If Image is virtual



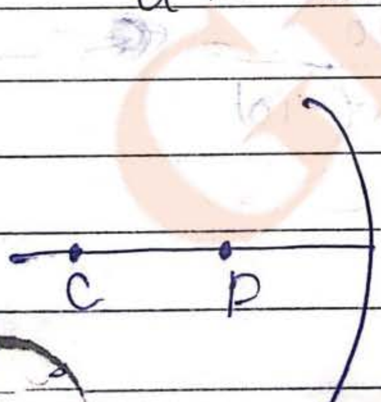
$m = 5$

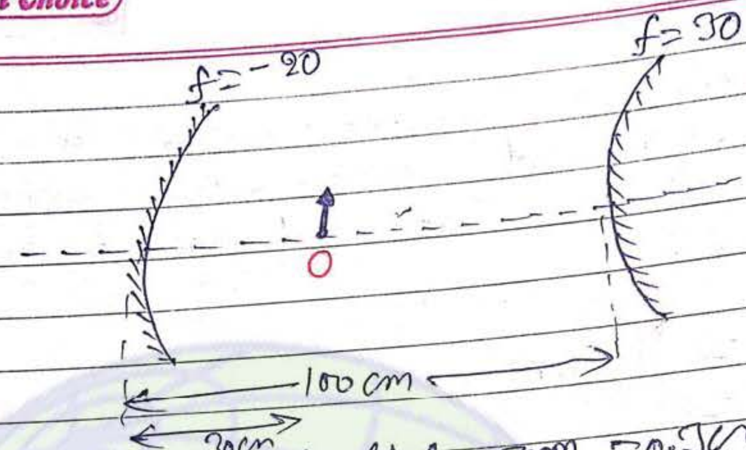
$R = -30$

$f = -15$

$m = 5 = \frac{-15}{-15-}$

$u = -12cm$

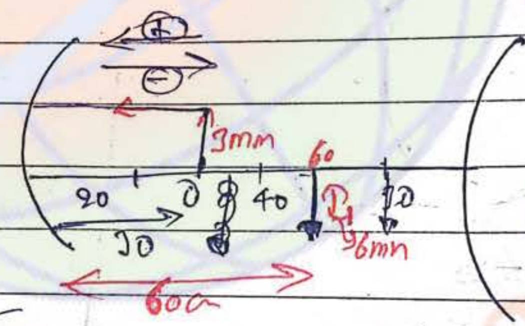




height of object = 3mm = 0.3cm

In the figure shown the first reflection is taking place through concave mirror and 2nd reflection through convex mirror. Find out the height of Image formed after two reflection.

30/4



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

$u = -30cm$

$f = -20cm$

$$m = \frac{f}{f-u} = \frac{-20}{-20-(-30)} = -2 = \frac{-v}{u} = \frac{-v}{-30}$$

$$\boxed{v = -60cm}$$

For reflection through convex mirror:

$u = -40cm$
$f = 30cm$

$$m_2 = \frac{f}{f-u} = \frac{30}{30-(-40)} = \frac{3}{7} = \frac{-v}{u} = \frac{-v}{-40}$$

$$\boxed{v = \frac{120}{7} cm}$$

$$\frac{H_I}{-6} = \frac{3}{7}$$

$$\boxed{H_I = \frac{-18}{7} mm}$$

Note

$$\boxed{m_{net} = m_1 \times m_2 \times m_3 \times - - -}$$

Proof:- According to above questo:-

$m_1 = -2$

$m_2 = \frac{3}{7}$

$m_{net} = \frac{-6}{7}$

$$\frac{H_{I_{final}}}{H_0} = \frac{-6}{7}$$

$$\frac{}{3} = \frac{-6}{7} \Rightarrow H_I = \frac{-18}{7} cm$$

In b/w the two mirror ~~...~~ an object has to be kept on the Principal axis find out it's Position ~~of~~ of the Image formed so that Image ~~so that Image~~ after ~~after~~ two reflection, 1st through concave and 2nd through convex is two times magnified.

80/4 2

$\frac{f}{h_0}$

$u = ?$
$f = -30cm$

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

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

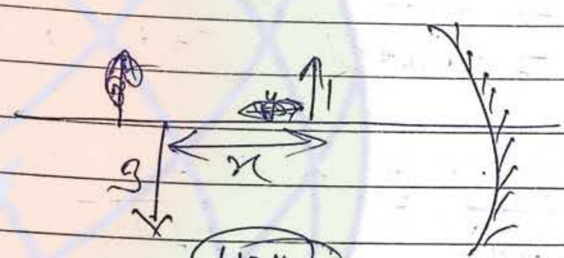
$m = \frac{f}{f-x} = \frac{-30}{-30-x}$

$= \frac{30}{30+x}$

—V—

Eg. 9. A concave mirror form the real Image on the screen having size thrice that of object. Now the object and screen are moved until the Image size becomes that of object. If the shifting of object is 6cm then find out focal length of the mirror as well as shifting of screen.

Sol^n



$m = -3$

$f = ?$

$\frac{h_i}{h_o} = -3$

$\frac{x - h}{3h} = -3$

$\boxed{h = -9h}$

$\boxed{f = 9/2}$

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

$\frac{f}{f-u} = -3$

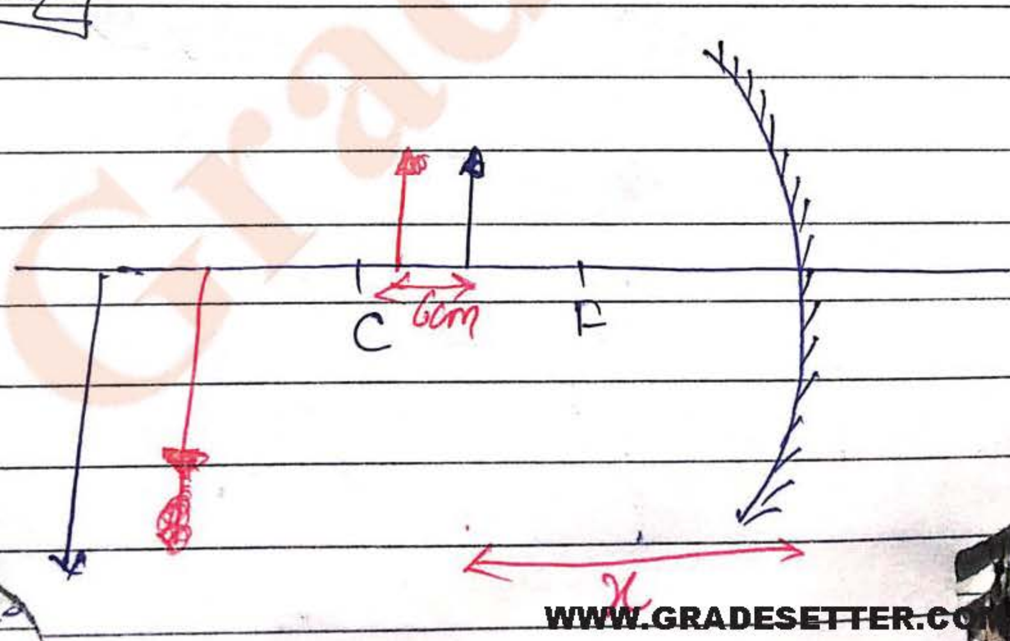
$\frac{f}{f-6} = -3$

$f = -3(f-6)$

$f = -3f + 18$

$4f = 18$

$f = ?$



$$m = -3 = -\frac{v}{u} = -\left[\frac{v}{-x}\right]$$

$$\boxed{v = -3x}$$

$$u = -(x+6)$$

$$m = -2 = \frac{f}{f-u}$$

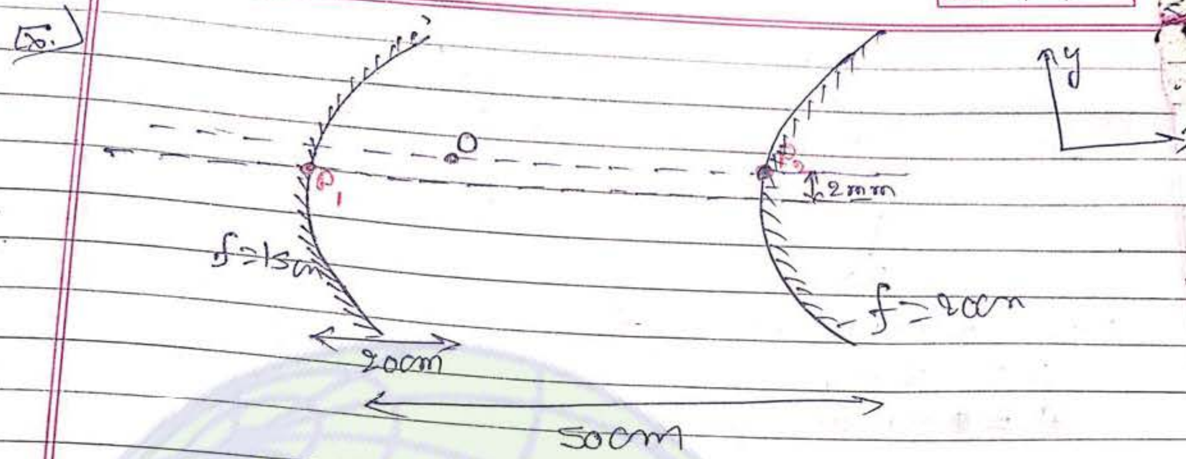
$$-2 = \frac{-f}{-f-[-x-6]} = \frac{-f}{-f+x+6} \quad \text{--- (1)}$$

$$-3 = \frac{-f}{-f-(-x)} = -3 = \frac{-f}{-f+x} \quad \text{--- (2)}$$

$$\boxed{f = 36}$$ → sign convention से पहले ही put किये हैं

$\boxed{\text{Shifting} = 36\text{cm}}$

Q.



Taking P_1 as origin find out x and y-coordinates of the image which is formed after two reflection (first through concave and 2nd through convex)

Sol/n For concave mirror.

$f = -15cm$

$u = -20$

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

$\frac{1}{-15} + \frac{1}{20} = \frac{1}{v}$

$\frac{1}{v} = \frac{-4+3}{60}$

$\frac{1}{v} = \frac{-1}{60}$

$\boxed{v = -60}$

$m = \frac{+60}{-20}$

$= -3$

→ 2mm हीमानें

$\frac{h_i}{2} \Rightarrow \boxed{h_i = -6mm}$

~~f = 20cm~~

Now!-

$-3 = -\left[\frac{+v}{-20}\right] \Rightarrow \boxed{v = -60}$

For convex –

$u = 10cm$

$f = 20 cm$

$m_2 = \frac{20}{20-10} = 2 = \frac{H_I}{-8} \Rightarrow \boxed{H_I = -16mm}$

$2 = \frac{-v}{10} \Rightarrow \boxed{v = -20cm}$

$(30cm, -14mm)$

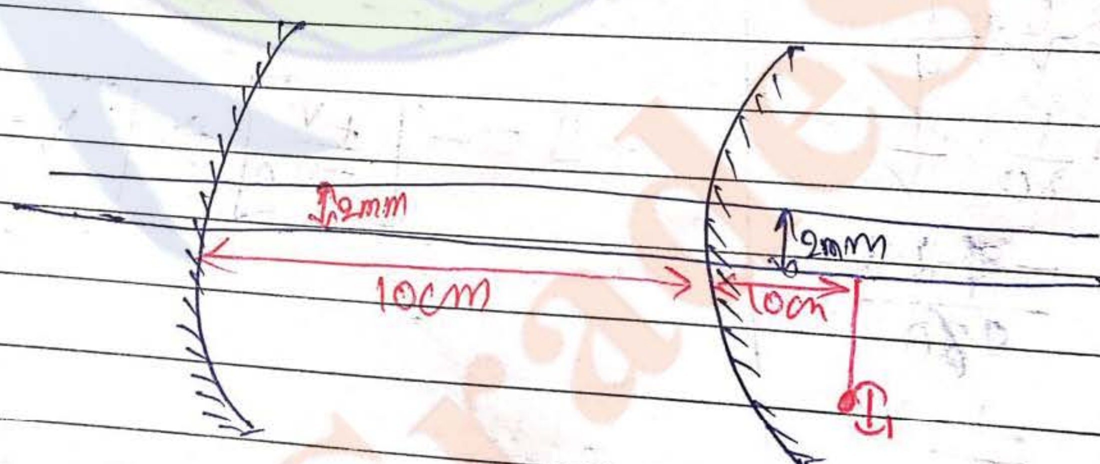
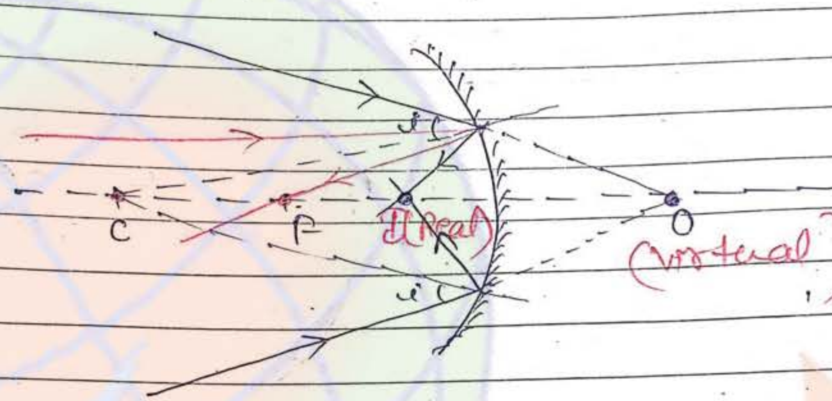


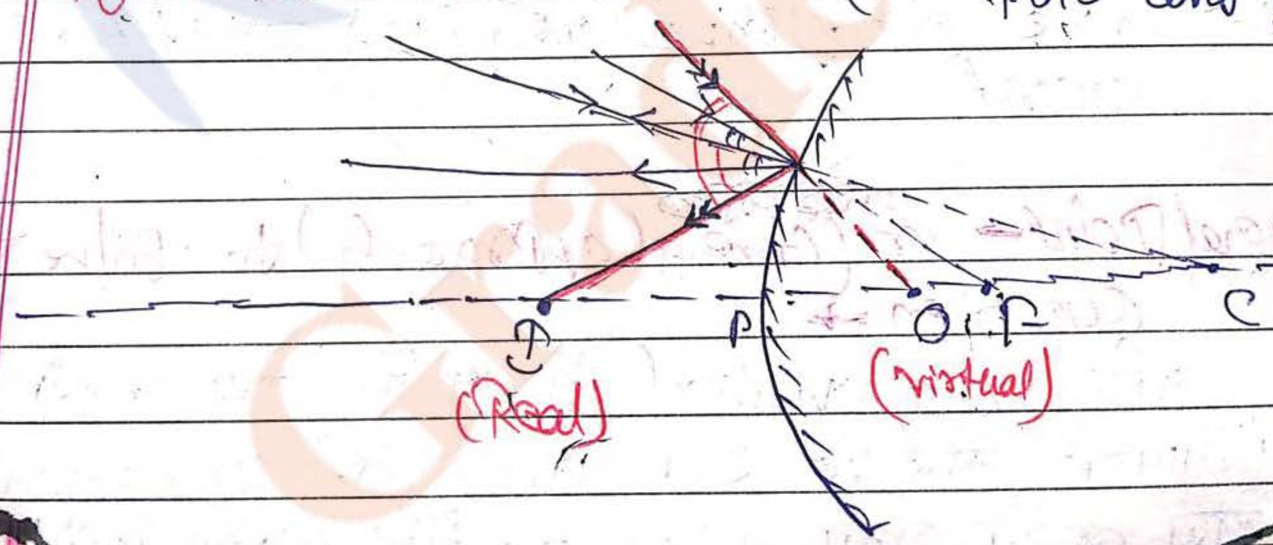
Image formation by the spherical mirror's object is virtual ⇒

1) If mirror is Concave ⇒



For the virtual object concave mirror always fo... the real Image which is formed b/w "focus and ...

2) If mirror is Convex → (when object lying ... Pole and foc...



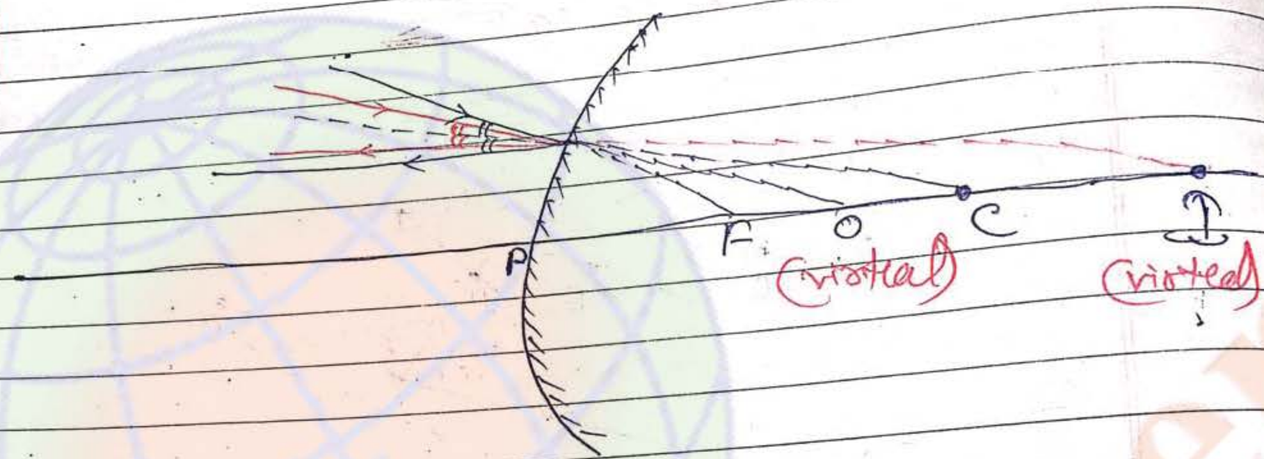
... the virtual object is lying b/... then, it's real Image ...

1st Choice

Date

of the convex mirror and Image formed is also magnified. (याद रखें) – concave mirror की जब इस object को Pole और focus के बीच में रखते हैं।

☆ when object lying b/w focus and Infinity



If the virtual object is lying b/w focus and the Infinity then Image form will always be virtual

• इस में concave की छोटी पाँच case होंगी।

-ces → solve sheet (Ex-2) (Ques no. 19) based on this concept

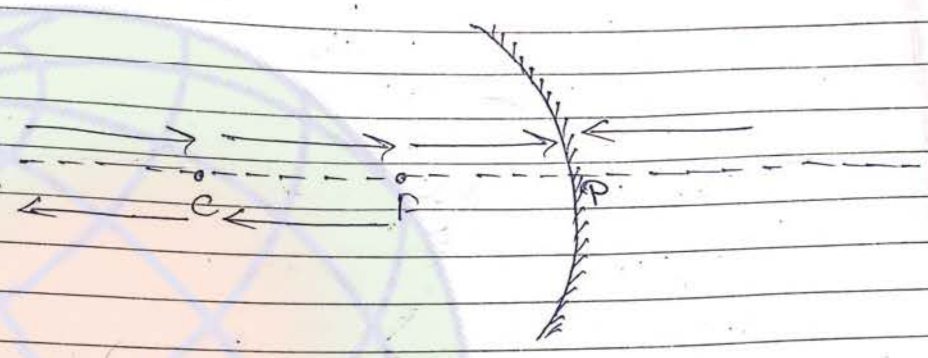
General Point → or (General approach) to solve the Question →

यदि object virtual है और इस case में आपको कोई सा एक mirror (जैसे concave या conve- द्वारा बनने वाला Image का size, nature Posi- है तो आप इस case में mirror solve कर ले फिर ... इस प्रकार ... जाता है

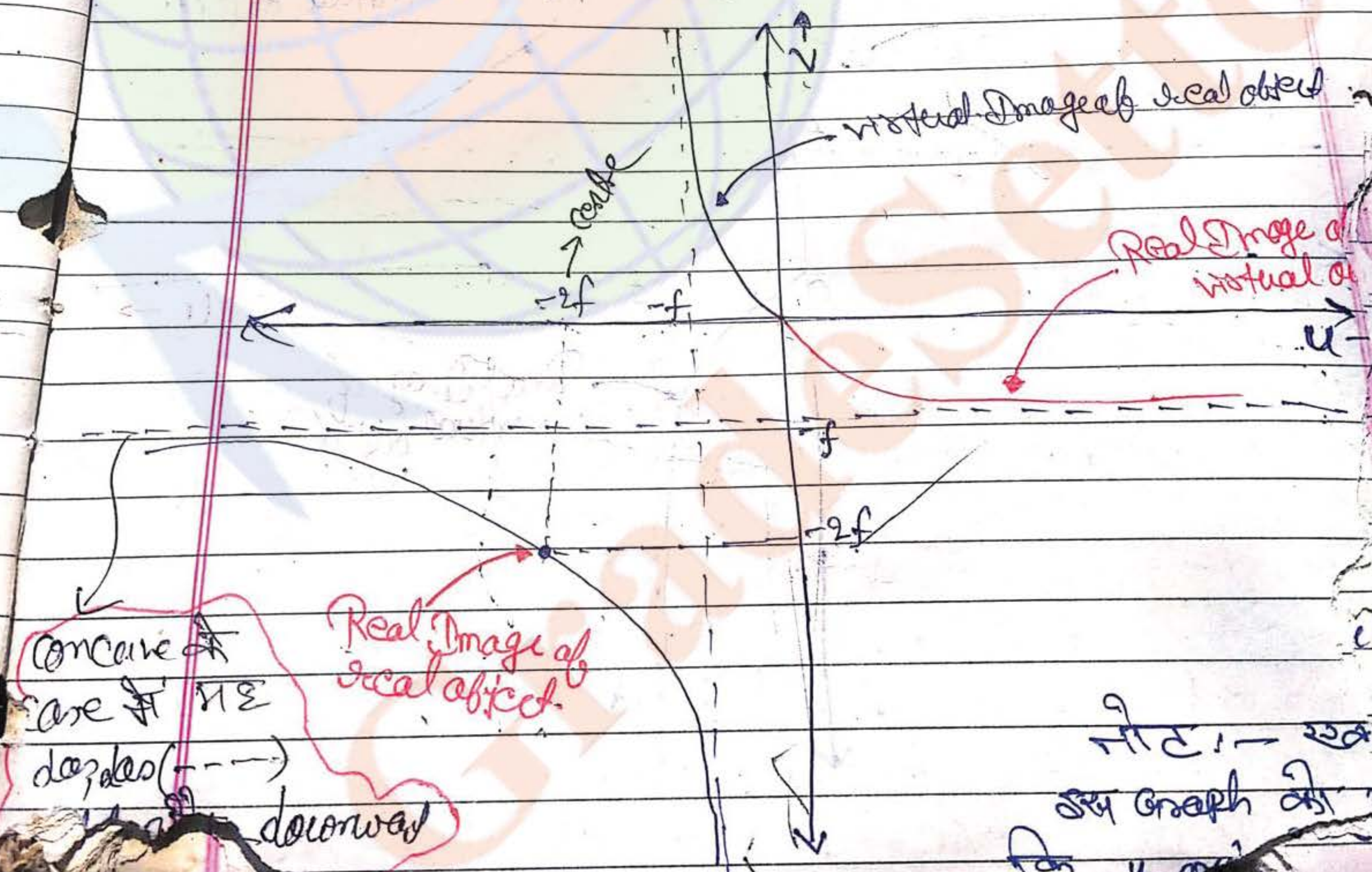
1st Choice

Page No. 67
Date / /

Graph b/w "u" and "v" for the concave mirror →

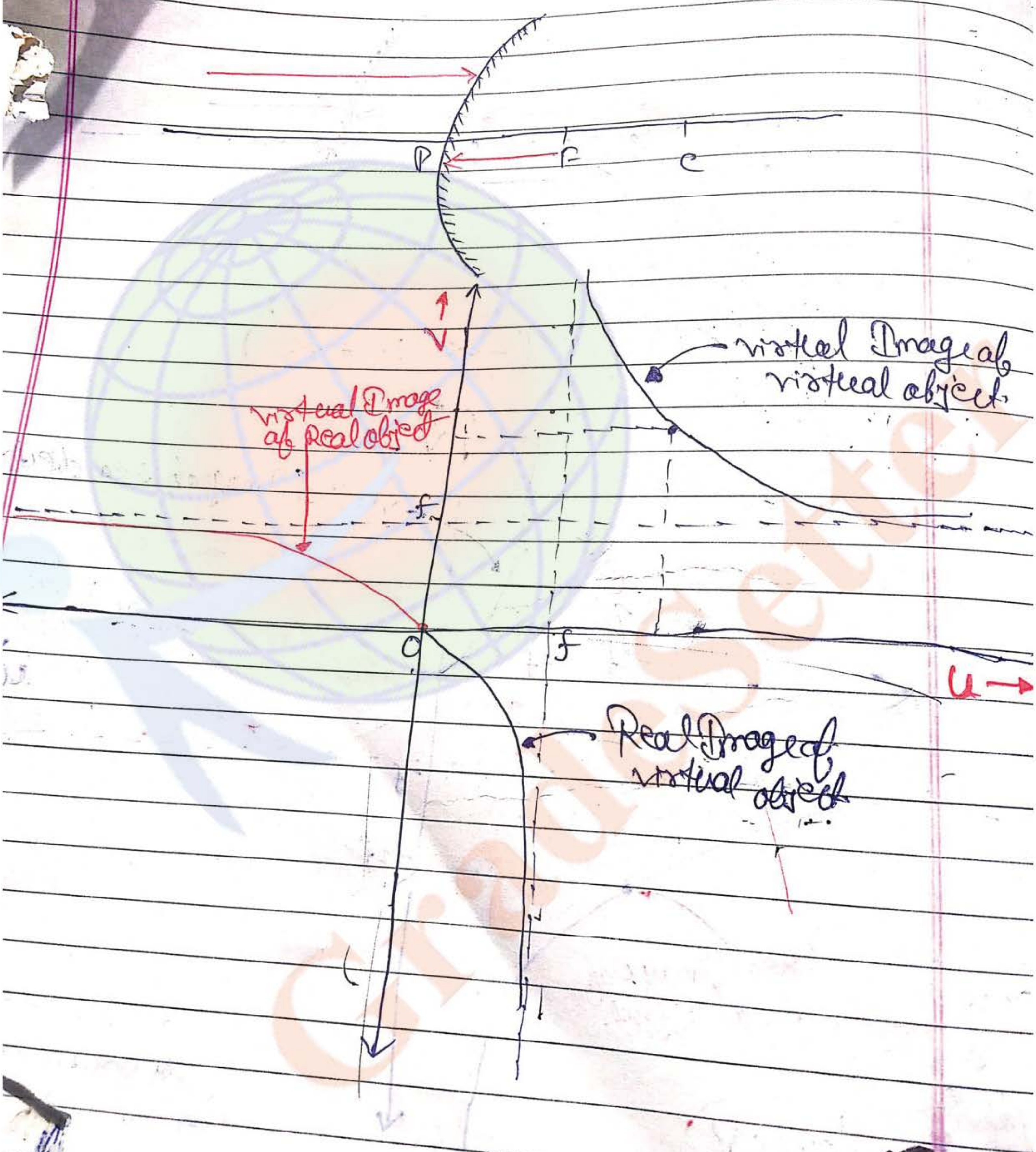


(−∞ to +∞)



नोट :- इस
इस Graph को
कि y-a
Image of
है रहा

... u and v for the convex mirror →



Longitifiduenal magn

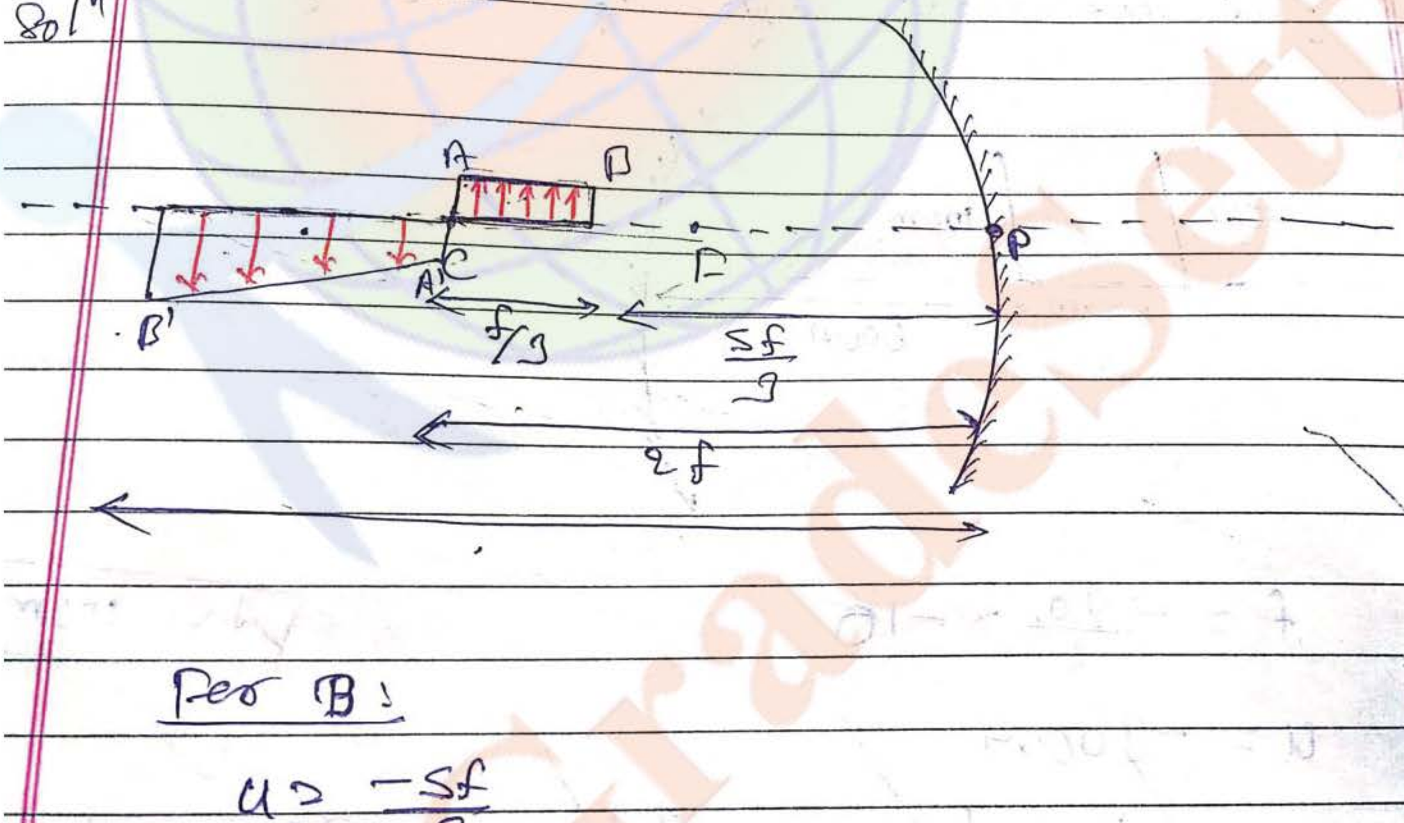
If the object is lying parallel (or along) principal axis, then the ratio of length of the Image to the length of the object is called as longitiuidunal magnification

so,

$$m = \frac{\text{length of Image}}{\text{length of object}} = \frac{l_i}{l_o}$$

Ex.) A thin rod of length $f/3$ is lying along the principal axis of a concave mirror of focal length "f" so that the image which is real and elongated just touches the rod. Find the longitudinal magnification

Sol^n



For B:

$$u = \frac{-5f}{3}$$

$$f = -f$$

$$\frac{1}{v} - \frac{1}{5f} = \frac{-1}{f} \Rightarrow \boxed{v = \frac{-5f}{2}}$$

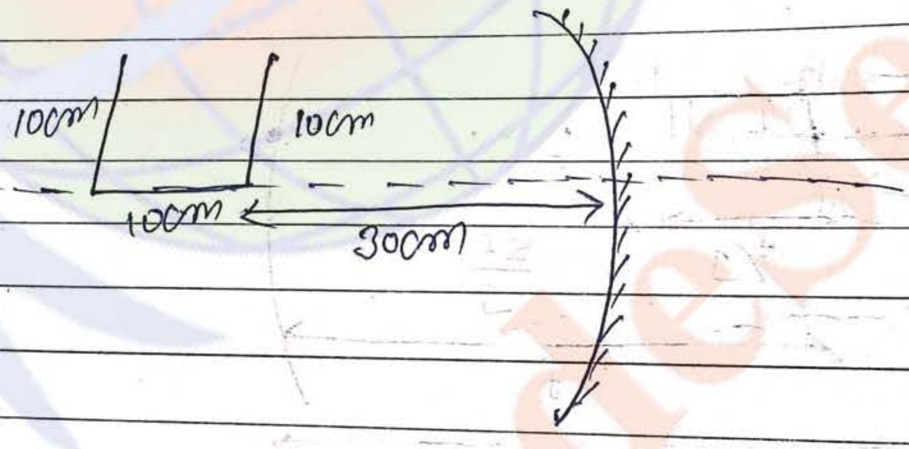
length of Image $= \frac{5f}{2} - 2f = \frac{f}{3}$

length of ~~ob~~ object $= \frac{f}{3}$

longitudinal magnification $= \frac{f/2}{f/3}$

$= \frac{3}{2}$

Q. A ~~....~~ "U" shaped wire is placed before a concave mirror having radius of curvature "20cm" find out total length of the Image.



$f = -\frac{20}{2} = -10$

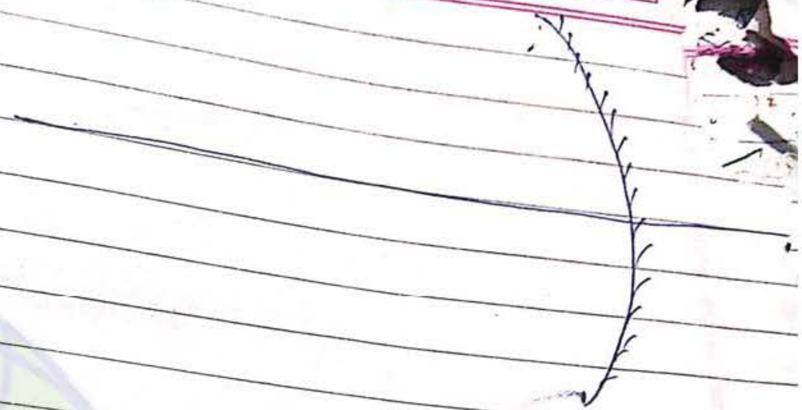
$u = -30cm$

$\frac{1}{v} = \frac{1}{-10} + \frac{1}{30} \Rightarrow \frac{-3+1}{30} = \frac{-2}{30} = \frac{-1}{15}$

$v = -15$

$\boxed{\text{Ans} = 100cm}$

$\frac{24 \times 5}{120}$



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

$h_i = \frac{+15}{-30} \times 10$

$\Rightarrow -5$

$\Rightarrow$

$u = -40$

$f = -10$

$\frac{1}{v} = \frac{-1}{10} + \frac{1}{40}$

$= \frac{-8 + 3}{120}$

$= \frac{-5}{120}$

24

$v = -24$

$\frac{h_i}{h_o} = \frac{+24}{-40}$

$h_i = \frac{24}{-40} \times 10$

$h_{i_2} = -6$

$\frac{l_i}{l_o} = \frac{v^2}{u^2}$

spherical mirror

Here we are assuming the pole of sp mirror as the origin of co-ordinate all the distances are defined with pole.

Along x-axis $\Rightarrow$

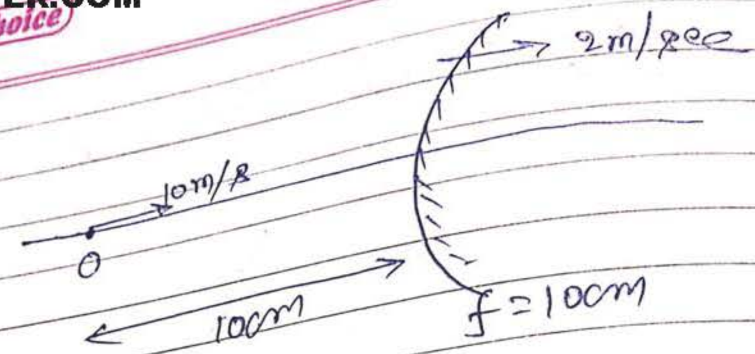
$$\frac{1}{x_{Im}} + \frac{1}{x_{om}} = \frac{1}{f}$$

Differentiate w.r.t. time,

$$\Rightarrow \frac{1}{x_{Im}^2}\frac{dx_{Im}}{dt} - \frac{1}{x_{om}^2}\frac{dx_{om}}{dt} = 0$$

$$\Rightarrow \vec{V}_{Im(x)} = -\left(\frac{x_{Im}}{x_{om}}\right)^2 \vec{V}_{om(x)}$$

$$\boxed{\vec{V}_{Im(x)} = -m^2 \vec{V}_{om(x)}}$$



find the vel. of Image at the Instant shown.

Sol^n

$$\frac{dx}{dt} = 10$$

$$\frac{dy}{dt} = 2 \quad , \quad \frac{dZ}{dt} = ?$$

$$u = -10$$

$$f = 10$$

$$\cancel{\frac{1}{x^2}\,10 + \frac{1}{y^2}\,2 = \frac{1}{10}}$$

$$m = \frac{10}{10-(-10)} = \frac{1}{2}$$

$$V_I - 2 = -\left(\frac{1}{4}\right)\left(10-2\right)$$

$$V_I - 2 = -2$$

$$\boxed{V_I = \text{Zero}}$$

* vel. of Image along y-axis →

$$m = \frac{y_{Im}}{y_{om}} = \frac{f}{f-u}$$

$$y_{Im} = \left(\frac{f}{f-u}\right) y_{om}$$

Differenciat. w.r.t. time.

$$\frac{d y_{Im}}{dt} = \left(\frac{f}{f-u}\right) \frac{d y_{om}}{dt} + y_{om} \frac{d}{dt}\left(\frac{f}{f-u}\right)$$

$$\boxed{\vec{V}_{Im(y)} = m \vec{V}_{om(y)} + \frac{y_{om} f}{(f-u)^2}\left(\frac{du}{dt}\right)}$$

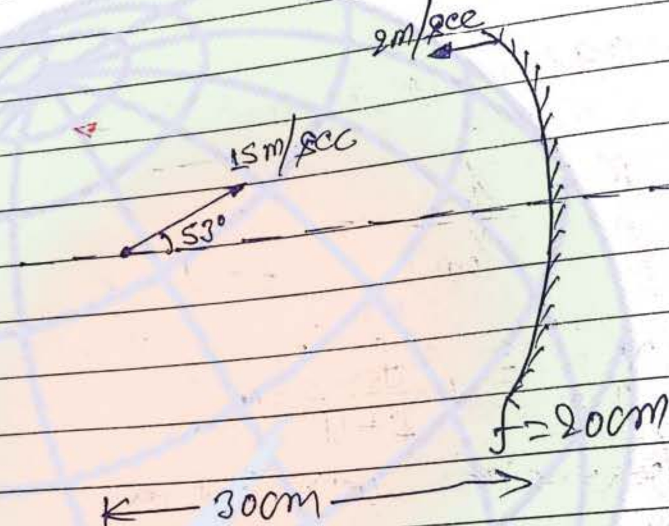
Here ↳ (Problem is Present to self c.u page →

$V_{Im(y)}$ ⇒ vel. of Image w.r.t mirror in y-a

Note → If object is lying on Principal axis.

then " $y_{om} = 0$

$$\boxed{\vec{V}_{Im(y)} = m\,\vec{V}_{om(y)}}$$



Find out the velocity of Image.

Along y-axis → Here object lying on the Principal axis, so

$$V_{om} = 0$$

so,

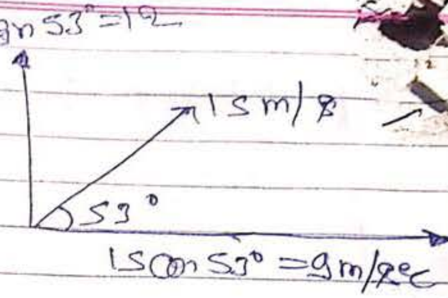
$$\vec{V}_{Im(y)} = m\,\vec{V}_{om(y)}$$

$$m = \frac{f}{f-u} = \frac{-20}{-20+30} = \frac{-\cancel{20}}{\cancel{10}} = -2$$

Now

$$V_{Im(y)} = (-2)\times(12)$$

Along x-axis ⇒



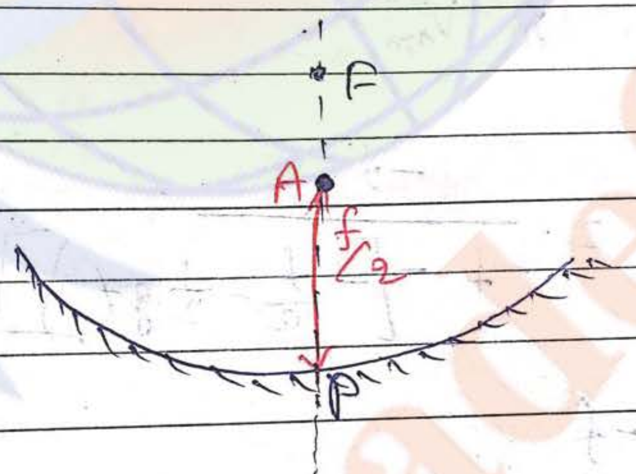
$\vec{V}_{Im(x)} = -m^2 \vec{V}_{om(x)}$

$\left(\vec{V}_I - (-2)\right) = -(4)\left[9 - (-2)\right]$

$V_I + 2 = -44$

$\boxed{\vec{V}_I = -46\hat{i}}$ Along x-axis.

So, Ans ⇒ $-46\hat{i} - 24\hat{j}$

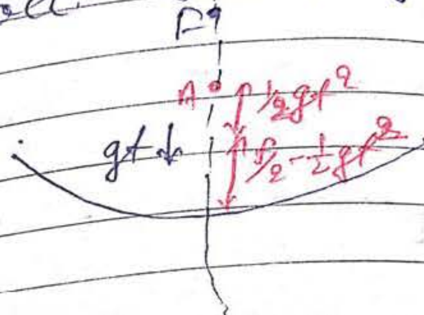


g → Acc^n due to

A particle is released from rest from p
"A". which is at the height f/2 from the
d out the time afte[r] ... vel. of Im
... max... and ab...

1st Choice

max. vel. of the Imag. f is the focal length of concave mirror. and 'g' is acc^n due to gravity



Sol^n $u = -f/2$

$\frac{dx}{dt} = 10\ m/s$

Initial vel $= 0$, vel is maximum $= ?$
$t = ?$

$$\cancel{m = \frac{-f}{-f-u} = \frac{-f}{-f+\frac{f}{2}} = \frac{2f}{3f} = \frac{2}{3}}$$

$$\cancel{\vec{V}_{Im} = -m^2 \vec{V}_{om}}$$

$$\vec{V}_{Im} = m^2 \vec{V}_{om}$$

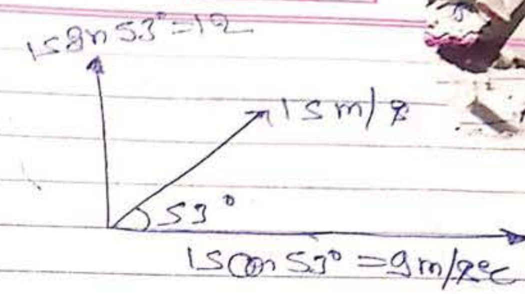
$$m = \frac{f}{f-u} = \frac{-f}{-f-\left[-\frac{f}{2}-\frac{1}{2}gt^2\right]}$$

$$m = \frac{-f}{-f+\frac{f}{2}-\frac{1}{2}gt^2}$$

$$m = \frac{2f}{f+gt^2}$$

V_{Im}

Along x-axis ⇒



$$\vec{V}_{Im(x)} = -m^2 \vec{V}_{om(x)}$$

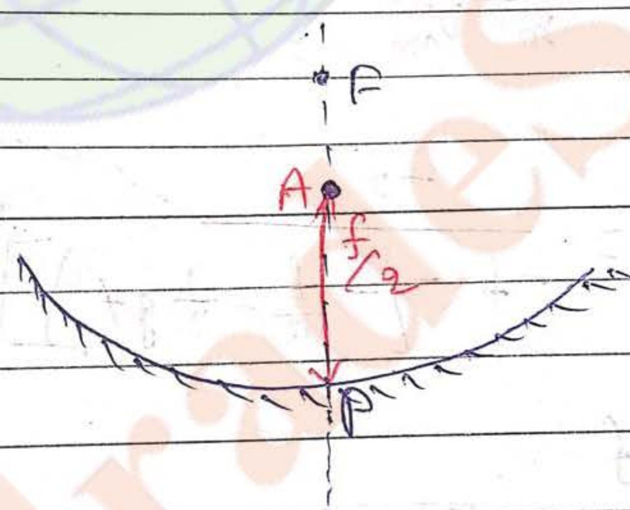
$$\left(\vec{V}_I - (-2)\right) = -(4)\left[9 - (-2)\right]$$

$$V_I + 2 = -44$$

$\boxed{\vec{V}_I = -46}$ Along x-axis.

So, Ans ⇒ $-46\hat{i} - 24\hat{j}$

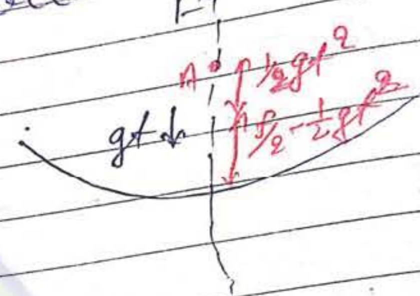
Ex



g → Accⁿ d

A particle is released from rest
"A". which is at the height f/2
d out the time aft

max. vel. of the Image
f is the focal length of concave mirror and 'g' is acc^n due to gravity



Sol^n $u = -f/2$

$\frac{dx}{dt} = 10\ m/s$

Initial vel $= 0$

$t = ?$, vel is maximum $= ?$

$$\cancel{m = \frac{-f}{-f-u} = \frac{-f}{-f+\frac{f}{2}} = \frac{2f}{3f} = \frac{2}{3}}$$

$$\cancel{\vec{V}_{Im} = -m^2 \vec{V}_{om}}$$

$$\vec{V}_{Im} = m^2 \vec{V}_{om}$$

$$m = \frac{f}{f-u} = \frac{-f}{-f - \left[-\frac{f}{2} - \frac{1}{2}gt^2\right]}$$

$$m = \frac{-f}{-f + \frac{f}{2} - \frac{1}{2}gt^2}$$

$$m = \frac{2f}{f + gt^2}$$

$$v_I = -\left[\frac{2f}{f+gt^2}\right]^2 gt = -\left[\frac{4f^2gt}{(f+gt^2)^2}\right]$$

$$\frac{d}{dt}(v_I) = 0$$

$$\because \frac{d}{dt}\left(\frac{a}{b}\right) = b\frac{d}{dt}(a) - a\frac{d}{dt}(b)$$

$$\Rightarrow \frac{(f^2+g^2t^4+2fgt^2)\,4f^2g - (4f^2gt)(4g^2t^3+4fgt}{(f+gt^2)^4}$$

$$\Rightarrow 4f^4g + 4f^2g^3t^4 + 8f^3g^2t^2 - 16f^2g^3t^4 - 16f^3g^2t^2$$

$$\Rightarrow 4f^4g - 12f^2g^3t^4 - 8f^3g^2t^2 = 0$$

$$\Rightarrow f^2 - 3g^2t^4 - 2fgt^2 = 0$$

$$\Rightarrow \boxed{3g^2t^4 + 2fgt^2 - f^2 = 0}$$ Let $t^2 = x$

$$\Rightarrow 3g^2x^2 + 2fgx - f^2 = 0$$

$$x = \frac{-2fg \pm \sqrt{4f^2g^2 + 12g^2 \ldots}}{6g^2}$$

$$t^2 = \frac{4fg - 2fg}{6g^2} = \frac{2gf}{6g^2}$$

$$\cancel{t = \sqrt{\frac{2f}{6g}}}$$

$$t = \sqrt{\frac{2f}{6g}}$$

then
this value of "t" is putting

$v_1 =$

Definition:-

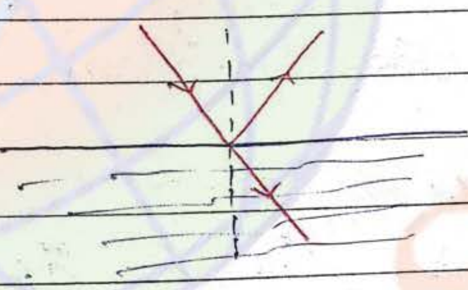
~~....~~ when the light is going from one medium to another medium then this Phenomenon is called as refraction.

Note:-

1) During the refraction of light the frequency does not change whereas the speed and wavelength accordingly change as per the given expression.

$$f = \frac{v}{\lambda} = \text{Constant}$$

2)



Refraction is not 100% it takes place with some reflection also.

* Refractive Index of a medium ⇒

It is defined in two different ways:-

1) Absolute refractive Index → The refractive ... of a medium ... defined ... respect ...

1st Choice

$$\boxed{\mu = \frac{\text{speed of light in air/vacuum}}{\text{speed of light in medium}} = \frac{c}{v}} \quad (\because c > v)$$

Absolute refractive Index of any medium is greater than one (because c is greater than v)

some Standard result -

$$\mu_{water} = \frac{4}{3}$$

$$\mu_{glass} = \frac{3}{2}$$

2) Relative refractive Index ⇒

This refractive Index of a medium is defined w.r.t any other medium except air/vacuum

$${}_{B}\mu_{A} = \frac{\mu_A}{\mu_B} = \frac{c/v_A}{c/v_B} = \frac{v_B}{v_A} = \frac{\lambda_B}{\lambda_A}$$

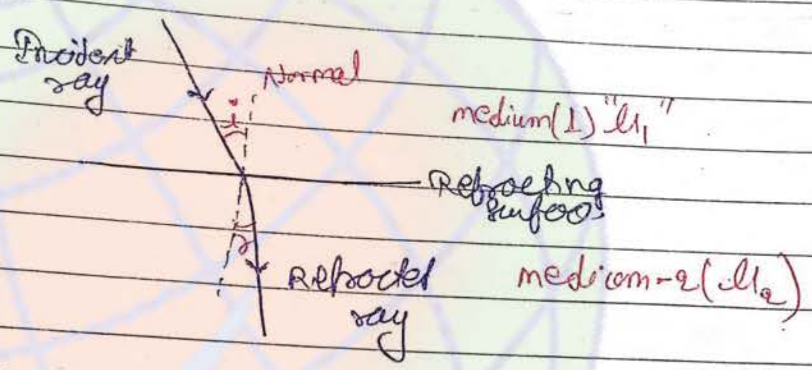
$${}_{A}\mu_{B} = \frac{\mu_B}{\mu_A} = \frac{1}{{}_{B}\mu_{A}}$$

The Relative refractive Index of a m... can ... than ...

eg:-

$${}_g\mu_w = \frac{\mu_w}{\mu_g} = \frac{4/3}{3/2} = \frac{8}{9} < 1$$

☆ Law of Refraction →



Here
$\angle i$ = Angle of Incidence
$\angle r$ = Angle of refraction.

1) Incident ray, Normal and Refracted ray all lie in the same plane

2) Snell's law ⇒
This law says the ratio of sine of angle of Incidence to the sine of angle of refraction is constant.

$$\frac{\sin(i)}{\sin(r)} = \text{Constant}$$

⇒ modified form →

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

This can also be written as =

$$\boxed{\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1} = {}_1\mu_2}$$

Q1) The boundary of a medium is lying in the x-y plane a ray of light is incident in the region

$z \geq 0$ having $\mu = \sqrt{2}$ and the refracted ray is going in the region

$z \leq 0$ having $\mu = \sqrt{3}$

The incident ray is along the direction given by

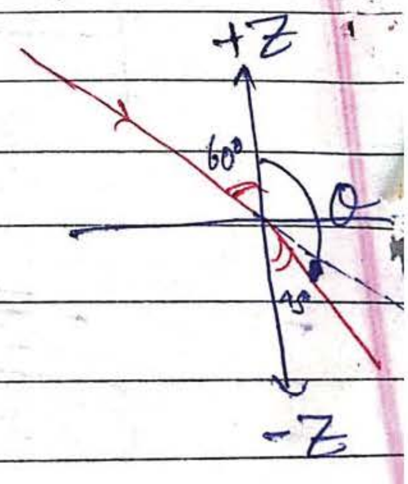
$6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\hat{k}$. Find out the unit vector along the direction of refracted ray.

Sol^n

Unit vector along the direction of incident ray.

$$\Rightarrow \frac{6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\hat{k}}{\sqrt{108+192+100}} = \frac{6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j}}{20}$$

unit vector along Normal $\rightarrow \hat{k}$



$$\Rightarrow \left[\frac{6\sqrt{3}\hat{i} + 8\sqrt{2}\hat{j} - 10\hat{k}}{20}\right] \cdot \hat{k} = \cos\theta$$

$$\Rightarrow \cos\theta = \frac{-1}{2} \Rightarrow \theta = 120^\circ$$

so $i = 60$

From Snell's law

$$= \sqrt{3}\sin r$$

$$\Rightarrow \sqrt{2}\left(\frac{\sqrt{3}}{2}\right) = \sqrt{3}\sin r$$

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

$$\Rightarrow \angle r = 45^\circ$$

The refracted ray will be along the direction given by

$$6\sqrt{3}\,\hat{i} + 8\sqrt{3}\,\hat{j} + Z\hat{k}$$

Unit vector along refracted ray:—

$$\frac{6\sqrt{3}\,\hat{i} + 8\sqrt{3}\,\hat{j} + Z\hat{k}}{\sqrt{300+Z^2}}$$

Unit vector along downward normal :→ $-\hat{k}$

$$\Rightarrow \left[\frac{6\sqrt{3}\,\hat{i} + 8\sqrt{3}\,\hat{j} + Z\hat{k}}{\sqrt{300+Z^2}}\right]\cdot\left[-\hat{k}\right] = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \frac{-Z}{\sqrt{300+Z^2}} = \frac{1}{\sqrt{2}}$$

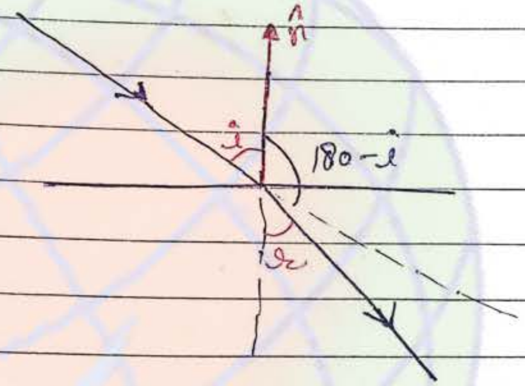
$$\Rightarrow Z^2 = 300$$

$$Z = -10\sqrt{3}$$

Unit vector along refracted ray :—

$$= \frac{1}{10\sqrt{6}}\left[6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\sqrt{3}\hat{k}\right]$$

Alt →



$\hat{e}_1$ = Unit vector ~~onto~~ along Incident ray

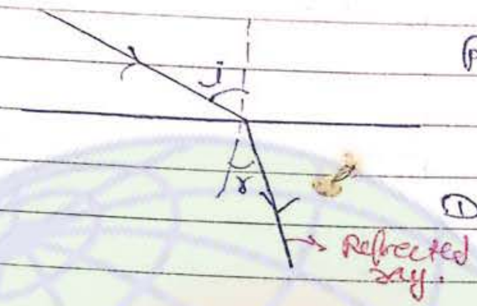
$\hat{n}$ = unit vector along Normal [from 2nd medium towards 1st med

$\hat{e}_2$ = unit vector along ~~surface~~ refracted Ray.

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

$$\Rightarrow \boxed{\mu_1\left[\hat{e}_1 \times \hat{n}\right] = \mu_2\left[\hat{e}_2 \times \hat{n}\right]}$$ v.v.i

☆ Rarer → Denser



$(\mu_D > \mu_R)$

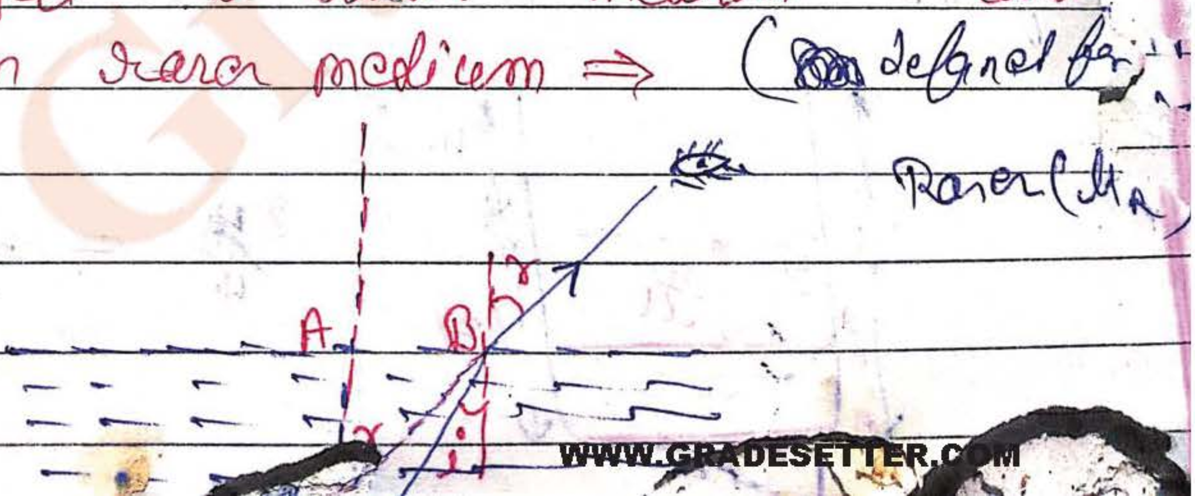
$$\mu_R \sin i = \mu_D \sin r$$

$$\frac{\sin i}{\sin r} = \frac{\mu_D}{\mu_R}$$

when the ray of light goes from rarer to denser medium then it bend's toward's the normal
whereas if the ray of light goes from dense to rarer medium then it bend's away from the normal.

Application of Snell's law ⇒

If the object is denser medium and seen from rarer medium ⇒ (defined for



* ~~Paraxial rays~~

Now ~~for Paraxial rays~~

from snell's law:-

$\mu_D \sin i = \mu_R \sin r$

for Paraxial Rays

$\mu_D \tan i \approx \mu_R \tan r$

$\Rightarrow \mu_D \left[\frac{AB}{AO}\right] = \mu_R \left[\frac{AB}{AI}\right]$

$\Rightarrow \frac{\mu_D}{\mu_R} = \frac{AO}{AI}$

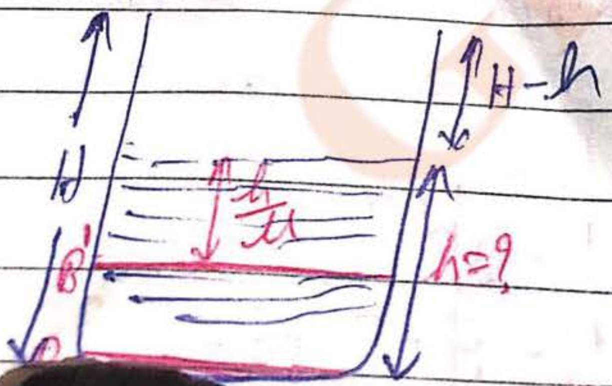
$$\boxed{\frac{\text{Real depth}}{\text{App. depth}} = \frac{\mu_D}{\mu_R} = {}^{R}\mu_D}$$

[observer का R.I निचे ही रहेगा]

Note:- Length is always measured from the surface of the media

यदि observe Rare medium में रहे तब $\frac{\text{Real dep.}}{\text{App. dep.}} = \frac{\mu_D}{\mu_R}$ रहेगा लेकिन यदि observe Dense में रहेगा $\frac{\text{Real dep.}}{\text{App. dep.}} = \frac{\mu_R}{\mu_D}$ हो जाएगा।

A cylindrical bucket is having total height "H" find out upto which height water having refractive index μ has to be filled so that it appears to be $\frac{1}{2}$ empty.



$\frac{2h}{H} = \frac{\mu_D}{\mu_R}$

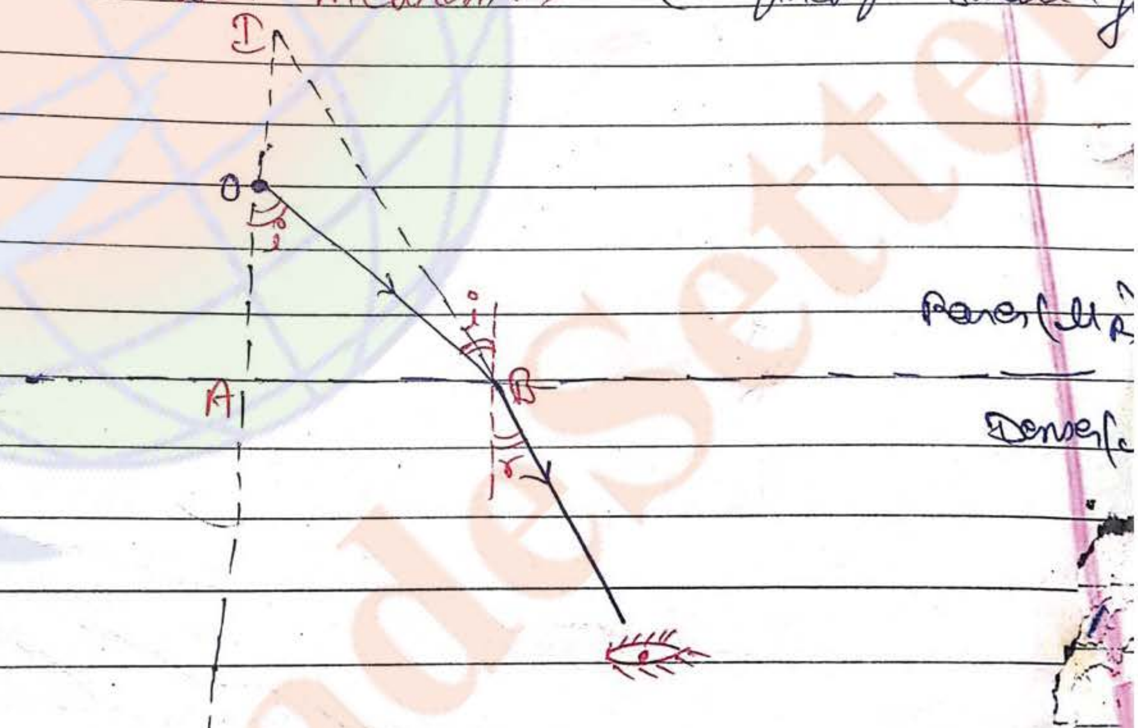
Real depth of base = h

App. depth of base from surface of water ⇒ $\frac{h}{\mu}$

$$\frac{h}{\mu} = H - h \Rightarrow h\left(\frac{1}{\mu}+1\right) = H$$

so $\boxed{h = \frac{\mu H}{\mu + 1}}$ Ans.

2.) If the object is in rarer medium and it is seen from denser medium ⇒ (Defined for small ang



From Snell's law

$$\mu_R \sin i = \mu_D \sin r$$

For Paraxial rays –

$$\mu_R \tan i \approx \mu_D \tan r$$

$$\mu_R \left[\frac{AB'}{AO}\right] = \mu_D \left[\frac{AD}{AD}\right]$$

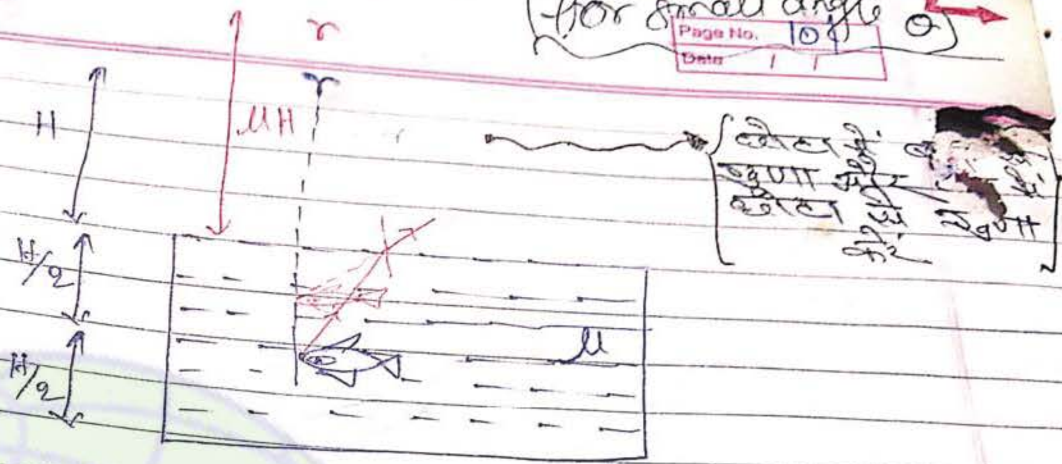
$$\Rightarrow \frac{\mu_D}{\mu_R} = \frac{AD}{AO}$$

$$\frac{\text{App. height}}{\text{Real height}} = \frac{\mu_D}{\mu_R} = {}_R\mu_D$$

Problem based on Real depth and Apparent depth, (for small angle θ)

Page No. 104

Sol.



Calculate :-

a) seperation of fish on, seen by bird through refraction ?

(b) Seperation of bird on seen by fish through refraction.

Sol^n

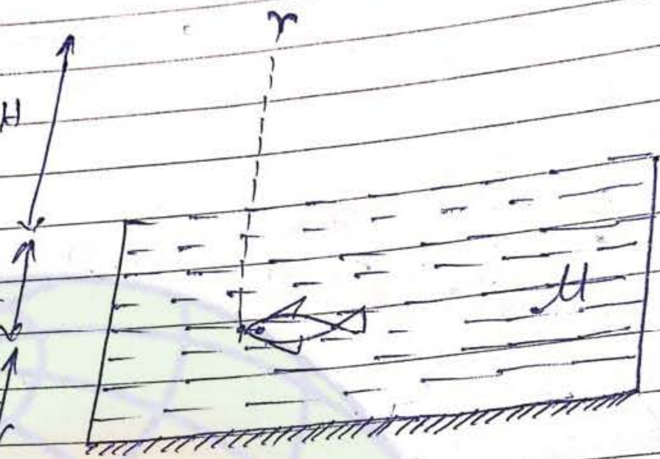
(a) Real depth $= \frac{H}{2}$

App. depth $= \frac{H}{2\mu}$

Seperation $= \cancel{H + \frac{H}{2\mu}}$ $H + \frac{H}{2\mu}$

b) App. Height from Surface $= \mu H$

Seperation $= \frac{H}{2} + \mu H$

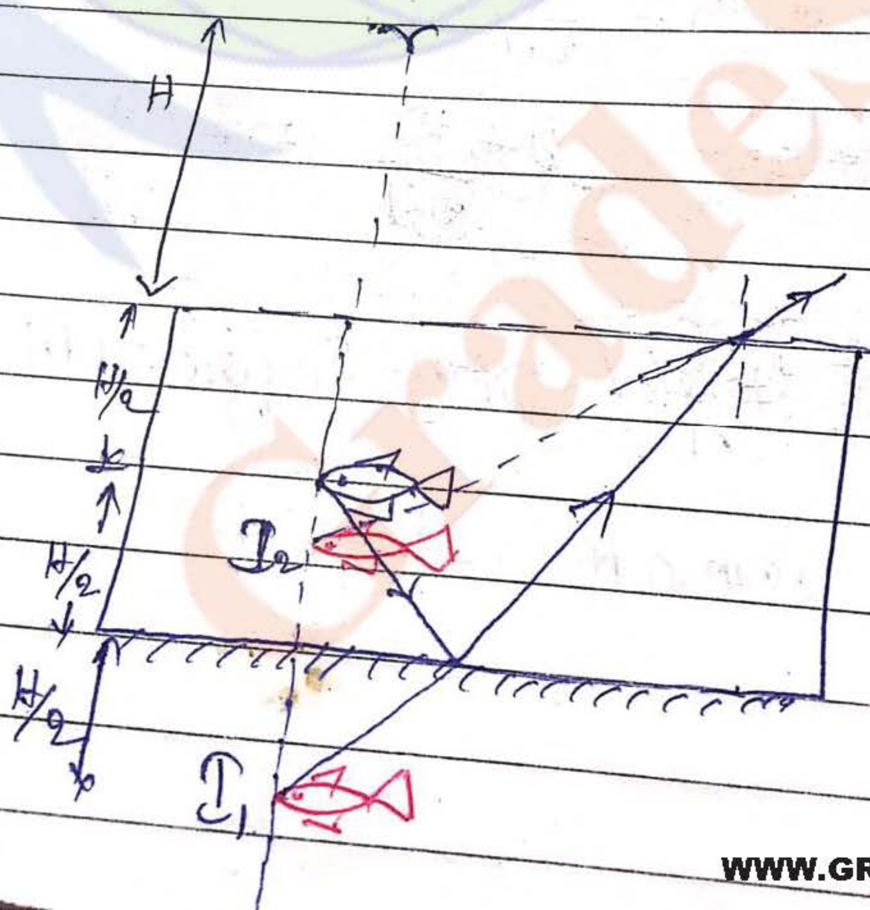


Calculate:-

a) sep. of Image of fish through reflection as seen by bird

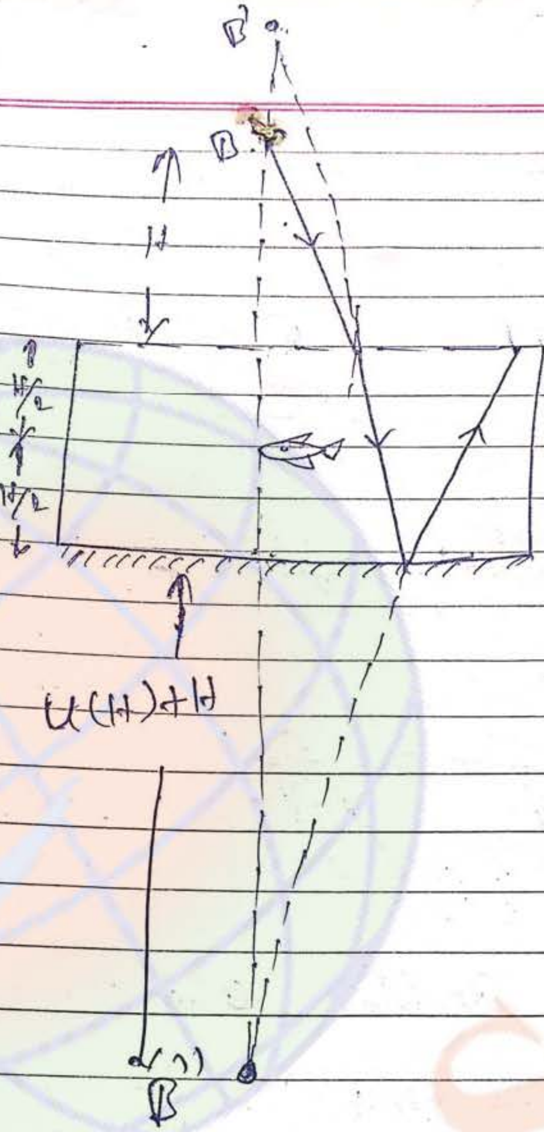
b) separation of Image of bird through reflection as seen by fish.

a)



$\mu = \frac{3H}{2(9}$

b)



$\mu = \frac{y}{H}$

$y = \mu H$

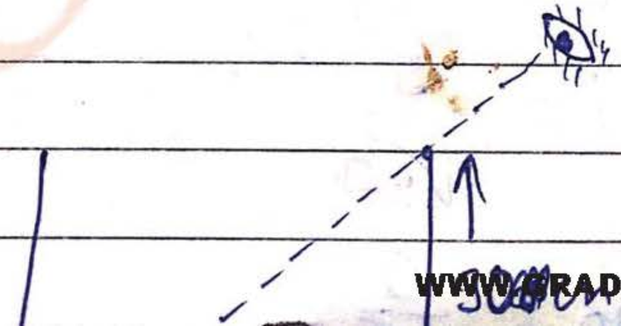
seperation $= \mu H + H + H$

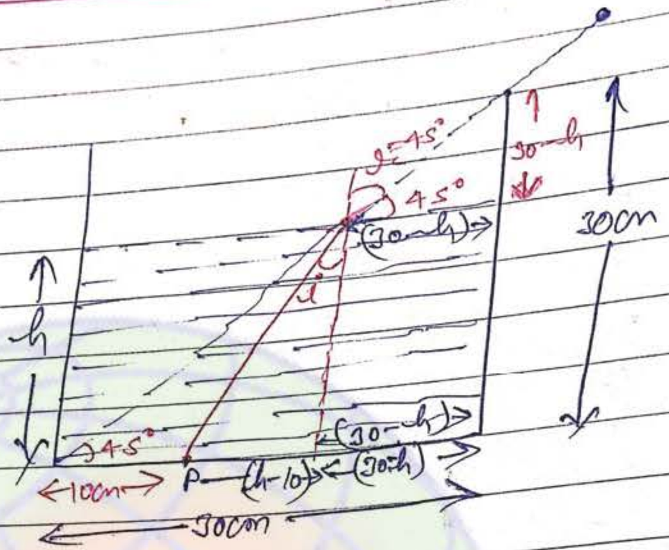
$= \mu H + 3H$

Problem's based on Snell's lane (use for large angle)

Ex2)

In the given figure find out at which height water having refractive Index ... to be filled so that point "P" becomes ... to the person.





~~from~~ ~~$\frac{h-10}{h} = \frac{3}{\sqrt{23}}$~~

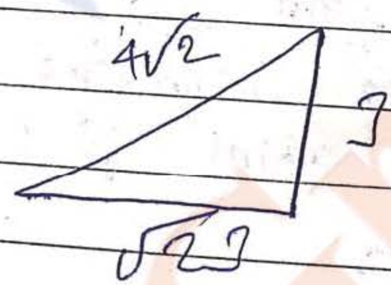
~~$h = 2$~~

from Snell's law

(Here angle is large so use Snell's law)

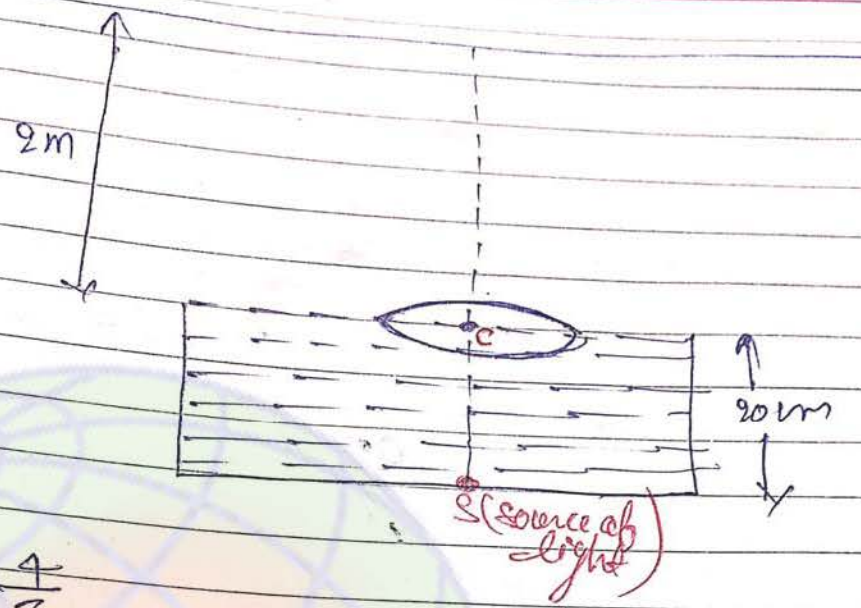
$$\frac{4}{3}\sin i = \sin 45^\circ = \frac{1}{\sqrt{2}}$$

$$\sin i = \frac{3}{4\sqrt{2}}$$



$$\tan i = \frac{3}{\sqrt{23}}$$

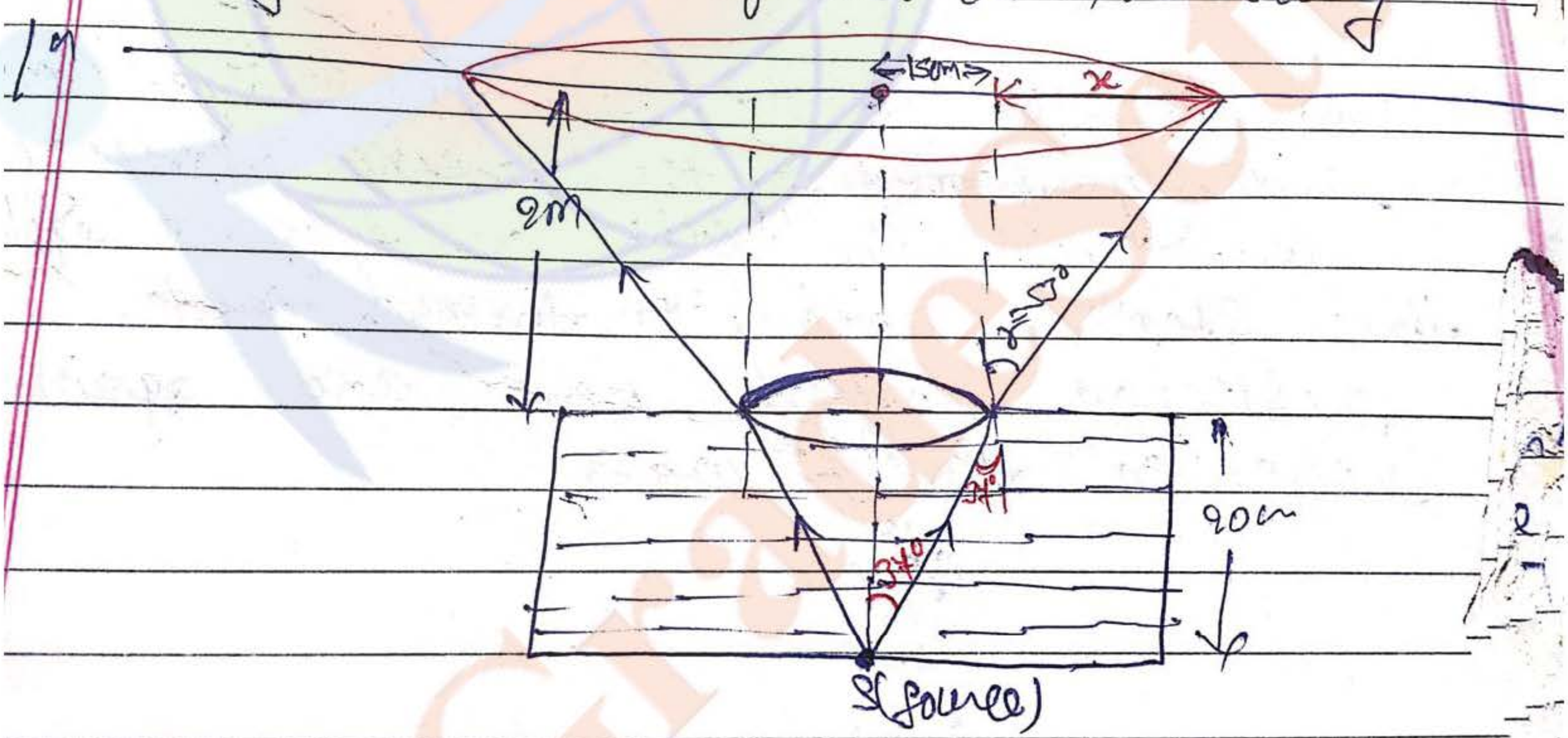
$$\frac{h-10}{h} = \frac{3}{\sqrt{23}}$$



$\mu_{water} = \frac{4}{3}$

Radius of ring = 15 cm

find out the radius of the shadow of the ring which is formed on the silling.

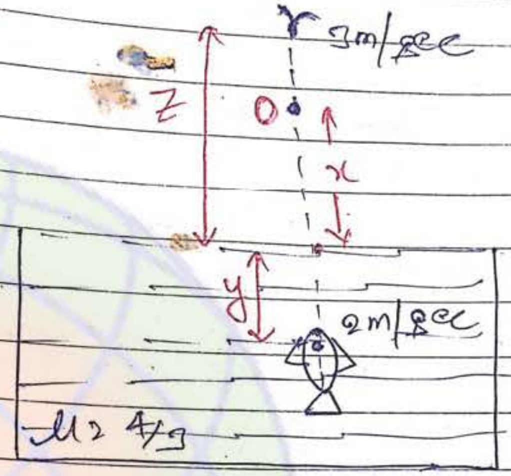


From Snell's law

$\frac{4}{3} \sin 37^\circ = \sin r$

$\sin r = \frac{4}{...}$

Problem's based on velocities in the case of refraction ⟹



Calculate:-
a) vel. of fish as observed by bird.
b) vel. of bird as observed by fish.

sol^n
a) For stationary observer.

$$s = x + \frac{y}{\mu}$$

$$\frac{ds}{dt} = \frac{dx}{dt} + \frac{3}{4}\frac{dy}{dt}$$

$$\frac{ds}{dt} = 0 + \frac{3}{4}(-2) = \frac{-3}{2}$$

w.r.t. bird

$$V_{bird} = \frac{-3}{2} - 3$$

$$\frac{dS}{dt} = (10^{-2}) + \frac{3}{4}(-6) - \frac{3}{4}(10^{-2})$$

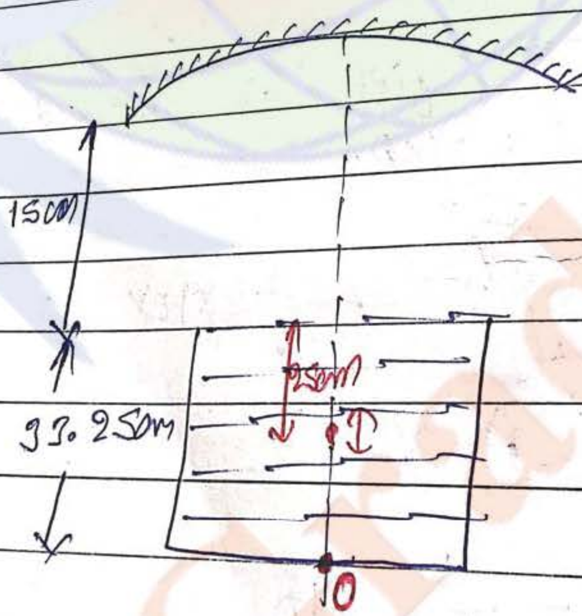
$$= 0.01 - 4.5 - \frac{0.03}{4}$$

method IInd -

$$S = x + \frac{Z}{\mu}$$

$$\frac{dS}{dt} = \frac{dx}{dt} + \frac{3}{4}\left[\frac{dZ}{dt}\right]$$

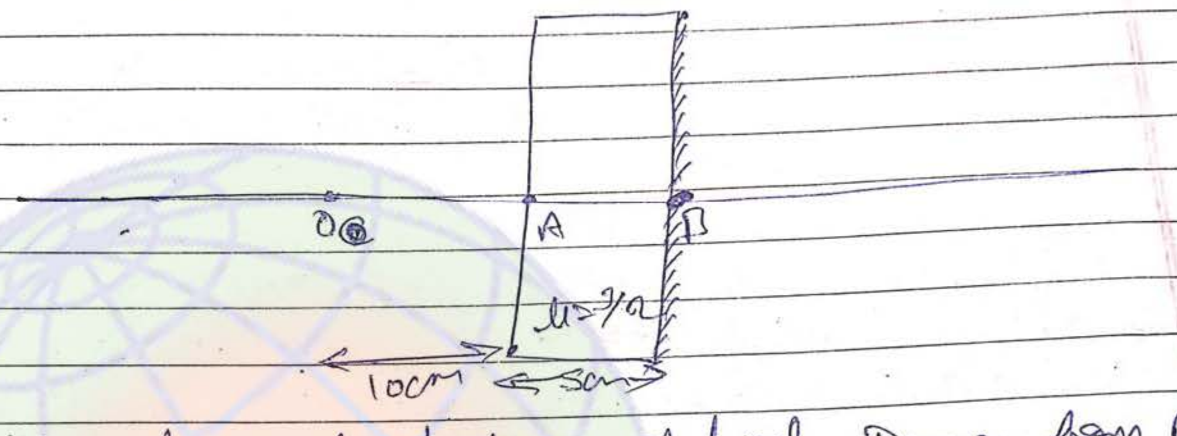
$$\frac{dS}{dt} = (10^{-2}) - \frac{3}{4}\left[10^{-2} + 6\right]$$



I = Position of final Image
Calculate focal length of mirror

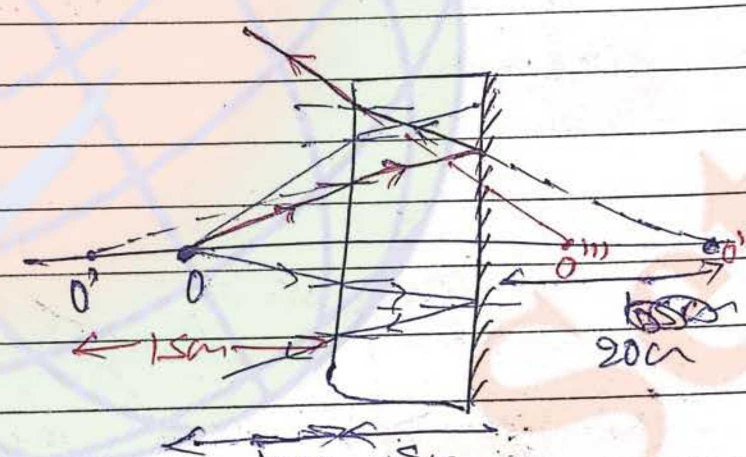
Problem based on glass slab:→

(Q.)



find out distance of final Image from B.

80/9



$$\frac{10}{app} = \frac{3/2}{1}$$

$$app = \frac{10 \times 2}{3}$$

$$app = \frac{20}{3} = 6.6$$

For first refracte

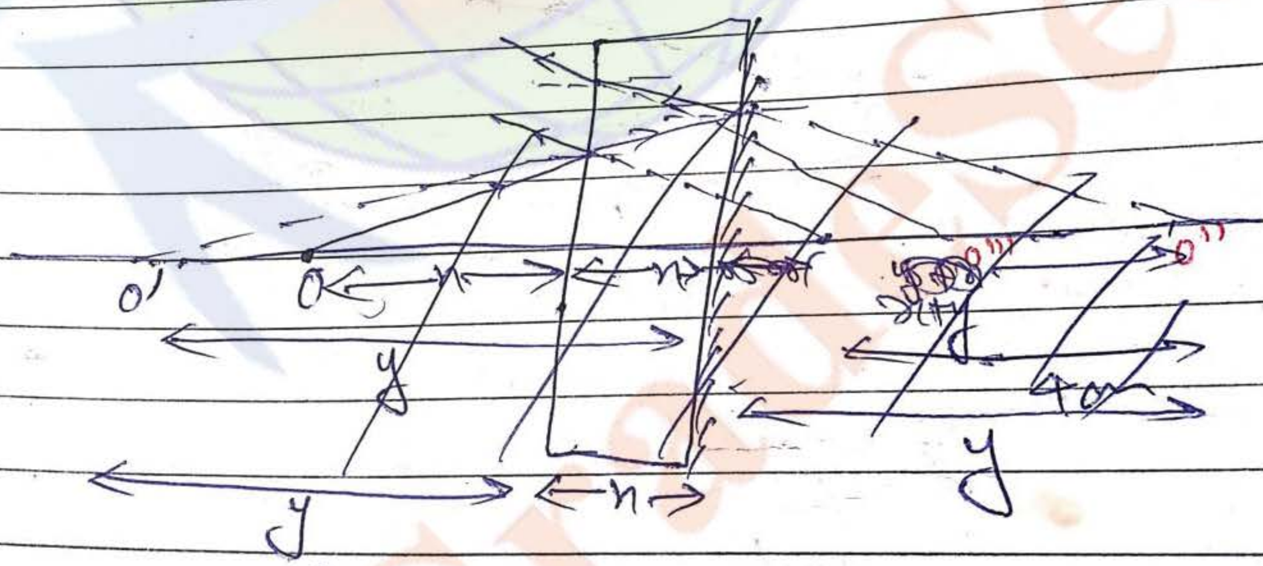
$$\mu = 3/2 = \frac{AO'}{AO} = \frac{AO'}{10}$$

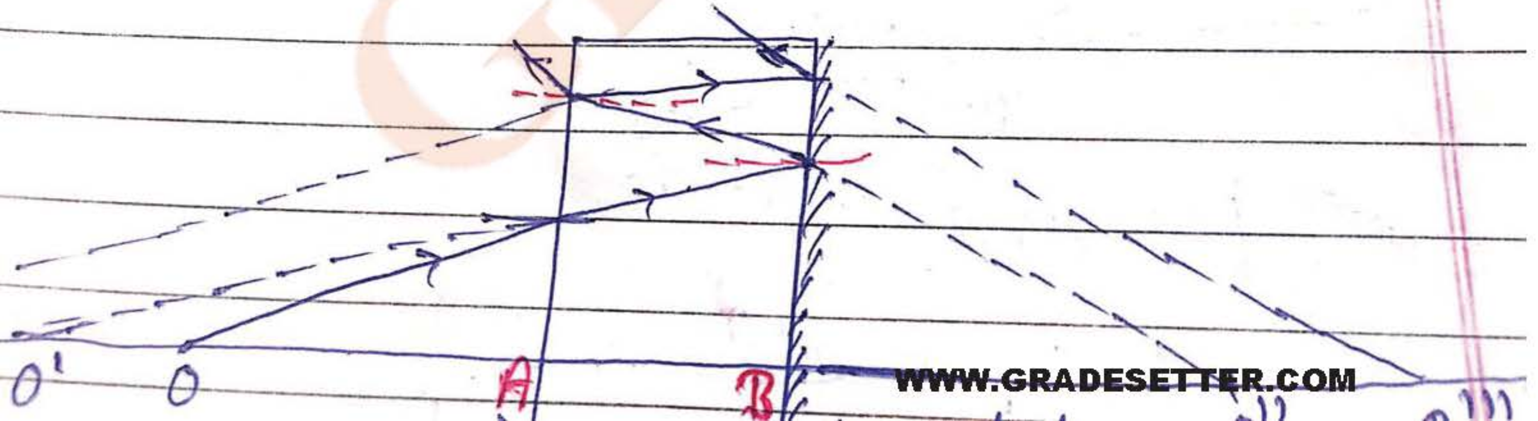
$AO' = 15$ cm

$$\mu = \frac{3}{2} = \frac{AO''}{AO'''} \cdot \frac{25}{AO'''}$$

$$AO''' = \cancel{25}\ \frac{50}{3}\ cm$$

Q2.) There is a glass slab infront of which an object is kept. The rear surface of the glass slab is silvered. The distance b/w the two images formed by this silvered (or real) surface is 4cm. Find out thickness of the glass slab.





given that :⇒

$O'' O''' = 4cm$

$\cancel{4x} + 3f - \cancel{4x} - f = 4$

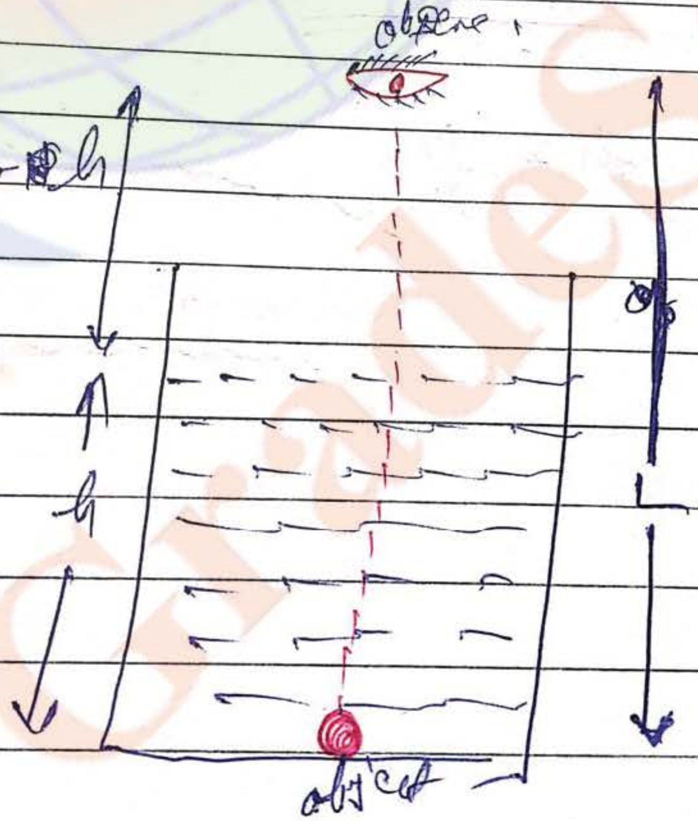
$2f = 4$

$f = 2$

$\boxed{\text{Ans} = 2}$

$\boxed{\text{QNO. 3}}$ The radius of the cylinder is decreasing at constant rate "k". The volume of the liquid the container remain's constant which is "B". Find out the apparent vel. of the object seen by the observer when the radius of the cy is "r".

Sol^n



$V = \pi r^2 h$

$$\pi r^2 \frac{dh}{dt} = -2\pi h r \frac{dr}{dt}$$

$$\frac{dh}{dt} = -\frac{2h}{r}\frac{dr}{dt} = \frac{2Kh}{r}$$

separation of "O" as seen by observed.

$$S = L - h + \frac{h}{\mu}$$

$$\frac{dS}{dt} = \cancel{\frac{dL}{dt}} + \left(\frac{1-\mu}{\mu}\right)\frac{dh}{dt}$$

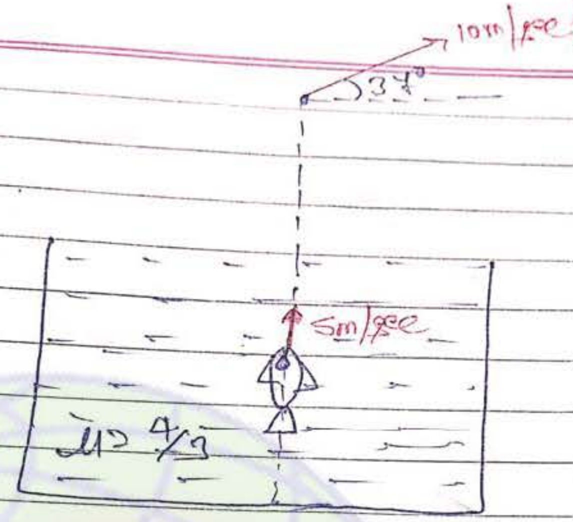
$$\boxed{\frac{dS}{dt} = \left(\frac{1-\mu}{\mu}\right)\frac{2Kh}{r}}$$

Now

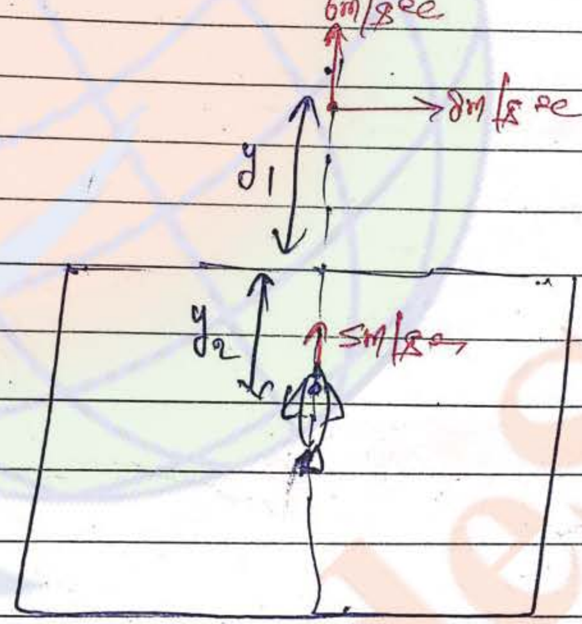
Put $h = \frac{V}{\pi r^2}$ $\quad \because V = \pi r^2 h$

$$\frac{dS}{dt} =$$

H.W
Ex.



Find out at which angle the vel. of Bird will be appeared (with horizontal) by the fish.



$$s = y_2 + \mu y_1$$

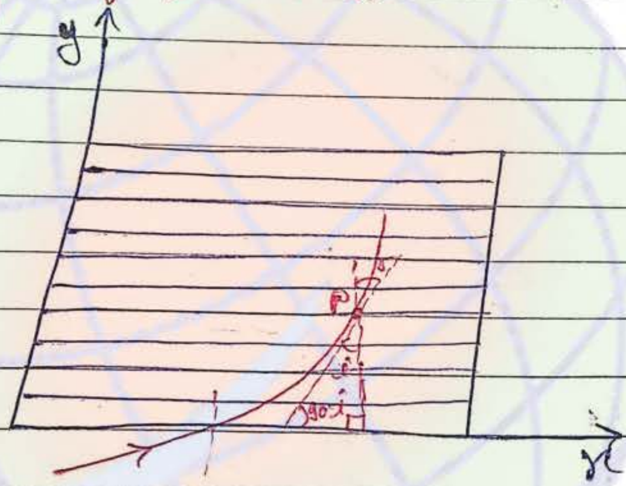
$$\frac{ds}{dt} = \frac{dy_2}{dt} + \frac{4}{3}\frac{dy_1}{dt}$$

$$\Rightarrow -5 + \frac{4}{3}(6)$$

$$\Rightarrow 3$$

How to solve the problem based on variable Refractive Index →

(i) If $\mu = f(y)$

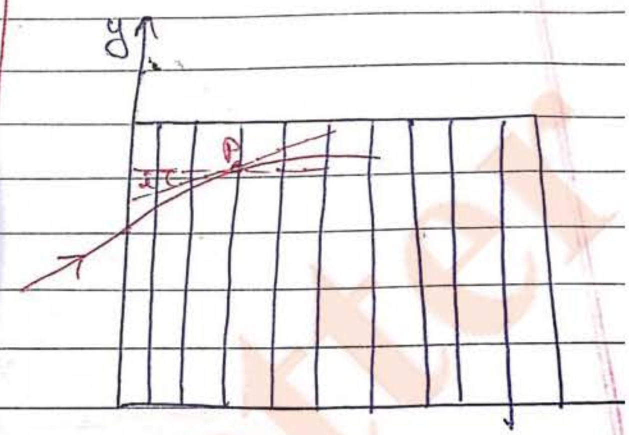


Slope at 'P'

$$\boxed{\frac{dy}{dx} = \cot i} \quad \text{—(1)}$$

$$\boxed{\mu \sin\theta = \text{Constant}} \quad \text{—(2)}$$

(ii) If $\mu = f(x)$



Slope at P,

$$\boxed{\frac{dy}{dx} = \tan i} \quad \text{—(1)}$$

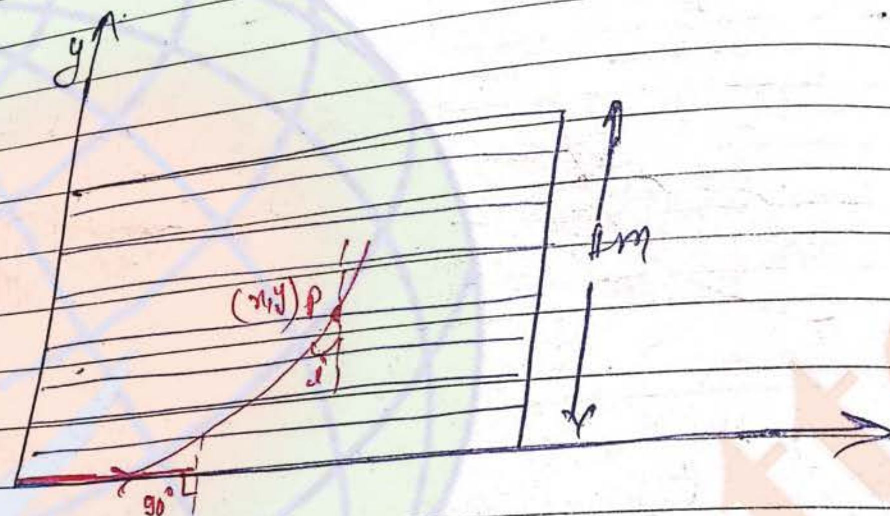
$$\boxed{\mu \sin\theta = \text{constant}}$$

1st Choice

A ray of light is incident at grazing incidence ($i = 90°$) on a regular slab having thickness 1m

$$\mu = f(y) = \sqrt{Ky^{3/2} + 1}$$

where K, Constant = 1



a) obtain the relation b/w slope and angle of incidence

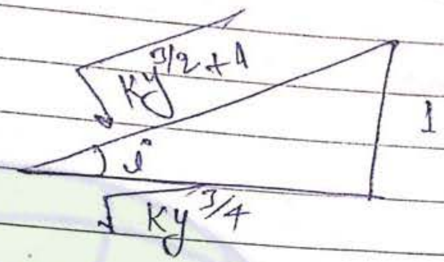
(b) obtain the eq^n of trajectory.

$$\frac{dy}{dx} = \cot i$$

$\mu \sin\theta$ = Constant

$$\frac{dy}{dx} = \cot i \quad \text{--- (i)}$$

$$1 = \sqrt{ky^{3/2} + 1} \sin i$$



$$\boxed{\cot i = \sqrt{Ky^{3/4}} = y^{3/4}}$$

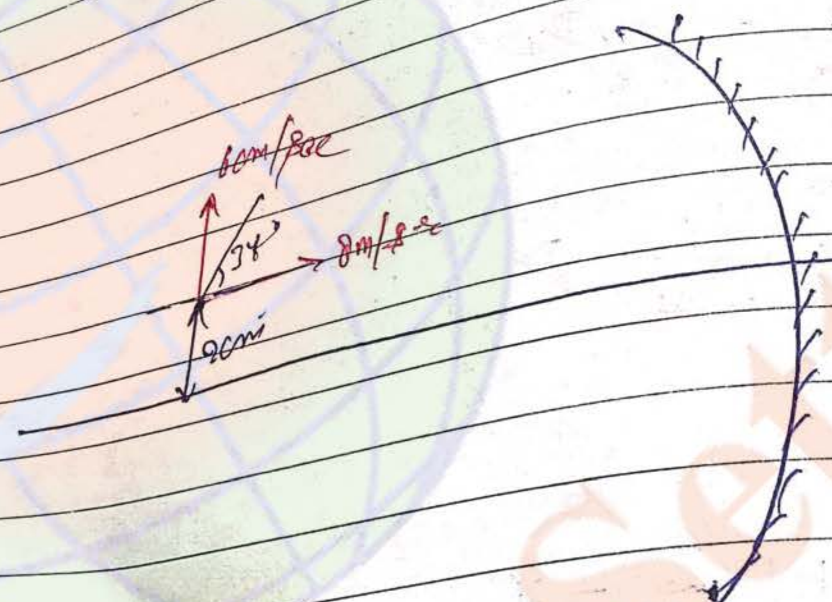
Substitute value of $\cot i$ in eq (1)

$$\frac{dy}{dx} = y^{3/4}$$

$$\int_0^y \frac{dy}{y^{3/4}} = \int_0^x dx$$

$$4y^{1/4} = x$$

$$\boxed{y = \frac{x^4}{256}}$$



Along x-axis

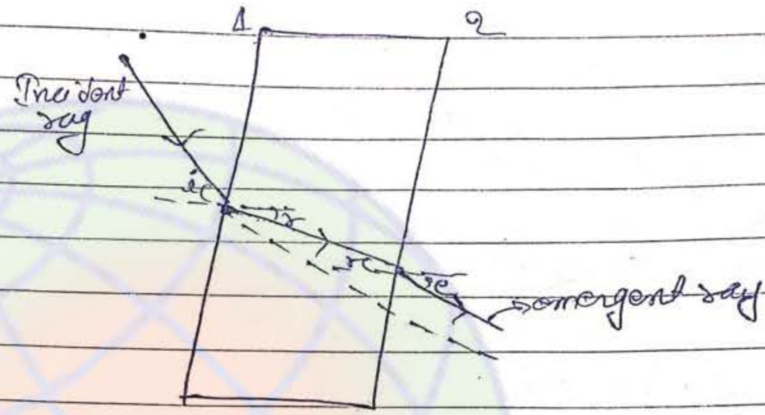
$$m = \frac{f}{f-u} = \frac{-10}{-10+40} = \frac{-1}{3}$$

$$V_{Im(x)} = -m^2 V_{om(x)}$$

$$V_I = \frac{-1}{9} \times 8 = \frac{-8}{9}$$

$$\vec{V}_{Im(y)} = m\vec{V}_{om} + y_{om} f$$

Double Refrection through glass slab



e: → Angle of emergence

At 1st surface –

$\sin i = \mu \sin r$

At 2nd surface

$\mu \sin r = \sin(e)$

$$\boxed{\angle i = \angle e}$$

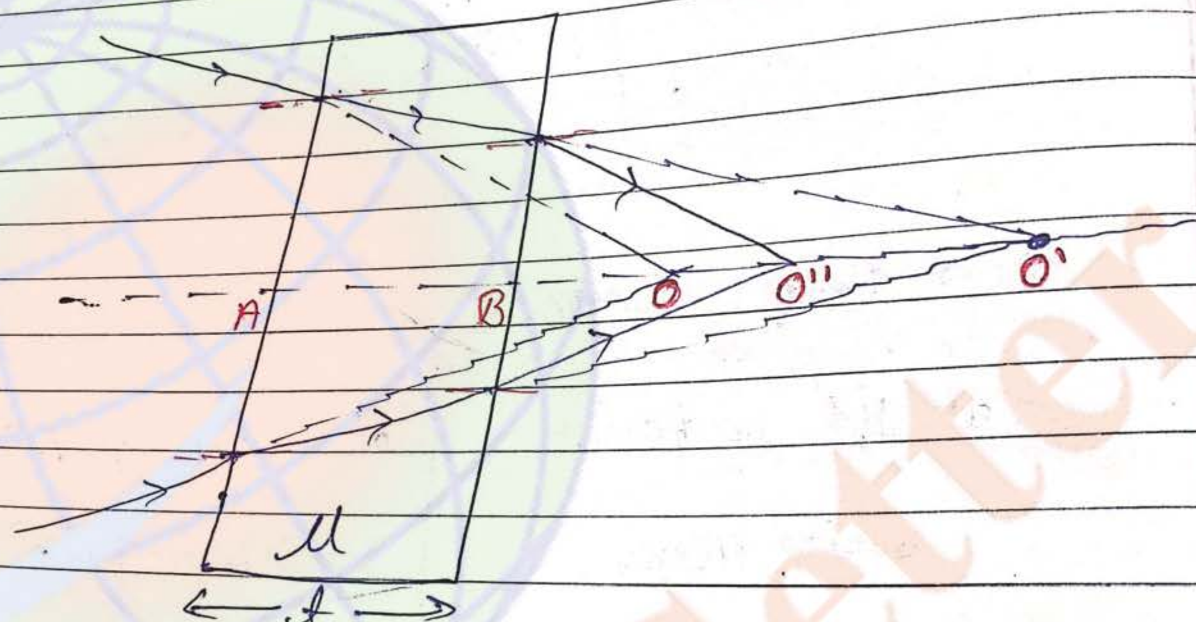
1) For a glass slab if there is same medium over the sides than the emergent ray will be Pa[rallel to] Incident ray

1st Choice

Normal or Apparent shift due to glass slab →

a) For converging rays:-

(OO'' ⇒ Normal shift)



Let $BO = x$

For 1st refraction

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

$$\Rightarrow AO' = \mu(AO) \quad \text{---(1)}$$

for 2nd refraction

$$\mu = \frac{BO'}{B\ldots}$$

$$BO'' = \frac{\mu(t+x) - t}{\mu}$$

$$BO'' = t + x - \frac{t}{\mu} \quad \text{--- (2)}$$

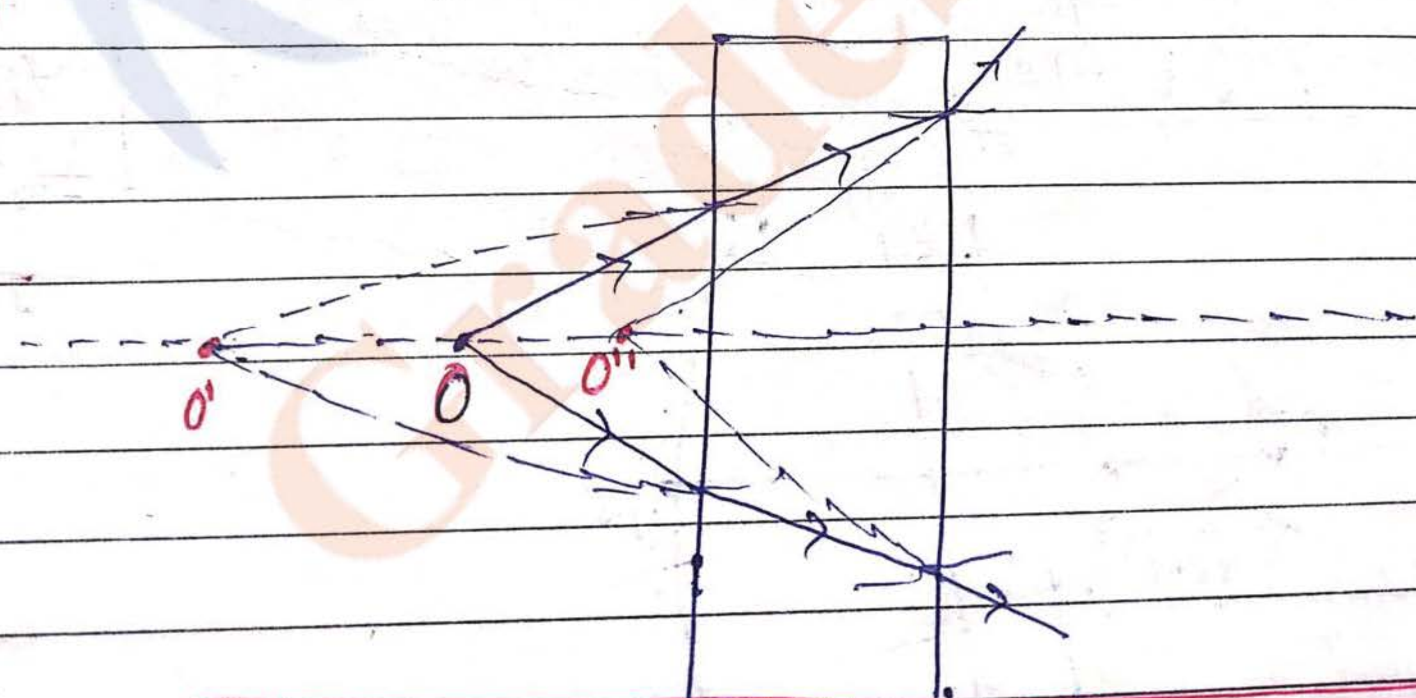
Normal shift $= OO''$

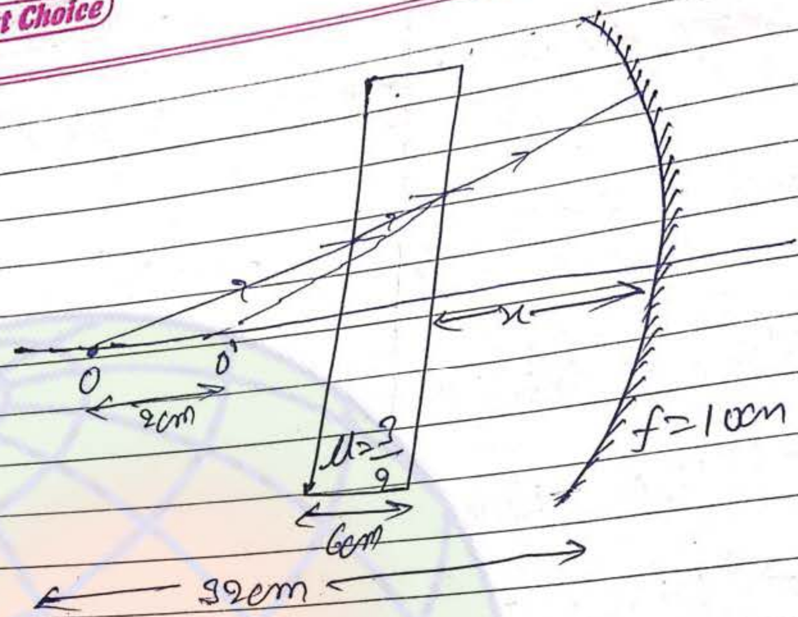
$\Rightarrow BO'' - BO$

$\Rightarrow t + x - \frac{t}{\mu} - x$

$$\boxed{\text{Normal shift} \Rightarrow t\left(1 - \frac{1}{\mu}\right)}$$

(b) For Diverging rays ->





In the figure shown find out nature and position of final image formed if

A) if $x = 5cm$

B) if $x = 20cm$

A) Normal shift $= 2cm$

for concave mirror

$u = -30cm$

$f = -10cm$

$\boxed{v = -15cm}$

$u = -32$

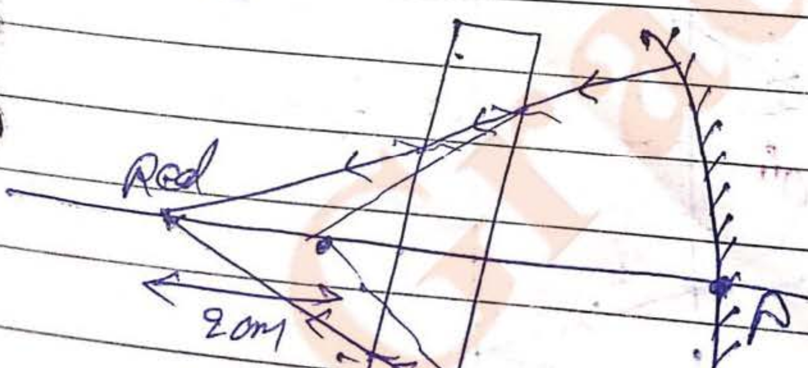
$f = -10$

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

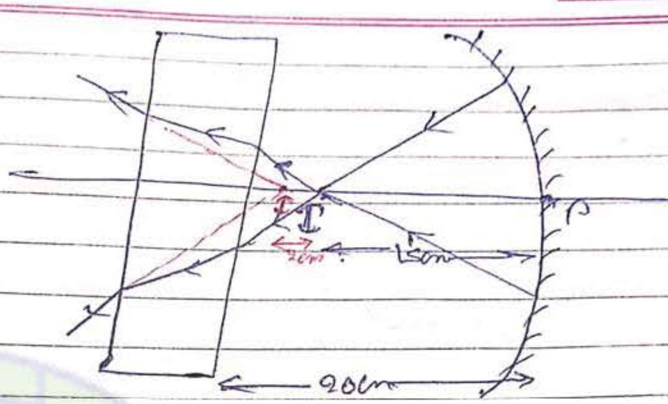
$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

$\frac{1}{v} = \frac{1}{-10} + \frac{1}{32}$

$= \frac{\quad}{32}$



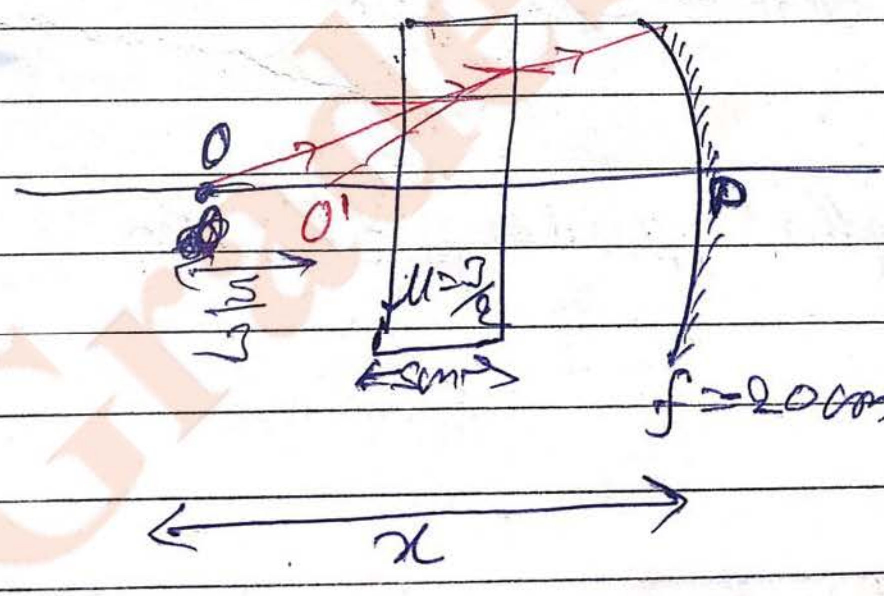
B)



Final Image will be virtual and formed at 14cm from pole towards left

(e.g.) A glass slab of thickness 5cm and $\mu = \frac{3}{2}$ is in front of a concave mirror having radius of curvature 40cm. How far from the mirror n[illegible] a small object be placed so that its Image co-incides with the object.

Sol^n



Normal [illegible]

1st Choice

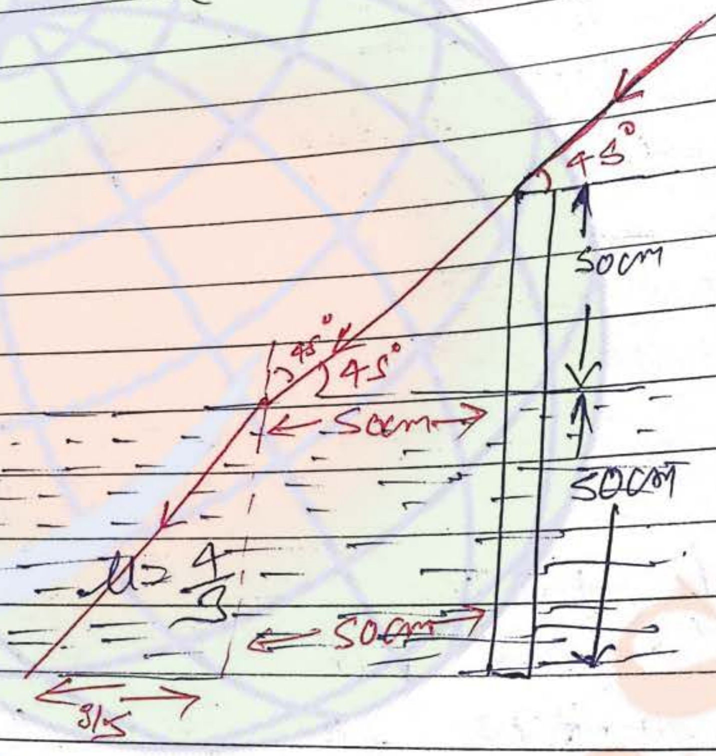
For concave mirror

$\mu = -\left(x - \frac{5}{3}\right)$

$f = -20cm$

$v = -\left(x - \frac{5}{3}\right)$

Ex.

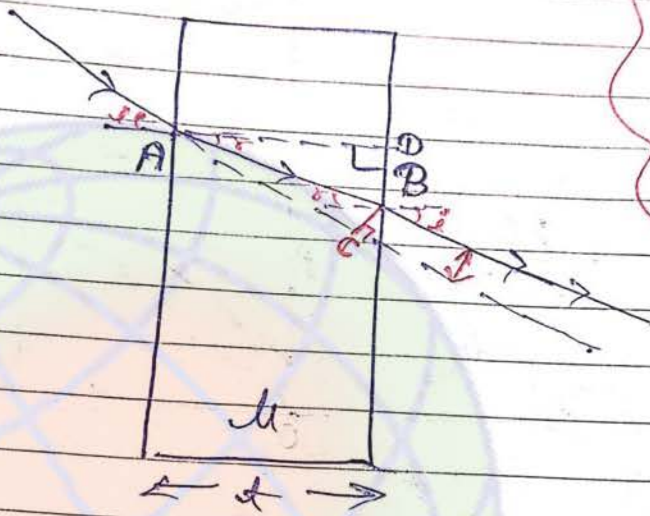


In the figure shown find out the length of shadow of the pole which is formed at the base of the pole.

So. length of shadow = 81.5cm

Lateral shift due to glass slab ⇒

It depends on –
i) thickness
ii) Angle of Incidence
iii) Refractive Index



lateral shift = BC

In ΔABD

$$\cos r = \frac{AD}{AB}$$

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

In ΔABC

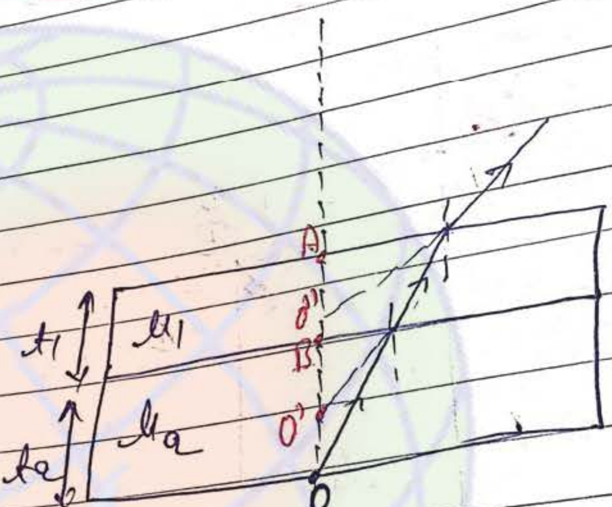
$$\sin(i-r) = \frac{BC}{AB}$$

$$\Rightarrow BC = (AB) \sin(i-r)$$

lateral shift $= \frac{t}{\cos r}(\sin(i-r))$

Refraction through multiple layers:-

Let:- ($\mu_2 > \mu_1$)



For 1st refraction:

$$\frac{\mu_2}{\mu_1} = \frac{BO}{BO'} = \frac{t_2}{BO'}$$

$$\Rightarrow BO' = \frac{t_2 \mu_1}{\mu_2} \quad \text{—(i)}$$

For 2nd refraction:-

$$\mu_1 = \frac{AO'}{AO''} = \frac{AB + BO'}{AO''}$$

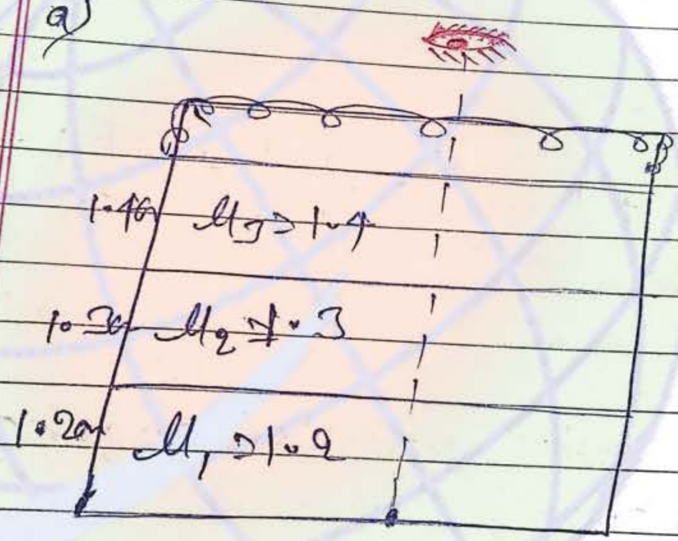
~~$\Rightarrow AO'' = AB + BO'$~~

App. depth from top surface:-

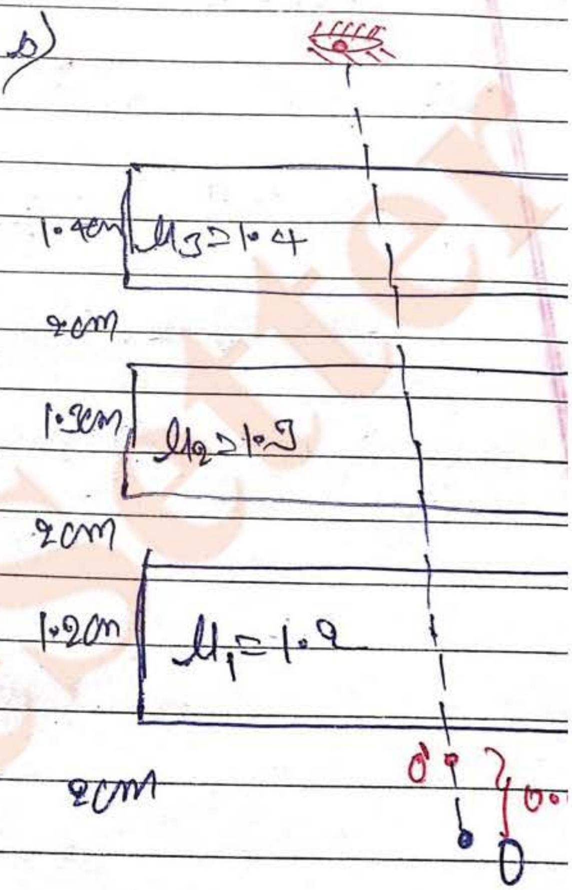
$$\rightarrow \frac{t_1}{\mu_1}+\frac{t_2}{\mu_2}+\frac{t_3}{\mu_3}+ - - - - - - -$$

Example)

a)



b)



Find out position of "O" as seen from t

a) App depth from top surface

$$= \frac{1.2}{1.2}+\frac{1.3}{1.3}+\frac{1.4}{1.4}$$

b) App. depth from top surface

$$\Rightarrow \frac{1.4}{1.4} + \frac{2}{1} + \frac{1.3}{1.3} + \frac{2}{1} + \frac{1.2}{1.2} + \frac{2}{1}$$

$\Rightarrow$ 9cm from top surface.

method →

Total normal shift :-

$$\Rightarrow 1.4\left[1 - \frac{1}{1.4}\right] + 1.3\left[1 - \frac{1}{1.3}\right] + 1.2\left[1 -\right.$$

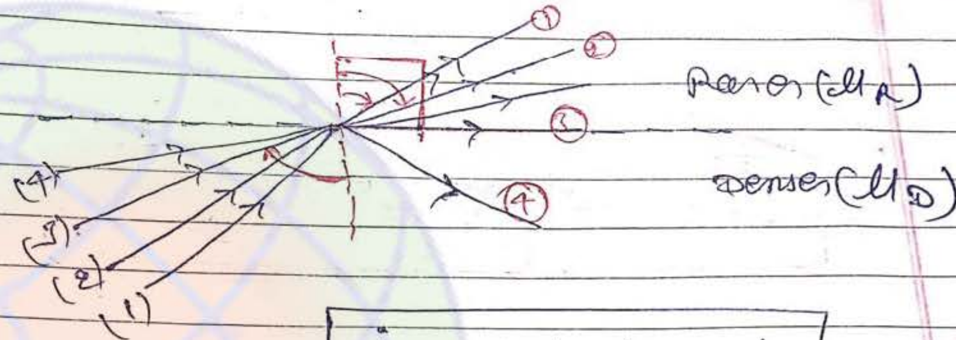
$\Rightarrow$ 0.9 cm

Total app. depth from top surface

$\Rightarrow 9.9 - 0.9$

$= 9$ cm

Total Internal Reflection (TIR)



$\boxed{i_c = \text{Critical angle}}$

Definition ⇒

If a ray of light is Incident from denser to rarer medium and angle of Incidence is greater than Critical angle than the ray of light is totally reflec back in the same medium. This Phen. is called as "Total Internal reflection (TIR)"

Critical angle ⇒

Critical angle is the minimum value angle of Incidence after which ... take place or we can say if a ray light is going from denser to rarer med than it is the value of angle of Inciden corresponding to which angle of refrac ...mes 90°.

From Snell's law:-

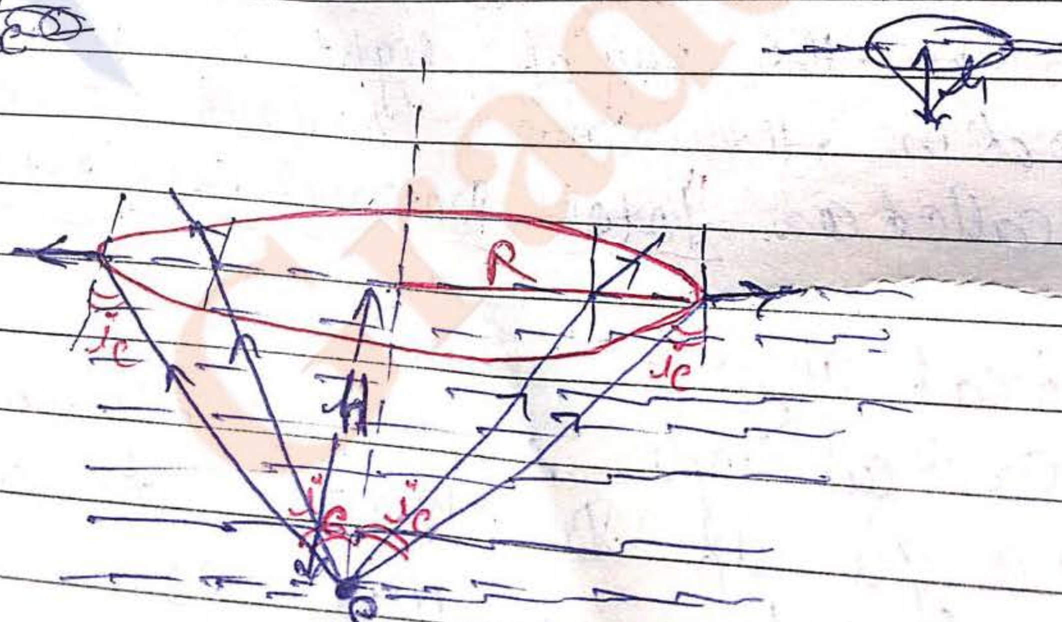
$$\mu_D \sin i_C = \mu_R \sin 90^\circ$$

$$\Rightarrow \sin i_C = \frac{\mu_R}{\mu_D} = \frac{1}{{}_R\mu_D}$$

$$\boxed{i_C = \sin^{-1}\left[\frac{\mu_R}{\mu_D}\right] = \sin^{-1}\left[\frac{1}{{}_R\mu_D}\right]}$$

Ex:) Inside the water a source of light is kept at a depth of "h" from the surface. Find out the area on the surface of water through which light from the source can be transmitted.

i_C



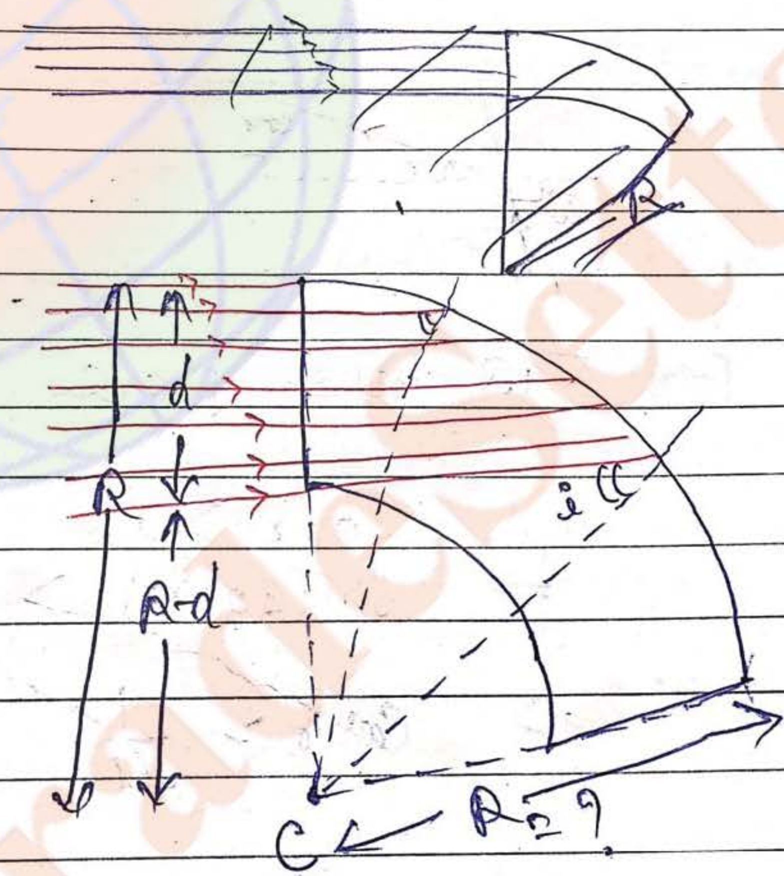
$$R = \frac{H}{\sqrt{\mu^2-1}}$$

So, Area of circle

$$\Rightarrow \pi R^2$$

$$\Rightarrow \frac{\pi H^2}{\mu^2-1}$$

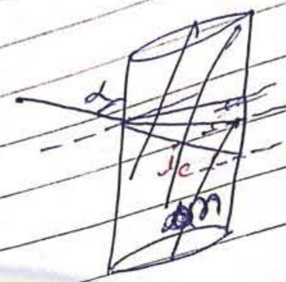
[Q 9]
Q.No = 4
P > 40

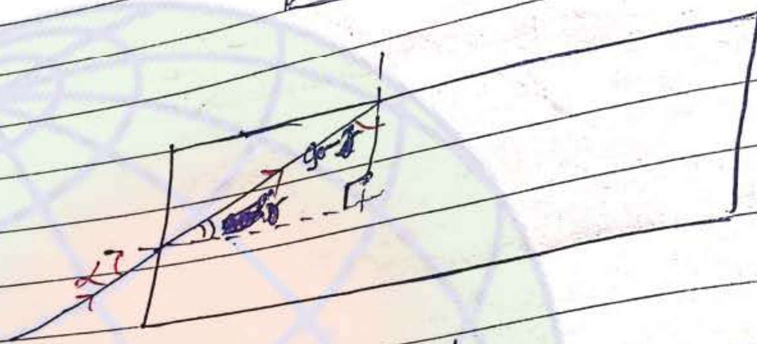


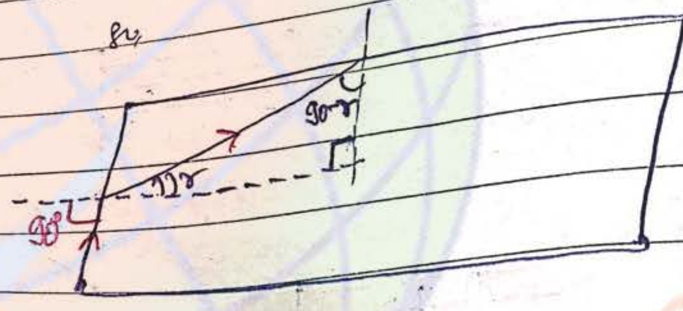
$$i > i_c$$

$$\sin i > \sin i_c$$

Ex: 4
Q.N: 4







For TIR takes place

$\Rightarrow 90 - r > i_c$

$\Rightarrow \sin(90 - r) > \sin i_c$

$\Rightarrow \cos r > \dfrac{1}{\mu}$ —(i)

At AA surface

$\sin 90^\circ = \mu \sin r$

$\sin r = \dfrac{1}{\mu}$

From ② and ①

$$\sqrt{1-\frac{1}{\mu^2}} > \frac{1}{\mu}$$

$$\sqrt{1-\frac{1}{\mu^2}} \quad \mu > \sqrt{2}$$

Read :- Concept D.P.P.

1st Choice

For boards

Application of total Internal Reflection

1) optical fibre →

($\mu_1 > \mu_2$)

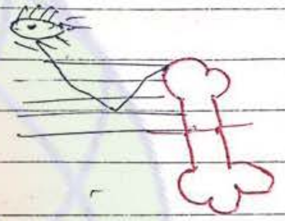
The application of optical fibres is based on total Internal reflection and it is used in the transmission of signals from one location to another location.

2.) Brilliance of diamond →

The value of critical angle for the diamond is app. 24° and the cutting of the diamond is done in such a way that the ray of light falling on the surface of diamond is more than 24° so TIR takes place at the multiple surfa

3.) mirrage →

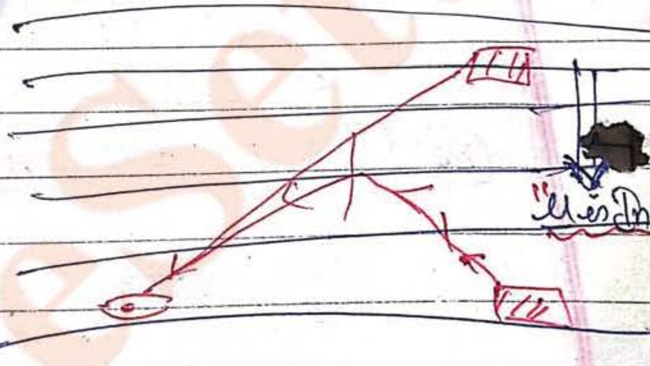
याद रखें → mirrage गर्मी के दिनों में मरुस्थल में होगा।



μ is decreasing (In summer seaso

In the different/desert area as we are close to earth the R.I of air continuou decrease

4.) Looming → (In colder regio



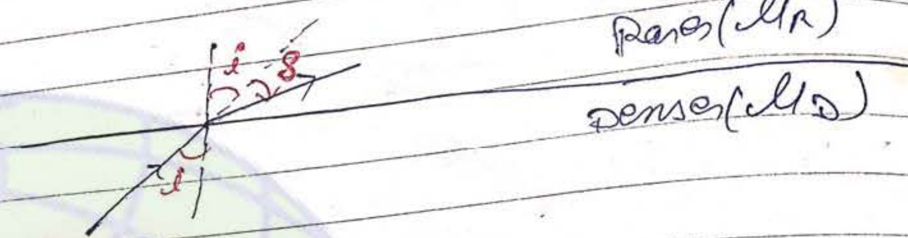
μ is Inc

Deviation during refraction of light →

e) A ray of light is going from denser medium (μ_d) to rarer medium (μ_r) derive for the deviation as a fu... / Incidence.

1st Choice

Sol^n From denser to Rarer medium →



$\delta = r - i$

From Snell's law

$\mu_D \sin i = \mu_R \sin r$

$\sin r = \frac{\mu_D}{\mu_R} \sin i$

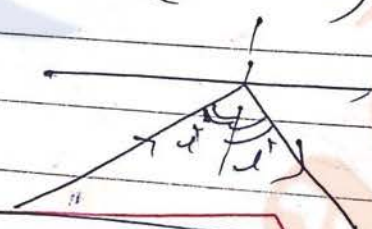
$r = \sin^{-1}\left[\frac{\mu_D}{\mu_R} \sin i\right]$

$$\boxed{\delta = \sin^{-1}\left[\frac{\mu_D}{\mu_R} \sin i\right] - i}$$

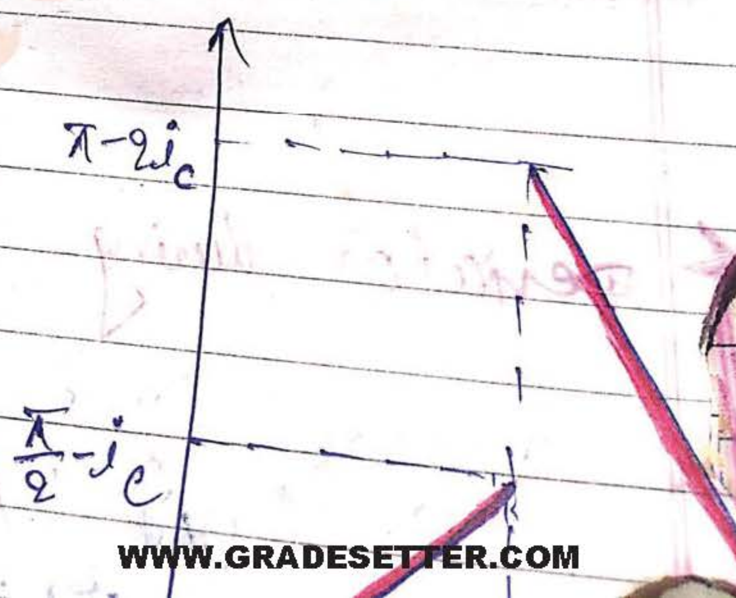
(i) At $i = i_c$

$$\boxed{\delta = \frac{\pi}{2} - i_c}$$

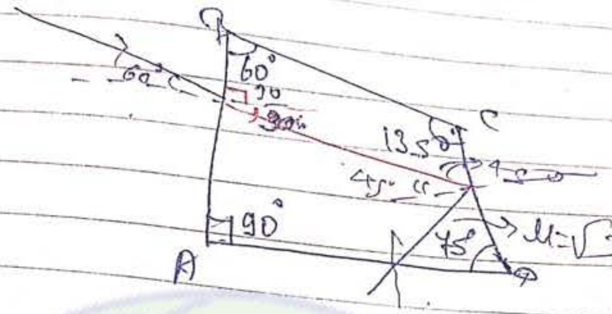
(ii) After TIR ($i > i_c$)



$$\boxed{\delta = \pi - 2i}$$

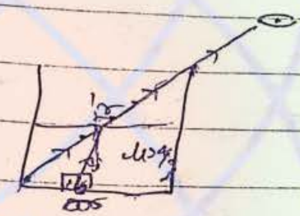


Ex = 8.4
Q.No = 13



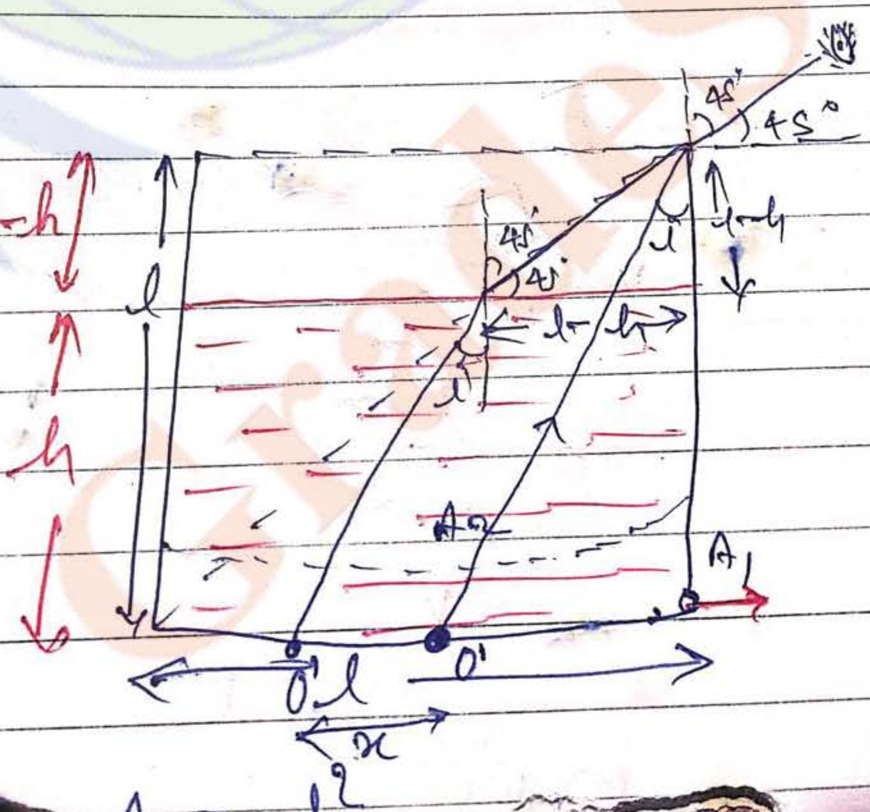
$\sin i_c = \frac{1}{\sqrt{3}}$

Ex = 5
Q.No = 2



a)

b)



$A_1 = \frac{l^2}{50\sqrt{5}}$

$$\frac{\sqrt{5}}{2}\sin i = \sin 45^\circ = \frac{1}{\sqrt{2}}$$

$$\sin i = \frac{1}{\sqrt{5}}$$

$$\boxed{\tan i = \frac{1}{2}}$$

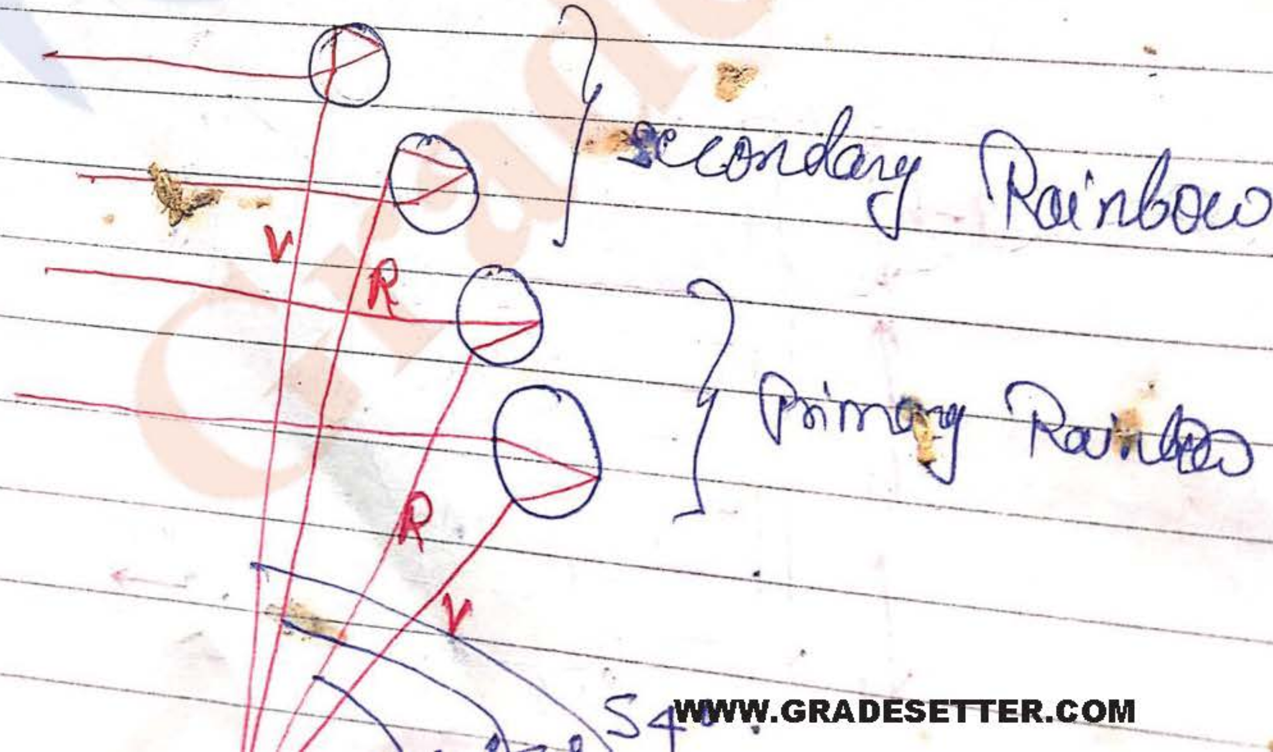
$$x = (l-h) - \left(\frac{l-h}{2}\right)$$

$$x = \frac{l-h}{2}$$

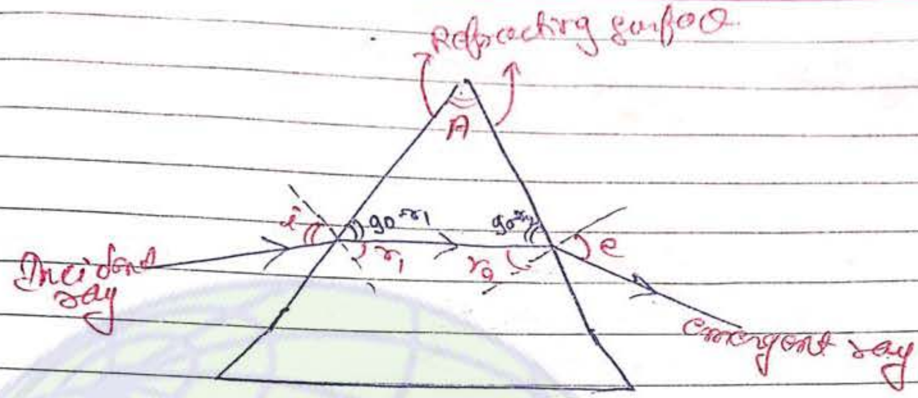
$$\frac{dx}{dt} = \frac{1}{2}\left[\frac{dl}{dt} - \frac{dh}{dt}\right]$$

$$\frac{dx}{dt} = -\frac{1}{2}\frac{dh}{dt}$$

Rainbow formation

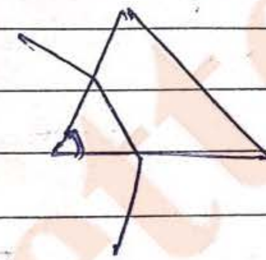


Prism



∠A :→ Angle of Refracting s
∠i :→ Angle of Incidence
∠e :→ Angle of emergence.

Note→



1) Prism is an optical device made up of transparent surface where the two refr surfaces are not Parallel to each other

2) The angle b/w two refracting surface called as Angle of Prism.

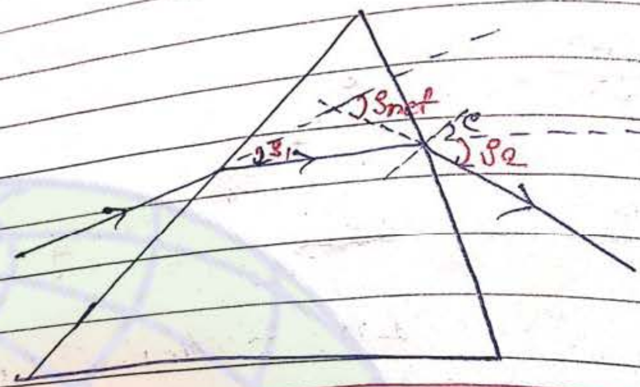
Some Important expression's about Pr

1) $A + (90 - r_1) + (90 - r_2) = 180$

$$\boxed{\angle A = \angle r_1 + \angle r_2}$$

1st Choice

2) Deviation through Prism



$$\boxed{\delta_1 = i - r_1 \; (\circlearrowright)}$$

$$\boxed{\delta_2 = e - r_2 \; (\circlearrowleft}$$

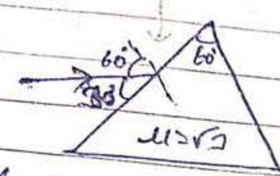
$$\delta_{net} = (i+e) - (r_1 + r_2)$$

$$\Rightarrow \boxed{\delta_{net} = i + e - A}$$

Note → The net deviation produced by the prism depends upon:—

i) Angle of Incidence.
ii) Angle of Prism
iii) Refractive Index of material
iv) wavelength of light.

5a)



find out
a) Angle of emergence
b) Net deviation

80/4

$1 \sin 60 = \mu_2 \sin \theta$

$\frac{\sqrt{3}}{2} \times \frac{1}{\sqrt{3}} = \sin \theta$

$\sin \theta = \frac{1}{2}$

$r_1 = \theta = 30°$

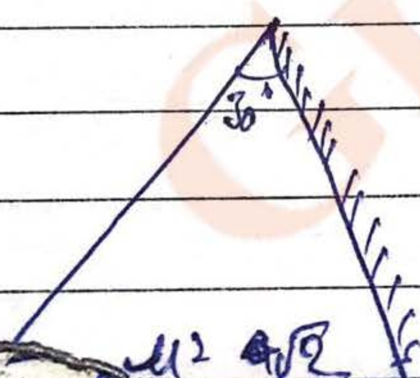
$\angle r_2 = 60 - r_1$

$= 30°$

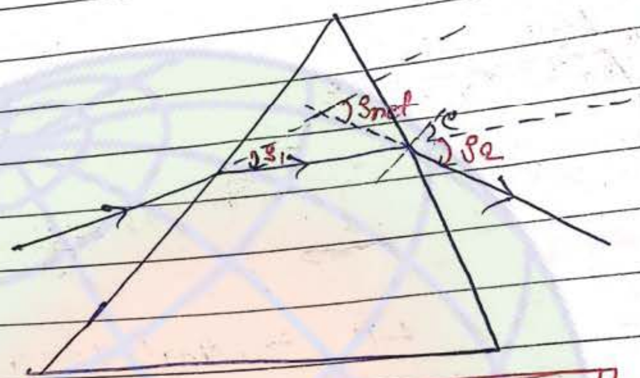
$\sqrt{3} \sin 30 = \sin(e)$

$\boxed{\angle e = 60}$ (a)

$\boxed{\delta_{net} = 60 + 60 - 60 = 60°}$ (b)



2) Deviation through Prism



$$\boxed{\delta_1 = i - r_1 \ (1)}$$

$$\boxed{\delta_2 = e - r_2 \ (2)}$$

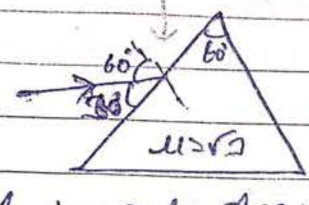
$$\delta_{net} = (i+e) - (r_1 + r_2)$$

$$\Rightarrow \boxed{\delta_{net} = i + e - A}$$

Note → The net deviation produced by the prism depends upon:—

i) Angle of Incidence
ii) Angle of Prism
iii) Refractive Index of material
iv) wavelength of light.

5a)



find out :-
a) Angle of emergence
b) ~~Angle~~ Net deviation

Sol/n

$$1 \sin 60 = \mu_2 \sin \theta$$

$$\frac{\sqrt{3}}{2} \times \frac{1}{\sqrt{3}} = \sin \theta$$

$$\sin \theta = \frac{1}{2}$$

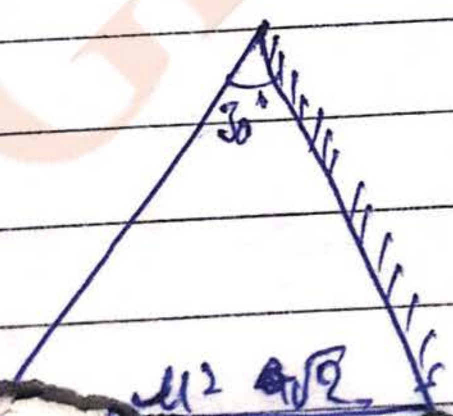
$$r_1 = \theta = 30°$$

$$\angle r_2 = 60 - r_1$$
$$= 30°$$

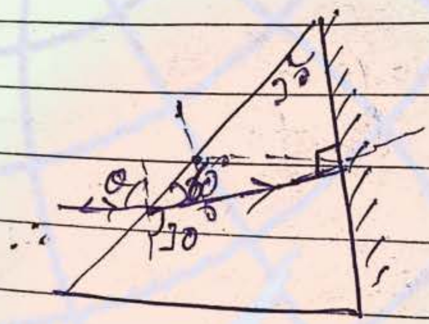
$$\sqrt{3} \sin 30 = \sin(e)$$

$$\boxed{\angle e = 60}$$

$$\boxed{\delta_{net} = 60 + 60 - 60 = 60°}$$



should be Incident on the first surface as shown so that it can retrace it's path.



$\mu_1 \sin\theta = \mu_2 \sin 90°$

$\sin\theta = \sqrt{2} \times 1$

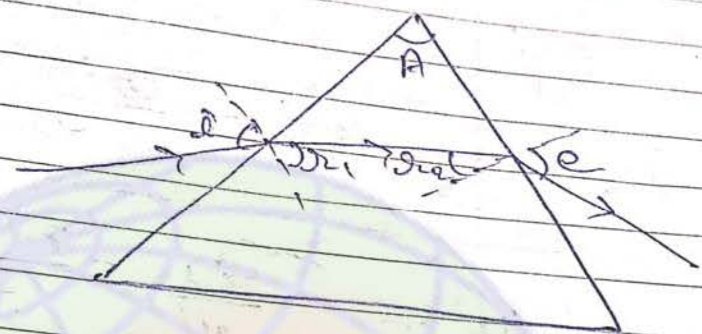
$\sin\theta = \sqrt{2}$

$\sin i = \sqrt{2}\left(\frac{1}{2}\right)$

$\angle i = 45°$ Ans.

Page No. 158

Angle of deviation → (δ)



Angle of deviation –

$$\boxed{\delta_{net} = i + e - A} \quad \text{—(i)}$$

At second surface.

$\mu \sin r_2 = \sin e$

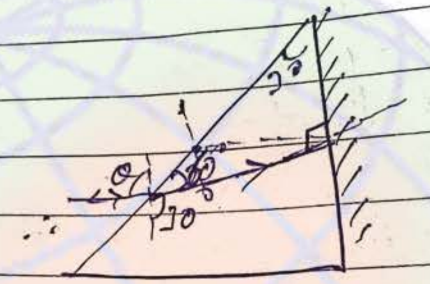
$\Rightarrow \quad e = \sin^{-1}[\mu \sin r_2]$

$\Rightarrow \quad e = \sin^{-1}[\mu \sin(A - r_1)]$

$\Rightarrow e = \sin^{-1}[\mu\{\sin A \cos r_1 - \cos A \sin r_1\}]$

$\Rightarrow e = \sin^{-1}[\mu\{\sin A\sqrt{1-\sin^2 r_1} - \cos A \sin r_1$

should be Incident on the first surface as shown so that it can retrace it's Path.

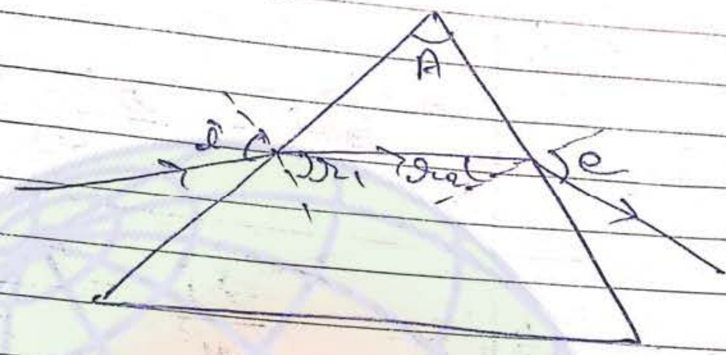


$\mu_1 \sin\theta = \mu_2 \sin 90°$
~~$\sin\theta = \sqrt{2} \times 1$~~
~~$\sin\theta = \sqrt{2}$~~

$\sin i = \sqrt{2}\left(\frac{1}{2}\right)$

$\angle i = 45°$ Ans.

Angle of deviation → (δ)



Angle of deviation.—

$$\boxed{\delta_{net} = i + e - A} \quad \text{—(i)}$$

At second surface.

$$\mu \sin r_2 = \sin e$$

$$\Rightarrow \quad e = \sin^{-1}[\mu \sin r_2]$$

$$\Rightarrow \quad e = \sin^{-1}[\mu \sin(A - r_1)]$$

$$\Rightarrow \quad e = \sin^{-1}[\mu\{\sin A \cos r_1 - \cos A \sin r_1\}]$$

$$\Rightarrow \quad e = \sin^{-1}[\mu\{\sin A \sqrt{1-\sin^2 r_1} - \cos A \sin r_1$$

Page
Date / /

1st Choice

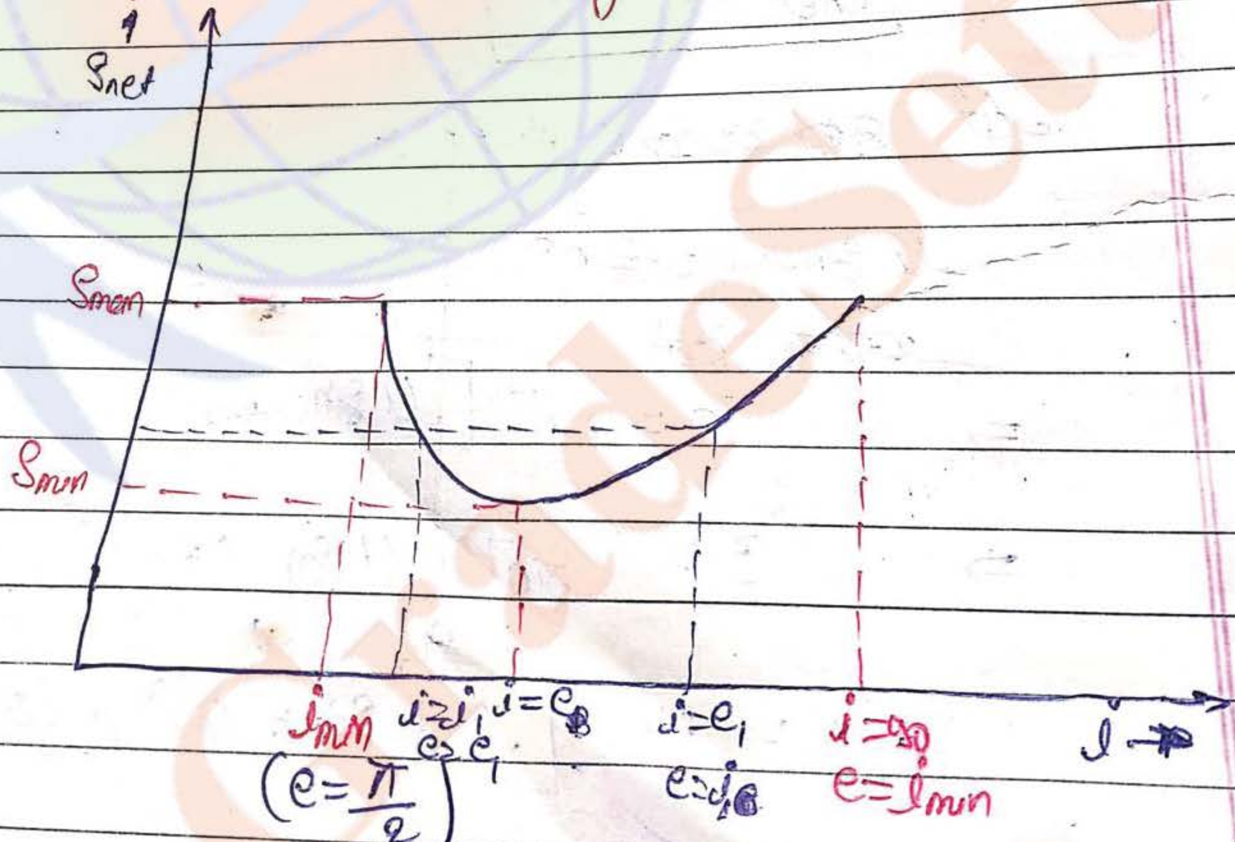
~~At first~~

$$\sin r_1 = \frac{\sin i}{\mu}$$

$$e = \sin^{-1}\left[\mu\left\{\sin A\sqrt{1-\frac{\sin^2 i}{\mu^2}} - \frac{\cos A \sin i}{\mu}\right\}\right]$$

$$\boxed{\delta_{net} = i + \sin^{-1}\left[\mu\left\{\sin A\sqrt{1-\frac{\sin^2 i}{\mu^2}} - \frac{\cos A \sin i}{\mu}\right\}\right] - A}$$

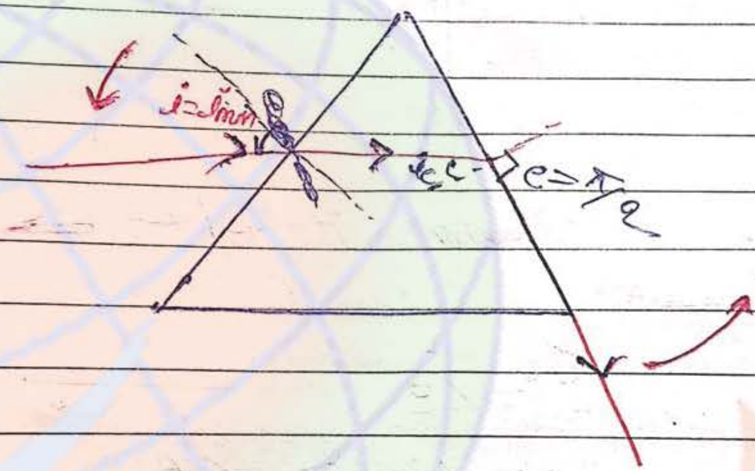
→ Graph b/w δ_{net} and angle of Incidence →

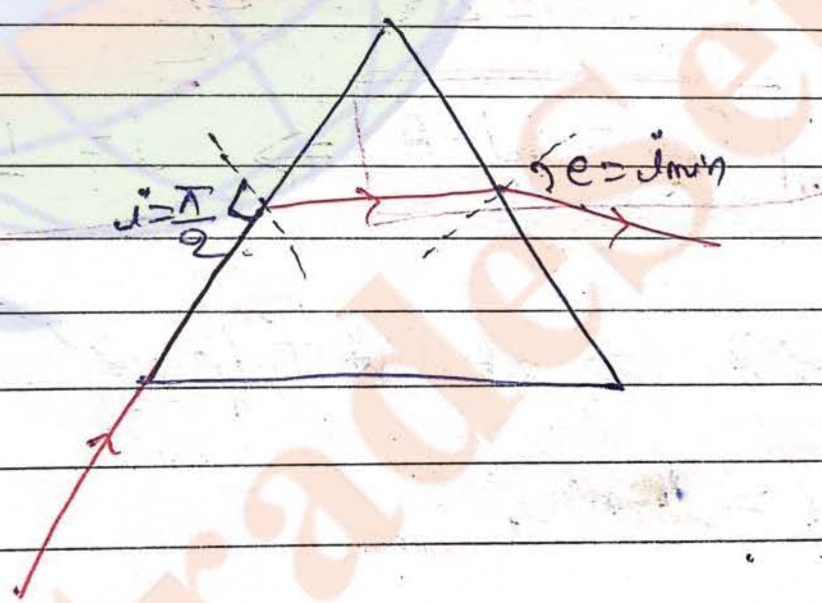


...portant Point Related to graph

On this graph a certain ...

angle r_2 will be larger. and if this value of r_2 is greater than critical angle then T.I. will take place at the 2nd surface and ... will not be able to receive any emergent ray for the second surface.





2.) Principal of reversibility ⇒

From the principal of reversibility we can say the value of Angle of Incidence and angle of emergence can be mutually Interchang that's why we are getting the same deviate for two different values of Angle of Incidence.

3) when the deviation is minimum the angle of Incidence is found to be equal to angle of emergence.

Angle of minimum deviation →
when deviation is minimum

$$\angle i = \angle e$$

$$\angle r_1 = \angle r_2 = \frac{\angle A}{2}$$

$$\boxed{\delta_{min} = 2i - A} \Rightarrow \boxed{i = \frac{A + \delta_{min}}{2}}$$

From snell's law at At surface -

$$\sin i = \mu \sin r_1$$

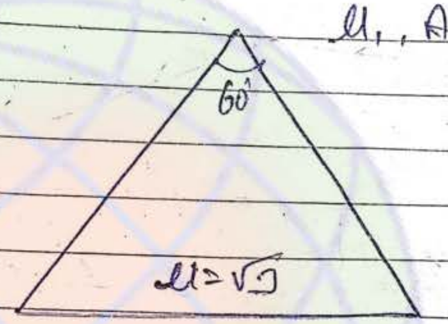
$$\Rightarrow \sin\left(\frac{A+\delta_{min}}{2}\right) = \mu \sin\left(\frac{A}{2}\right)$$

Important

$$\mu = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\ldots}$$

The value of angle of minimum deviation depend's upon angle of prism as well as refrective index of it's mat

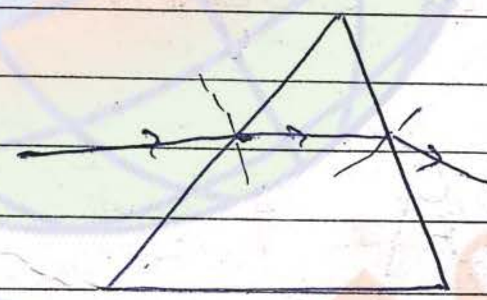
Example:→



find out angle of minimum deviation as well as angle of incidence for which deviation is

Sol^n

Ans 60,

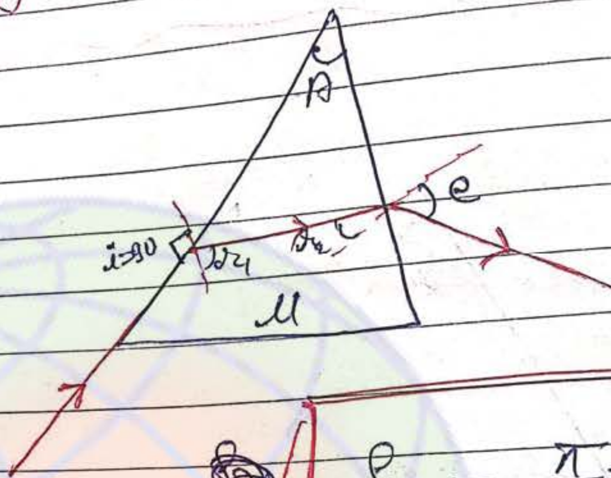


$$\sqrt{3} = \frac{\sin\left(\frac{60 + \delta_{min}}{2}\right)}{\sin\left(\frac{60}{2}\right)}$$

$\delta_{min} =$

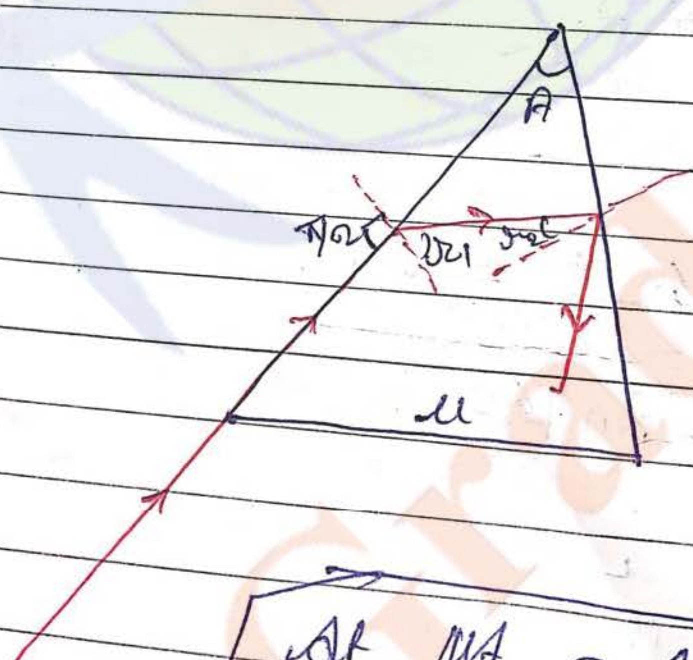
$i = \frac{A + \delta_{min}}{2}$

4) Angle of maximum deviation:-



$$\boxed{\delta_{max} = \frac{\pi}{2} + e - A}$$

5.) Condition of No-emergence →



$(r_2 = A - r_1)$

At 1st surface

$\sin 90 = \mu \sin r_1$

$\sin r_1 = \frac{1}{\mu}$

At 2nd surface :-

$r_2 > i_c$

$\sin r_2 > \sin i_c$

$\sin r_2 > \frac{1}{\mu}$

$\sin (A - r_1) > \frac{1}{\mu}$

$\Rightarrow$

At 1st surface

$\sin 90 = \mu \sin r_1$

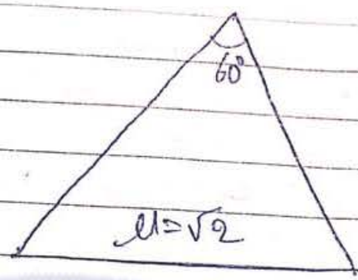
$\sin r_1 = \frac{1}{\mu} = \sin i_c$

$r_1 = i_c \quad —(i)$

At 2nd surface

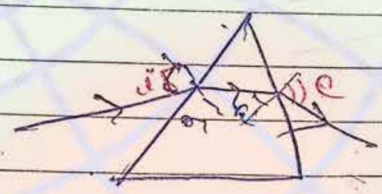
$A - r_1 > i_c$

Ex)



Find out angle of max. deviation.

Sol/n



$i = \frac{\pi}{2}$

$e = ?$

$\mu_1 \sin 90 = \sqrt{2} \sin r_1$

$\frac{1}{\sqrt{2}} = \sin r_1$

$\boxed{r_1 = 45°}$

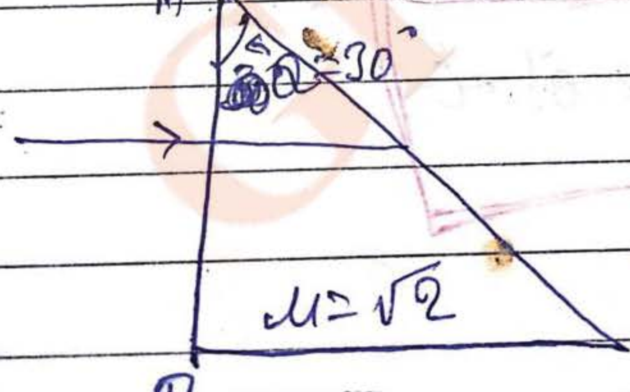
$\boxed{r_2 = 15°}$ $\boxed{\because 45 + ...}$

$\sqrt{2} \sin 15° = 1 \sin e$

$\sin e = \sin^{-1}(\sqrt{2} \sin 15°)$

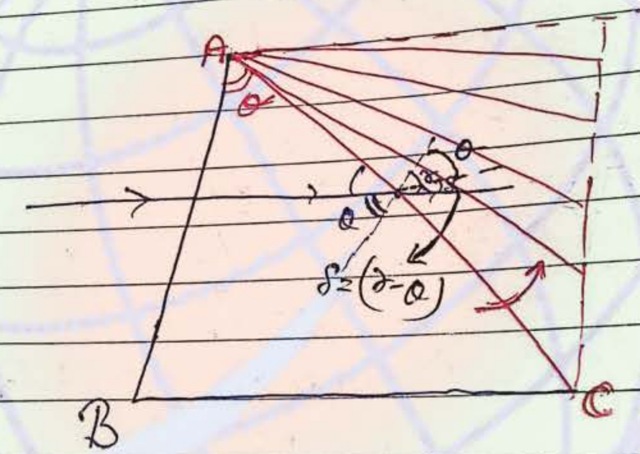
$\delta_{max} = \frac{\pi}{2} + \left[\sin^{-1}(\sqrt{2} \sin 15°)\right] - 60$

$= 30° + \sin^{-1}(\sqrt{2} \sin 15°)$



1st Choice

~~Q~~ keeping phase AB vertical till the angle becomes 90°, find out an expression for the deviation through the IInd phase AC as a function of "θ" and draw the graph also.



सोल्यू→
AB and BC में कोई change नहीं है सिर्फ "AC" पर material depend करके Angle "θ" को increase करेंगे 90° तक

$i_C = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right) = 45°$

when $\theta < 45° \rightarrow$

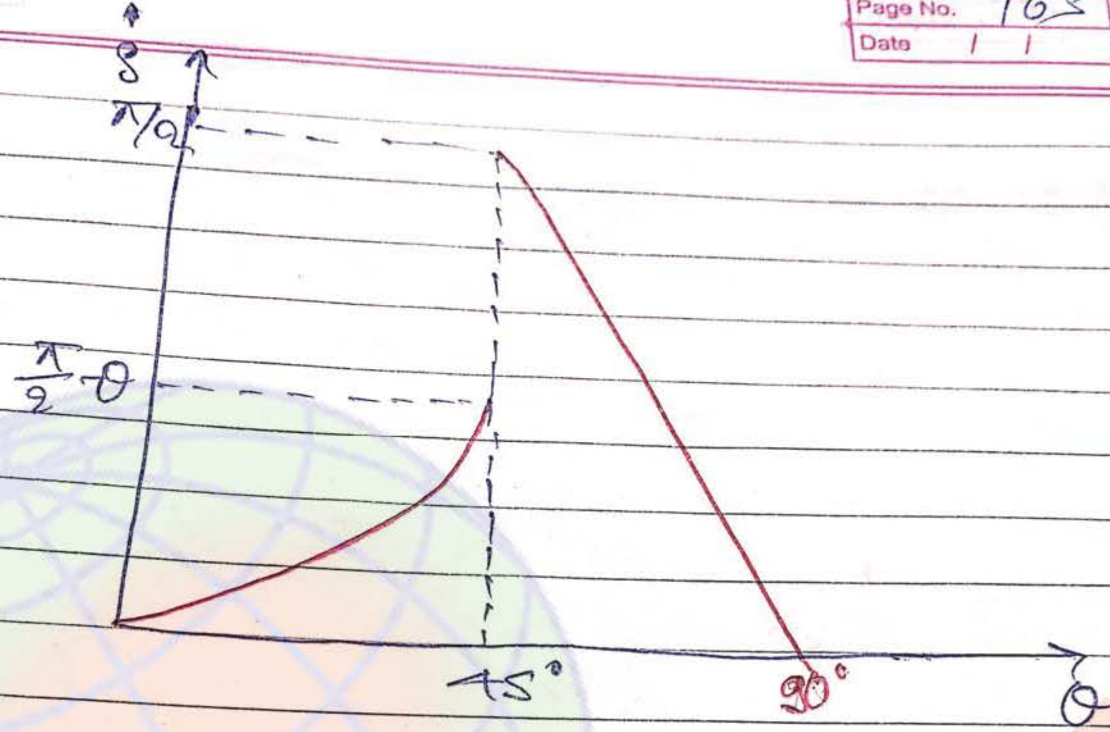
$\sqrt{2} \sin\theta = \sin r$

$r = \sin^{-1}[\sqrt{2} \sin\theta]$

$\delta = r - \theta$

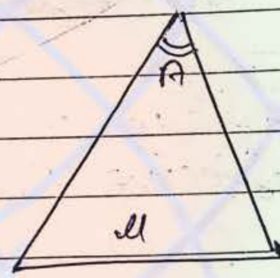
$$\boxed{\delta = \sin^{-1}[\sqrt{2}\sin\theta] - \theta}$$

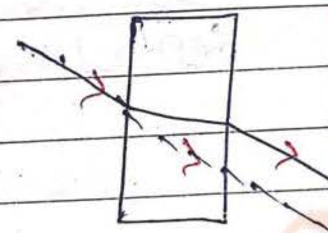
$\delta = \frac{\pi}{2} - \theta$


δ
π/2
$\frac{\pi}{2}-\theta$
45°
90°
θ

Thin Prism =

A prism having angle of prism less than 6° called as thin prism, where the two refracting surfaces are nearly parallel.

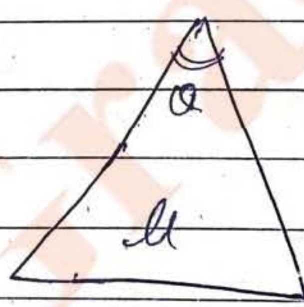




In the case of glass slab where the two refracting surfaces are exactly parallel the deviation (δ) whereas!,

In the case of thin prism the refracting surfaces are nearly parallel so the will be very-very small hence All the deviation can be treated as minimum deviation.

So,



$$\Rightarrow \mu = \frac{\sin\left(\frac{A+\delta}{2}\right)}{\sin\left|\frac{A}{2}\right|}$$

$\left(\delta_{min} \simeq \delta \right.$ (as

1st Choice

$$\frac{\mu A}{2} = \frac{A+\delta}{2}$$

IMP

$$\boxed{\delta = (\mu-1)A}$$

For the thin prism the angle of deviation depend's upon :-

i) Angle of prism and
ii) Refractive Index (μ) of the material.

1st Choice

Dispersion of light →

① monochromatic :- The monochromatic light has ... wavelength only.

② Dispersion of light →

when the light having more than one ... falls on one surface of the prism then it splits into it's constituents wavelength. This phenomenon is called as dispersion of ...

⇒ Cauchy's expression :-

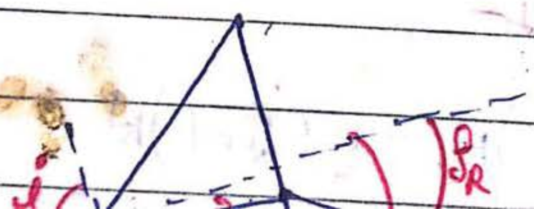
$$\boxed{\mu = A + \frac{B}{\lambda^2} + \dots}$$

A and B → constant (the value depend's on ...

λ = wavelength

Imp:

$$\boxed{\begin{gathered} \lambda_V < \lambda_I < \lambda_B < \lambda_G < \lambda_Y < \lambda_O < \lambda_R \\ \mu_V > \mu_I > \mu_B > \mu_G > \mu_Y > \mu_O > \mu_R \\ \delta_V > \delta_I > \delta_B > \delta_G > \delta_Y > \delta_O \end{gathered}}$$

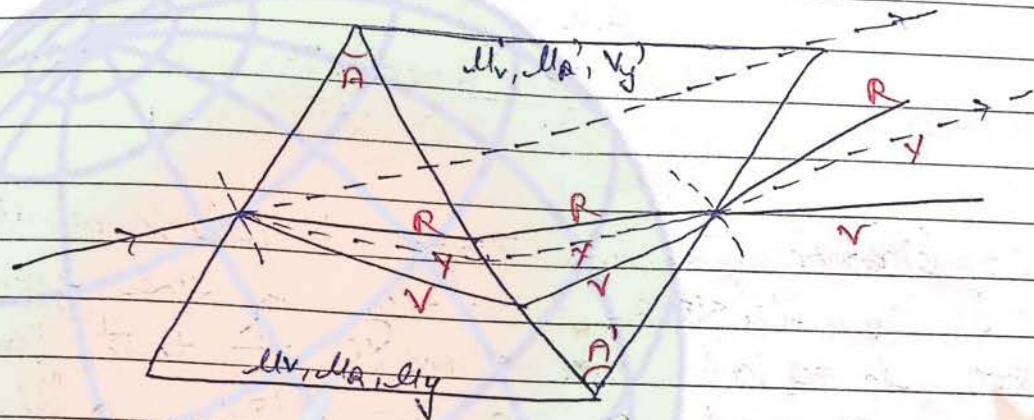


1st Choice

Note ⇒ A beam of white light passing through a hollow prism give no spectrum

Combination of two prism →

1) Dispersion without deviation →



$$(\mu_y - 1)A = (\mu_y' - 1)A'$$

$$\boxed{A' = \frac{(\mu_y - 1)A}{(\mu_y' - 1)}} \quad -(1)$$

→ याद रखें

or $A' = \frac{(\mu_y}{(\mu_y}$

$$\theta_{net} \Rightarrow (\mu_v - \mu_R)A - (\mu_v' - \mu_R')A'$$

$$\Rightarrow (\mu_v - \mu_R)A - \frac{(\mu_v' - \mu_R')(\mu_y - 1)}{(\mu_y' - 1)}$$

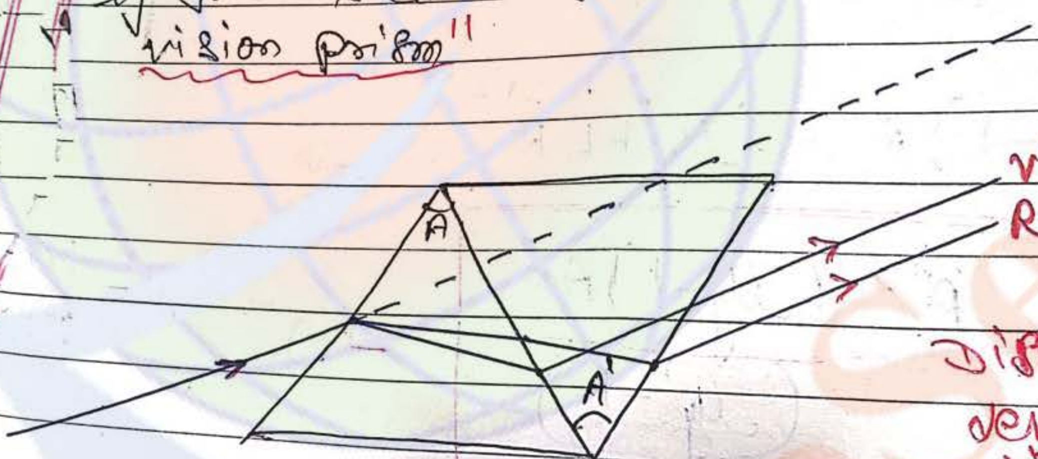
$$\Rightarrow (\mu_y - 1)A \left[\frac{(\mu_v - \mu_R)}{} \right.$$

so,

$$\boxed{\theta_{net} = \delta_1 [\omega - \omega']}$$

Here
$\delta_1 \Rightarrow$ mean deviation produced by 1st prism.

"A combination of two prism in which deviation produced for the mean ray by the first prism is equal and opposite to that produced by the second prism is called a direct vision prism"



Dispersion without deviation
(यहाँ dispersion तो हो रहा है लेकिन deviation नहीं हो रहा है।)

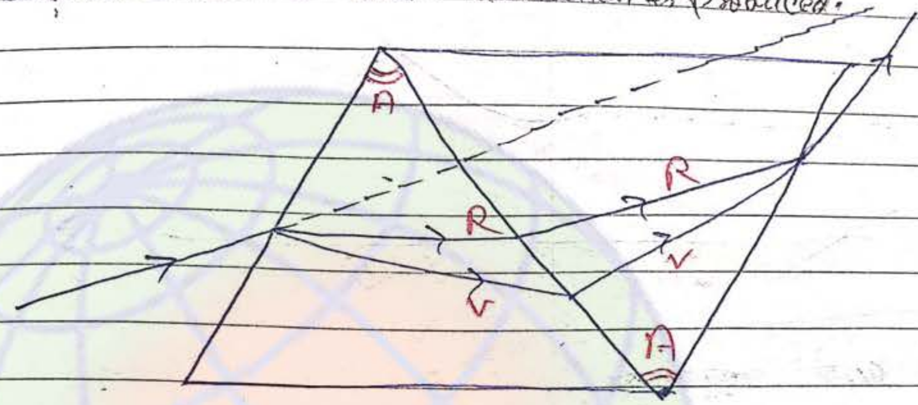
Deviation ⇒ अपने original path (mean Path) से विचलित होना।

Head DO DPPS Group

Learn all formulas very carefully

2.) Deviation without Dispersion (Achromatism)

An achromatic combination of two prism in which net or resultant dispersion is zero and deviation is produced.



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

$$\boxed{A' = \left(\frac{\mu_V - \mu_R}{\mu_V' - \mu_R'}\right) A}$$

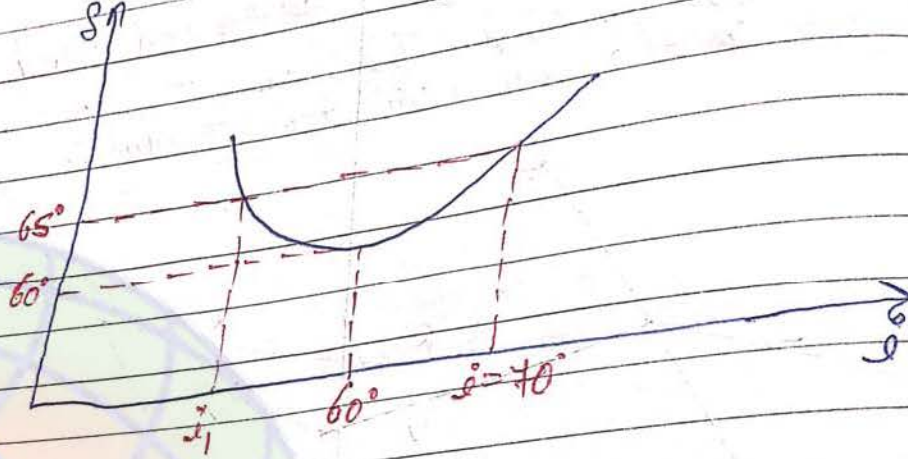
$$\delta_{net} = (\mu_y - 1) A - (\mu_y' - 1) A'$$

$$= (\mu_y - 1) A - \frac{(\mu_y' - 1)(\mu_V - \mu_R) A}{(\mu_V' - \mu_R')}$$

$$= (\mu_y - 1) A \left[1 - \frac{(\mu_y' - 1)(\mu_V - \mu_R)}{(\mu_y - 1)(\mu_V' - \mu_R')} \right]$$

1st Choice

Q. 5)



Find out :- ~~angle of~~

i) Angle of prism

ii) μ

iii) angle $\angle i_1$

a i) $\delta_{min} = 120 - A$

$60° - 120 = -A$

$-A = -60$

$A = 60°$

ii)

$$\mu = \frac{\sin\left(\frac{A + \delta_{min}}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

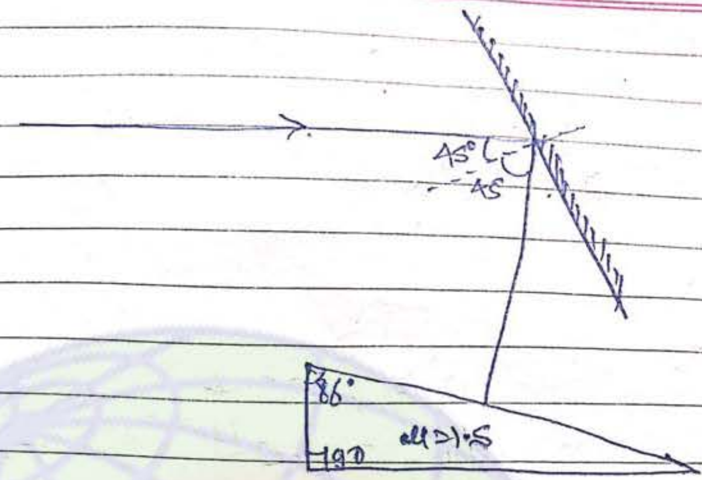
$= \sqrt{3}$

iii) $\delta = i + e - A$

$65 = i_1 + 70 - 60$

$i_1 = 55°$

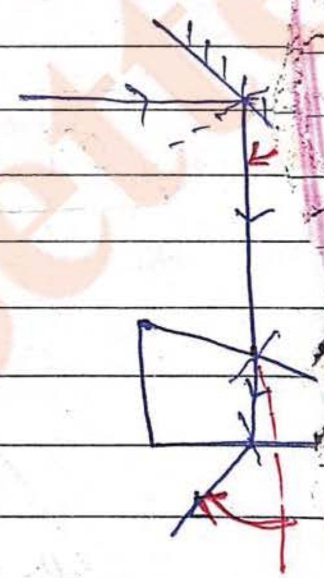
(Q.2)



Find out with how much angle the plane mir... to be rotated so that the net deviation be

Sol^n

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



$$\delta_{prism} = (\mu-1)A = 2^\circ$$

$$\delta_{mirror} = 90^\circ = 180 - 2i$$

$$\boxed{\delta_{net} = 92^\circ}$$

So,
we rotate mirror by 1°

$\cancel{\omega_f = 0.083}$

$\omega_c' = 0.$ ...

$A = 4^\circ$

$$A' = \left(\frac{\mu_v - \mu_R}{\mu_v' - \mu_R'}\right) A$$

$\omega = 0.053$ $\qquad$ $\omega' = 0.034$

$\mu_y = 1.68$ $\qquad$ $\mu_y' = 1.53$

$A' = 4$

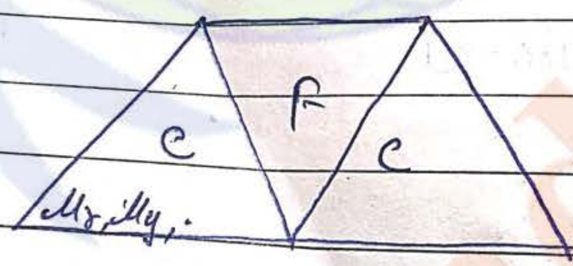
$A = ?$

(mean means

$\theta = 0$

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

$$\boxed{\omega(\mu_y - 1)A = \omega'(\mu_y' - 1)A'}$$



a) $\dfrac{A'}{A}$

$$2(\mu_v - \mu_R)A = (\mu_v' - \mu_R')A'$$

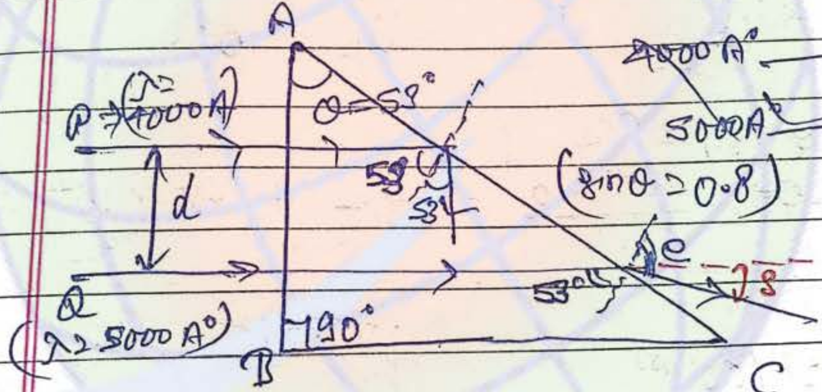
$2(\mu$

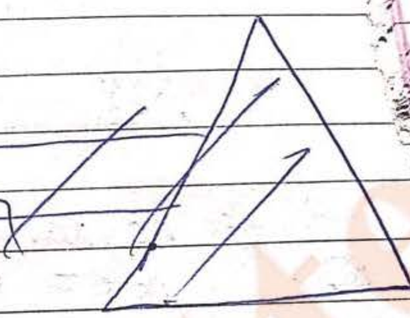
b) $2(\mu_y - 1)A = (\mu_y' - 1)A'$

$$\frac{A'}{A} = \frac{2(\mu_y - 1)}{(\mu_y' - 1)}$$

Ex-4
Q.No-1

$$\boxed{\mu(\lambda) = 1.20 + \frac{b}{\lambda^2}}$$





$\mu \sin \theta_c = 1$

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

$\theta_c = \sin^{-1}$

$\boxed{\theta_c = \sin^{-1}}$

a) $\mu = 1.20 + \frac{b}{\lambda^2}$

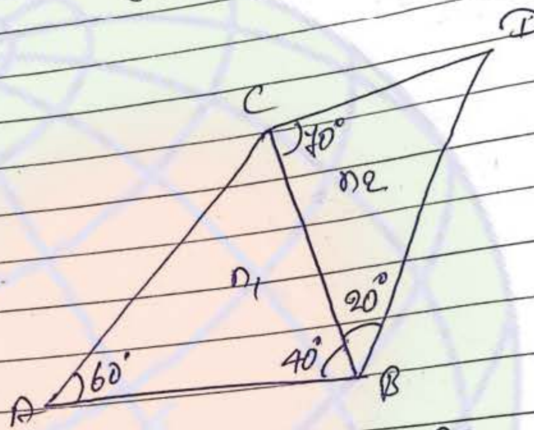
$$0.8 = \sin 53 = \frac{1}{1.20 + \frac{b}{\lambda^2}}$$

$\lambda = 4000 A^\circ$

$$\boxed{b = 0.8 \times 10^{-6}}$$

b) $\delta = e - 53°$

δ_2



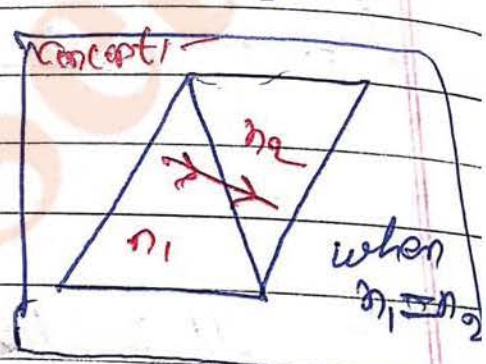
$i_c = 10°$

a) for no bending $n_1 = n_2$

$1.20 + \frac{10.8 \times 10^4}{\lambda^2} = 1.05 + \frac{1.80 \times 10^4}{\lambda^2}$

$\lambda = 600\,nm$

concept



b) $\lambda < \lambda_0$

$i = ?$

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

$A = 60°$

$\mu_1 = \sin^{-1}(\mu_2 \sin r)$

D.P.P.S ... 9,10
Sheet, Ex 2 1,2,3,4
181

~~sin i = 2 ... A~~

$$\sin i = [\mu]^{1/2}$$

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

$\boxed{\text{Ex}=2 \quad \text{Q.No}-4}$

$\mu =$

$\boxed{r_1 + r_2 = A}$

For T.I.R

$$A > 2i_c$$

$$\frac{A}{2} > i_c$$

$$\sin\left(\frac{A}{2}\right) > \sin i_c$$

$$\sin\left(\frac{A}{2}\right) > \frac{1}{\mu}$$

$$\mu > \frac{1}{\sin A/2}$$

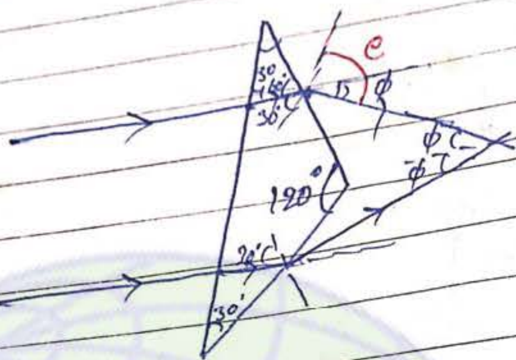
$$\mu > \operatorname{cosec}\left(\frac{A}{2}\right)$$

~~For T.I.R Not to take Place~~

$$\mu_{max} < \operatorname{cosec} A/2$$

$$\mu = \sqrt{1 + \cot^2\left(\frac{A}{2}\right)}$$

$\boxed{\begin{array}{c}Ex\ 4\\ Q.No-2\end{array}}$



$\mu = 1.44$

$1 \sin 0 = \mu_2 \sin r$

$0 = \cancel{1.44}\ \sqrt{2} \sin r$

$\sin r = 0$

$r = \sin^{-1} 0$

$r = 0$

$\cancel{\mu_2 \sin i = \mu_2 \sin r}$

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

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

$\cancel{r = 45°}$

For T.I.R

$\sin 30 = \frac{1}{2}$

$\sin i_c = \frac{1}{1.44}$

$1.44 \sin 30 = \sin e$

$e = \sin^{-1}(0.72)$

$\phi = e - 30°$

$$\boxed{\phi = \sin^{-1}(0.72) - 30°}$$

1) $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$ ((Relation b/w "u" and "v").)

2) $m = \frac{h_i}{h_o} = \frac{\mu_1}{\mu_2}\left(\frac{v}{u}\right)$

3) $\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ (∵ when both side have same R, I (lense maker formula)

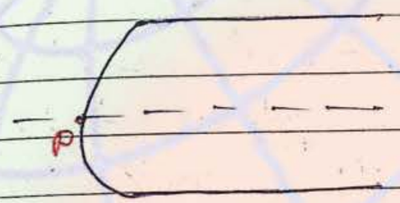
4) $\frac{1}{f} = \frac{\mu_2 - \mu_1}{\mu_3 R_1} + \frac{\mu_3 - \mu_2}{\mu_3 R_2}$ (∵ " " " " " dible " "

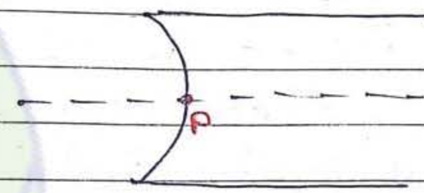
Refraction at Spherical Surface

★ Spherical refracting surface →

spherical refracting surface is a part of solid sphere which is made up of any transparent substance

convex Refracting surface | concave Refracting surface

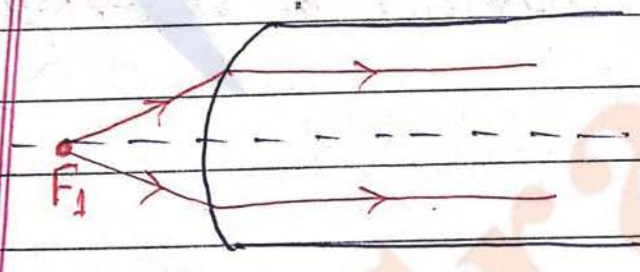


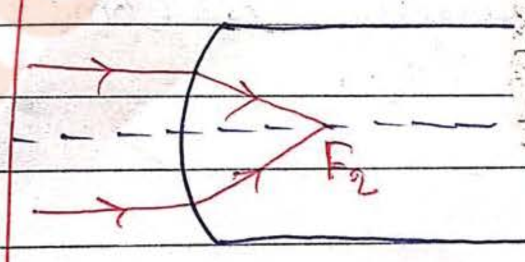


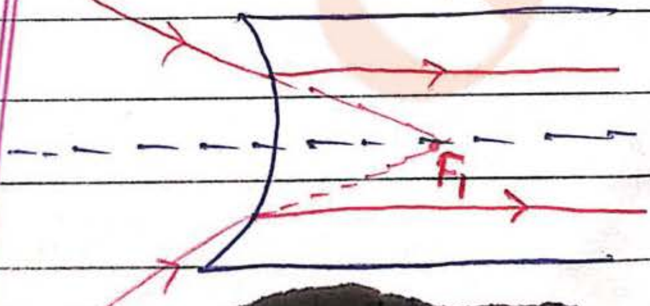
For any spherical refracting surface we define two different foci

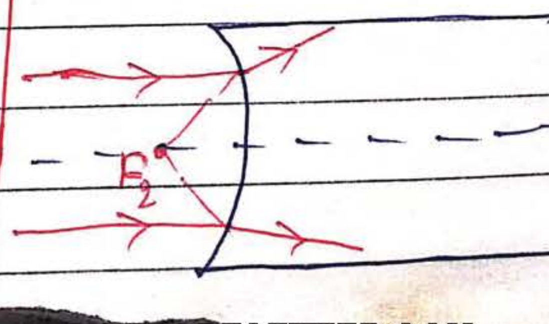
1) First Principal focus.
(जाने वाला ray parallel होगा)

2) Second Principal









1st Choice

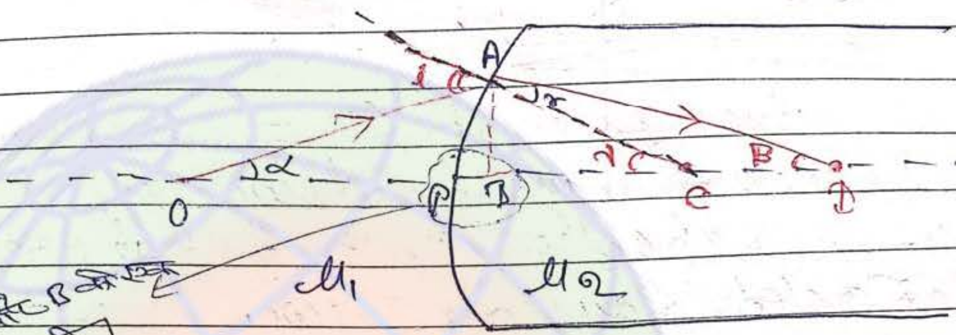
1st Principle focus- It is a point on the principal axis from where Incident rays diverse or where Incident ray appear to converse so that after the refraction the refracted ray become parallel to principle axis.

2nd Principle axis- If the Incident ray's are parallel to Principle axis then 2nd Principle focus is a point on principle axis where the refracted ray's either converse or from where refracted ray's appear to diverse

The convex refracting surface behaves like a conversing surface whereas the concave refracting surface behaves like a diversing surface provided the outside medium is rarer as compare to material of refracting surface.

Board

Relation b/w object distance (u) and Image distance for spherical refracting surface.



P और C B के बीच है

Step 1st
↳ Apply Snell's law

from Snell's law -

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

$$\Rightarrow \mu_1 i = \mu_2 r \quad \text{---(1)}$$ (for paraxial rays ∠i and ∠r a…

Step 2nd
↳ for angle "i" and "r"

$$i = \alpha + \gamma \quad \text{---(2)}$$

$$\gamma = r + \beta$$

$$\Rightarrow r = \gamma - \beta \quad \text{---(3)}$$

Step 3rd
अब सभी के value रखना है
α का value tan से पता करना है

$$\Rightarrow \mu_1 [\alpha + \gamma) = \mu [\gamma - \beta]$$

$$\Rightarrow \mu_1 \left[\frac{AB}{PO} + \frac{AB}{PC}\right] = \mu_2 \left[\frac{AB}{PC} - \frac{AB}{PI}\right]$$

Step 4th
↳ अब sign convention से value put करो

$$\Rightarrow \frac{\mu_1}{PO} + \frac{\mu_1}{PC} = \frac{\mu_2}{PC} - \frac{\mu_2}{PI}$$

$$\Rightarrow PO = -u$$

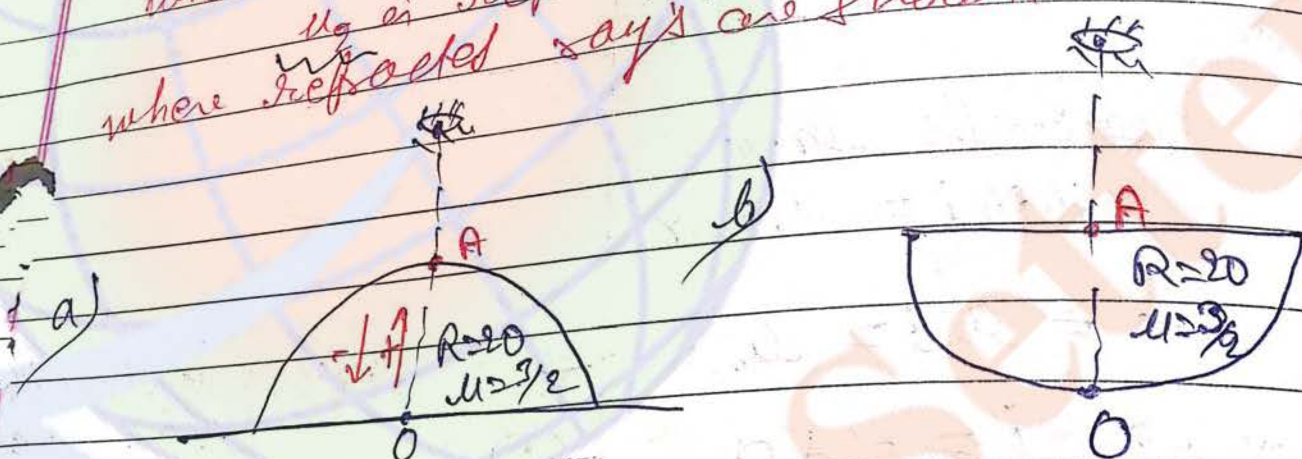
$PI = v$

1st Choice

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

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

Note ⇒ μ_1 is refractive index of that medium where incident rays are shown and μ_2 is refractive index of that medium where refracted rays are shown.

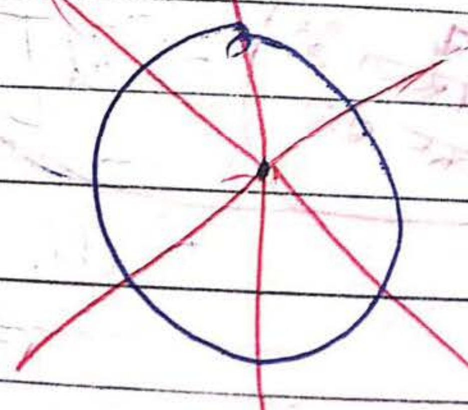


Find out app' depth from top surface for Image of Point "O".

Sol

(a) $\frac{3}{2v} - \frac{1}{u} = \frac{3/2 - 1}{R}$

(b)



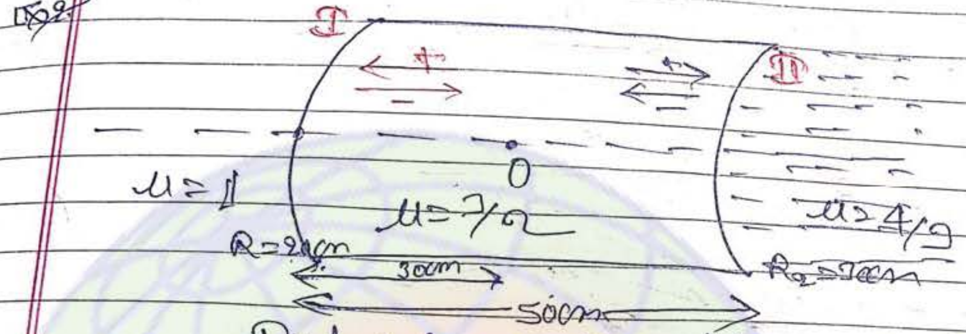
$$\frac{1}{v} - \frac{3}{2(-20)} = \frac{1 - 3/2}{-20}$$

$$\Rightarrow \boxed{v = -20\ cm}$$

1st Choice

Page No. 193
Date / /

Q2.



Find out the position of Images formed by both the refracting surfaces separately.

Sol: For 1st surface.

$$\frac{1}{30} - \frac{3}{2u} = \frac{1 - 3/2}{20}$$

$\mu_1 = 3/2$, $\mu_2 = 1$, $u = -30$, $R = -20cm$

$$\frac{-3}{2u} = \frac{\frac{2-3}{2}}{20} - \frac{1}{30}$$

$$\frac{-3}{2u} = \frac{-1}{40} - \frac{1}{30}$$

$$\frac{-3}{2u} = \frac{-3-4}{120}$$

$$\frac{\cancel{-}3}{\cancel{2}u} = \frac{\cancel{-}7}{\cancel{120}\,60}$$

$$u = \frac{180}{7}$$

For 1st surface

$$\frac{1}{v} - \frac{3}{2(-30)} = 1$$

$$\boxed{v = -40cm}$$

For 2nd surface

$\mu_1 = 3/2$, $\mu_2 = 4/3$

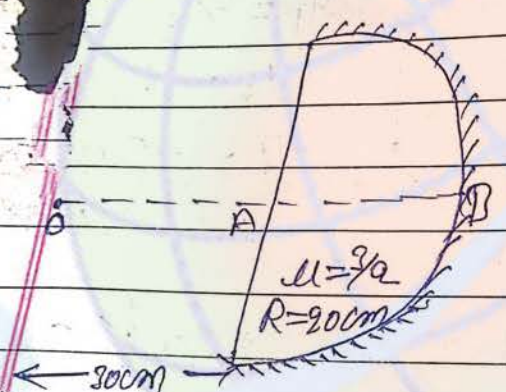
20, R = ...

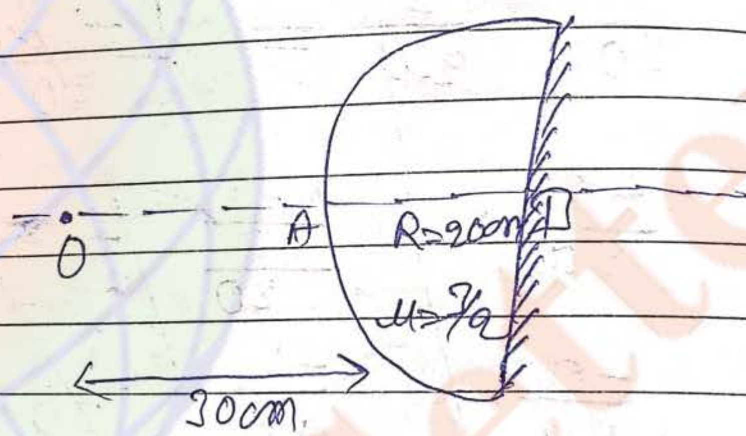
$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\frac{4}{3(v)} - \frac{3}{2(-20)} = \frac{4/3 - 3/2}{30}$$

$v = -16.5$ cm

Ex9) (a) (b)





Find out the distance of final Image from 'A'!

$u_2 = 3/2$

$R = -20$ cm

$u = -30$ cm

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

$\frac{3}{2v} - \frac{1}{-30}$ ...

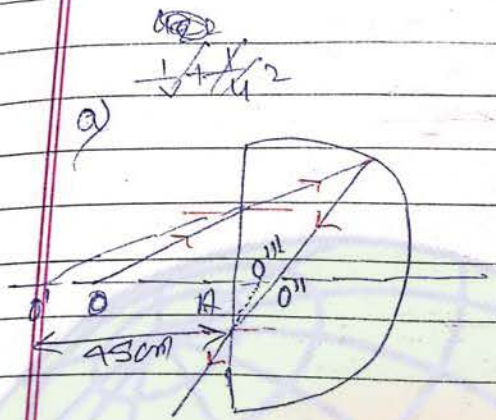
$\frac{3}{2v} - \frac{1}{-40} = \frac{1}{30}$

$\frac{3}{2v} = \frac{-3+4}{120/180}$

$\frac{1}{v_2} = \frac{7}{180}$

$\boxed{v_2 = \frac{180}{7}}$

a)



For 1st refraction

$\mu = \frac{3}{2} = \frac{AO'}{AO} \Rightarrow AO' = 45cm$

For Concave mirror

$u = -65cm$

$f = -10cm$

$\frac{1}{v} = -\frac{1}{10} + \frac{1}{65} = \frac{-13+2}{130}$

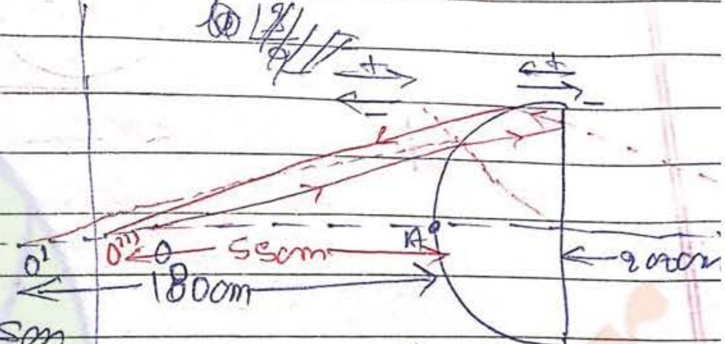
$\boxed{v = \frac{-130}{11}}$

For 2nd refraction.

$\mu = \frac{3}{2} = \frac{AO''}{AO'''} = \frac{20 - \frac{130}{11}}{AO'''} = \frac{90}{11(AO''')}$

$\boxed{AO''' = \frac{180}{33} = \frac{60}{11} cm}$

b)



For 1st refraction:-

$\frac{3}{2v} + \frac{1}{30} = \frac{\frac{3}{2} - 1}{20} =$

$\frac{3}{2v} = \frac{1}{40} - \frac{1}{30}$

$\boxed{v = -180cm}$

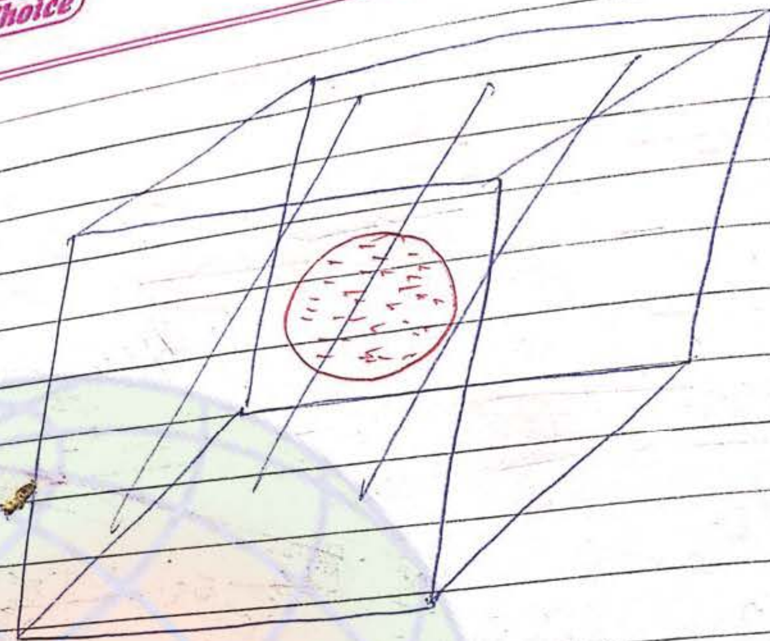
For 2nd refraction:-

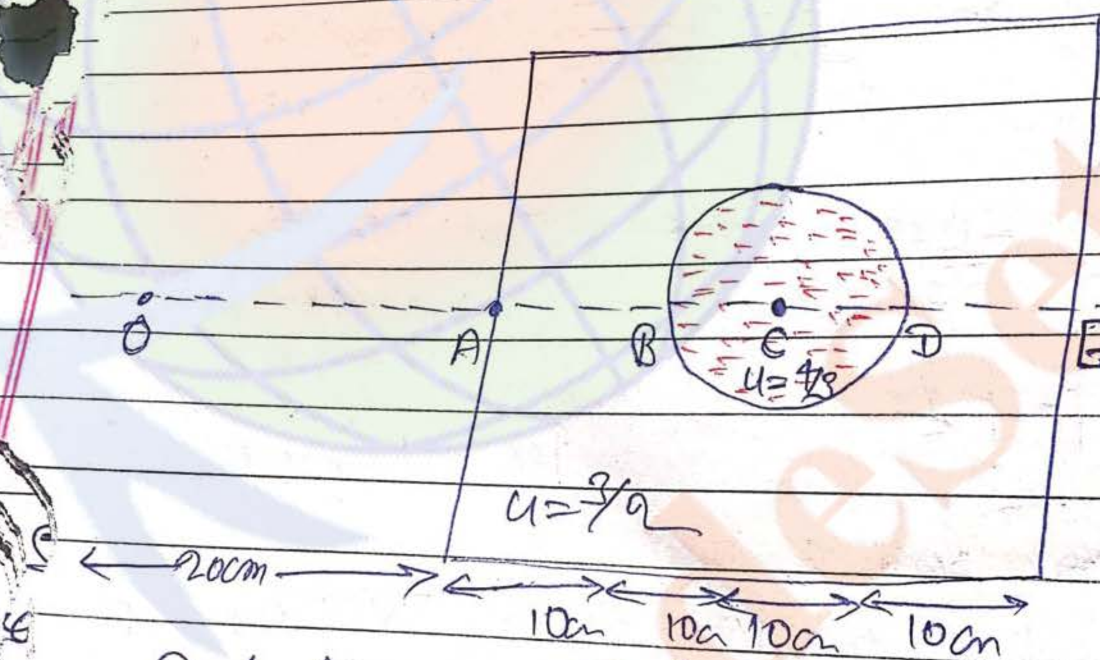
$\frac{1}{v} - \frac{3}{2(-220)} =$

$\frac{1}{v} + \frac{3}{440} =$

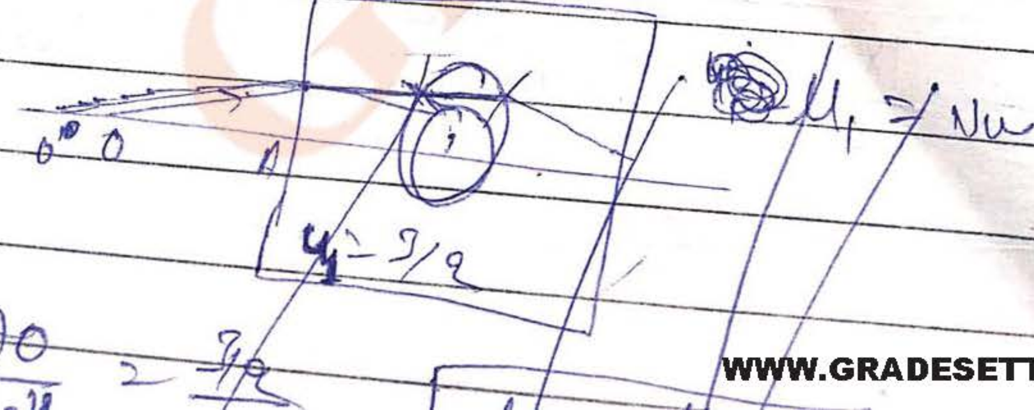
$\frac{1}{v} = \frac{1}{40} - \frac{}{4}$

$\boxed{v = 55cm}$

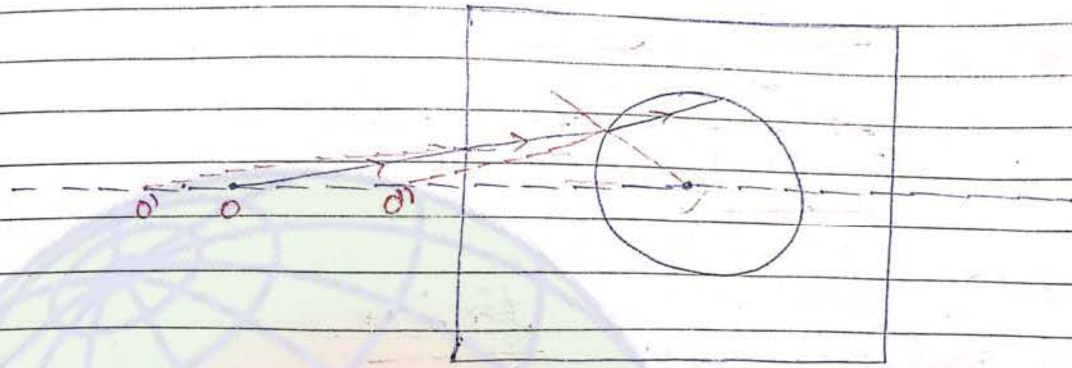




Find distance of final Image from "E".



$\frac{AO}{AO''} = \frac{3/2}{}$



For 2nd refraction -

$$\frac{4}{3(v)} - \frac{3}{2(-40)} = \frac{4/3 - 3/2}{10}$$

$$v = \frac{-320}{13} \text{ cm}$$

For 3rd refraction

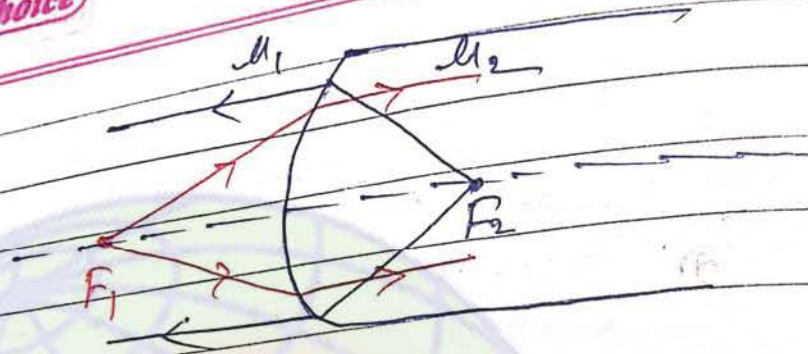
$$\frac{3}{2(v)} - \frac{4}{3\left(\frac{-580}{13}\right)} = \frac{3/2 - 4/3}{-10}$$

$$\frac{3}{2v} - \frac{4}{\frac{-1740}{13}} = \frac{9-8}{6\times 10}$$

$$\frac{3}{2v} + \frac{4\times 13}{1740} = \frac{-1}{60}$$

$$\frac{3}{2v} = \frac{-1}{60} - \frac{54}{1740}$$

$$\frac{3}{2v} = \frac{-29-54}{1740}$$



for f_1 :-

$$\frac{-\mu_1}{f_1} = \frac{\mu_2-\mu_1}{R} \quad —(1)$$

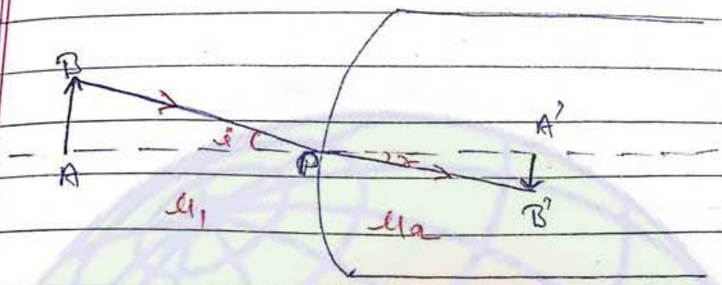
for f_2 :-

$$\frac{\mu_2}{f_2} = \frac{\mu_2-\mu_1}{R} \quad —(2)$$

$$\frac{-\mu_1}{f_1} = \frac{\mu_2}{f_2} \Rightarrow \frac{-f_2}{\mu_2} = \frac{f_1}{\mu_1}$$

$$\Rightarrow \frac{-f_1}{\mu_1} = \frac{f_2}{\mu_2}$$

Linear magnification for refraction through spherical su[rface]



From Snell's law

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

For Paraxial ray's

$$\mu_1 \tan i = \mu_2 \tan r$$

$$\Rightarrow \mu_1 \left[\frac{AB}{PA}\right] = \mu_2 \left[\frac{A'B'}{PA'}\right]$$

$$\left.\begin{aligned} AB &= H_0 \\ A'B' &= -H_I \\ PA &= -u \\ PA' &= v \end{aligned}\right\}$$

$$\Rightarrow \mu_1 \left[\frac{H_0}{-u}\right] = \mu_2 \left[\frac{-H_I}{v}\right]$$

$$\boxed{m = \frac{H_I}{H_0} = \frac{\mu_1}{\mu_2}\left(\frac{v}{u}\right)}$$

In this expression all the term's will be taken with ⊕ sign ... while ... the problem ...

$\frac{1}{10-4}$ Sol^n $H_0 = 0.5cm$ (convex mirror)

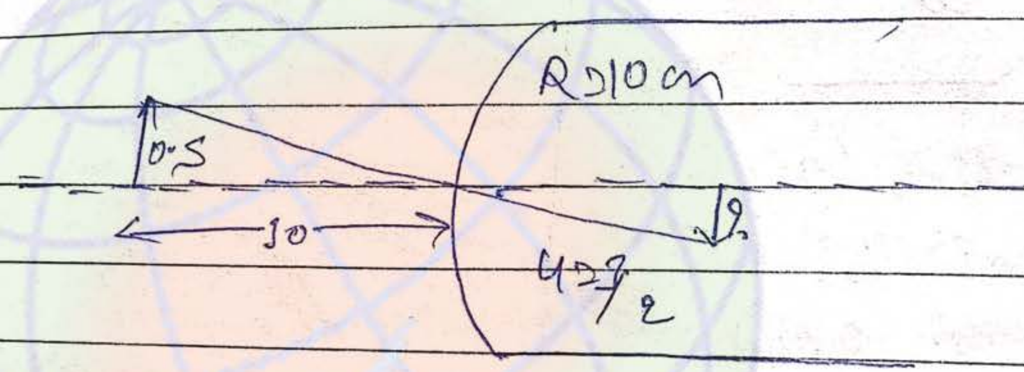
$\mu = 1.5$

$R = 10cm$

$u = -30cm$

$H_I = ?$

Sol^n



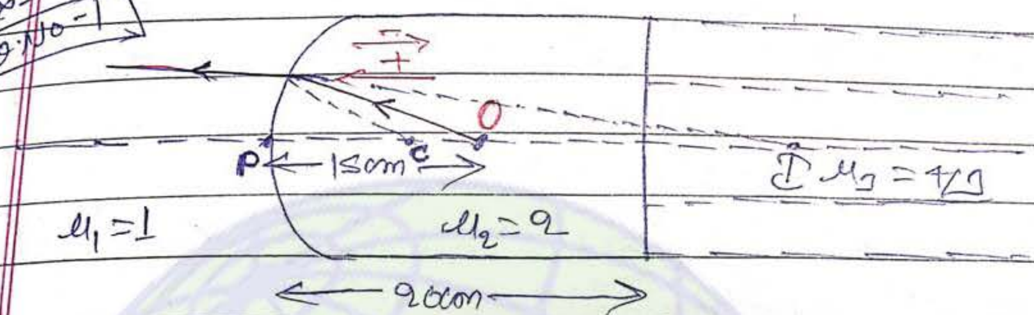
$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

$v = $ ___

then put

$m =$

Q.No-1



calculate the distance of final Image of "O" as viewed from left.

Sol^n $u = -15cm$

$R = -10cm$

$\mu_2 = 1$

$\mu_1 = 2$

$\Rightarrow \frac{1}{v} + \frac{2}{15} = \frac{1-2}{-10}$

$\Rightarrow \boxed{v = -30cm}$

Lense is an optical device made up of a transparent substance where atleast one of the surface has to be spherical Refracting surface.

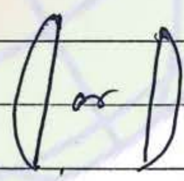
The problem based on thin lense can be directly solved using the expressions derived for thin lense whereas the problem based on thick lense can be solved by applying the expression from refraction at spherical surface twice.

Type of lense:-

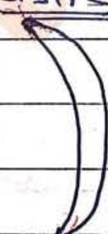
1) Convex :-

a) Biconvex

b) Plano Convex

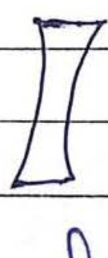


c) Concavo Convex

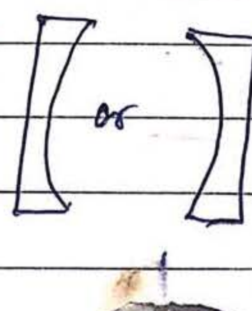


2) Concave :-

a) Biconcave



b) Plano Concave



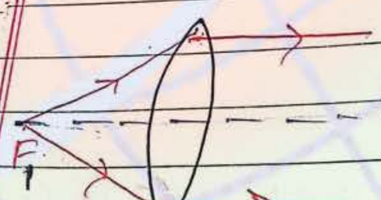
c) Convexo concave

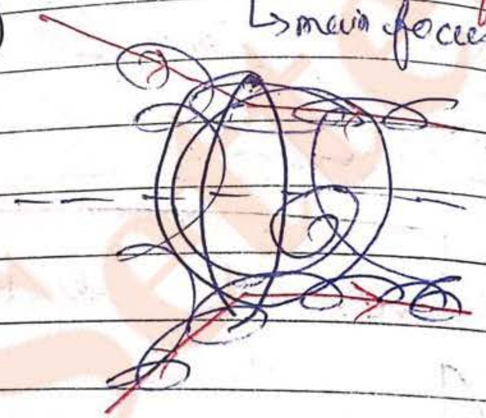
Note:-

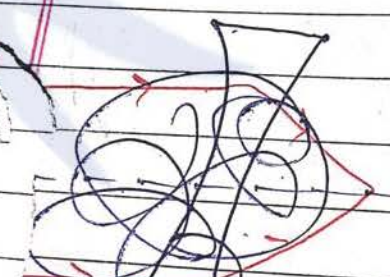
1) The convex lenses are relatively thicker in the middle whereas concave lens are thin at the middle.
2) The surface having larger radius of curvature should be written 1st.
3) For any lens two diff^n foci are defined.

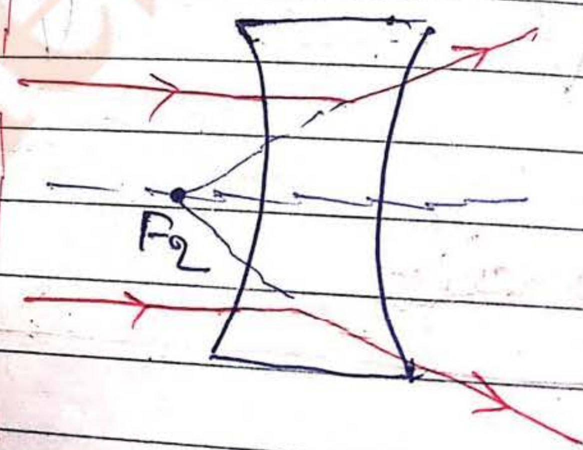
1st Principle focus (जाने वाला ray Parallel होगा)

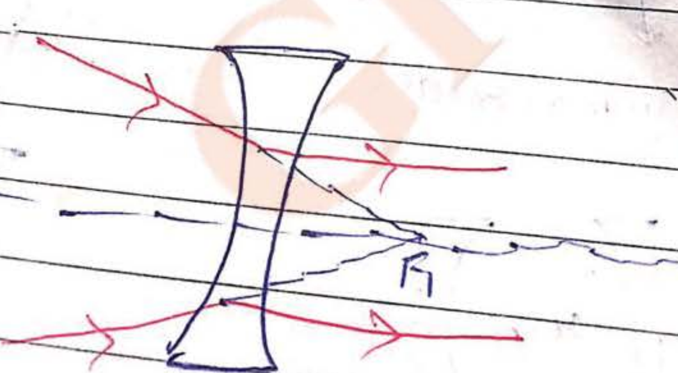
2nd Principle focus
↳ main focus यही





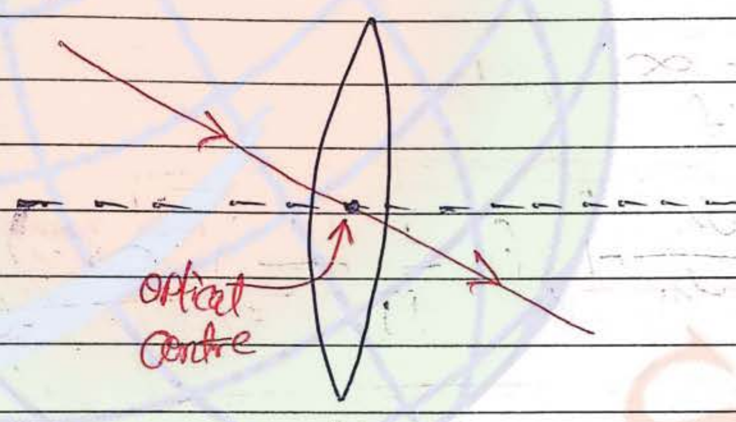






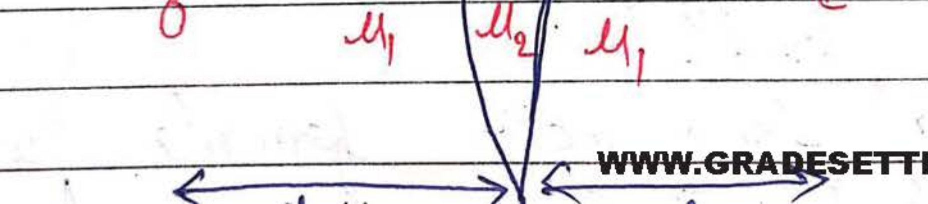
Note:- use the 2nd focal length to solving the problem while solving the problem based on lens it is the 2nd focal length which will be used as it is +ve for convex lens and -ve for concave lense

★ optical centre →



It is the point on the principle axis as shown in the figure through which a ray of light passes undeviated.

★ lens maker's formula → जब lense के दोनों तरफ का medium का R.I. same हो तब यह formula होगा



per 2nd surface-

$$\frac{\mu_1}{v} - \frac{\mu_2}{v'} = \frac{\mu_1 - \mu_2}{R_2} \quad —(2)$$

eq (2) + eq (1)

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

$$u = -\infty$$
$$v = f$$

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

→ lens makers formula

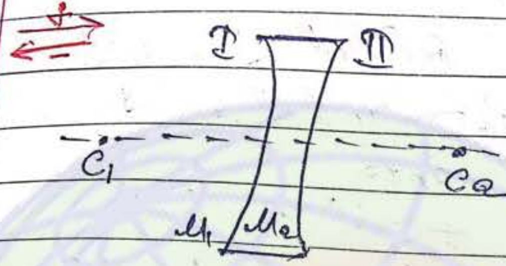
Note:- ~~Comparison~~

1) The focal length of spherical mirror depends only on the radius of curvature ~~whereas~~ whereas the focal length of a lens depend's upon following parameter
   i) Radii of curvature of both the sides,
   ii) Refractive Index of the material of lense
   iii) R.I of the medium in which lense is kept.

ii) Using lense maker formula when we are finding out the focal length of a lense all the term ...

(iii) This formula will be only applied if there are same medium over both the sides of lens

Concave

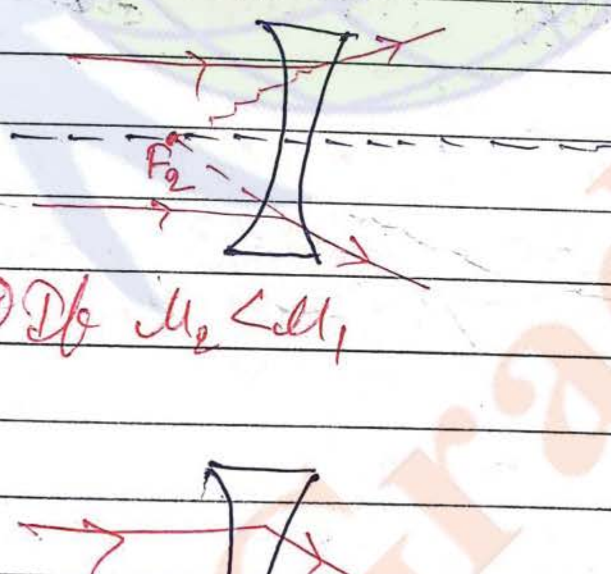


$R_1 = -ve$, $R_2 = +ve$

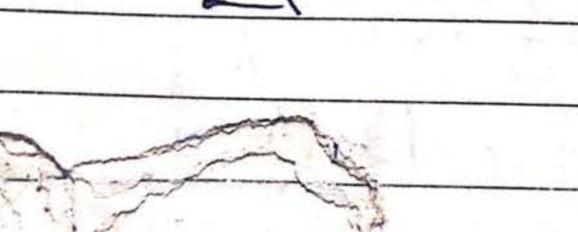
(a) If $\mu_2 > \mu_1$

$$\frac{1}{f} = \underbrace{\left(\frac{\mu_2}{\mu_1} - 1\right)}_{+ve} \underbrace{\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}_{-ve}$$

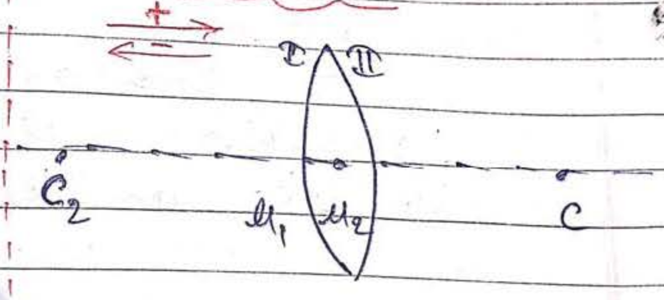
So,
$f = -ve$



(b) If $\mu_2 < \mu_1$



Convex.

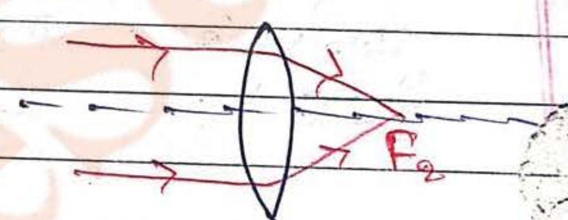


$R_1 = +ve$, $R_2 = -ve$

(a) If $\mu_2 > \mu_1$

$$\frac{1}{f} = \underbrace{\left(\frac{\mu_2}{\mu_1} - 1\right)}_{+ve} \underbrace{\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}_{+ve}$$

So,
$f = +ve$



(b) If $\mu_2 < \mu_1$

$$\frac{1}{f} = \underbrace{\left(\frac{\mu_2}{\mu_1} - 1\right)}_{-ve} \underbrace{\left(\frac{1}{R_1} \ldots\right.}_{+ve}$$

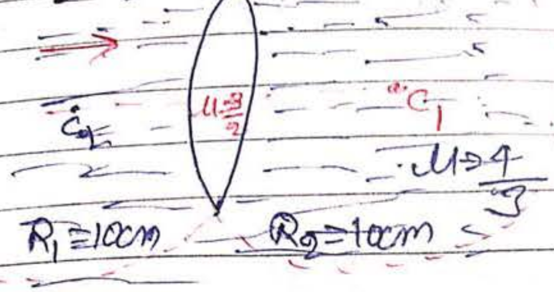
So,
$f = -ve$

Note:-
For the convex lense, if R.I of medium is small than it behaves like a converging lense.
whereas If R.I of the medium is large than that of lane than it behaves like as diverging lense.

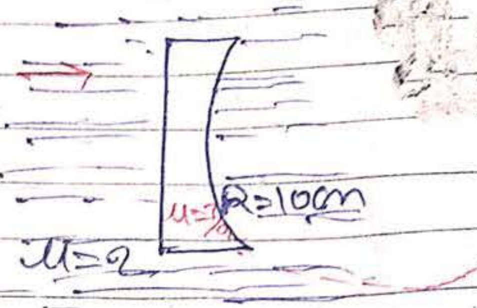
Similarly for concave lense if R.I of the medium is smaller than it behaves like a diverging lense and vice versa.

याद रखें :-> Lense अपना Properties तभी show करेगा जब इस lense के बाहर दोनों तरफ उससे कम R.I का medium present है।
यदि lense का R.I उसके medium से कम होगा। तब इस case में दोनों lense अपने से diffn Properties show करेंगे।

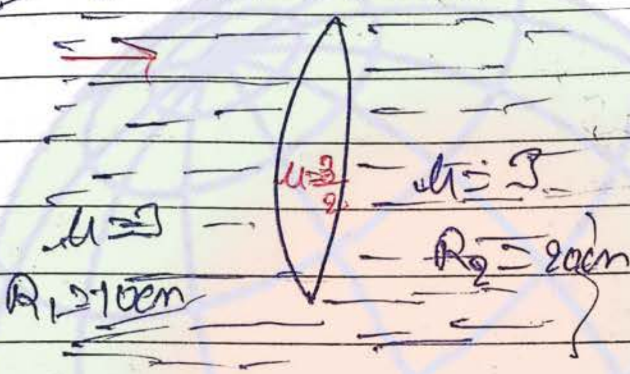
Ex) a)



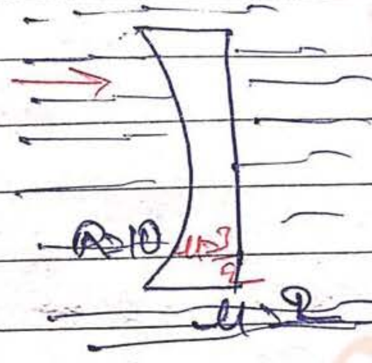
b)



c)



d)



Find out focal length of lens

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

$$= \left(\frac{3/2}{4/3} - 1\right)\left(\frac{1}{10} + \frac{1}{10}\right)$$

$$\boxed{f = 40cm}$$

मीडियम medium for "μ_2" को Refer किया। R.I. ~~...~~ R.I. है

$$\frac{1}{F} = \left(\frac{3/2}{2} - 1\right)\left(\frac{1}{\infty} - \frac{1}{10}\right)$$

$$\boxed{f = 40}$$

$R_1 \Rightarrow$ Left side Curve Surface उसका Radius है

c) $\frac{1}{f} = \left(\frac{7/2}{3} - 1\right)\left(\frac{1}{10} + \frac{1}{20}\right)$

$$\boxed{f = \frac{40}{3}\,cm}$$

d) $\frac{1}{f} = \left(\frac{7/2}{2} - 1\right)\left(\frac{1}{-10} - \frac{1}{\infty}\right)$

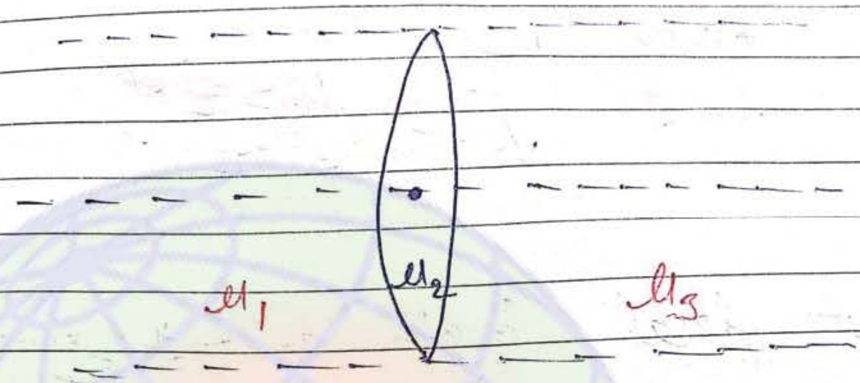
$$\boxed{f = 40}$$

Conclusion →

If there is same medium on both the sides of lense than focal length does not depend's upon from which direction the light rays are coming.

(यदि lense surface के दोनों तरफ के medium का R.I same हो तब उस Case में light किसी भी तरफ से आए focal length of lense same आएगा।

How to find out focal length of a lens over both the sides of lens are differ...



For 1st refraction –

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

for first ...

μ_3 – ...

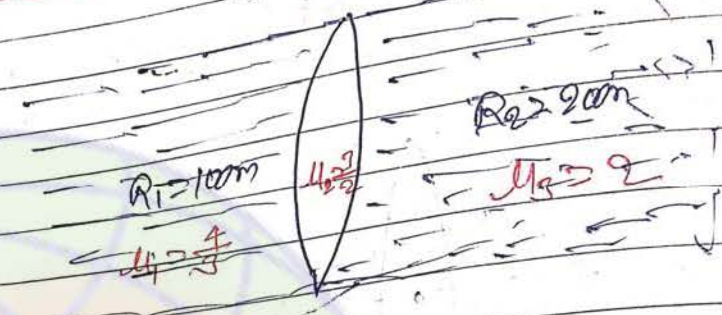
For 2nd refraction:–

$$\frac{\mu_3}{f} - \frac{\mu_2}{v'} = \frac{\mu_3 - \mu_2}{R_2} \quad \text{—(ii)}$$

v

eq (i) + eq (ii)

$$\boxed{\frac{1}{f} = \frac{\mu_2 - \mu_1}{\mu_3 R_1} + \frac{\mu_3 - \mu_2}{\mu_3 R_2}}$$



Findout focal length of ~~the given~~ lens if

a) Rays of light are coming from left

b) rays of light are coming from right

a) $\frac{1}{f} = \frac{\frac{3}{2} - \frac{4}{3}}{2 \times 10} + \frac{2 - \frac{3}{2}}{2 \times -20}$

$= \frac{9-8}{6 \times 20} + \frac{1}{2 \times -20 \times 2}$

$\Rightarrow \frac{1}{120} - \frac{1}{80}$

$\Rightarrow \cancel{\frac{1-3}{120}} = \cancel{\frac{-2}{120}}$

$\cancel{f = -60}$

$\frac{1}{f} \Rightarrow \frac{2-3}{240}$

b) $$\frac{1}{f} = \frac{3/2 - 2}{4/3 \times 20} + \frac{4/3 - 3/2}{4/3 \times (-10)}$$

$$\Rightarrow \frac{3-4}{2 \times \frac{4}{3} \times 20} +$$

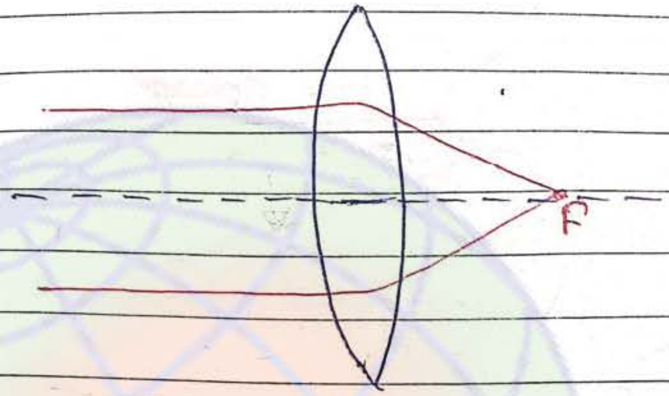
$$\boxed{f = -160cm}$$

Conclusion.

If there is diffⁿ medium one both sides of lens then focal length depends upon from which direction ray's of light are coming.

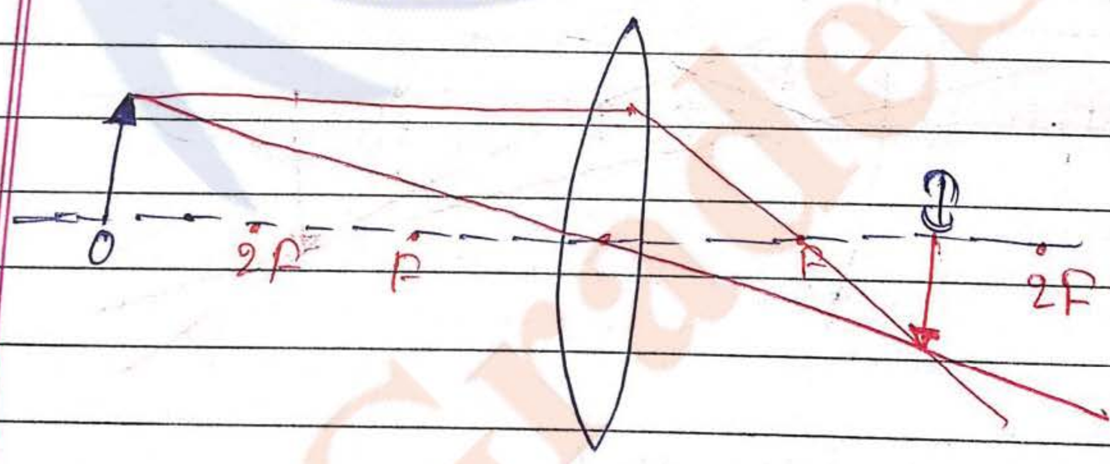
Ray diagram for convex lense →

1) If object is kept at ∞



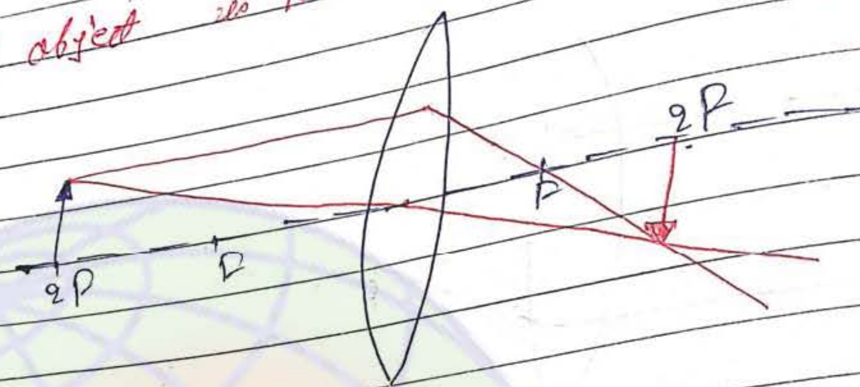
Position of Image → at focus
Nature → Real and Inverted.
Size → highly oualified

2) If object is kept beyond "2F" →



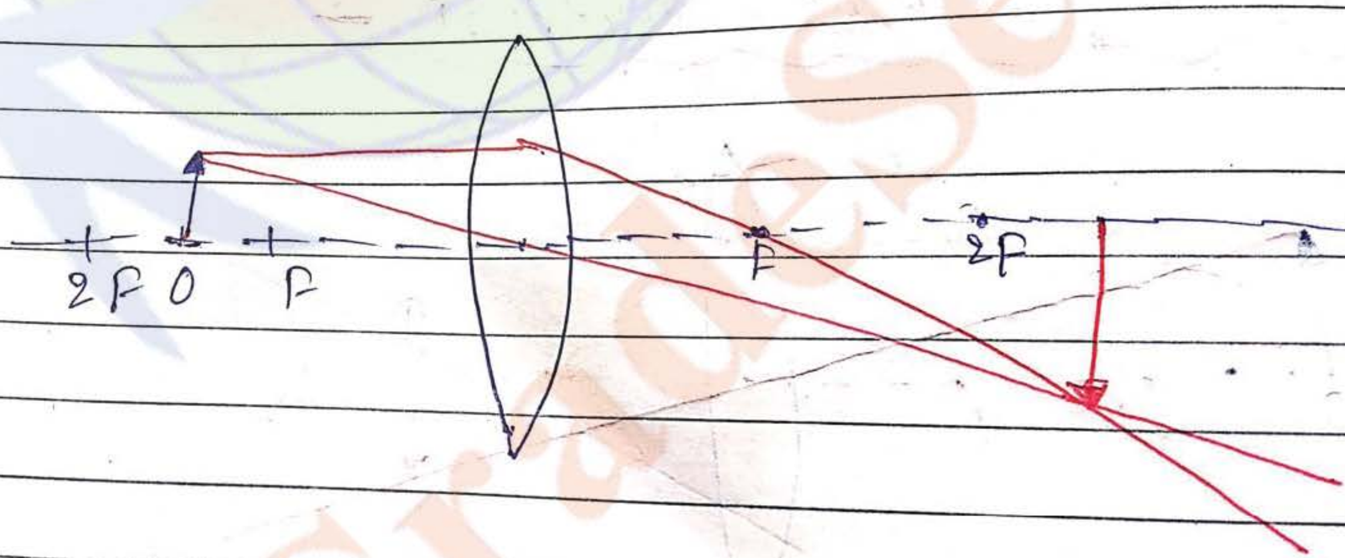
Position of Image → b/w F and 2F
Nature → Real and Inverted
Size → smaller than object.

9.) If object is kept at "2F"



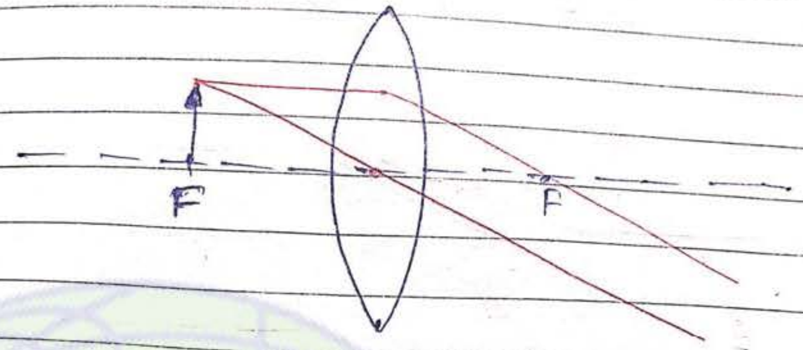
Position of Image :-> At 2F
Nature :-> Real and Inverted
Size :-> Same as that of object.

If object is kept b/w "F and "2F"



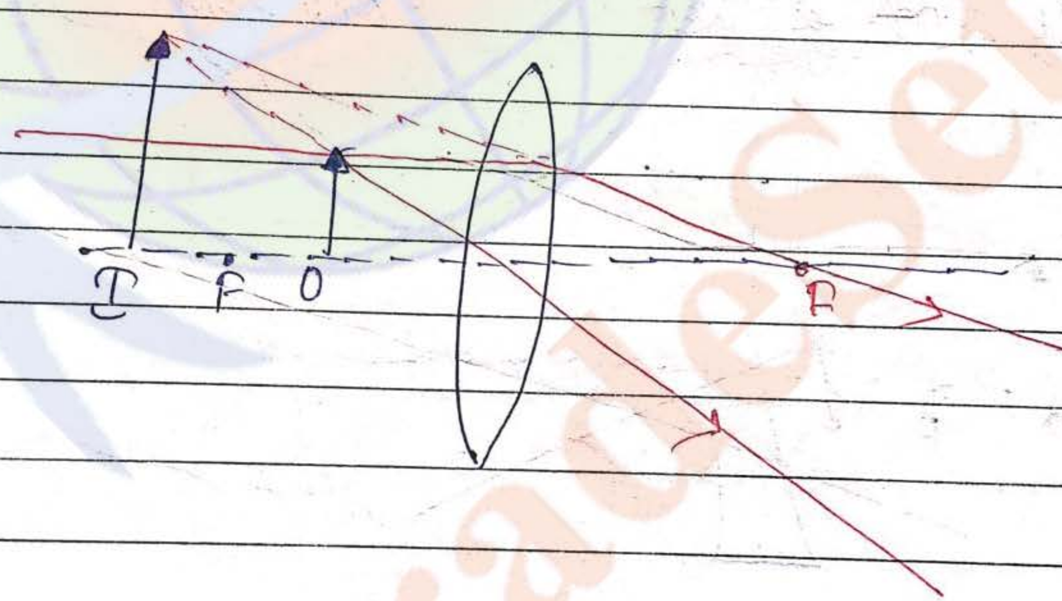
Position :-> Beyond 2F
Size :-> larger than object
Nature :-> Real and Inverted

⇒ If object is kept at "F".



Position of Image ⇒ At ∞
Nature → Real and Inverted
Size ⇒ highly magnified

6) If object is kept b/w Focus and lens.

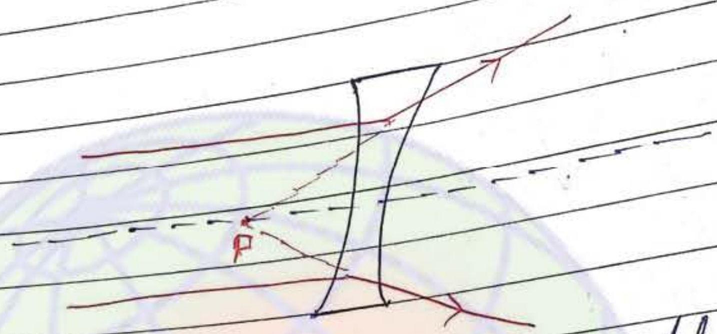


Position of Image ⇒ On the same side as the object
Nature ⇒ virtual and erect
Size ⇒ larger than object

1st Choice

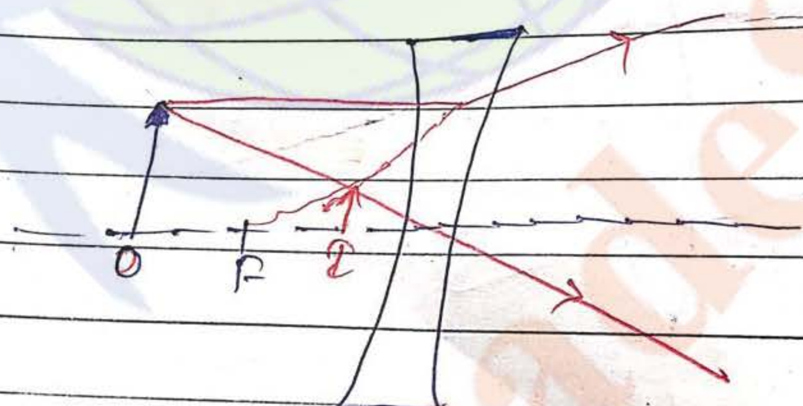
Concave lenses →

1.) If object is kept at "∞" →



Position of Image is At F
Nature is virtual and erect
Size → Highly diminished

2.) If object is kept b/w F and lens.



Position of Image is b/w optical centre and focus
Nature is virtual & erect
Size is smaller than object.

☆ Lense formula and it's application -

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

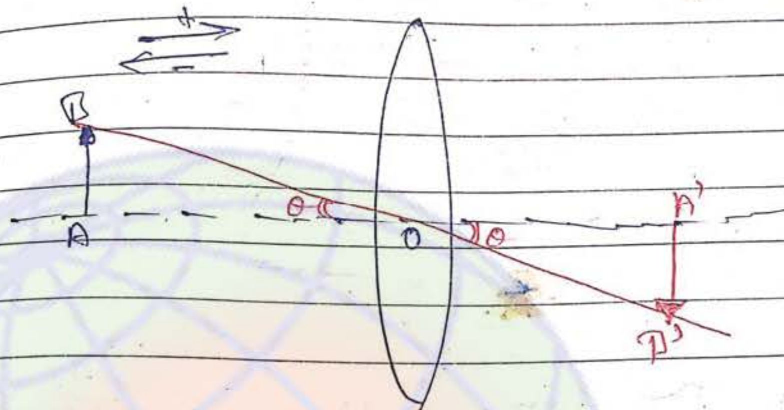
$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{--- (2)}$$

From (1) and (2)

$$\boxed{\frac{1}{f} = \frac{1}{v} - \frac{1}{u}}$$ "Hence Proved"

(Q) Board में शुरू से derive करें।

Linear magnification for the lens →



$$\tan\theta = \frac{AB}{OA} = \frac{A'B'}{OA'}$$

where, $AB = H_0$
$A'B' = -I$
$OA = -u$
$OA' = v$

$$\frac{H_0}{-u} = \frac{-H_I}{v}$$

$$\Rightarrow m = \frac{H_I}{H_0} = \frac{v}{u} = \frac{f}{f+u}$$

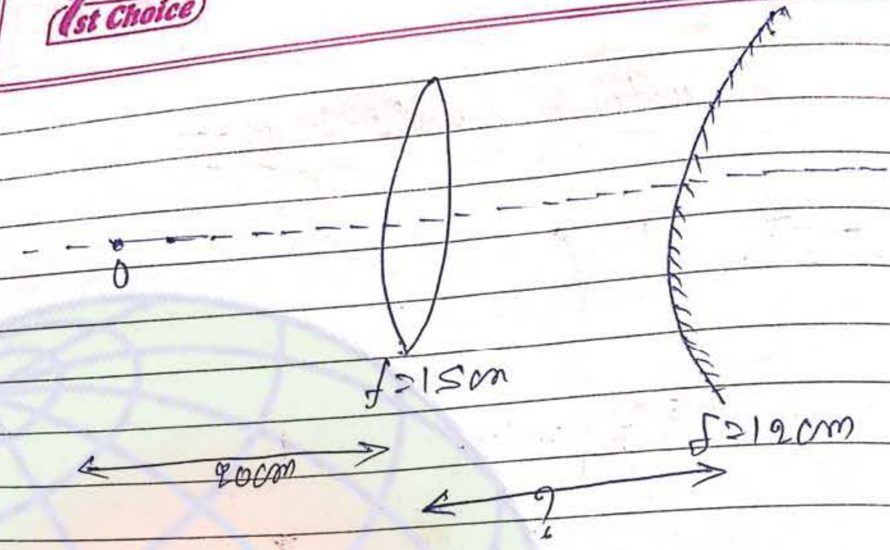
Board Q) If convex lens is having focal length 10 cm find out where the object should be placed so that Image is two times magnified.

If Image is real
$m = -2$
$f = 10$ cm

$$\frac{10}{10+u} = -2$$

If Image is virtual
$m = 2$

$m = \frac{f}{f+u}$ ...



Find the separation b/w lense and mirror so that final Image coincides with the object)

Sol^n

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

$$\frac{1}{15} = \frac{1}{v} - \left(-\frac{1}{20}\right)$$

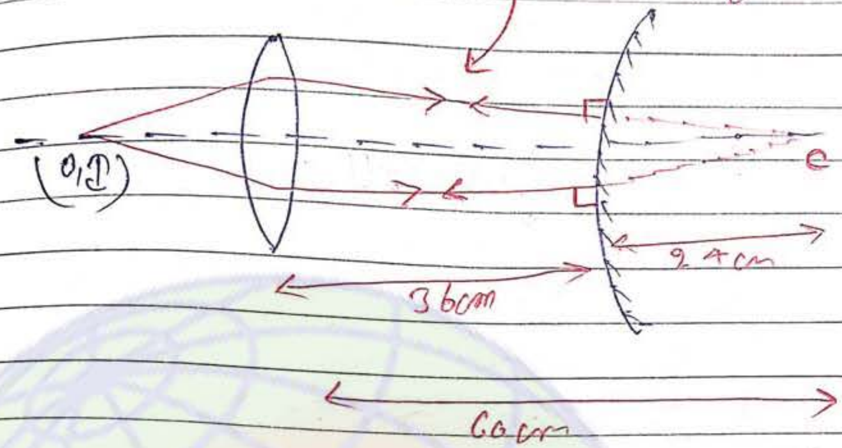
$$\frac{1}{v} = \frac{1}{15} - \frac{1}{20}$$

$$= \frac{4-3}{60}$$

$$\boxed{v = 60}$$

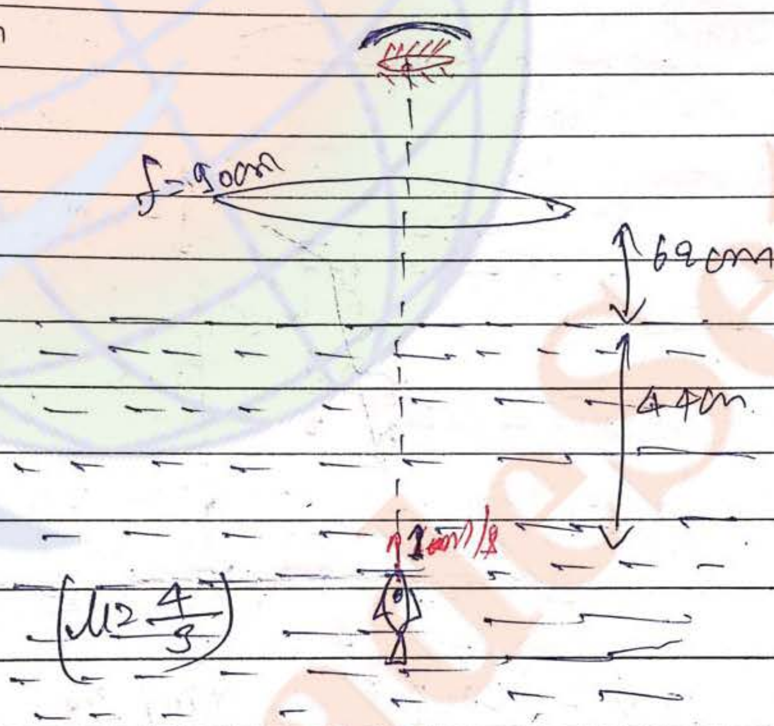
v = 60
u = 10cm
f = 1

इस तरह से ray of light perpendicular fall करता है



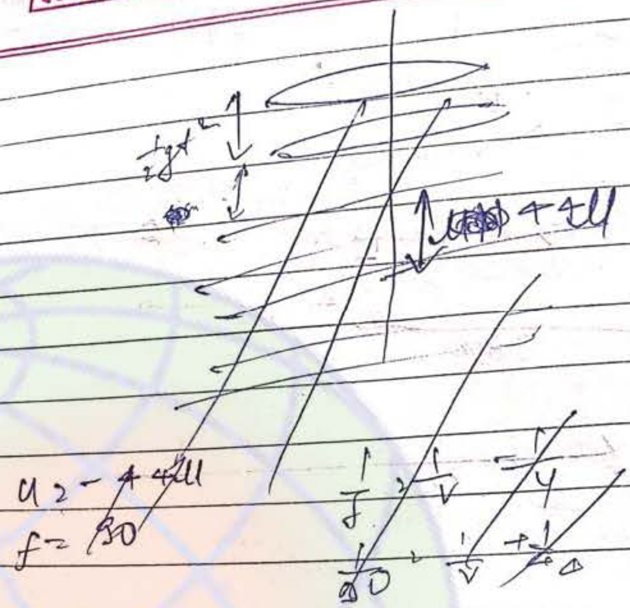
for lense
$u = -20cm$
$f = 15cm$
$v = 60cm$

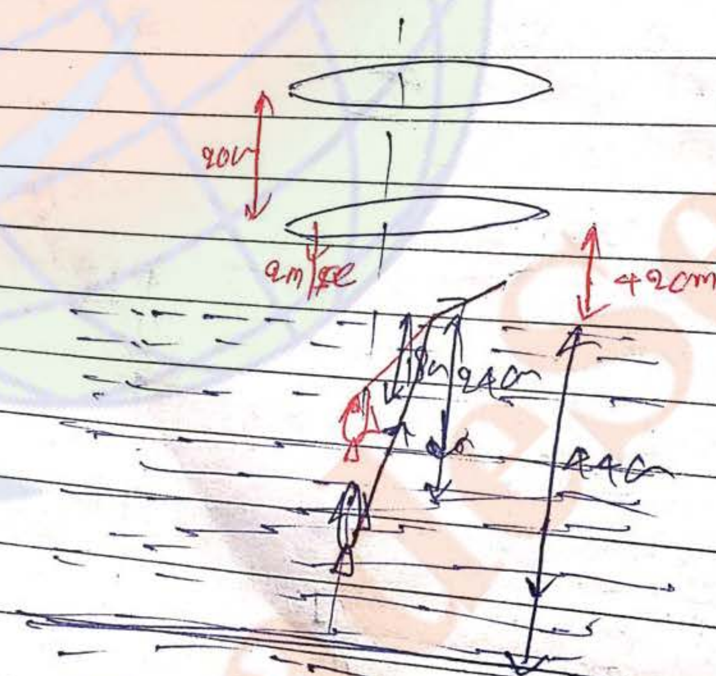
Advance (02)



In the figure shown fish moving up with constant speed where a lense is released rest. find out the speed of image of the fish which is found to the lense after 0.2s

u=0



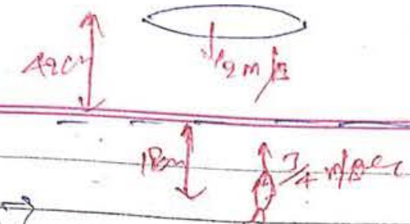


$v = 10 \times 0.2 = 2m/sec$

$\frac{4}{3} = \frac{24}{\text{app depth}}$

App. depth = 18cm

$\frac{4}{3} \cdot \frac{1}{\text{App.}}$



$$\vec{V}_{Il} = m^2 \vec{V}_{Ol}$$

$$V_I - (-2) = \left[\frac{30}{30-60}\right]^2 \left[\frac{3}{4} - (-2)\right]$$

$$\boxed{V_I = \frac{91}{4}\ m/sec}$$

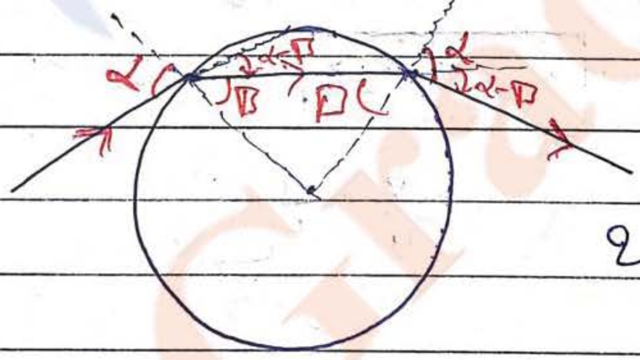
$$\frac{1}{x_{om}} + \frac{1}{x_{Im}} = \frac{1}{f}$$

$$\frac{1}{x_{IL}} - \frac{1}{x_{OL}} = \frac{1}{f}$$

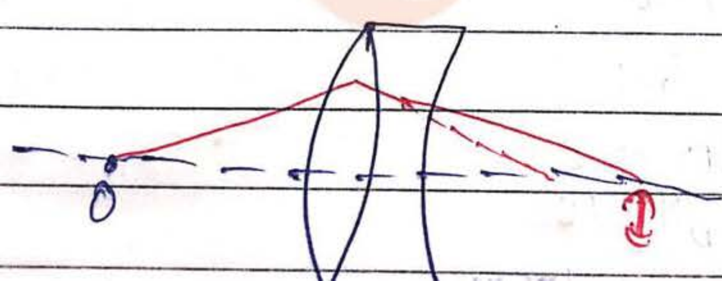
$$\frac{1}{x_{IL}^2}\frac{dx_{IL}}{dt} + \frac{1}{x_{OL}^2}\frac{dx_{OL}}{dt} = 0$$

$$\vec{V}_{IL} = \left(\frac{x_{IL}}{x_{OL}}\right)^2 \vec{V}_{OL}$$

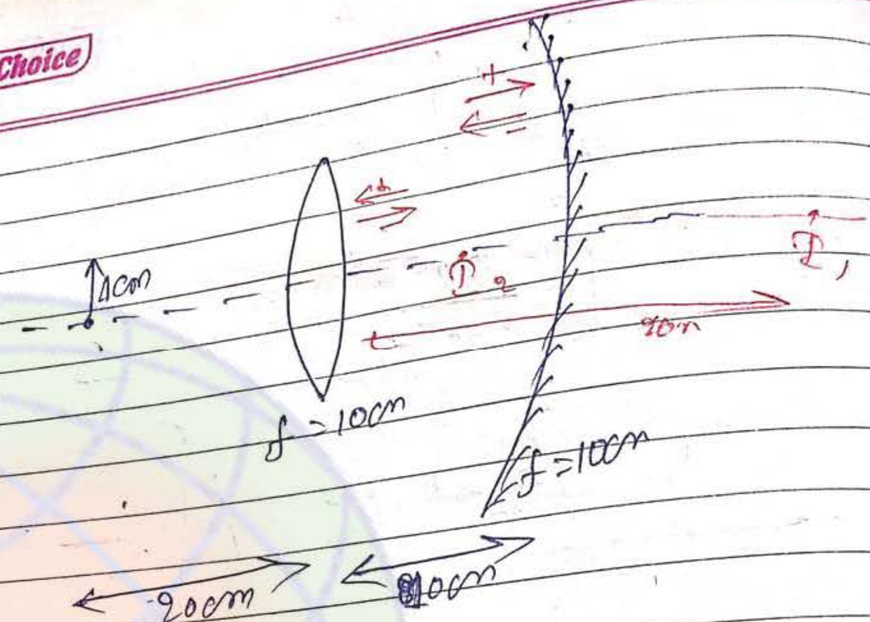
$$\boxed{\vec{V}_{IL} = m^2 \vec{V}_{OL}}$$



$$2(\alpha - \beta)$$



1st Choice



Find out position and size of final Image formed.

Sol^n For lens:-

$h_0 = 1cm$

$f = 10cm$

$u = -20cm$

$v = ?$

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

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

$= \frac{1}{10} - \frac{1}{20}$

$= \frac{2-1}{20}$

$\Rightarrow \frac{1}{20}$

$\boxed{v = 20}$

$m = -1$

For mirror.

$u = 10$

$f = -10$

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

$\frac{1}{v} = \frac{1}{-10} - \frac{1}{10}$

$\Rightarrow \frac{-2}{10}$

$\boxed{v = -5}$

$m_2 = \frac{-v}{u} = \frac{1}{2}$

Now

For lens

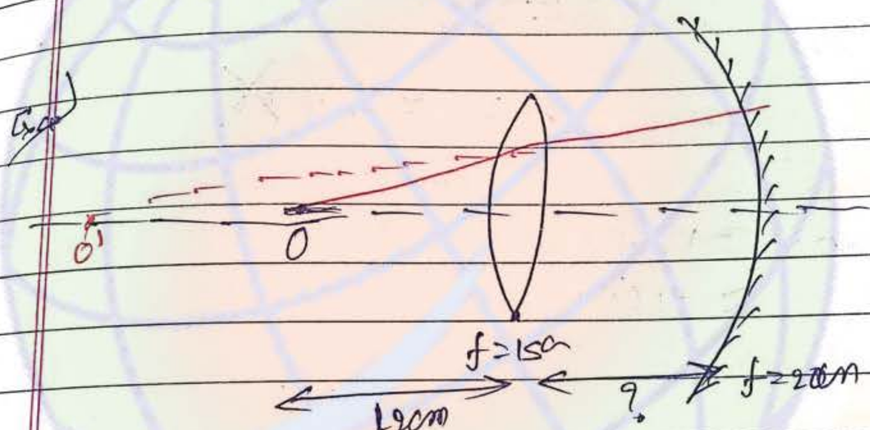
$u = -5cm$

$M_{net} = m_1 \times m_2 \times m_3$

$= (-1) \times \frac{1}{2} \times 2$

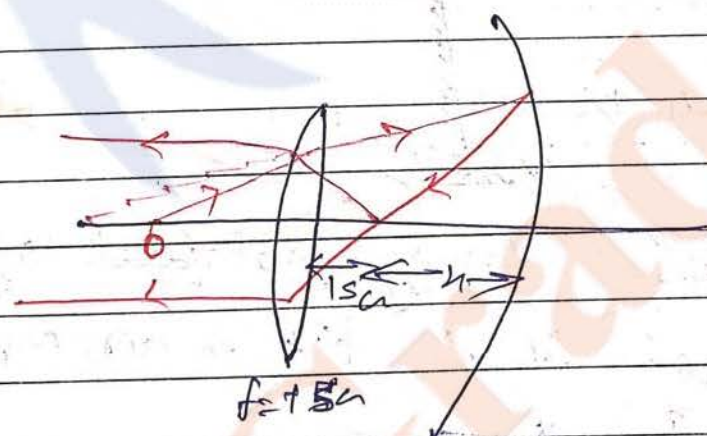
$= -1$

Size of final Img = 1cm (below the P.A)



Find out the separation b/w the lense and mirror so that the final Images formed as Infinite on the same size as that of object

80/1



f = 15cm
u = -12 cm
v = ?

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

For mirror

u = -(75+x)

$$\frac{1}{v} = \frac{1}{15} - \frac{1}{12} = \frac{4-5}{60} = -\frac{1}{60}$$

$$\boxed{v = -60}$$

$$\frac{1}{-x} + \frac{1}{-(75+x)} = \frac{1}{20}$$

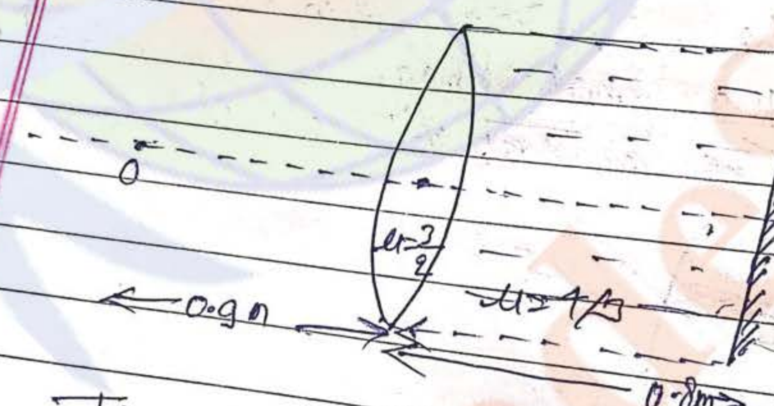
$$\frac{-(75+x) - x}{x(75+x)} = \frac{1}{20}$$

$$\frac{-75-x-x}{x(75+x)} = \frac{1}{20}$$

$$x = 25, -\cancel{80}$$

The seperation $= 15+25$
$= 48cm$

Q.



The equivalen lens is having focal ~~focal~~ length 0.3m. when it is kept in air. find out Position of final image.

$$\frac{1}{10} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{R} + \frac{1}{R}\right)$$

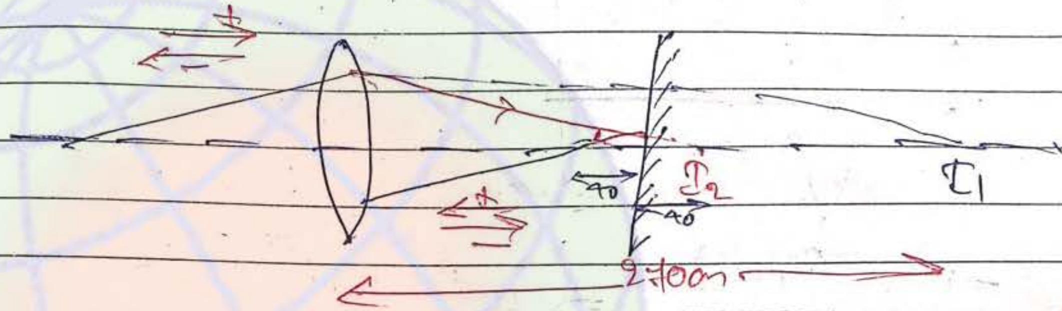
$$= \frac{1}{2} \times \frac{2}{R} \quad ; \boxed{R = 10cm}$$

For 1st refraction —

$$\frac{3}{2v} + \frac{1}{90} = \frac{\left(\frac{3}{2}-1\right)}{30}$$

$v = 270\,cm$

For 2nd refraction —



$$\frac{4}{3v} - \frac{3}{2(270)} = \frac{\frac{4}{3} - \frac{3}{2}}{-30}$$

$v = 120\,cm$

For 3rd refraction —

$$\frac{3}{2v} + \frac{4}{3(40)} = \frac{\frac{3}{2} - \frac{4}{3}}{30}$$

$$\cancel{\frac{1}{200} \quad \frac{3}{2v} + \frac{4}{3(40)} = \ldots}$$

$$\frac{3}{2v} + \frac{4}{3(40)} = \frac{\frac{3}{2} - \frac{4}{3}}{30}$$

$\boxed{v = -54}\,cm$

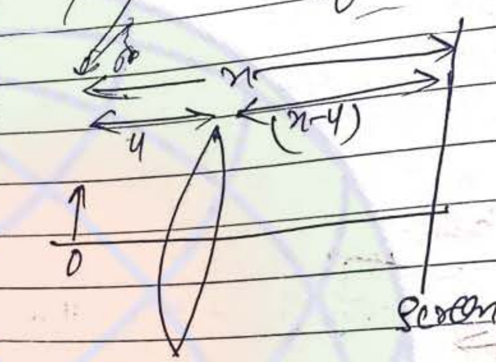
$\frac{1}{30}$ $\frac{3}{2}$ $\frac{1}{54}$ for 4th Refraction

$$\frac{1}{\ldots} + \frac{3}{2(5\ldots}$$

Ex 4

10) An equiconven lense is shown in figure so that the final Image coincide with the object Of wate in the figure

Ex 2
Q NO 16

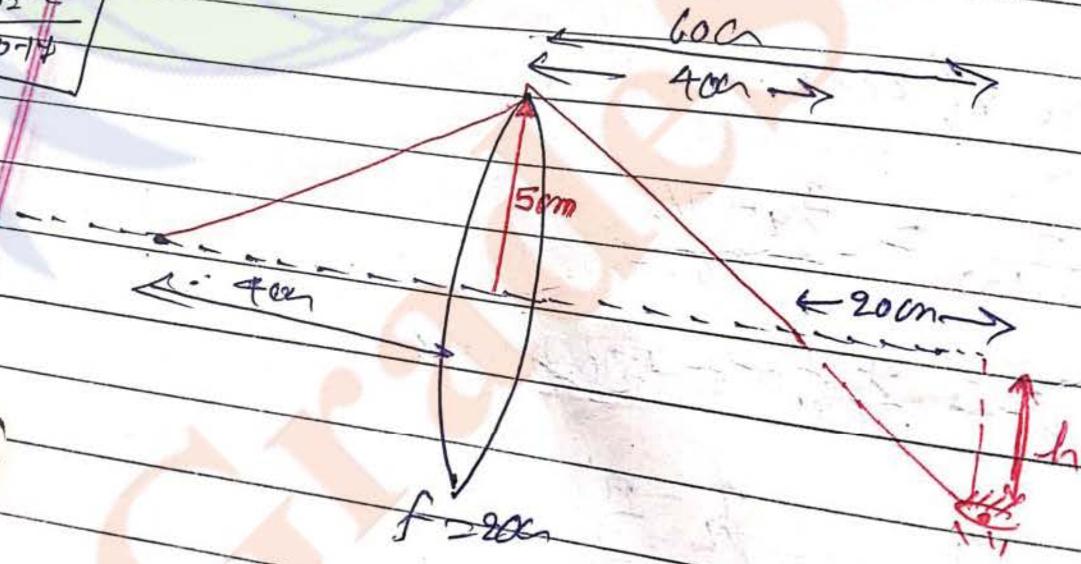


$$-m = \frac{(x-4)}{-4} \Rightarrow 4 = ?$$

$$-m = \frac{f}{f+4}$$

$f = $

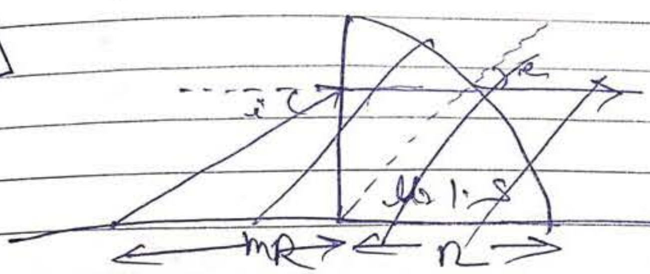
Ex 2 Q
Q NO 17



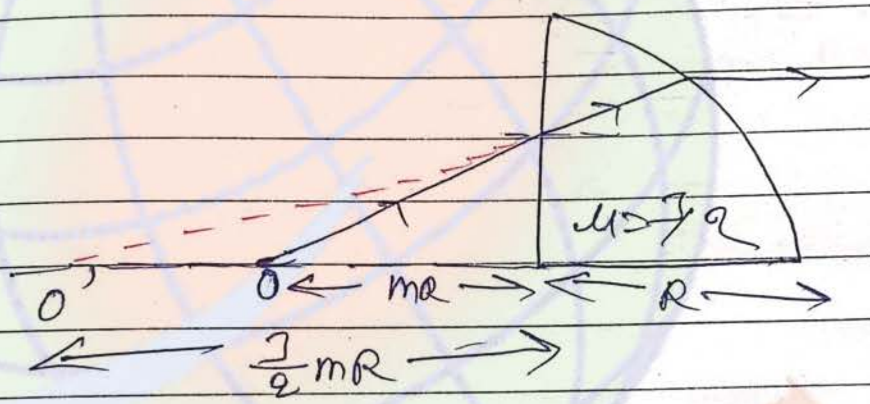
$$\frac{5}{40} = \frac{h}{20}$$

$$h = 2.5$$

Ex - 4
QNo - 8



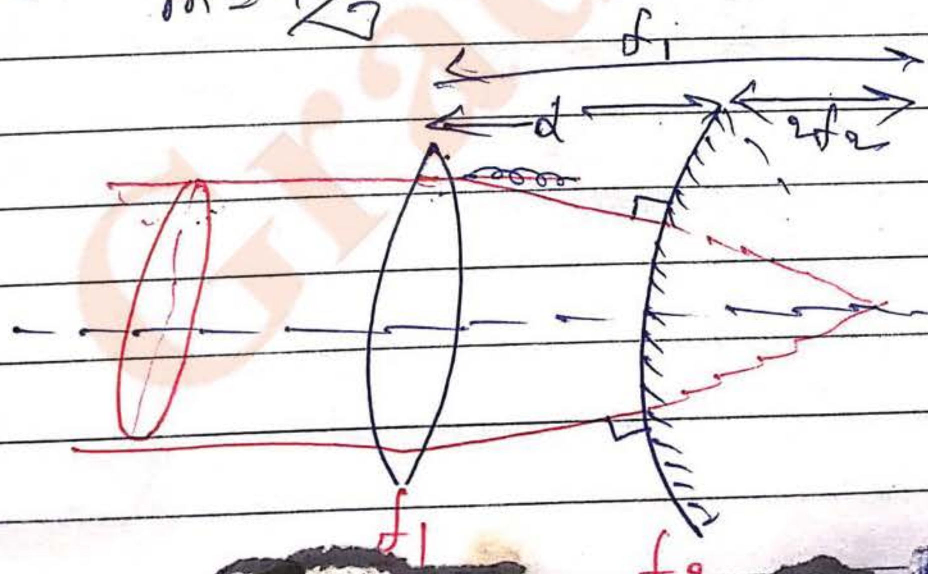
Ex - 4
QN = 8



$$\frac{1}{\infty} - \frac{3}{2\left(\frac{3}{2}mR + R\right)} = \frac{\left(1 - 3/2\right)}{-R}$$

$$m = 4/3$$

Ex = 2
QNo - 18



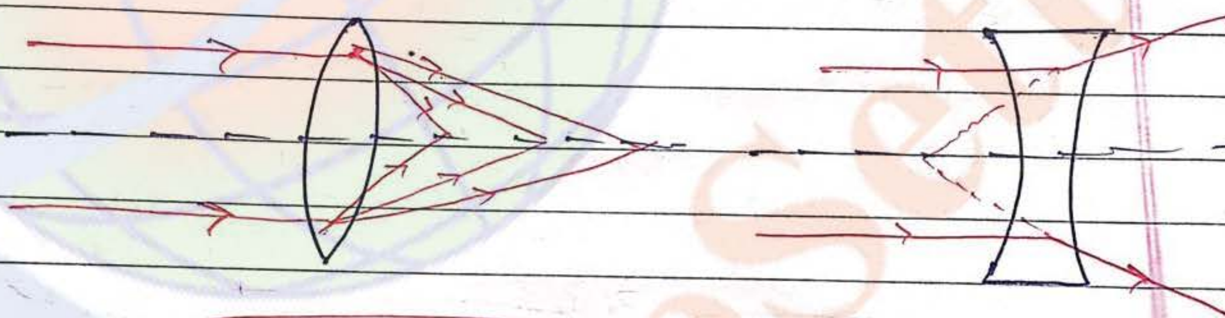
Power of an optical device :-

The power of an optical device is it's ability to deviate the ray's of light. If the optical device converse the ray's of light than it's power will be +ve whereas if it will diverse the ray's of light than power will be "-ve".

Converge किया तो Power +ve

S.I unit of Power ⇒ m^{-1} or Dioptr.

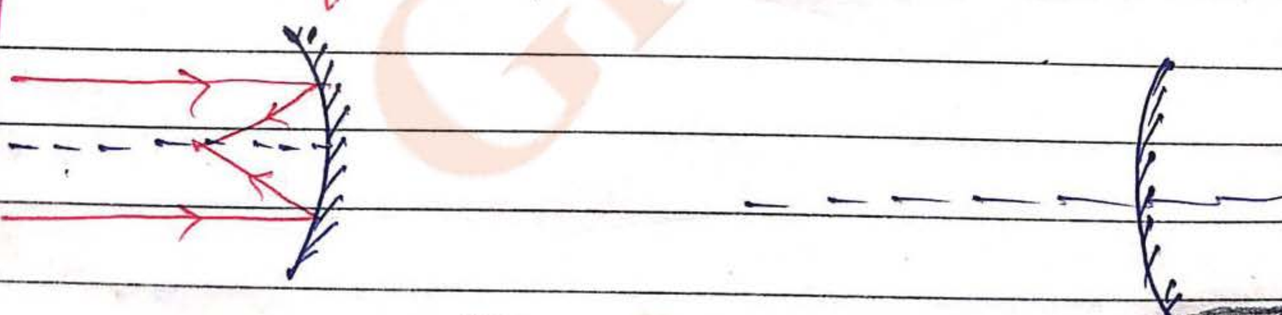
⇒ Power of a lense →



$$\boxed{P_l = \frac{1}{f_l}}$$

P_l = Power of lense
f_l = focal length of lense

⇒ Power of Spherical mirror →

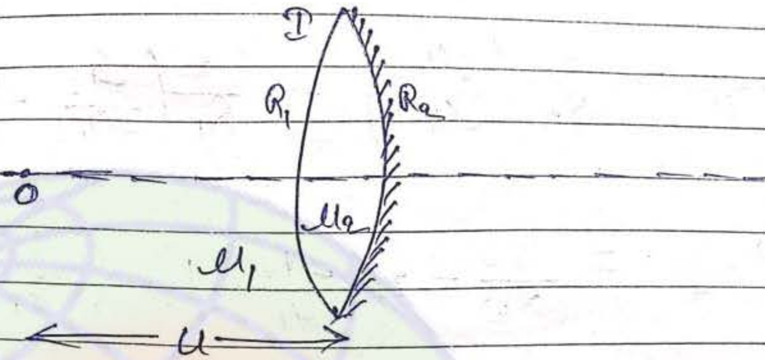


Note

	f	P
convex lense	+	+
Concave lens	−	−
Convex mirror	+	−
Concave mirror	−	+

not in board

Silvering of lense -



For 1st refraction -

$$\frac{\mu_2}{v_1} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R_1} \Rightarrow \frac{1}{v_1} - \frac{\mu_1}{\mu_2 u} = \frac{\mu_2 - \mu_1}{\mu_2 R_1}$$

For reflection

$$\frac{1}{v_2} + \frac{1}{v_1} = \frac{2}{R_2} \quad (2)$$

For 2nd refraction -

$$\frac{\mu_1}{v} - \frac{\mu_2}{v_2} = \frac{\mu_1 - \mu_2}{R_1}$$

$$\frac{\mu_1}{\mu_2 v} - \frac{1}{v_2} = \frac{\mu_1 - \mu_2}{\mu_2 R_1} \quad (3)$$

(2) + (3) - (1)

$$\frac{\mu_1}{\mu_2 v} + \frac{\mu_1}{[illegible]} = \frac{\mu_1 - \mu_2}{[illegible] R} = \frac{2}{[illegible]}$$

1st Choice

$$\Rightarrow \frac{\mu_1}{\mu_2}\left(\frac{1}{v}+\frac{1}{u}\right) = \frac{2}{R_2} - \frac{2}{R_1}\left(\frac{\mu_2-\mu_1}{\mu_2}\right)$$

$$\Rightarrow \frac{1}{v}+\frac{1}{u} = \frac{2}{R_2}\left(\frac{\mu_2}{\mu_1}\right) - \frac{2}{R_1}\left(\frac{\mu_2}{\mu_1}-1\right) + \frac{2}{R_2} - \frac{2}{R_2}$$

$$\Rightarrow \frac{1}{v}+\frac{1}{u} = \frac{2}{R_2} - 2\left(\frac{\mu_2}{\mu_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\Rightarrow \boxed{\frac{1}{v}+\frac{1}{u} = \frac{1}{f_m} - \frac{2}{f_l}}$$

⇒ The silvered lense behaves like a mirror whose focal length (f_{eq}) can be given by ⇒

$$\boxed{\frac{1}{f_{eq}} = \frac{1}{f_m} - \frac{2}{f_l}}$$

$$\because \frac{1}{f_{eq}} = \frac{1}{v}+\frac{1}{u}$$

- Power of a silvered lense

$$-P_{eq} = -P_m - 2P_l$$

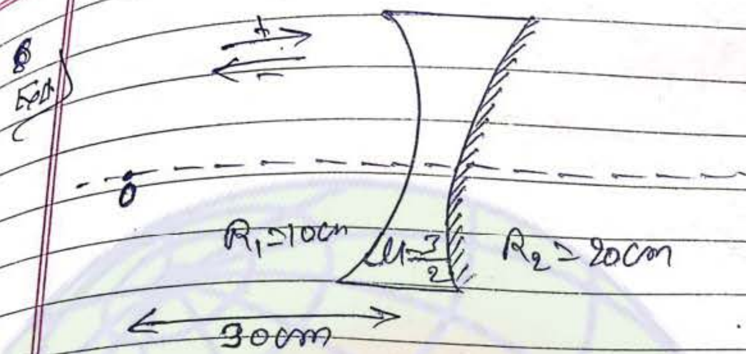
$$\boxed{P_{eq} = P_m + 2P_l}$$

Here:-

P_{eq} = Power of silvered lense

P_m = Power of mirror

Q)



find out focal length of silvered lens as well as position of final image of object.

Sol^n

$\frac{1}{f_{eq}} = \frac{1}{10} - \frac{2}{5}$

$\frac{1}{f_{eq}} = \frac{1-4}{10}$

$\frac{1}{f_{eq}} = \frac{-3}{10}$, so, $f_{eq} = \frac{-10}{3}$

Now

$\frac{1}{v} + \frac{1}{-30} = \frac{-3}{10}$

$\frac{1}{v} = \frac{-3}{10} + \frac{1}{30}$

$= \frac{-9+1}{30}$

$= \frac{-8}{30}$ 4

$v = -15$

$\frac{1}{f_l} = \left(\frac{3}{2} - 1\right)\left(\frac{-1}{10} - \frac{1}{20}\right)$

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

$= \frac{-3}{40}$

$f_m = 10cm$

$\frac{1}{f_{eq}} = \frac{1}{10} + \frac{2(3)}{40}$

$= \frac{4+6}{40}$

$= 4$

$\boxed{f_{eq} = 4cm}$

Now

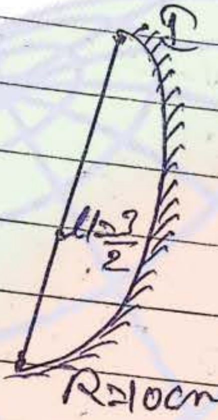
$u = -30$

$f = 4$

$v = ?$

$v = \frac{60}{17}$ cm

Ex 2.



Find out ratio of Power.

$$\frac{1}{f_{eq}} = \frac{1}{S} - \frac{2}{f_l}$$

$$f_l = \left(\frac{3}{2} - 1\right)\left(\frac{1}{\infty} + \frac{1}{10}\right)$$

$$= \left(\frac{3-2}{2}\right)\left(\frac{+1}{10}\right)$$

$$= \frac{1}{2} \times \frac{-1}{10} = \frac{-1}{20}$$

Now

240

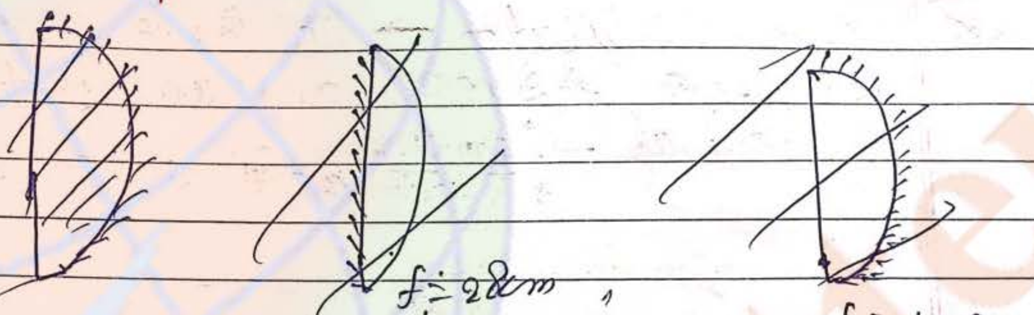
1st Choice

when the ~~plane mirror~~ curved surface is silvered and the object is in front of plane ~~mirror~~ surface

$P_{eq} = P_m + 2P_l \Rightarrow 2P_l = 2\left(\frac{3}{2}-1\right)\left(\frac{1}{10}\right) - \frac{1}{10}$

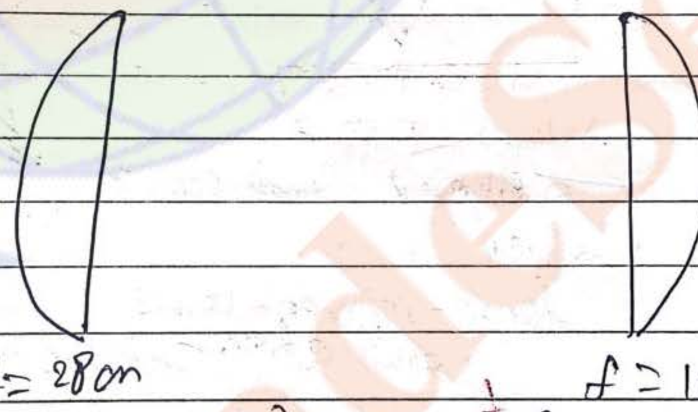
$\frac{P_I}{P_{II}} = 3$

Ex-2
QNO-10



$f = 28cm$, $f = 10cm$

Ex=2
QNO⇒10



$f = 28cm$ (concave mirror) $f = 10cm$ (concave mirror)

$\frac{1}{-28} = -2(\mu-1)\left(\frac{1}{R}\right)$ —(1)

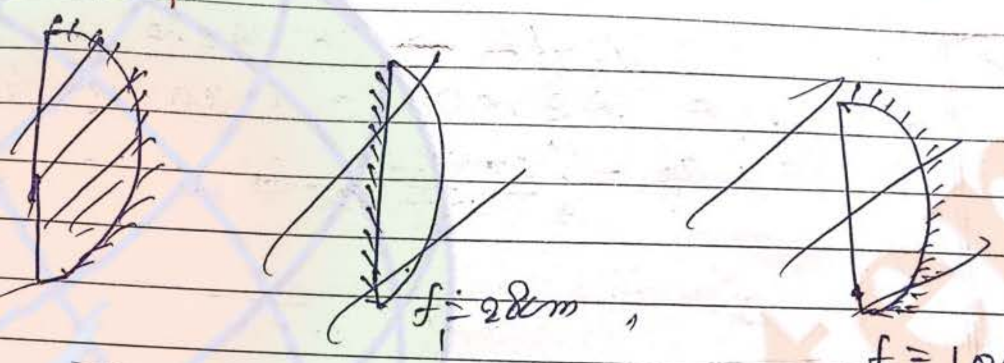
$\frac{1}{-10} = -\frac{2}{R} - 2(\mu-1)\left(+\frac{1}{R}\right)$ —(2)

Now

$P_{eq} = P_m + 2P_l = 2P_l = 2\left(\frac{3}{2}-1\right)\left(\frac{1}{10}\right) - \frac{1}{10}$

$\frac{P_I}{P_{II}} = 3$

Ex-2 QNo-10



$\boxed{\text{Ex-2 QNo-10}}$

f = 28cm
(concave mirror)

f = 10cm
(concave mirror)

$$\frac{1}{-28} = -2(\mu-1)\left(\frac{1}{R}\right) \quad \text{--- (1)}$$

$$\frac{1}{-10} = \frac{-2}{R} - 2(\mu-1)\left(+\frac{1}{R}\right) \quad \text{--- (2)}$$

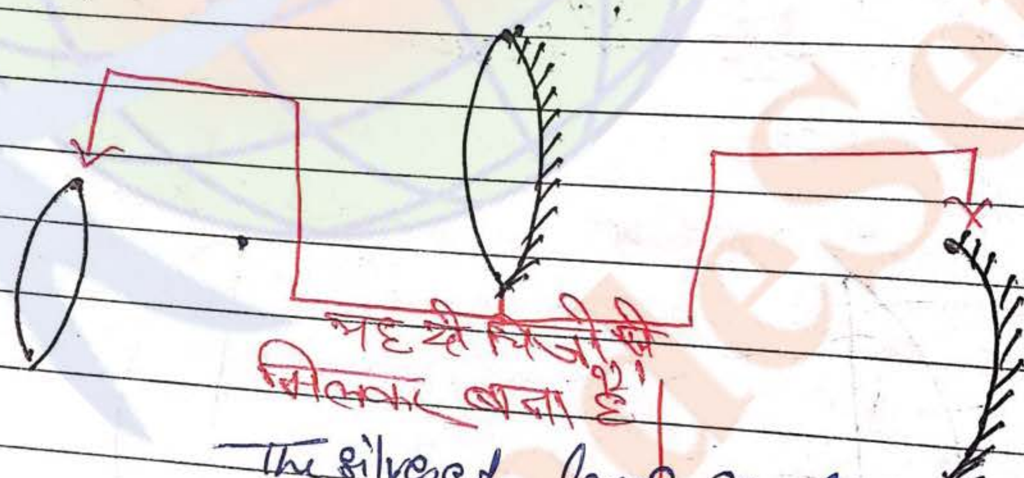
Now

M = ✓

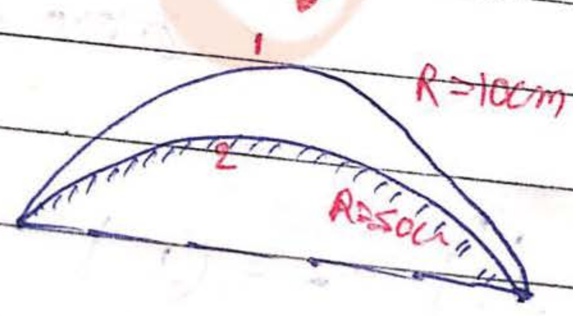
R = ✓

(X) Decon visualisation → If the back surface of a lense is silvered and an object is placed in front of ~~them~~

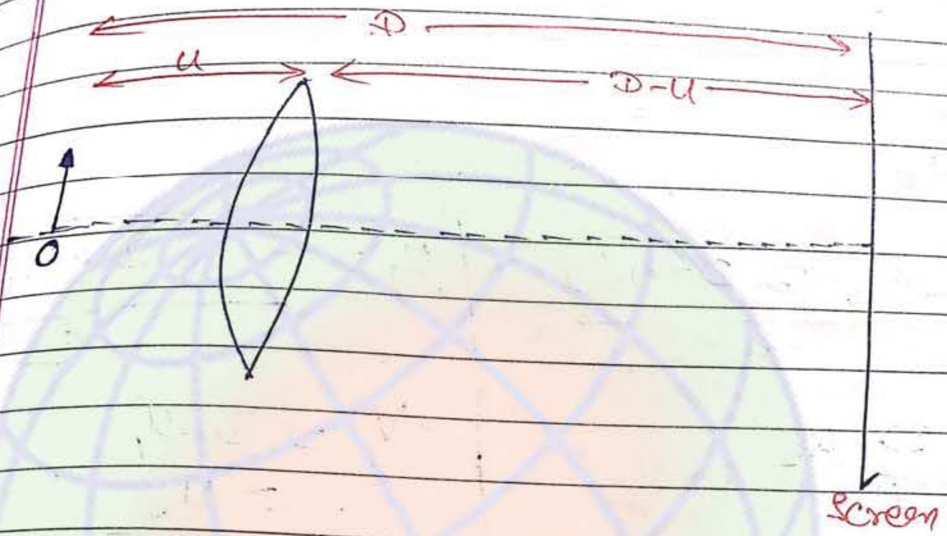
[illegible]



The silvered lense can be modified as a lense-mirror-lense combination



☆ Displacement method to find out focal length of a convex lens-



$u = -u$

$f = f$

$\Rightarrow v = (D-u)$

$\Rightarrow \frac{1}{(D-u)} + \frac{1}{u} = \frac{1}{f}$

$\Rightarrow \frac{u+D-u}{(D-u)u} = \frac{1}{f}$

$\Rightarrow Df = Du - u^2$

$\Rightarrow u^2 - Du + fD = 0$

$\Rightarrow \boxed{u = D \pm \sqrt{D^2 - 4fD}}$

$$\boxed{u = \frac{D \pm \sqrt{D(D-4f)}}{2}}$$

(1) Case (1) →

If $D > 4f$

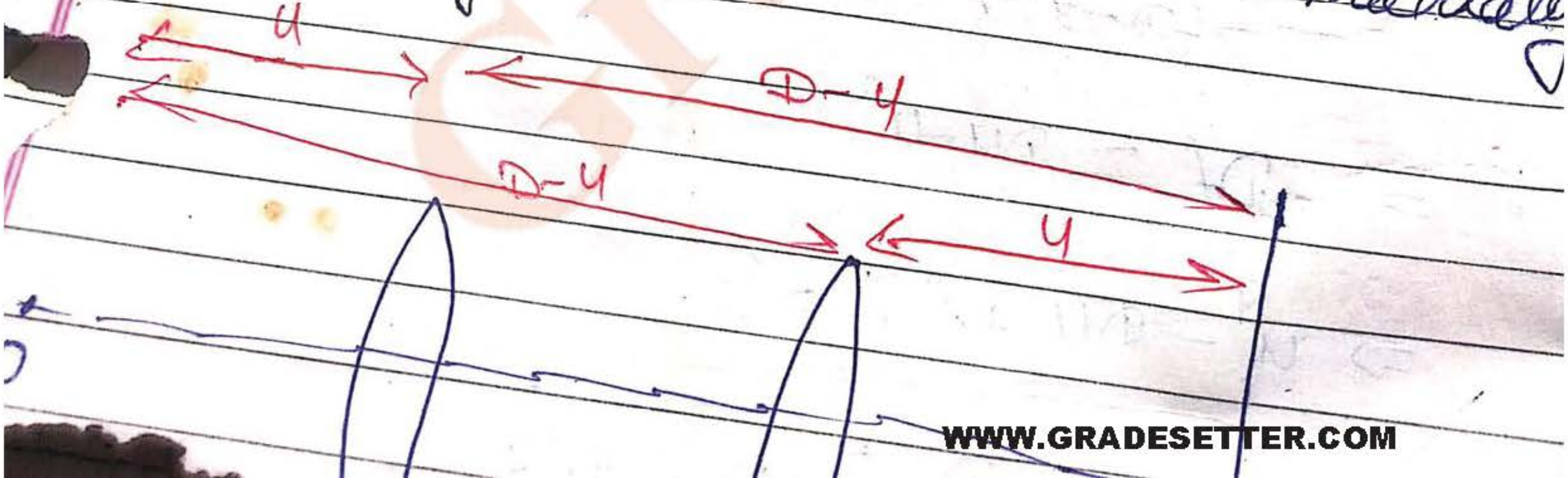
$$u_2 = \frac{D + \sqrt{D(D-4f)}}{2} \qquad u_1 = \frac{D - \sqrt{D(D-4f)}}{2}$$

(2) $v_2 = D - u_2$
$= u_1$

$v_1 = D - u_1$
$= u_2$

Note → $m_2 = \frac{H_I(2nd)}{H_0} = \frac{v_2}{u_2}$ $\qquad$ $m_1 = \frac{H_I(1st)}{H_0} = \frac{v_1}{u_1}$

If the separation b/w object and screen is greater than 4 times of focal length of lense then their will be two positions of lense for which we will be able to see the image on the screen and for these two positions of lense "u" and "v" can be mutually interchanged.



$$m_2 = \frac{H_{I(2)}}{H_0} = \frac{v_2}{u_2} \qquad m_1 = \frac{H_{I(1)}}{H_0} = \frac{v_1}{u_1}$$

$$m_1 \times m_2 = \frac{H_{I(1st)} \times H_{I(2nd)}}{H_0^2} = 1$$

$$\boxed{H_0 = \sqrt{H_{I(1st)} \times H_{I(2nd)}}}$$

Case 2nd

If $D = 4f$

$$\boxed{u = \frac{D}{2}}$$

In this case there will be only one instance when we will get the image on the screen and for this situation the lens exactly lies b/w the object and screen and here the size of image is equal to the size of the object.

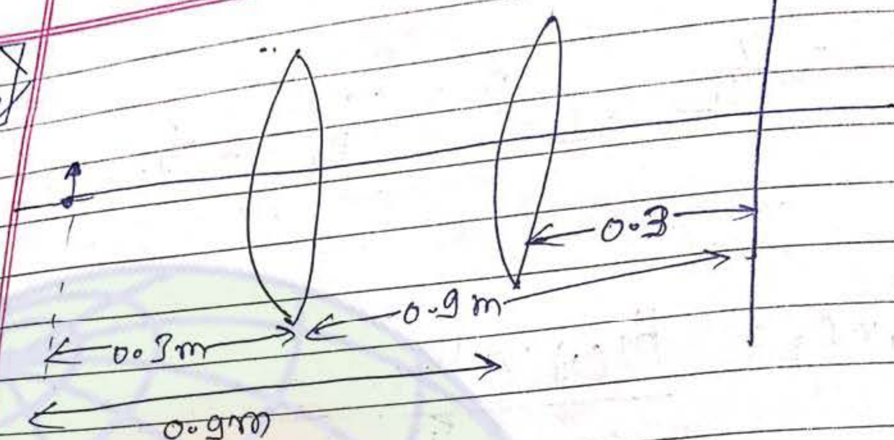
Case 3rd

$D < 4f$

In this c[illegible] image on [illegible] here.

1st Choice

Ex-1 Q No-8



$D = 1.2\,m$

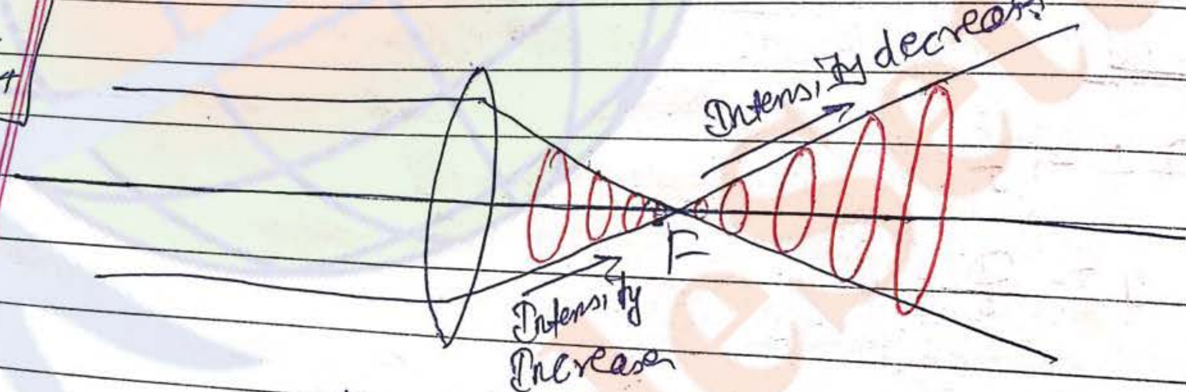
Ex-2 Q No-7

$D < 4f$

$40 < 4f$

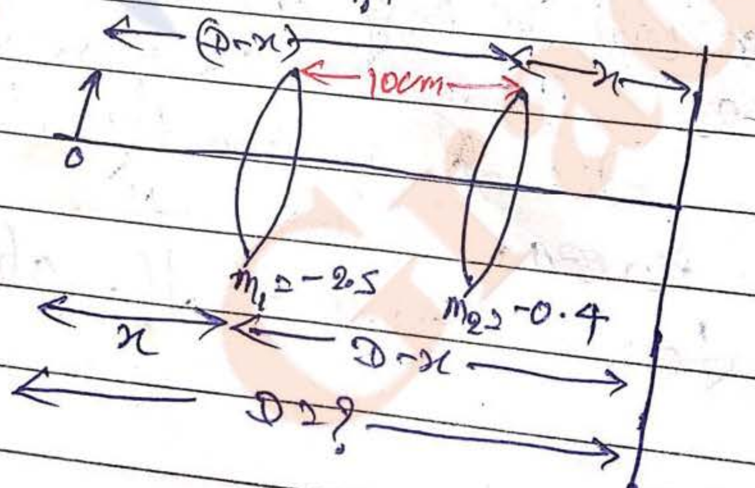
$D > 10$

Ex-2 Q No-14



##

3 6



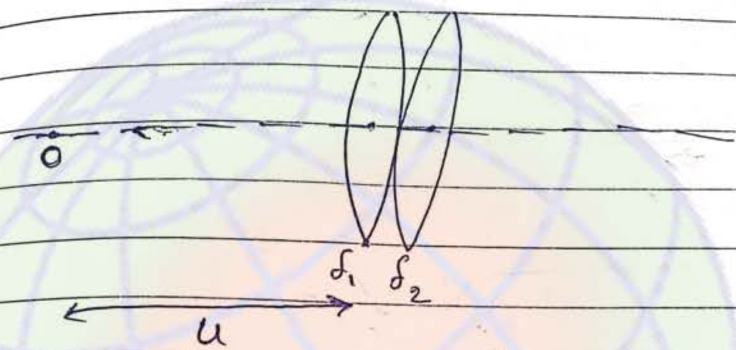
$$-2.5 = \frac{D-x}{-x}$$

$$-0.4 = \frac{x}{-(D-x)}$$

$D = ?$

Combination of lenses →

A) If lenses are kept in contact →



$$\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1} \quad —(1)$$

$$\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2} \quad —(2)$$

eq(1) + eq(2)

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

$$\boxed{\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}}$$

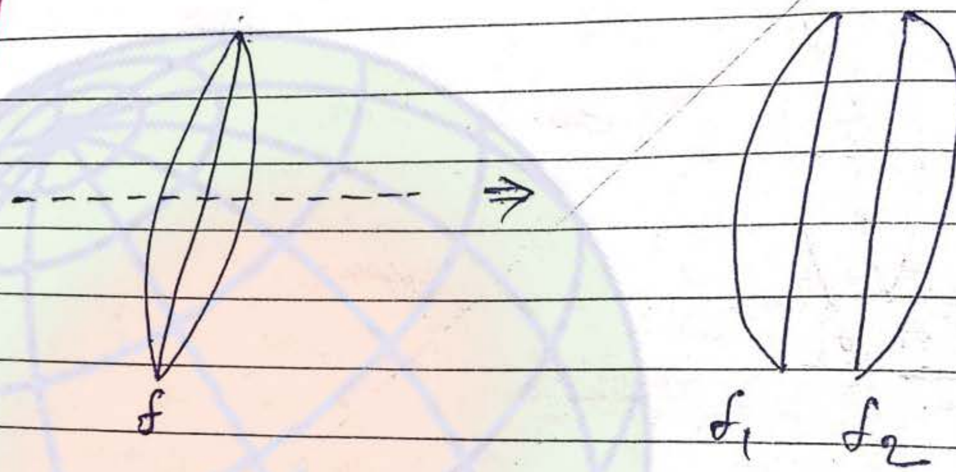
If the lenses are kept in contact then this combination of lense can be replace by another lense having equivalent focal length ~~of given Dng~~ which is given by above expression.

And In term's of Power →

$P_{eq} = P_1 + P$ ...

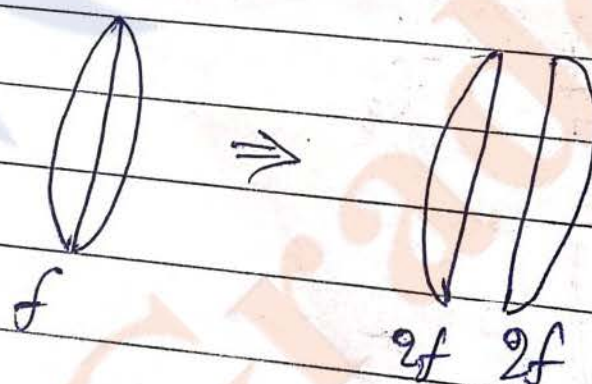
Cutting of lense →

(a) If cutting is done $\perp r$ to Principle axi

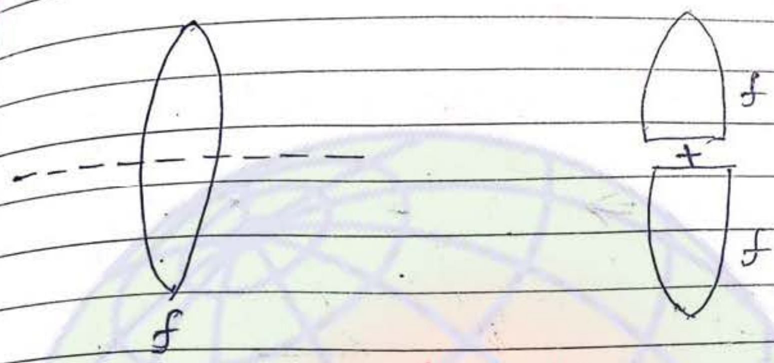


$\boxed{f_1 \text{ and } f_2 > f}$

⇒ for equiconvex lenses ⇒

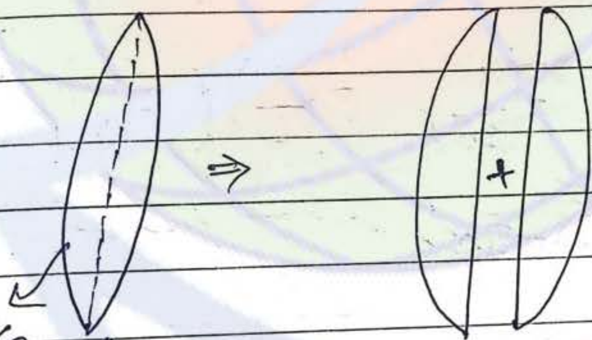


b) If cutting is done parallel to principle axis ⇒



⇝ focal length will remain uneffected.
because curvature is not changed.

Ex.



$\mu = 3/2$ $f = 20cm$

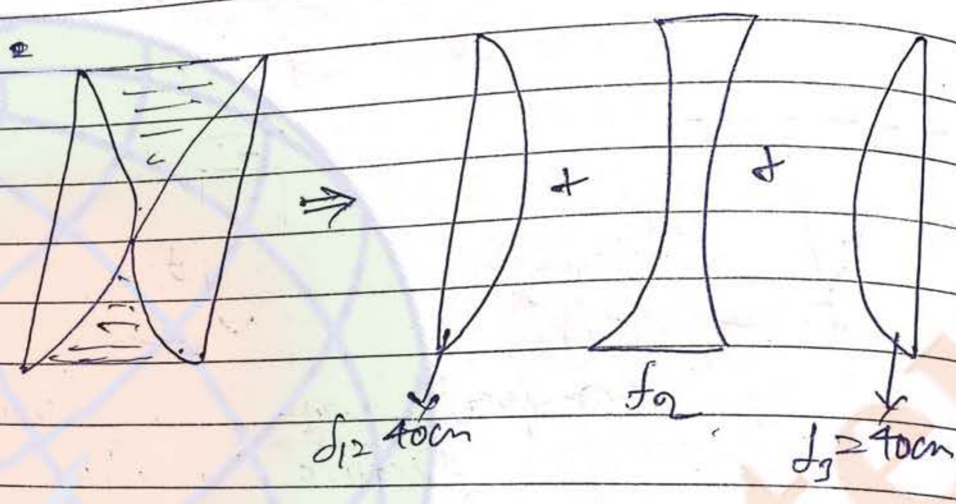
An equiconvex lense ha…
focal length ~~[illegible]~~ 20c…
air is cut into two …
shown and the water i…
as shown in the new arrangement
… length …

new

1st Choice

Sol^n

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



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

$\Rightarrow R = 20cm$

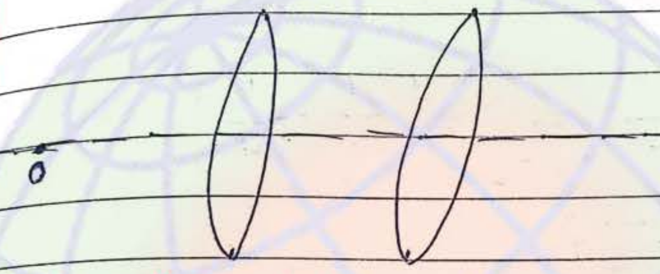
$$\frac{1}{f_2} = \left(\frac{4}{3} - 1\right)\left(\frac{1}{-20} - \frac{1}{20}\right) = \left(\frac{1}{3}\right)\left(\frac{-1}{10}\right)$$

$$f_2 = -30cm$$

$$\frac{1}{f_{eq}} = \frac{1}{40} - \frac{1}{30} + \frac{1}{40}$$

$$\boxed{f_{eq} = 60cm}$$

(6) If the lenses are not kept in Contact :→



Advice by PAH →

If the two lenses are not kept in contact then the problem can be solved by directly applying lense formula for the two lenses seperately.

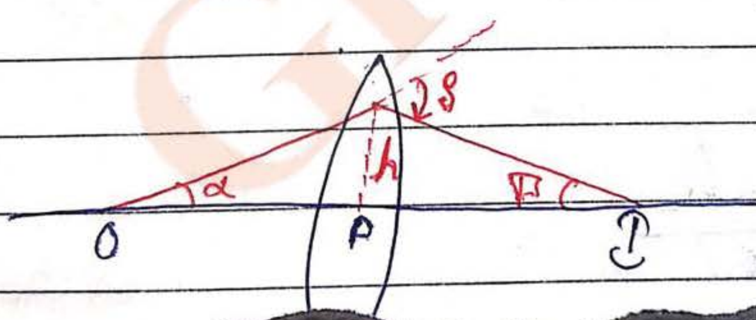
Note Special Point

If the lenses are not in contact then the be replaced by an equivalent lenses only if Incident ray's are coming parallel to principl

(जब Ray of light " || " हो होगा तभी तभी इसका ...

deviation की आवश्यकता नहीं

⟹ Deviation Produced by lens :→



For Paraxial Ray's

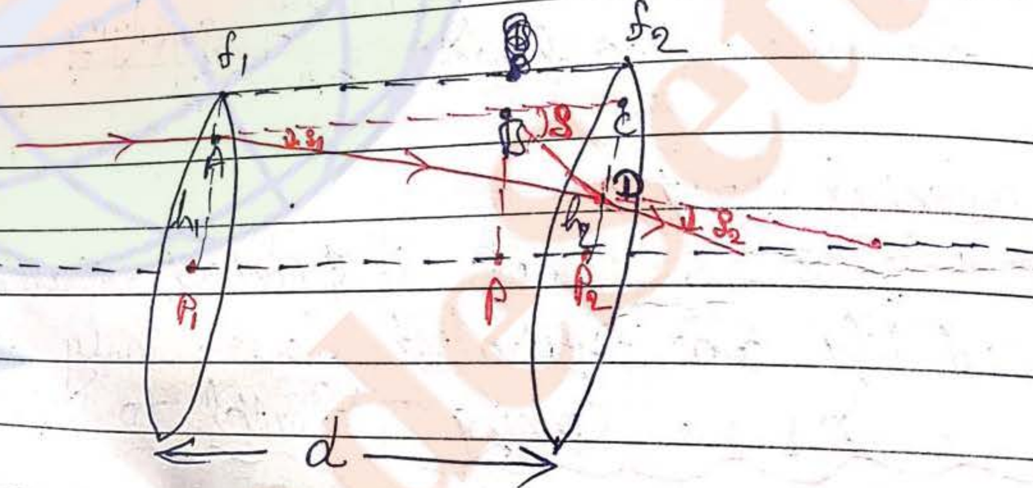
$$\delta = \frac{h}{PO} + \frac{h}{PI}$$

where $PO = -u$

$PI = v$

So, $\delta = \frac{h}{-u} + \frac{h}{v} = h\left(\frac{1}{v} - \frac{1}{u}\right)$

Angle of deviation $\leftarrow$ $\boxed{\delta = \frac{h}{f}}$



$$\delta = \delta_1 + \delta_2$$

$$\frac{h_1}{f_{eq}} = \frac{h_1}{f_1} + \frac{h_2}{f_2} \quad \text{—(1)}$$

In ΔACD,

$$\tan \delta_1 = \frac{h_1 - h_2}{d}$$

$$\frac{h_2}{d} = \frac{h_1}{d} - \frac{h_1}{f_1}$$

$$h_2 = h_1 - \frac{h_1 d}{f_1} \qquad \text{—(2)}$$

Put (2) in (1)

$$\frac{h_1}{f_{eq}} = \frac{h_1}{f_1} + \frac{h_1}{f_2} - \frac{h_1 d}{f_1 f_2}$$

$$\boxed{\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}}$$

→ Position of equivalent lense –

In ΔBCD

$$\tan\delta = \frac{h_1 - h_2}{PP_2}$$

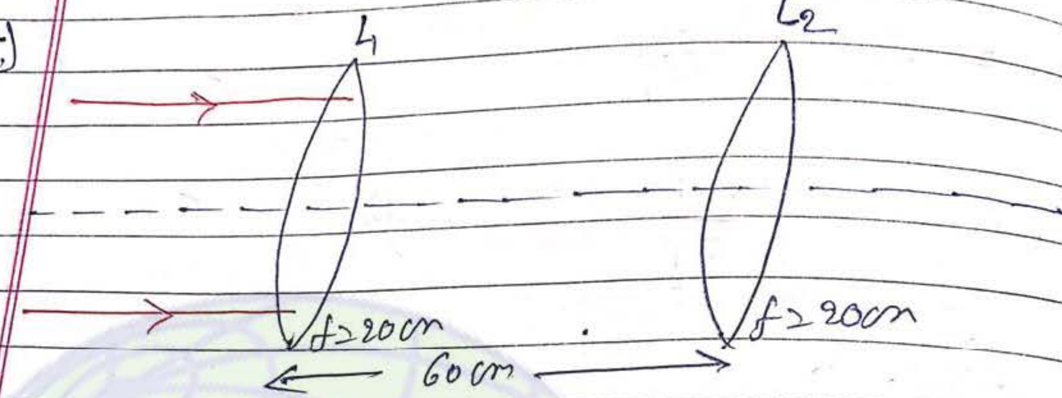
$$\frac{h_1}{f_{eq}} = \frac{h_1 - h_2}{PP_2}$$

$$\boxed{P_1P_2 = f_{eq}\left[\frac{h_1 - h_2}{h_1}\right] = \frac{f_{eq}\, d}{f_1}}$$

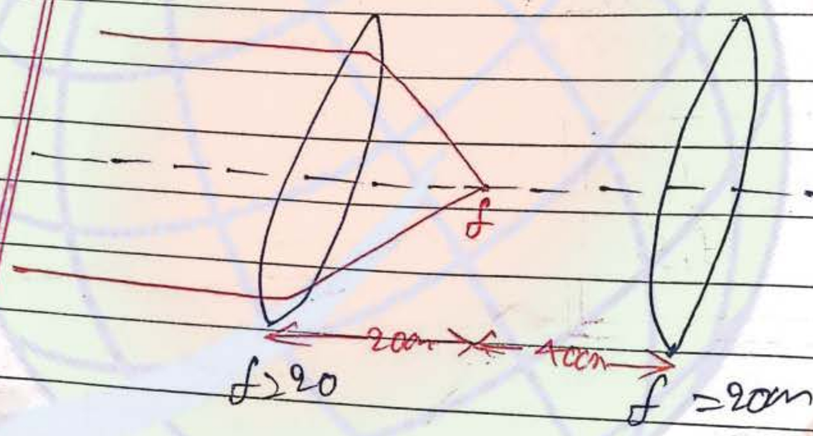
Conclusion:–

If the sepe

Q.)



Sol^n^ Ist method →



from 2nd lens

$u=-40$

$v=?$

$f=20$, $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$

$\frac{1}{v}=\frac{1}{20}-\frac{1}{40}$

$\boxed{v=40cm}$

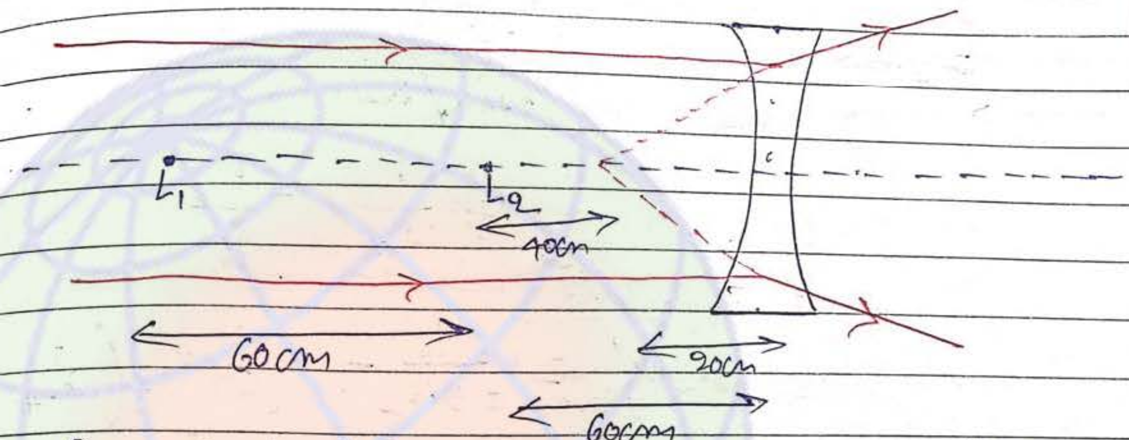
→ Image will be formed at 40cm from second lens toward's right.

IInd method →

$$\frac{1}{f_{eq}}=\frac{1}{20}+\frac{1}{20}-\frac{60}{(20)(20)}$$

$$\boxed{f_{eq}=-20cm}$$

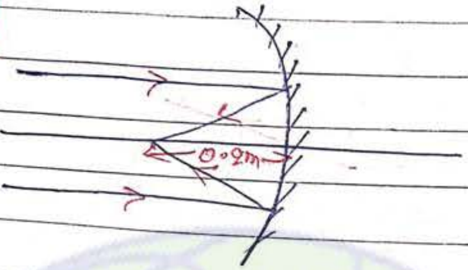
⇒ Sheet all done (Gr/HoT)
⇒ Read S.H.M and wave

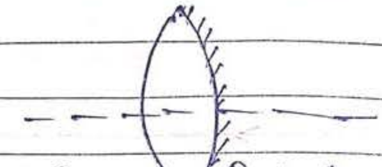


यदि PP_2 "-ve" में आए तो 2nd lense से left में PP_2 की आधा value पर lense को रखें। Here f_2 is -ve it stand's that lense is concave.

Ex-4
Q.No-4

Ex 1
Q No-17

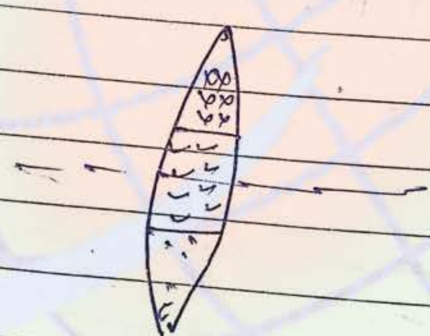




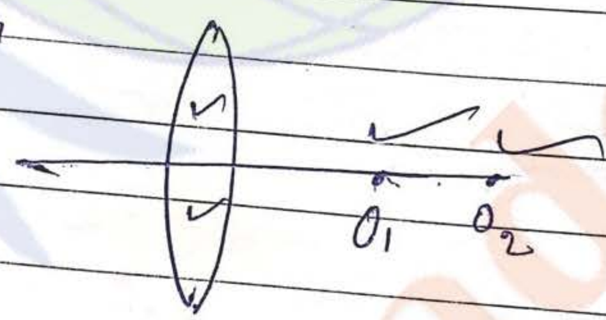
$$\frac{1}{f_{eq}} = \frac{1}{f_m} - \frac{2}{f_l}$$

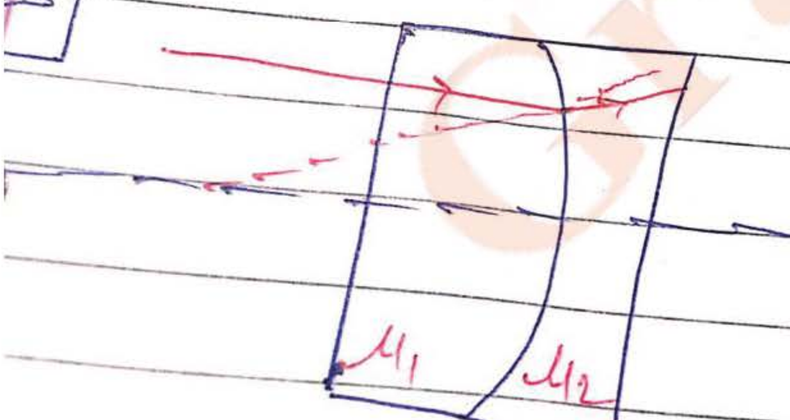
$$\frac{1}{f_{eq}} = \frac{1}{-0.2} - 2\left(\frac{4}{3}-1\right)\left(\frac{1}{0.4}+\frac{1}{0.4}\right)$$

Ex 2
Q No-24



sv

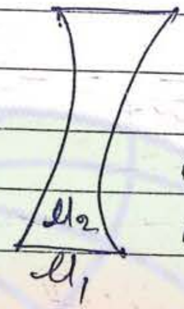




$\mu_2 > \mu_1$

1st Choice

$n_2 > n_1 > 1$
$(L_2)\ (L_1)\ (air)$

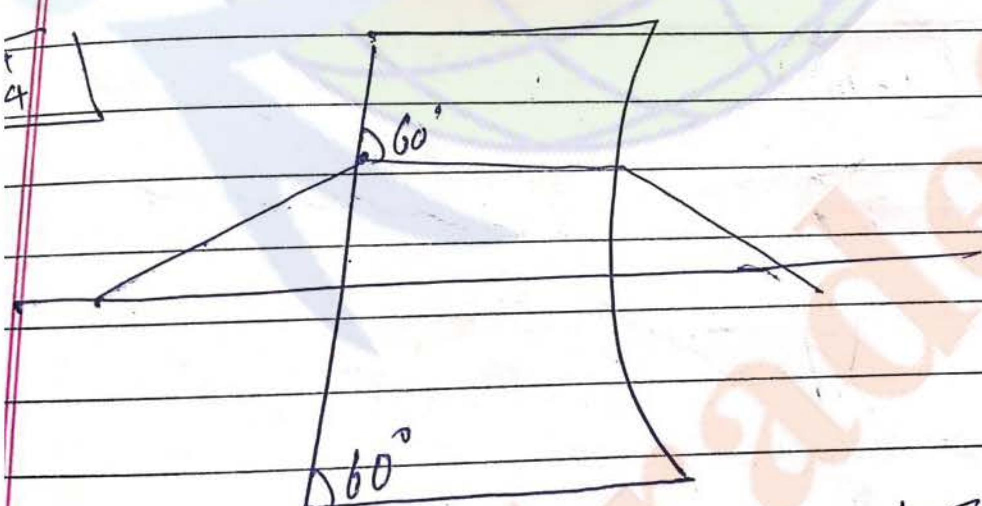


$\boxed{\mu_2 > \mu_1}$

$\frac{\mu_2}{v'} = \frac{\mu_2 - \mu_1}{R}$ — (1)

$\frac{\mu_3}{f} - \frac{\mu_2}{v'} = \frac{\mu_3 - \mu_2}{R}$ — 2

(1) + (2)



$\sin 45^\circ = \sqrt{2} \sin r$

$\angle r = 30^\circ$

$\frac{1.514}{v} = \frac{1.514 - 1.414}{0.4}$

$v =$

1st Choice

Ex 24
Q No > 15

$\vec{v}_{1l} = m^2 \vec{v}_{ol}$

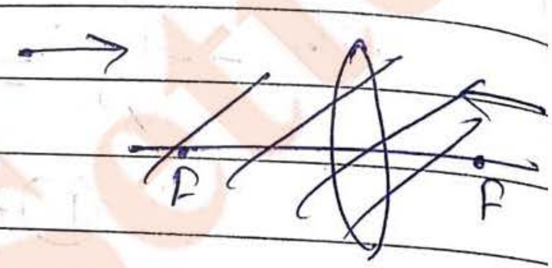
$v_1 = 9[0.01] = 0.09\ m/sec$

$m = \frac{f}{f+u} = \frac{0.3}{0.3-0.4} = -3$

$m = \frac{v}{u}$

$\frac{dm}{dt} = \frac{u \cdot \frac{dv}{dt} - v \cdot \frac{du}{dt}}{u^2}$

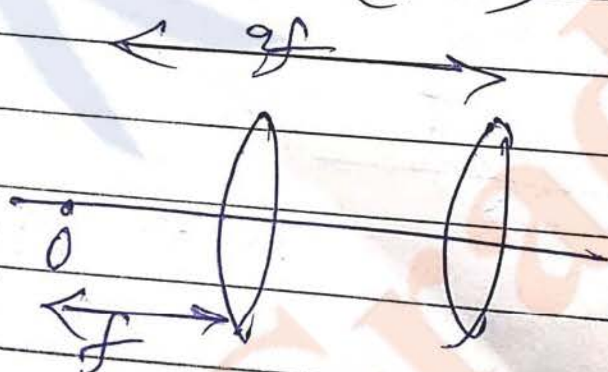
Ex 25
Q No 9



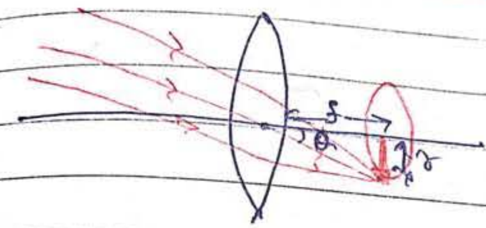
$v_{Il} = m^2 v_{ol}$

$v_1 - v = m^2[-v]$

$v_I = v(1-m^2)$



Ex 2.4 Q No 4



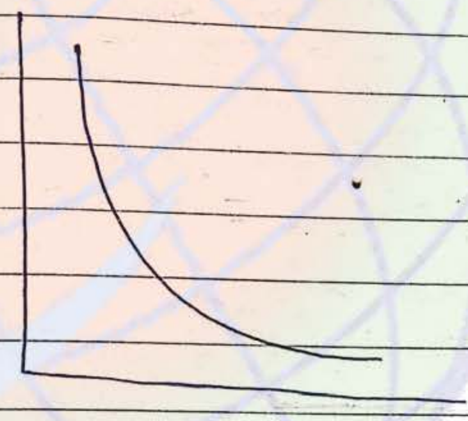
$\tan\alpha = \frac{r}{f}$

$r = f\tan\alpha$

$r = f$

$\pi r^2 \propto f^2$

Ex 2.4 Q No 5



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

$\frac{1}{f} = \frac{1}{10} + \frac{1}{10} = \frac{1}{5}$

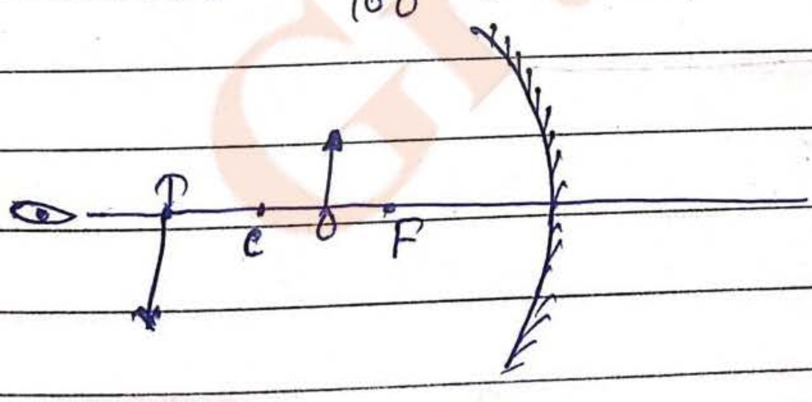
$\boxed{f = 5cm} \pm 0.005$

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

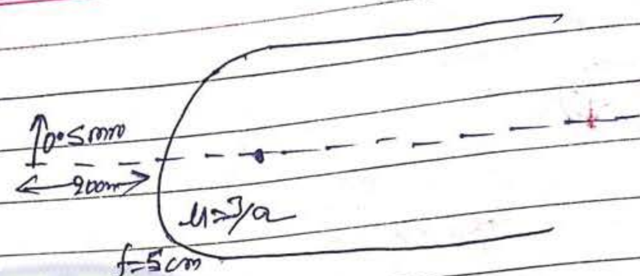
$\frac{\Delta f}{25} = \frac{0.1}{100} + \frac{0.1}{100} = \frac{0.2}{100}$

$\Delta f = \frac{5}{100} = 0.05$ Ans.

Ex 2.4 Q No 2



Q.3 on 10->2



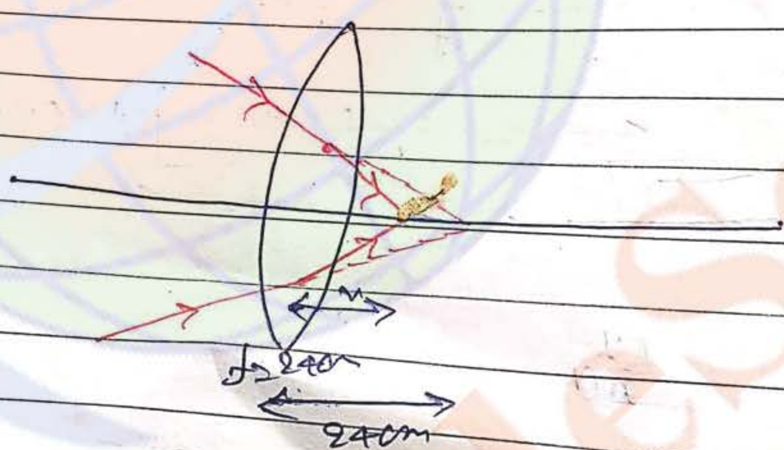
$$\frac{3}{2v} + \frac{1}{20} = \frac{3/2 - 1}{5}$$

$$\Rightarrow v = \text{—}$$

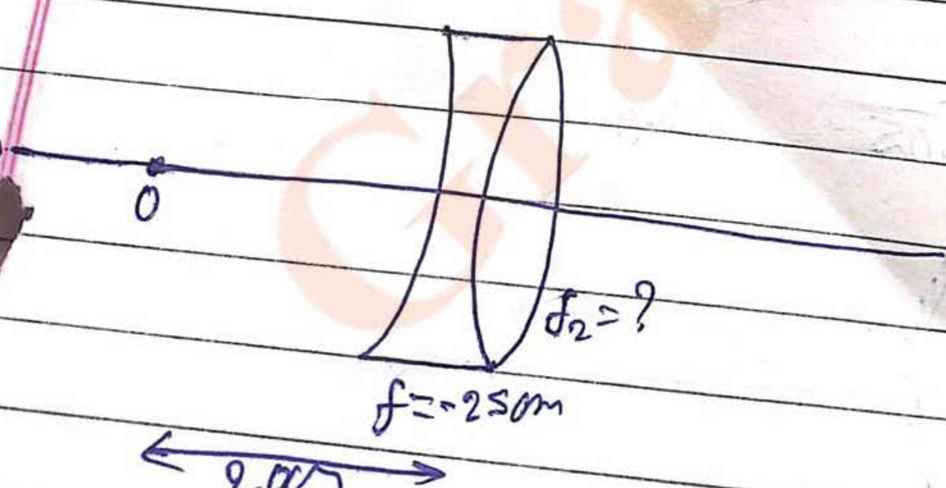
$$\frac{H_I}{H_O} = \left(\frac{1}{3/2}\right)\left(\frac{v}{-20}\right)$$

$$\Rightarrow H_I = \text{—}$$

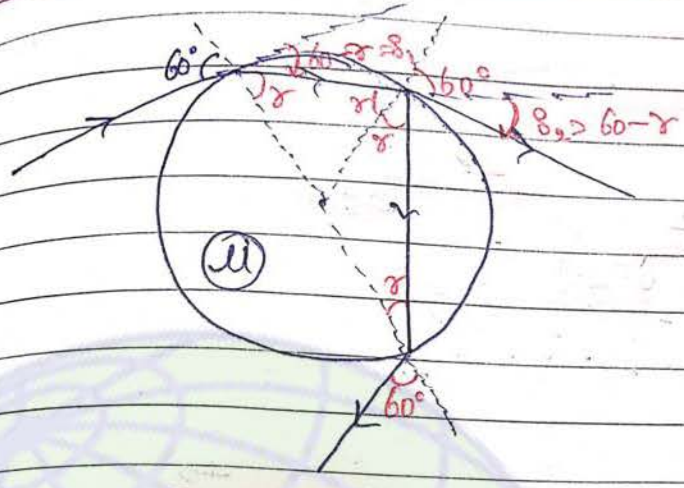
Q.2 on I



u = 24cm
f = 24cm
v = ?



(Ex → 2)
ONo → 8



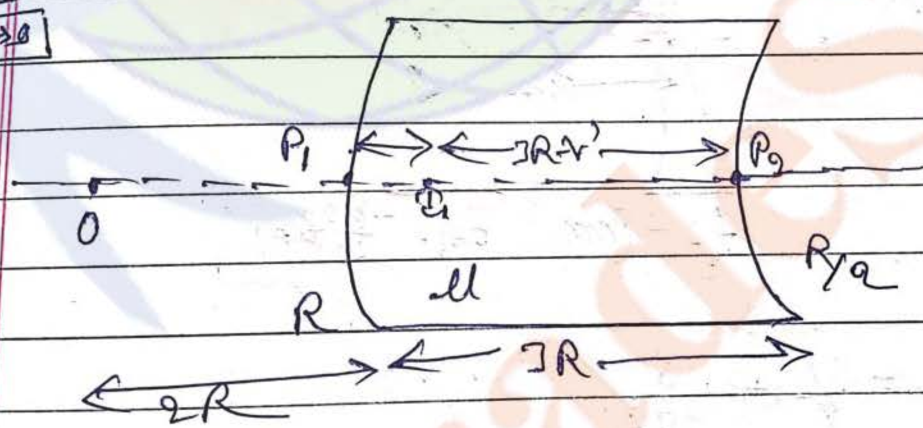
$$120 - 2r = \frac{1}{3}\left[60 - r + 180 - 2r + 60 - r\right]$$

$$r = 30$$

$$\sin 60 = \mu \sin 30$$

$$\boxed{\mu = \sqrt{3}}$$

Ex → 7
ONo → 8

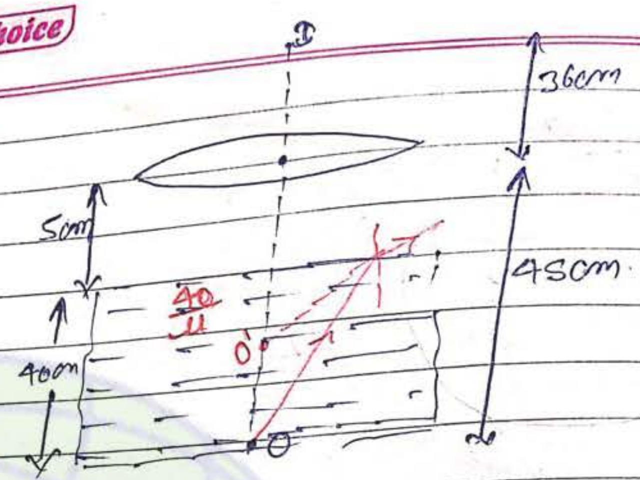


$$\frac{\mu}{v'} + \frac{1}{2R} = \frac{\mu - 1}{R} \quad (1)$$

$$v' = ?$$

$$\frac{1}{v} + \frac{\mu}{(3R \ldots} \ldots \frac{1 - \mu}{\ldots}$$

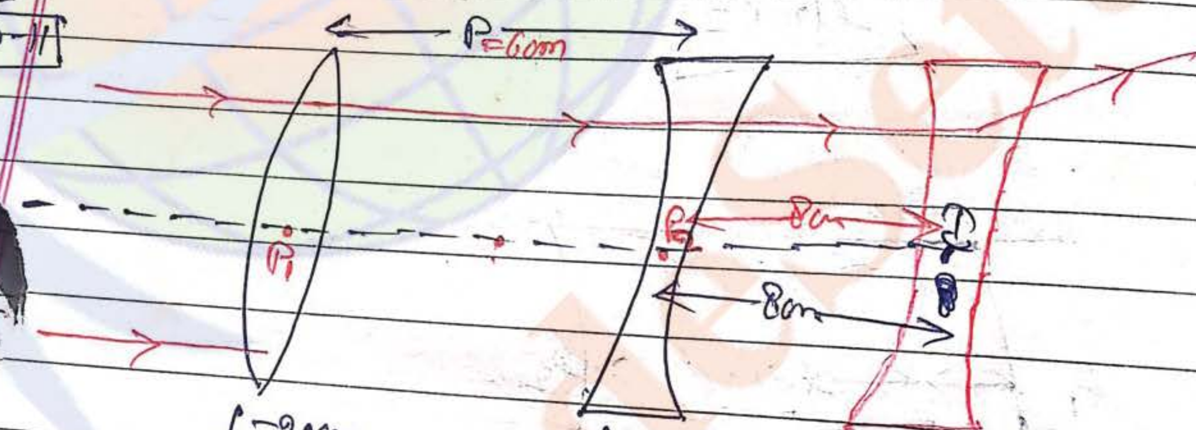
Q No → 10



$u = -45cm$
$v = 36cm$
$\boxed{f = 20cm}$

$u = -\left(5 + \frac{40}{\mu}\right)$
$\boxed{f = 20cm}$
$v = 48cm$
$\mu = ?$

Q No - 11

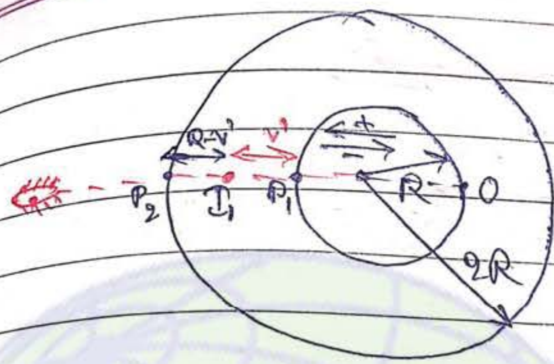


$f_1 = 20cm$ $\quad f_2 = -8cm$ $\quad f_{eq} = \frac{-80}{3} cm$

$$\frac{1}{f_{eq}} = \frac{1}{20} - \frac{1}{8} + \frac{6}{20(8)}$$

$$\frac{1}{f_{eq}} \Rightarrow \frac{1}{20} - \frac{1}{8} + \frac{6}{160}$$

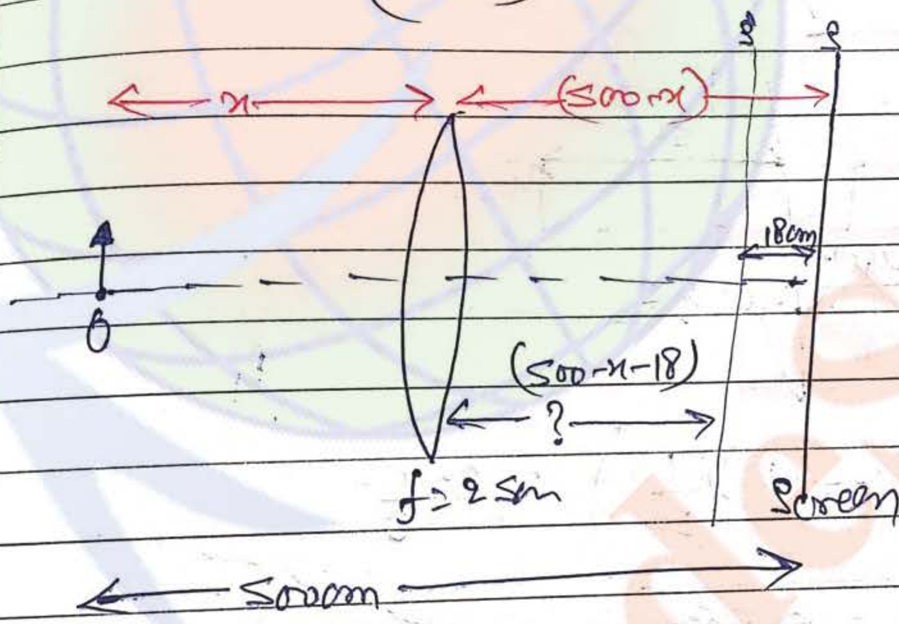
$$f_{eq} = \frac{-80}{3}$$



$$\frac{\mu}{v'} + \frac{1}{2R} = \frac{\mu - 1}{-R} \Rightarrow v' = ?$$

$$\frac{1}{v} + \frac{\mu}{(R - v')} = \frac{1 - \mu}{-2R} \Rightarrow v = ?$$

14)

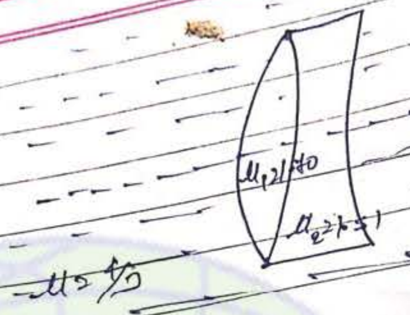


$u = -x$
$v = 500 - x$
$f = 25cm$
$x = ?$

$v = (500 - x - 18)$
$f = 25cm$
$u = ?$

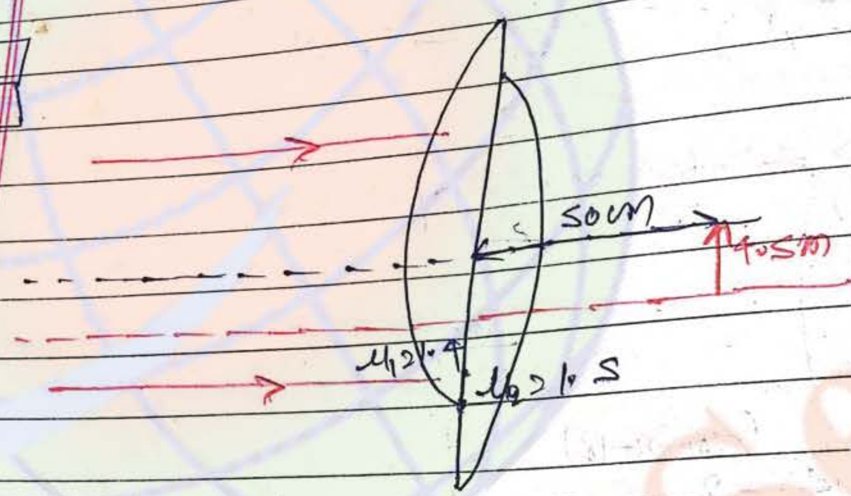
1st Choice

Q=3
Q.No>18



$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}$$

Q=2
Q.No>19



$$\frac{1}{f_1} = (1.4-1)\left(\frac{1}{20}\right) = \frac{0.4}{20}$$

$$\boxed{f_1 = 50cm}$$

$$\frac{1}{f_2} = (1.5-1)\left(\frac{1}{20}\right) = \frac{0.5}{20}$$

$$\boxed{f_2 = 40cm}$$

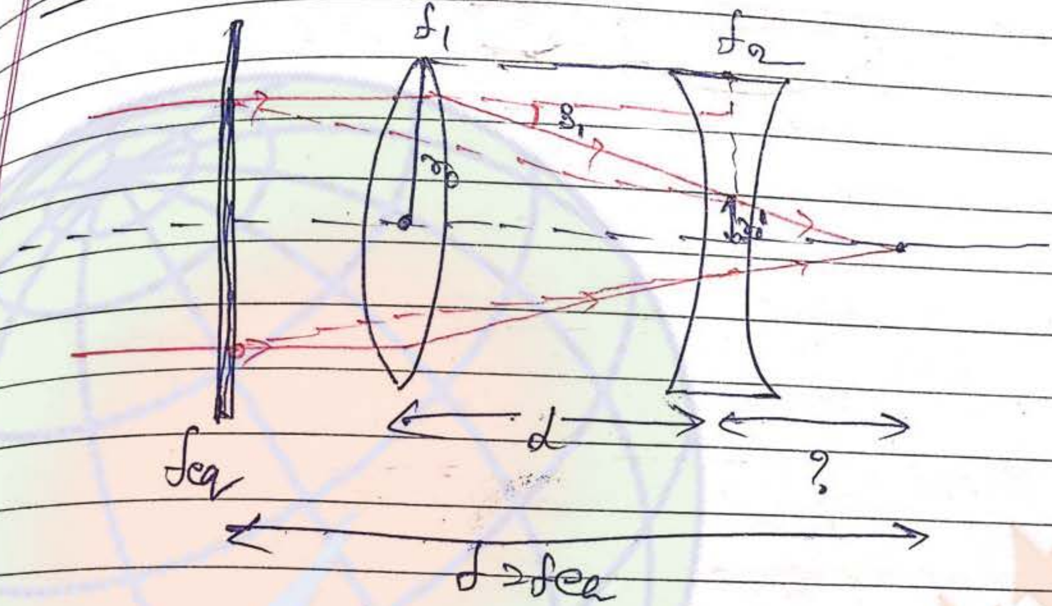
for second lense →

$u = 50cm$

$f = 40cm$

$v = ?$

Passage 1st

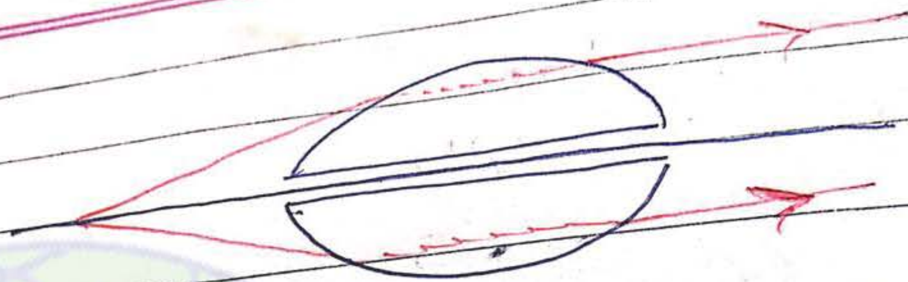


$$\frac{r_0}{f_1} = \frac{r_0 - r_0'}{d}$$

$$r_0' = \left(\frac{f_1 - d}{f_1}\right) \cdot r_0$$

1st Choice

Ex= 5
QNO -> 6



Date / /

The optical device that is used to increase the field of view magnification power and resolving power of the eye is called optical Instrument

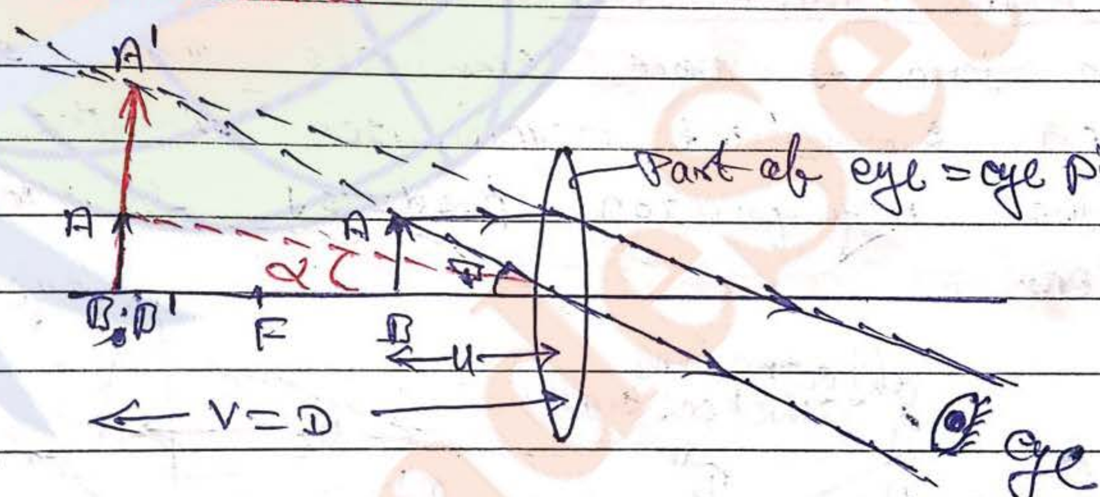
The final Image formed by an instrument is virtual

* magnification power:-

$$m.P = \frac{\text{field angle made by final image on the eye}}{\text{max}^m \text{ field angle made by object on the eye at clear vision}}$$

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

* Simple microscope:-



$$m.P = \frac{\beta}{\alpha} = \frac{\tan\beta}{\tan\alpha}$$

$$= \frac{\cancel{AB}}{+u} \times \frac{+D}{\cancel{AB}}$$

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

1st Choice

* $m.P_{min} = \lt V \rightarrow \infty$
  far point adjustment, normal adjustment
  parallel adjustment, unstrained adjustment

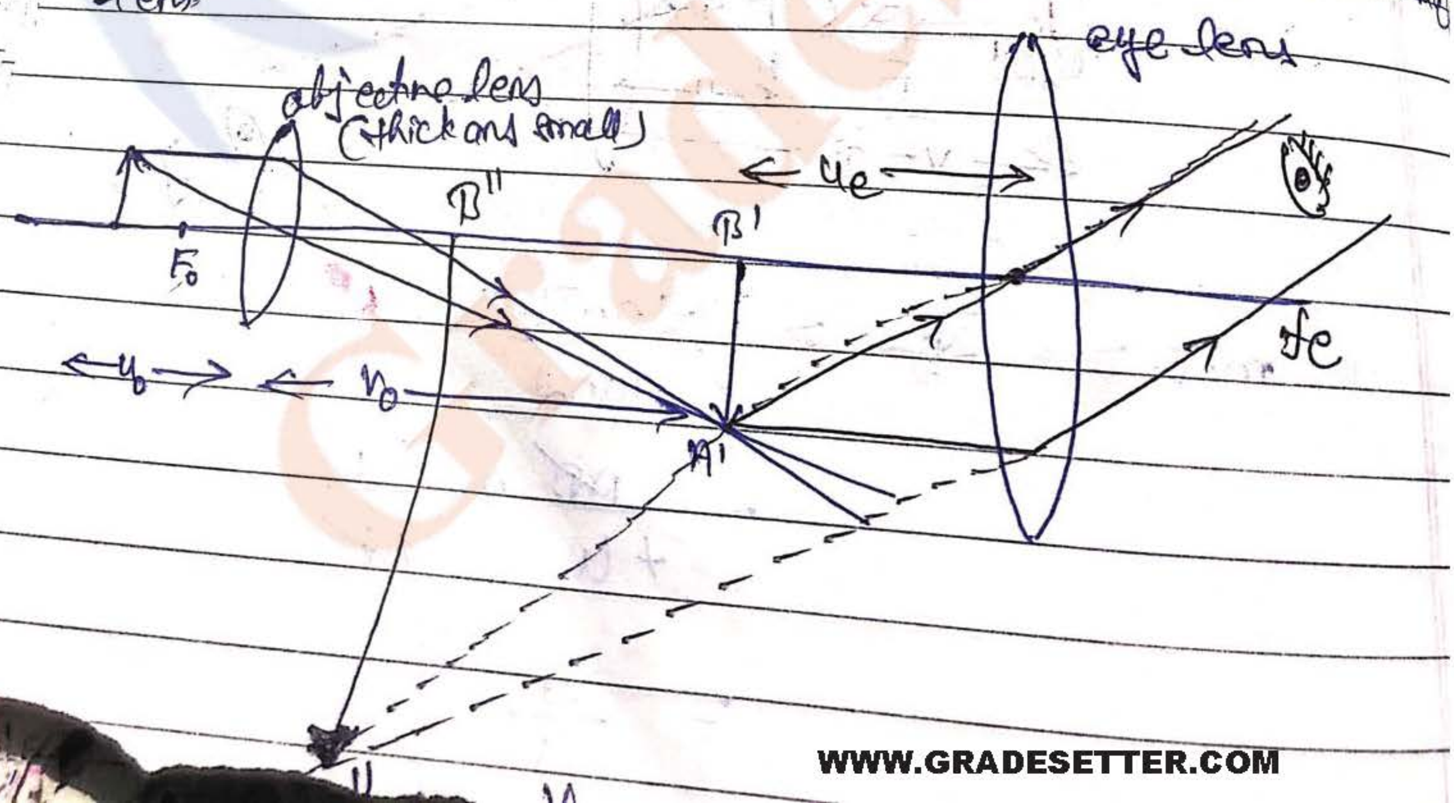
$$\boxed{m.P_{min} = m.P_{far} = \frac{D}{f}}$$

* $m.P_{max} = \lt V = 0$
  near point strained adjustment

$$\boxed{m.P_{max} = 1 + \frac{D}{f}}$$

Note: - In magnification power sign convention is "not" valid (not live)

(II) Compound microscope: —
when two or more lens are used in a system then resultant magnification is the product of the magnification produced by individual lens.



(c) $\boxed{m.P_{max} = m.P_{(\text{near point})} = -\frac{v_o}{u_o}\left(1+\frac{D}{f_e}\right)}$

(d) $\boxed{m.P_{min} = m.P_{(\text{far point})} = -\frac{V_o}{u_o}\frac{D}{f_e}}$

length of tube :-

L = Distance b/w eyepiece and objective lens.

(i) $L = |v_o| + |u_e|$

$= |v_o| + \left|\frac{v_e f_e}{v_e + f_e}\right|$

(ii) for near point ($v_e = D$)

$$\boxed{L_{near} = v_o \left|\frac{D f_e}{D + f_e}\right|}$$

(iii) for far point ($v_e \to \infty$, $u_e = f_e$)

$$\boxed{L_{far} = |v_o| + |f_e|}$$

special case :-

If $u_o \approx F_o$ then $v_o >> u_e$

$\therefore V_o \approx L$

for far point :-

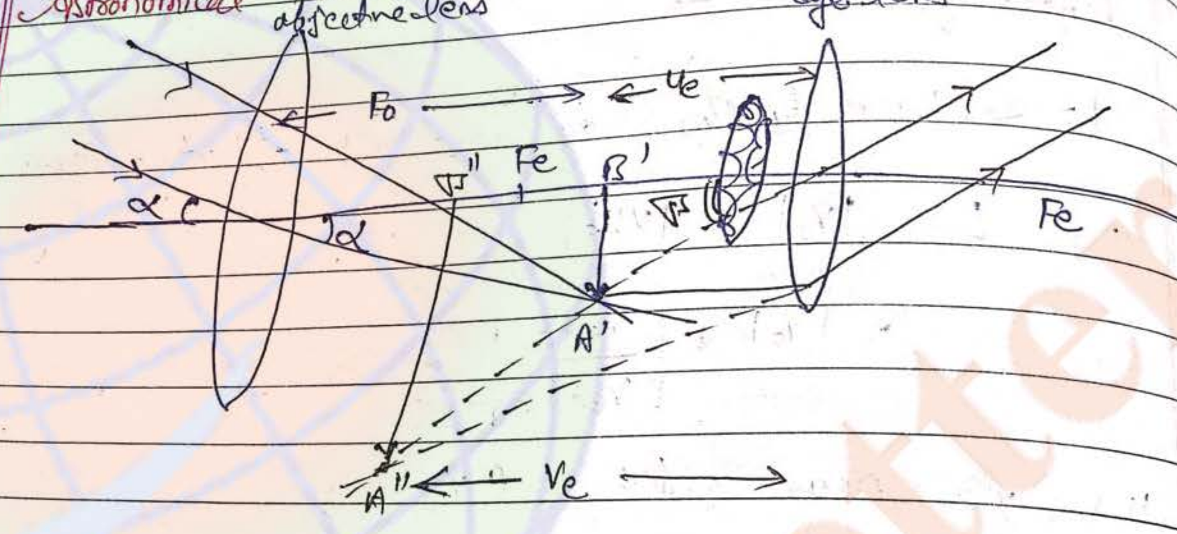
$$|m.P|_{far} = -\frac{L}{f_o} \times \frac{D}{f_e}$$

1st Choice

Note:- Resolving power:-

$$\boxed{R.P = \frac{2\mu \sin\theta}{\lambda} \propto \frac{1}{\lambda}}$$

(3) Astronomical telescope:-



$$M.P = \frac{\tan\beta}{\tan\alpha} = \frac{-A'B'}{-u_e} \times \frac{F_o}{-A'B'} = \frac{-F_o}{u_e} = \frac{-F_o}{D} \times \frac{D}{u_e}$$

(i) $$\boxed{M.P_{max} = M.P_{(near\ point)} = \frac{-F_o}{D} \times \left(1 + \frac{D}{f_e}\right)}$$

(ii) $$\boxed{M.P_{min} = M.P_{(far\ point)} = \frac{-F_o}{D} \times \frac{D}{f_e} = \frac{-F_o}{f_e}}$$

* length of tube:-

$$L = |F_o| + |u_e|$$

$|F_o| + |V_e f_e$ ...

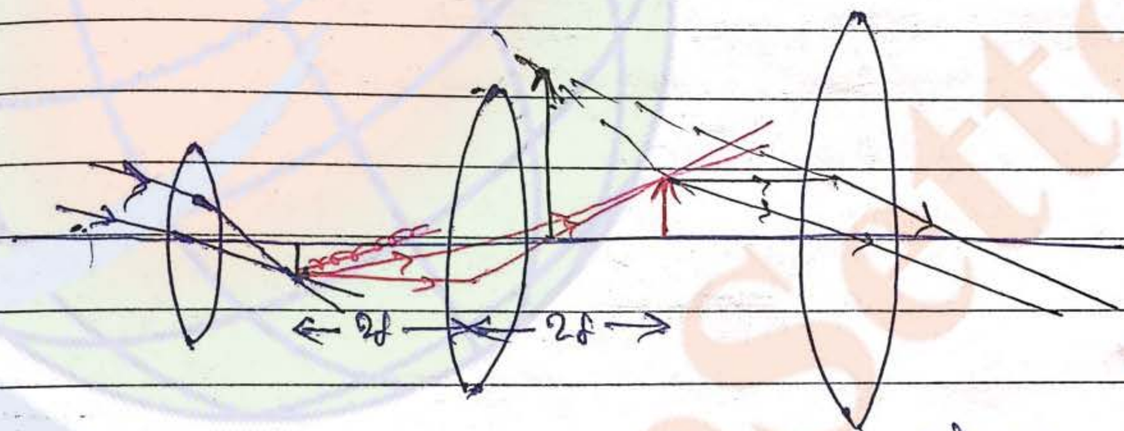
(ii) for near point $= (v_e = 0)$

$$\boxed{L_{near} = |F_o| + \left|\frac{D f_e}{D + f_e}\right|}$$

(iii) for far point $(v_e \to \infty)$

$$\boxed{L_{far} = |F_o| + |f_e|}$$

(4) Telescope or terrestrial telescope:–



$$\boxed{m.p_{far} = \frac{f_o}{f_e}} \quad ; \quad \boxed{L_{far} = f_o + f_e + 4f}$$

when the two waves of the same frequency travel in the same direction (or nearly same direction) then due to ~~this~~ their superposition at some position Intensity becomes maximum ~~or~~ wave is at some position it becomes min. this re-distribution of energy is called as Interference (व्यतिकरण)

$$y_1 = A_1 \sin(\omega t - kx)$$ → पहले source से आती light के निकलने वाली equation

$$y_2 = A_2 \sin(\omega t - kx + \phi)$$ → दूसरे source " " "

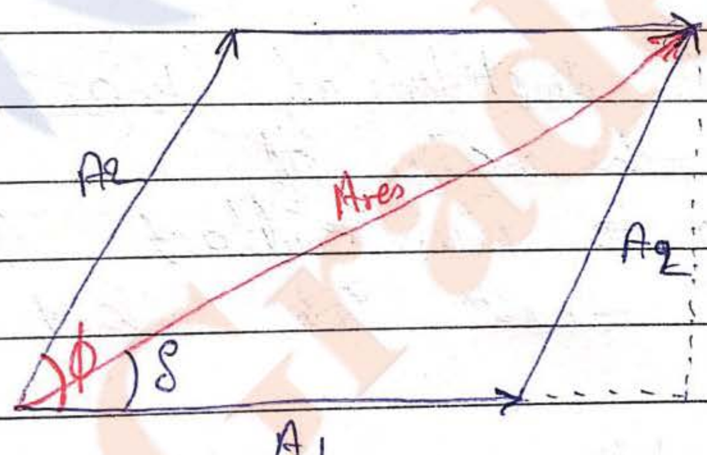
ϕ :→ Phase difference

$$y = y_1 + y_2$$

$$y = A_1 \sin(\omega t - kx) + A_2 \sin(\omega t - kx + \phi)$$

$$\boxed{y = A_{res} (\omega t - kx + \delta)}$$

A_{res} = Resultant amplitude



$$\boxed{A_{res} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}}$$

$\sin\phi$

1st Choice

$$\boxed{\text{Intensity} \propto (\text{Amplitude})^2}$$

⇒ Let I_1 and I_2 be the Intensity of two wave

$$\boxed{I_{res} = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi}$$

For constructive Interference	For destructive Interference
* A_{res} and I_{res} should be maximum	* A_{res} and I_{res} should be min
* $\cos\phi = 1$	* $\cos\phi = -1$
* $\phi = 2n\pi$ where $n = 0, 1, 2, ---$	* $\phi = (2n-1)\pi$, $n = 1, 2, 3 ---$
* $A_{max} = A_1 + A_2$	* $A_{min} = \lvert A_1 - A_2 \rvert$ ∵ "-ve" का कोई Physical meaning नहीं
* $I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2 = 4I_0$	* $I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2 = 0$
* Bright fringe form होता है।	

Example – The ratio of Amplitude of two waves is 2:1 find out the ratio of
i) max. to min. resultant Amplitude
ii) max. to min. resultant Intensity

Sol^n a) $\dfrac{A_{max}}{A_{min}} = \dfrac{A_1 + A_2}{A_1 - A_2} = \dfrac{\frac{A_1}{A_2} + 1}{\frac{A_1}{A_2} - 1}$ ∵ $\dfrac{A_1}{A_2} = \dfrac{2}{1}$

$= \dfrac{2+1}{\ldots} = \dfrac{5/1}{1/1} = \ldots$

* Path difference -

Path difference of the two waves at a given point is simply the difference of the path travelled by the two waves.

$$\boxed{\text{Phase diff} = \frac{2\pi}{\lambda}\cdot(\text{Path diff})}$$

→ Relation b/w phase diff and Path diff.

(i) For constructive Path -

$$\cancel{\text{Path diff} = \frac{\lambda}{2\pi}(2n-1)\pi = (2n-1)\frac{\lambda}{2}}$$

$$\boxed{\text{Path diff} = \frac{\lambda}{2\pi}(2n\pi) = n\lambda}$$

$n = 0, \pm1, \pm2$ ——

(ii) For destructive Path :-

$$\boxed{\text{Path diff} = \frac{\lambda}{2\pi}(2n-1)\pi = (2n-1)\frac{\lambda}{2}}$$

$n = \pm1, \pm2,$ ——

Note ⇒

1) If sources are coherent :->

$$I_{res} = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

⇒ If sources are In-coherent ⇒

$I_{res} = I$ [illegible]

Young's double slit Exp. (YDSE) →

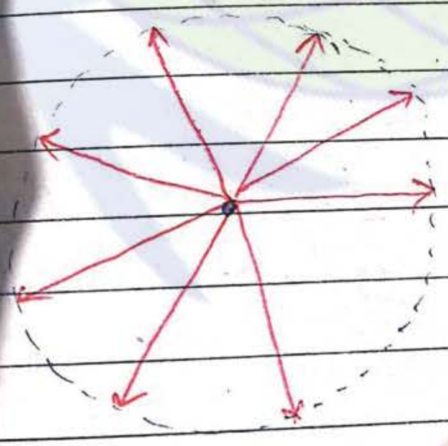
Young proved experimentally through his young double slit Experiment that light could produce Interference pattern. So we can say light is having the wave nature.

Huygen's wave theory →

wave front :- wave front is a locus of all the point which are vibrating in the same phase.

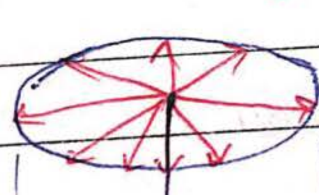
Depending upon the source of light three types of wave front are defined :-

1) Spherical wave front →



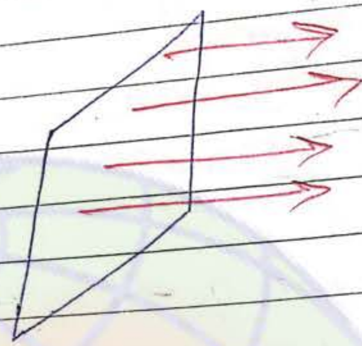
→ If source of light is a point source.

2) Cylindrical wave front.



1st Choice

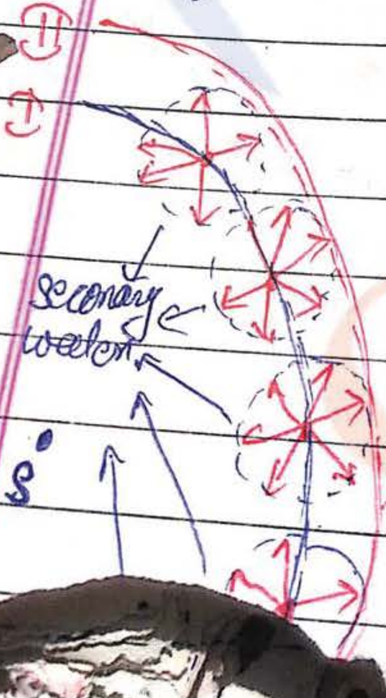
3) Planar wavefront -



Planar wavefront →

If the source of light (either point or line) far away than any smaller section of either spherical or cylindrical can be co as a planar wave front

For any wave front the direction of propaga of wave is perpendicular to the surfa of wavefront.

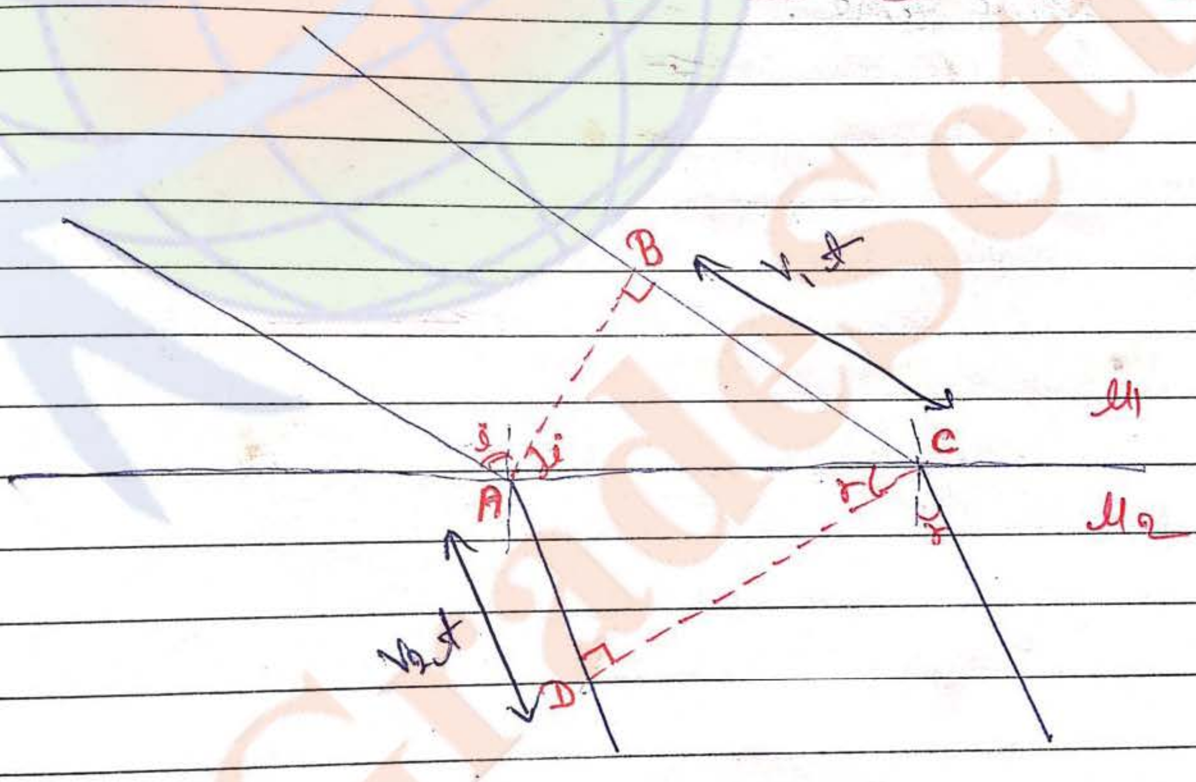


As per the Hygen's theory:→

i) The point present on the surface behaves like the source of new disturbance as shown in the figure which are called as secondary wavelets.

ii) The new position of the wavefront can be seen with the help of ~~outer~~ ~~envelope~~ outer envelope.

Ⓠ Proof the Snell's law as per the hygen's theory⇒



AB ⇒ Incident planar wave front

CD ⇒ Refracted planar wavefront.

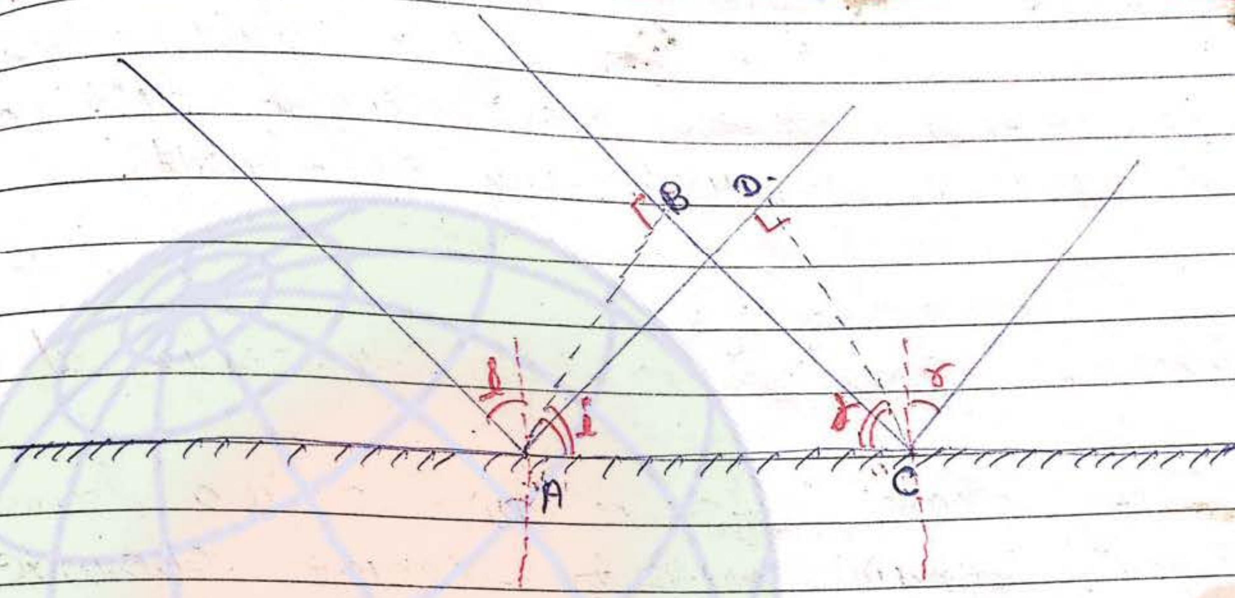
V_1t

$$\sin r = \frac{AD}{AC} = \frac{v_2 t}{AC}$$

$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{c/\mu_1}{c/\mu_2} = \frac{\mu_2}{\mu_1} = \text{Constant}$$

Note →
The phase difference b/w any two point on a wavefront is zero
because light from the source reaches every point of the wavefront at the same time.

Proof of law of reflection as per the Hugen's th



AB ⇒ Incident Planar wavefront
CD ⇒ Refracted planar wavefront

$\angle ABC = \angle ADC$
$BC = AD$
$AC = AC$ (common)

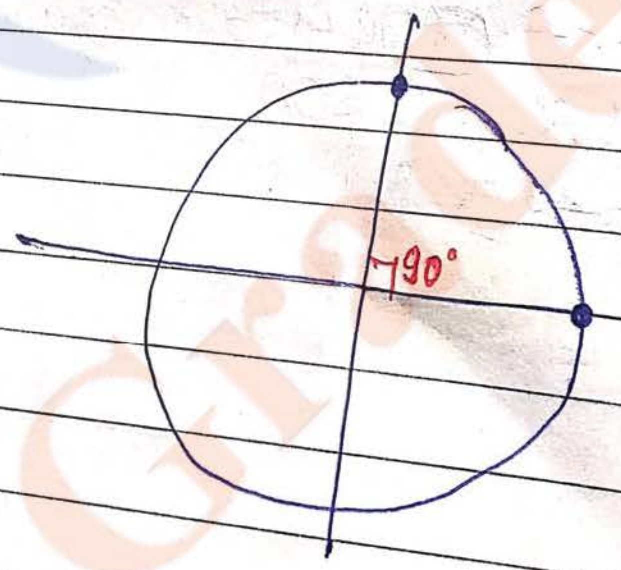
$\triangle ABC$ and $\triangle ACD A$ are congruent
$\angle BAC = \angle DCA$
$\Rightarrow \angle i = \angle r$

*) Young proved experimentally through young's double slit experiment (YDSE) that light could produce Interference so the wave nature of light can be proved through this experiment.

* Essential condition's for the Interference of light

i) The phase difference b/w the two beam's should remain constant because otherwise if phase diff (ϕ) is variable than at a given point Intensity will ~~continue~~ continuously change.

* The sources which are used to maintain the constant phase difference are called as coherent sources.



$$\left(f = \frac{1}{T} \right)$$

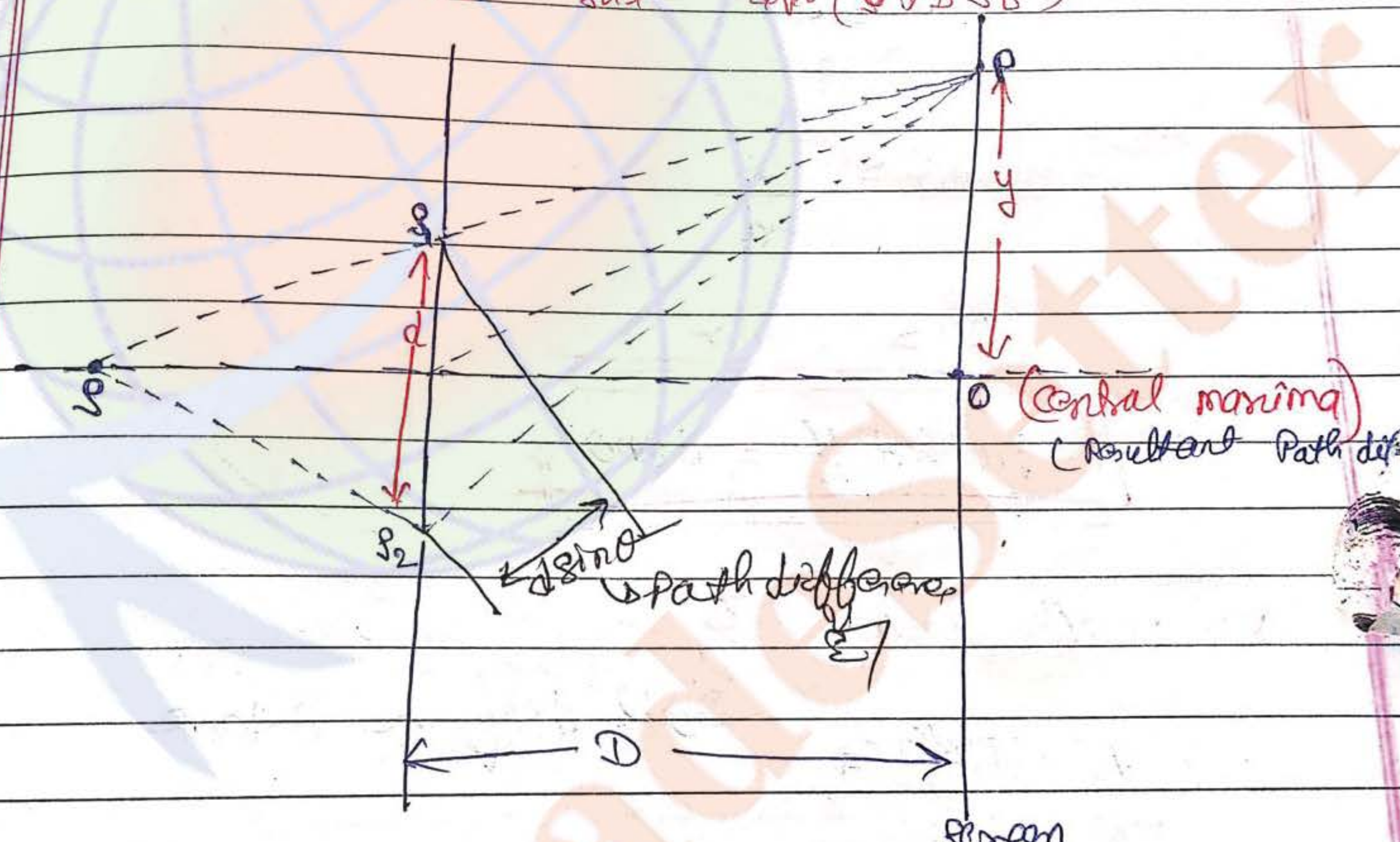
iii) The frequency of the two beam's be same ...

$A_1 = A_2$
$I_1 = A_2$

→ Dark
→ Bright
→ Dark
→ Bright

It is not necessary that the amplitude of two waves should be same but if it is same than we can observ a better contrast on the screen.

★ Young's double slit Exp. (YDSE)



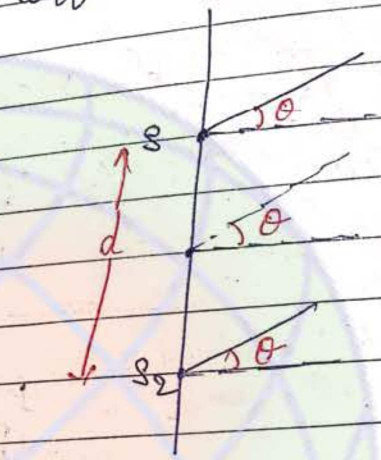
$$\boxed{d <<<< D}$$

S_1 and S_2 ⇒ slit
S ⇒ source of light

1st Choice

⇒ Path difference

Path diff $= S_2P - S_1P$



$$\sin\theta = \frac{\Delta y}{d}$$

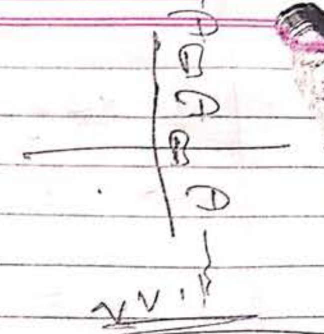
$$\Delta y = d\sin\theta$$

$$\boxed{\text{Path diff} = d\sin\theta}$$

For smaller value of θ,

~~Path diff~~ Path diff $\approx d\tan\theta$

$$\boxed{\text{Path diff} = d\left(\frac{y}{D}\right)}$$



(8) For constructive Interference

$$\frac{yd}{D} = n\lambda$$

$$\cancel{y = \frac{n\lambda D}{d}}$$

$$\boxed{y = \frac{n\lambda D}{d}} = n \cdot \beta$$

Central bright fringe $y = 0$

where, $n = 0, 1, 2, \ldots$

$$\boxed{y = \frac{\lambda D}{d}, \frac{2\lambda D}{d}, \frac{3\lambda D}{d} \ldots}$$

Position of any nth order maxima or any nth order bright fringe.

(bright fringes)

(9) For destructive Interference

$$\frac{yd}{D} = (2n-1)\frac{\lambda}{2}$$

$$\boxed{y = \frac{(2n-1)\lambda D}{2d}} = \left(\frac{2n-1}{2}\right) \cdot \beta$$

where, $n = 1, 2, 3, \ldots$

$$y = \frac{\lambda D}{2d}, \frac{3\lambda D}{2d}, \frac{5\lambda D}{2d} \ldots$$

Position of

In YDSE →

→ $I_1 = I_2 = I_0$

$I_{res} = I_0 + I_0 + 2 I_0 \cos\phi$

$I_{res} = 2 I_0 (1 + \cos\phi)$

$$\boxed{I_{res} = 4 I_0 \cos^2\left(\frac{\phi}{2}\right)}$$

* $I_{max} = 4 I_0$
* $I_{min} = 0$

→ $A_1 = A_2 = A_0$

$A_{res} = \sqrt{A_0^2 + A_0^2 + 2 A_0^2 \cos\phi}$

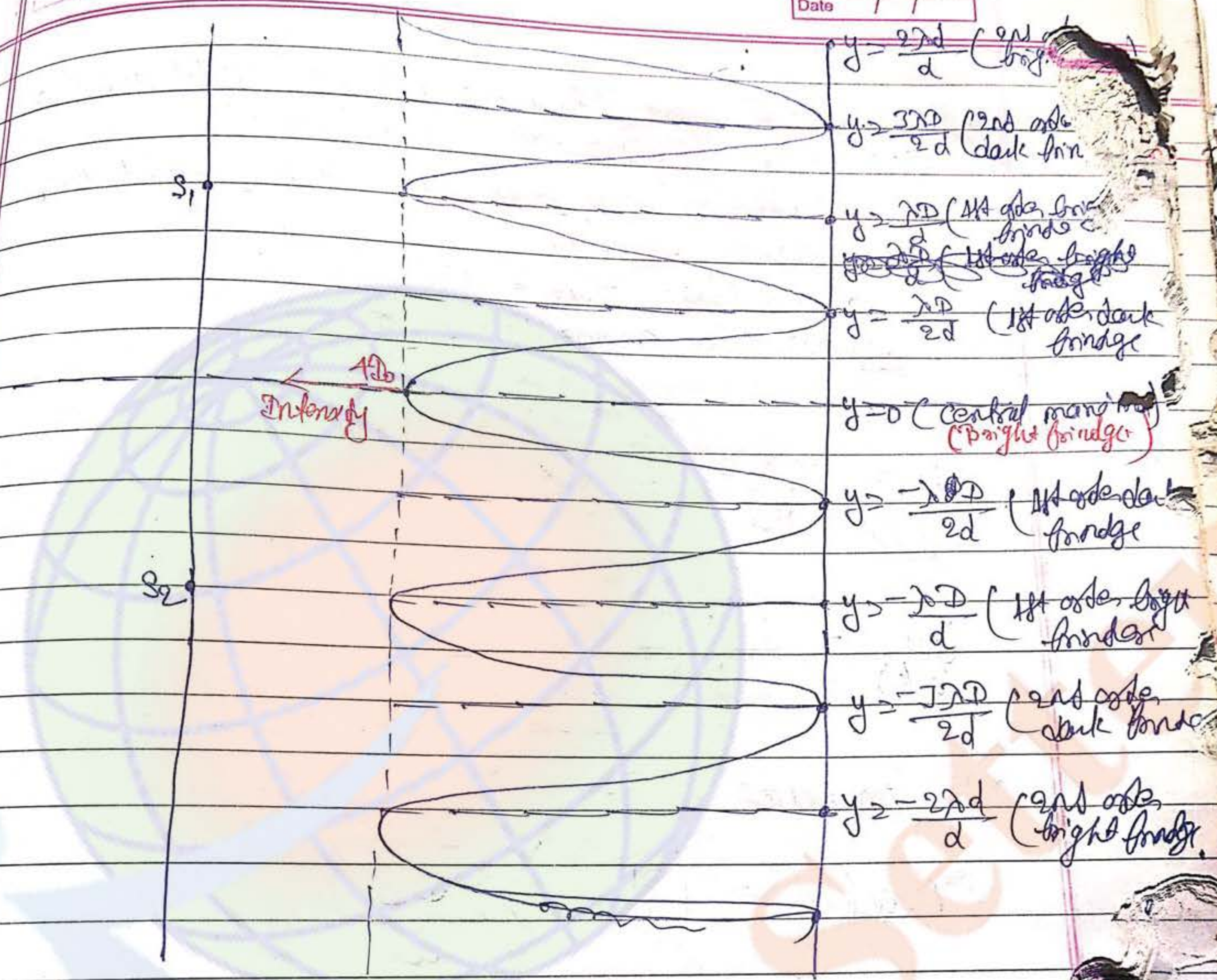
$= \sqrt{2 A_0^2 (1 + \cos\phi)}$

$$\boxed{A_{res} = 2 A_0 \cos\left(\frac{\phi}{2}\right)}$$

* $A_{max} = 2 A_0$
* $A_{min} = 0$

Central maxima is a Point on the

the resultant



नोट :-> ध्यान दें
Bright fringe maxima ($4I_0$) पर स्थित होता है।

1st Choice

Example In YDSE the wavelength of light used is 5000 A°, D = 2m, d = 1mm
Find out the separation b/w 8th bright and 11th dark fringe
a) on the same side
b) on the opposite side

Sol/n

$$\underset{(bright)}{y_8} = \frac{8\lambda D}{d} = 8X$$

$$\underset{(dark)}{y_{11}} = \frac{21\lambda D}{2d}$$

a) on same side

$$\text{Separation} \Rightarrow \left(\frac{21}{2} - 8\right)\frac{\lambda D}{d}$$

$$= \frac{5}{2} \times \frac{5\times10^{-7} \times 2}{10^{-3}} m$$

$$=$$

b) on opposite side

$$\text{Separation} = \frac{37}{2}\frac{\lambda D}{d} =$$

Example 2 → In YDSE the Intensity of light used is ... the resultant ...

this point is $\pi/3$

b) The path diff b/w the two beam's reaching at this point is $\lambda/2$

Sol^n

a) $I_{res} = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$

$= 4I_0 \cos^2\left(\frac{\pi}{6}\right)$

$= 4I_0 \left(\frac{\sqrt{3}}{2}\right)^2$

$= 3I_0$

b) Path diff $= \lambda/2$

Phase diff $= \frac{2\pi}{\lambda}\left(\frac{\lambda}{2}\right) = \pi$

$I = 4I_0 \cos^2(\pi/2)$

$= 0$

Q3.) The Intensity of the light in YDSE is "I_0" Find out the position of nearest point where the resultant Intensity becomes

a) I_0

b) $3I_0$

Sol^n [λ, D, d are given]

a) $I_0 = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$

$\cos^2\left(\frac{\phi}{2}\right) = \frac{1}{4}$

$\cos\left(\frac{\phi}{2}\right) = \frac{1}{2}$

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

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

Path diff $= \frac{\lambda}{2\pi}\left(\frac{2\pi}{3}\right) = \frac{\lambda}{3} = \frac{yd}{D}$

$$\boxed{y = \frac{\lambda D}{3d}}$$

b) $y = \frac{\lambda D}{6d}$

Date / /

$\beta = 0$

$D = 4\lambda$

$$\frac{n\lambda \cancel{D}}{\cancel{d}} = \frac{n\lambda \cancel{D}}{\cancel{d}}$$

$n_1 =$

8) $d = 5$

$D = 12$

$\lambda = ?$

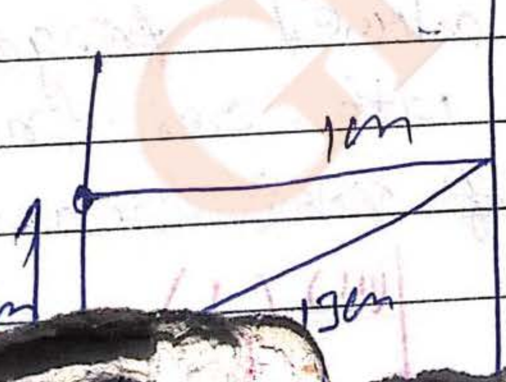
$$\Rightarrow \frac{(2n-1)\lambda D}{d} \Rightarrow \frac{\lambda \times 12}{5}$$

$$\Rightarrow \cancel{(2n-1)\lambda D} \quad \Rightarrow \lambda = \frac{5}{12}$$

$$\Rightarrow \frac{\lambda \times 12}{d} \quad \Rightarrow \frac{3\lambda \cancel{D}}{\cancel{d}}$$

$$\frac{\lambda_1 \cancel{D}}{\cancel{2d}} = \frac{3\lambda \cancel{D}}{\cancel{2d}}$$

$\lambda = 3\lambda$



12λ

1st Choice — Page No. 337

नोट॰ इसका मतलब यह है कि Y.D.S.E experiment का medium, colour of light, wavelength आदि पर असर पड़ता।

Fringe width (β)

$$\beta = \frac{(n+1)\lambda D}{d} - \frac{n\lambda D}{d}$$

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

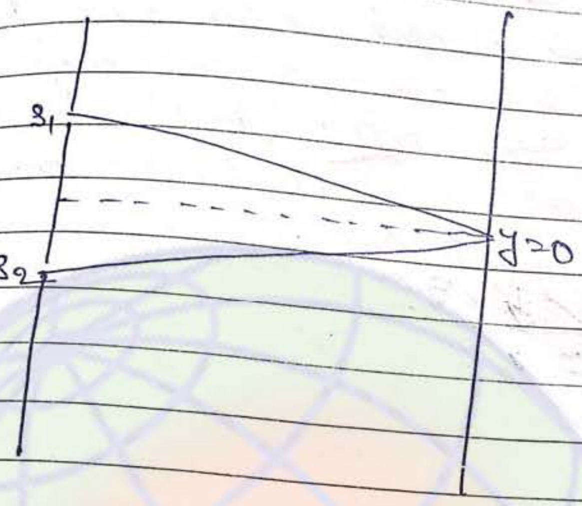
Fringe width is the separation b/w either two consecutive maxima or two consecutive minima. and it is directly proportional to wavelength of the light used.

$$\boxed{\beta \propto \lambda}$$

नोट॰

1.) In Y.D.S.E apparatus is immersed in a liquid of refractive Index "μ", then wavelength of light and fringe width decrease "μ" time.

2.) If white light is used in place of mono-chromatic light than coloured fringes are obtained on the screen with red fringes of larger size than that of violet because $\lambda_{red} > \lambda_{violet}$ so, what happen's if YDSE is Immersed a liquid



$$y = \frac{n\lambda D}{d}$$

$$y_n = \frac{(2n-1)\lambda D}{2d}$$

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

$$\boxed{\mu = \frac{\lambda_{air}}{\lambda_{med}}}$$

$$\boxed{\lambda_{med} = \frac{\lambda_{air}}{\mu}}$$

If YDSE setup is Immersed in a liquid the position of central maxima does not change but because in the medium wavelength of light decrease so fringe width also decrease.

Hence on a given section of sc more number of fringe will be obtained

Q. If YDSE is performed in air then 24 bright fringes is formed on a given scale. Now this exp. is performed in water having $\mu = \frac{3}{2}$ then How many bright fringes are formed on the same scale.

Sol $\frac{24 \times \lambda D}{d} = \frac{n \times \lambda D \times 3}{d \times 4}$

$\frac{24 \times 4}{3} = n$

$n = 32$

length of screen $= 24\left(\frac{\lambda_{air} D}{d}\right)$

" " " $= n\left(\frac{\lambda_{water} D}{d}\right)$

$24 \lambda_{air} = n \lambda_{water}$

Q. If YDSE is performed in a liquid then third dark fringe is obtained at the same position where initially second bright fringe was obtained in vaccum. Find out refractive Index of this liquid?

Sol $\frac{5\lambda D}{2d} = \frac{2\lambda D}{d}$

$\mu =$

Tear

$$y = \frac{2\lambda_{air} D}{d} = \frac{5\lambda_{med} D}{2d}$$

$$\frac{\lambda_{air}}{\lambda_{med}} = \frac{5}{4} = \mu$$

* what happens if more than one wavelength are used in YDSE ⇒

Here the central maxima corresponding to diff wavelength's will be obtained at the same position

If white light is used in YDSE then fringe width will be diff for diff colour & will be max. for red colour and min. for violet colour.

$$y = \frac{n\lambda D}{d}$$

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

Q Two diff. λ's are used in YDSE

$\lambda_1 = 5200 A^{\circ}$

$\lambda_2 = 6500 A$

$D = 2m$

find out the position nearest to central maximal where the maximal corresponding to both the wavelength co-incide.

Sol $\frac{n_1 \lambda_1 \cancel{D}}{\cancel{d}} = \frac{n_2 \lambda_2 \cancel{D}}{\cancel{d}}$

$\frac{n_1}{n_2} = \frac{6500}{5200}$

$\frac{n_1}{n_2} = \frac{\cancel{65}\ 5}{\cancel{52}\ 4}$ $\therefore \frac{n_1}{n_2} = \frac{5}{4}$

Teach

$y = \frac{n_1 (5200 \times 10^{-10}) 2}{10^{-3}} = \frac{n_1 (6500 \times 10^{-10}) 2}{10^{-3}}$

$\boxed{n_1 = 5}$ $\boxed{n_2 = 4}$

$y = \frac{5 \times 52 \times 10^{-8} \times 2}{10^{-3}}$

$= 5.2 \times 10^{-4}\ m$

$\lambda_1 = 560$
$\lambda_2 = 400$
$D = 0.1\,mm$
$d = 10^3\,mm = 1\,m$

$(2n_1 - 1)\,560 = (2n_2 - 1)\,400$

$$\frac{(2n_1 - 1)}{2n_2 - 1} = \frac{56}{40} = \frac{7}{5} \times \frac{3}{7} = \frac{21}{15}$$

$n_1 = 11 \quad | \quad n_2 = 8$

$$y = \frac{5 \times 560 \times 10^{-9} \times 0.1 \times 10^{-3}}{1}$$

$y = 5 \times 5.6 \times 10^{-7} \times 1 \times 10^{-4}$

$y = 5 \times 5.6 \times 10^{-11}$

$y = 25$

$$y = \frac{7 \times 400 \times 10^{-9} \times 0.1 \times 10^{-3}}{1}$$

-12

28000×10

1st Choice

Note ⇒

If white light is used in a Young's double slit experiment then:—

$\because \beta = \frac{\lambda D}{d}$

A) bright white fringe is formed at the centre of the screen

B) fringe of diff colours are observed clearly only in the 1st order

c) the first-order violet fringes are closer to the centre of ~~the~~ the centre of the screen ~~than~~ than the first order red fringe.

What happens if a glass slab is kept Infront of any of the slit in YDSE →

~~optical path length of glass slab~~

→ Optical Path length of glass slab →

~~The optical path~~ ~~The distance of light~~

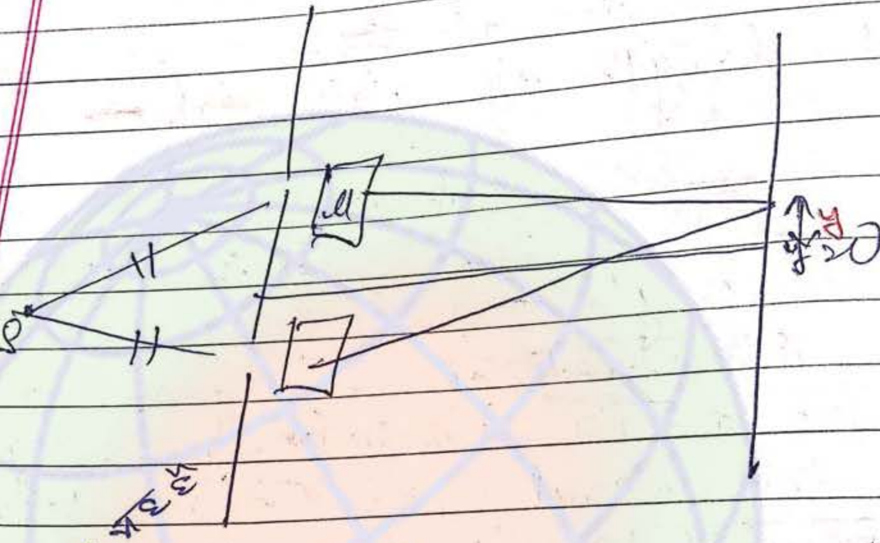
Optical Path length →

The optical path length of any glass slab is defined as the distance travelled by the light in air In the same time Interval which has been taken to ~~travel~~ travell's through the glass slab ~~In the same which has been taken to travells through the glas slab~~.

$$\boxed{\text{Speed of light in glass slab} = \frac{c}{\mu}}$$

taken to [illegible]

optical path length $= \left(\frac{\mu t}{c}\right) c = \mu t$



formula याद रखे

optical path diff $= (\mu - 1)t$

formula याद रखे

Geometrical optics diff $= \frac{yd}{D}$

$$\frac{yd}{D} = (\mu - 1)t$$

formula याद रखे

$$\boxed{y = \frac{(\mu - 1)tD}{d}}$$

shifted central maxima

Note →

Here the complete pattern of Interference ... same ...

Note

$$y = \frac{n\lambda D}{d}$$

and of any dark frindge frindge is given by

$$y = \frac{(2n-1)\lambda D}{d}$$

but these seperation's are measured for new position of central maxima,

ii) If the glass slab is kept infront of upper slit then central maxima shift upward and if kept in

Q) A glass slab having R.I $\mu = 3/2$ is kept in front of upper slit so that the central maxima is obtained at the same position where Initially that bright fringe was obtained, $\lambda = 5000$

so

$$\frac{\frac{1}{2} t \times \cancel{D}}{\cancel{d}} = \frac{3\lambda \cancel{D}}{\cancel{d}}$$

$$t = 6\lambda$$

$$t = \frac{5\lambda}{4}$$

$$t = 6 \times 5000$$

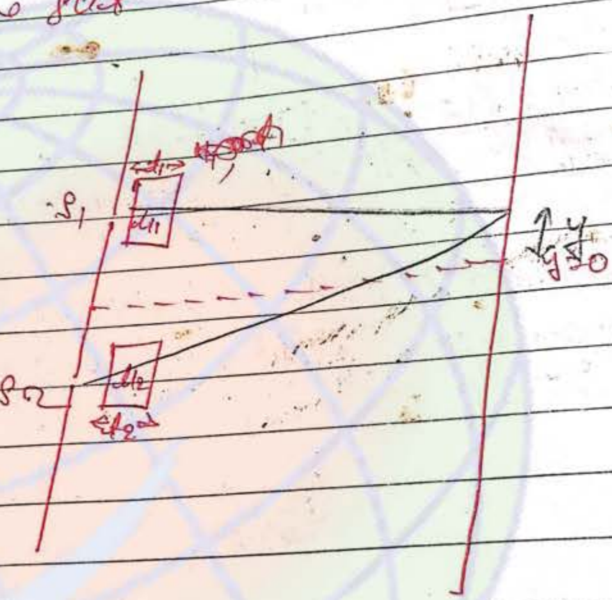
$$= \frac{5 \times 5000}{4} = \frac{25000}{4}$$

$$= 30000$$

1st Choice

~~If glass slab are kept infront of both the slit~~

If glass slab are kept infront of both the slit →



If $(\mu_1-1)t_1 > (\mu_2-1)t_2$

The central maxima shift upward

$$[(\mu_1-1)t_1 - (\mu_2-1)t_2] = \frac{yd}{D}$$

So

$$\boxed{y = [(\mu_1-1)t_1 - (\mu_2-1)t_2]\frac{D}{d}}$$

2.) If $(\mu_1-1)t_1 < (\mu_2-1)t_2$

The central maxima shift downward's.

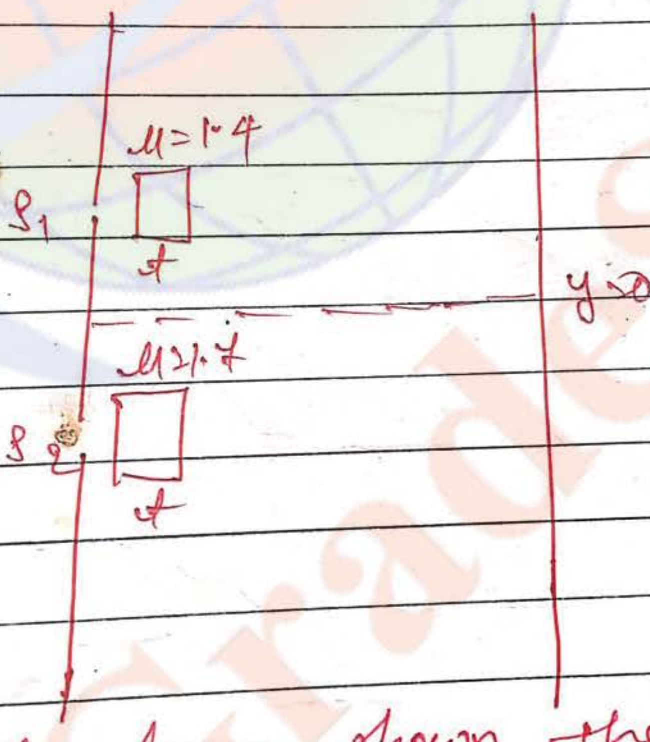
$$\boxed{y = \left[(\mu_2-1)t_2 - (\mu_1-1)t_1\right]\frac{D}{d}}$$

3) If $(\mu_1-1)t_1 = (\mu_2-1)t_2$

The central maxima does not shift.

$$\boxed{y = 0}$$

7a)



In the figure shown the central maxi. obtained at the same position. Initially 4th fringe was obtained. Find out thickness of each. $\lambda = 5000 A^\circ$.

$$0.3\lambda = \frac{7 \times 5000}{2}$$

$$\lambda = \frac{7 \times 5000 \times 10}{0.3 \times 2}$$

$$= \frac{35 \times 10000}{3 \times 2}$$

$$= \cancel{11.6 \times 10^{4}}$$

$$= \cancel{1.16 \times 10^{5}}$$

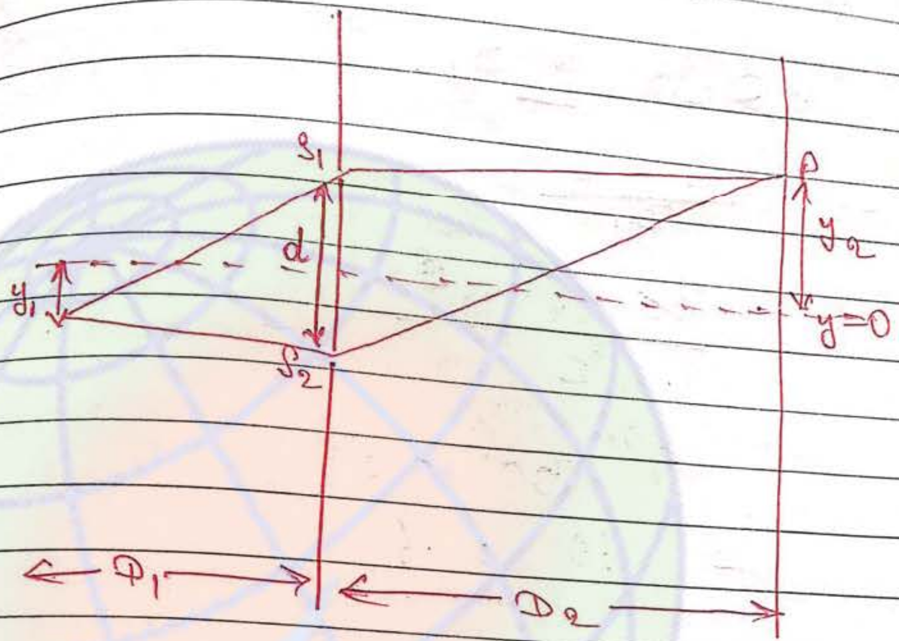
$$=$$

$$\Rightarrow \frac{35}{6} \times 10^{4} \,\text{Å}$$

$$= \frac{35}{6} \times 10^{4} \times 10^{-10} \,m$$

$$= \frac{35}{6} \times 10^{-6} \,m$$

what happen's if source of light S is kept unsymmetrically



$$SS_1 - SS_2 = \frac{y_1 d}{D_1}$$

$$S_2P - S_1P = \frac{y_2 d}{D_2}$$

$$\frac{y_1 d}{D_1} = \frac{y_2 d}{D_2}$$

$$\boxed{y_2 = \frac{y_1 D_2}{D_1}}$$ (formula)

1) If source of light kept outside is shifted slig[ht] downward than central maxima shift's upwa[rd]

1st Choice

4/22

$D_2 = 0.8\ mm \times 10^{-1}$

$y_1 = 40cm$

$D_1 = 2cm$

$y_1 D_2 = y_2 D_1$

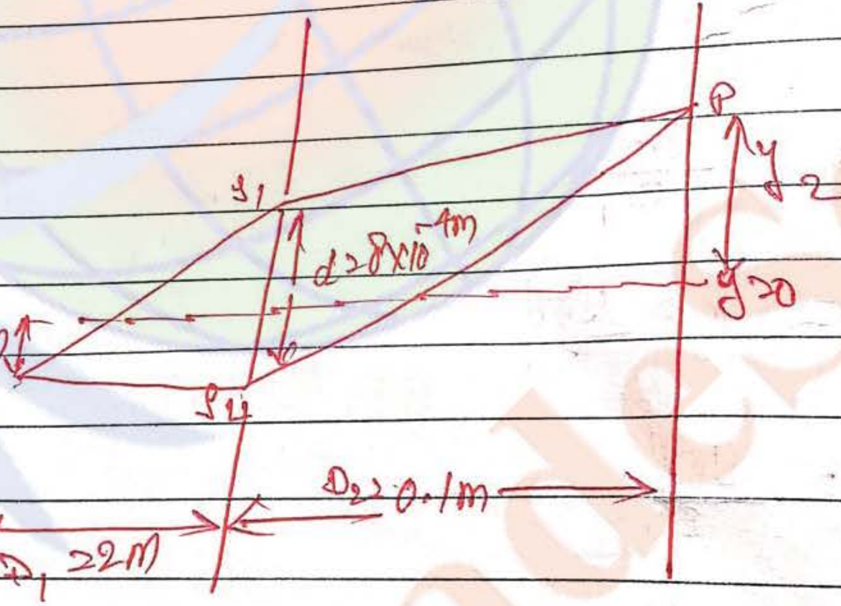
$y_2 = \frac{y_1 D_2}{D_1}$

$= \frac{40 \times 0.8 \times 10^{-3}}{2}$

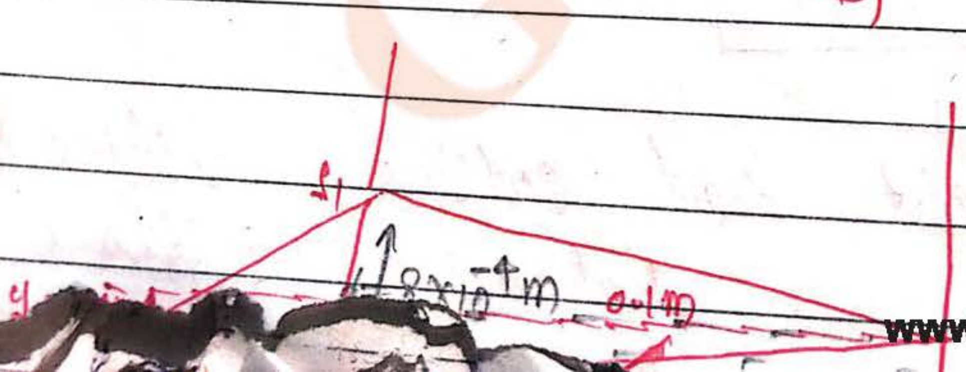
$= \frac{20 \times 0.8 \times}{100}$

$y\ 160 = 1.6$

Q.No > 2



$y_2 = \frac{y_1 D_2}{D_1} = \frac{0.04 \times 0.1}{2} =$



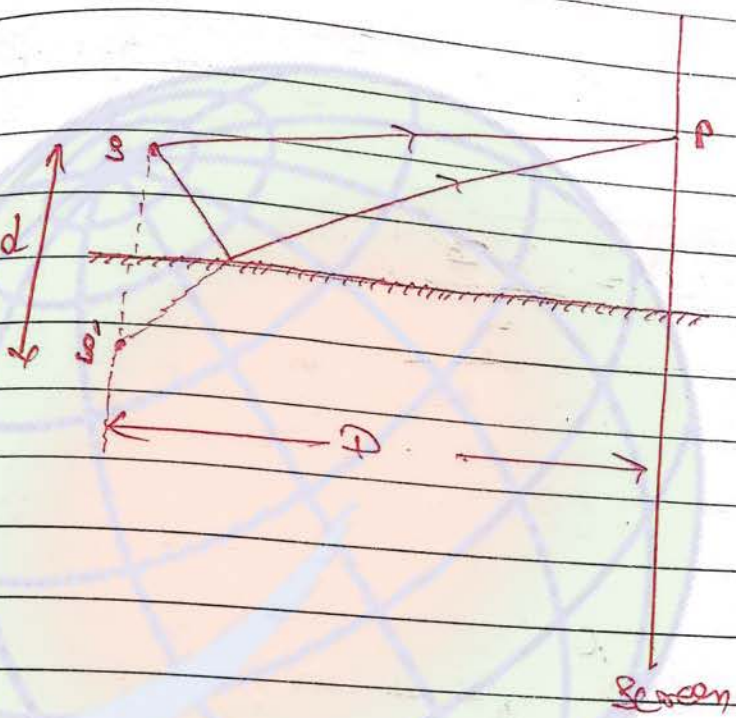
$$\Rightarrow \frac{y_1 d}{D} = (\mu_1 - 1)\sqrt{10^{-2} + 16\times10^{-8}}$$

$$\Rightarrow \frac{0.4\times 8\times10^{-4}}{2} = (\mu_1 - 1)\sqrt{10^{-2} + (16\times10^{-8})}$$

$$\Rightarrow \mu = 1.0196$$

Ans

Lloyd's mirror



1) If the reflection is taking place from the boundary of denser medium than an extra phase difference of "π" is Introduced due to reflection.
So that the path difference of "$\frac{\lambda}{2}$" also Introduced.

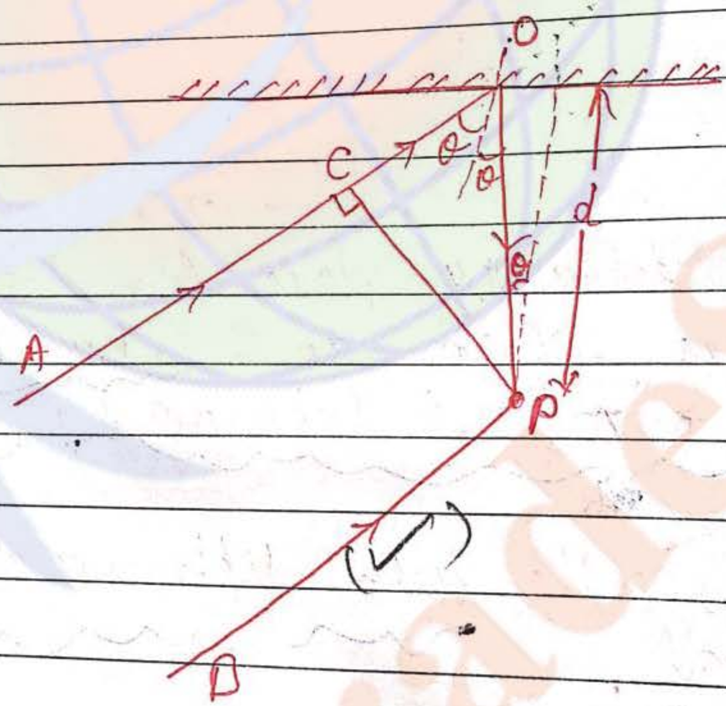
2) where if the reflection is taking place from the boundary of rarer medium than no phase diff^n is taken

If $S'P - SP = (2n-1)\frac{\lambda}{2}$ [Constructive Interference

[illegible]

$$\boxed{\text{Fringe width} = \frac{\lambda D}{d}}$$

$\boxed{\begin{array}{l} Lx\ 24 \\ 21m - S \end{array}}$



Geometrical Path diff $= (CO + OP)$

$\cos\theta = \frac{d}{OP} \Rightarrow \boxed{OP = \frac{d}{\cos\theta}}$

Ex 1 ⇒ Complete
Ex 2 ⇒ ... को ...
Ex 3 ⇒ ... (concept ... passage)
Ex 4 ⇒ ...

Page No. 352

Total Geom. Path diff $= \frac{d}{\cos\theta}(1+\cos 2\theta)$

$= \frac{d}{\cos\theta} 2\cos^2\theta$

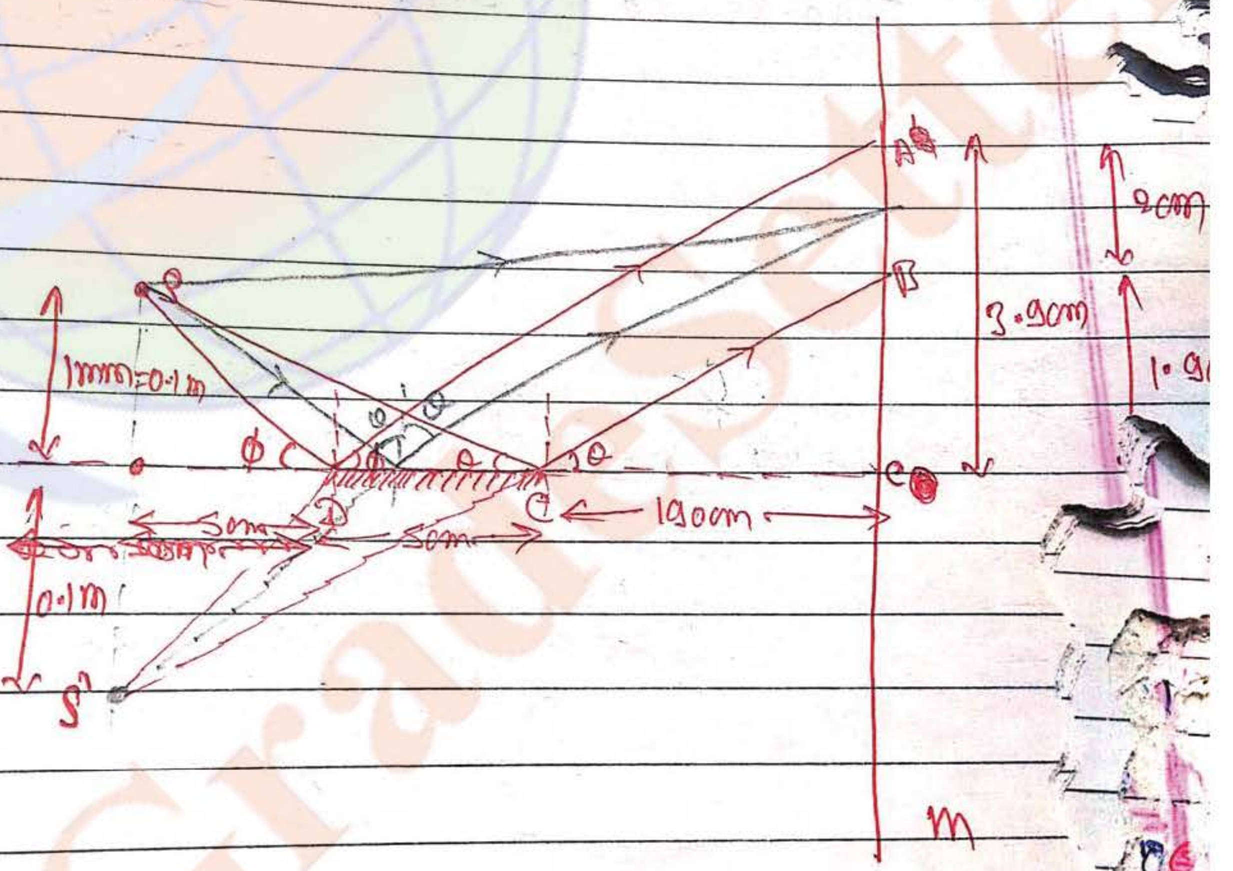
$= 2d\cos\theta$

(T)

$2d\cos\theta = \frac{\lambda}{2}$

$$\boxed{\cos\theta = \frac{\lambda}{4d}}$$

Ex = 8
ONO ⇒ 1.5
~~very good dash~~



$\tan\phi = \frac{0.1}{5} = \frac{AC}{195} \Rightarrow AC = 3.9\,cm$

Fringe width, $\beta = \frac{\lambda D}{d}$

$= \frac{3\times10^8}{6\times10^{14}} \times \frac{2}{0.2\times10^{-2}}$

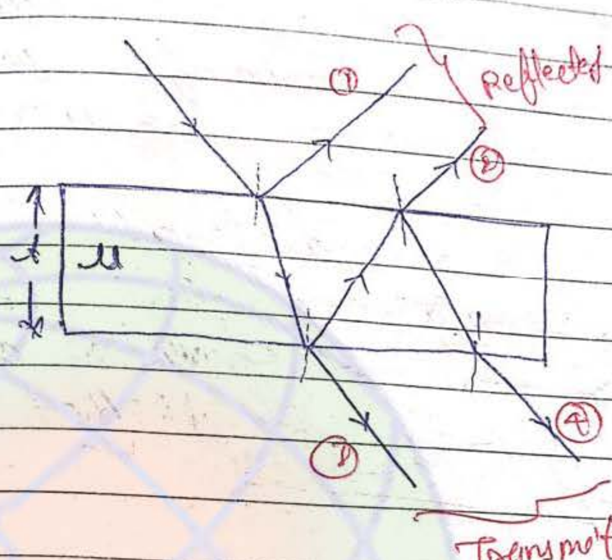
$= 5\times10^{-4} m$

यदि No. of dark या bright fringe निकालना हो तो सिर्फ "2" को बाटा करेंगे

Total no of fringe $= \frac{2\times10^{-2} m}{5\times10^{-4} m} = \frac{\text{length of AD}}{\text{fringe width}}$

$= 40$

Interference through thin films →



→ For normal Incidence

Path diff ① and ② / b/w ③ and ④ $= 2\mu t$

For Reflected beam :→

If $2\mu t = n\lambda$ (Destructive Inte.)

if $2\mu t = (2n-1)\frac{\lambda}{2}$ (Constr

For transmitted beam →

If $2\mu t = n\lambda$ (Const. Int)

if $2\mu t = (2n-1)\lambda/2$ (Dest. Int)

1st Choice

Note →
If either in the reflected or transmitted beam any wavelength is found to be missing, then condition of destructive Interference should be satisfied for this wavelength
whereas
If any wavelength is found to be either strongly reflected or strongly transmitted then the condition of constructive Interference should be satisfied for this wavelength.

$\mu = 1.6$,

$2\mu t = n\lambda$

$\mu = \frac{n\lambda}{2t}$

$\frac{432}{2t} = 1.6$

$t = \frac{43210}{3.2}$

missing ⟹
120,
432 nm
540 nm

$\mu = 1.6$

$2 \times 1.6 \times t = n_1 (120) = n_2 (432) = n_3\, 540$

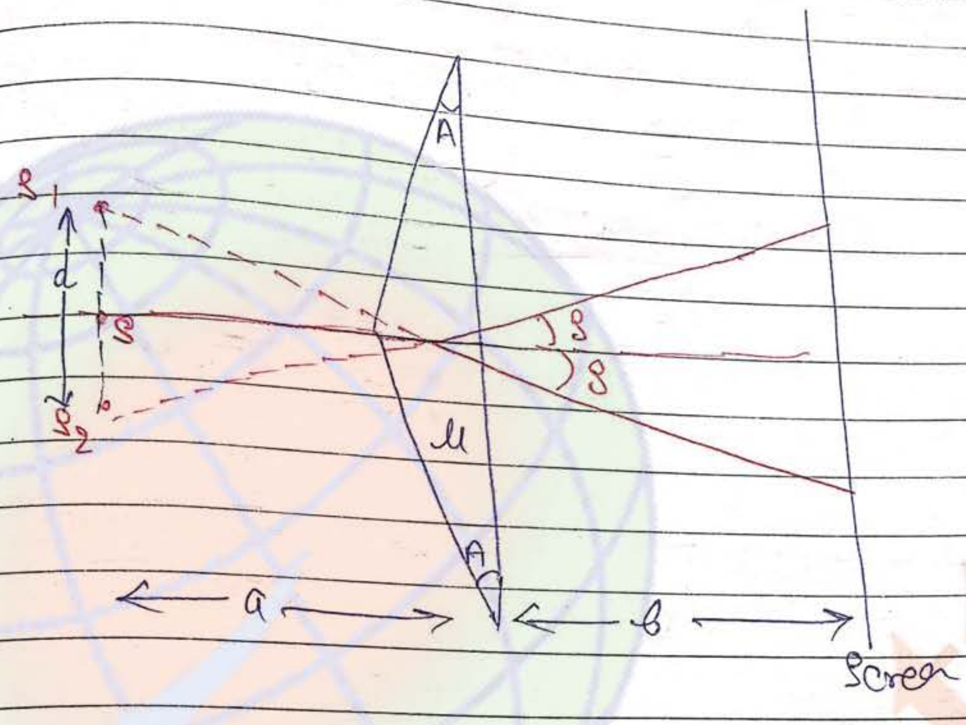
$n_1 \to 18$, $n_2 \to 5$, $n_3 \to 4$

$t = \frac{18 \times 120}{3.2} = 675\, m$

$2 \times 1.6 \times 675 = 2160 = (\text{odd})\, \frac{\lambda}{2}$

$\lambda = \frac{2160 \times 2}{}$

Fresnel Biprism →



Given → μ, A, a, b

$$\delta = (\mu-1)A = \frac{d}{2a}$$

$$\boxed{d = 2a(\mu-1)A}$$

fringe width, $\beta = \frac{\lambda D}{d}$

so

$$\boxed{\beta = \frac{\lambda(a+b)}{2a(\mu-1)A}}$$

~~Note~~ Ex - 2

Ex-2 QNo. 1

$I_{max} = 4I_0$, $I_{min} = 0$

Now glass slab is kept →

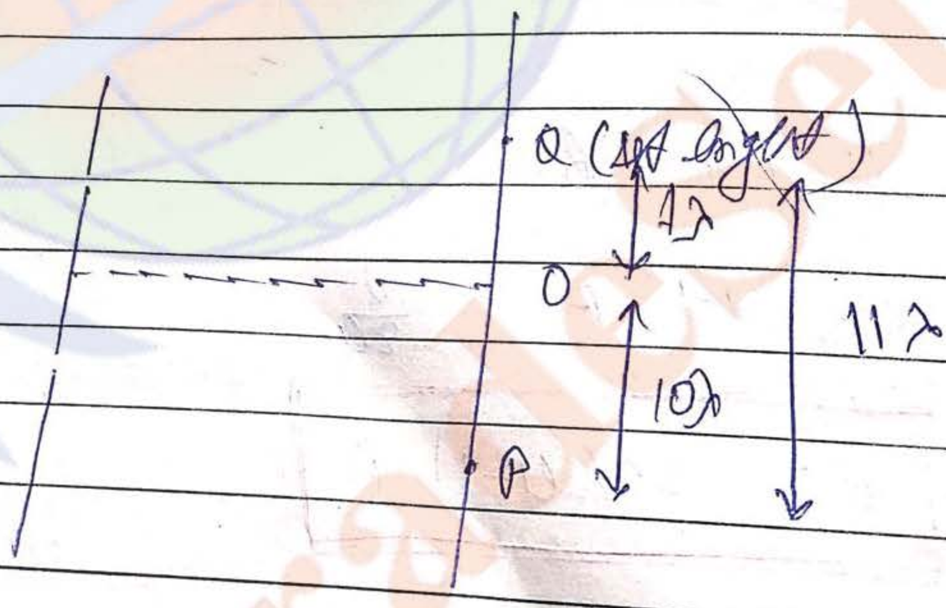
$I_1 = \frac{I_0}{2}$, $I_2 = I_0$

$I_{max} = \left(\sqrt{I_0} + \sqrt{\frac{I_0}{2}}\right)^2 = ✓$

$I_{min} = \left(\sqrt{I_0} - \sqrt{\frac{I_0}{2}}\right)^2 = ✓$

Dark का कुल प्रकाश बढ़ेगा तथा Bright का कुल घटेगा।

Ex-2 Q 5

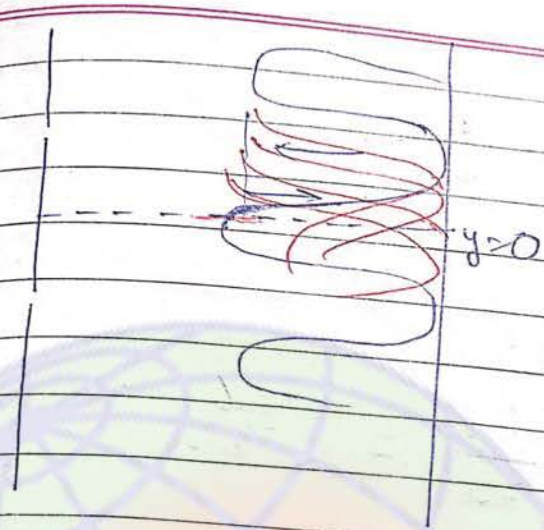


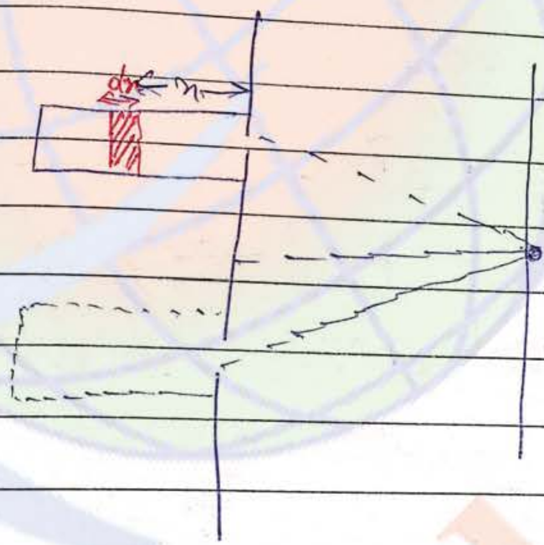
$S_1P = 10\lambda$

$= 10 \times 6000 \,Å$

$= 6 \times 10^4 \times 10^{-10} m$

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





optical path length of small element = (1+a

total optical path length = $\int_0^l ($

$= l +$

optical path diff $= l + \frac{al^2}{2} - l$

$= \frac{al^2}{2} = \frac{\lambda}{2}$

1st Choice

~~Note~~

Ex-2

Ex-2 QNo-1

$I_{max} = 4I_0$, $I_{min} = 0$

Now glass slab is kept →

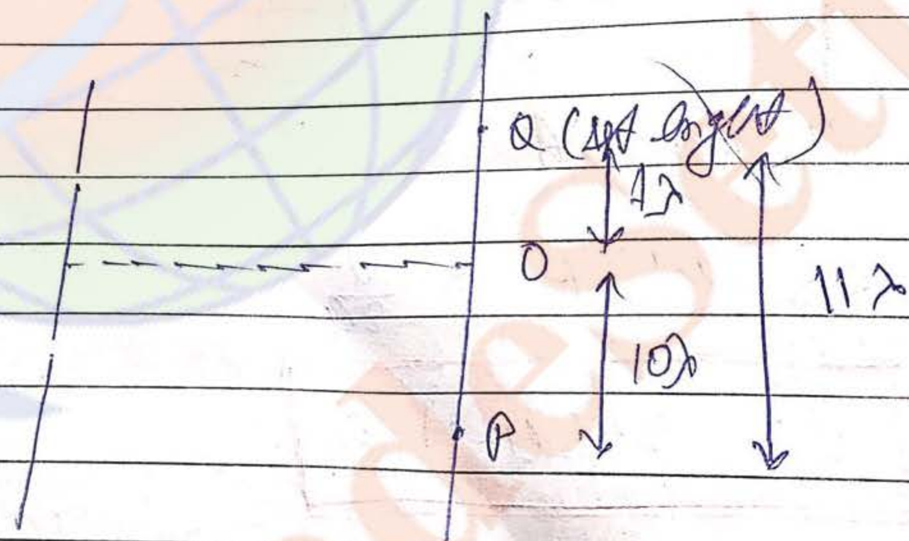
$I_1 = \frac{I_0}{2}$, $I_2 = I_0$

$$I_{max} = \left(\sqrt{I_0} + \sqrt{\frac{I_0}{2}}\right)^2 = \checkmark$$

$$I_{min} = \left(\sqrt{I_0} - \sqrt{\frac{I_0}{2}}\right)^2 = \checkmark$$

Dark का मुख्य प्रकाश बढ़ेगा तथा
Bright का मुख्य घटेगा।

Ex-2 QNo-5



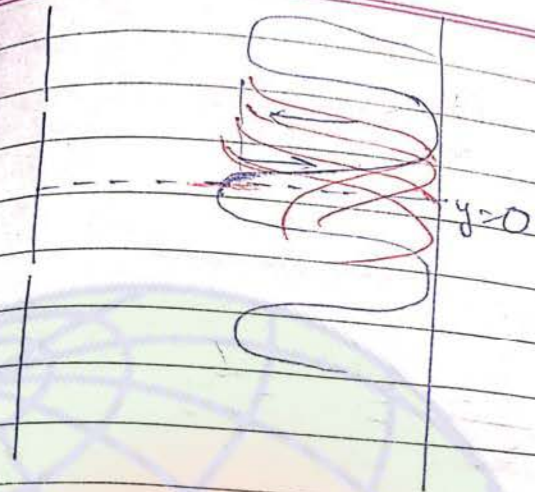
$S_1B = 10\lambda$

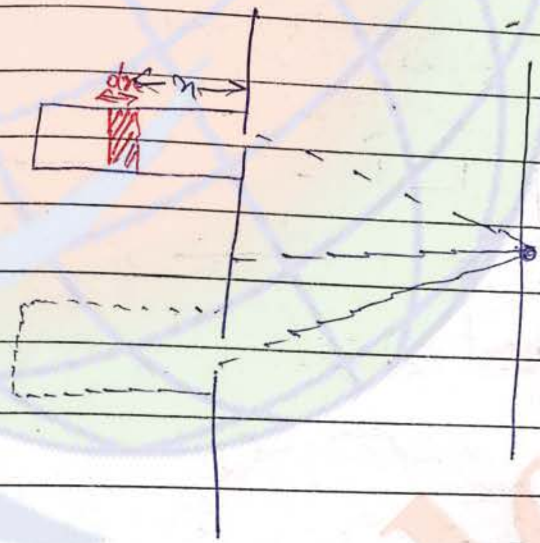
$= 10 \times 6000\,Å$

$= 6 \times 10^{4} \times 10^{-10}\,m$

$= 6 \times 10^{-6}\,m$

1st Choice





optical path length of small element = (1+ax

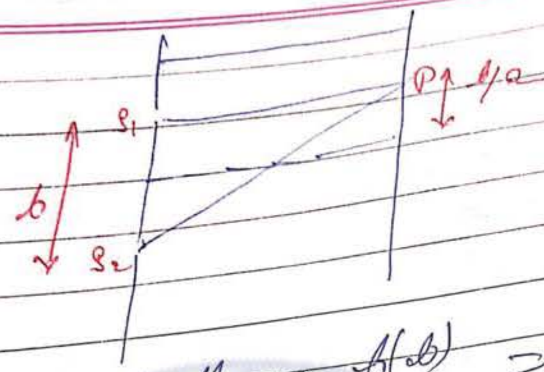
total optical path length = $\int_0^l$ (

= l +

optical path diff = $l + \frac{al^2}{2} - l$

$= \frac{al^2}{2} = \frac{\lambda}{2}$

Q-20
Q NO 314



Path diff $= \frac{b(b)}{2d} = \frac{b^2}{2d} = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2}$

$$\lambda = \frac{b^2}{d}, \frac{b^2}{3d}, \frac{b^2}{5d}, \frac{b^2}{7d}$$

Q-2
Q NO 315

Let I_1 and I_2 be the Intensity of 2 coh

$$\frac{I_{max}}{I_{min}} = 9 = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2$$

$$\frac{\sqrt{\frac{I_1}{I_2}}+1}{\sqrt{\frac{I_1}{I_2}}-1} = 7.$$

Read 3 photoelectric effect
Q. 2, 3, and 4 solve

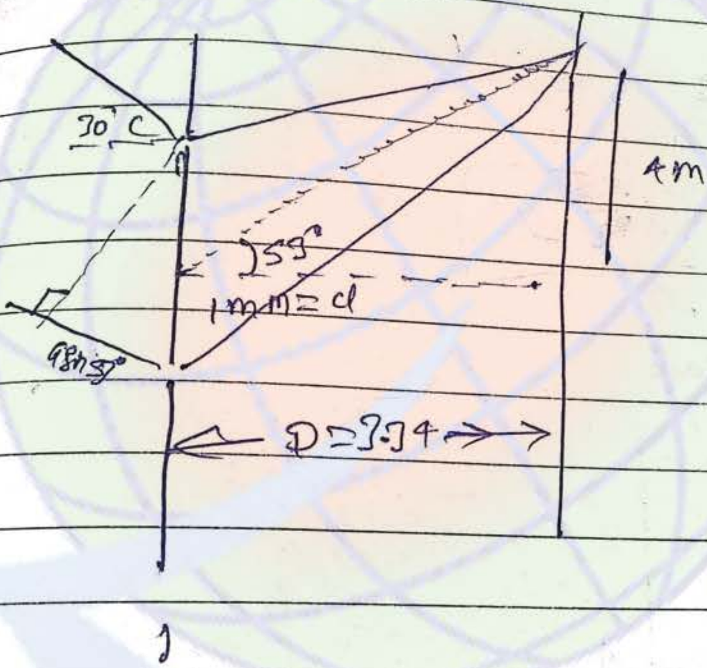
for strongly reflected

$2\mu t = (2n-1)\frac{\lambda}{2}$ 5000 Å

1.5

$3t =$

18.



$d\sin 30 = 10^{-3} \times \frac{1}{2} = 0.5 \times 10^{-7}$

$n = \frac{10^{-3}}{10 \times 10^{-7}} = 1000$

Net path diff

Exp 59

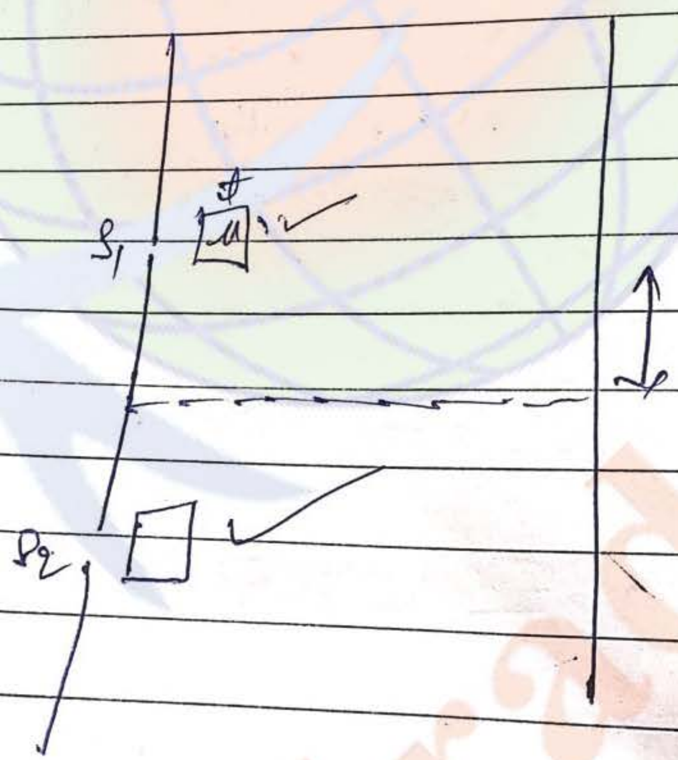
4) $\lambda_1 = 400 A$, $\lambda_2 = 5600 A^0$

$$\frac{(2n-1)\,4000 A^0 D}{d} = \frac{(2n_2-1)\,5000 A^0 D}{d}$$

$$\frac{(2n_1-1)}{2n_2-1} = 7/5$$

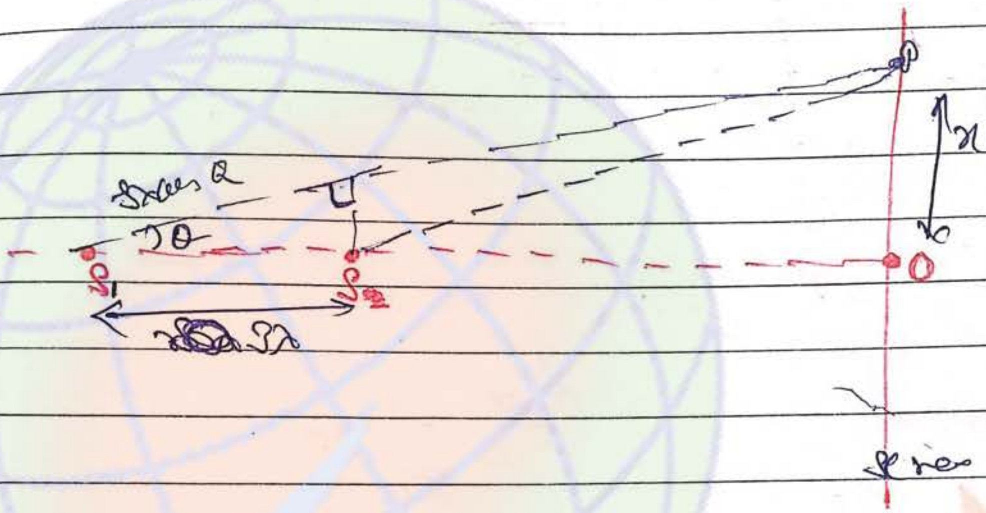
$\boxed{n_1 = 4}$ | $\boxed{n_2 = 3}$

5)



No of fringes = $\frac{(\mu_1 - 1)\, t D}{d} \Big/ \beta$

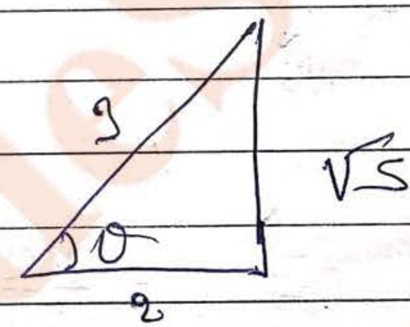
Q.No. → 10 When the slitt is in the horizoral posit



$$3\lambda \cos\theta = 2\lambda$$

$$\cos\theta = \frac{2}{3}$$

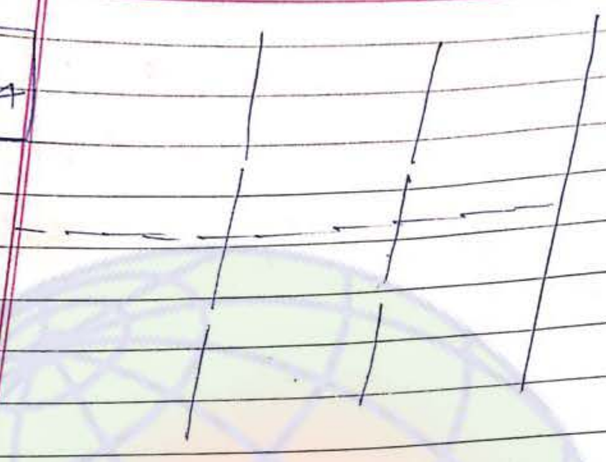
$$\tan\theta = \frac{\sqrt{5}}{2}$$



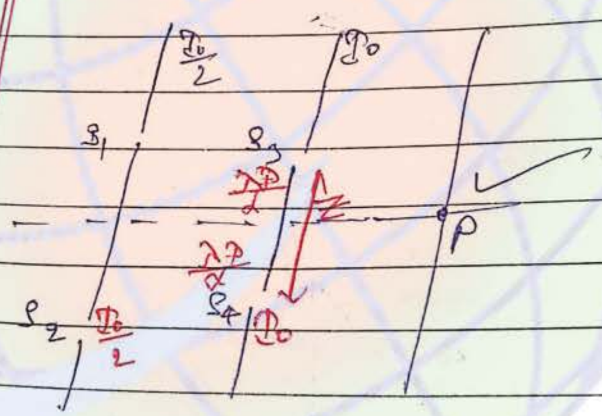
$$\frac{x}{D} = \frac{\sqrt{5}}{2}$$

$$\boxed{x = \frac{D\sqrt{5}}{2}}$$

Ex=2
ΛSo>14



17.)



If $Z = \frac{\lambda D}{2d}$, then $I_P = 4I_0$

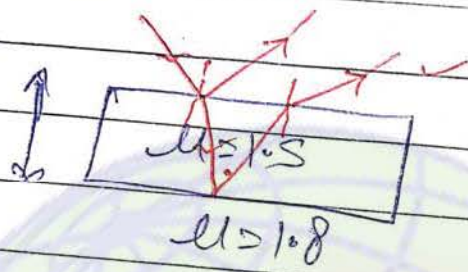
If $Z = \frac{2\lambda D}{d}$ then I_0 ...

Path diff $= \frac{\lambda D}{d} \times \frac{d}{D} = \frac{\lambda}{4}$

Phase diff $= \frac{2\pi}{\lambda}\left(\frac{\lambda}{4}\right) = \pi/2$

$I_0 = 4I_0\cos^2\left(\frac{\pi}{4}\right)$

$\boxed{I = I_0}$



$$2 \times 1.5 \times t = n\lambda$$

$$\boxed{t = \frac{\lambda}{3}}$$

Photo electric effect

1) light is having particle as well as wave nature. the particle nature of the light can be proved by the phenomenon like photo electric effect.

2) light is having small energy packet's will are called as photons and these photons travel with the same speed as that of light.

3) Each photon is having definite amount of energy and momentum

$$\boxed{\text{Energy of photon }(E) \quad E = h\nu = \frac{hc}{\lambda}} = \frac{1242}{\phi}$$

where, $hc = 1240$ (ev-nm)

h = Plank's constant

$= 6.6 \times 10^{-34}$ J-sec

$\boxed{1ev = 1.6 \times 10^{-19} J}$

$\nu \rightarrow$ frequency of light

$$\boxed{\text{momentum of photon}, \; P = \frac{h}{\lambda} = \frac{E}{C}}$$

4) photons are not deflected by electric or magnetic field.

5) The rest mass of a photon is zero whereas mass of a moving photon is

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

Example → A source of light having power 200 watt is emitting 4×10^{20} photons/sec. find out "λ" of the light.

$P = 200$ watt

$$200 = 4\times10^{20}\times\frac{hc}{\lambda}$$

$$200 = 4\times10^{20}\times\frac{6.6\times10^{-34}\times3\times10^{8}}{\lambda}$$

$$\lambda = 3.96\times10^{-7}\ m$$

Photo electric effects :-
when the light having photons of sufficient energy falls on the surface of a metal then e⁻ can be ejected out. This phenomenon is called as "photoelectric effect" and the ejected "e⁻" are called "photo electrons".

Work function (ϕ) → $\boxed{\frac{1242}{\lambda} = \phi = h\nu_0 = \frac{hc}{\lambda_0}}$

ν_0 → threshold frequency

λ_0 → threshold wavelength

is the min. amount of energy which the incident photons must have so the emission of "e⁻" can take place.
[It depends upon the nature of the