Handwritten Notes
On
Ray Optics

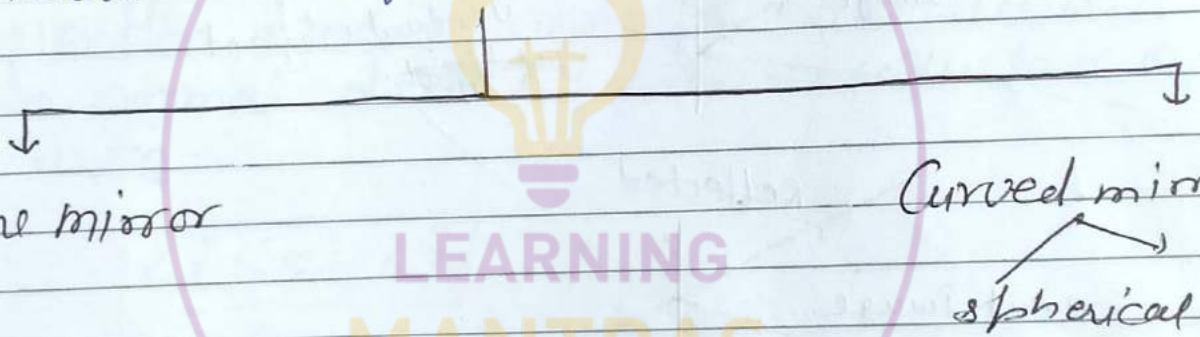
Ray Optics

* Some important defination:

Reflection:

Bouncing back of light in same medium is known as reflection.

(2) highly Polised surface used for Reflection is known as Reflectors or mirror



* Ray's:

Source to ∞ Path →

* One End fixed and other not terminating End is known as Ray

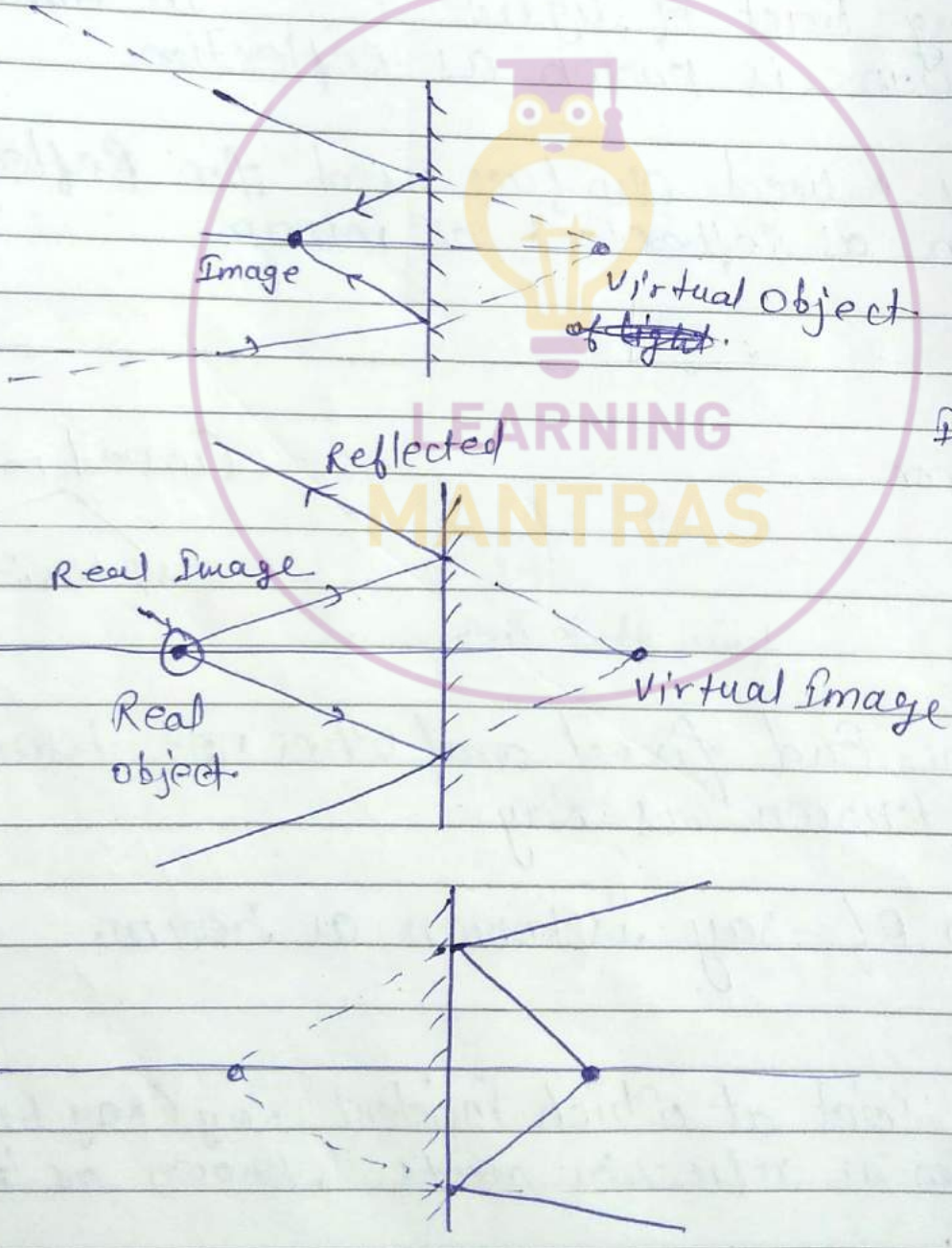
* Collection of ray is known as beam

* Object: Point at which incident Ray (Ray before Reflection or refrection meets is known as ~~incid~~ Object.

Object is classified into two type

(1) Real object: Incident Ray actually meet this Point

(2) Virtual object: Incident Ray appears to meet this point



* Image:- Point at which Reflected or Refracted Ray meet is known as Image.

* Law of Reflection:-

Law:- 1. Incident ray, Normal & Reflected ray, all three lies in the same plane.

$$\hat{i} \cdot [\hat{n} \times \hat{r}] = 0$$

Law:- 2

Angle of incidence is equal to angle of reflection where angle is measured from normal drawn from the surface of mirror.

$$\angle i = \angle r$$

$$\hat{r} = \hat{i} - 2(\hat{i} \cdot \hat{n})\hat{n}$$

* Plane mirror:-

* Plane mirror forms virtual Image of real object & real Image of virtual object

*

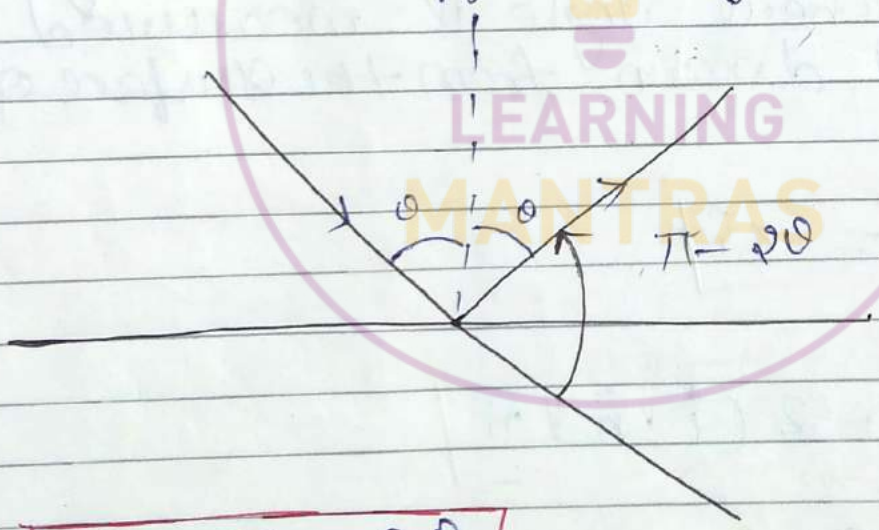
* Plane mirror performs lateral inversion (Left hand coordinate system into right hand coordinate system.

* To find Time of Analog clock in mirror Subtract the given time with

11 : 59 : 60

* Distance of Image from the Plane mirror is same as that of distance of object from it.

* Deviation Suffered by a ray :-

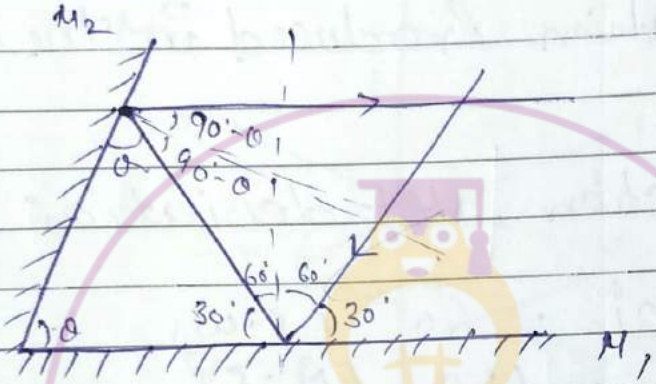


$$\delta = \pi - 2\theta$$

* Image formed in plane mirror is erect if object is placed Principal axis

* retrace its path or Image formed on object itself mean $i = 0$

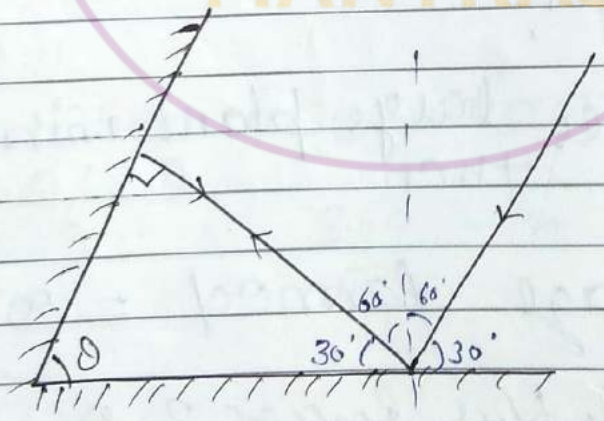
Q. what should be the angle b/w two mirror if ray passes parallel to mirror L after 2nd reflection.



$2\theta + 30 = 180$

$\theta = 75$

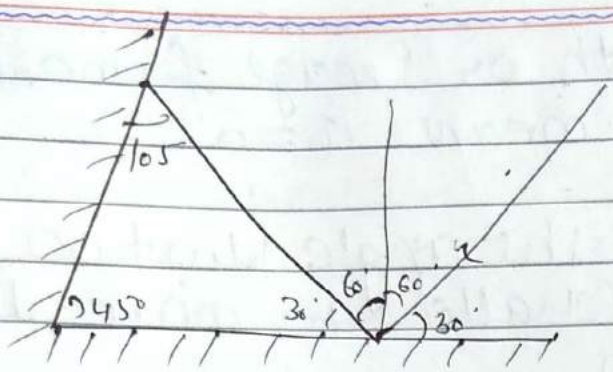
Que:

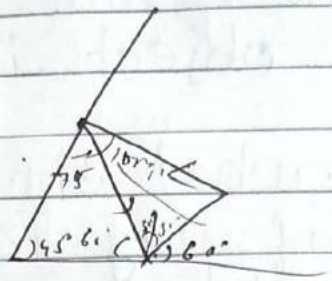


Find the angle b/w twice mirror if ray retrace its path after 2nd reflection.

$\theta = 60°$

Q.





find net deviation produced in the incident ray.

After 3 reflection, net deviation

Ans

$\delta_1 = 180 - 2i = 60°$ (C.W)

$\delta_2 = 180 - 2i = 180$ (A.C)

$\delta_3 = 180 - 2i = 120$ (A.C)

Net deviation 210° (A.C

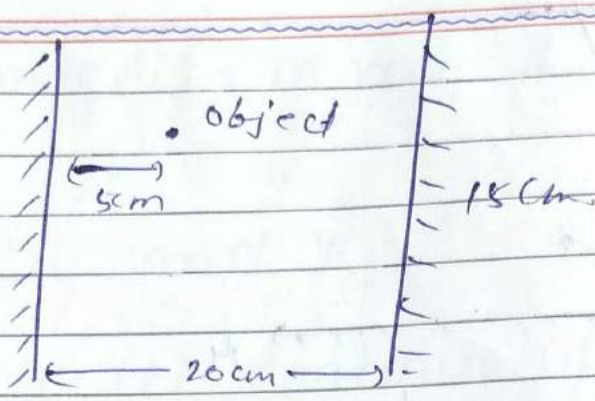
* No. of Images:

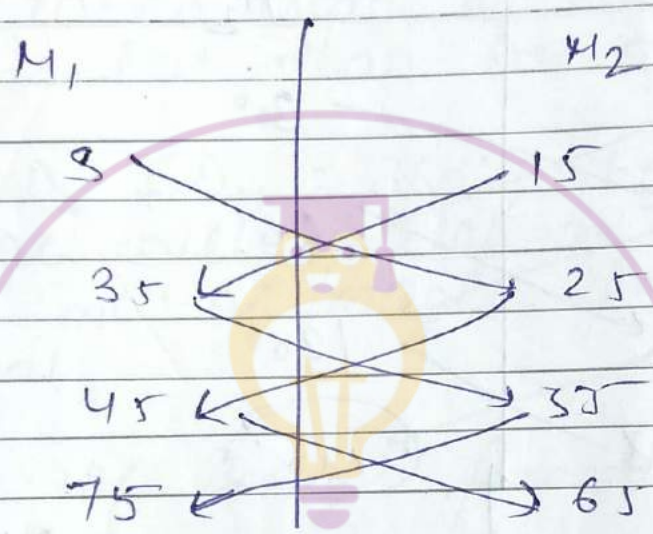
Case:1 If ~~three~~ twice large plane mirror are placed " , then

No. of Image formed = ∞

Q. Find the dist. b/w Image 2 of mirror 1 & 3 image of mirror 2.

Ans



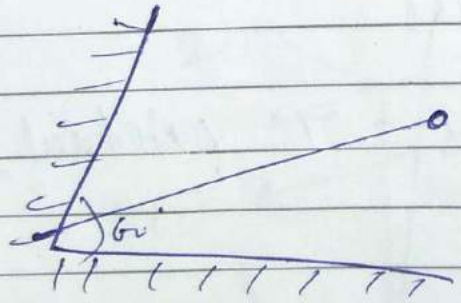


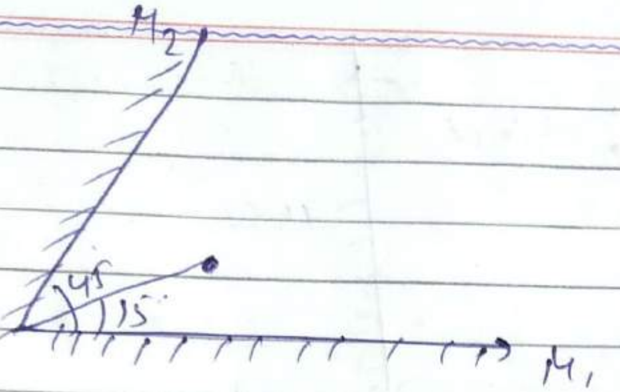
$35 + 55 + 20 = 110$ cm.

Case :- II)

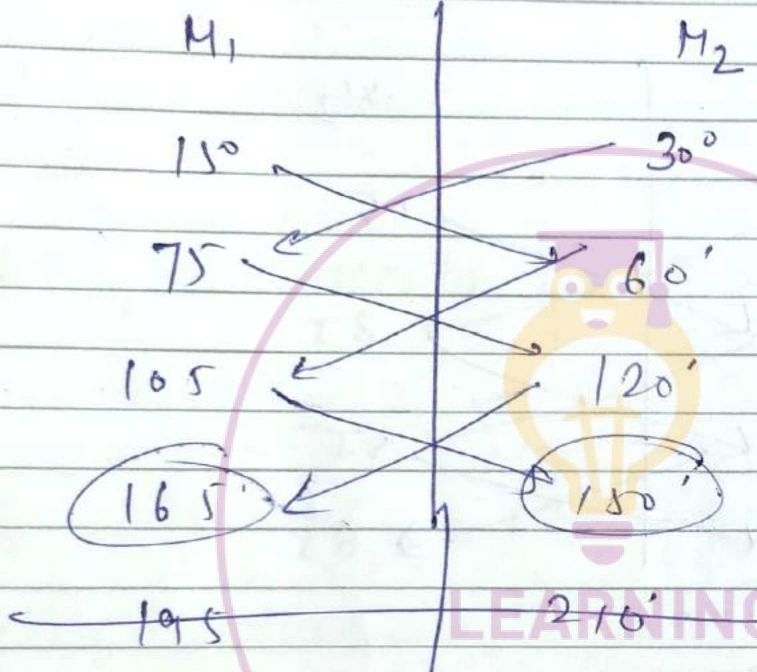
When two mirror are at an angle of θ

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



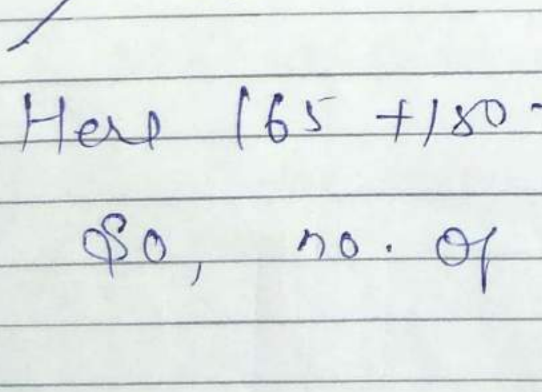


$\frac{360}{60}$ 6



65
50
45
360

(180° के बाद काट देना)



If $\theta_1 + \theta_2 + \theta_M = 360$ then overlapped image

Here $165 + 180 + 45 = 360$

So, no. of Images = 7 (Actual)

* Angle of Image in mirror 1 = θ_1

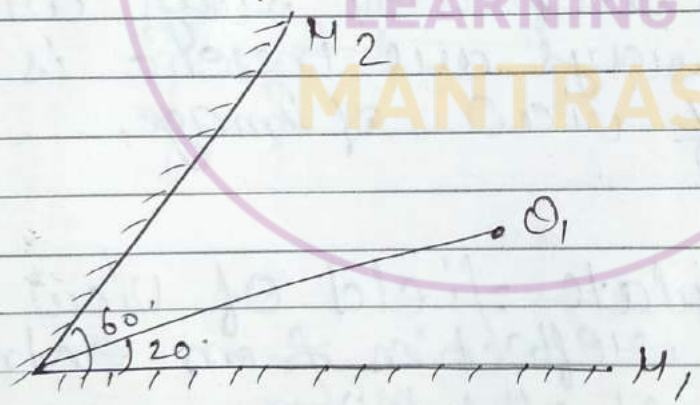
" " " " 2 = θ_2

" b/w M_1 and M_2 = θ_M

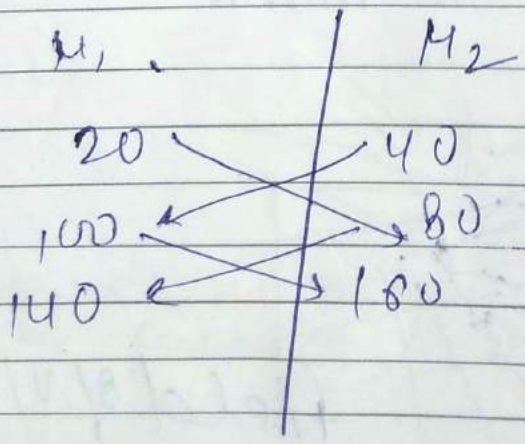
* This process will continue upto the instant when some of the angle θ_1 and θ_2 is less than or equal to 180°

* If $\theta_1 + \theta_2 + \theta_M = 360°$, then two of the image will overlap on each other therefore no. of images form will be $n-1$

Q. find no. of image formed by



$$n = \frac{360}{60} - 6$$ (except)



140
100
60
360

$140 + 160 + 60 = 360$.

So, $n-1$ ~~Same~~ Images.

$6-1 = 5$ Images.

* Field of View :

* Field of View for object :

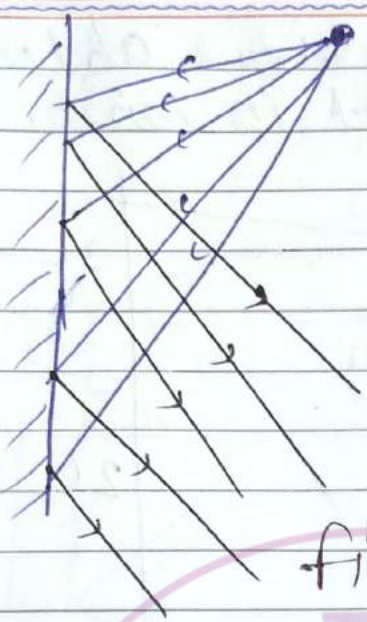
Space in which incident rays is present of object

* Field of View of Image :

Space in which reflected rays or refracted rays are present is known as field of view of image.

Note :

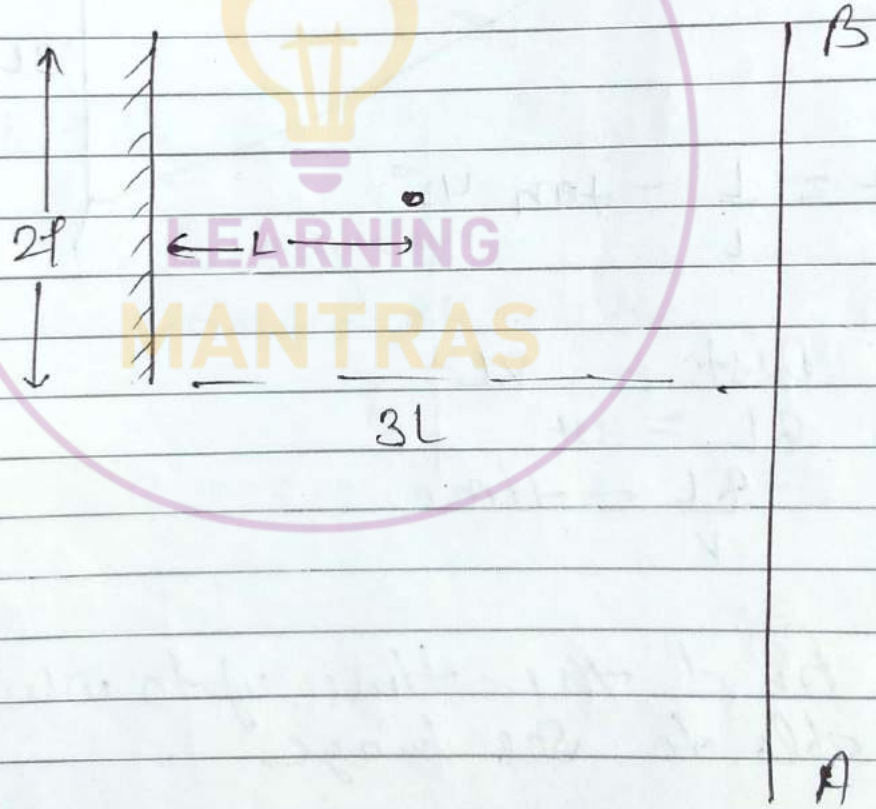
To Calculate field of view always take reflection from extreme (or) corners of the mirror.



o → can't see the Image.

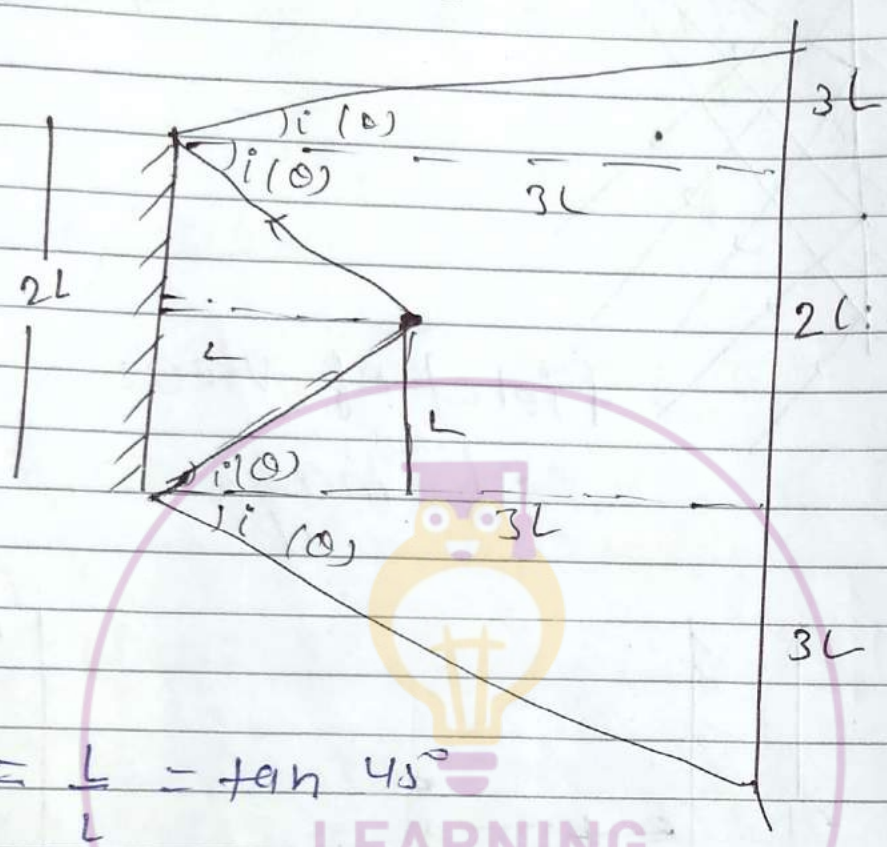
field of view of Image

Q.



An observer is moving ⊥ to mirror on line AB with constant velocity v.

Q. Find time upto which he is able to see image of object in mirror.



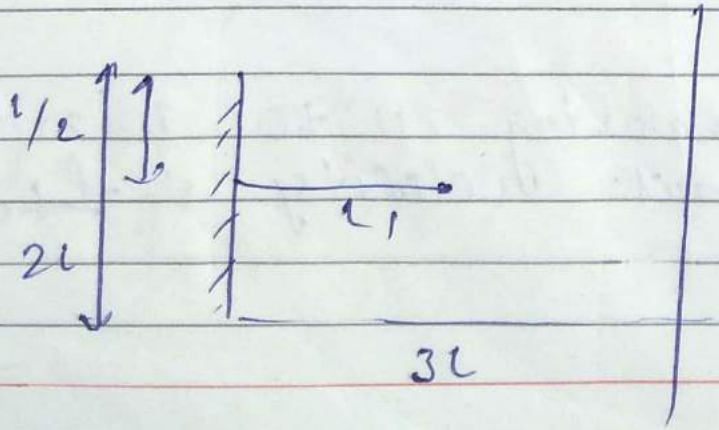
$\tan\theta = \frac{L}{L} = \tan 45°$

Dist = 8L

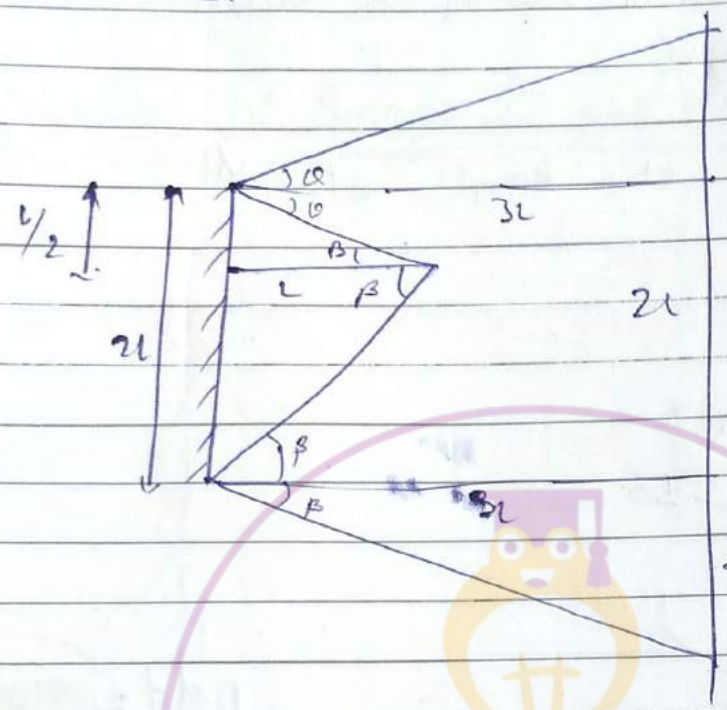
$8L = vt$

$\frac{8L}{v}$ = time.

Qu: Find the time upto which he is able to see image.



$\tan\theta = \frac{1}{2}$, $\tan\beta = \frac{3}{2}$



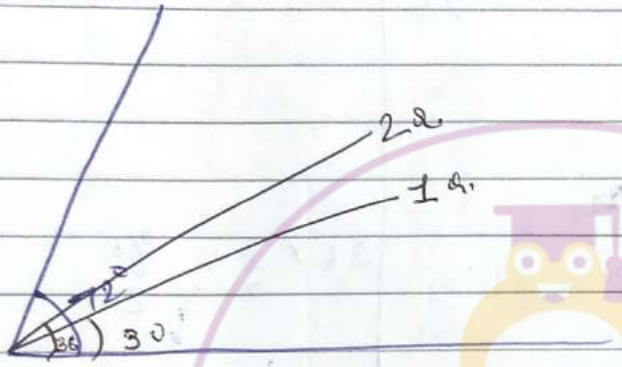
$\frac{9L}{2} + 2L + \frac{3L}{2}$

Dist = 8L

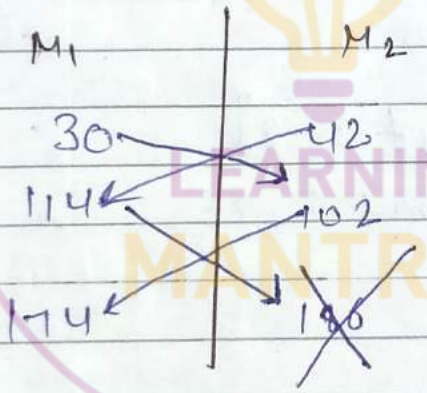
time = $\frac{8L}{V}$ s

Q. Angle b/w two mirror is 72° and their object is placed at an angle of 30° from one of the mirror find no. of the image.

If object is placed at angle of 36°.



Odd = (n, n-1)



(5)

130
174
~~71~~
~~9~~
57

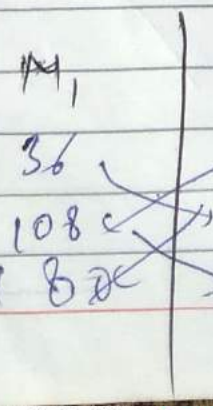
360/72

$\theta_1 + \theta_2 + \theta_4 = 360$

$174 + 102 + 720 =$

Overlapping images = 5

Overlapping

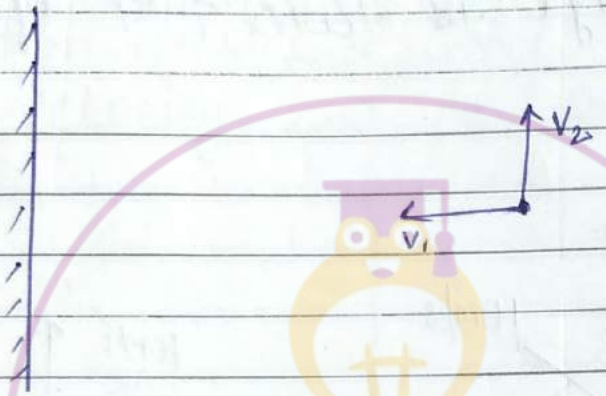


4 to 179.9

108 + 108 + 72 =

* Velocity of Image in Plane Mirror :-

*



Case :- 1

* When object is moving

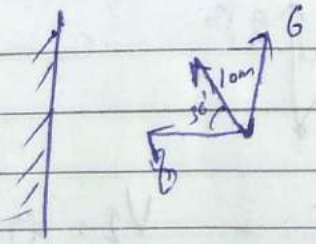
⇒ if Velocity of object is Parallel to Plane of mirror Velocity of image will be same as that of Velocity of object

$$\vec{V}_{O \parallel M} = \vec{V}_{I \parallel M}$$

⇒ if object moves Perpendicular to the mirror

$$V_{I \perp M} = - V_{Obj. \perp M}$$

Ex :-



$V_0 = -8\hat{i} + 6\hat{j}$

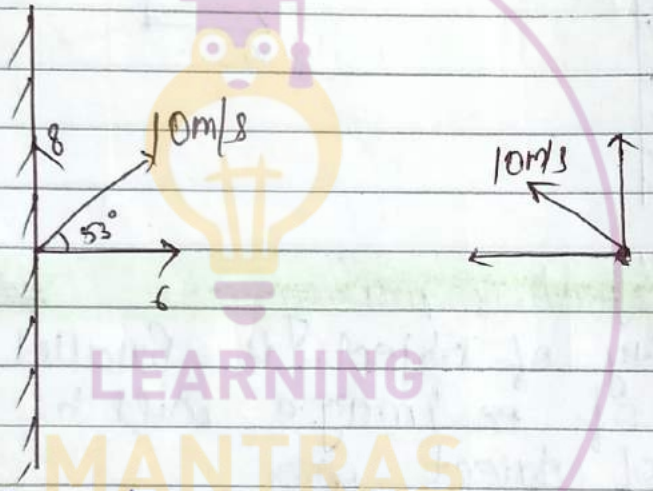
$V_I = 8\hat{i} + 6\hat{j}$

Case: 2 When mirror is moving.

* When Velocity of mirror is ⊥ to its plane there will be no effect on Velocity of Image

* When Velocity of mirror is ⊥ to its Plane Velocity of Image is twice that of Velocity of mirror

Ex:-

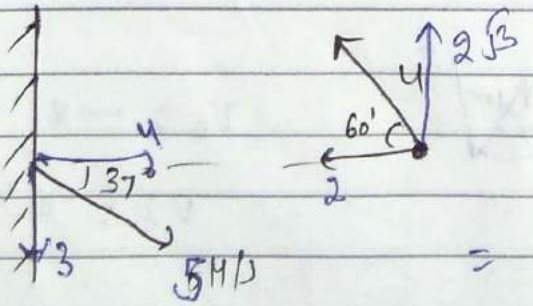


$V_M = 6\hat{i} + 8\hat{j}$

$V_I = 12\hat{i} + 0\hat{j}$

$$\vec{2V}_{M \perp M} = \vec{V}_{I \perp M}$$

Q. Find Image w.r.t Object



$= V_I = 10\hat{i} + 2\sqrt{3}\hat{j}$

Important

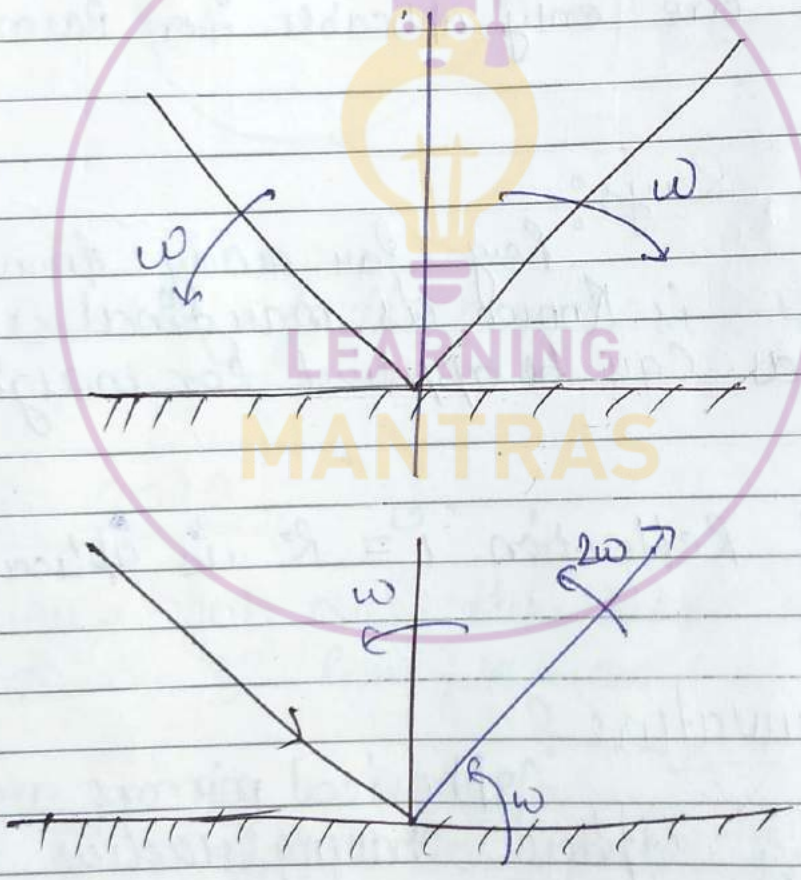
$+O_2 - I_2$

field of - no. -ve

* Angular Velocity :-

If Incident Ray is Rotated by angular Velocity ω Reflected Ray will also rotate with same angular velocity with opposite sence.

If mirror is rotated by angular velocity ω in then reflected ray will move with angular velocity 2ω in same direction.



Field of view

* Spherical mirror:

Some Imp. definations:

* Paraxial Rays:

All rays close to principle axis is known as Paraxial Rays

Angle of incidence for Paraxial Rays is Less then $1-10^\circ$
All formulas are only aplicable for Paraxial rays only.

* Marginal Rays: Ray far away from axis

x Principle axis is Known as marginal rays
No formulas can be applied for marginal Rays

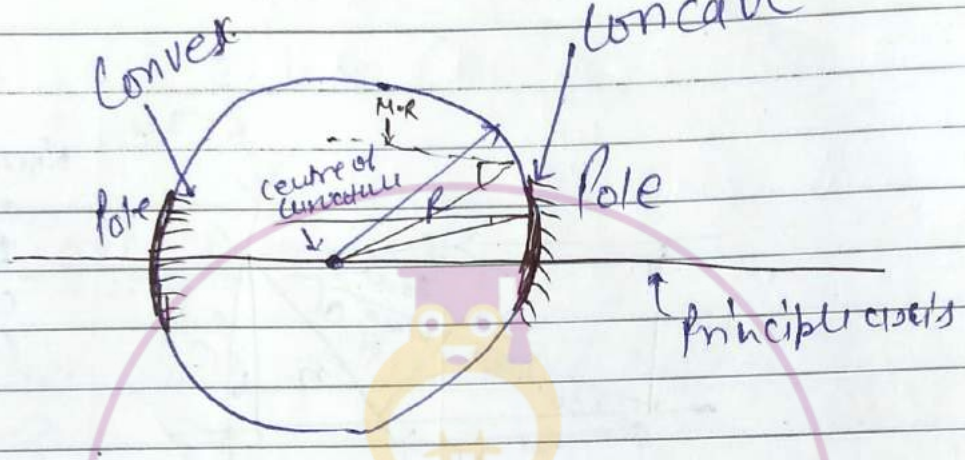
x only Law of Reflection $i^\circ = R$ is aplicable for it

* Radius of Curvature: Spherical mirrors are the part of Big Sphere having same radius R.

This Radius is Known as radius of Curvature

* Centre of curvature:

Centre of the sphere from which spherical mirrors is make is known as centre of curvature



* Pole:

Centre of the mirror is known as Pole

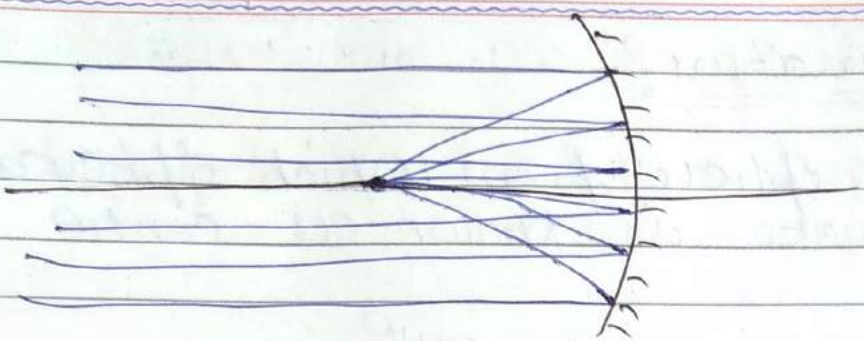
* Principle axis:

Line joining pole and the centre of curvature is known as principle axis

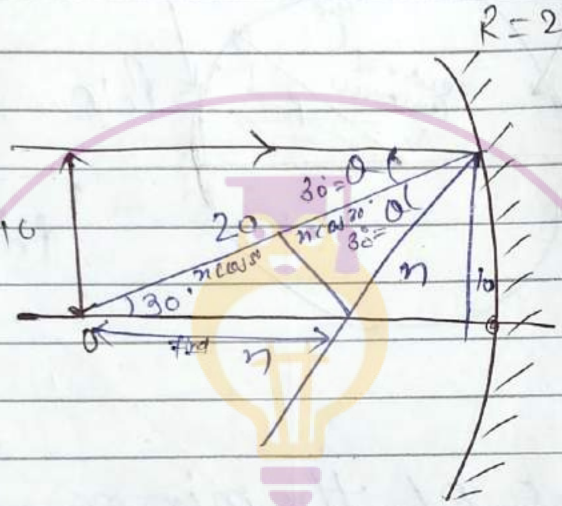
* focus:

Only define for paraxial rays Point at which all paraxial rays passes through principle axis after reflection is known as focus.

Plane Mirror / E concave
71-72
Race



Que'



Normal will always passes centre of curvature

find the distance where Reflected Ray will cross Principle axis after reflection
find the dist. from Point O.

Ans:

$2x\cos 30 = 20$

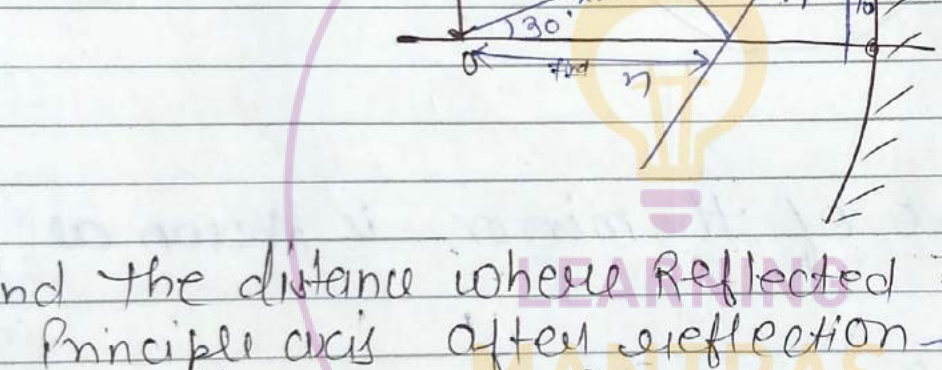
$x\sqrt{3} = 20$

$x = \frac{20}{\sqrt{3}}$

[20]
Parallel 10 → 10mm
say focus the
$f = \frac{R}{2}$

$i = R$

Q.2



$Y = \sin\left(\frac{\pi}{4}x\right)$

$\frac{dy}{dx} = \frac{\pi}{n}\cos\left(\frac{\pi}{4}x\right) = 1$

Incident ray after reflection become reverse. find the point of incidence.

$$\cos\left(\frac{\pi}{4}n\right) = \frac{4}{\pi}$$

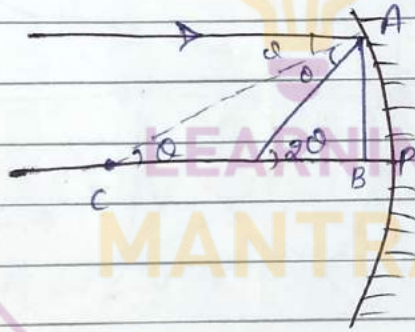
$$\frac{\pi}{4}n = \cos^{-1}\left(\frac{4}{\pi}\right)$$

For

* Spherical Mirrors :-

1) Relation b/w focus and Radius of curvature:

Imp. for Board



$$\tan\theta = \frac{AB}{BC} \cong \frac{AB}{BP} \quad -(I)$$

$$\tan 2\theta = \frac{AB}{BD} \cong \frac{AB}{DP} \quad -(II)$$

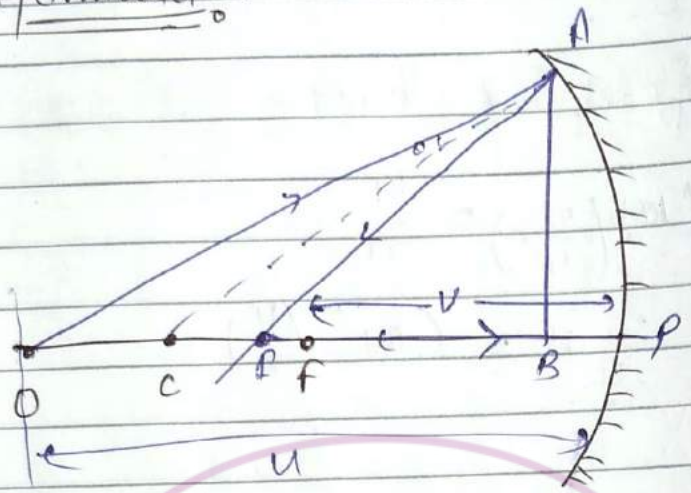
$$\frac{AB}{DP} = \frac{2AB}{CP}$$

$$CP = 2DP$$

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

Board

* Mirror's formula:-



In ABO

$$\tan\alpha = \frac{AB}{PO}$$

In ABI

$$\tan r = \frac{AB}{PI}$$

In ABC

$$\tan\beta = \frac{AB}{PC}$$

$$\beta + \alpha = r \quad -(i)$$

$$\alpha + \alpha = \beta \quad -(ii)$$

$$\beta - \alpha = r - \beta$$

$$2\beta = r + \alpha.$$

$$2\left[\frac{AB}{R}\right] = \frac{AB}{u} + \frac{AB}{v}$$

$$\boxed{\frac{1}{F} = \frac{1}{u} + \frac{1}{v}}$$ learn

Learn

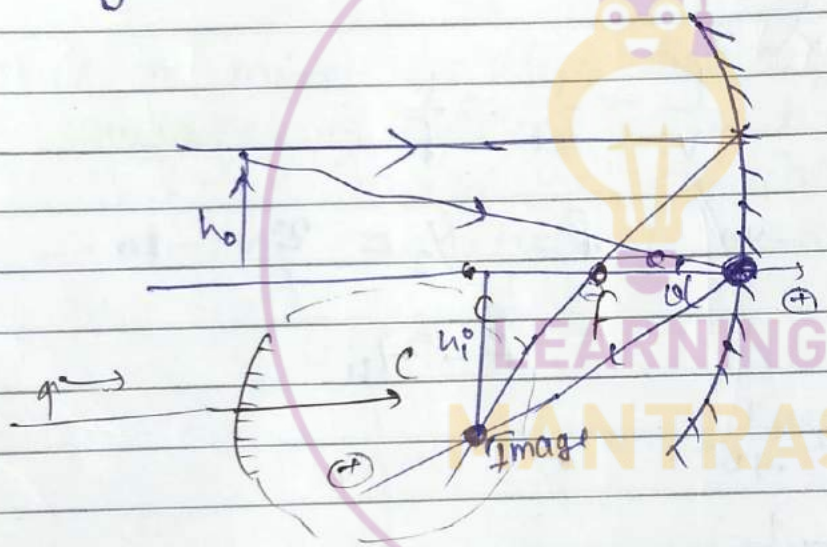
* Sign Convention:

Imp.

* All the distances are measured from poles

* Dist. above Principle axis is taken as Positive and dist. below Principle axis is taken as -ve.

In the direction of Ray we will take Positive and opp. to the dirn of the ray we will take Negative.



$$\frac{+h_o}{-u} = \frac{+h}{+v}$$

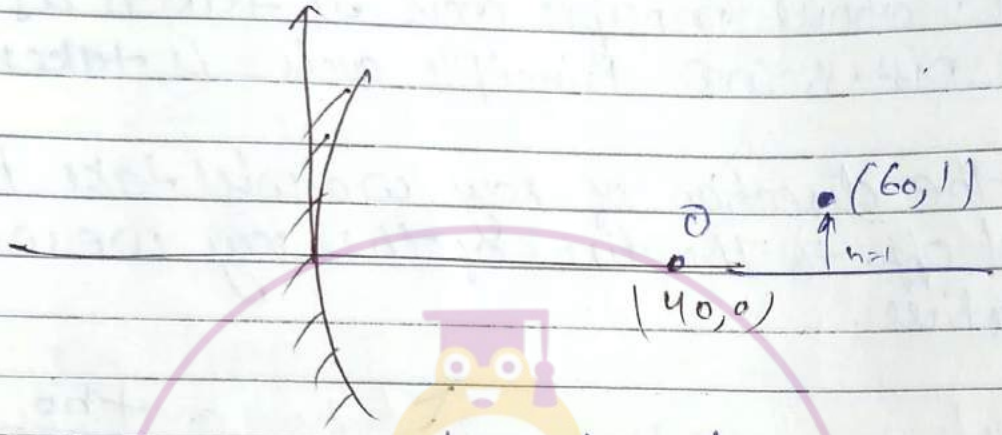
$$\boxed{\frac{-v}{u} = \frac{h_i}{h_o}}$$

* Magnification:

$$\boxed{M = -\frac{v}{u}}$$

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

Que: A Concave mirror is Origin as shown in diagram Radius of Curvature of mirror is 20 cm. find the Image of a point (40, 0)



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

$v = ?$ $\quad u = -40 \quad f = R/2 = \frac{20}{2} = -10$

$f = -10$

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

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

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

In the above Que find the Position of Image of a Point (60, 1)

$n = -12 \quad y = \text{height} = 0.2$

$V = ? ; \quad u = -60, \quad f = -10$

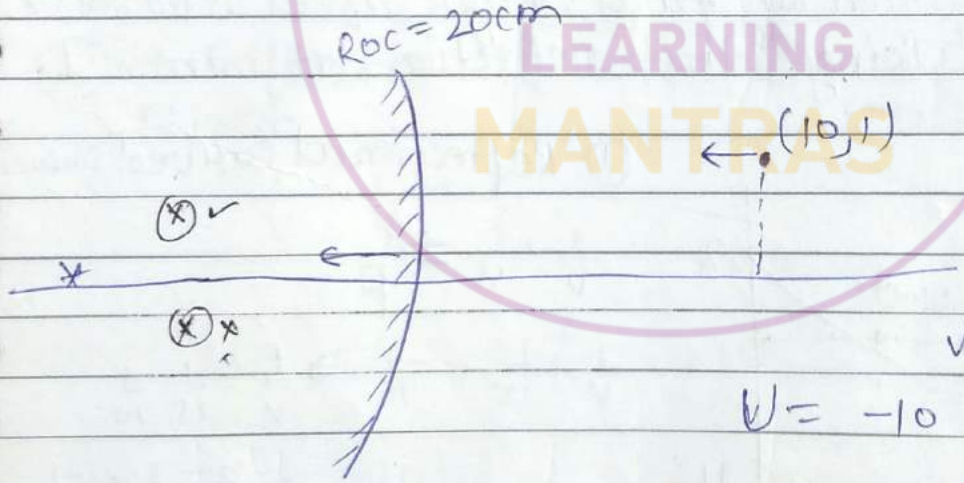
$V = -12$

$h_o = 1 \qquad h_i = ?$

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

$$\frac{h_i}{1} = +\left[\frac{+12}{-60}\right]$$

Q. Convex mirror is Place that origin and Reflecting surfaces is facing toward x-axis find the image of a point (10,1) given that radius of curvature is 20 cm. find



$R = +20$

$v = ?$

$u = -10 \quad , \quad f = +10$

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

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

$$= \frac{2}{10}$$

$$v = +5$$

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

$$\frac{h_i}{1} = \frac{+(5)}{+10} \qquad \frac{h_i}{1} = \frac{1}{2} \qquad h_i = \frac{1}{2}$$

$$I\left(5, \frac{1}{2}\right)$$

T = concave. Real- Convex mirror
Uses

★ (2)

Note

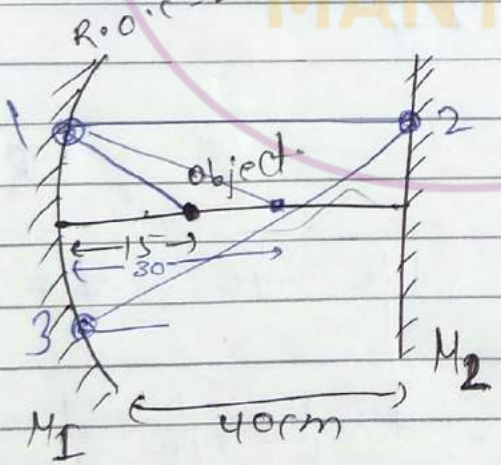
Convex mirror makes Real & virtual image of all the Real object b/w O to F

* Therefore Convex mirror is used as real view mirror in the vechicles.

* These images are diminished (small).

* Concave mirror is are used as looking mirrors and shaving mirror and they produces enlarge image for the object placed b/w O and f.

Que:- find the Position of final image after 3 successive reflection taking first reflection at mirror 1.



① Reflection at curved surface

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

$$\frac{1}{v} - \frac{1}{15} = \frac{-1}{10} \Rightarrow \frac{1}{v} = \frac{1}{15} - \frac{1}{10}$$

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

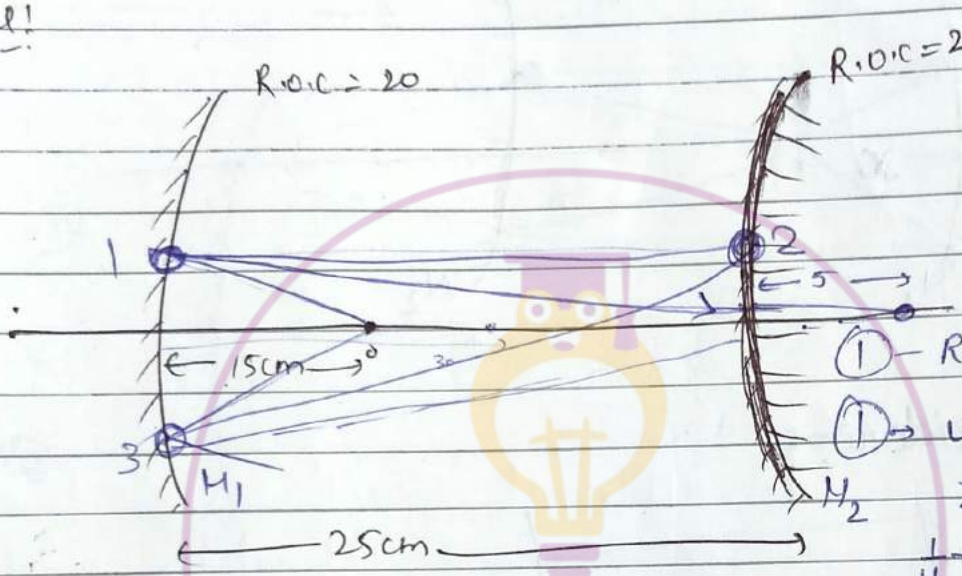
② Reflection surface at Plane

10 cm behind mirror.

Concave +f

③ $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $u = -15$ $f = -10$

Que!



① → Reflection at concave mirror

① → $u = -15$

$f = -10$

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

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

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

$v = -30.$

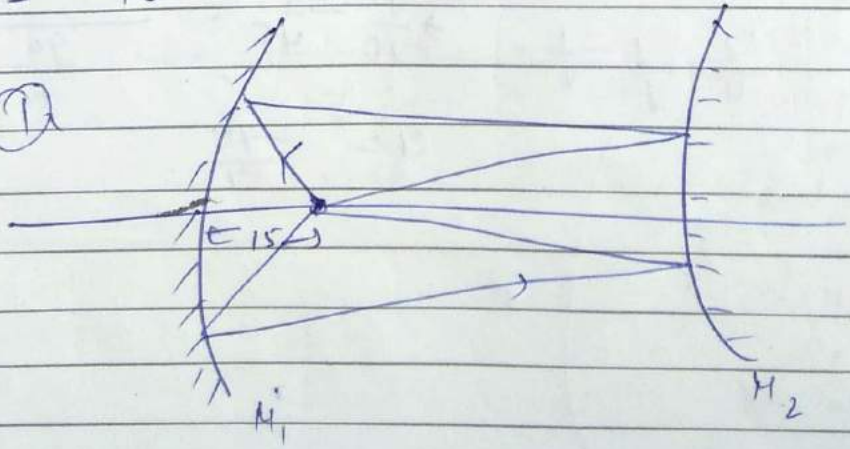
② → Reflection at convex Mirror.

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

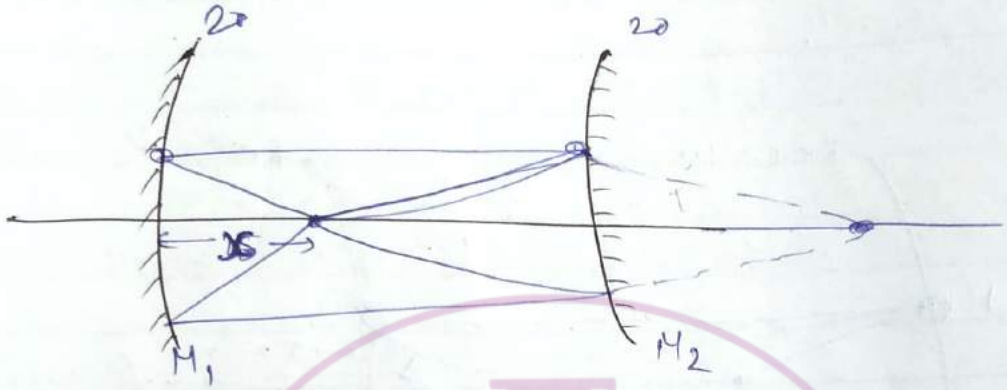
$u = +5$ $f = +10$

$v = -10$

③ Same as ①



In the above Que find the Position of object from the mirror 1 So that ray will retrace its path, after 2nd reflection (at M_2)



$\angle$ angle of Incidence = 0

$V = -45, \quad f = -10$

$u = ?$

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

$\frac{1}{u} = \frac{1}{f} - \frac{1}{v} = \Rightarrow \frac{1}{-10} + \frac{1}{45} = \frac{-9+2}{90} = \frac{-7}{90}$

$u = \frac{-90}{7}$

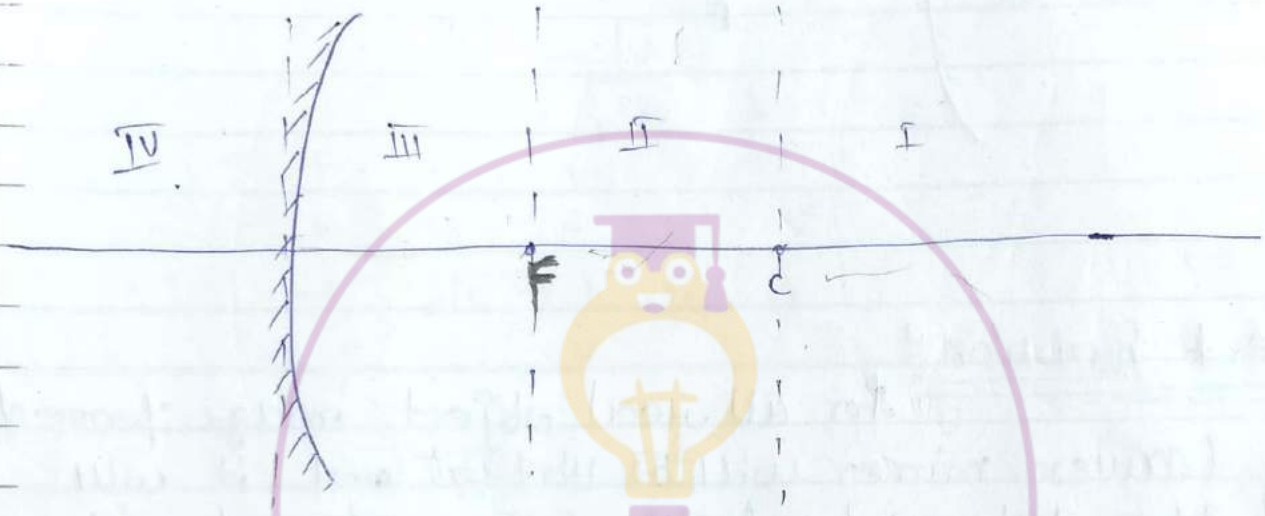
76, Rau - Ex. 1 to 10

Both same side
⇒ Inverted

* Important Points for Curved Mirror:

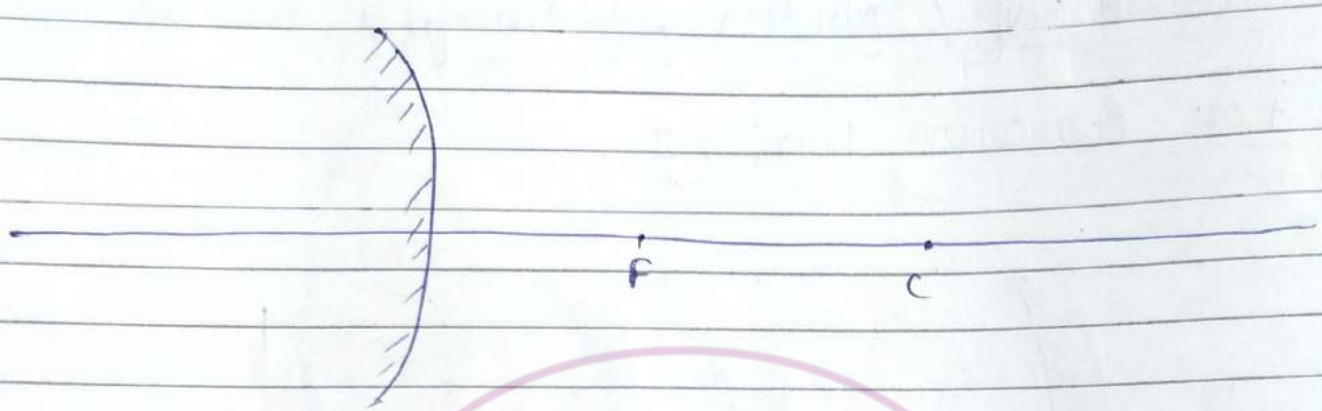
* Position & Nature of Image:

(A) for Concave mirror:



Object Position	Image Position	Nature.
$f \geq u \geq 0$ Real	(0 to ∞) behind Mirror	Enlarged (Erect) Real object, virtual Image
between f to C	In front Mirror	Enlarged, Inverted Real object, Real Image
beyond C ∞	f to C f	diminished Inverted Real object, Real Image
behind Mirror	0 to f	diminished, Erect. Virtual object, Real Image

* for Convex mirror :-

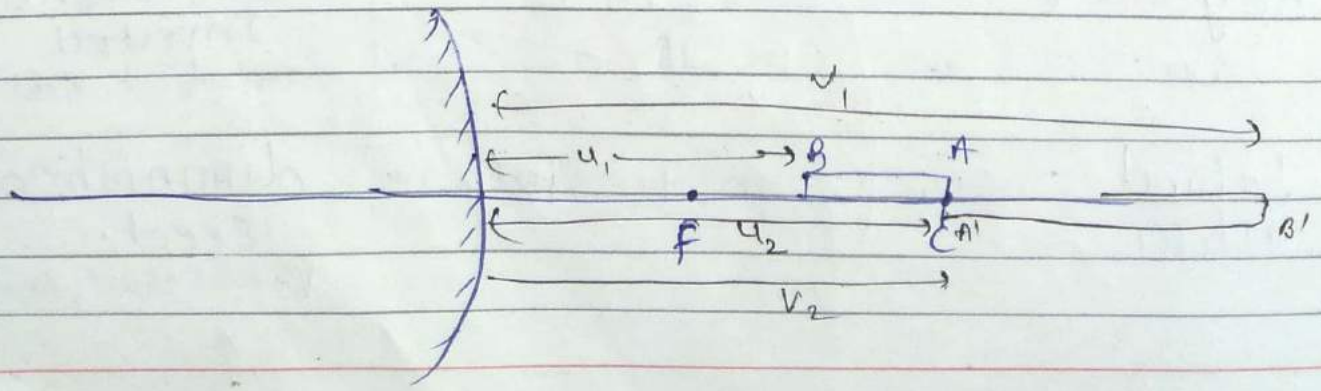


Object Position :-

(d) (i) for all real object image formed by Convex mirror will be virtual and it will be b/w pole and focus. Image formed will be diminished.

(ii) Convex mirror can formed real as well as virtual image for virtual object

(2) * Longitudinal magnification :-
When an object is placed along the principle axis image magnification is known as Longitudinal magnification.



for a mirror

$$M = \frac{L_I}{L_O} = \frac{v_1 - v_2}{u_2 - u_1}$$

(ii) if an object is very short.

$$= \frac{-dv}{du}$$

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

$$-\frac{1}{v^2}dv - \frac{1}{u^2}du = 0$$

$$\frac{-dv}{du} = \frac{v^2}{u^2}$$

Longitudinal

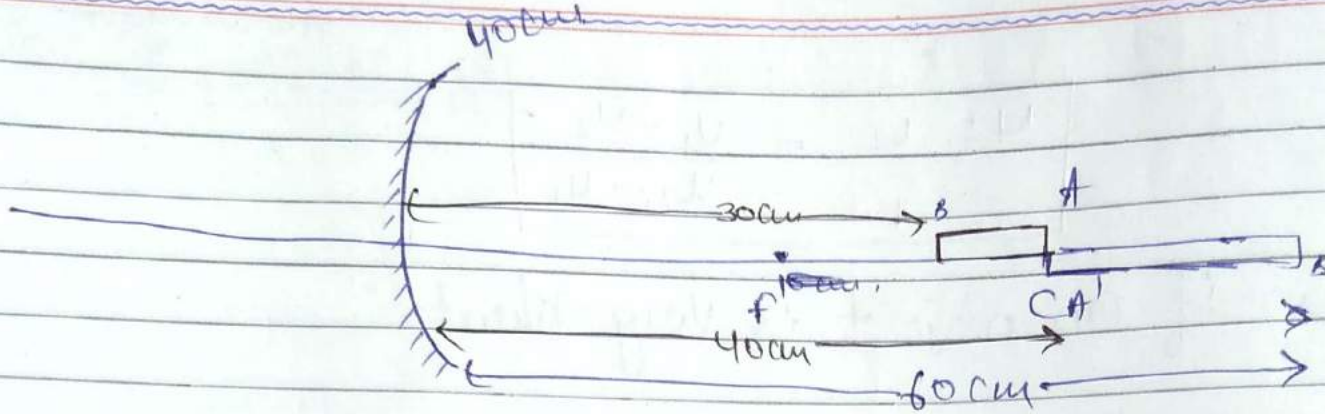
$$M_L = M_T^2 \text{ or } \frac{v^2}{u^2}$$

Que:- An object of length 10cm is placed along principle axis of a concave mirror having radius of curvature 40 cm. Near end of an object is at a dist. of 30 cm. from the pole find Longitudion magnification and length of Image.

(ii) In the above Que if a cube of long side length 1 milimeter is placed at a distance of 60 cm from the same mirror find Volume of the Image obtain

Transverse - ⊥ to P.A Long - ∥ to P.A

(1)



$\frac{1}{u}$

$\frac{40}{30} = 1.2$

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

$u = -30 \quad f = -20$

$v = ?$

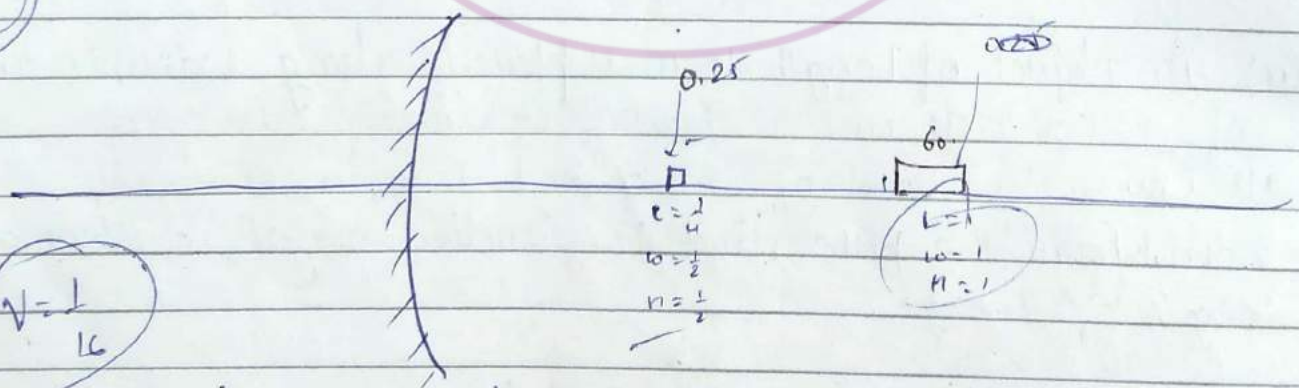
$V = -60$

$L_I = 20$

$= \frac{60-40}{40-30} =$

$M_L = \frac{60-40}{40-30} = \frac{20}{10} = 2$

(2)



$V = \frac{1}{16}$

$\frac{1}{V} + \frac{1}{u} = \frac{1}{f} \qquad u = -60 \quad f = -20$

$V = -30$

$\frac{dv}{du} = \left(\frac{v^2}{u^2}\right) = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$

concave +u for convex +u for

$$\frac{h_1}{h_0} = \frac{-v}{u}$$

$$\frac{h_1'}{1\text{mm}} = \frac{1}{2}$$

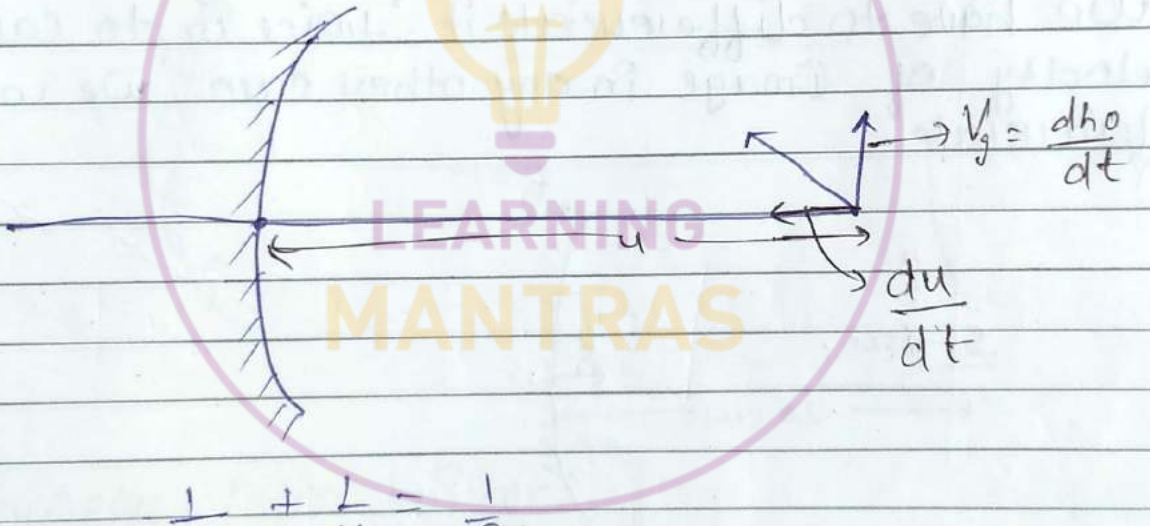
$$= \frac{1}{16}$$

$$L = \frac{1}{4}$$

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

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

(iii) Velocity of Image and object for a Spherical mirror:



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

$$\frac{-1}{v^2}\frac{dv}{dt} - \frac{1}{u^2}\frac{du}{dt} = 0$$

$$\boxed{V_I = \frac{-v^2}{u^2} V_0 \text{ // Principle axis.}}$$

(b) $\frac{h_i}{h_o} = \frac{v}{u}$ [if v & u constant]

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

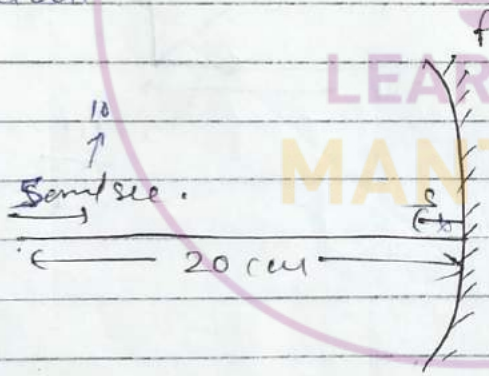
$\frac{dh_i}{dt} = \frac{v}{u} \frac{dh_o}{dt}$

v_I — v_o

$$\boxed{v_I = \frac{-v}{u} v_o}$$

Note:- To Calculate acc. of an object we have to differentiate it twice or to calculate velocity of Image in any other case we will differentiate

Q.



Find Velocity of Image w.r.t ground.

$f = 15 \quad u = -20$

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

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

$= \frac{1}{15} + \frac{1}{20} = \frac{4+3}{60} = \frac{7}{60}$

$v = -60$

$v_I = -\left(\frac{v}{u}\right)^2 v_o$

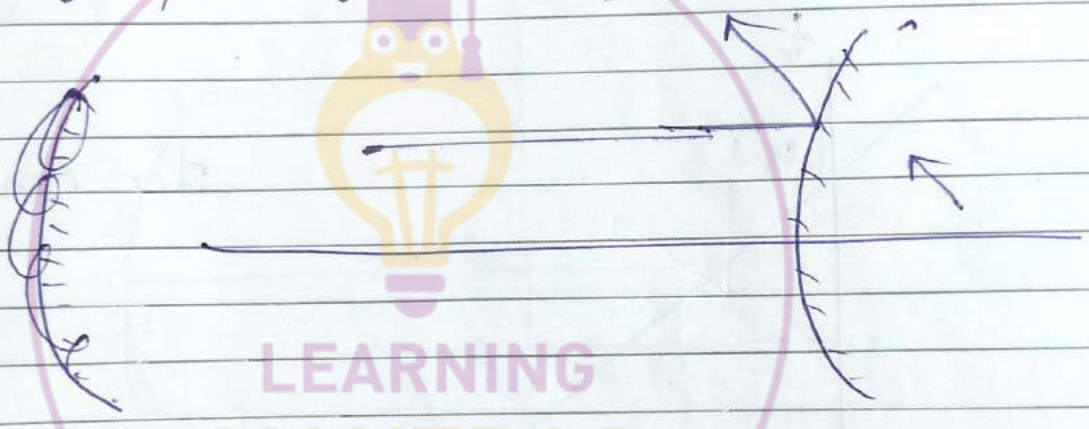
$= -(9) v_o$

$v_I = -90$

$$V_{IM} = 90 = V_I - V_M$$

$$90 + V_M = V_I$$
$$90 + 5 = V_I$$
$$V_I = 95$$

* Direction of Velocity of Image can be predict by making ray along velocity And Velocity of Image is along the reflected ray



* Power of a Mirror:

$$= \frac{1}{f}$$

Power of Mirror $= \frac{1}{f}$ diopter

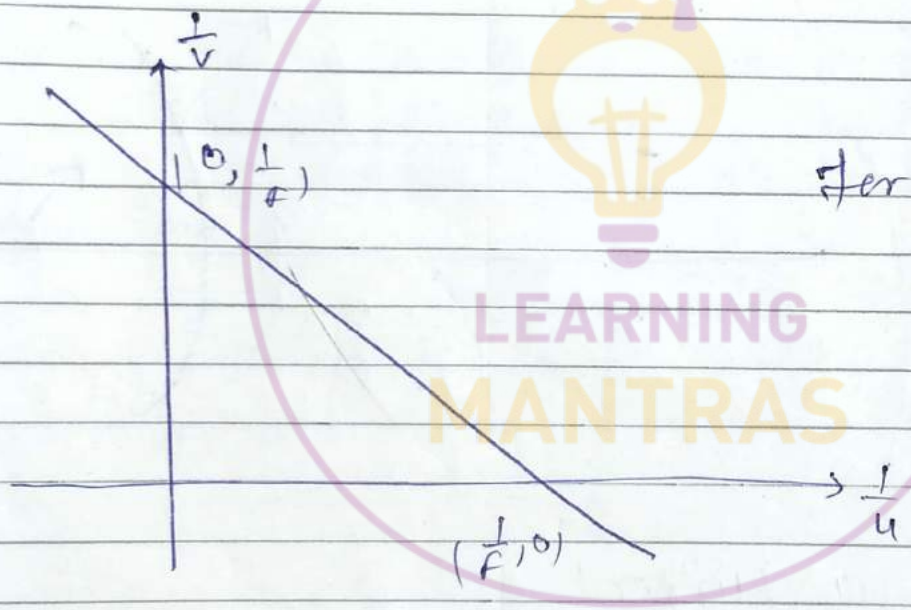
- f cm

* Graph of Spherical Mirror :-

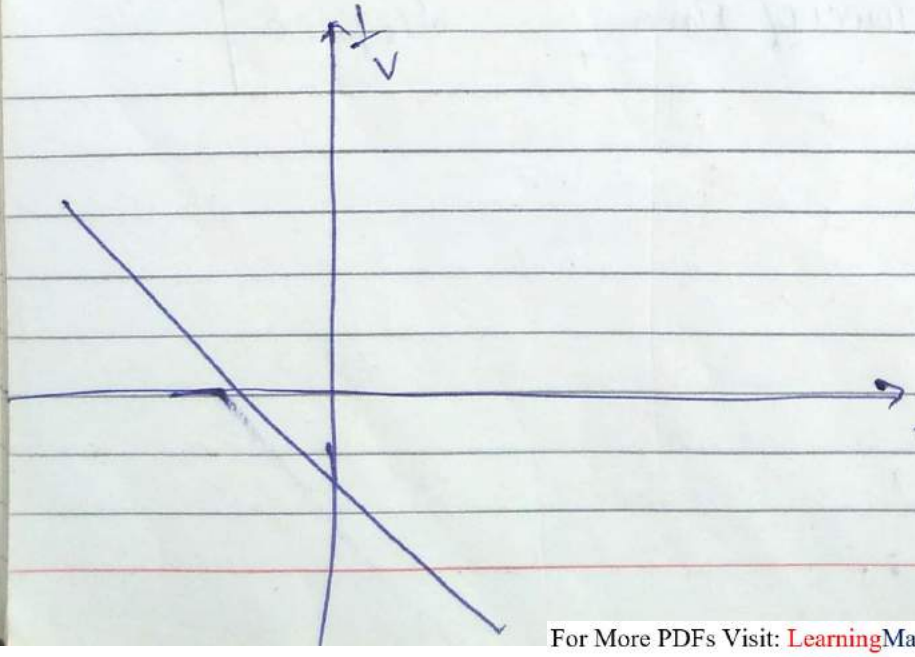
$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = -\frac{1}{u} + \frac{1}{f} \quad \rightarrow \text{for convex mirror}$$

$$\frac{1}{v} = -\frac{1}{u} - \frac{1}{f} \quad \rightarrow \text{for concave mirror}$$



for convex



Concave mirror

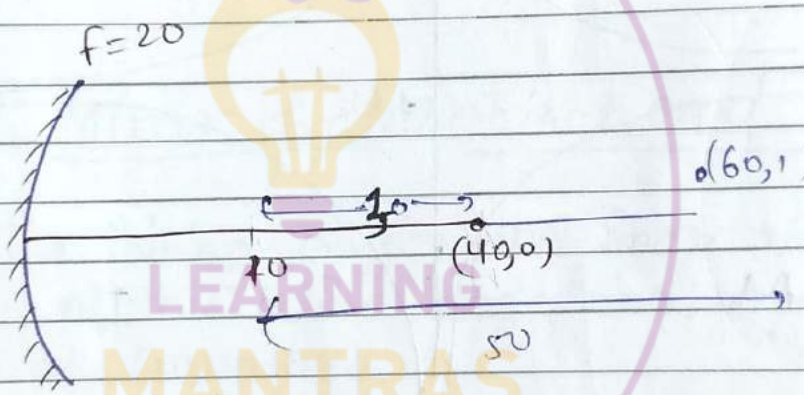
* Newton's formula :

$$x_1 x_2 = f^2$$

where x_1 and x_2 are the distances of object and Image from focus

Object and Image both lies on the same side of focus.

Que



$$20 \times n = 10 \times 10$$
$$n = 5$$

$= 15$ Ans

$$30 \times v = 100$$
$$v = \frac{100}{30} = \frac{10}{3}$$
$$= 10 + \frac{10}{3} = \frac{40}{3}$$ Ans.

(ii)

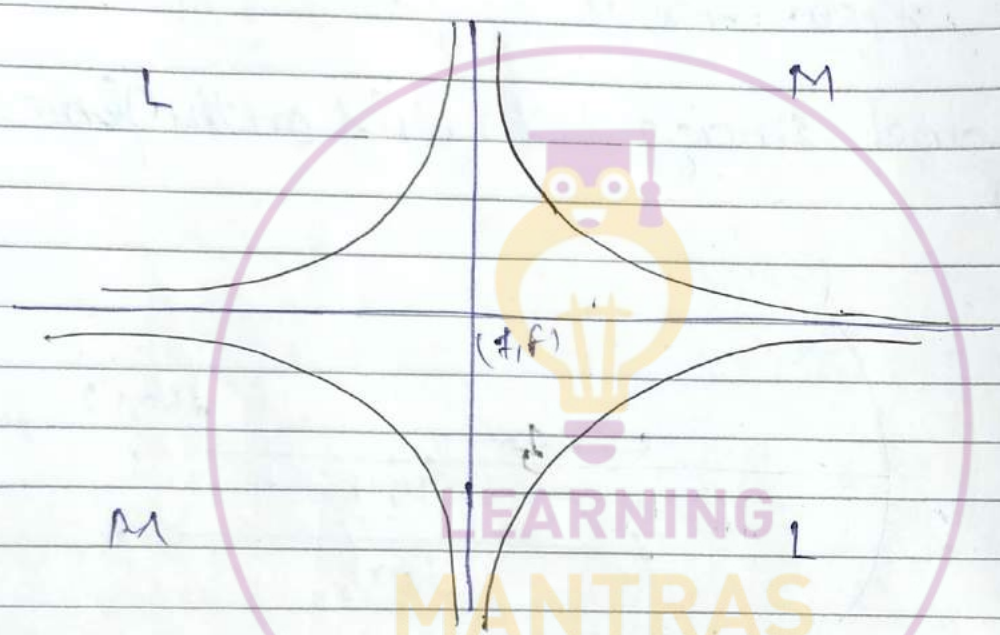
$$50 \times n = 10 \times 10$$
$$n = 2$$
$$\text{Ans} = 10 + 2 = 12.$$

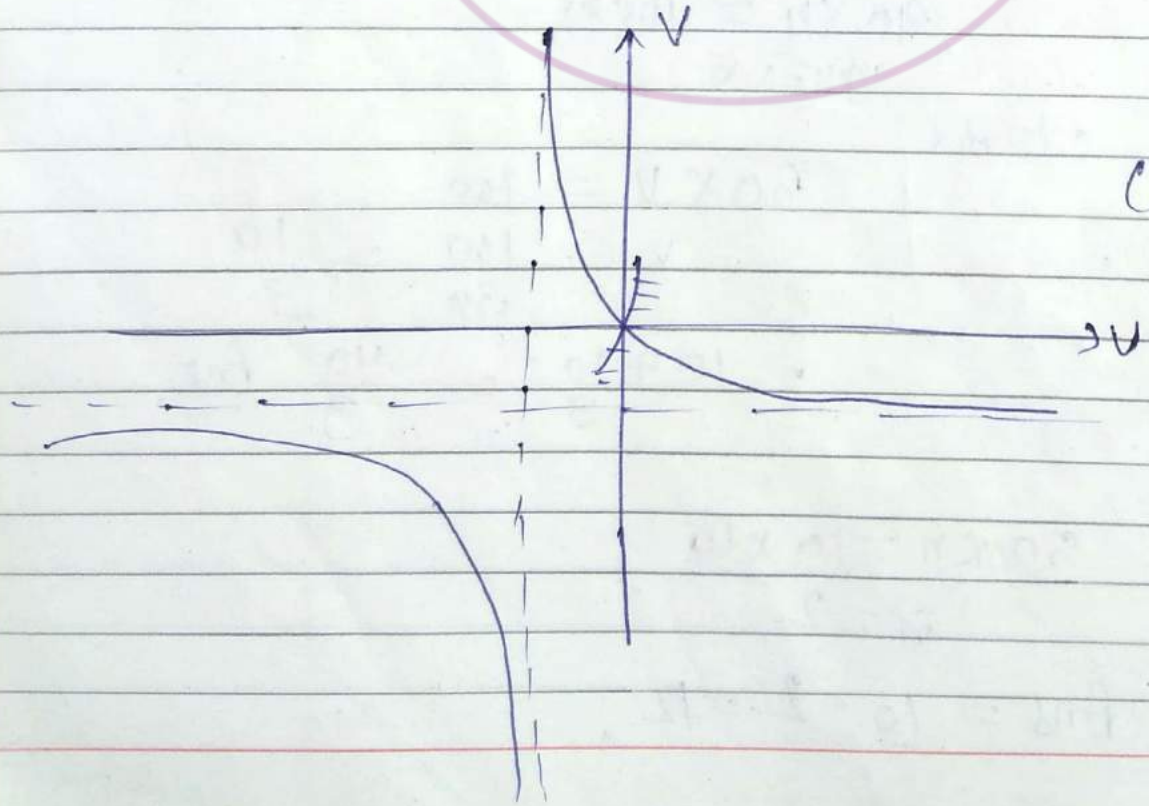
xy = Constant

P.V.

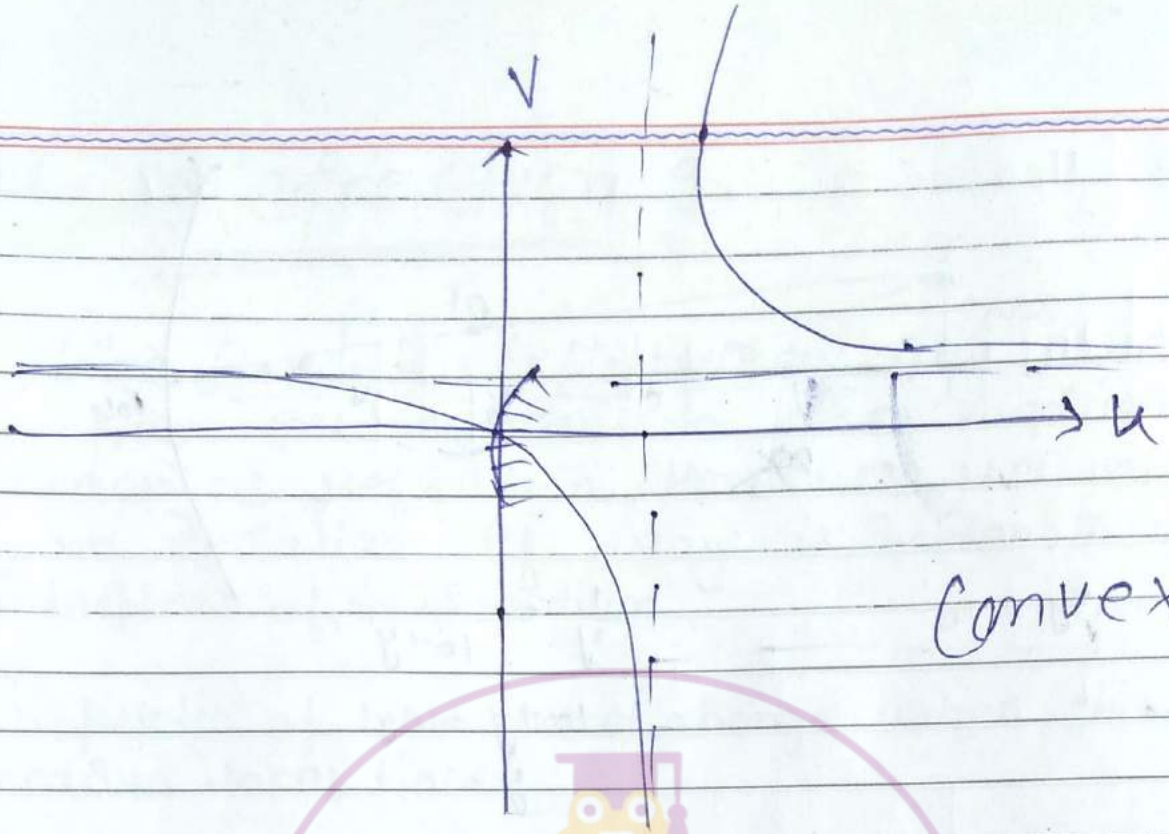
$x_1 x_2 = f^2$

$(u - f)(v - f)$





Concave



Convex

* Location of Mirror from object and Image:-

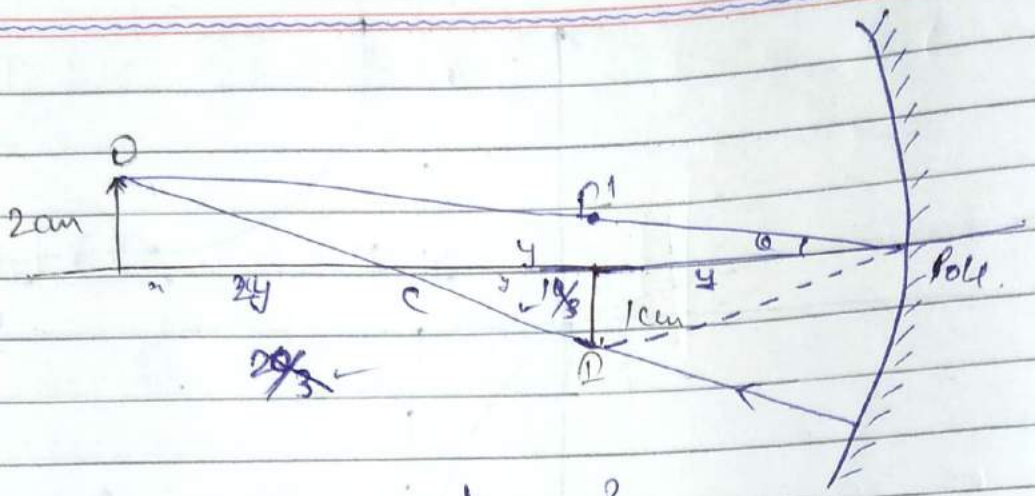
* (1) Draw a line joining object and Image Point of Intersection of this line and Principle axis gives centre of curvature

* Draw a conjugate Point (reflection of object or Image in Principle axis is known as Conjugate Point) and join with other point

Line OI' or IO'
where O' is C and Conjugate Point.

Intersection of this line with Principle axis gives Pole.

Q-1 Ans



$3y = 10$

$\frac{1}{y} = \frac{2}{10+y}$

$10+y = 2y$

$y =$

* Refraction :-

Bending of light :- When ray passes from one medium to other medium is known as refraction However there will be no deviation of ray is incident Normally on interphase of two medium

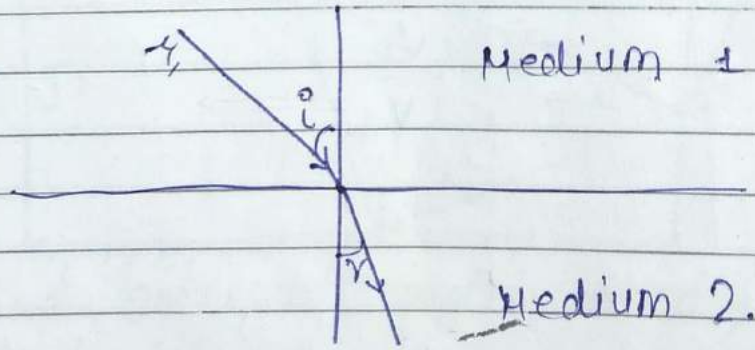
Property of Light make change when change in medium takes place.

* Law of Refraction :- 'Snell's law'

Law :1 :- Incident ray, Normal ray and refracted ray all three lies in same plane

$$\boxed{\hat{i} \cdot (\hat{n} \times \hat{r}) = 0}$$

Law :- 2 (Snells :-)



$\frac{\sin(i)}{\sin(r)} = \mu$ = refractive index

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

Snell's law

$$\mu_1 [\hat{i} \times \hat{n}] = \mu_2 [\hat{r} \times \hat{n}]$$

* Refractive Index:

Ratio of velocity of light in Vacuum to that of Velocity of Light in medium is known as refractive index.

$$\mu = \frac{c}{v}$$

RI of Medium w.r.t Air.

$$\mu_0 = \frac{v_1}{v_2}$$

$$\mu_2 = \frac{c}{v_2}$$

$$\frac{\mu_2}{\mu_1} = \frac{c/v_2}{c/v_1}$$

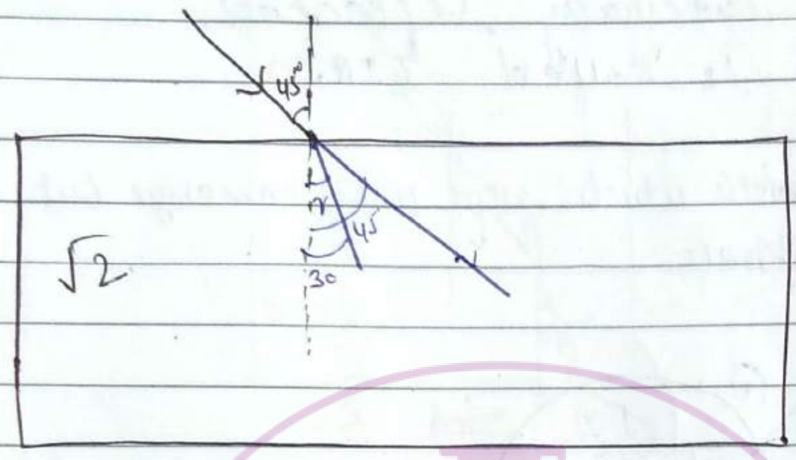
refractive of 2 w.r.t

$$= \frac{v_1}{v_2}$$

G alomoke G – Sexg C – tehe.

Next Race.
$\mu = 2$ 0–2 = 1to17
Mell = 1to10

Q find angle of Refraction and deviation produce in the Ray. Refractive I of Medium is $\sqrt{2}$



$$\frac{\sin 45}{\sin r} = \sqrt{2}$$

$$\frac{\sin r}{\sin 45} = \frac{1}{\sqrt{2}}$$

$$\sin r = \frac{\sqrt{3}}{2}$$

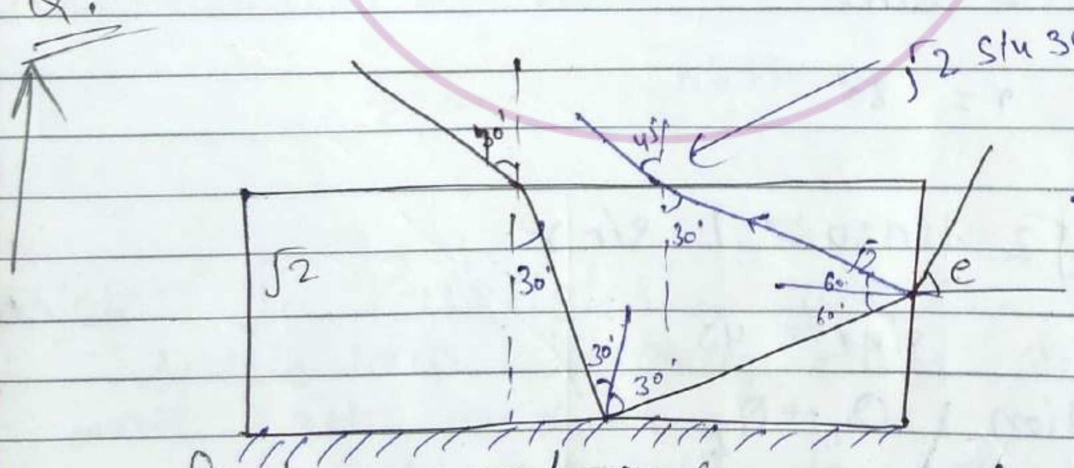
$$\sin 45^\circ = \sqrt{2}\,\sin r$$

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

$$\Rightarrow \sin r = \frac{1}{2} \Rightarrow r = 30^\circ$$

Q.

$\sqrt{2} \sin 30 = 1 \sin \theta$



Then two ray become parallel.

find emergent angle = angle with which light ray

$$\sqrt{2} \sin 60 = 1 \sin e$$

$$\sqrt{2} \sin 60 = \sin e$$

$$\sqrt{2}\,\frac{\sqrt{3}}{2} = \sin e$$

$\sin e = \sqrt{\frac{3}{2}}$

$\sin e = \sqrt{1.5}$

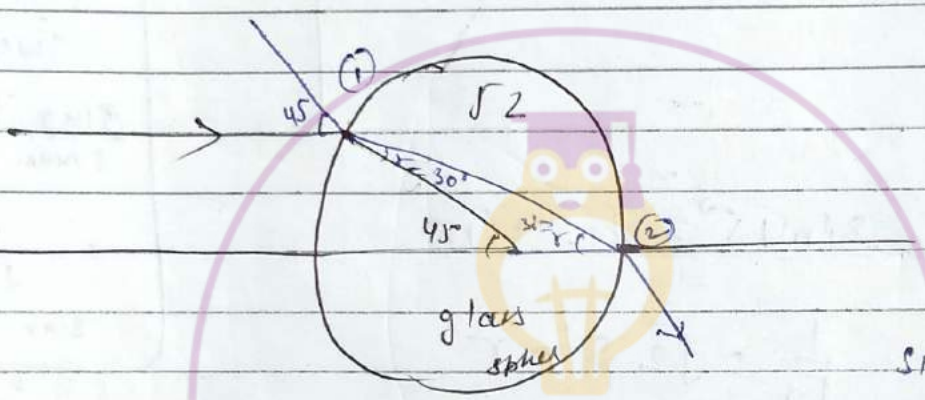
$\sin^{-1} \frac{\sqrt{3}}{\sqrt{2}}$

never $\sin e > 1$ ray not come in e point

$\sin\theta > 1$ never. — Imp.

Ray will get internally reflected.
This phenomina is called TIR.

Que: find angle with which ray will emerge out from the glass sphere



$\sin 45° = \sqrt{2} \sin r$

$\frac{\sqrt{3}}{\sqrt{2}} \quad \frac{1}{2} \quad \sin r$

① — (At) $\mu_1 \sin i = \mu_2 \sin r$

because in Air

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

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

$r = 30°$

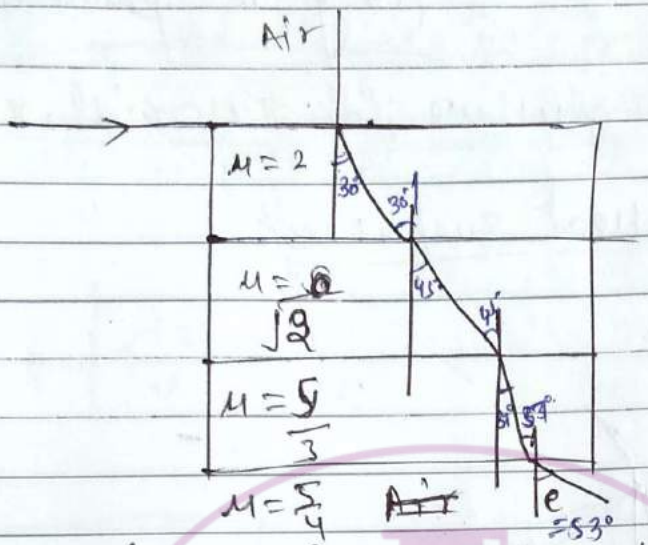
② $\sqrt{2} \sin 30 = 1 \sin r$

$\sin r = 45°$

deviation $\theta_1 + \theta_2$

$\frac{4}{5} = \sin r$

Ques



Find angle of emergent of the ray of the glass ray ③ reflect.

$\mu = 2$

$1 \sin 90 = \frac{5}{4} \sin r$

$1 = \frac{5}{4} \sin r$

$\frac{4}{5} = \sin r$.

$1 = 2 \sin r \quad \sin r = \frac{1}{2} = 30°$

$\sqrt{2} \sin 30° = 1 \sqrt{2} \sin r \Rightarrow 2 \times \frac{1}{2} = \sqrt{2} \sin r$.

$\frac{1}{\sqrt{2}} = \sin r \quad \sin r = 45°$

$\sqrt{2} \sin 45° = \frac{5}{3} \sin r \quad \sqrt{2} \times \frac{1}{\sqrt{2}} = \frac{5}{3} \sin r$.

$\frac{3}{5} = \sin r \quad \sin r = 37°$.

$\frac{5}{3} \times \frac{3}{5} = \frac{5}{4} \sin r$

$\frac{4}{5} = \sin r$.

$e = r = 53°$.

Note: In Parallel slab we can applyed snells law directally to first midium and last medium.

Snells law is indipendent from intermediate medium if refrecting surfaces are parallel to each other

Imp: Board

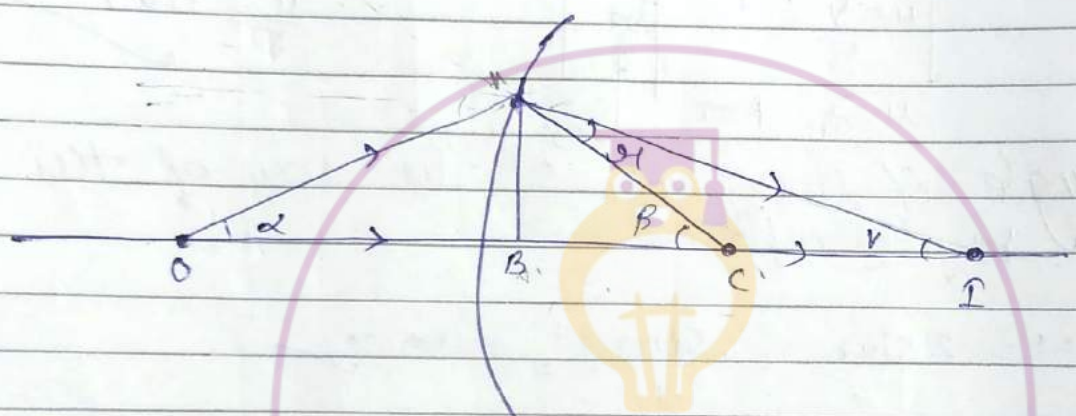
$r \to \infty$ plane.

Apperent depth:

(only for small angle)

Refraction at plane surface for Paraxial rays:

Refraction at curved surface:



$$\tan\alpha = \frac{AB}{PO} = \frac{AB}{u} \qquad \alpha + \beta = i$$

$$\tan\beta = \frac{AB}{BC} = \frac{AB}{R} \qquad \gamma + r = \beta$$

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

$$\mu_1 i = \mu_2 r$$

$$\mu_1(\alpha + \beta) = \mu_2(\beta - \gamma)$$

$$\mu_1\alpha + \mu_2\gamma = (\mu_2 - \mu_1)\beta$$

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

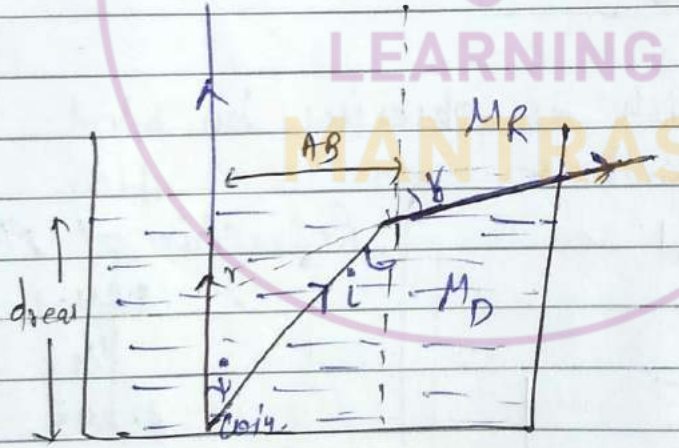
By putting sign convention to make value free

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

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{\infty}$$ — for plane mirror

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

* Apparent depth:



$$\mu_D \sin i^\circ = \mu_r \sin \gamma$$

$$\mu_D i^\circ = \mu_r \gamma$$

$$\mu_D \frac{AB}{d_{real}} = \mu_r \frac{AB}{d_{AB}}$$

$$d_{AP} = \frac{d_{real}}{\frac{\mu_D}{\mu_r}} \text{ or } \frac{d_{real}}{\frac{\mu_{object}}{\mu_{observer}}}$$

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

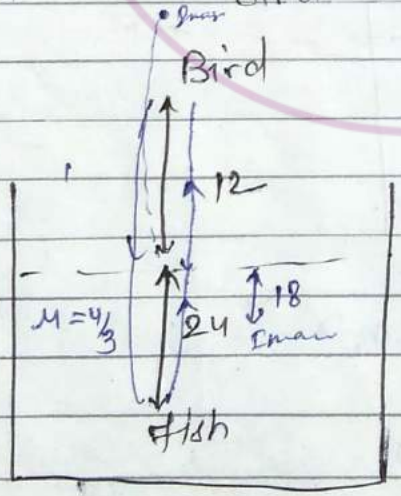
$$\frac{\mu_R}{v} + \frac{\mu_D}{d_{real}} = 0$$

$$\frac{\mu_R}{v} = -\frac{\mu_D}{d_{real}}$$

$$-\mu_R \frac{d_{real}}{\mu_D} = v$$

Q. find dist. of fish as observed by bird.

" " " bird " " " fish.



Refraction at Plane Surface

$$= \frac{8 \cdot 24 \cdot 1}{4/3}$$

$$\frac{3 \cdot 24}{4} = 18.$$

$$= 18 + 12 = 30$$

$$= \frac{12 \cdot 4}{1} = \frac{36 + 24}{5} = 60$$

Refraction at Plane surface.

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = 0 \Rightarrow \frac{1}{v} - \frac{4}{3(-24)} = 0$$

$30 + 12 = 30$ $\quad v = -18$

No HW

(2) $\frac{\mu_2}{v} - \frac{\mu_1}{u} = 0$

$\frac{4/3}{v} + \frac{1}{12} = 0$

$\frac{4}{3v} + \frac{1}{12}$

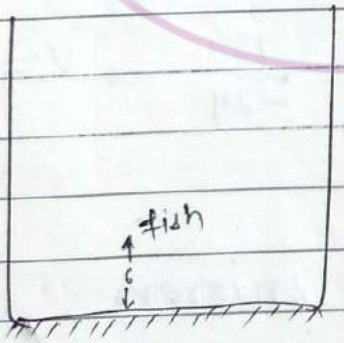
$\frac{4}{3v} = \frac{-1}{12}$

$\frac{3v}{4} = -12$

$v = \frac{-12}{3} \times 4 = -16.$

$16 + 24 = 40$ Ans

Que: find

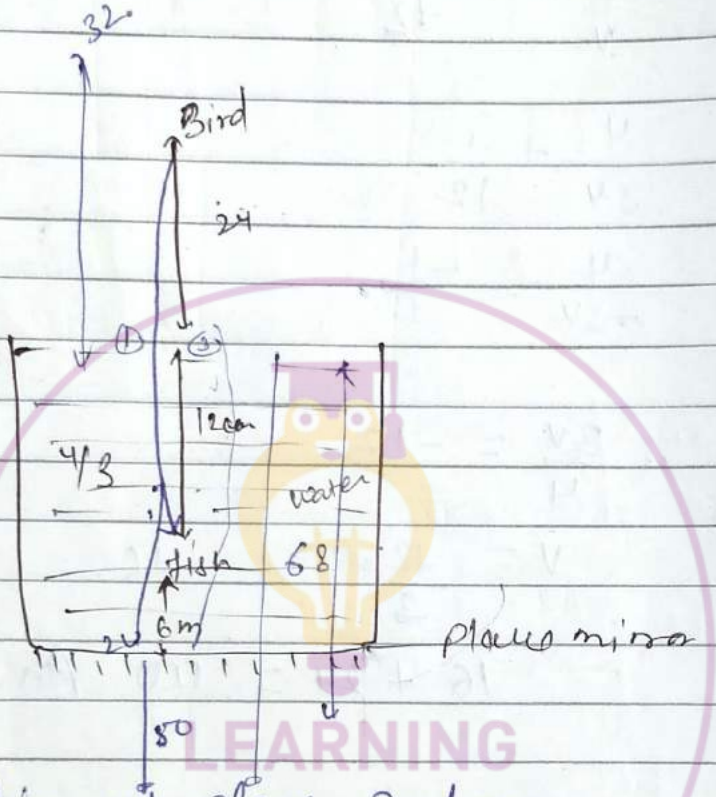


Que: find distance of Image of Bird as observed by fish in the mirror

(ii) find " " " " " in the mirror as observed by Bird

(iii) find the I of fish as Observed by

(iv) Find dist of Image of fish as Observed by Bird, in the mirror



(i) Refraction at plane surface

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

$$\frac{\mu_2}{V} - \frac{\mu_1}{u} \Rightarrow \frac{4}{3V} = \frac{1}{-24} \Rightarrow V = -32$$

(ii) Reflection at plane mirror

$$\frac{1}{v} + \frac{1}{u} = \frac{2}{R=\infty}$$

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

$$u = -v$$

50 m below the mirror

Obj ray ~~Image~~

(3) Refraction at Plane surface

$$\frac{\mu_2}{v} = \frac{\mu_1}{u} \Rightarrow \frac{1}{v} = \frac{4}{3(68)}$$

$$v = \frac{3(68)}{4}$$

$$v = 57 \text{ cm} \longrightarrow$$

Object

Image

(i) $\frac{1}{v} = \frac{4}{3(12)}$ $\Rightarrow$ $v = 9$.

(ii) 66 cm

(iii) 12 cm

(iv) $\frac{1}{v} = \frac{4/3}{24}$

$v = 18$.

$\frac{24}{12}$

3c

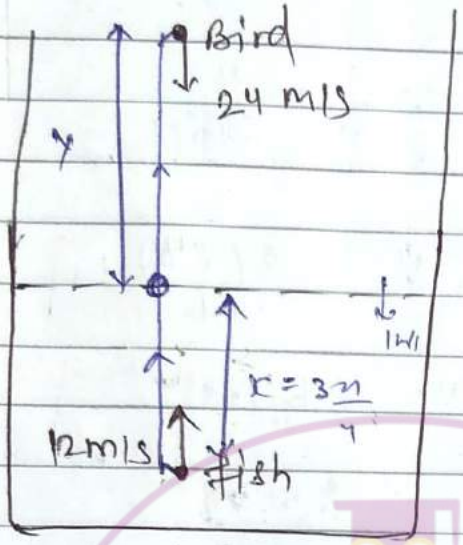
$\frac{1}{v} = \frac{4}{3(18)}$

$v = \frac{52}{4} = 13$.

13.5

$\frac{d}{dx}$ Distance = velocity

Q.



↓24
−1< 24/12 (3)

Qu: find the velocity of fish as observed by Bird

$\frac{u_2}{v} = \frac{u_1}{4}$

$\frac{1}{v} = \frac{4}{3(n)}$

$v = \frac{3n}{4}$

H-2

$\frac{n}{4/3} + \frac{4}{1}$

$\frac{3}{4}n + 4$

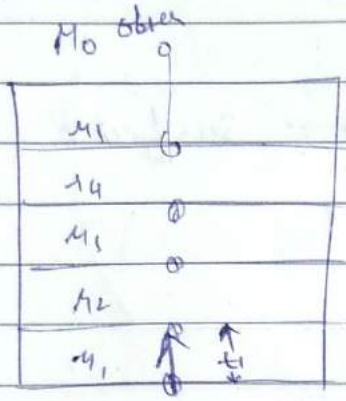
$D_{FB} = 4 + \frac{3n}{4}$

$V_{FB} = \frac{dy}{dt} + \frac{3}{4}\frac{dn}{dt}$

$24 + \frac{3}{4}(12)^3 = 24 + 9 = 33$ m/s.

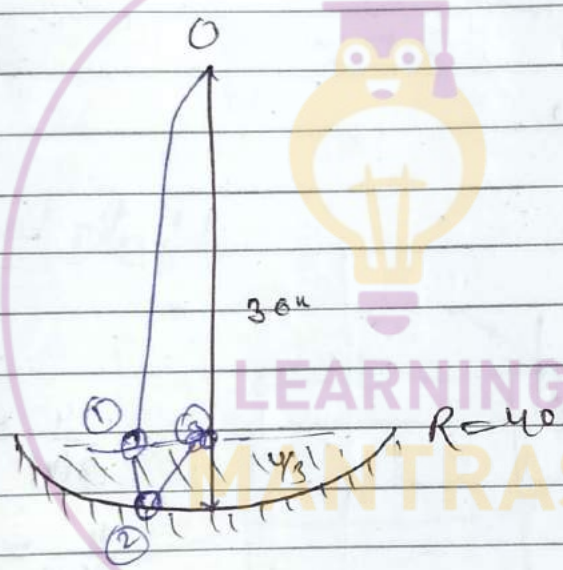
* Refraction through of glass slab :-

Note:



$$\frac{t_1}{\frac{\mu_1}{\mu_0}} + \frac{t_2}{\frac{\mu_2}{\mu_0}} + \frac{t_3}{\frac{\mu_3}{\mu_0}} + \frac{t_4}{\frac{\mu_4}{\mu_0}} + \frac{t_5}{\frac{\mu_5}{\mu_0}}$$

Q



$$\frac{4}{\frac{30}{4}} \quad \frac{30 \times 4}{4}$$

$$\frac{4}{3 \times 30}$$

Find position of final image of an object O in the given diagram

① Refraction at Plane surface

$$\frac{\mu_2}{v} = \frac{\mu_1}{u} \Rightarrow \frac{4}{3(v)} = \frac{1}{-30} \Rightarrow v = -40$$

So $\frac{1}{v} - \frac{1}{30} = \frac{1}{20}$

② Refraction at curved surface:

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \qquad u = -40 \qquad f = -20$$

$$v = -40$$

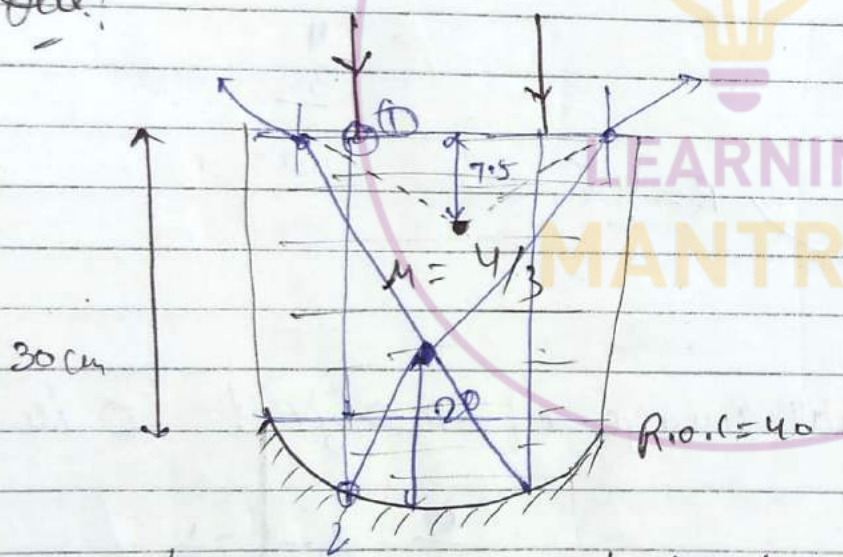
(3) Refraction at plane ~~Mirror~~ surface

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

$$\frac{1}{v} = \frac{4}{3(-40)}$$

$$v = -30$$

Ans!



$$\frac{4}{3(v)} = \frac{1}{\infty}$$

$$\frac{4}{3(v)} = \frac{4}{3(\infty}$$

Find the position of final image

(1) $$\frac{\mu_2}{v} = \frac{\mu_1}{u}$$

$$\frac{4}{3v} = \frac{1}{\infty}$$

$$v = \infty$$

(2) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ $\quad u = \infty \quad f = -20$

$v = ?$

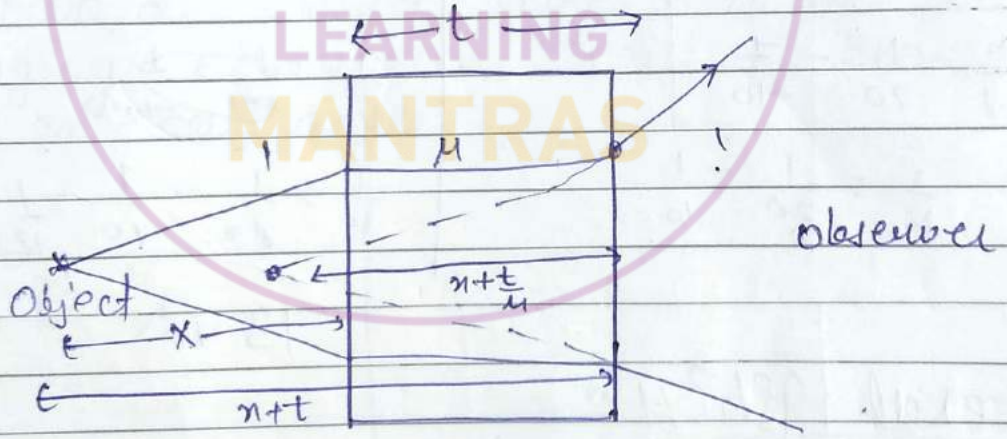
$\frac{1}{v} + \frac{1}{\infty} = \frac{1}{-20}$

$v = -20$

(3) $\frac{1}{v} = \frac{4}{3(10)}$

$v = \frac{30}{4} = 7.5$

* Normal shift :-



$$N.S = t\left[1 - \frac{1}{\mu_{relative}}\right]$$ Imp.

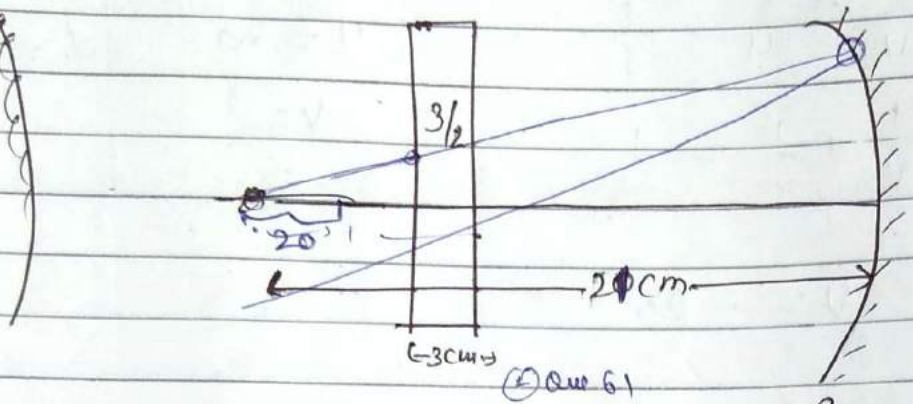
(1) $\frac{\mu}{v} = \frac{1}{x}$ $\quad v = \mu x$

(2) $\frac{1}{v_f} = \frac{\mu}{[\mu x + t)}$

$v_f = \frac{\mu x + t}{\mu}$

$v_f = x + \frac{t}{\mu}$

Que!



Q Que 61

final final position of an image

$$\text{NRS: } t\left(1-\frac{1}{\mu_{rel}}\right) = 3\left(1-\frac{2}{3}\right) \qquad ① \; \frac{3}{2(v)} = \frac{1}{x}$$

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

M-2

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

$$\frac{1}{V} - \frac{1}{20} = \frac{1}{-10}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{10}$$

Ans-2

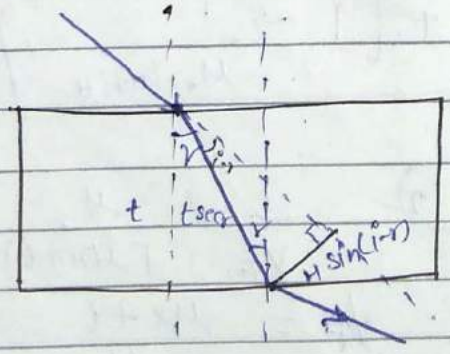
$$\frac{1}{V} - \frac{1}{20} = \frac{1}{-10}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{10} = \frac{1}{12}$$

13 Ans

Lateral Shift :-

$$\frac{t}{H} = \cos r$$



L.S =

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

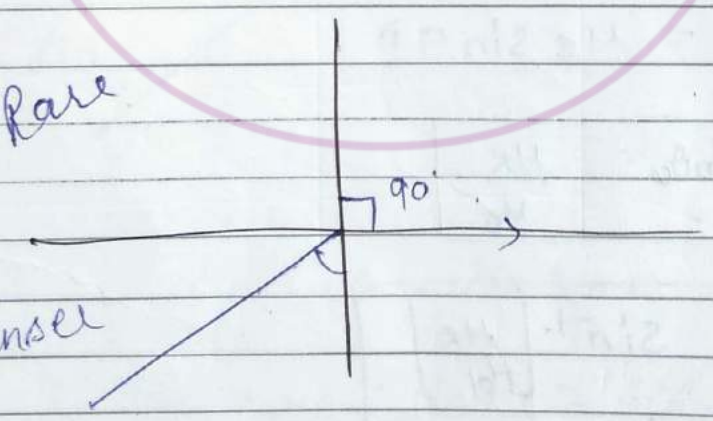
Shift towards the Normal.

* Total Internal Reflection (TIR)

When Ray moves from ~~rayer to denser~~ denser to rayer medium it may reflect back into the medium for the angle greater than Particular angle. this phenomina is known as total internal reflection

* Critical angle:

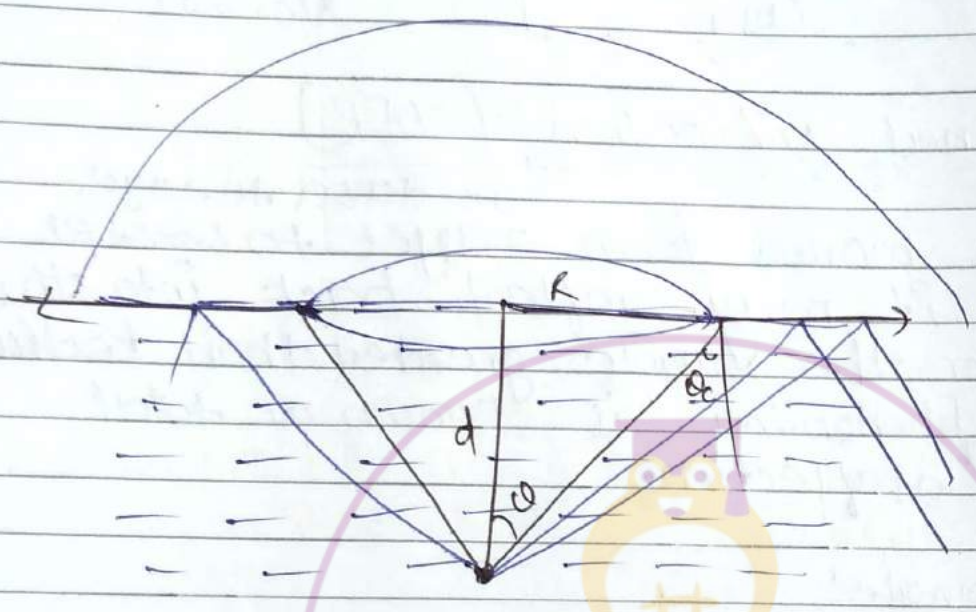
Angle after which ray gets internally reflected is known as Critical angle or angle for which guaging emergence occur is known as critical angle

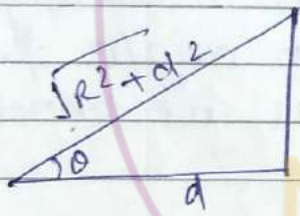


$$\mu_D \sin\theta_C = \mu_R \sin 90^\circ$$

$$\sin\theta_C = \left(\frac{\mu_R}{\mu_D}\right)$$

Total illumances circle





$$\mu \sin\theta_c = \mu_e \sin 90$$

$$\boxed{\sin\theta_c = \frac{\mu_R}{\mu_D}}$$

$$\boxed{\theta = \sin^{-1}\left[\frac{\mu_R}{\mu_{D_1}}\right]}$$

$$\frac{R}{\sqrt{R^2+d^2}} = \frac{\mu_R}{\mu_D}$$

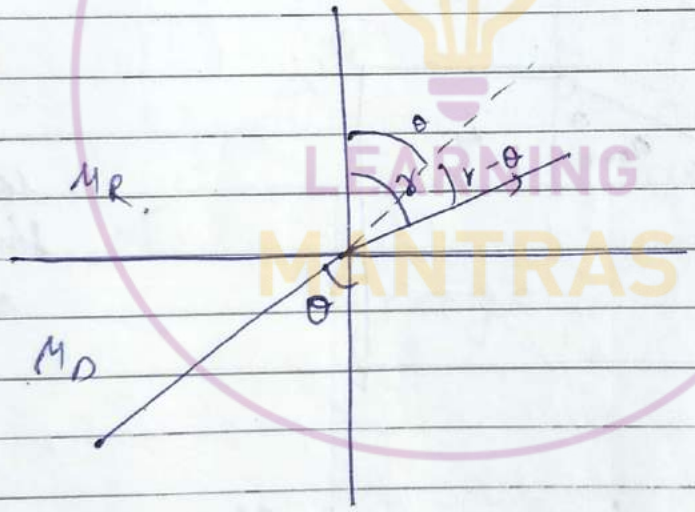
$$\frac{R^2}{R^2+d^2} = \frac{\mu_R^2}{\mu_D^2}$$

17% goes out

$$R^2\mu_D^2 = \mu_R^2 R^2 + \mu_R^2 d^2$$

$$\boxed{R = \left(\frac{\mu_R}{\sqrt{\mu_D^2 - \mu_R^2}}\right) d}$$

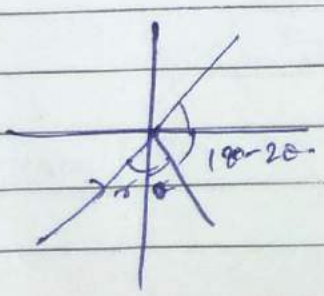
* **Deviation of a Ray:** When it moves from Denser to layer medium.



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

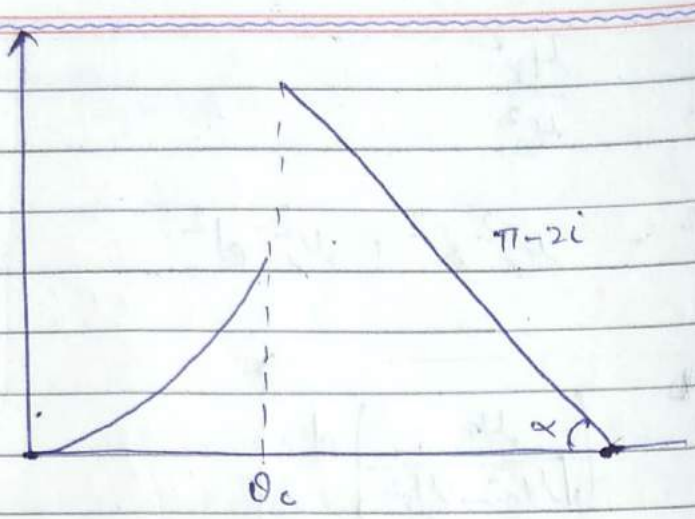
$$\mu_D \sin\theta = \mu_R \sin r$$

$$\frac{\mu_D}{\mu_R}(\sin\theta) = \sin r$$

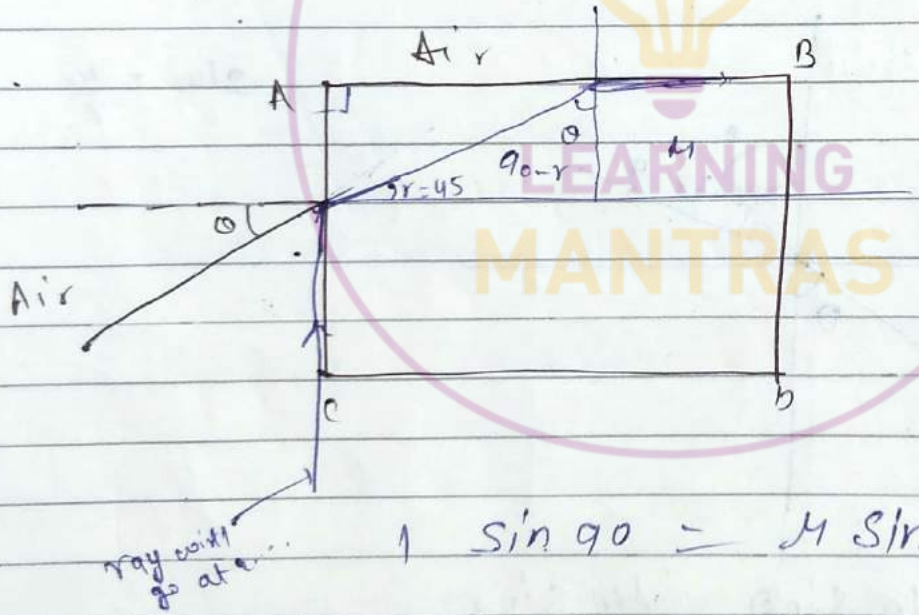


$$\sin^{-1}\left[\frac{\mu_D \sin\theta}{\mu_R}\right] = r$$

Critical angle $\theta_c = \sin^{-1}\left(\frac{1}{\mu}\right)$



Que! Find Refractive index of the glass slab ABCD so, that ray does not Leave Out of the glass slab from its lateral side ABCD.



Ld:
$\sin\theta = \mu \sin 90$
$\sin\theta = \mu$
$\theta = \sin^{-1}\mu$

$1 \sin 90 = \mu \sin r$

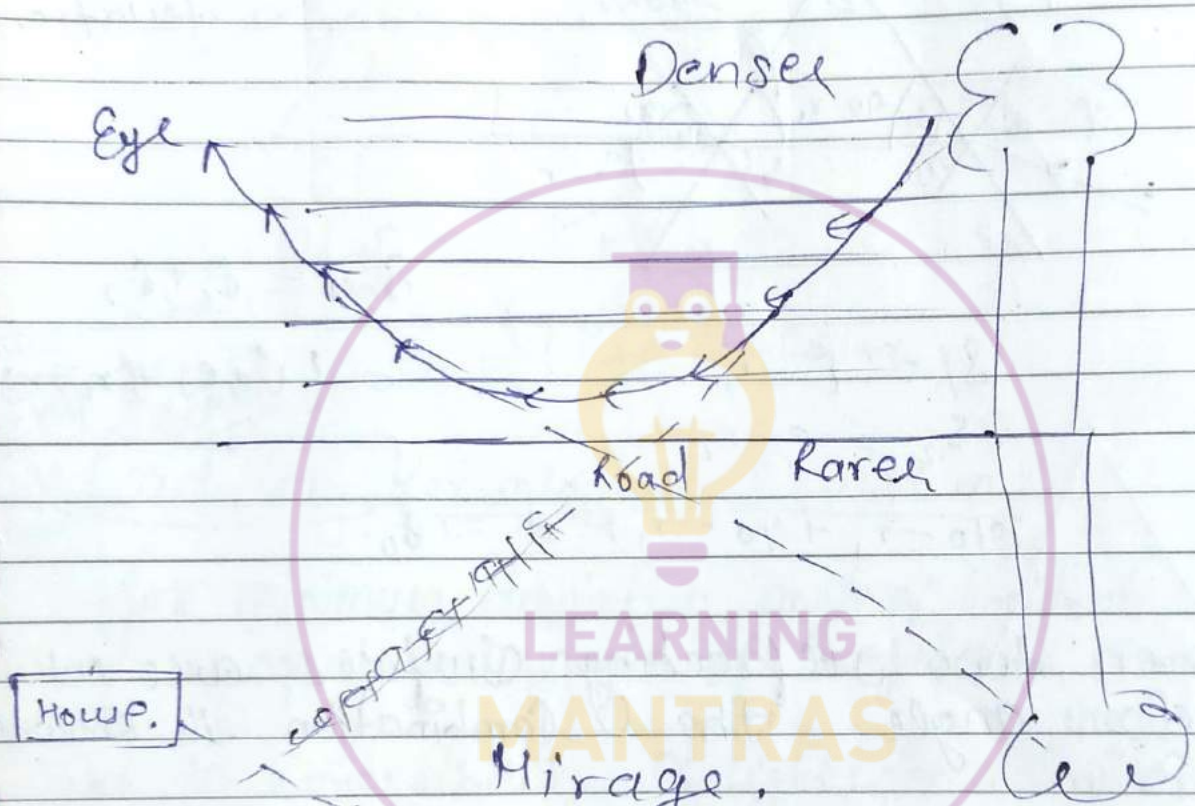
$\mu \sin(90-r) = 1$ (1)

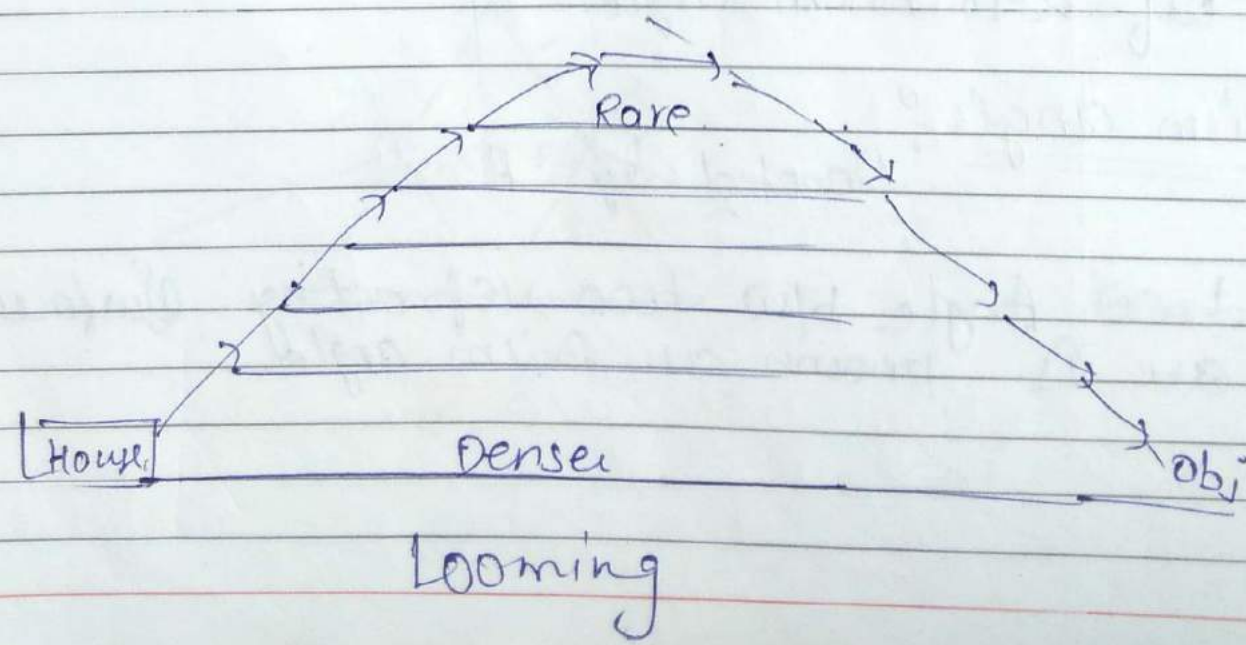
$\sin 90^\circ = \tan r$

$\sqrt{2}$

* Application of TIR :

Sparkling of diamond, optical fiber, Mirage and looming all the same ex of TIR.

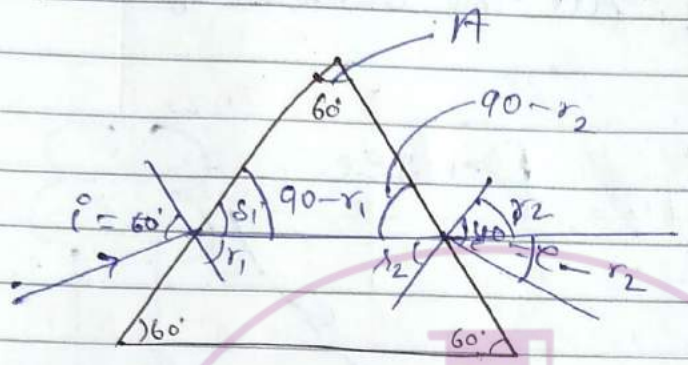




Looming

* Prism :-

Prism Angle



δ ⇒ deviation.

$\delta_{net} = \delta_1 + \delta_2$

$= (i + e) - (r_1 + r_2)$

$\delta_1 = i - r_1$

$\delta_2 = e - r_2$

$90 - r_1 + 90 - r_2 + A = 180$

When two refracting surfaces are at an some angle the combination is known as Prism.

Glass slab can also be consider as Prism of zero Prism angle.

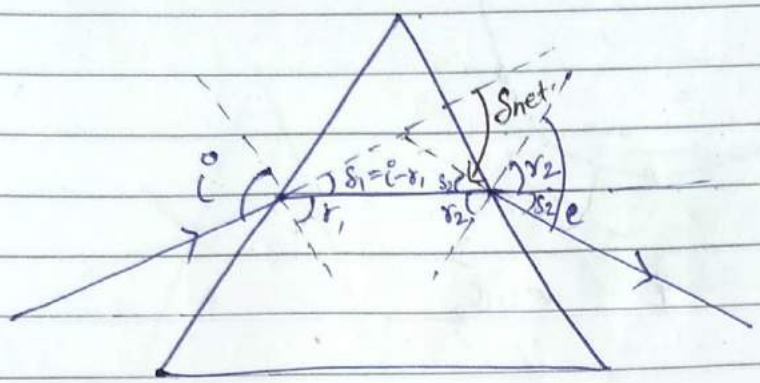
Prism angle :-

Denoted by 'A'

⇒ ~~Two~~ Angle b/w two refracting surfaces is known as Prism angle.

Next → Kal

$\mu_{CV} = 1 - t_0 - 2r$



$\delta_1 = i - r_1$,

$\delta = \delta_1 + \delta_2$

Derivation.

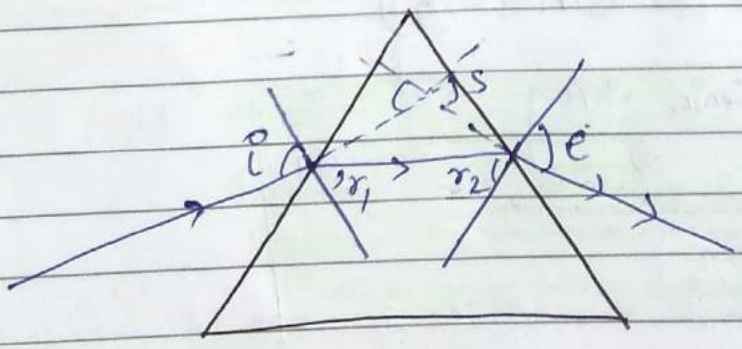
Imp. for Board

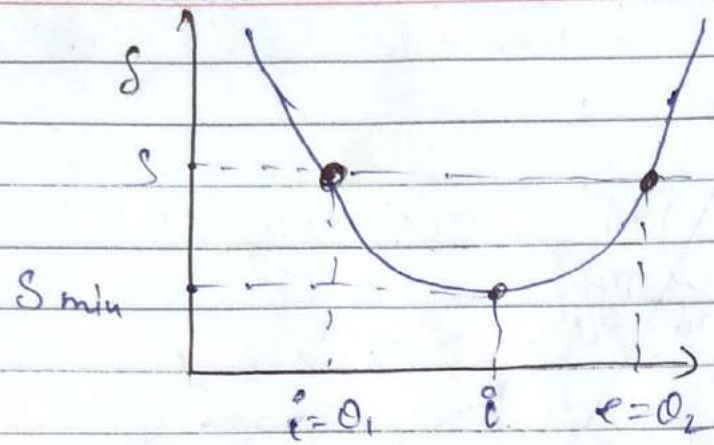
$\delta_2 = (i + e) - (r_1 + r_2)$

* Condition for minimum Deviation:

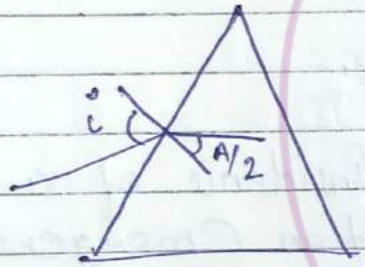
for minimum deviation, angle of Incidence of a ray is equal to angle of ~~reflection~~ Emergence.

Due to Reversibility of Light for a Particular deviation there are two angle of Incidence





Therefore for minimum deviation angle of Incidence is equal to angle of emergence.



$$\delta = i + e - (r_1 + r_2)$$

$$\delta_{min} = 2i - (A) \quad \Rightarrow i = \frac{\delta_{min} + A}{2}$$

$$r_1 + r_2 = A \Rightarrow 2r = A$$

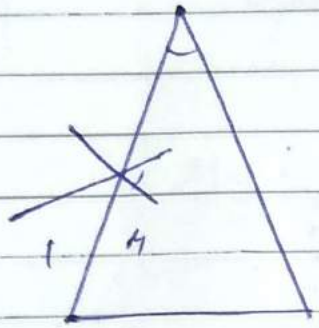
Snell's law

$$1 \sin i = \mu \sin(A/2)$$

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

Note: If rays undergoes minimum deviation and the glass Prism is isoceles or equilateral then reflected ray will pass parallel to Base.

* Small Prism Angle :- (for Angle 1° to 5°)



$$\delta = A[\mu - 1]$$

$\delta = i + e - A = i + e - (r_1 + r_2)$

$\because$ $\sin i = \mu \sin r_1$ | $\sin e = \mu \sin r_2$

for small angle $i = \mu r_1$ | $e = \mu r_2$

$\delta = \mu(r_1 + r_2) - (r_1 + r_2)$

$$\boxed{\delta = A[\mu - 1]}$$ ~~Cauchy's formula~~

* Cauchy's formula :-

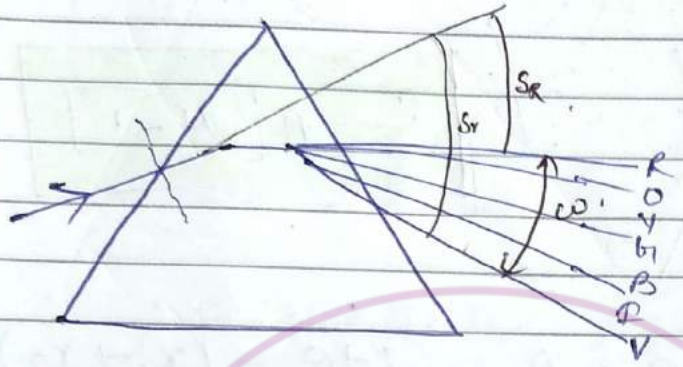
$$\mu = A + \frac{B}{\lambda} + \frac{C}{\lambda_2}$$

$$\boxed{\mu \propto \frac{1}{\lambda}}$$

VIBGYOR
Ev ↓ At ↑

λ ↑↑ μ ↓

for Red colour ↓ μ ∝ 1/λ↑ small deviation.



✗ Dispersion :

Splitting of White light in seven colour is known as dispersion

$$D.A = \delta_v - \delta_R$$

$$= A[\mu_v - 1] - A[\mu_R - 1]$$

$$\boxed{DA = A[\mu_v - \mu_R]}$$

✗ Dispersing power (ω)

Ratio of Dispersion angle to that of mean deviation is known as Dispersing power

$$\omega = \frac{\mu_v - \mu_R}{2}$$

$$\omega = \frac{D \cdot A}{\delta_{mean}} = \frac{A[\mu_v - \mu_R]}{A[\mu_y - 1]}$$

$$\mu_y = \frac{\mu_v + \mu_R}{2}$$

* Dispersion without deviation :-

$$\delta_1 + \delta_2 = 0$$

$$A_1(\mu_1 - 1) + A_2(\mu_2 - 1) = 0$$

$$\theta = \theta_1 + \theta_2$$

$$= A_1(\mu_{v_1} - \mu_{R_1}) + A[\mu_{v_2} - \mu_{R_2}]$$

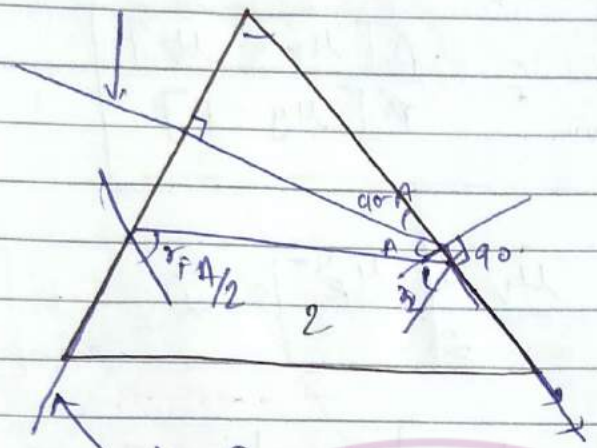
* Deviation without Dispersion : (Achromatic Combination)

$$\theta = \theta_1 + \theta_2$$

$$0 = A_1[\mu_{v_1} - \mu_{R_1}] + A[\mu_{v_2} - \mu_{R_2}]$$

* Condition for no Emergence :-

All Emergence.



No Emergence

Condition for all emergence: $> 30°$.

$$\mu \sin A = 1 \sin 90°$$

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

$$A = \theta_c$$

No Emergence: $> 60°$

$$1 \sin(90) = \mu \sin A/2$$

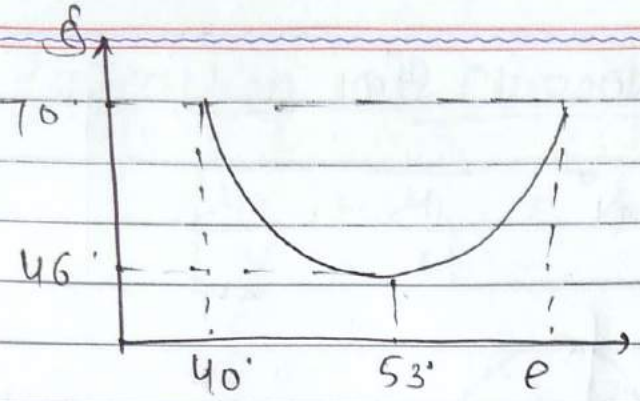
$$\sin \theta_c = \sin A/2$$

$$\theta_c = A/2$$

$$A = 2\theta_c.$$

$\delta = i + e - (r_1 + r_2)$

Q.



find angle of Prism emergent angle & refractive index for the given deviation vs incidend graph for the Prism:

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

$$46 = 53 + 53 - A$$

$$A = 60$$

$$70 = 40 + e - 60$$

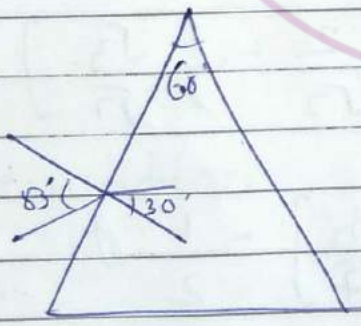
$$90 = e$$

$A = 60 = r_1 + r_2$ $r_1 = r_2 = 30$ (for mini. deviation)

$$1 \sin 53 = \mu \sin 30$$

$$\frac{4}{5} = \mu \frac{1}{2}$$

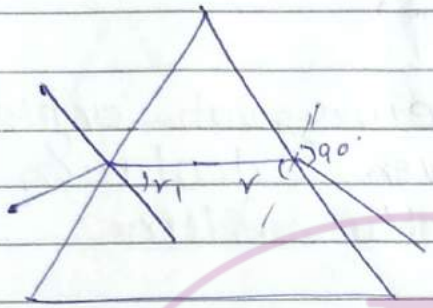
$$\frac{8}{5} = \mu$$



Q. for a Prism $A = 60°$, refractive index $= \sqrt{\frac{7}{3}}$. find the minimum Possible angle of incidend. so, that the secnd surface of deviation?

$$\frac{\sqrt{7}}{3} \times \sin 30 = 1 \sin i$$

$$\frac{\sqrt{7}}{6} = \sin i$$



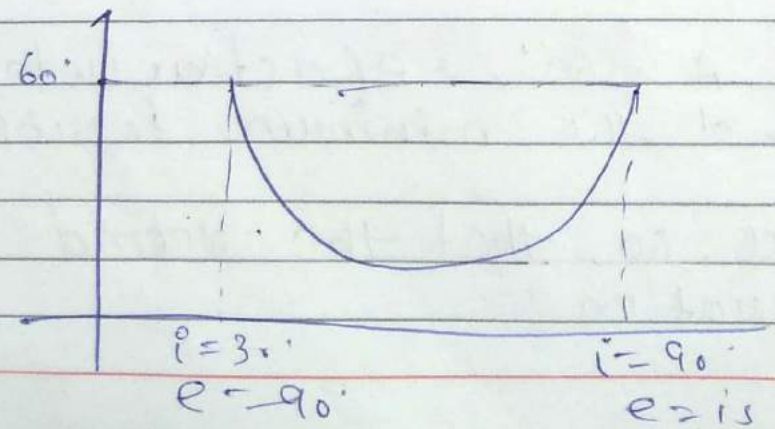
$$\sqrt{\frac{7}{3}} \sin r = \frac{1}{\cancel{\sin i}}$$

$$\sin r = \sqrt{\frac{3}{7}}$$

$$1 \sin i = \sqrt{\frac{7}{3}} \left(\frac{\sqrt{3}}{2} \cos r - \frac{1}{2} \frac{\sqrt{3}}{\sqrt{7}} \right.$$

$$= \sqrt{\frac{7}{\sqrt{3}}} \left[\frac{\sqrt{3}}{2} \frac{2}{\sqrt{7}} - \frac{1}{2} \frac{\sqrt{3}}{\sqrt{7}} \right]$$

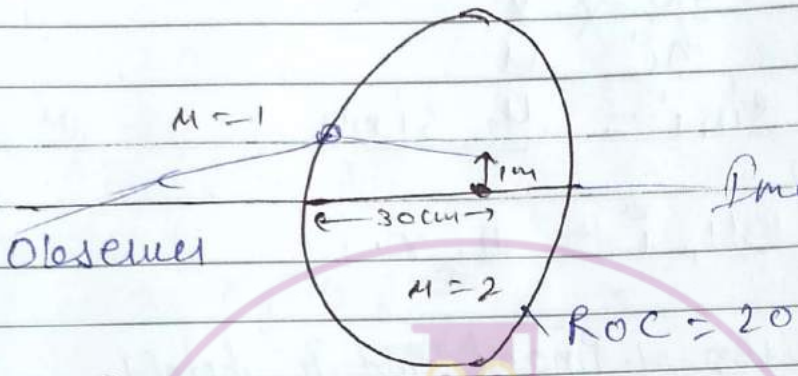
$$= \frac{\sqrt{7}}{\sqrt{3}} \left[\frac{1}{2} \frac{\sqrt{3}}{\sqrt{7}} \right] - \frac{1}{2}$$



* Refraction at Curved Surface :

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

Qu.



Find Position of Image.

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

$$\frac{1}{v} = \frac{1}{20} - \frac{2}{30} = \frac{-1}{60}$$

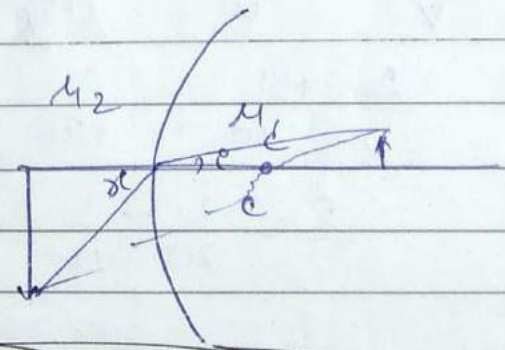
$$v = -60.$$

* Magnification Produced due to refraction :

$$m = \frac{v\mu_1}{\mu_2 u}$$

Derivation

$$m = \frac{v\mu_1}{v\mu_2 - h_1}$$



$$m = \frac{h_i}{h_o} = \frac{1}{\mu} \times \frac{v}{u} = \frac{\mu_1 v}{\mu_2 u}$$

$$\tan i = \frac{h_0}{\mu} \quad - (1)$$

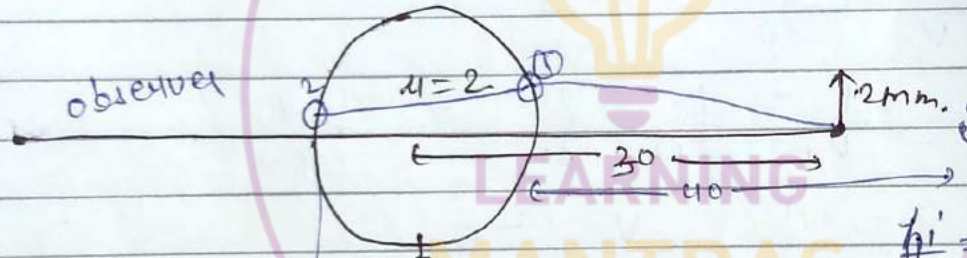
$$\tan r = \frac{h_i}{v} \quad - (2)$$

$$\frac{i}{r} = \frac{h_0}{h_i} \times \frac{v}{u}$$

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

$$\mu_1 i = \mu_2 r$$

Q. Find final position of image and its height



$$\frac{h_i}{2} = \frac{4}{1} \Rightarrow h_i = 4.$$

$$\frac{h_i}{h_0} = \frac{v}{u}$$

(1)

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

$$\frac{2}{v} + \frac{1}{10} = \frac{2-1}{+20}$$

$$\frac{2}{v} = \frac{1}{20} - \frac{1}{10} \Rightarrow v = -40$$

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

$$\frac{1}{v} + \frac{2}{80} = \frac{1-2}{-20} \qquad v = 40$$

$$m_1 = \frac{v}{u_2}\frac{u_1}{u}$$

$$= \frac{+40}{2} \times \frac{1}{-10} = +2$$

$$m_2 = \frac{v}{u_2}\frac{u_1}{u}$$

$$= \frac{-40}{-80_2} \times \frac{-2}{1} = -$$

$$\frac{40}{1} \times \frac{2}{-80_2} = -1$$

$$m_{net} = m_1 \times m_2$$

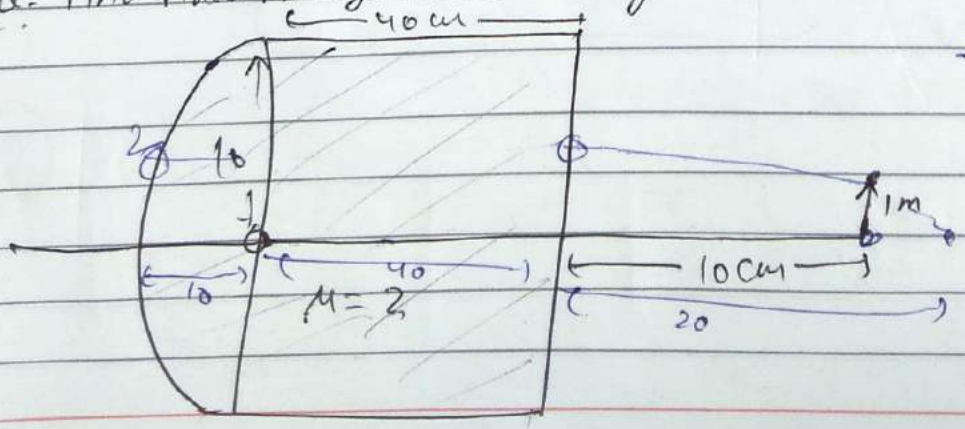
$$= 2 \times -1 = -2$$

$$\frac{h_i}{h_o} = -2$$

$$h_i = -2 \times 2 \Rightarrow h_i = 4$$

Final Image: Enlarge, Real, Inverted.

Que: Find final Image and its height



$$\frac{2}{v} - \frac{1}{10} = \frac{1}{10}$$

$$\frac{2}{v} = \frac{1}{10} + \frac{1}{10}$$

$$\frac{2}{v} = \frac{2}{10}$$

$$v = 10$$

(1) $\longrightarrow$ $\frac{\mu_2}{v} = \frac{\mu_1}{u}$

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

$$v = -20$$

(2)

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

$$\frac{1}{v} - \frac{2}{(-70)} = \frac{1-2}{-10}$$

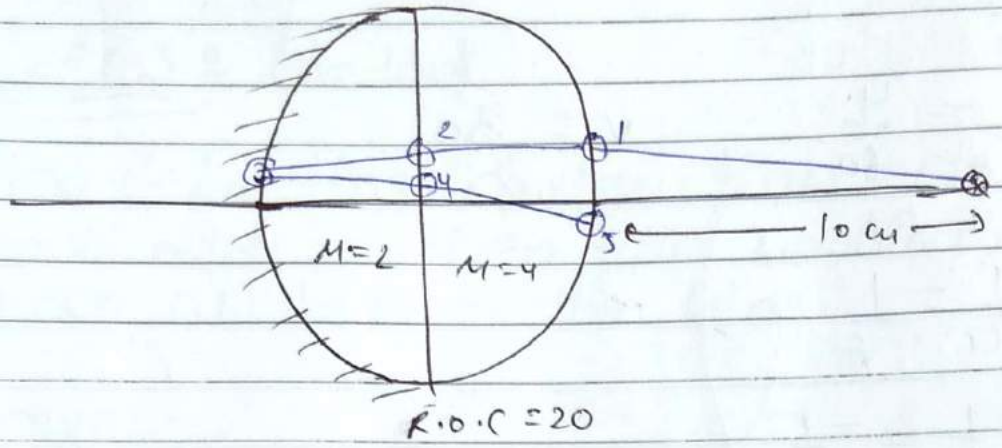
$$\frac{1}{v} + \frac{2}{70} = \frac{+1}{+10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{2}{70} = \frac{7-2}{70} = \frac{5}{70} = \frac{1}{14}$$

$$v = 14.$$

$$m = \frac{v}{\mu_2} \times \frac{\mu_1}{u}$$

Qu



(1) →
$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\frac{4}{v} - \frac{1}{-10} = \frac{4-1}{20}$$

$$\frac{4}{v} = \frac{3}{20} - \frac{1}{10}$$

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

$v =$

$$\frac{4}{v} + \frac{1}{10} = \frac{4-1}{20}$$

$$\frac{4}{v} = \frac{3}{20} - \frac{1}{10}$$

$$\frac{4}{v} = \frac{3-2}{20} = \frac{1}{20}$$

$v = 80.$

(2)

(2) $\frac{\mu_2}{v} = \frac{\mu_1}{u}$

$\frac{2}{v} = \frac{4}{60}$ $\quad v = 30$

(3) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

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

$v = -5$

(4) $\frac{\mu_2}{v} = \frac{\mu_1}{u}$

$\frac{2}{v} = \frac{4}{60}$

$v = 30$

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

$\frac{1}{v} + \frac{4}{50} = \frac{1-4}{-20}$ $\quad v =$

$\frac{1}{v} = \frac{+3}{+20} - \frac{4}{50}$

Important for Board.

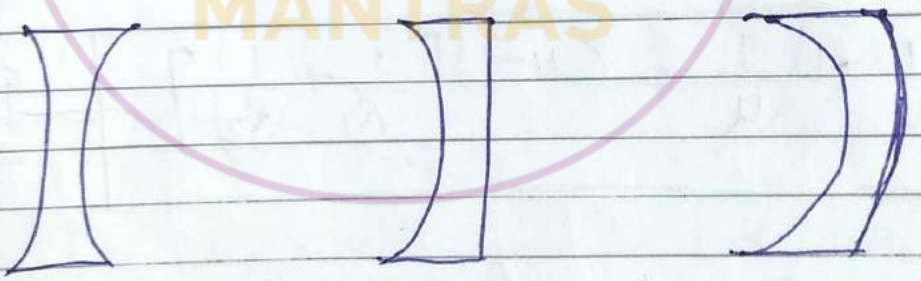
Lens :- (Thin Lens)

Two Refracting Surfaces place close to each other then the combination is known as lens or thin Lens.

Convex:

Bi-convex Plano-convex Concavo Convex

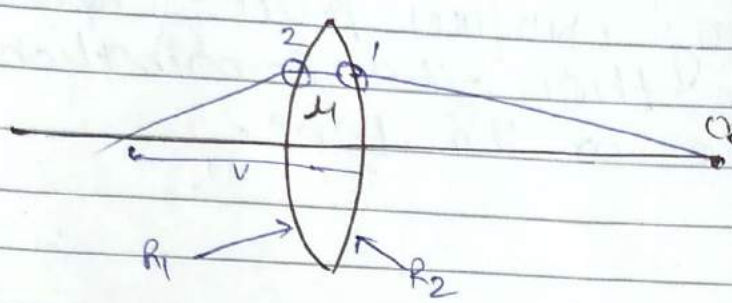
Concave:



Bi-Concave Plano-Concave Convexo Concave.

Rnk for Board

Lens Maker formula :



$f = \frac{\mu_L}{\mu_S}$

(1) $$\frac{\mu}{V_1} + \frac{1}{(-u)} = \frac{\mu_2 - \mu_2}{+R_1}$$

$$\frac{-\mu/}{V_1} + \frac{1}{u} = \frac{\mu_2 - 1}{+R_1} \quad \text{---(1)}$$

(2) $$\frac{1}{v} - \frac{\mu/}{V_1} = \frac{1-\mu}{-R_2} \quad \text{---(2)}$$

divide (1) and (2)

$$\boxed{\frac{1}{v} + \frac{1}{u} = (\mu - 1)\left[\frac{1}{R_1} + \frac{1}{R_2}\right]}$$

only convex

Important

~~No sign change~~

To Make it Nature free Again we use sign

$$\frac{1}{v} - \frac{1}{u} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$\Rightarrow \boxed{\frac{1}{v} - \frac{1}{u} = \frac{1}{f_L}}$$

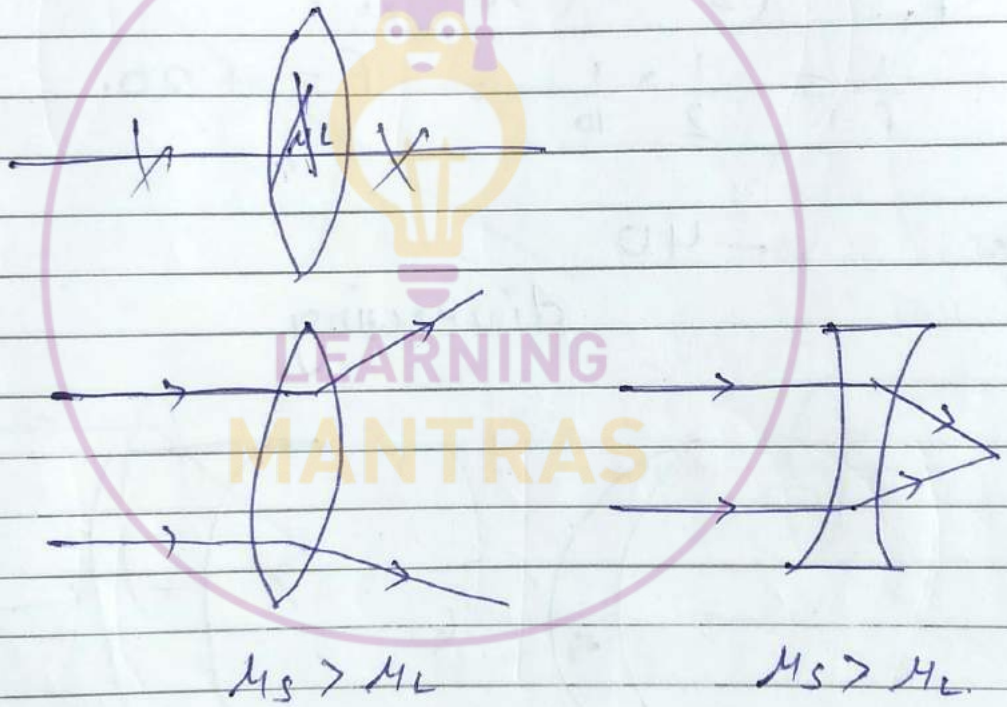
$$\boxed{\frac{1}{f_L} = \left[\frac{\mu_L}{\mu_S} - 1\right]\left[\frac{1}{R_1} - \frac{1}{R_2}\right]}$$

TER = $\frac{0-1}{S-1}$

focal length. + Convex Converging
(-) Concave. Diverging.

1) focal length of a lens is independent from the direction of incidence Ray.

2) If Refractive Index of surrounding medium is greater then Refractive Index of Lens.
Lens changes it nature.
Converging becomes Diverging
Diverging " Converging



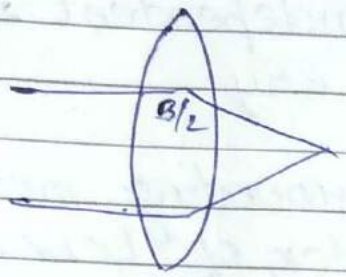
Bi Convex

Q. Lens having refractive index of material is $\frac{3}{2}$ of radius of curvature is 20
find its focal length

2) A Lence is Placed in ~~medium~~ Samandiu of Refractive index & find its focal length.

focal length no.- concave
no.+ convex,

Ans:



focal length
(-) ⇒ diverging
Concave,

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

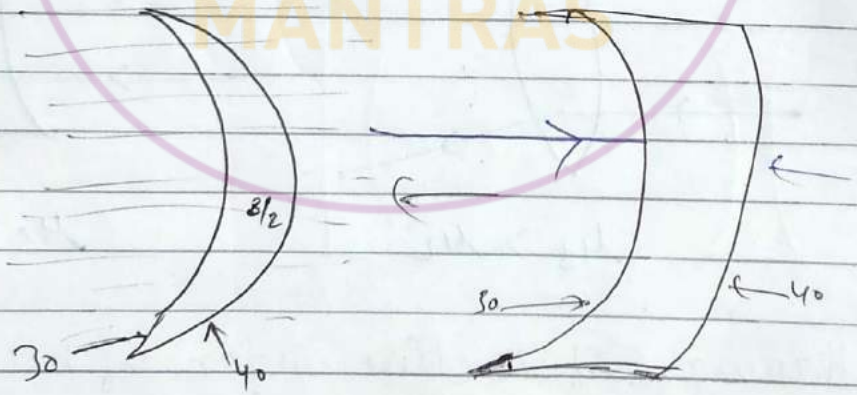
$$\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{20} + \frac{1}{20}\right)$$

$$\frac{1}{F} = \frac{1}{2} \times \frac{1}{10} \Rightarrow f = +20.$$

(11) = −40

diverging

Ques:



(i) Determine the sum name the
(ii) find f.l if ray is incident from right
(ii) from left. Lens placed in air

Right $\frac{1}{F_L} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{40} - \frac{1}{30}\right) =$

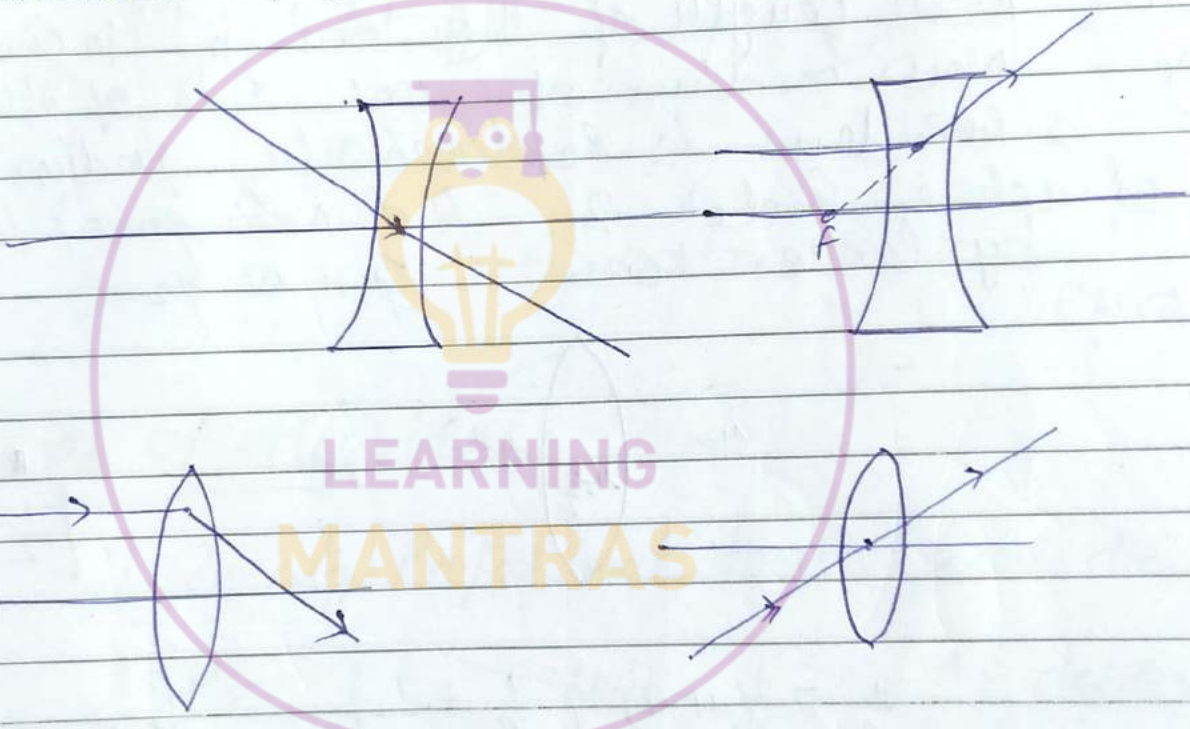
$\frac{1}{F_L} = \frac{1}{2} \times \frac{3-4}{120} = \frac{1}{2} \times \frac{-1}{120}$ $f = -240$

Note:- focal length of a lens does not depend on ray.

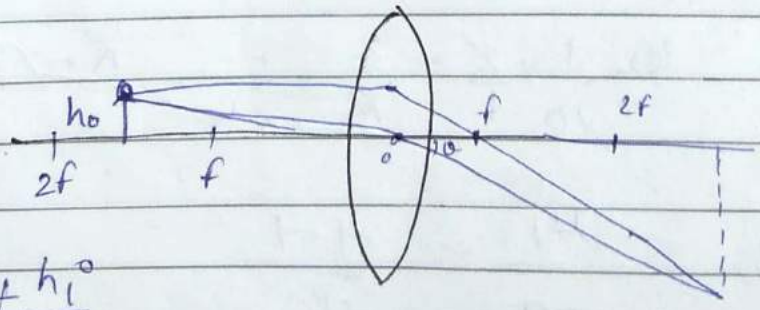
Magnification of Lens

Ray Tracing

Light ray passing from optical centre will pass undeviated ~~to~~ the lens.



Magnification:



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

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

$A + B = C$

$-\frac{B}{A}$ = magnification. convex

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

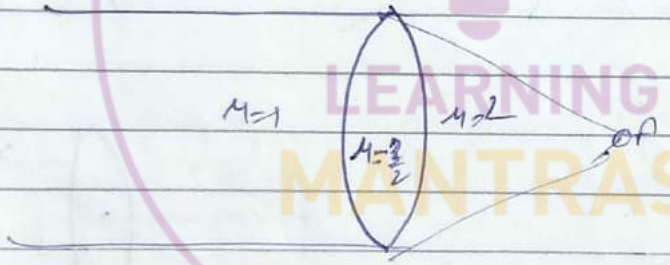
$m = -\left[\frac{-1/u}{1/v}\right]$

Note.

To find focal length of any system light is incident on a system ~~at an angle of~~ parallel to principle axis.

Que: focal length of thin lens in Air is 10 cm. Now medium of one side of the lens is replaced by medium of Refractive index 2 find new focal length by convex lens. Glass $\mu = 3/2$

Ans:



$\left[\frac{1}{2} - 1\right]\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{F} = (\mu - 1)\left(\frac{1}{R} + \frac{1}{R}\right)$

$\frac{1}{10} = \left(\frac{3}{2} - 1\right)\left(\frac{2}{R}\right)$

$\frac{1}{10} \times \frac{2}{1} = \frac{2}{R} \Rightarrow R = 10.$

$\frac{\mu_2}{v} - \frac{\mu_1}{\infty} = \frac{\mu - 1}{+R}$

$\frac{2}{F} - \frac{\mu}{v} = \frac{2 - \mu}{-R}$

Focal length ∞ = sunglass

$\frac{1}{f} = 0$, $f = \infty$

$$\frac{2}{f} = \frac{\mu}{R} - \frac{1}{R} - \frac{2}{R} + \frac{\mu}{R}$$

$$\frac{2}{f} = \frac{\mu - 1 - 2 + \mu}{R}$$

$$\frac{2}{f} = \frac{2\mu - 3}{R}$$

$$\frac{2}{f} = \frac{1}{R}(2\mu - 3)$$

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

$$\frac{2}{f} = \frac{1}{R}(0)$$

$$\frac{2}{f} = 0 \qquad f = \infty m$$

$f = \infty$, $P = 0$

* Power of the Lens:

is inversly Proportional to it focal length

$P \propto \frac{1}{f}$

$$P = \frac{1}{f}$$

unit $\Rightarrow \frac{1}{m} = m^{-1}$ = dioptre

= D, Dioptre