Topics to be covered

1) Reflection from plane mirror and spherical mirrors
2) Refraction of Light
3) TIR
4) Prism
5) Refraction from spherical surfaces
6) Thin lenses
7) Questions

7 - 8 hours

younity.pw.live

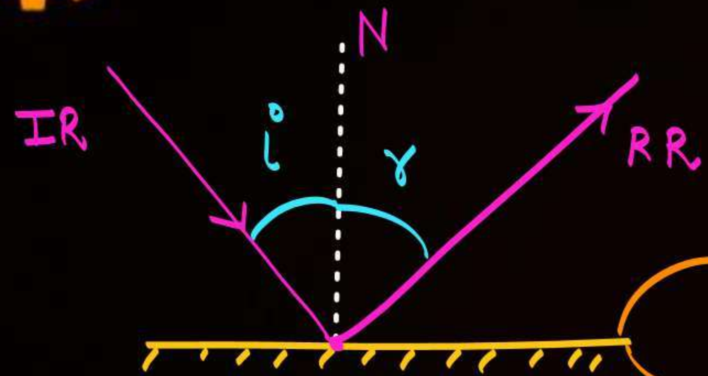
/doubts

/doubt

/Notes

/Note

Reflection and laws of Reflection



→ Regular (Smooth)
→ Diffused. (Rough)

(Laws are applicable)

* IR, N, RR lies in Same plane.
* $\boxed{\angle i = \angle r}$

Yes it is Imp!

Vector form:- $\boxed{\hat{I} = \hat{R} + 2(\hat{I}\cdot\hat{n})\hat{n}}$

dir of IR   dir of RR   dir of normal.

Plane Mirror

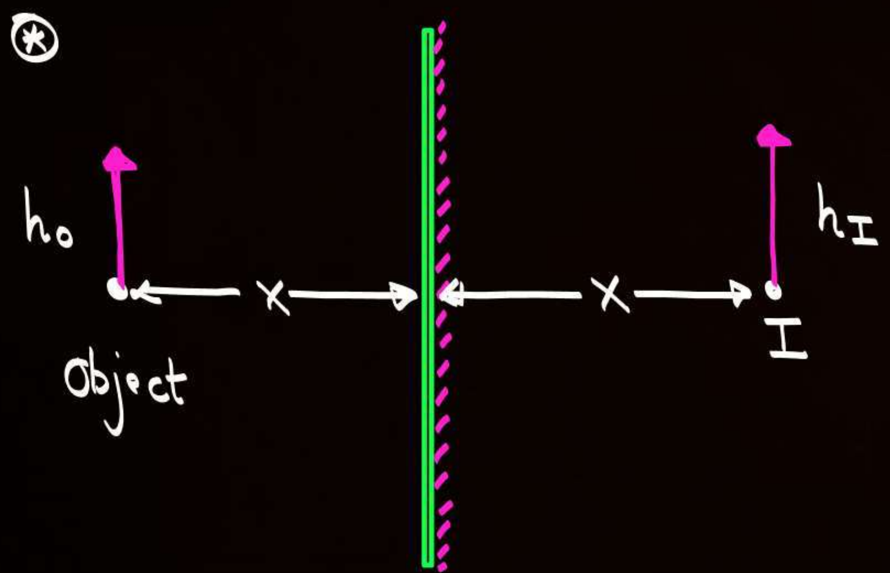


Image distance = object distance.

Size of Image = Size of object

$|h_o| = |h_I|$.

⊗ Object & Image are always of opp Nature.

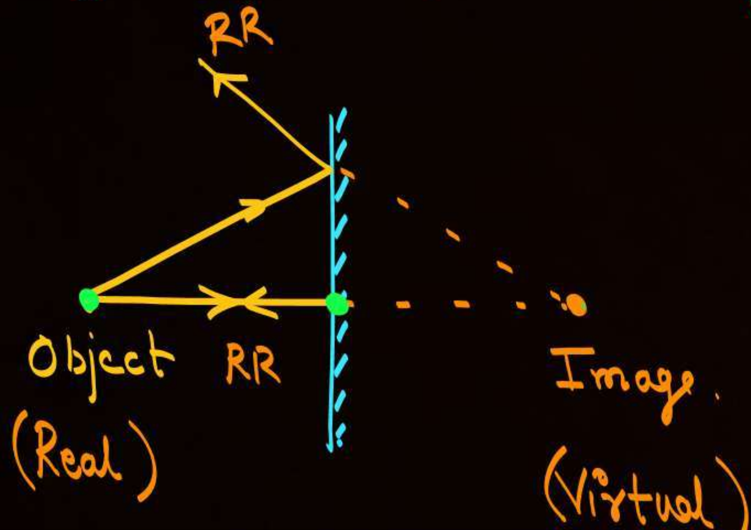
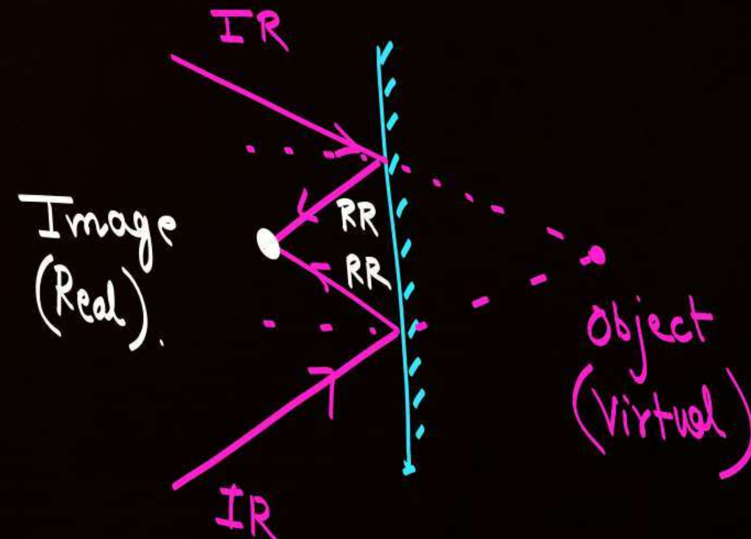


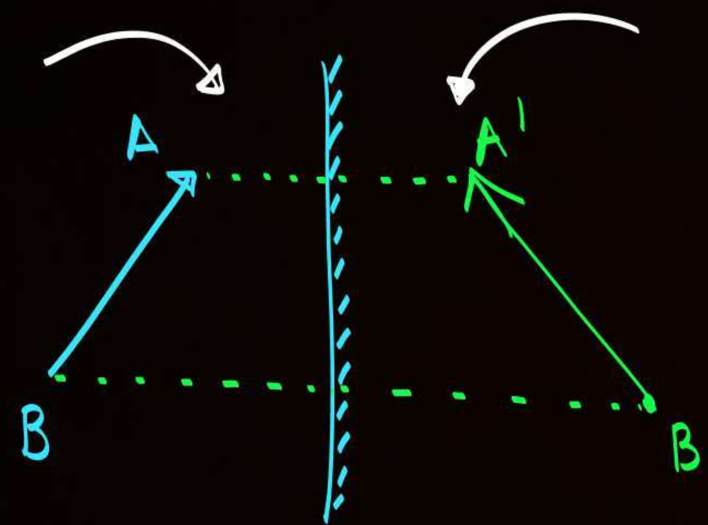
Image → Intersection of RR

Object → Intersection of IR

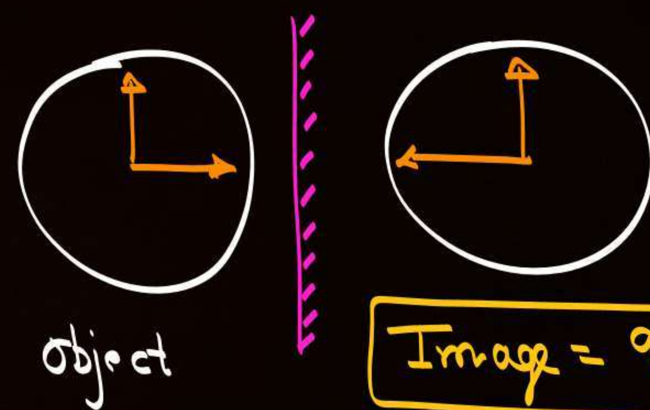


" Plane Mirror is ⊥ bisector to line joining O & I ".

(*) Laterally Inverted.



Clock Problems :-



$\boxed{\text{Image} = 9}$ Ans. (12−3)

Ex:- Clock 8:50

Image time ⇒ 11:60 − 8:50 = ______.

Ex:- Clock 5:20:35

Image = 11:59:60 − 5:20:35

= ______.

Plane mirror

- Image Distance is equal to object distance

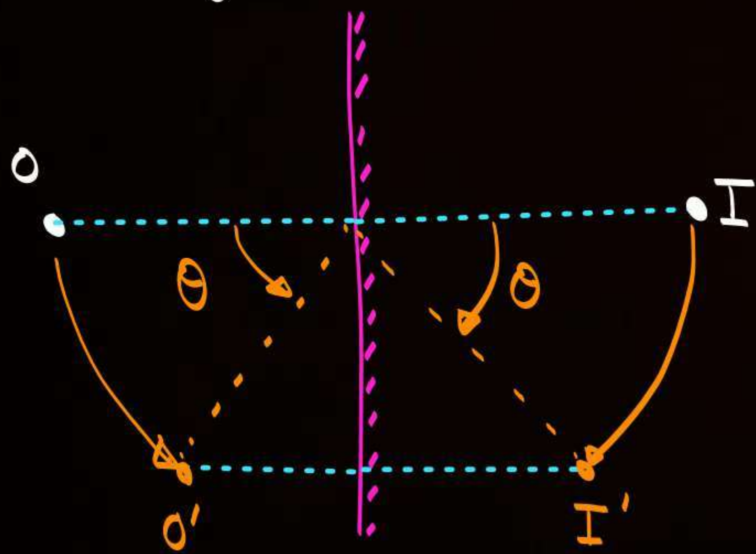
- Nature of Image is opposite to that of object

- Image is laterally Inverted

Plane mirror

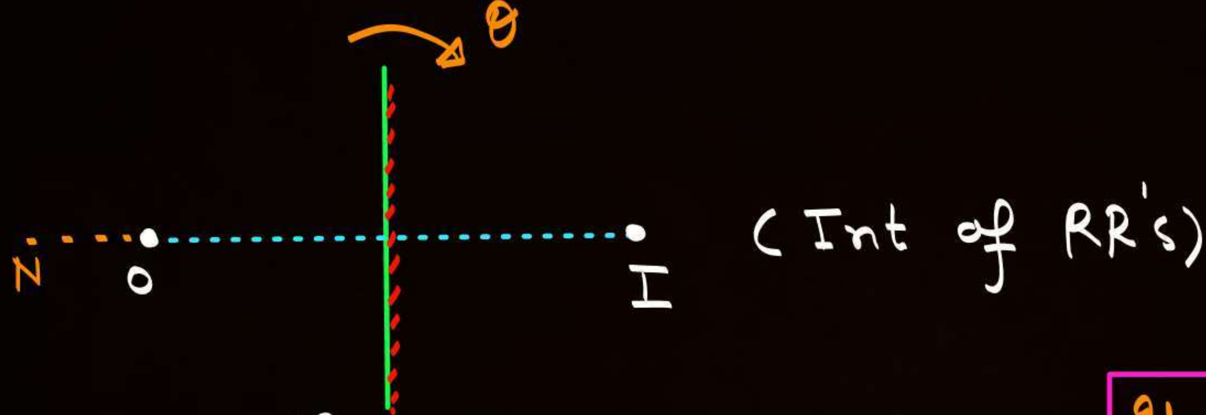
- **Rotation of object in front of plane mirror**

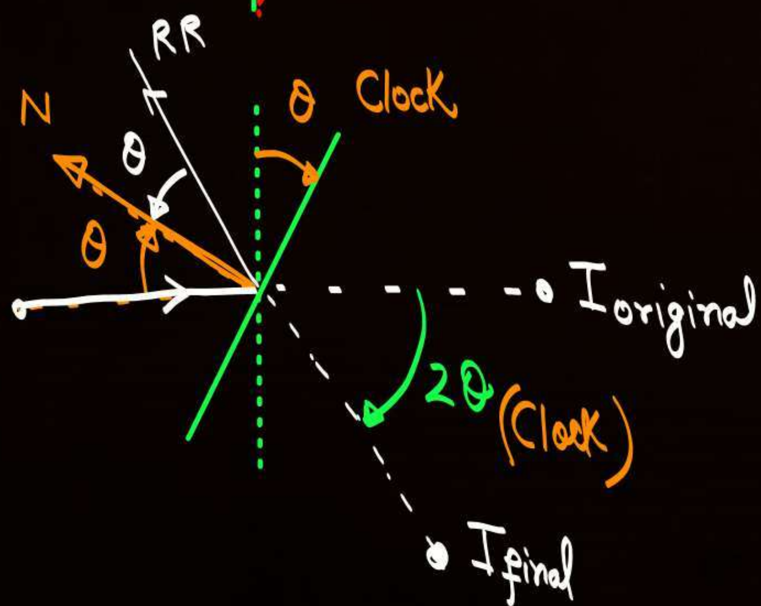
Case.1. Object is Rotated.



$\boxed{\text{Image Rot by Same Angle in opp Sense.}}$

⊛ Case 2. Mirror is Rotated.

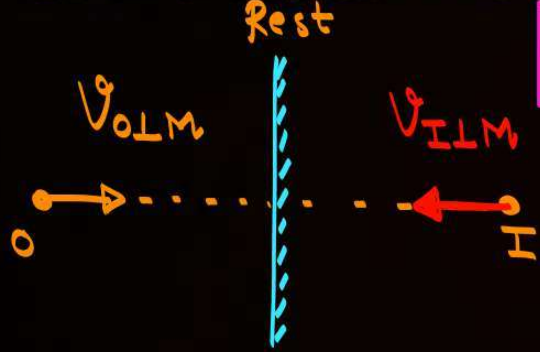




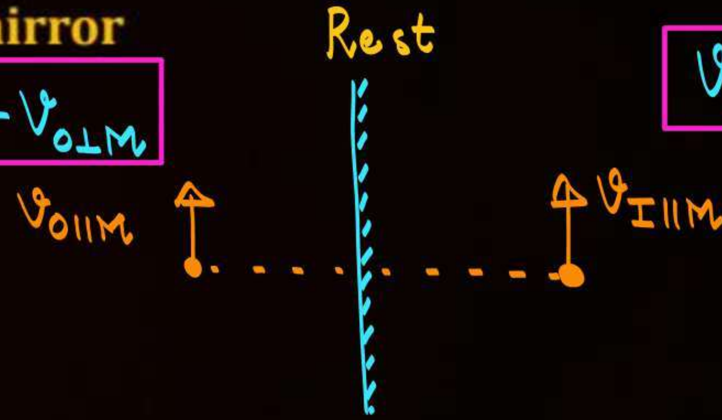
If Mirror is Rot by θ Image Rotates by 2θ in Same Sense.

Plane mirror

- **Motion of object in front of plane mirror**

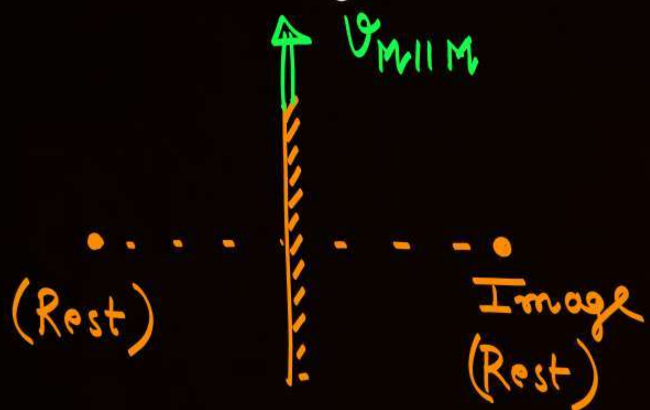


$$\boxed{⊛\; v_{I\perp M} = -v_{O\perp M}}$$



$$\boxed{v_{I\parallel M} = v_{O\parallel M}}$$

Case. 2. Object Rest / M → Moving.



No Impact Velocity of Image.

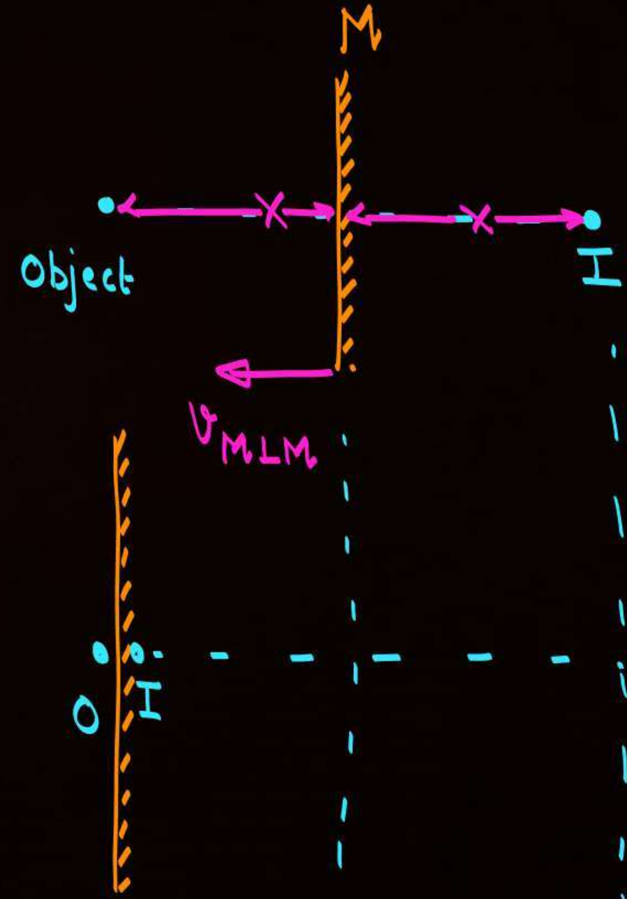
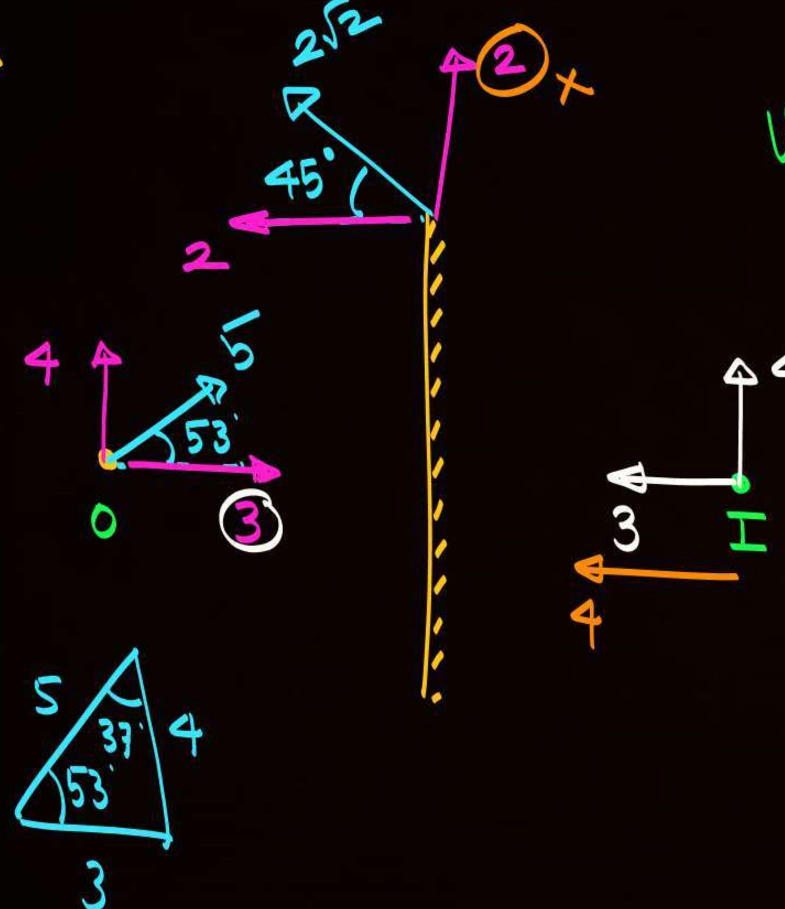


Image moves with 2v wrt ground in same dir of Mirror.

Ex :-



$v_{\text{Image wrt ground}} = ?$

$$\boxed{\vec{v}_{I/g} = -7\hat{i} + 4\hat{j}}$$

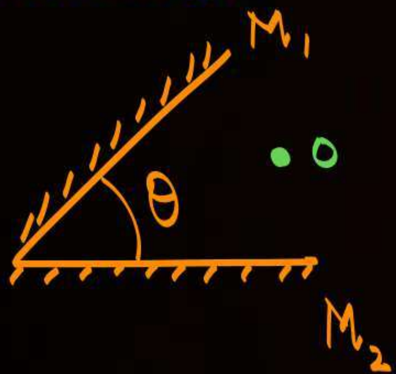
$$\vec{v}_{I/O} = \vec{v}_{I/g} - \vec{v}_{O/g}$$

$$= (-7\hat{i} + 4\hat{j}) - (3\hat{i} + 4\hat{j})$$

$$= -10\hat{i}$$

Plane Mirror

❖ No of images



1. Calculate $\frac{360}{\theta}$

Even

No of Image $= \left(\frac{360}{\theta} - 1\right)$

odd

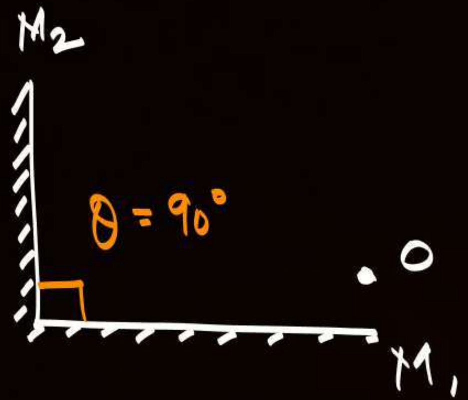
Object Symmetric

$\left(\frac{360}{\theta} - 1\right)$

Object Asymetric

$\left(\frac{360}{\theta}\right)$

Ex :-



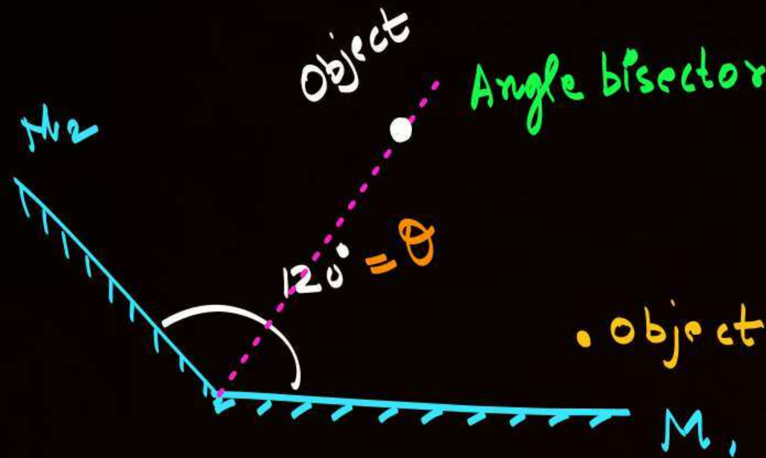
No of Images.

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

(Even)

$$\boxed{\text{No of Images} = 3}$$

Ex:



(In this Case :- No of I $= \frac{360}{\theta} - 1$

$= 3 - 1 = \boxed{2}$

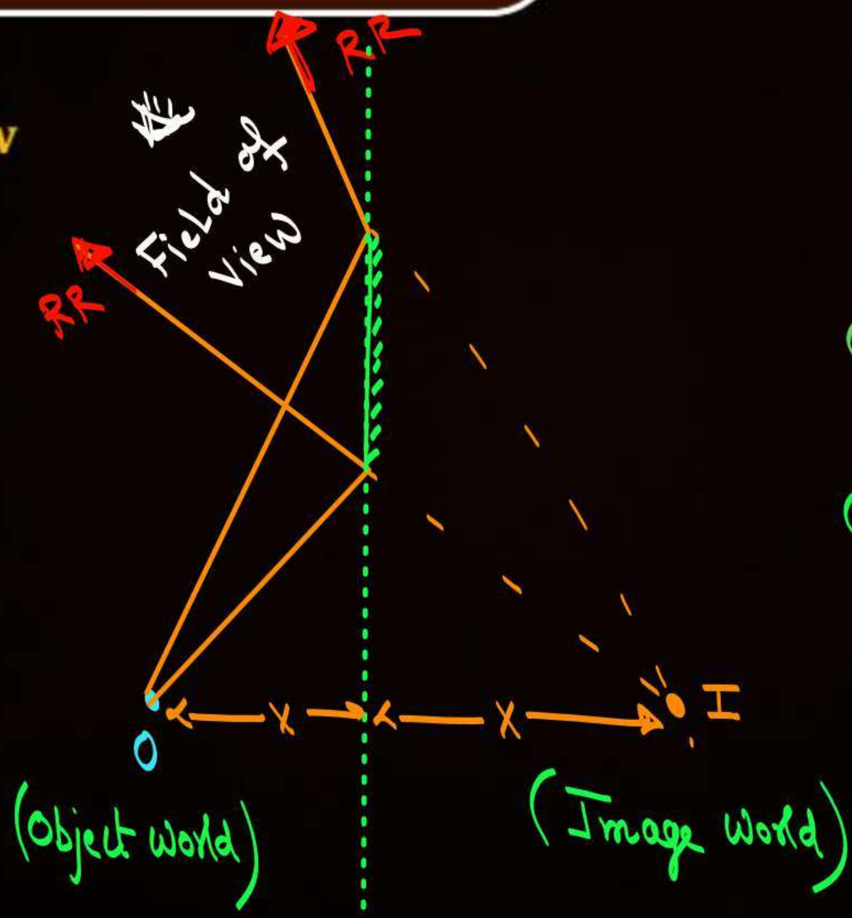
No of Images =

$\frac{360}{\theta} = \frac{360}{120} = 3$ (odd)

$\boxed{\text{No of Images} = 3}$

Plane Mirror

❖ Field of View

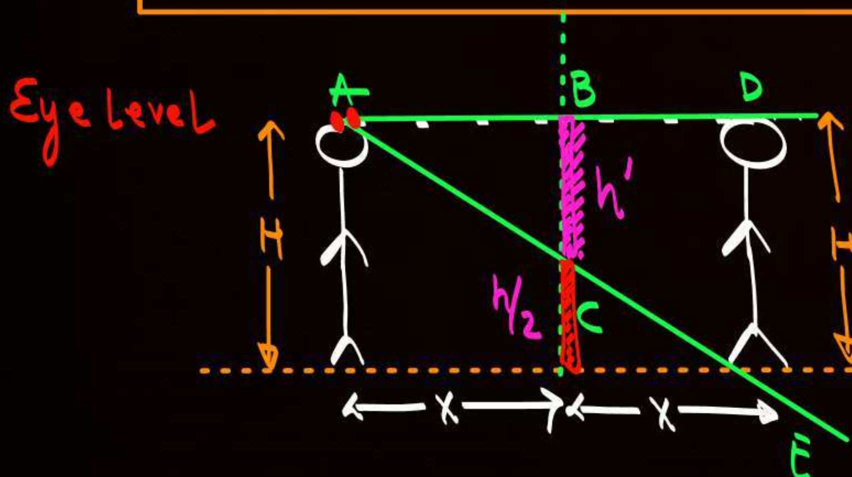


* Whatever may be the Size / Location of Mirror Image is always formed.
* Draw an Extended Mirror
  Object dist = Image dist.
* Size of Mirror will decide the portion of Image Visible.

Ex:- **Minimum Size of Mirror to form Complete Image.**

"Point Size".

Ex:- **Minimum Size of Mirror to See Complete Self**



$ABC \sim ADE$

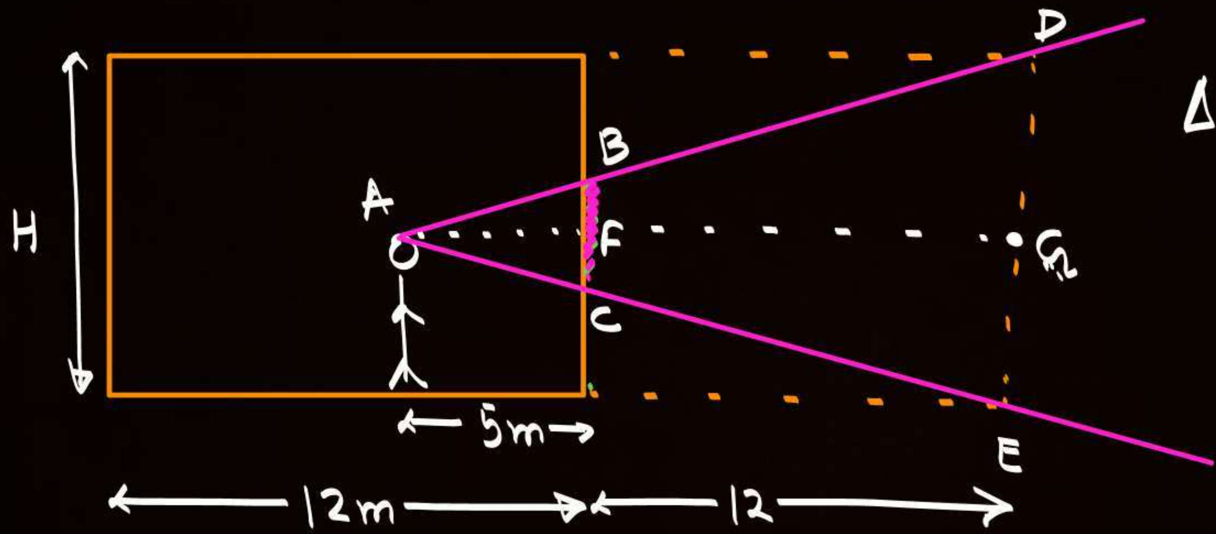
$$\frac{AB}{AD} = \frac{h'}{H}$$

$$\frac{x}{2x} = \frac{h'}{H}$$

$$\boxed{h' = H/2}$$

Mirror should be placed at distance $\frac{h_{eye}}{2}$ from ground

Q. Min Size of Mirror to See Complete back Wall.



$\Delta ABC \sim \Delta ADE$

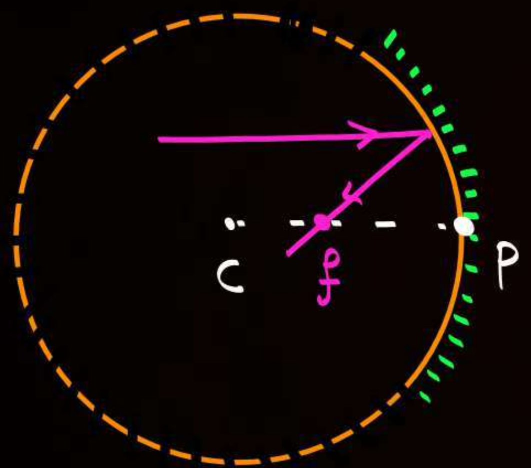
$$\frac{AF}{BC} = \frac{AG}{DE}$$

$$\frac{5}{h} = \frac{17}{H}$$

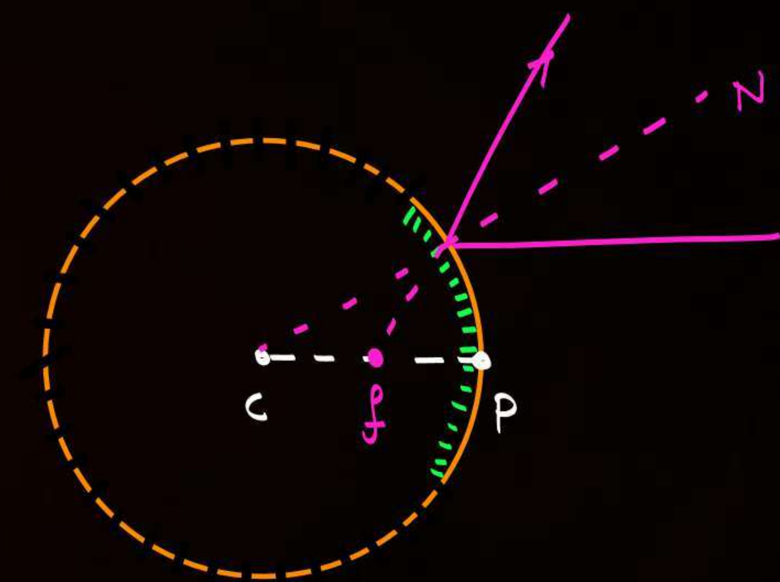
$$\boxed{h = \frac{5H}{17}}$$

Spherical Mirror

⊛ all Para-axial Rays



Concave Mirror
"Converging"

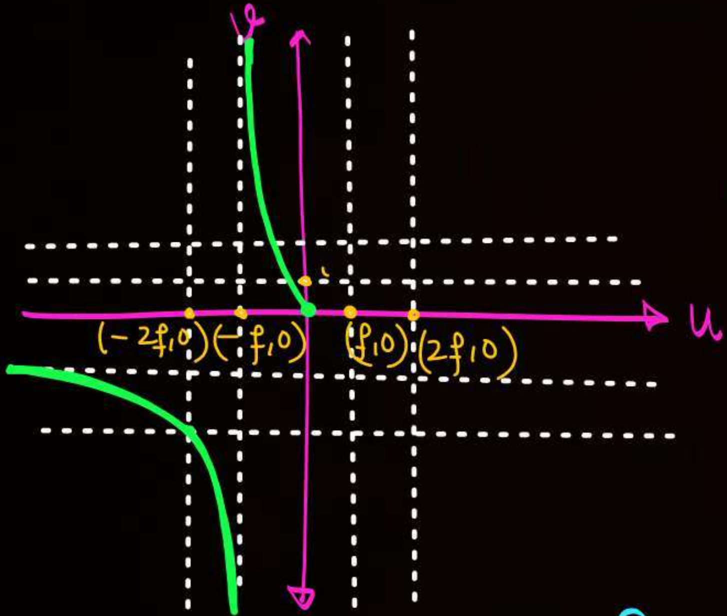


Convex Mirror
diverging Mirror.

Sphere Radius = R

$\boxed{f = R/2}$ ⊛ Independent of Med.

Ray diagrams



$u \to -\infty$ $v \Rightarrow -f$

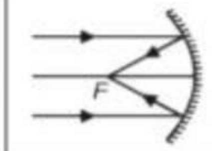
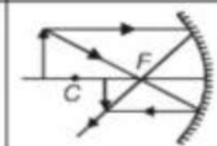
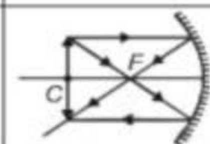
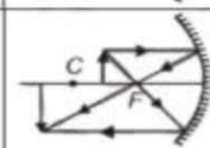
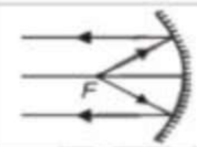
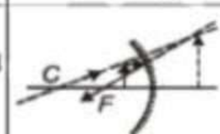
$u \to -2f$ $v = -2f$

$u \to -f$ $v = -\infty$

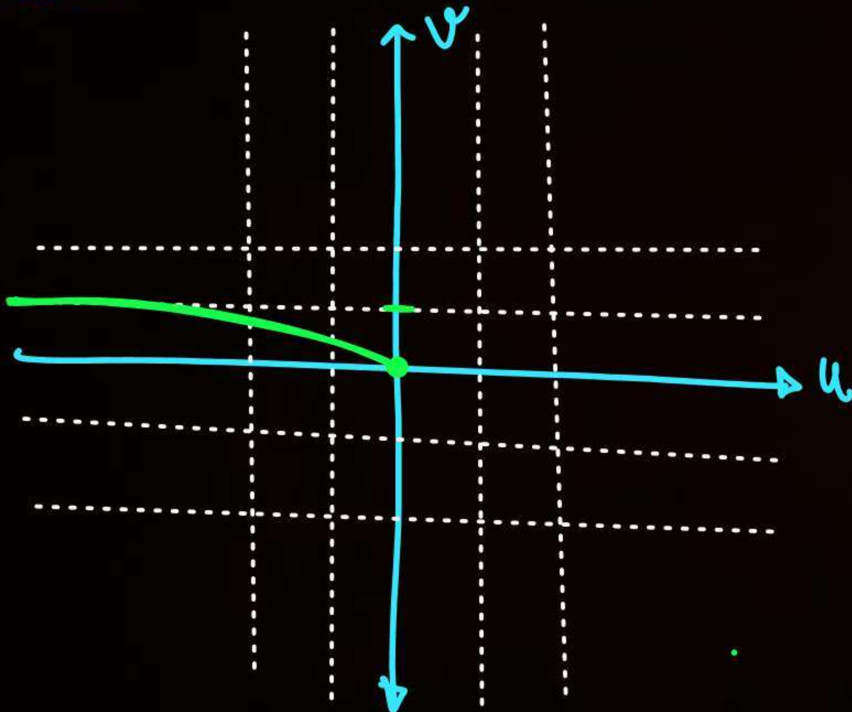
$u \to -f^{-}$ $v = +ve.$

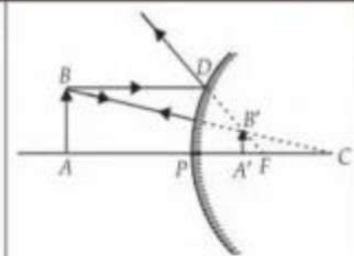
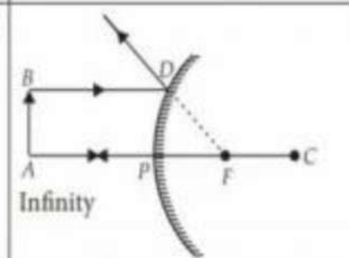
Real

Virtual.

1. At infinity		At the principal focus or in the focal plane	Real, inverted, extremely diminished in size
2. Beyond the centre of curvature		Between the principal focus and centre of curvature	Real, inverted and diminished
3. At the centre of curvature		At the centre of curvature	Real, inverted and equal to object
4. Between focus and centre of curvature		Beyond centre of curvature	Real, inverted and bigger than object.
5. At the principal focus		At infinity	Extremely magnified
6. Between the pole and principal focus		Behind the mirror	Virtual, erect and magnified

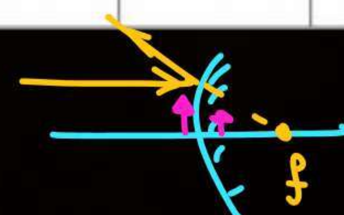
Ray diagrams

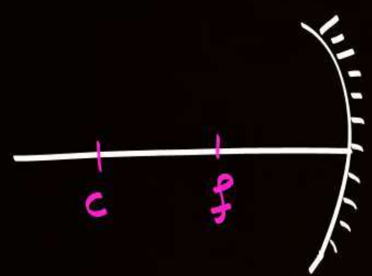


(a)		Between infinity and the pole	Behind the mirror between the focus and the pole	Virtual, smaller and erect
(b)		At infinity	Behind the mirror at the focus F	Virtual, point-sized and erect

$u \to -\infty \quad v = +f$

$u \to 0 \quad v \to 0$





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

If object is placed Near to Mirror, Image is formed.

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

Mirror formula.

u = object dist from P
v = Image dist from P
f = focal length from P.

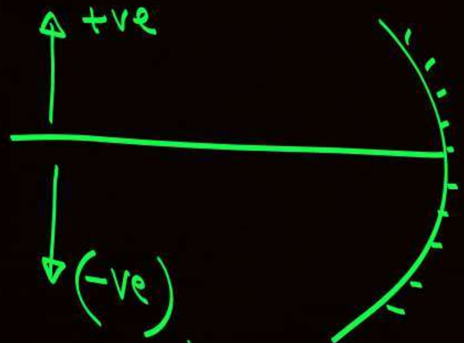
magnifications

→ Lateral Magnification $= m_{Lat} = \frac{h_I}{h_o} = -\frac{v}{u}$

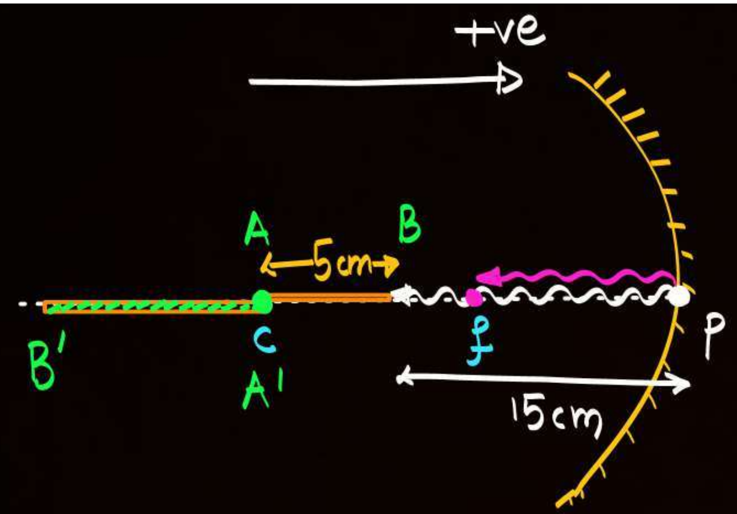
→ Longitudinal Magnification $= m_{Long} = \frac{t_I}{t_o} = \boxed{\frac{-v^2}{u^2}}$

Small thickness.

Sign Convention.

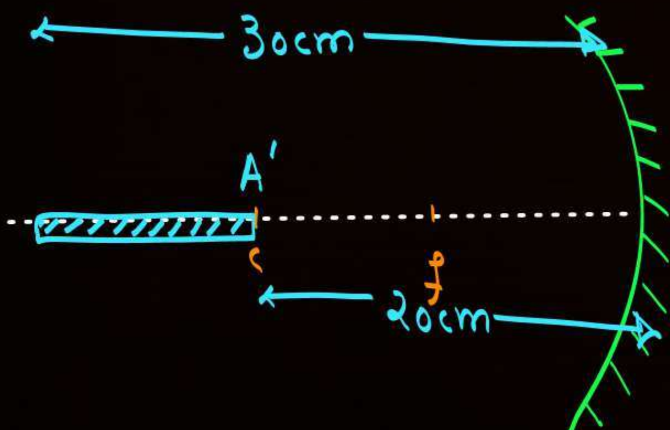
- dir of IR → (positive)
- all distances are measured from Pole.
- distance measured in dir of IR (+ve)
- " " " opp dir of IR (−ve)
- 

\# Find Length of Image



Concave $R = 20cm$

$f = 10cm$



Sol:- Image of A → at C.

(B) Object distance = -15 cm

$f = -10$

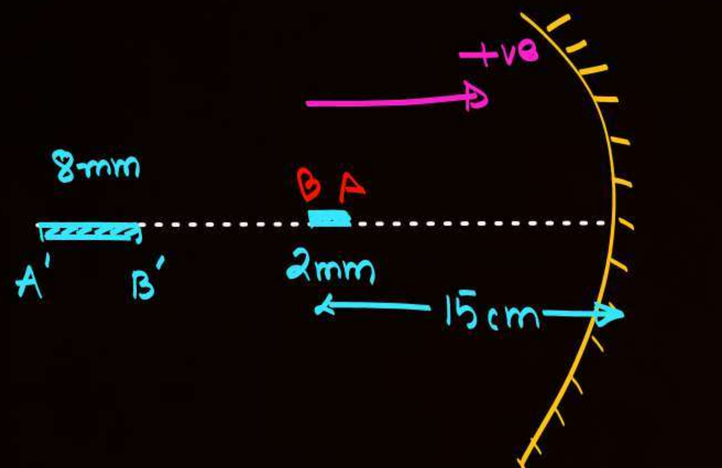
$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

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

$$\boxed{v = -30cm}$$

$$\boxed{\text{Length of Image} = 10cm}$$ Ans.

Previous Ques.



$R = 20\,cm$

$u = -15$

$f = -10$

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

$$\boxed{v = -30\,cm}$$

Find thickness of Image.

for Small thickness

$$m_{long} = \frac{t_I}{t_o} = -\frac{v^2}{u^2}$$

$$= \frac{t_I}{2\,mm} = -\frac{(\cancel{30}^{2} \times \cancel{30}^{2})}{\cancel{15} \times \cancel{15}}$$

$$\boxed{t_I = -8\,mm}$$

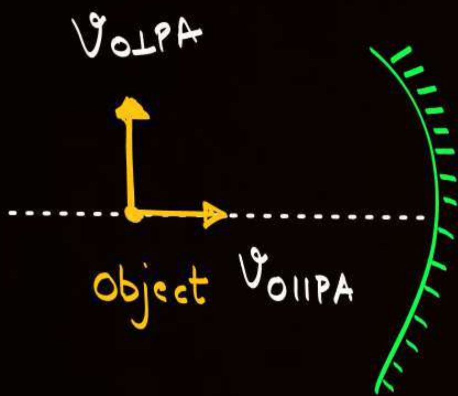
Inverted.

Length along PA = thickness.

Length $\perp$ to PA = height.

Velocity Magnifications

for both Mirrors.



Object move Karega ⟶ Image move Karegi.

$$v_{\text{Image}\perp PA} = (m_{Lat})\, v_{\text{object}\perp PA}$$

$$v_{\text{Image}\parallel PA} = (m_{Long})\, v_{\text{object}\parallel PA}$$

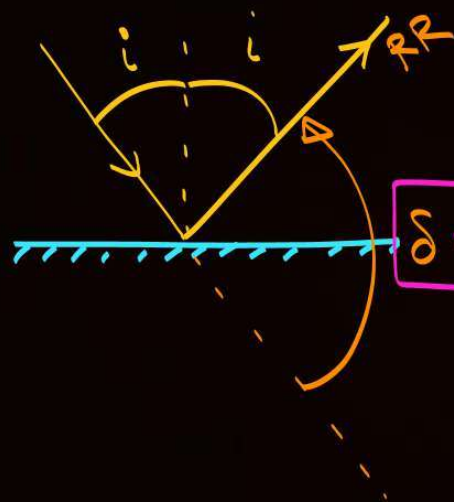
$$m_{Lat} = -\frac{v}{u}$$

$$m_{Long} = -\frac{v^2}{u^2}$$

Question 1

When one light ray is reflected from a plane mirror with 30° angle of reflection, the angle of deviation of the ray after reflection is

[Main 11th April 2nd Shift 2023]



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

Initial dir of IR

1. 130°
2. 120° Ans
3. 110°
4. 140°

$\angle i = \angle r = 30°$

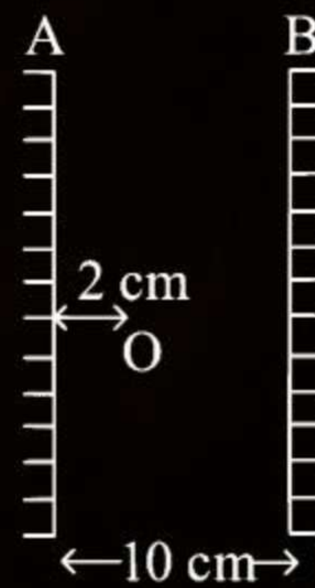
$$\text{Ans} = 180 - 2 \times 30$$
$$= 120°$$

[Ans: 2]

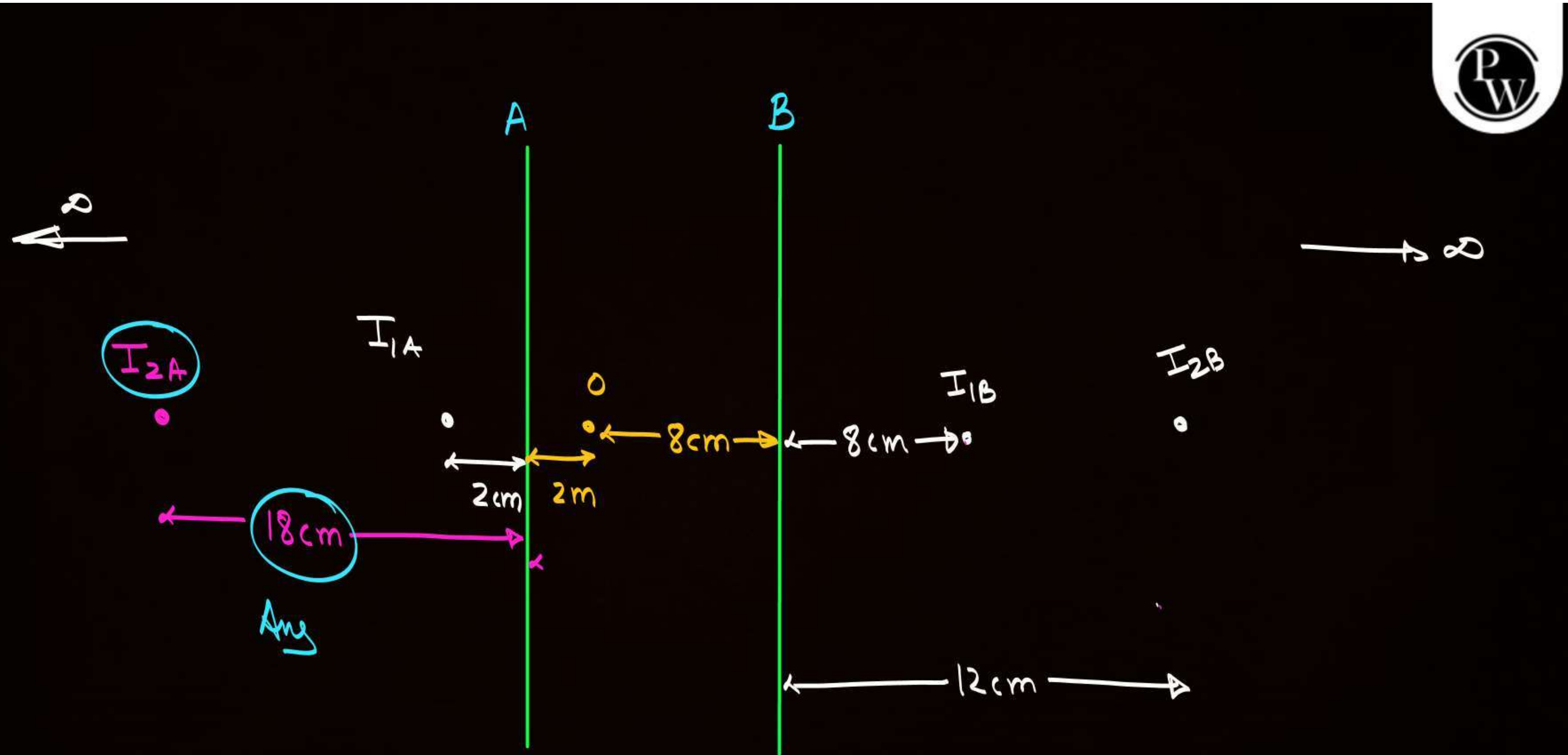
Question 2

Two vertical parallel mirrors A and B are separated by 10 cm. A point object O is placed at a distance of 2 cm from mirror A. The distance of the second nearest image behind mirror A from the mirror A is ....18.... cm . **[Main 6th April 1st Shift 2023]**

No of Image = ∞



[Ans: 18]

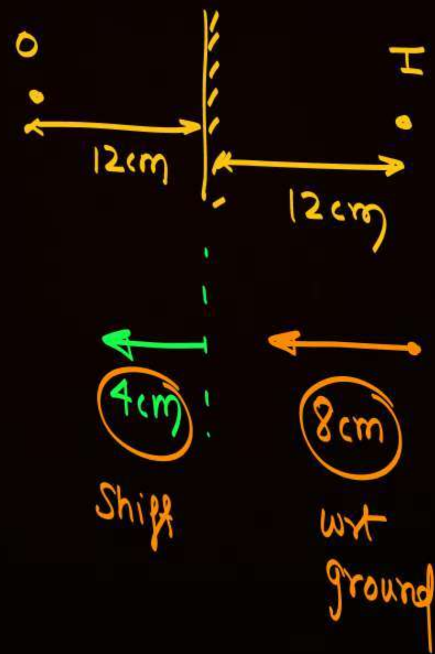

A
B
∞
∞
I1A
I2A
O
I1B
I2B
8cm
8cm
2cm
2m
18cm
Ang
12cm

Question 3

An object is placed at a distance of 12 cm in front of a plane mirror. The virtual and erect image is formed by the mirror. Now the mirror is moved by 4 cm towards the stationary object. The distance by which the position of image would be shifted, will be

[Main 10th April 1st Shift 2023]

1. 2 cm towards mirror
2. 4 cm towards mirror
3. 8 cm away from mirror
4. 8 cm towards mirror



Question 4

The incident ray, reflected ray and the outward drawn normal are denoted by the unit vectors $\vec{a}, \vec{b}$ and $\vec{c}$ respectively. Then choose the correct relation for these vectors

[JEE (Main) 2021 (24th Feb Shift 2)]

1. $\vec{b} = 2\vec{a} + \vec{c}$
2. $\vec{b} = \vec{a} - \vec{c}$
3. $\vec{b} = \vec{a} + 2\vec{c}$
4. $\vec{b} = \vec{a} - 2(\vec{a} \cdot \vec{c})\vec{c}$ ✓

Ans

$IR = \vec{a}$

$R = \vec{b}$

$n = \vec{c}$

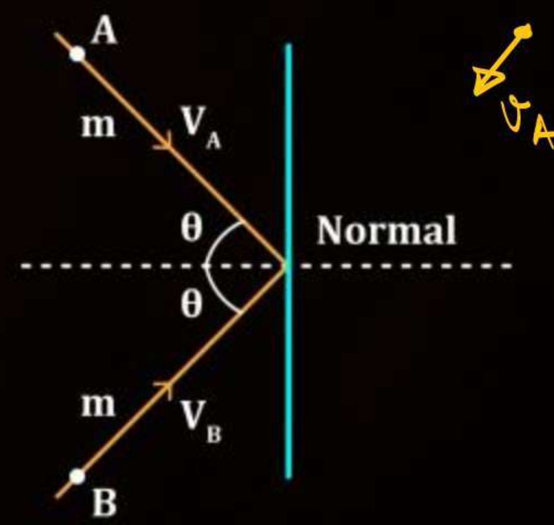
$\hat{I} = \hat{R} + 2(\hat{I} \cdot \hat{n})\hat{n}$

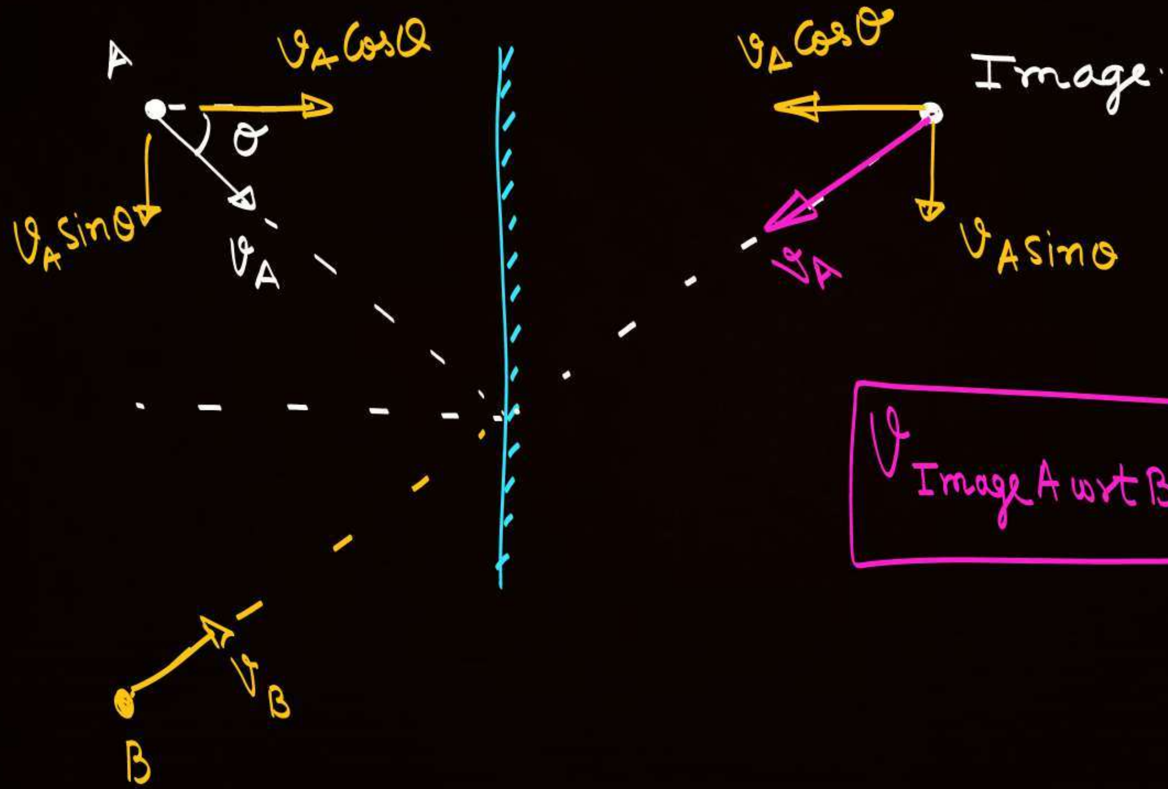
$\vec{a} = \vec{b} + 2(\vec{a} \cdot \vec{c})\vec{c}$

Question 5

Two bodies A and B are moving towards a plane mirror with speeds V_A and VB respectively as shown in the figure. The $\boxed{\text{speed of image of } A}$ with respect to the $\boxed{\text{body } B}$ is:

1. $V_A + V_B$ Ans
2. $|V_A - V_B|$
3. $\sqrt{V_A^2 + V_B^2}$
4. $\sqrt{V_A^2 - V_B^2}$





$$\boxed{v_{\text{Image A wrt B}} = v_A + v_B}$$

Question 6

For the arrangement shown below, determine the angular speed with which the reflected beam will rotate.

1. 40 rps
2. 20 rps
3. 30 rps
4. 0 rps

Ans

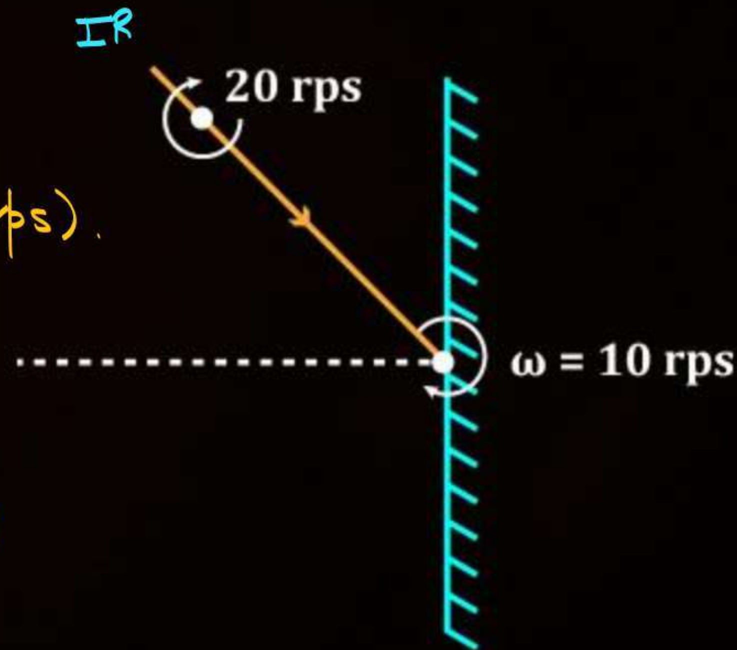
Object (IR) Rotate

ω_{Image} = anticlock (20 rps).

Mirror (Clock 10 rps)

Image = (Clockwise 20 rps)

0 rps.

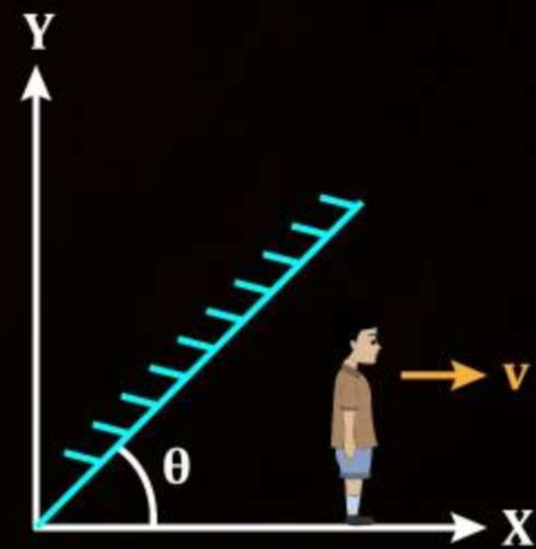


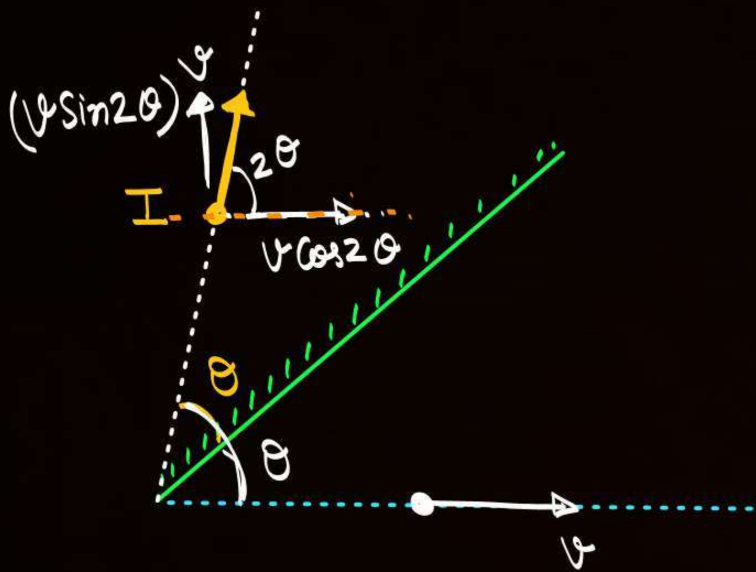
Question 7

A boy is walking under an inclined mirror at a constant velocity v m/s along the X-axis as shown in figure. If the mirror is inclined at an angle θ with the horizontal then what is the velocity of the image? [IIT-JEE 2002]

1. $v \sin\theta i + v\cos\theta j$
2. $v\cos\theta i + v\sin\theta j$
3. $v\sin 2\theta i + v\cos 2\theta j$
4. $v\cos 2\theta i + v\sin 2\theta j$

Ans



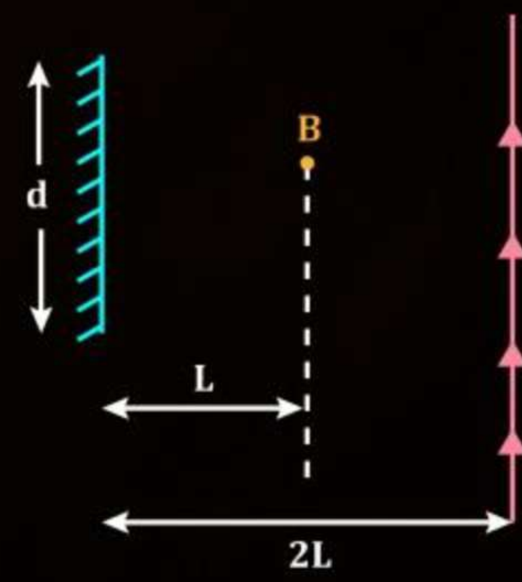


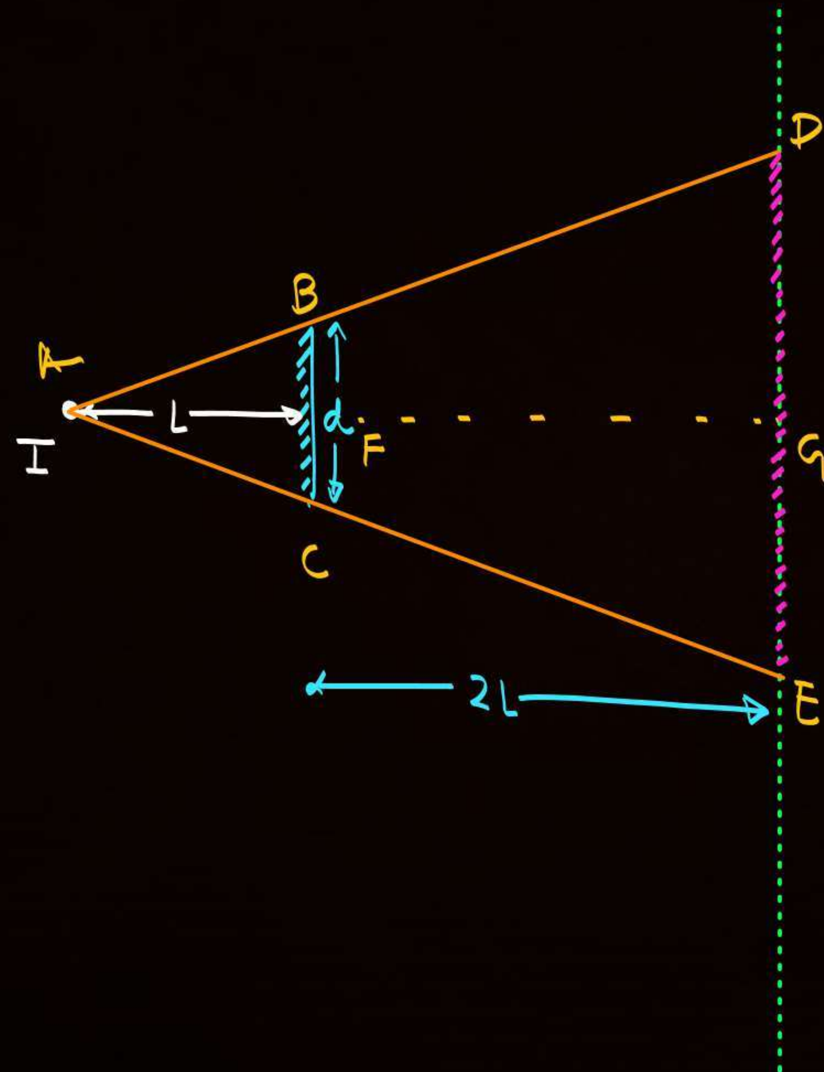
$$\boxed{\text{Ans} = v\cos 2\theta\,\hat{i} + v\sin 2\theta\,\hat{j}}$$

Question 8

A point source of light B is placed at a distance L in front of the centre of a mirror of width d hung vertically on a wall. A man walks in front of the mirror along a line parallel to the mirror at a distance $2L$ from it as shown. The greatest distance over which he can see the image of the light source in the mirror is: [IIT-JEE 2002]

1. $d/2$
2. d
3. $2d$
4. $3d$ Ans





$$\Delta ABC \sim \Delta ADE$$

$$\frac{AF}{AG} = \frac{BC}{DE}$$

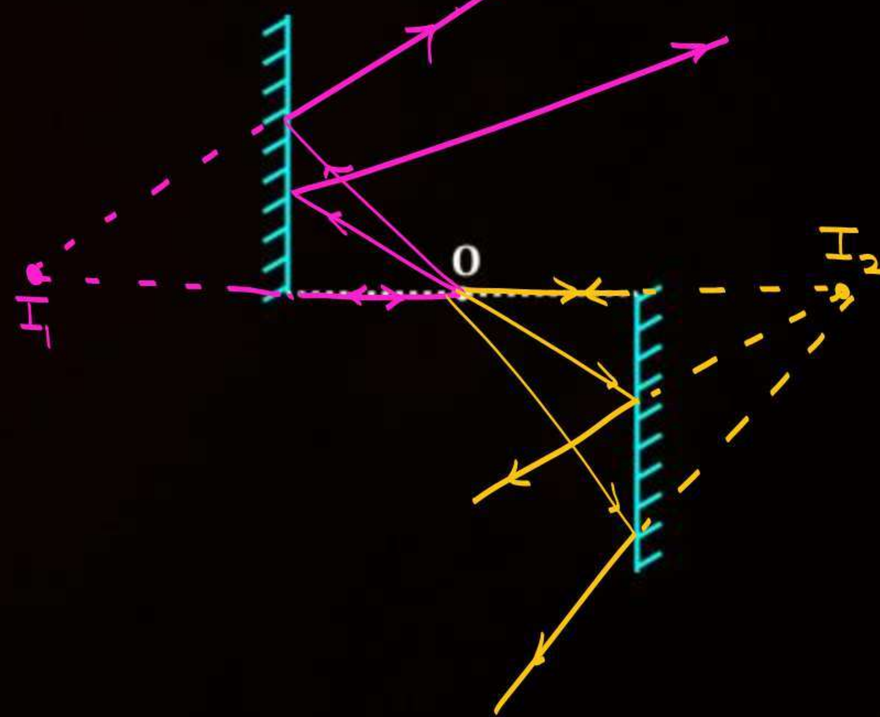
$$\frac{L}{3L} = \frac{d}{d'}$$

$$\boxed{d' = 3d}$$

Question 9

Find no of image formed, When two mirrors are parallel to each other $\theta = 180°$

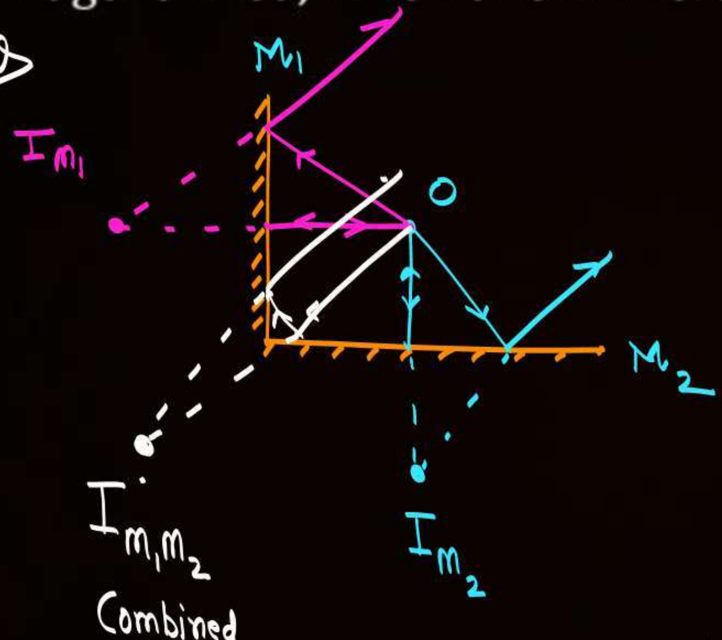
1. 2 . Ans
2. 3
3. 4
4. ∞



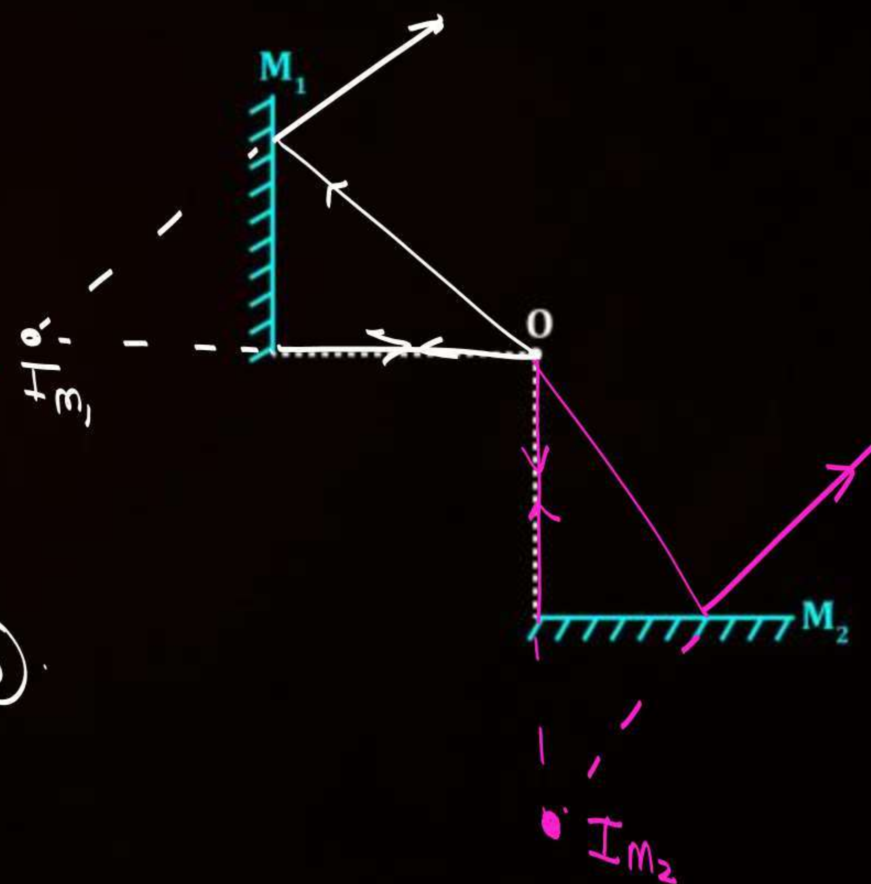
Question 10

Find no of image formed, When two mirrors are $\perp$ to each other $\theta = 90°$

1. 2 Ans
2. 3
3. 4
4. ∞



No of Images = 3.

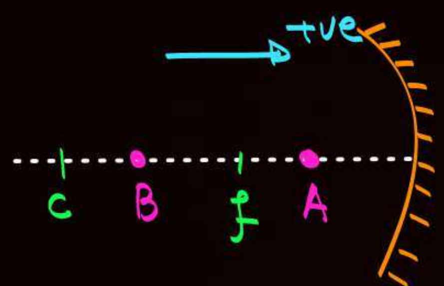


Question 11

Two objects A and B are placed at 15 cm and 25 cm from the pole in front of a concave mirror having radius of curvature 40 cm. The distance between images formed by the mirror is

[Main 1st Feb 2nd Shift 2023]

1. 40 cm
2. 160 cm
3. 60 cm
4. 100 cm



$R = 40\,\text{cm}$

$f = 20\,\text{cm}$

A

$u = -15$

$f = -20$

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

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

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

$v_A = \_\_\_\_$

B

$u = -25$

$f = -20$

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

$\frac{1}{-20} = \frac{1}{v} - \frac{1}{25}$

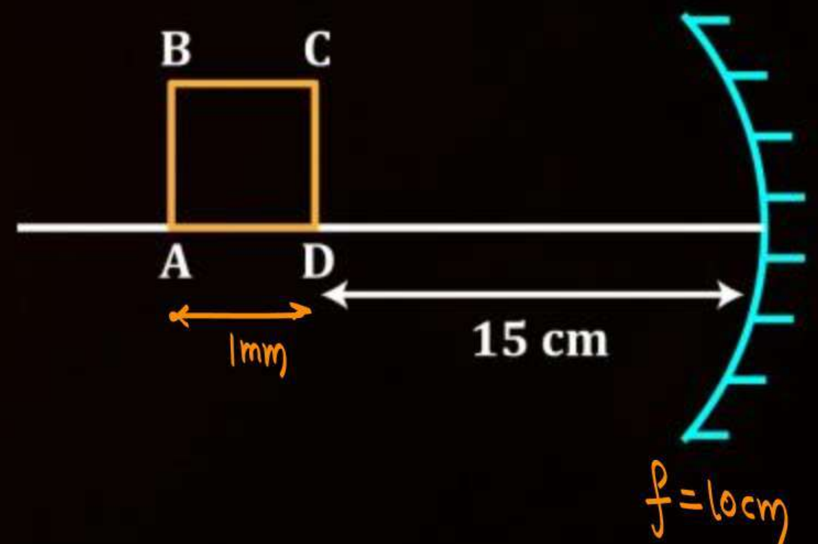
$-\frac{1}{20} + \frac{1}{25} = \frac{1}{v} = \_\_\_\_$

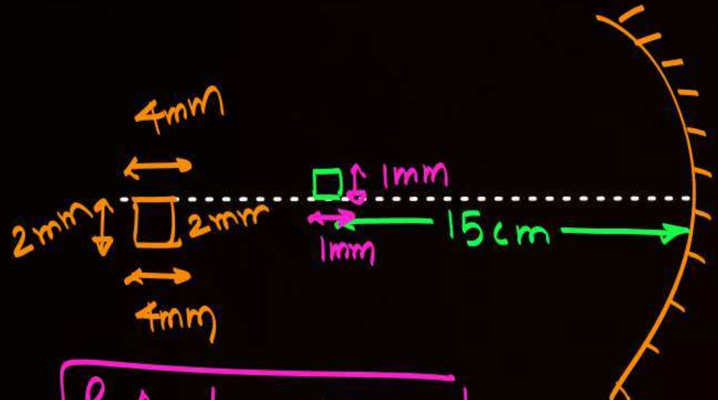
$v_B = \_\_\_\_$

Question 12

A square ABCD of side 1 mm is kept at distance 15 cm in front of the concave mirror as shown in the figure. The focal length of the mirror is 10 cm. The length of the perimeter of its image will be approximately:

1. 8 mm
2. 2 mm
3. 12 mm Ans
4. 6 mm





$\boxed{\text{Perimeter} = 12\text{mm}}$

$f = 10\text{cm}$

$u = -15$

$f = -10$

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

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

$$\boxed{v = -30}$$

$$m_{Lat} = \frac{h_I}{h_o} = \frac{-v}{u}$$

$$h_I = \frac{30}{15} \times 1\text{mm} = 2\text{mm}.$$

$$m_{Long} = \frac{t_I}{t_o} = -\frac{v^2}{u^2}$$

$$t_I = 4 \times 1\text{mm} = 4\text{mm}$$

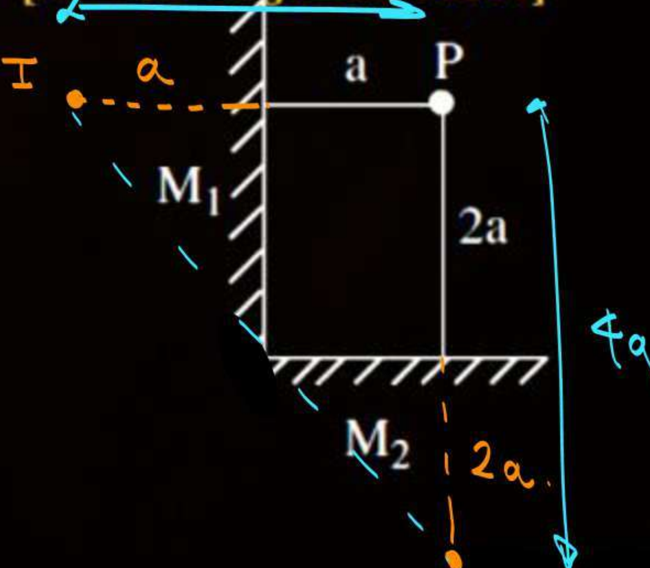
Question 13

Two plane mirrors M_1 and M_2 are at right angle to each other as shown. A point source P is placed at a and 2a meter away from M_1 and M_2 respectively. The shortest distance between the images thus formed individually by each mirror is (Take $\sqrt{5} = 2.3$)

$$dist = \sqrt{(4a)^2 + (2a)^2}$$

$$\boxed{dist = 4.3a}$$

[Main 31st Aug 1st Shift 2021]



1. 2.3a
2. $2\sqrt{10}a$
3. 4.6a
4. 3a

Question 14

Variation of v with u for a spherical mirror is as shown in figure. This curve is a hyperbola. A straight line of unit slope intersects the hyperbola at point 'A'. If the focal length of mirror is 20 cm, coordinates of point A are:

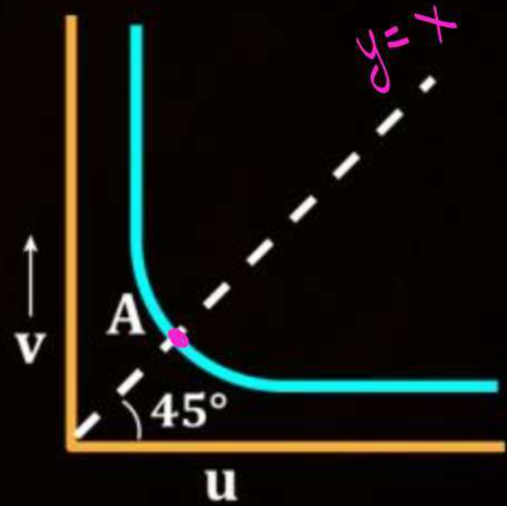
1. 20 cm, 10 cm
2. 40 cm, 40 cm Ans
3. 40 cm, 20 cm
4. 20 cm, 20 cm

$(f = 20\,cm)$

When $v = u$

When object at C.

$$\boxed{\begin{aligned} u &= 40\,cm \\ v &= 40\,cm \end{aligned}}$$



Question 15

In a three dimensional coordinate system (OXYZ), a concave mirror of radius of curvature 40 cm is placed at $x = 80$ cm. An object placed at origin is given a velocity $\vec{v}_0 = (9\hat{\imath} + 6\hat{\jmath} + 3\hat{k})$ cm/s. Find out the magnitude of velocity of its image.

1. $\sqrt{46}$ cm/s
2. $\sqrt{6}$ cm/s
   Ans
3. $\frac{\sqrt{14}}{3}$ cm/s
4. None of these

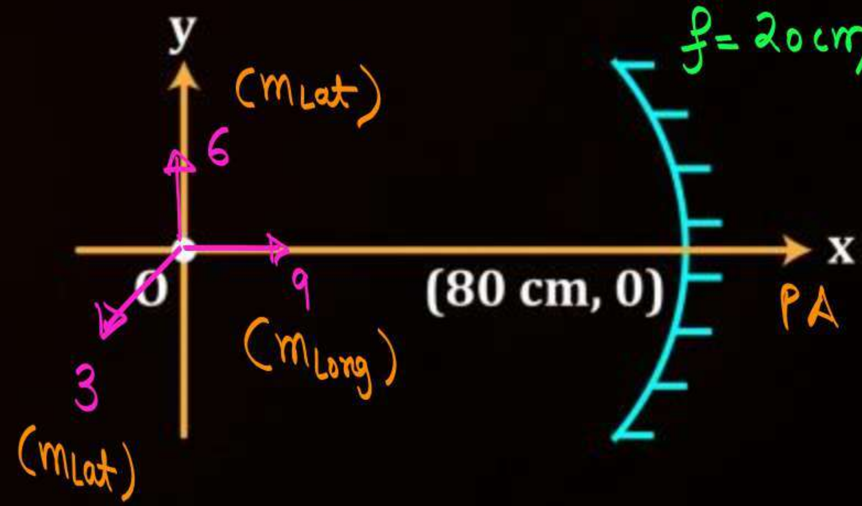
$u = -80$

$f = -20$

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

$-\frac{1}{20} + \frac{1}{80} = \frac{1}{v} = \frac{-4+1}{80}$

$\boxed{v = -80/3}$



$$m_{Lat} = -\frac{v}{u} = -\left(\frac{-80}{3\times -80}\right) = -\frac{1}{3}$$

$$\boxed{\vec{v_I} = -\hat{i} - 2\hat{j} - \hat{k}}$$

$$|v_I| = \sqrt{1+4+1} = \sqrt{6}$$

$$m_{Long} = -m_{Lat}^{2} = -\frac{1}{9}.$$

Concept = $v_{I \parallel PA} = m_{Long}\, v_{O \parallel PA}$

$v_{I \perp PA} = m_{Lat}\, v_{O \perp PA}$

along X = $v_I = -\frac{1}{9} \times 9\hat{i} = -\hat{i}$

along Y = $v_I = -\frac{1}{3} \times 6\hat{j} = -2\hat{j}$.

along Z = $v_I = -\frac{1}{3} \times 3\hat{k} = -\hat{k}$.

Question (Homework)

The light rays from an object have been reflected towards an observer from a standard flat mirror, the image observed by the observer are

A. Real

[Main 25th Jan 2nd Shift 2023]

B. Erect

C. Smaller in size than object

D. Laterally inverted

Choose the most appropriate answer from the options given below

1. B and C only
2. A, C and D only
3. B and D only
4. A and D only

[Ans: 3]

Question (Homework)

A short straight object of height 100 cm lies before the central axis of a spherical mirror whose focal length has absolute value $|f| = 40\, cm$. The image of object produced by the mirror is of height 25 cm and has the same orientation of the object. One may conclude from the information

[Main 26th Feb 1st Shift 2021]

1. Image is virtual, opposite side of convex mirror.
2. Image is real, same side of concave mirror.
3. Image is virtual, opposite side of concave mirror.
4. Image is real, same side of convex mirror.

[Ans: 1]

Question (Homework)

An object is placed between two plane mirrors inclined at an angle to each other. If the number of images formed is 7 then the angle of inclination is:

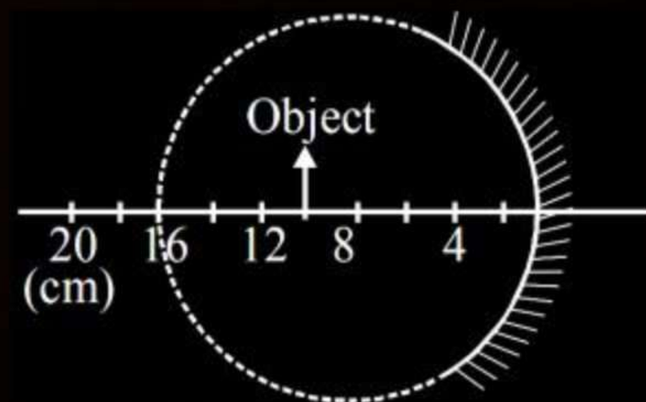
[JEE (Main) 2020]

1. $15°$
2. $30°$
3. $45°$
4. $60°$

Question (Homework)

A spherical mirror is obtained as shown in the figure from a hollow glass sphere. If an object is positioned in front of the mirror, what will be the nature and magnification of the image of the object?
(Figure drawn as schematic and not to scale)

[Main 2nd Sept 1st Shift 2020]



1. Inverted, real and magnified
2. Erect, virtual and magnified
3. Erect, virtual and unmagnified
4. Inverted, real and unmagnified

[Ans: 4]

Question (Homework)

A thin cylindrical rod of length 10 cm is placed horizontally on the principle axis of a concave mirror of focal length 20 cm. The rod is placed in a such a way that mid point of the rod is at 40 cm from the pole of mirror. The length of the image formed by the mirror will be $x/3$ cm. The value of x is **[Main 1st Feb 1st Shift 2023]**

[Ans: 32]

Question (Homework)

An object 'O' is placed at a distance of 100 cm in front of a concave mirror of radius of curvature 200 cm as shown in the figure. The object starts moving towards the mirror at a speed 2 cm/s. The position of the image from the mirror after 10 s will be at .... cm

[Main 28th July 22nd Shift 2022]

[Ans: 400]

Question (Homework)

When an object is kept at a distance of 30 cm from a concave mirror, the image is formed at a distance of 10 cm from the mirror. If the object is moved with a speed of 9 cm^{-1}, parallel to axis, the speed (in cms^{-1}) with which image moves at that instant is: **[JEE (Main) 2020 (3rd Sep Evening)]**

Refraction of Light

→ Phenomenon of bending of light

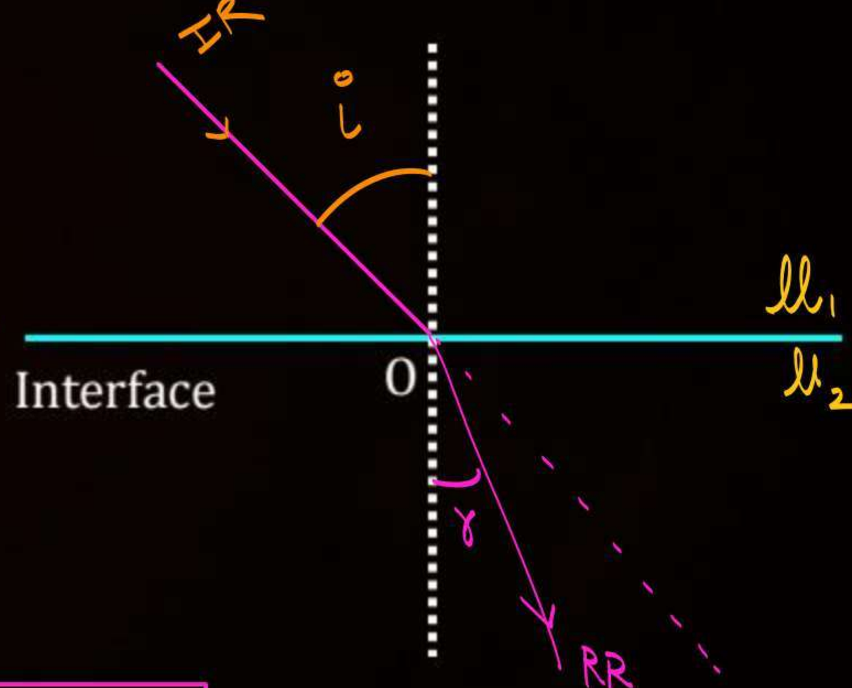
(*) ν = freq of light (Source dependent)
(Never Changes)

⇒ velocity & wavelength of light Changes.

(*) Refractive Index = μ

→ absolute

→ Relative.



$$\boxed{\mu = \frac{c}{v} = \frac{\nu \times \lambda_0}{\nu \times \lambda_m} = \frac{\lambda_0}{\lambda_m}}$$

$\mu > 1.$

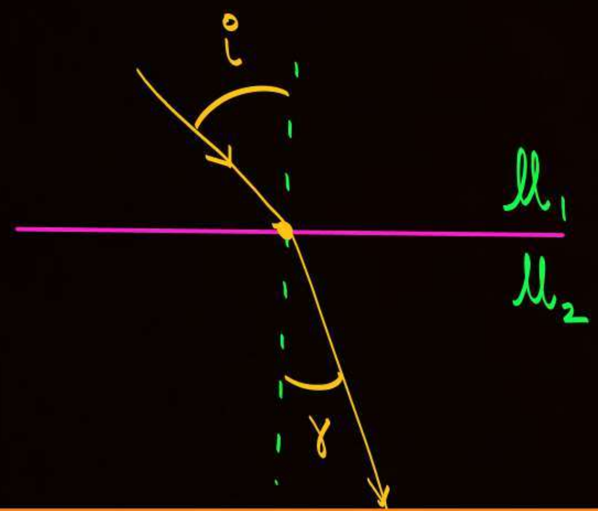
$$\boxed{{}_{1\to 2}\mu = \frac{\mu_2}{\mu_1} = \frac{c}{v_2} \times \frac{v_1}{c} = \frac{v_1}{v_2}}$$

may or may not be greater than 1.

Laws of Refraction

⊛ IR, Normal, RR all lies in Same plane.

⊛



Snell's Law = $\boxed{\mu_1 \sin i = \mu_2 \sin r}$

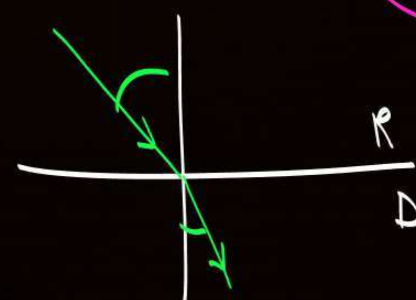
$\mu \sin(\theta) = \text{Const}$

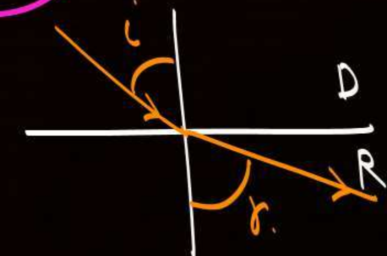
⊛ $\mu \uparrow \quad \theta \downarrow$

$\mu \downarrow \quad \theta \uparrow$

R ⟶ D Shift towards Normal

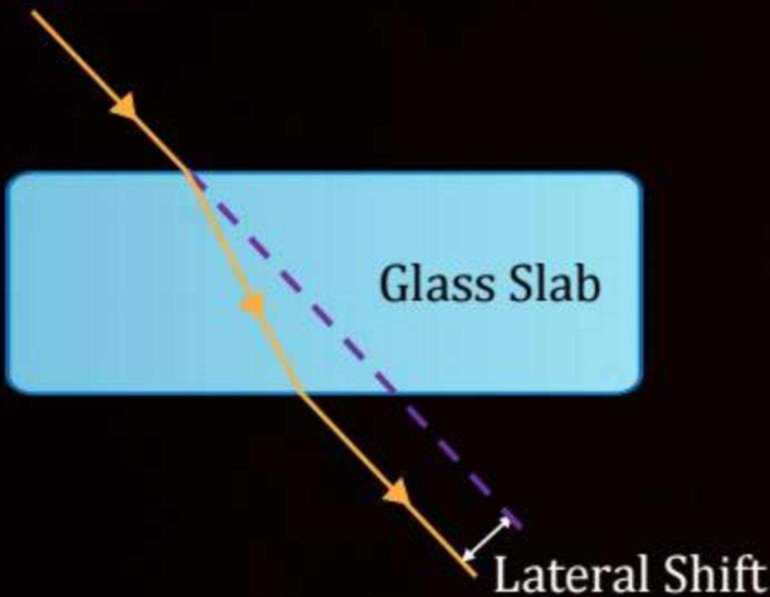
D ⟶ R Shift away from Normal





Refraction of Light from Glass Slab

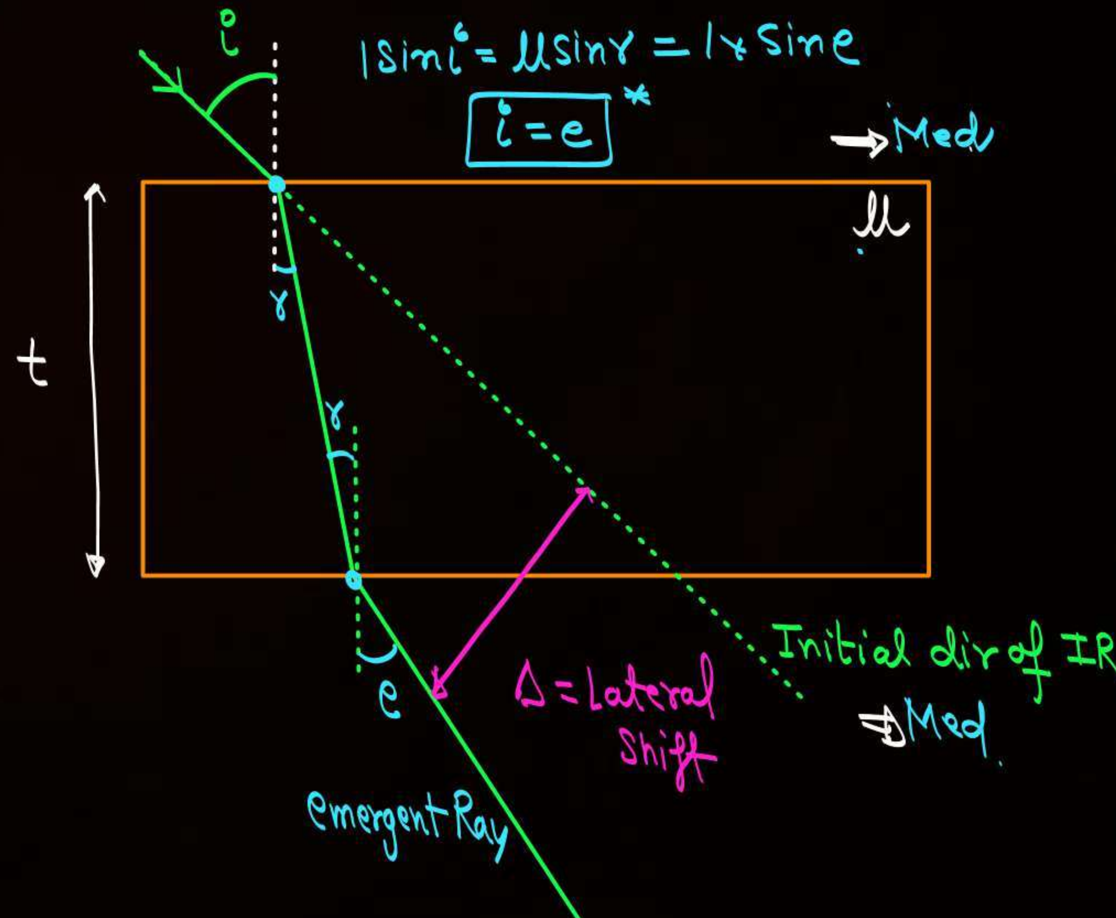
(Sirf Shift Karata hai)



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

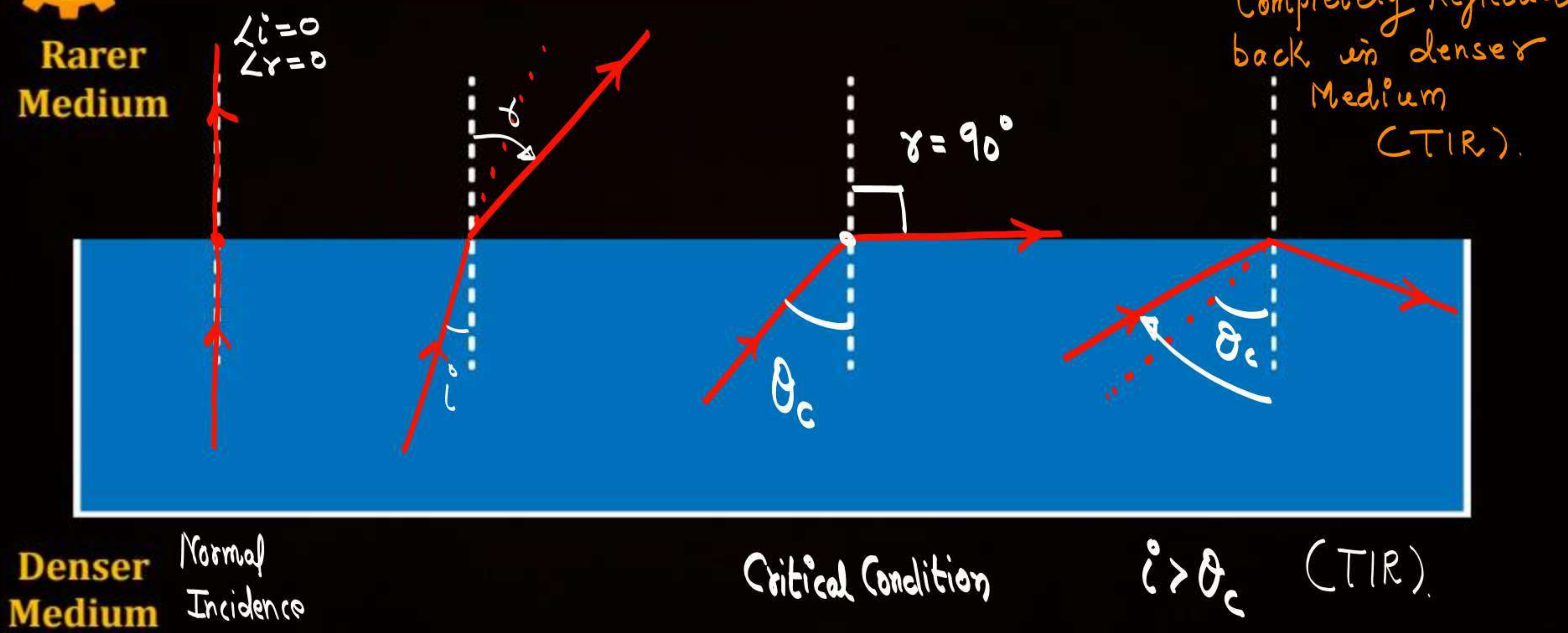
$$1 \sin i = \mu \sin r = 1 \times \sin e$$

$$\boxed{i = e}^{*}$$



Total Internal Reflection

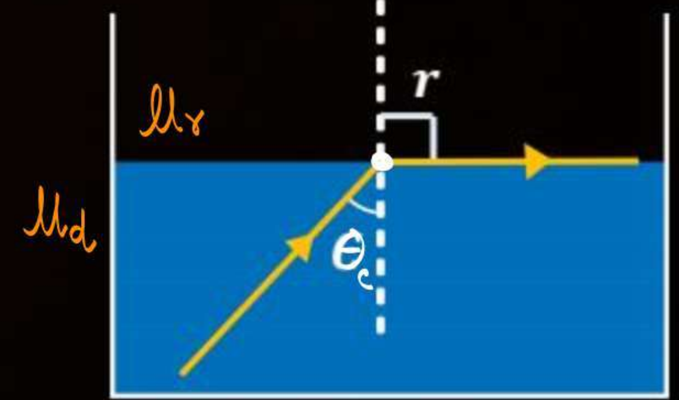
* Denser ⟶ Rarer.



Total Internal Reflection (TIR)

Calculation of critical angle in TIR

at Critical Angle. (Denser $\longrightarrow$ Rarer)



$$\mu_d \sin\theta_c = \mu_r \sin 90$$

$$\boxed{\theta_c = \sin^{-1}\left(\frac{\mu_r}{\mu_d}\right)}$$

Air $\rightarrow$ Rarer $\boxed{\theta_c = \sin^{-1}\left(\frac{1}{\mu}\right)}$

Question 16

Light propagates 2 cm distance in glass of refractive index 1.5 in time t_0. In the same time t_0, light propagates a distance of 2.25 cm in medium. The refractive index of the medium is

1. 4/3 Ans
2. 3/2
3. 8/3
4. None

$\mu = 3/2$

$\longleftarrow 2\text{cm} \longrightarrow$

Speed $= \dfrac{\text{dist}}{\text{time}}$.

$\dfrac{2c}{3} = \dfrac{2}{t_0}$

$\longleftarrow 9/4\,\text{cm} \longrightarrow$ μ

t_0

$\dfrac{c}{\mu} = \dfrac{9}{4t_0}$

Ratio $\dfrac{\cancel{2}\cancel{c}}{\cancel{3}} \times \dfrac{\mu}{\cancel{c}} = \dfrac{\cancel{2}}{\cancel{t_0}} \times \dfrac{4\cancel{t_0}}{\cancel{9}\,3}$

$\mu = 4/3$

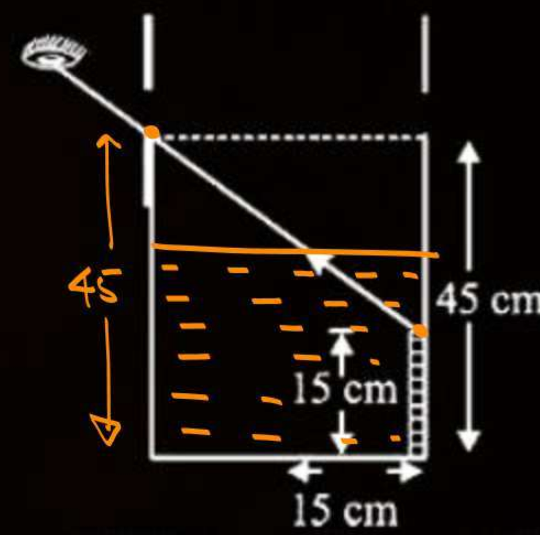
$\mu = \dfrac{c}{v_m}$

$v_{med} = \dfrac{c}{\mu}$

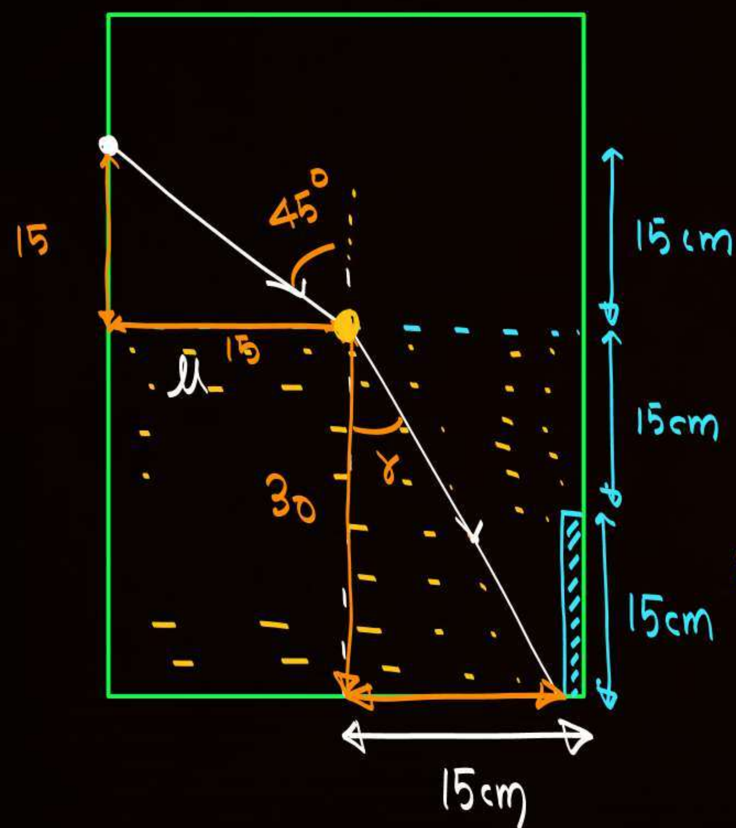
Question 17

An observer can see through a small hole on the side of a jar (radius 15 cm) at a point at height of 15 cm from the bottom (see figure). The hole is at a height of 45 cm. When the jar is filled with a liquid up to a height of 30 cm, the same observer can see the edge at the bottom of the jar. If the refractive index of the liquid is N/100, where N is an integer, the value of N is ________.

[Main 3rd Sept 1st Shift 2020]



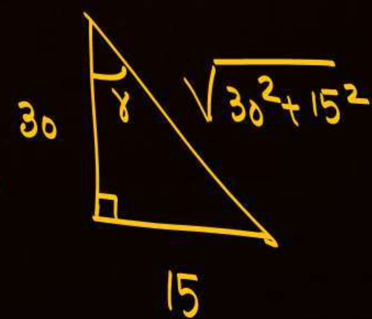
[Ans: 158]



$1 \times \sin 45 = \mu \times \sin r$

$\sin 45 = \mu \times \dfrac{15}{\sqrt{30^2 + 15^2}}$

$\mu = 1.58$



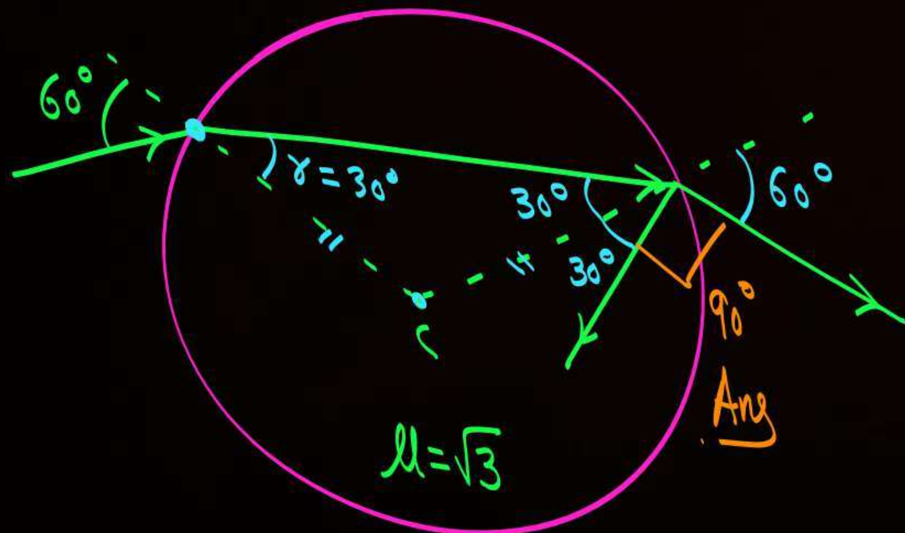
$\text{Ans} = \dfrac{N}{100} = 1.58$

$N = 158$

Question 18

A light ray enters a solid glass sphere of refractive index $\mu = \sqrt{3}$ at an angle of incidence $60°$. The ray is both reflected and refracted at the further surface of the sphere. The angle (in degrees) between the refracted and refracted rays at this surface is ______

[Main 2nd Sept 2nd Shift 2020]



$$1 \times \sin 60 = \sqrt{3} \sin r$$

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

$$r = 30°$$

[Ans: 90]

Question 19

A light beam travels at a speed of 1.94×10^8 m/s in quartz. The wavelength found in quartz is 355 nm. The wavelength of light in air will be?

1. 590 nm
2. 549 nm Ans
3. 460 nm
4. 707 nm

$v_m = 1.94 \times 10^8$

$\lambda_m = 355 \times 10^{-9}$ m

$\mu = \frac{c}{v} = \frac{\lambda_0}{\lambda_m}$

$\lambda_0 = \frac{c}{v}\lambda_m = \frac{3 \times \cancel{10^8} \times 355 \times 10^{-9}}{1.94 \times \cancel{10^8}} = 548.9 \times 10^{-9}$

$=$

Question 20

A ratio of the RI of red light to blue light in air is

1. Less than one Ans
2. Greater to one
3. Greater than one
4. Depends on surrounding condition

White light

V I B G Y O R

$\lambda \rightarrow$

$\leftarrow \mu$

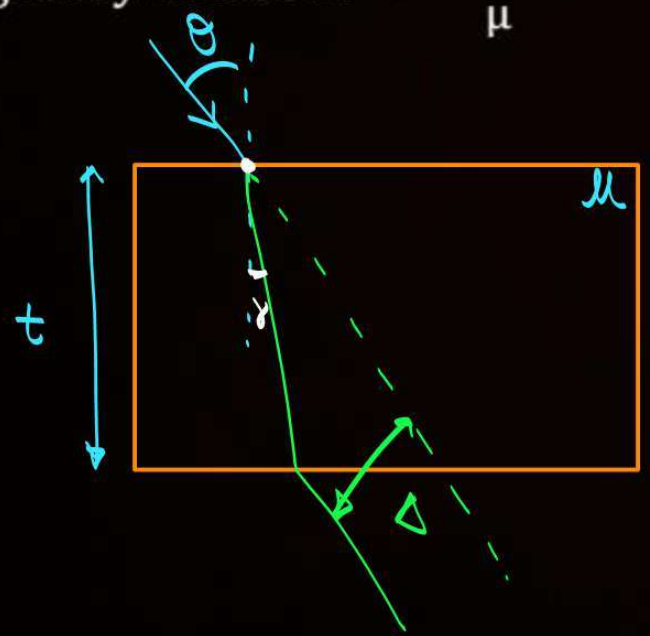
$\mu_B > \mu_R$

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

$$\frac{\mu_{Red}}{\mu_{blue}} = < 1$$

Question 21

A ray of light is incident on a parallel slab of thickness t and refractive index μ. If the angle of incidence is θ then for small θ show that the lateral displacement of light ray will be $\Delta = \frac{t\theta(\mu-1)}{\mu}$



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

for Small Angle.

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

$\cos\theta \approx 1$

$$\Delta = t(i-r)$$
$$= t\left(\theta - \frac{\theta}{\mu}\right)$$

$1 \times \sin\theta = \mu \sin r$

$\theta = \mu r$

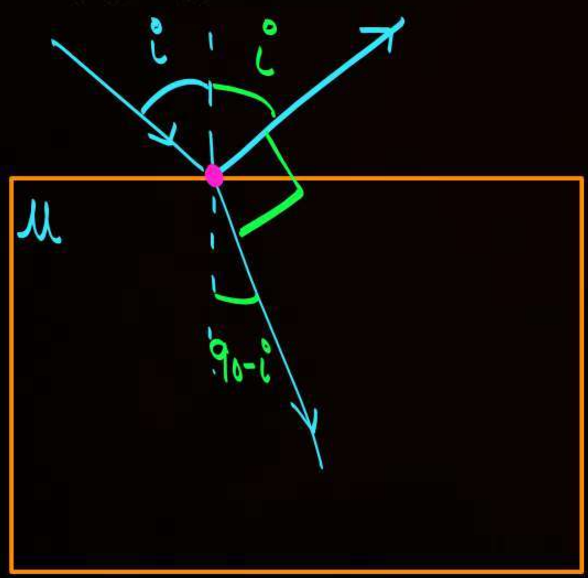
$r = \theta/\mu$

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

Question 22

Brewester's Law.

Monochromatic light falls at an angle of incidence 'i' on a slab of a transparent material, refractive index of this material being 'μ' for the given light. What should the relation between i and μ be so that the reflected and the refracted rays are mutually perpendicular?



$$1 \times \sin i = \mu \sin (90 - i)$$

$$\sin i = \mu \cos i$$

$$\boxed{\tan i = \mu}$$

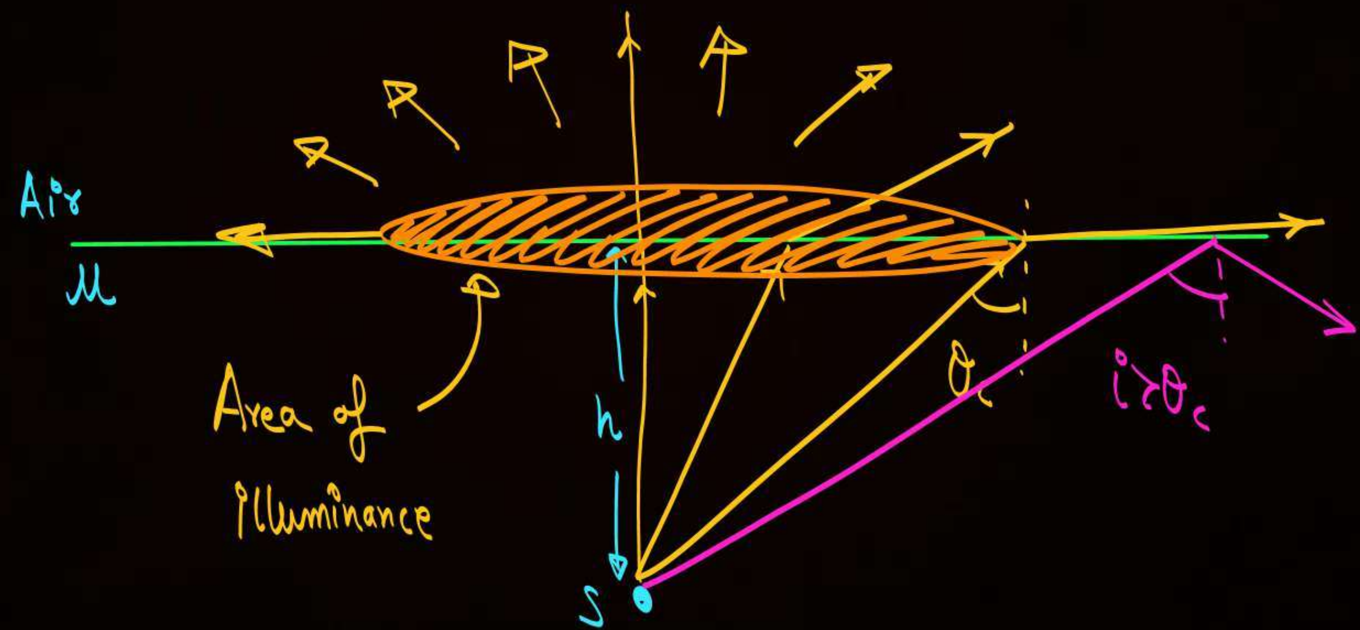
$\boxed{i = \text{Brewester's Angle.}}$

Question 23

(NCERT) + (PYQ)

Area of illuminance.

A point source of light is placed directly below the surface of a lake at a distance h from the surface. Find the area on water from which the light will come out from water.



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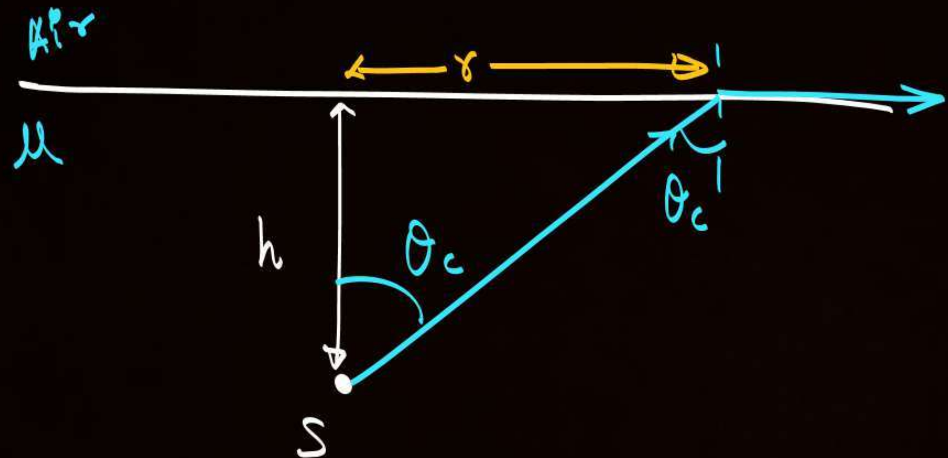


$$\tan\theta_c = \frac{P}{B}$$

$$\boxed{h\tan\theta_c = r}$$

$$\frac{h}{\sqrt{\mu^2-1}} = r$$ = radius of Area of Illuminance

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

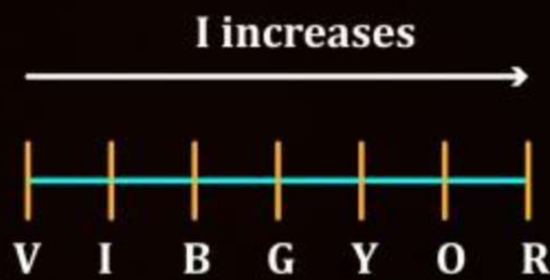
$$\boxed{\text{Area} = \pi r^2 = \frac{\pi h^2}{\mu^2-1}}$$

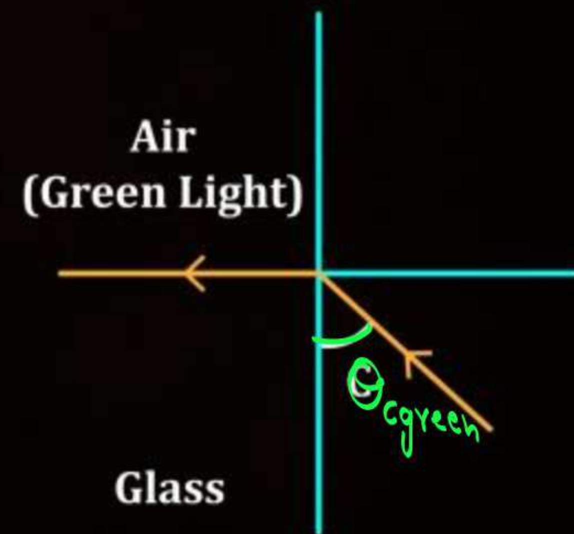
Question 24

VIBGYOR

A beam of white light is incident on glass –air interface from glass to air such that green light just suffers total internal reflection. The colors of the light which will come out to air are

1. Violet, Indigo, Blue
2. All colors except green
3. Yellow, Orange, Red Ans
4. White light





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

$\theta_c > \theta_{green}$

YOR

$\angle i = 45^\circ$

$\theta_c = 50, 60, 70$ $\Big\}$ $\angle i < \theta_c$

No TIR

V I B G Y O R

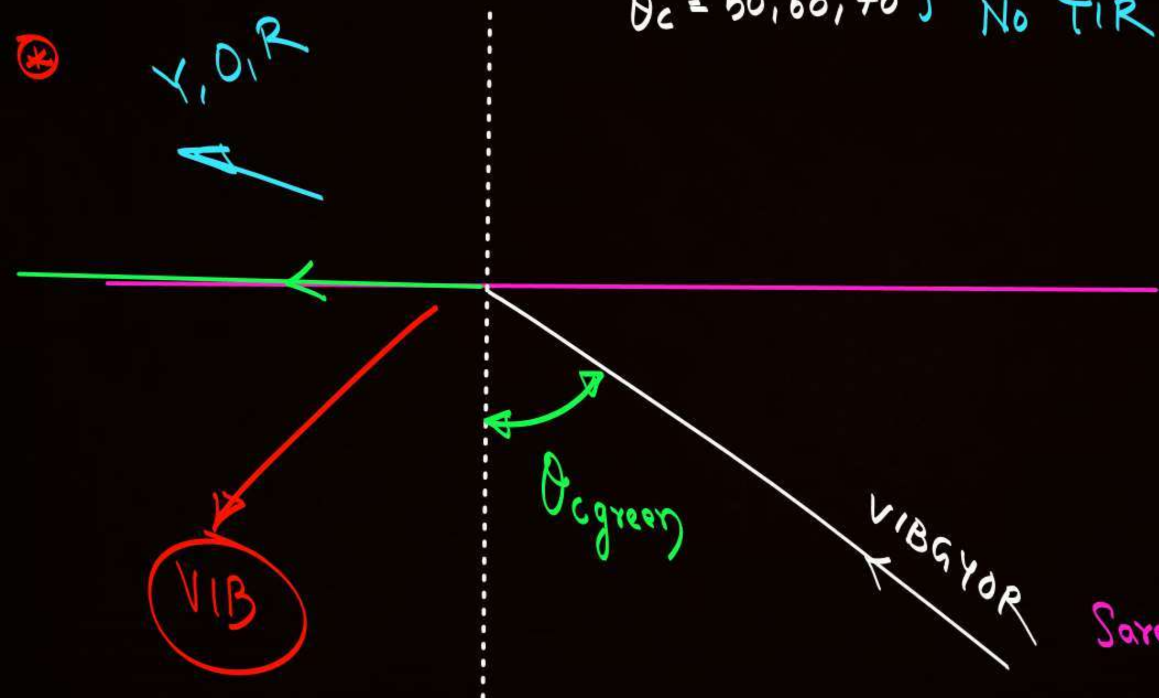
20 30 40   50 60 70

μ

θ_c

45°

$\theta_c > 45$



VIB

$\angle i = 45^\circ$

$\theta_c = 20, 30, 40$

$\angle i > \theta_c$

TIR

Same colors $\angle i = \theta_{c\,green}$

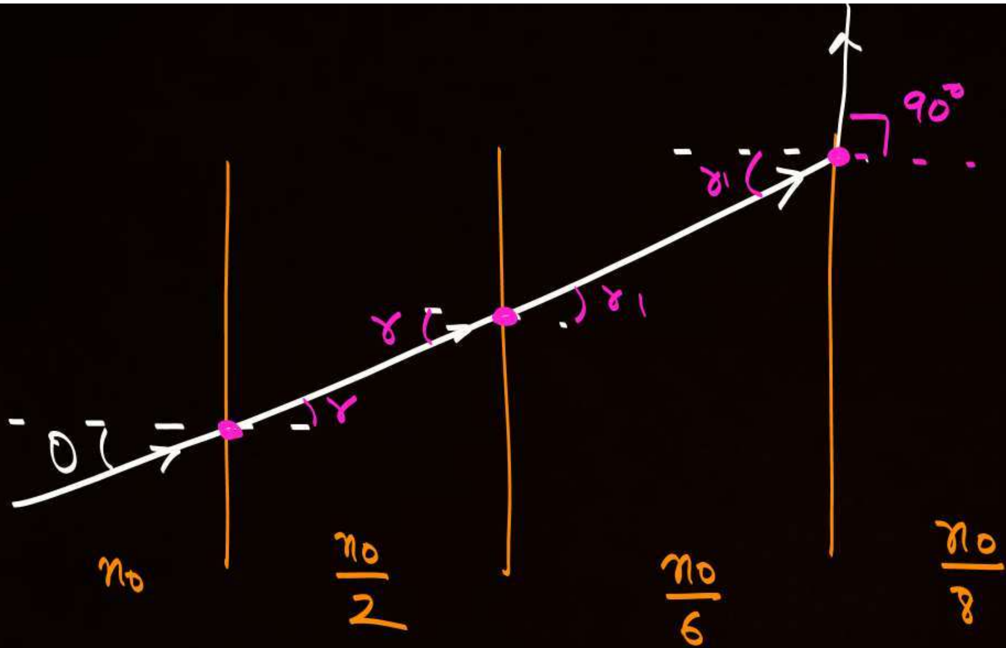
Question 25

A light beam is travelling from region I to region IV. The refractive index in regions I, II, III and IV are $n_0, \frac{n_0}{2}, \frac{n_0}{6}, \frac{n_0}{8}$ respectively. The angle of incidence θ for which the beam just misses entering region IV is:

denser → Rarer

Ans

1. $\sin^{-1}\left(\frac{3}{4}\right)$
2. $\sin^{-1}\left(\frac{1}{8}\right)$
3. $\sin^{-1}\left(\frac{1}{4}\right)$
4. $\sin^{-1}\left(\frac{1}{3}\right)$



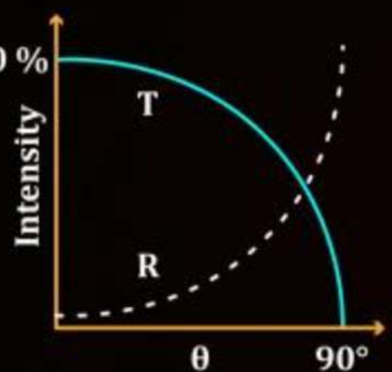
$$\cancel{n_0}\sin\theta = \frac{n_0}{2}\sin r = \frac{n_0}{6}\sin r_1 = \frac{\cancel{n_0}}{8}\sin 90$$

$$\theta = \sin^{-1}\left(\frac{1}{8}\right)$$

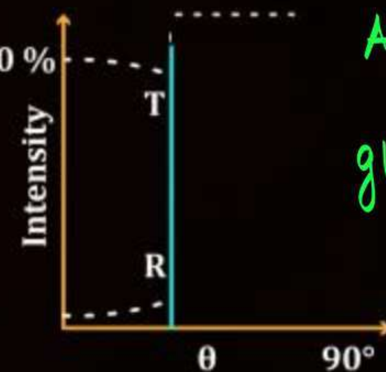
Question 26

A light ray travelling in glass medium is incident on glass-air interface at an angle of incidence θ. The reflected (R) and transmitted (T) intensities, both as function of θ, are plotted. The correct sketch is: (Refracted)

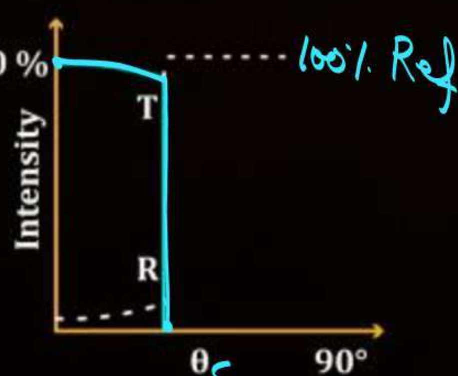
1



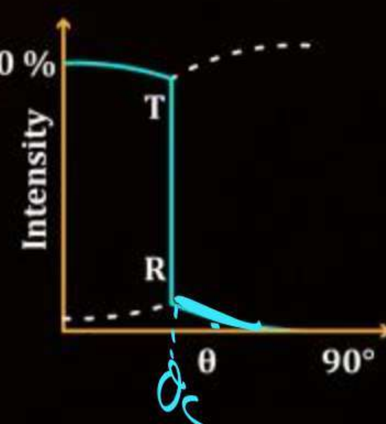
2

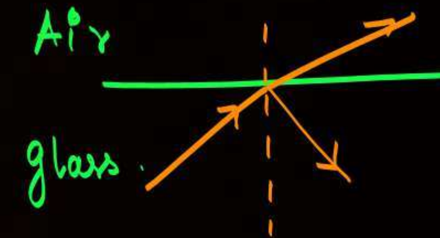


3 Ans



4

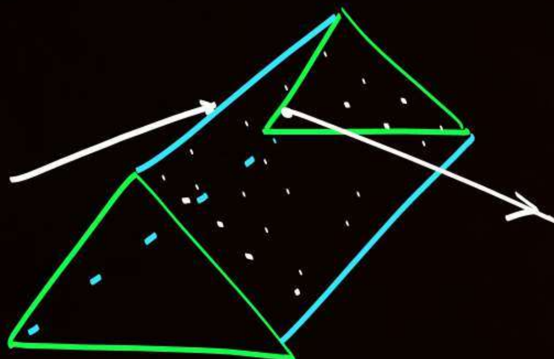




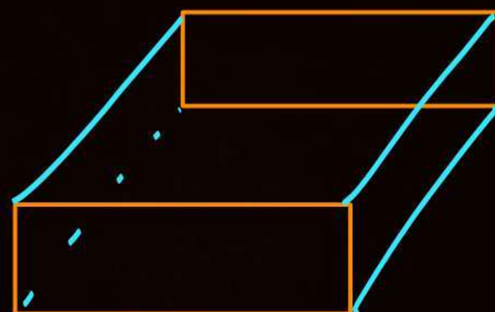
$\theta = 0°$ Reflect ✓
Refract ✓
(More)

$\theta > \theta_c$ (TIR)
Refraction = 0
100% Reflection

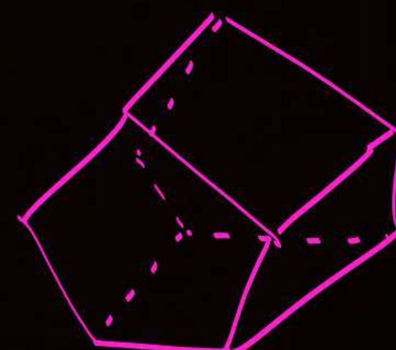
Prism → Refracting Med bounded by 2 polygons & Rectangular Matt surfaces.



Trihedral prism.



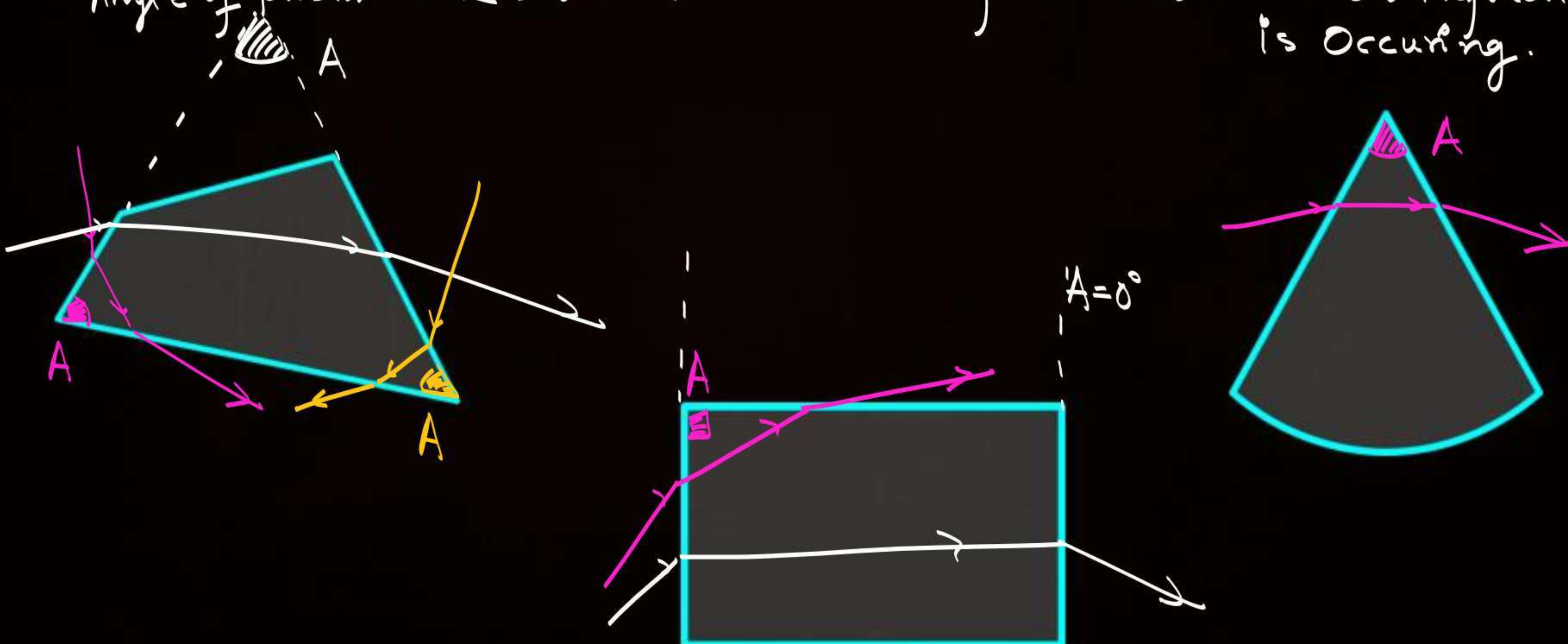
Rectangular prism
Slab.



Pentahedral Prism

Prism and its Types

Angle of prism → ∠ between two Matt Surfaces about which Refraction is Occuring.



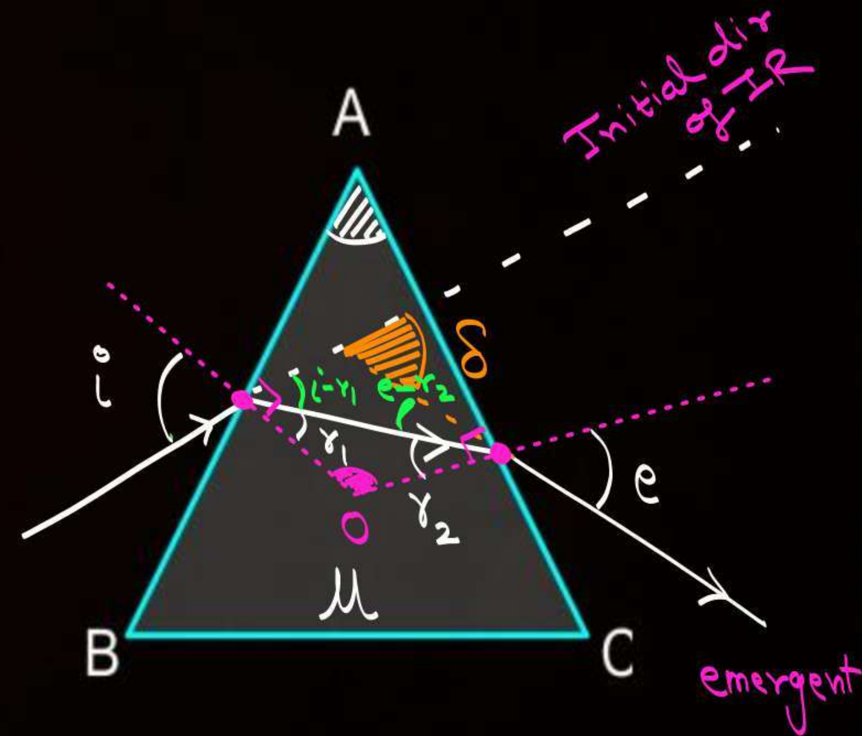
Deviation of Prism

$$\boxed{\begin{array}{l} 1.\quad 1 \times \sin i = \mu \sin r_1 \\ 2.\quad \mu \sin r_2 = 1 \times \sin e \end{array}}$$

3. $\left.\begin{array}{l} \angle A + \angle O = 180^\circ \\ r_1 + r_2 + \angle O = 180^\circ \end{array}\right\}$ $\boxed{A = r_1 + r_2}$

4. deviation $= \delta = i - r_1 + e - r_2$

$$\boxed{\delta = i + e - A}$$



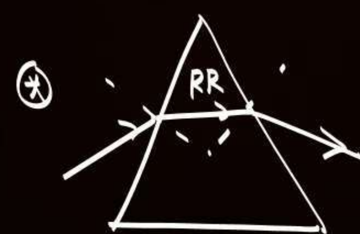
Minimum & Maximum Deviation

δ = Representation of δ.

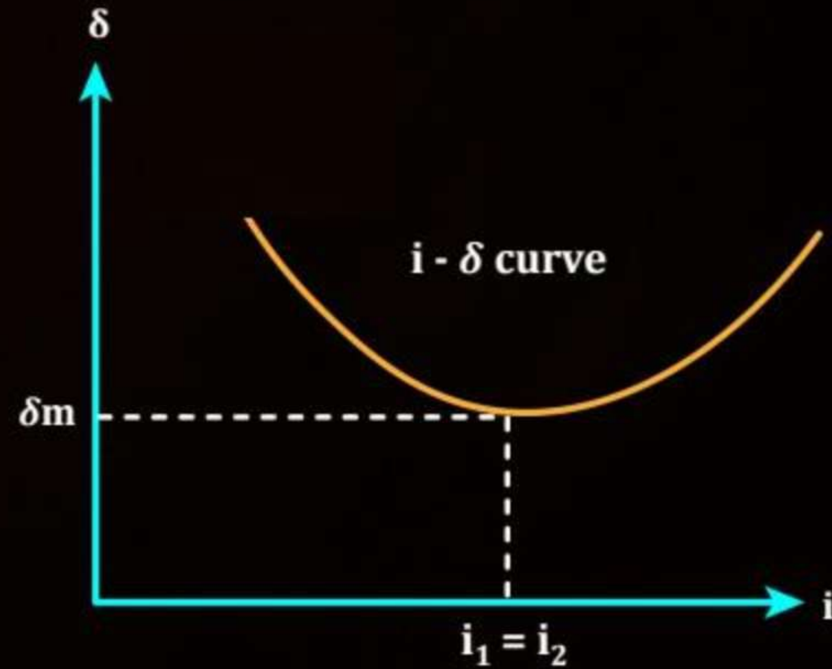
Condition for δ_{min}.

- $\boxed{i = e \quad \text{then } \delta_{min}}$
- $\boxed{\delta_{min} = 2i - A}$
- $\boxed{r_1 = r_2 = \frac{A}{2}}$
- $1 \times \sin i = \mu \sin \frac{A}{2}$

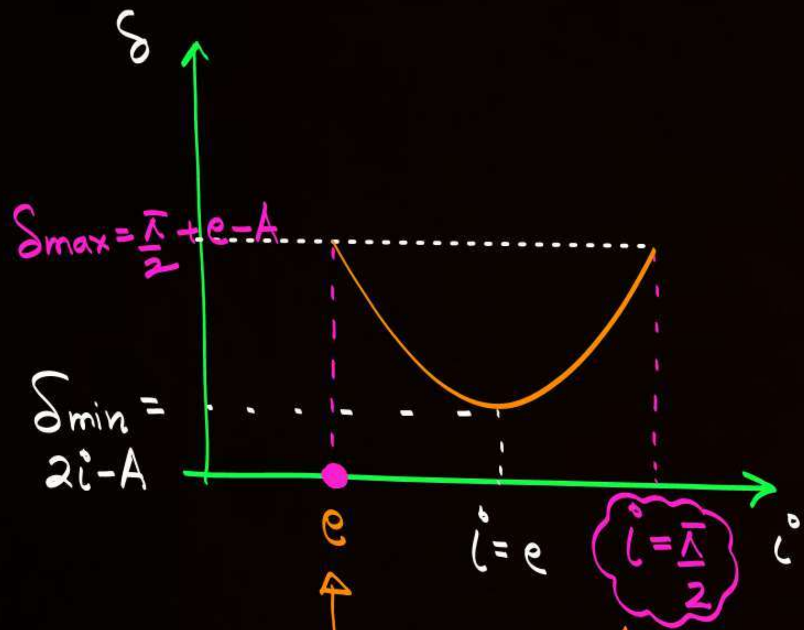
$$\boxed{\frac{\sin\left(\frac{\delta_{min}+A}{2}\right)}{\sin(A/2)} = \mu}$$

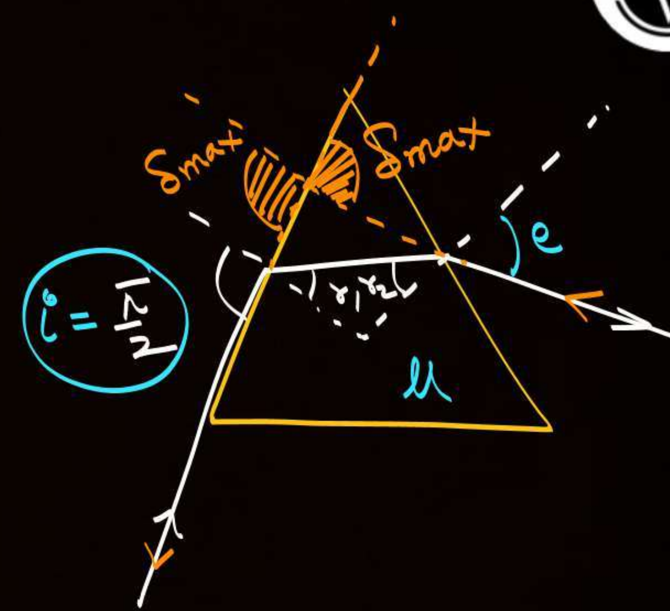
- 

Parallel to base.



"Assymetrical Graph"



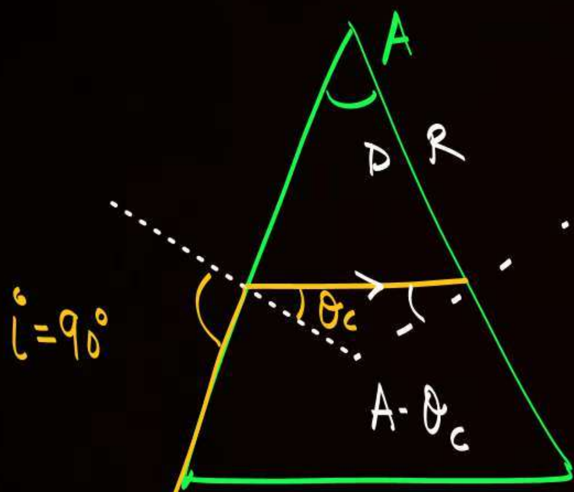


When $i = \frac{\pi}{2}$ then $\delta_{max} = i + e - A$

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

Whatever will be $\angle e$ in this case is the second angle at which δ_{max}.

TIR In prism



$$A = \theta_c + r_2$$

$$r_2 = A - \theta_c$$

What is the Condition for which light is always Reflected from Second Matt Surface

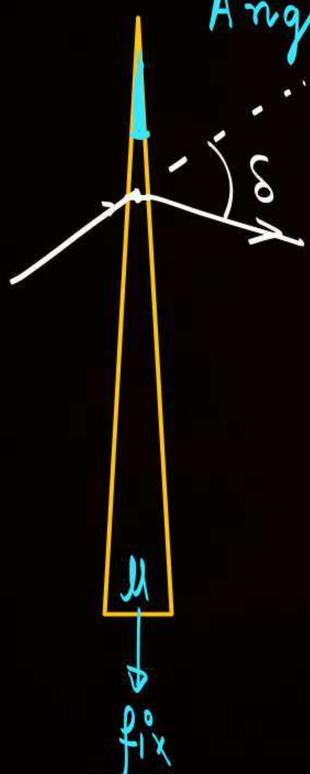
$$r_2 \geq \theta_c \quad (TIR)$$

$$A - \theta_c \geq \theta_c$$

$$A \geq 2\theta_c$$

$$\boxed{A \geq 2\sin^{-1}\left(\frac{1}{\mu}\right)} \quad (TIR)$$

Thin prism and Dispersion



Angle of prism less than 10° = Thin Prism

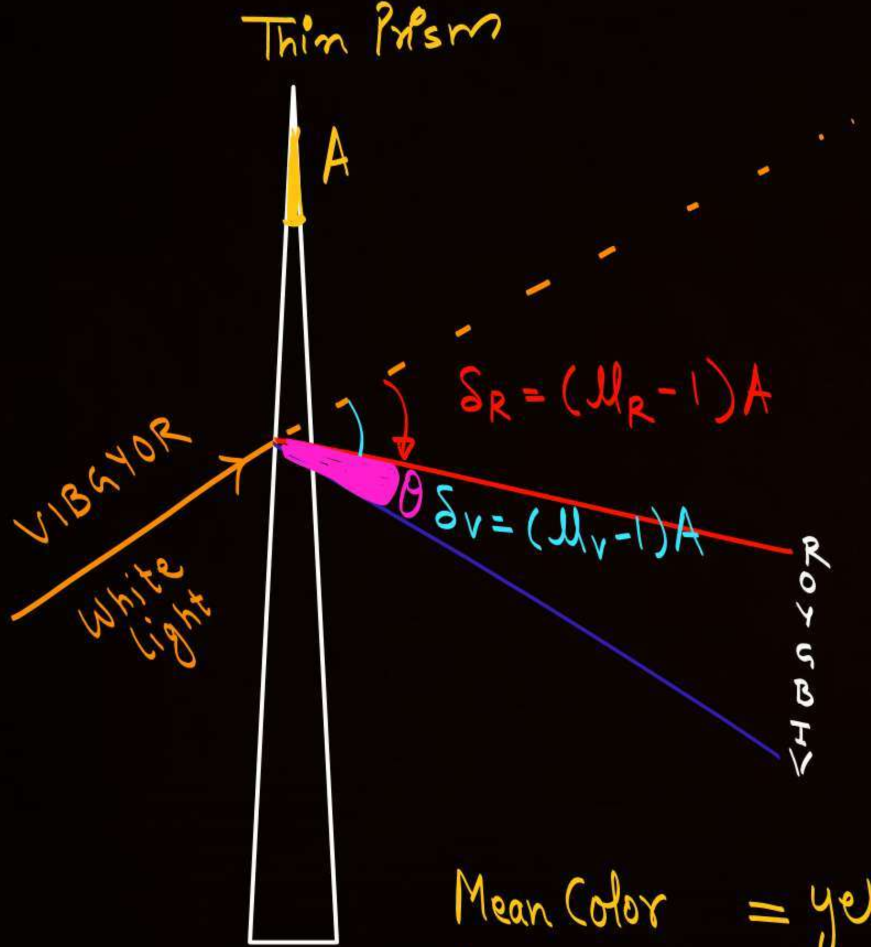
$A \rightarrow$ Small $= r_1 + r_2$

r_1 & $r_2 \rightarrow$ Small $(i$ & $e) \Rightarrow$ Small.

(Small Angle Appr)

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

δ by thin prism $\Rightarrow$ fix. (for Monochromatic)



Dispersion

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

V I B G Y O R $\longrightarrow \lambda$

$\mu \longleftarrow$

$\delta \longleftarrow$

θ = Angle of dispersion = $\delta_V - \delta_R$

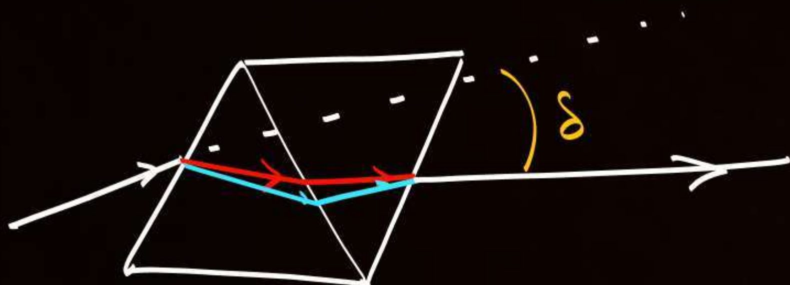
$$\boxed{\theta = (\mu_V - \mu_R)A}$$

$$\boxed{\text{dispersive Power} = \omega = \frac{\theta}{\delta_{mean}} = \frac{\mu_V - \mu_R}{\mu_y - 1}}$$

Mean Color = yellow
(Mean Wavelength)

Combination of prism.

deviation without dispersion



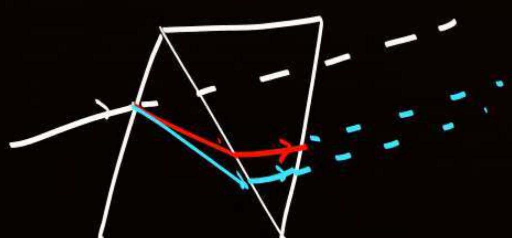
No dispersion

$$\boxed{\theta_{prism_1} + \theta_{prism_2} = 0}$$

$$(\mu_{V_1} - \mu_{R_1})A_1 + (\mu_{V_2} - \mu_{R_2})A_2 = 0$$

$$\boxed{A_2 = \frac{-(\mu_{V_1} - \mu_{R_1})A_1}{(\mu_{V_2} - \mu_{R_2})}}$$

dispersion without deviation



$$\delta_{Total} = 0 = (\mu_1 - 1)A_1 + (\mu_2 - 1)A_2 = 0$$

$$\boxed{A_2 = \frac{-(\mu_1 - 1)A}{(\mu_2 - 1)}}$$

Question 28

The refracting angle of a prism is A and refractive index of the material of the prism is $\cot(A/2)$. Then the angle of minimum deviation will be **(Main 28th June 1st Shift 2022)**

1. 180 – 2A Ans
2. 90 – A
3. 180 + 2A
4. 180 – 3 A

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

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

$$\frac{\pi}{2} - \frac{A}{2} = \frac{A}{2} + \frac{\delta_{min}}{2}$$

$$\boxed{\delta_{min} = 180 - 2A}$$

[Ans: 1]

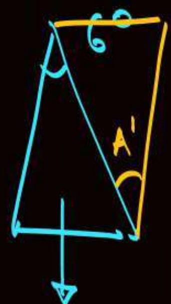
Question 29

A thin prism P_1 with an angle 6^0 and made of glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.72 to produce dispersion without average deviation. The angle of prism P_2 is

$\delta_{net} = 0$

(Main 30^{th} Jan 2^{nd} Shift 2023)

1. 7.8^o
2. 4.5^o Ans
3. 6^o
4. 1.3^o



$\mu = 1.54$

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

$$A_2 = -\frac{(\mu_1 - 1)A_1}{\mu_2 - 1} = -\frac{0.54 \times 6^\circ}{0.72} = 4.5^\circ$$

Second Prism → Inverted.

[Ans: 2]

Question 30

A prism of refractive index μ and angle of prism A is placed in the position of minimum angle of deviation. If minimum angle of deviation is also A, then in terms of refractive index, value of A is

(Main 25th July 2nd Shift 2021)

1. $2\cos^{-1}\left(\frac{\mu}{2}\right)$ Ans
2. $\sin^{-1}\left(\frac{\mu}{2}\right)$
3. $\cos^{-1}\left(\frac{\mu}{2}\right)$
4. $\sin^{-1}\left(\sqrt{\frac{\mu-1}{2}}\right)$

$$\delta_{min} = A$$

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

$$\frac{\mu}{2} = \cos\left(\frac{A}{2}\right)$$

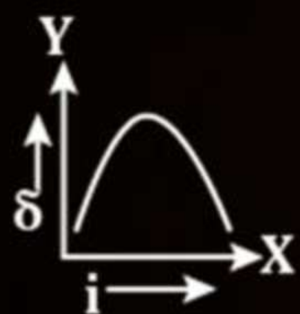
$$A = 2\cos^{-1}\left(\frac{\mu}{2}\right)$$

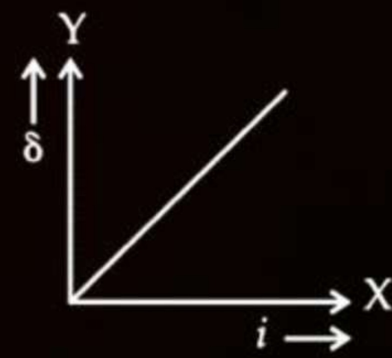
[Ans: 1]

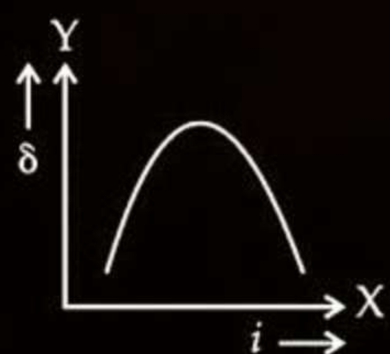
Question 31

The expected graphical representation of the variation of angle of deviation δ with angle of incidence i in a prism is

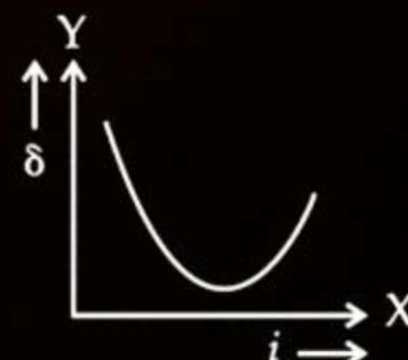
(Main 27th July 2nd Shift 2021)

1 

2 

3 

Ans

4 

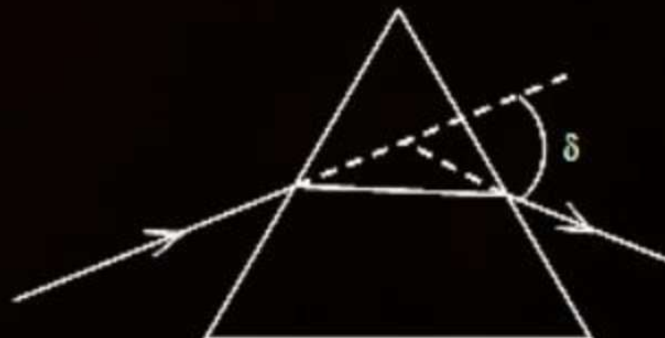
[Ans: 4]

Question 32

The angle of deviation through a prism is minimum when

(Main 16^{th} March 1^{st} Shift 2021)

(A) incident ray and emergent ray are symmetric to the prism
(B) the refracted ray inside the prism becomes parallel to its base
(C) angle of incidence is equal to that of the angle of emergence
(D) when angle of emergence is double the angle of incidence.



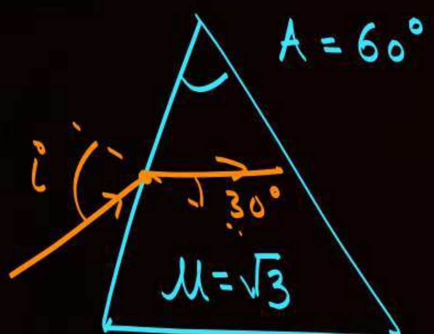
1. Only statements (A) and (B) are true.
2. Statements (B) and (C) are true.
3. Ans Statements (A), (B) and (C) are true.
4. Only statement (D) is true.

[Ans: 3]

Question 33

A monochromatic light is incident at a certain angle on an equilateral triangular prism and suffers minimum deviation. If the refractive index of the material of the prism is $\sqrt{3}$, then the angle of incidence is **(Main 11th Jan 2nd Shift 2019)**

1. 60° Ans
2. 45°
3. 90°
4. 30°



$r_1 + r_2 = A$

δ_{min}

$r = \frac{A}{2}$

$1 \times \sin i = \sqrt{3} \sin 30^\circ$

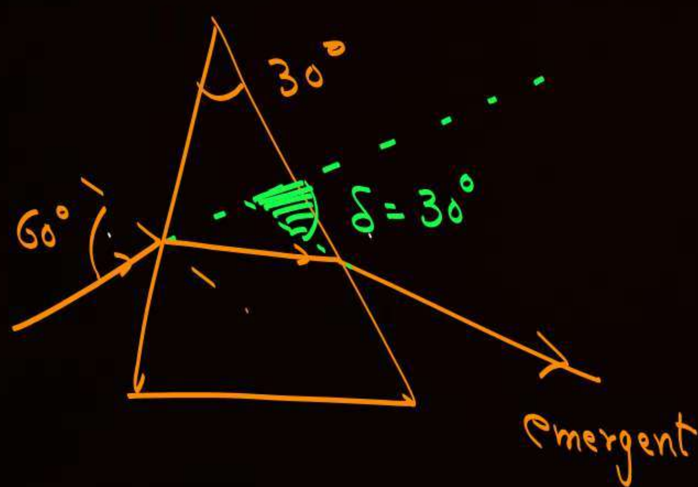
$i = 60^\circ$

[Ans: 1]

Question 34

A ray of light is incident at an angle of 60° on one face of a prism of angle 30°. The emergent ray of light makes an angle of 30° with incident ray. The angle made by the emergent ray with second face of prism will be (Main Online 2018)

1. 0°
2. 45°
3. 90° Ans
4. 30°

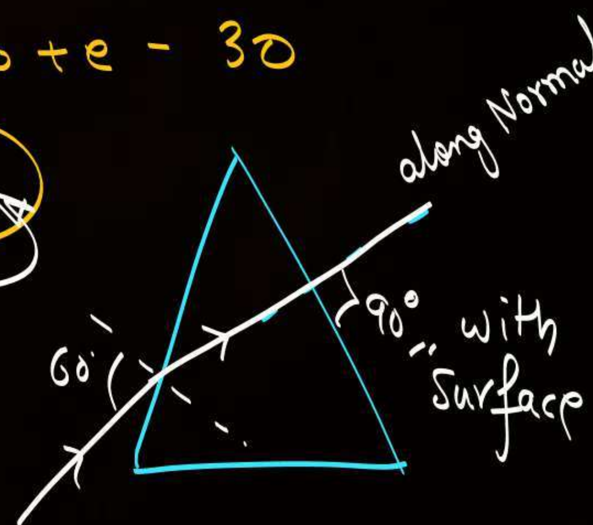


$\delta = i + e - A$

$30 = 60 + e - 30$

$e = 0$

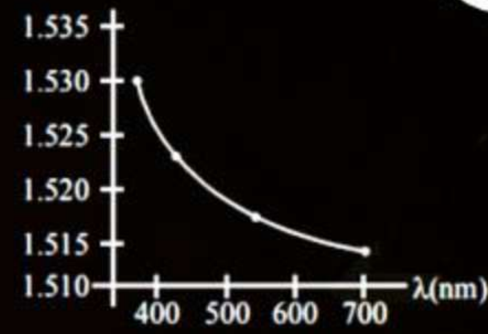
with Normal



[Ans: 3]

Question 35

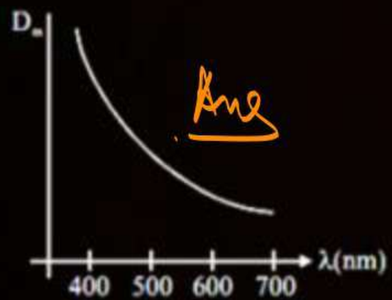
The variation of refractive index of a crown glass thin prism with wavelength of the incident light is shown. Which of the following graphs is the correct one, if D_m is the angle of minimum deviation? **(Main 11th Jan 1st Shift 2019)**



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

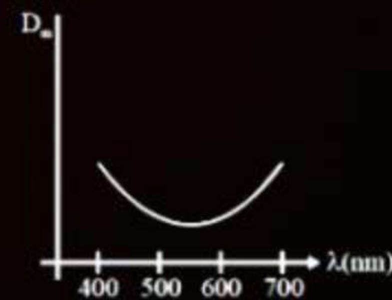
$\lambda \uparrow \ \mu \downarrow \ \delta \downarrow$.

1

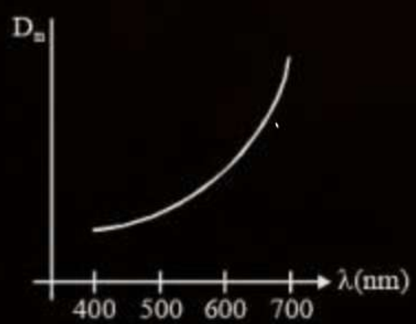


Ans

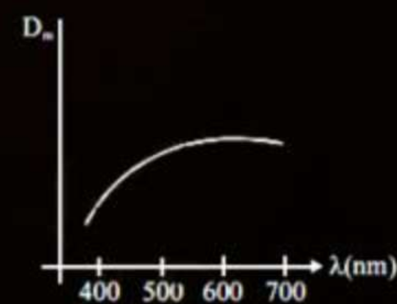
2



3

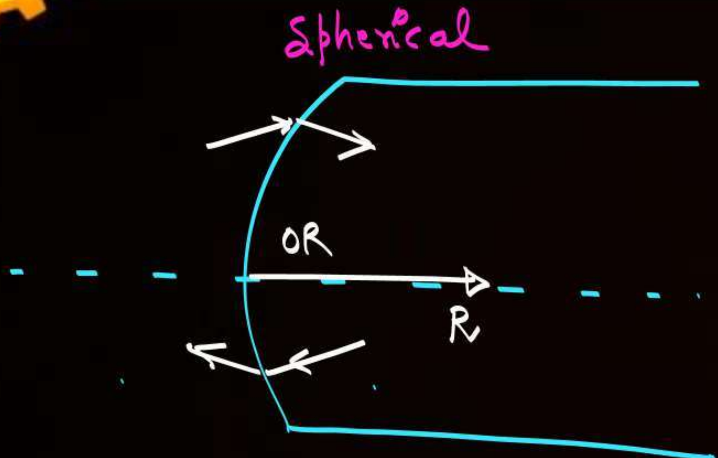


4

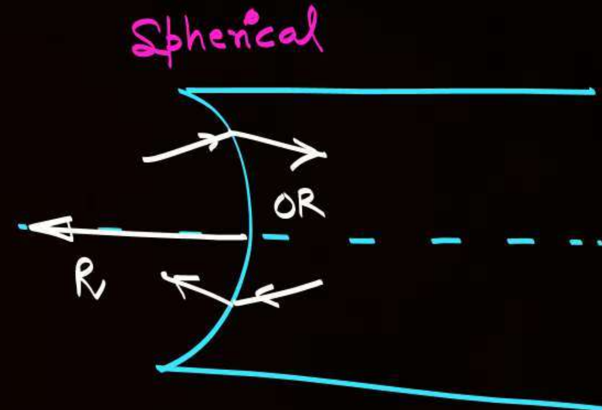


[Ans: 1]

Refraction from Spherical Surfaces



Convex surface.



Concave

1. object → Intersection of IR
   Image → " " RR's.

2. Refraction formula:- $\boxed{\dfrac{\mu_f}{v} - \dfrac{\mu_i}{u} = \dfrac{\mu_f - \mu_i}{R}}$

μ_f = Ja Rahi hai

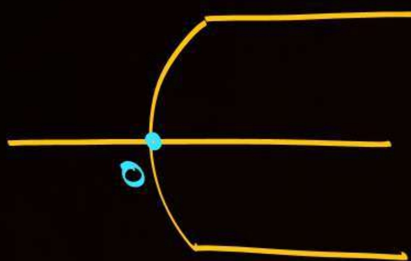
μ_i = Aa Rahi hai

u = Int of IR

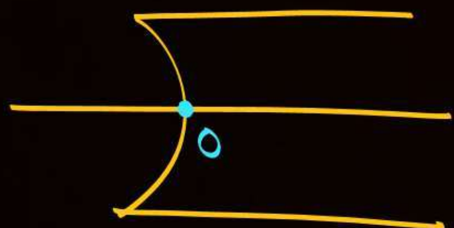
v = Int of RR

R = Radii of Curvature

(*) Same Sign Convention.



OR



all distances measured from O.

(*) magnification

$$m_{lat} = \frac{h_I}{h_O} = \frac{\mu_i}{\mu_f}\frac{v}{u} \qquad m_{long} = \frac{t_I}{t_O} = \frac{\mu_i}{\mu_f}\frac{v^2}{u^2}$$

(*) velocity of I $\parallel$ PA $= (m_{long})\, v_{O\parallel PA}$

velocity of I $\perp$ PA $= (m_{lat})\, v_{O\perp PA}$.

Question 36

Figure shows a glass sphere of radius 10 cm. Along its diameter AB from one side a parallel beam of paraxial rays incident on it. What should be the refractive index of glass so that after refraction all rays will converge at opposite end B.

$$\frac{\mu_f}{v} - \frac{\mu_i}{u} = \frac{\mu_f - \mu_i}{R}$$

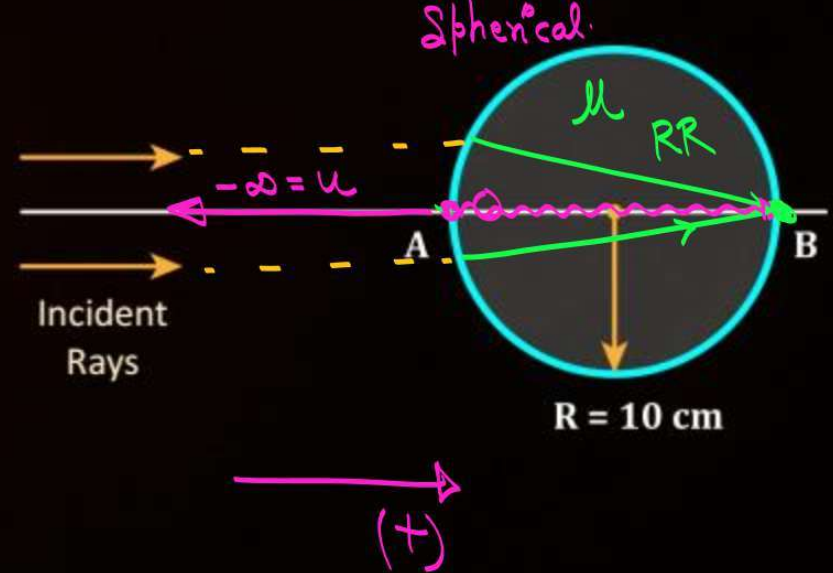
$\mu_f = \mu$

$\mu_i = 1$

$u = -\infty$

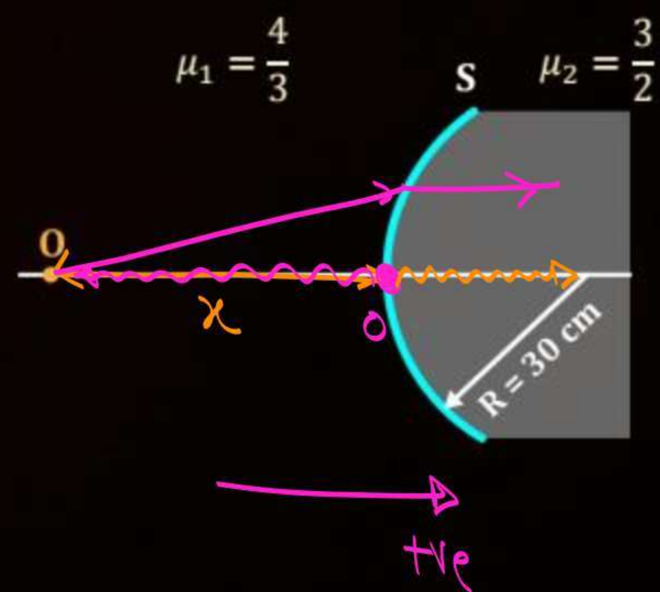
$v = +2R = +20$

$R = +R = +10$



Question 37

A spherical surface S separates two media 1 and 2 as shown in figure. Find where an object O is placed in medium-I so that the light rays from object after refraction becomes parallel to optics axis of this system.



Spherical

$$\frac{\mu_f}{v} - \frac{\mu_i}{u} = \frac{\mu_f - \mu_i}{R}$$

$\mu_f = 3/2$

$\mu_i = 4/3$

$u = -x$

$v = +\infty$

$R = +30$

Question 38

Figure shows a small object M of length 1 mm which lies along a diametrical line of a glass sphere of radius 10 cm and $\mu = 3/2$ which is viewed by an observer as shown. Find the size of object as seen by the observer.

+ve

$\mu = 3/2$

$$\frac{t_I}{t_0} = \frac{\mu_i}{\mu_f}\frac{v^2}{u^2}$$

$$\boxed{t_I = \frac{\mu_i}{\mu_f}\frac{v^2}{u^2} \times t_0}$$

$t_0 \rightarrow$ 1mm

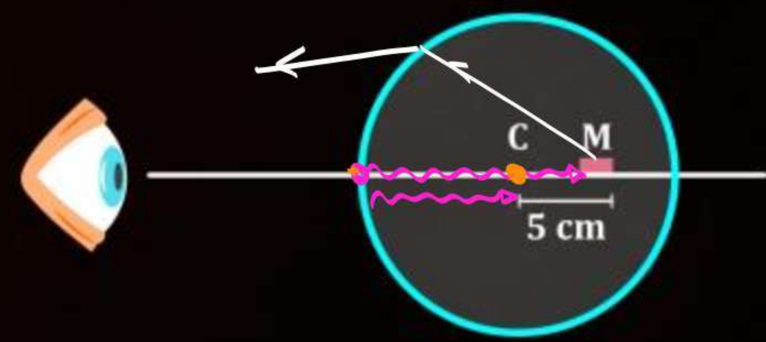
$\mu_i = 3/2$

$\mu_f = 1$

$u = -15$

$v = +v$

$R = -10$



$R = 10cm$

$$\frac{\mu_f}{v} - \frac{\mu_i}{u} = \frac{\mu_f - \mu_i}{R}$$

$v = \_\_\_$

Question 39

The figure shows a fish bowl of radius 10 cm in which along a diametrical line a fish F is moving at speed 2 mm/sec. Find the speed of fish as observed by an observer outside along same line when fish is at a distance of 5 cm from the centre of bowl to right of it.

$v_{I||PA} = (m_{Long})\, v_{O||PA}$

$$\boxed{v_{I||PA} = \left(\frac{\mu_i}{\mu_f}\frac{v^2}{u^2}\right) 2\frac{mm}{s}}$$

$\mu_i = 4/3$

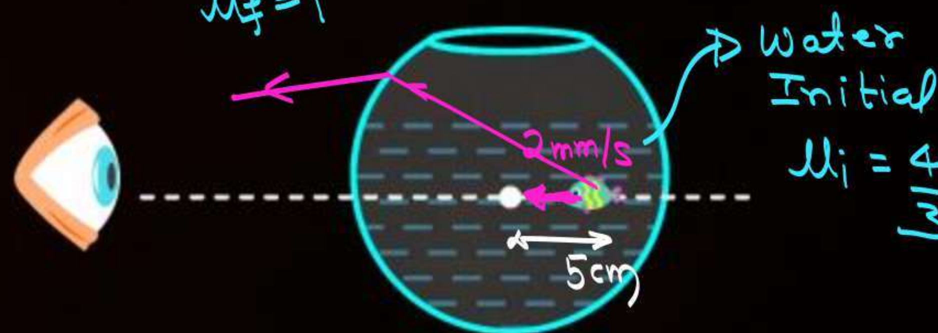
$\mu_f = 1$

$u = -15$

$R = -10$

$v = +v$

$$\boxed{\frac{\mu_f}{v} - \frac{\mu_i}{u} = \frac{\mu_f - \mu_i}{R}}$$



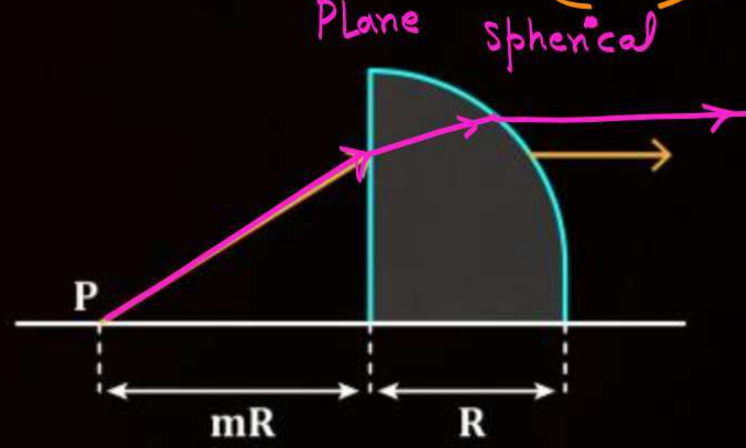
R = 10 cm

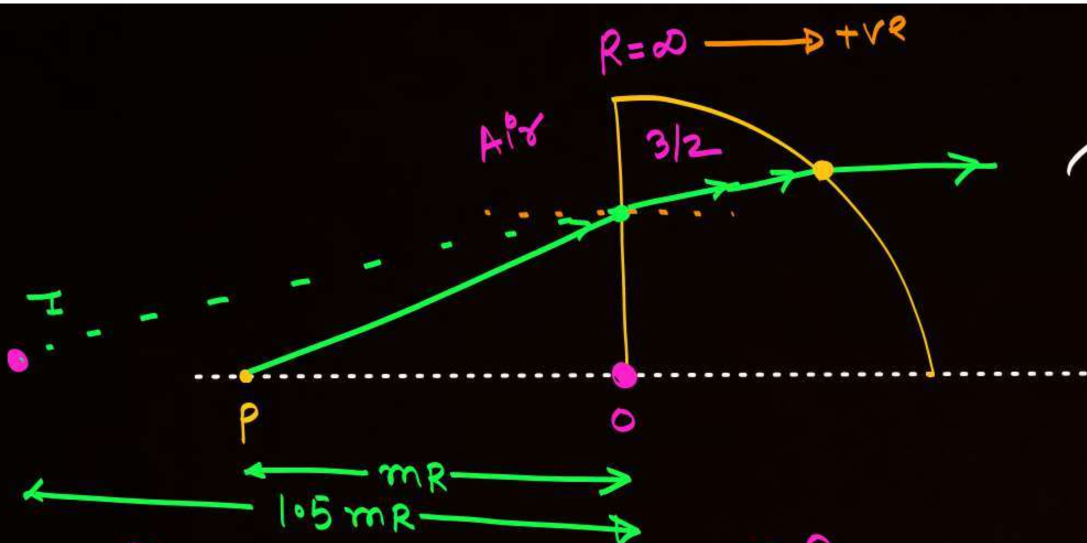
$v =$ ___.

Question 40

A quarter cylinder of radius R and refractive index 1.5 is placed on a table. A point object P is kept at a distance of mR from it. Find the value of m for which a ray from P will emerge parallel to the table as shown in the figure.

(JEE)





Plane

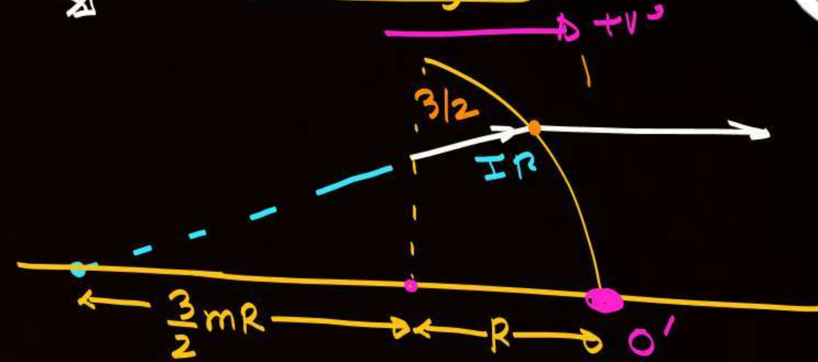
$$\frac{\mu_f}{v} - \frac{\mu_i}{u} = \cancel{\frac{\mu_f - \mu_i}{R}} \rightarrow 0$$

$$\frac{3}{2v} - \frac{1}{-mR} = 0$$

$$\frac{3}{2v} = -\frac{1}{mR}$$

$$\boxed{v = -\frac{3}{2}mR}$$

Second Surface



$$\frac{\mu_f}{v} - \frac{\mu_i}{u} = \frac{\mu_f - \mu_i}{R}$$

$\mu_i = 3/2$

$\mu_f = 1$

$u = -\left(\frac{3}{2}mR + R\right)$

$v = +\infty$

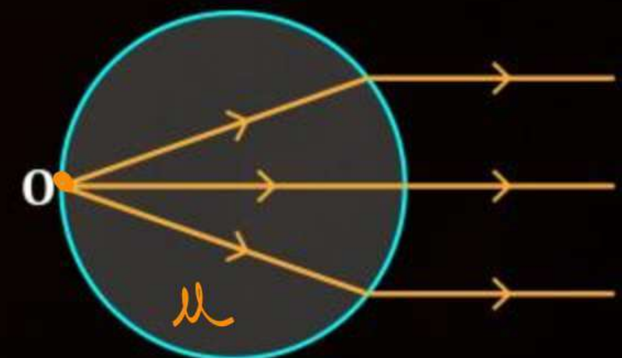
$R = -R$

$m =$ ___

Question 41

H/W

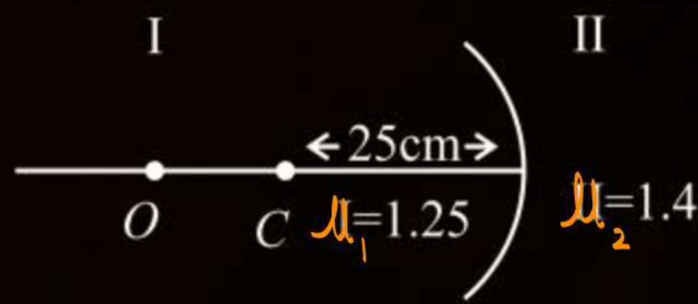
An object O is stuck on the surface of a transparent solid sphere of radius 20 cm. Find refractive index of the sphere such that rays from the object after refraction from the opposite side emerge as a parallel beam, as shown. Also prove that refractive index has the same value, in the given situation, for any value of radius of sphere.



Question (Homework)

Region I and II are separated by a spherical surface of radius 25 cm. An object is kept in region I and at a distance of 40 cm from the surface. The distance of the image from the surface is [Main 20th July 1st Shift 2021]

1. 9.52 cm
2. 37.58 cm
3. 55.44 cm
4. 18.23 cm



[Ans: 2]

Shift and Apparent Depth

Shift of object due to Refraction at Plane Surface

Case-1:- When O is in denser medium

$\mu_f = \mu_r$

$\mu_i = \mu_d$

$u = -d_o$

$v = -d_a$

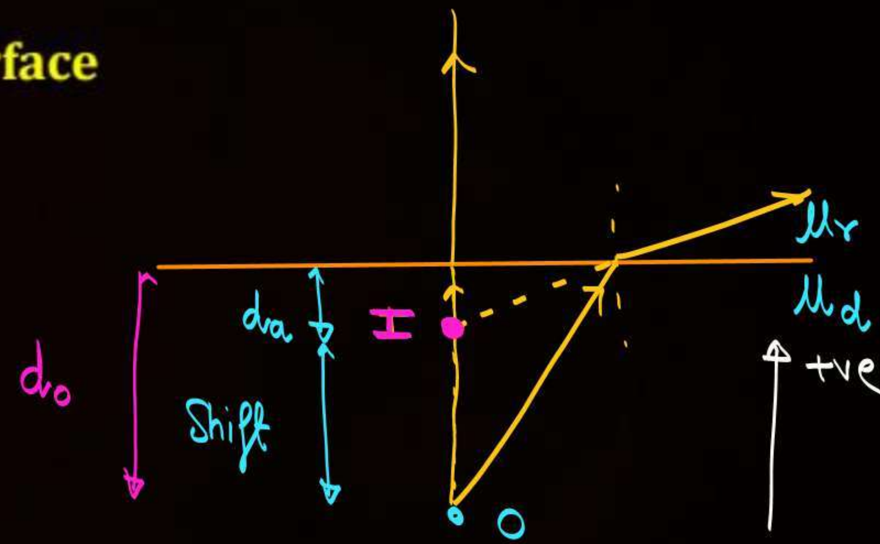
$\boxed{R = \infty}$

$$\frac{\mu_f}{v} - \frac{\mu_i}{u} = \frac{\mu_f - \mu_i}{\cancel{R}} \rightarrow 0$$

$$\frac{\mu_r}{-d_a} + \frac{\mu_d}{d_o} = 0$$

$$\boxed{d_a = \frac{\mu_r d_o}{\mu_d}}$$

If $\mu_r = 1$ $\quad \boxed{d_{app} = \frac{d_o}{\mu}}$



$$\boxed{\text{Shift} = d_o - \frac{d_o}{\mu} = d_o\left[1 - \frac{1}{\mu}\right]}$$

Shift and Apparent Depth

Shift of object due to Refraction at Plane Surface

Case-2:- When O is in rarer medium

$\mu_i = \mu_r$

$\mu_f = \mu_d$

$u = -h_o$

$v = -h_a$

$R = \infty$

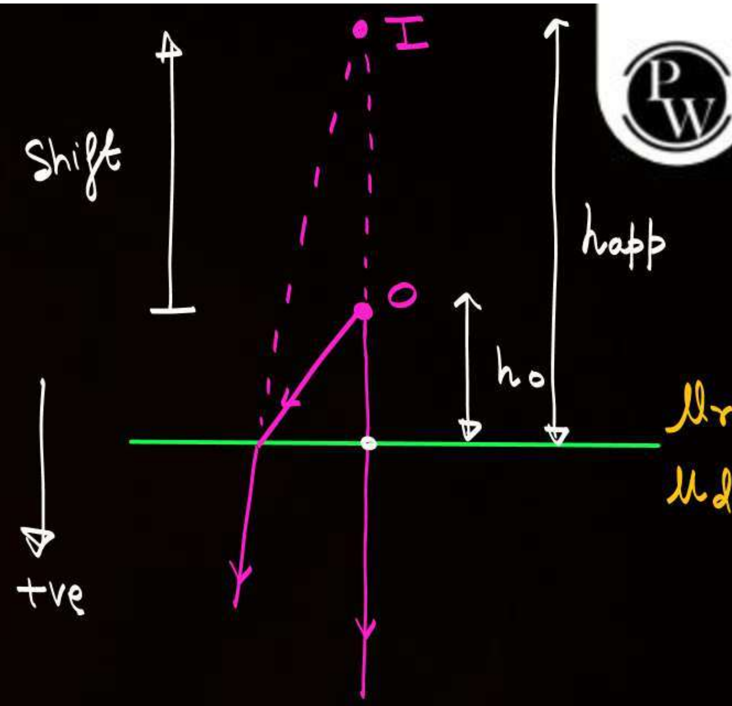
$$\frac{\mu_f}{v} - \frac{\mu_i}{u} = \cancel{\frac{\mu_f - \mu_i}{R}} \rightarrow 0$$

$$\frac{\mu_d}{-h_{ap}} + \frac{\mu_r}{h_o} = 0$$

$$\boxed{h_{app} = \frac{\mu_d h_o}{\mu_r}}$$

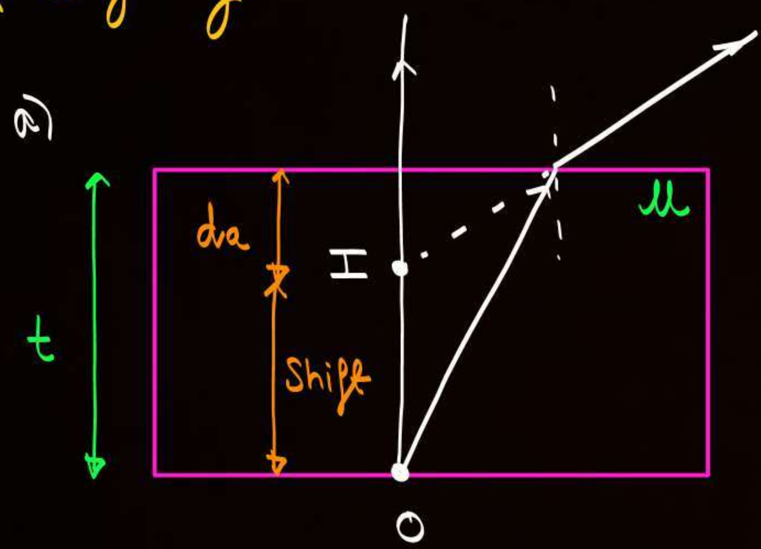
$\mu_r = 1$ $\boxed{h_{app} = \mu h}$

$$\boxed{\text{Shift} = \mu h - h = (\mu - 1)h}$$



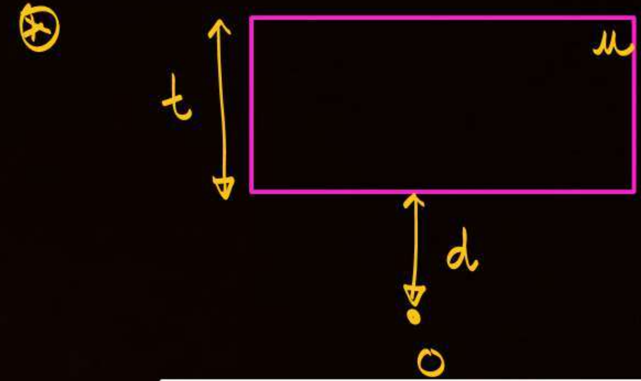
Shift by Slab

a)



$$d_a = \frac{d_{act}}{\mu} = \frac{t}{\mu}$$

$$\text{Shift} = t - \frac{t}{\mu} = t\left[1 - \frac{1}{\mu}\right]$$



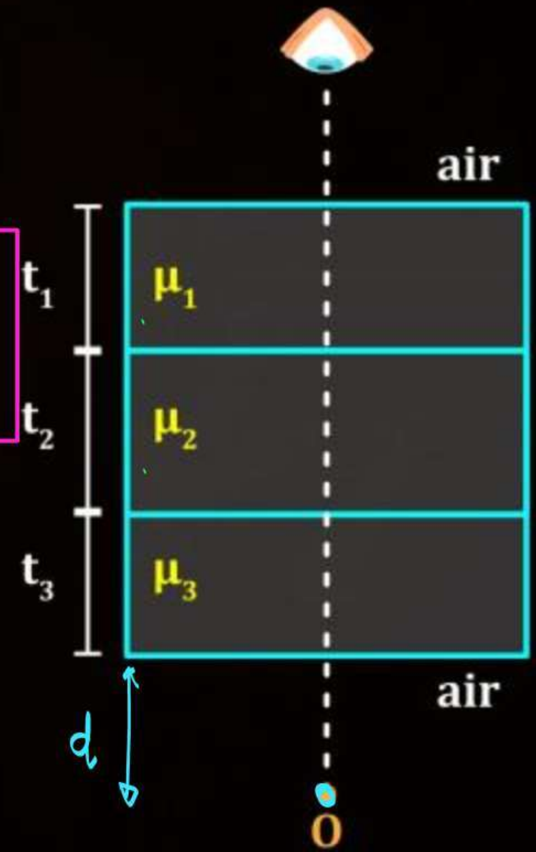
Shift by the Slab is $= t\left[1 - \frac{1}{\mu}\right]$

(Independent of d)

Shift by slabs and multiple slabs

Total Shift = $\sum$ Individual Shift.

$$\boxed{\text{Total Shift} = t_1\left[1-\frac{1}{\mu_1}\right] + t_2\left[1-\frac{1}{\mu_2}\right] + t_3\left[1-\frac{1}{\mu_3}\right]}$$



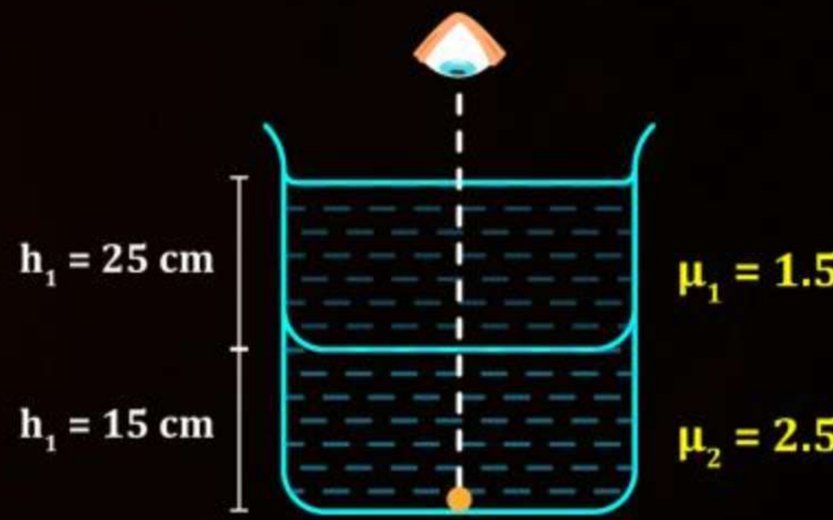
Question 42

Find the apparent depth of an object O placed at the bottom of a beaker as shown in which two layers of transparent liquids are filled.

(two - slab)

Total Shift $= h_1\left[1-\frac{1}{\mu_1}\right] + h_2\left[1-\frac{1}{\mu_2}\right]$

actual depth $= h_1 + h_2 = 25 + 15 = 40\,cm$



Apparent depth $= d_{actual} - $ Shift

$= 40 - [\text{Shift}]$

Question 43

A converging beam of light rays incident on a glass-air interface as shown. Find where these rays will meet after refraction.

$\mu_i = 1$

$\mu_f = 3/2$

$u = \text{(Intersection of IR)} = +20$

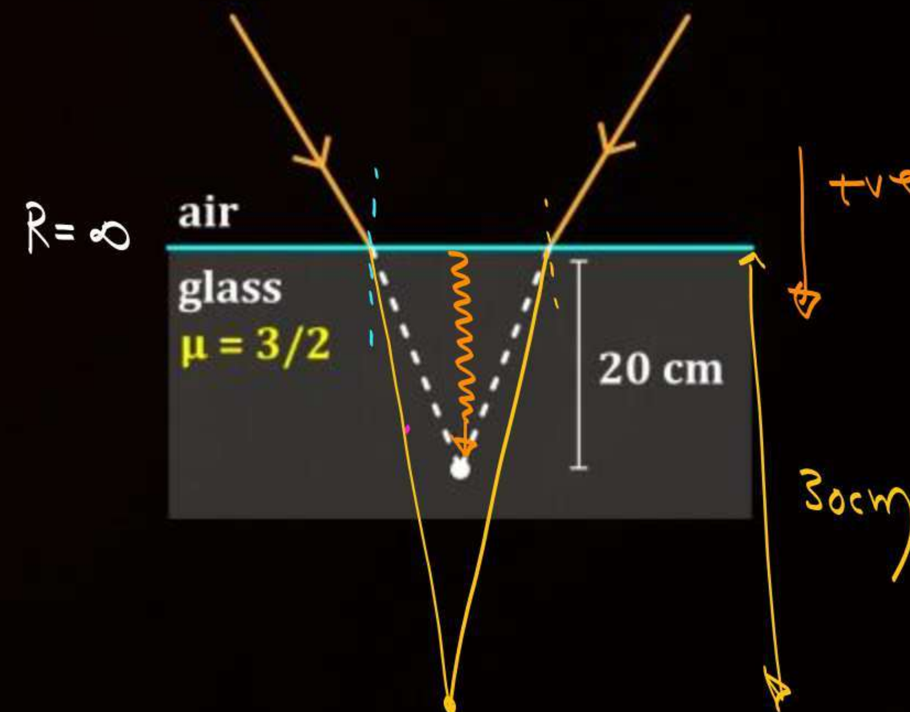
$v = +v$

$R = \infty$

$$\frac{\mu_f}{v} - \frac{\mu_i}{u} = \cancel{\frac{\mu_f - \mu_i}{R}} \to 0$$

$$\frac{3}{2v} - \frac{1}{+20} = 0$$

$$\boxed{v = +30\text{cm}}$$

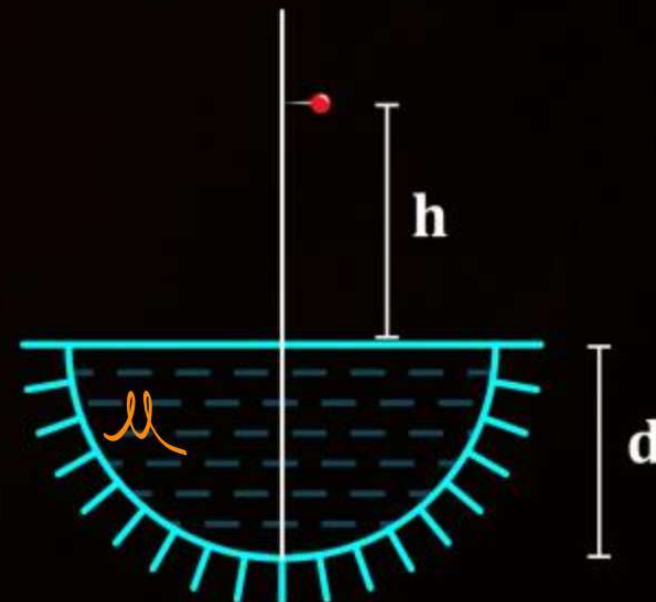


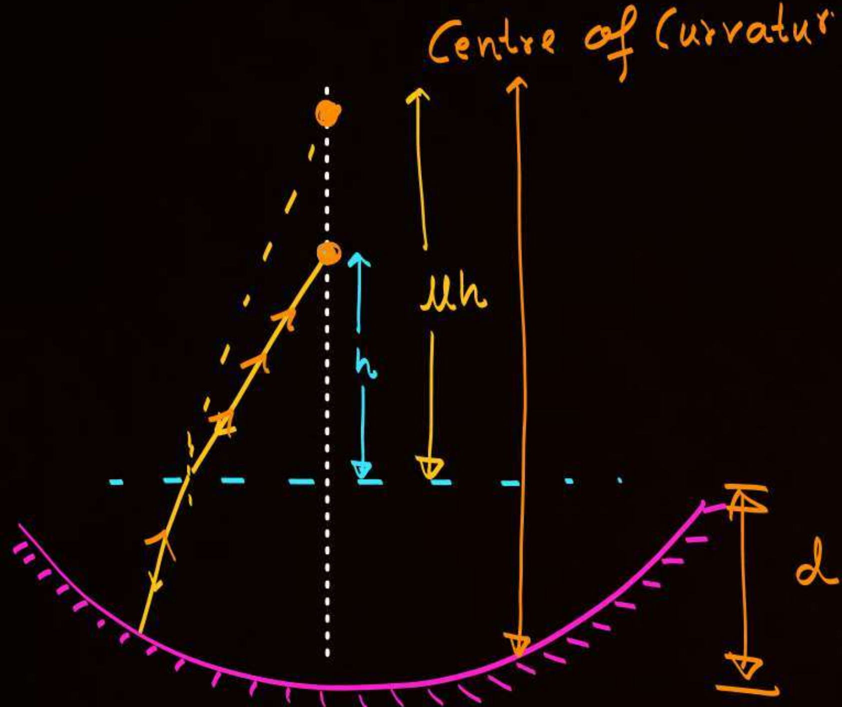
Question 44

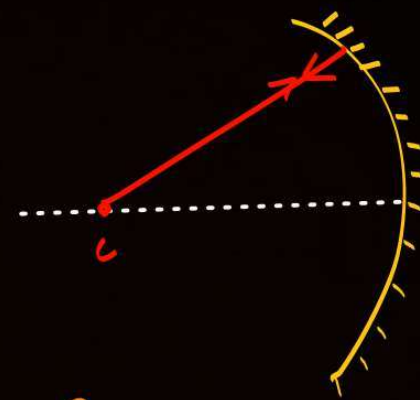
Figure shows a concave mirror of focal length F with its principal axis vertical. In mirror a transparent liquid of refractive index μ is filled upto height d. Find where on axis of mirror a pin should be placed so that its image will be formed on itself.

Concept:- Whenever Image has to be formed on object itself

(Retrack light)







$$\mu h + d = R$$

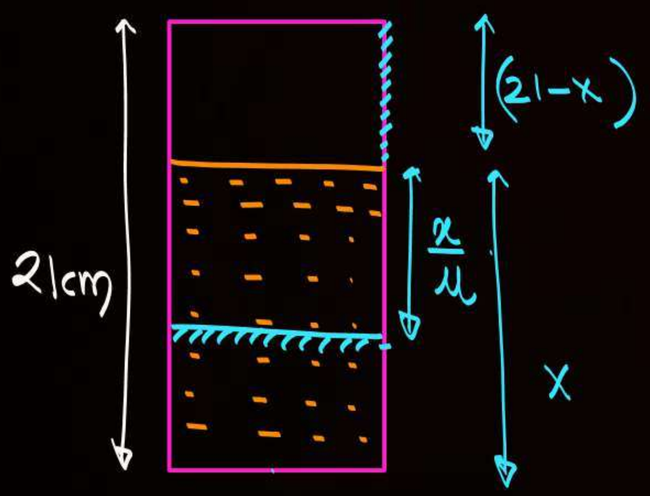
$$\mu h + d = 2f$$

$$\mu h = 2f - d$$

$$\boxed{h = \frac{2f - d}{\mu}}$$

Question 45

How much water should be filled in a container of height 21 cm so that it will appear half filled when viewed along normal to water surface. (Take $\mu_w = 4/3$)



Length of air coloum = length of Water coloumn

$$21 - x = \frac{x}{\mu}$$

$$21 - x = \frac{3x}{4}$$

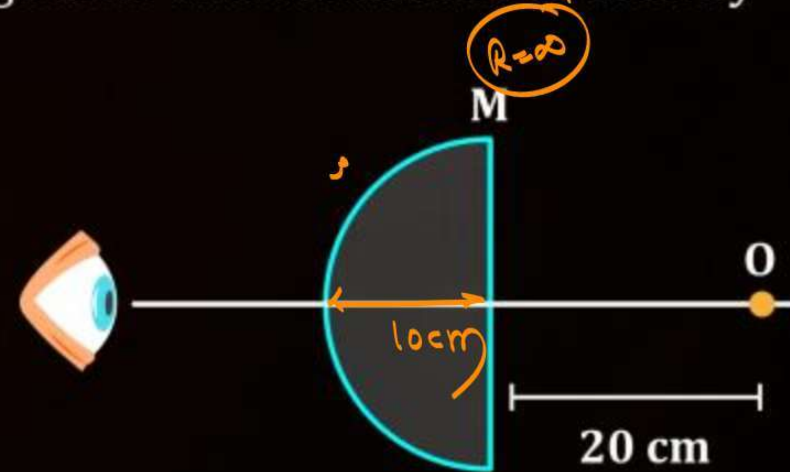
$$x = \_\_\_\_$$

Question 46

HW

Thick lens

Figure shows a glass hemisphere M of $\mu = 3/2$ and radius 10 cm. A point object O is placed at a distance 20 cm behind the flat face which is viewed by an observer from the curved side. Find location of final image after two refractions as seen by observer.

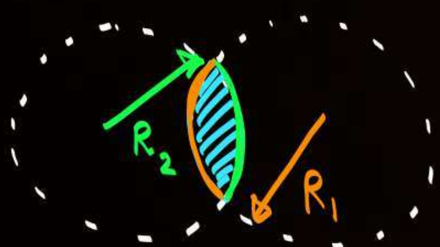


Thin Lenses and its Types

Beech se Mota hota hai!

Case-1:- Convex Lenses (Intersecting surface lenses)

Biconvex lens



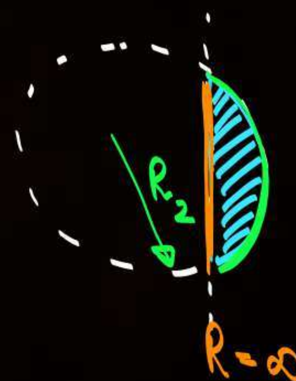
Bi-Convex

If $R_1 = R_2$

Equi-Convex lens.

Concavo-convex lens

Plano-convex lens



Thin Lenses and its Types

→ Beech Se Patla hota hai.

Case-2:- Concave Lenses (Non-Intersecting surface lenses)

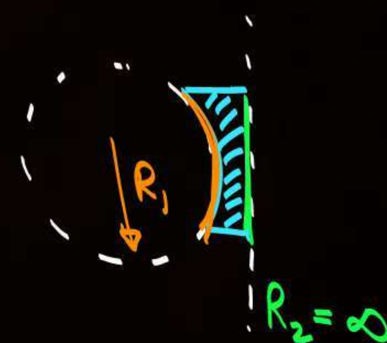
Bi-Concave

If $R_1 = R_2$

Equi-Concave.

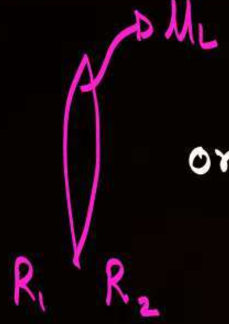
Convexo-Concave

Plano-Concave.



Lens Makers Formula

$\Rightarrow$ $\boxed{\text{derive focal length of thin lenses}}$



or any lens

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

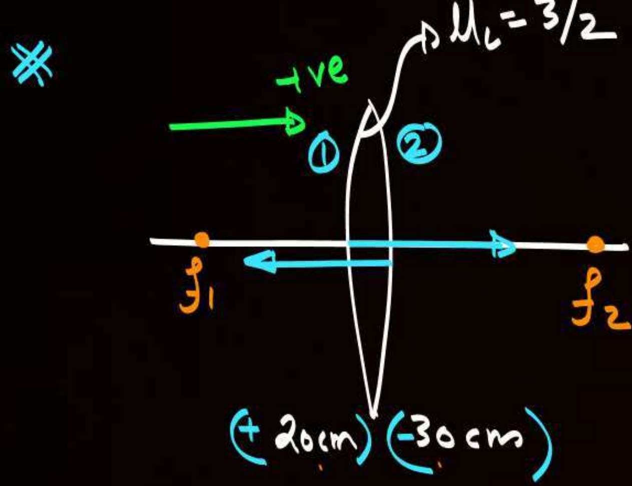
Lens Maker formula.

R_1 = first surface light is incident

R_2 = Second surface " " "

Please take time to consider R_1 & R_2

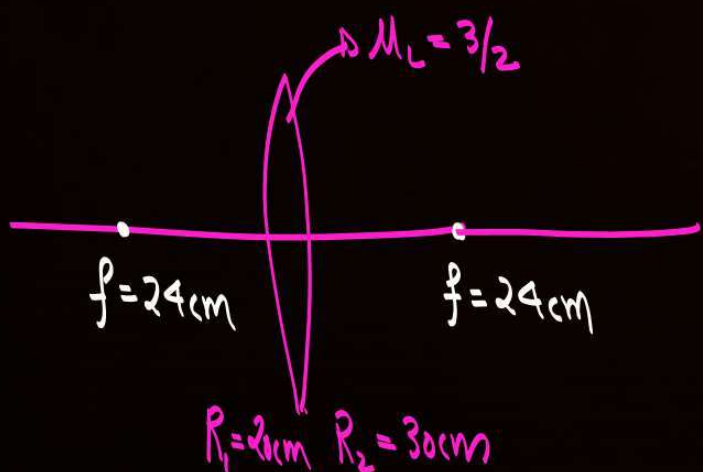
- Focus will be same on both side of lens even if radius is different
- Calculation of focal length using lens maker formula is independent of direction of incident ray
- We have to use the same sign convention used before. Light incident on first surface will be considered for first surface.
- For thick lenses we have to use the refraction formula separately for two surfaces keeping in consideration of thickness

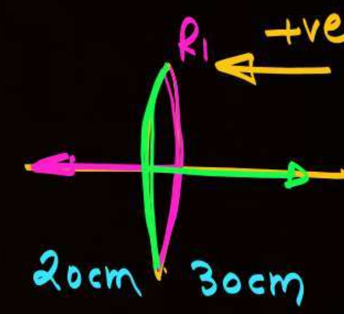


$$\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left[\frac{1}{+20} - \frac{1}{-30}\right]$$

$$\frac{1}{f} = \frac{1}{2} \times \frac{\cancel{5}}{\cancel{60}\,12}$$

$$\boxed{f = 24\,\text{cm}}$$





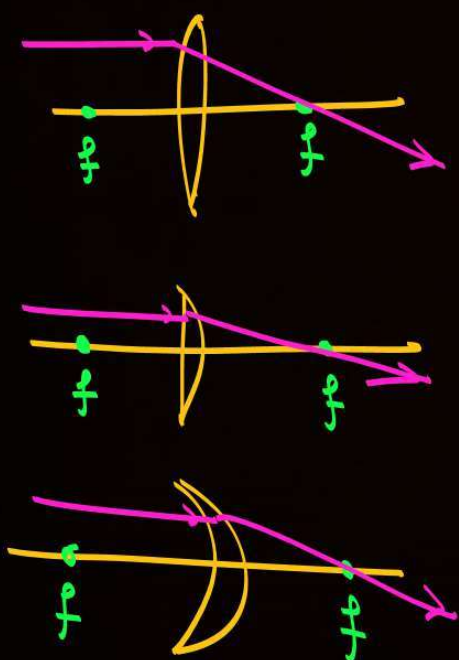
$$\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left[\frac{1}{+30} - \frac{1}{-20}\right]$$

$$\frac{1}{f} = \frac{1}{2} \times \frac{5}{60}$$

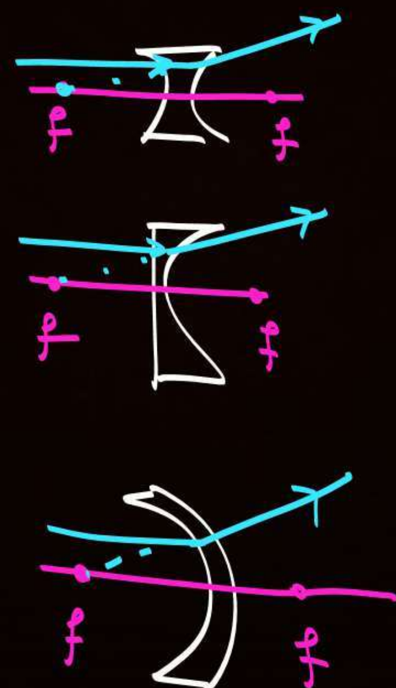
$$\boxed{f = +24\,\text{cm}}$$

⊛ After Lens Make formula $f = +ve$ (Converging) (Main focus in dir of IR)

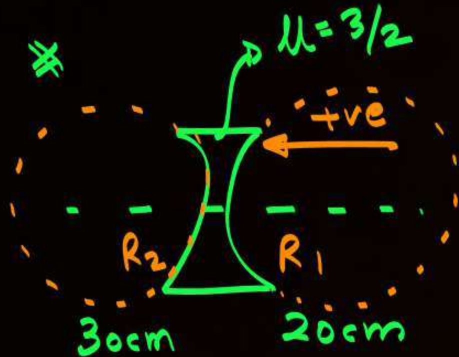
$f = -ve$ (diverging) (Main focus in opp dir of IR)



Converging.



#



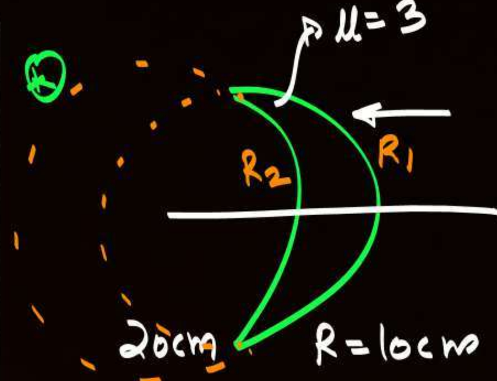
$$\boxed{\frac{1}{f} = \left(\frac{3}{2}-1\right)\left[\frac{1}{-20} - \frac{1}{30}\right]}$$

$R_1 = -20$

$R_2 = +30$

$f = -24\,cm$

(diverging)

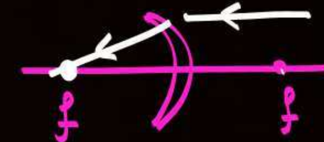


$$\frac{1}{f} = (3-1)\left[\frac{1}{+10} - \frac{1}{+20}\right]$$

$f = +ve\ 10\,cm$

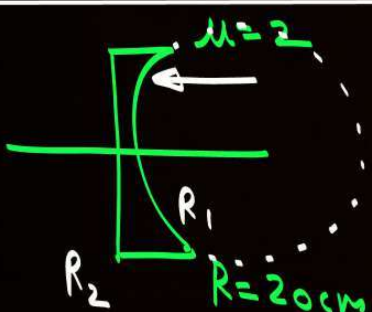
$R_1 = +10$

$R_2 = +20$



Converging.

#

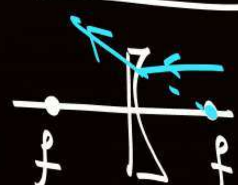


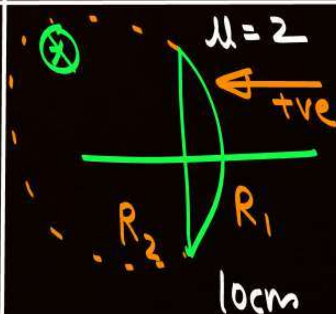
$$\frac{1}{f} = (2-1)\left[\frac{1}{-20} - \frac{1}{\infty}\right]$$

$\boxed{f = -20\,cm}$ diver

$R_1 = -20$

$R_2 = \infty$



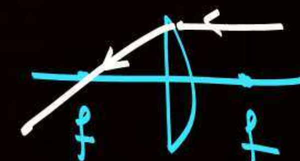


$$\frac{1}{f} = (2-1)\left[\frac{1}{10} - \frac{1}{\infty}\right]$$

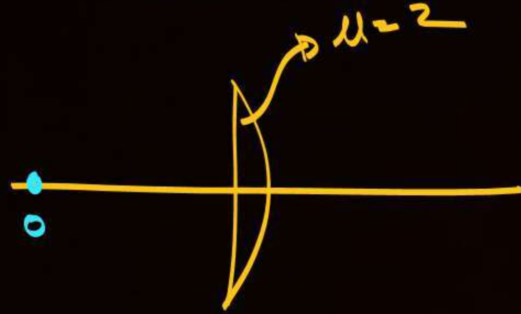
$\boxed{f = +10\,cm}$ Converging.

$R_1 = +10$

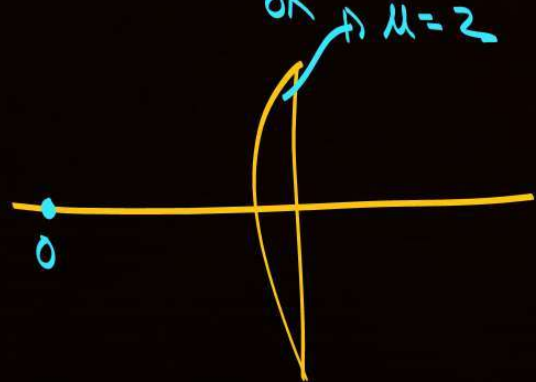
$R_2 = \infty$



for Thin lenses :



OR



Both are Same.

"f is indep of orientation" of Thin lenses.

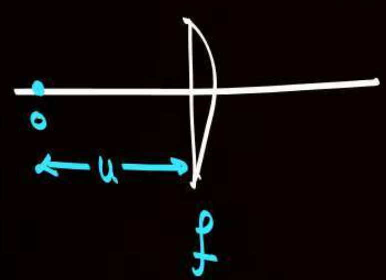
Light pahle plane par gire ya Curve par Koi difference nahi hai.

Lens Formula

for any lens $\boxed{\frac{1}{f} = \left(\frac{\mu_L}{\mu_s} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]}$

⊛ lens Maker formula.

⊛



$$\boxed{\text{Lens formula} = \frac{1}{f} = \frac{1}{v} - \frac{1}{u}}$$

⊛ Same Sign Convention

u = object dist

v = Image dist

f = focal length

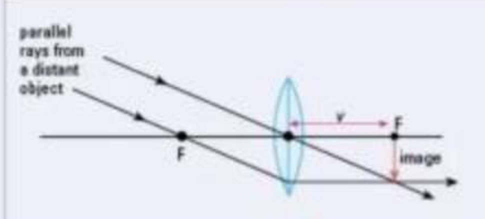
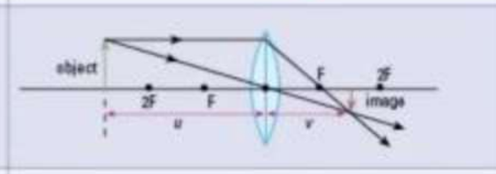
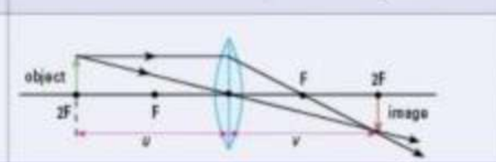
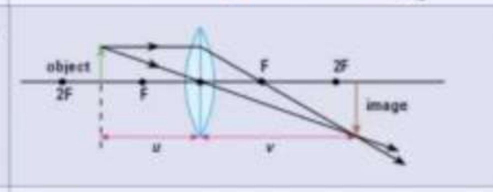
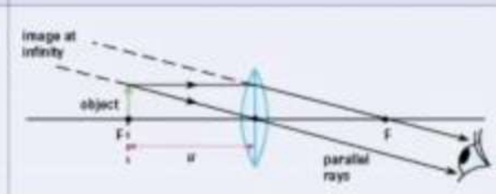
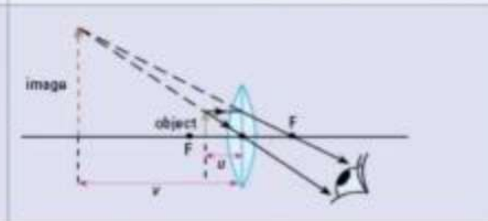
magnifications

$$\boxed{m_{Lat} = \frac{h_I}{h_O} = \frac{v}{u}} \qquad \boxed{m_{Long} = \frac{t_I}{t_O} = \frac{v^2}{u^2}}$$

⊛ $v_{I \parallel PA} = (m_{Long})\, v_{O \parallel PA}$

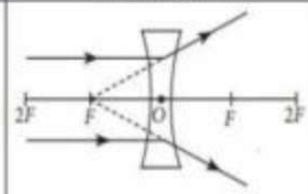
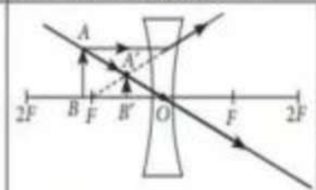
$v_{I \perp PA} = (m_{Lat})\, v_{O \perp PA}$

Ray Diagrams

$u = \infty$		- inverted - real - diminished	$v = f$ - opposite side of the lens
$u > 2f$		- inverted - real - diminished	$f < v < 2f$ - opposite side of the lens
$u = 2f$		- inverted - real - same size	$v = 2f$ - opposite side of the lens
$f < u < 2f$		- inverted - real - magnified	$v > 2f$ - opposite side of the lens
$u = f$		- upright - virtual - magnified	- image at infinity - same side of the lens
$u < f$		- upright - virtual - magnified	- image is behind the object - same side of the lens

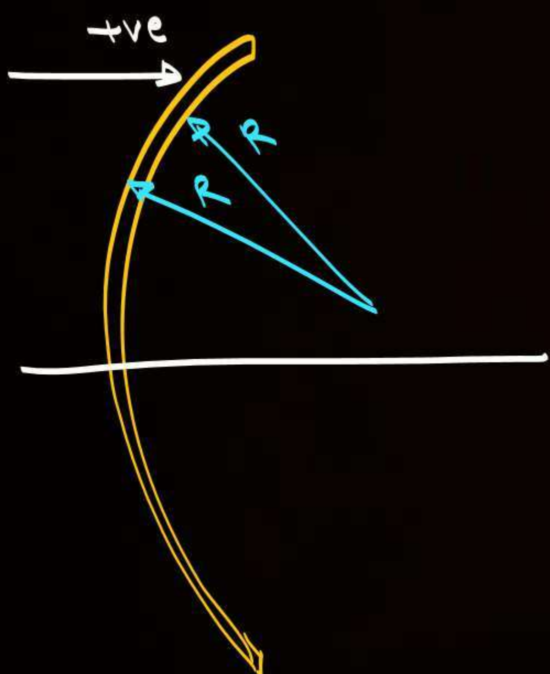
Ray Diagrams

Concave lens

	Ray diagram	Position of object	Position of image	Nature of image
(a)	 $u = -ve$, $v = -ve$ and $f = -ve$	At infinity	At F	Virtual, erect and highly diminished
(b)	 $u = -ve$, $v = -ve$ and $f = -ve$	Between infinity and O	Between F and O	Virtual, erect and diminished

Question 47

Prove that a hollow equiconvex lens of glass will behave like a glass plate.

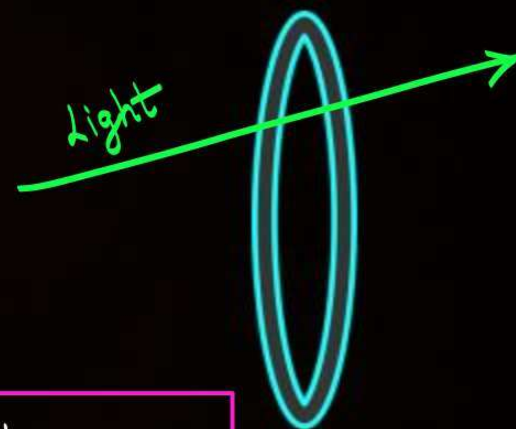


$$\frac{1}{f} = (\mu - 1)\left[\frac{1}{R} - \frac{1}{R}\right]$$

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

$$\boxed{f = \infty}$$

No Convergence & No divergence



Thin hollow equi-Convex

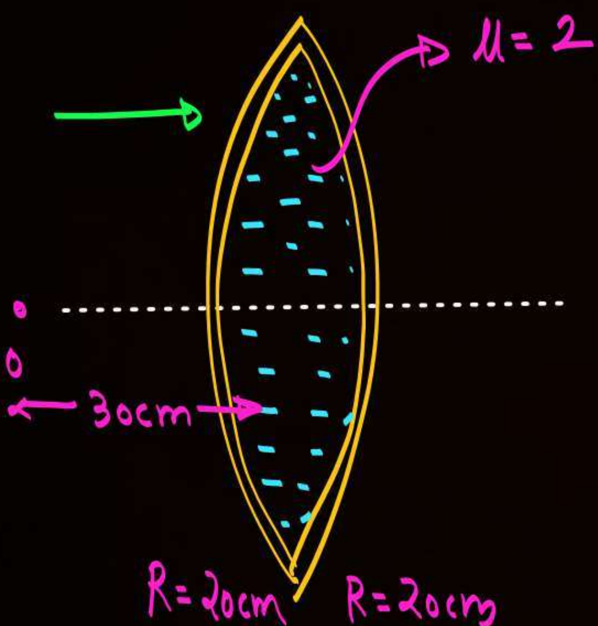


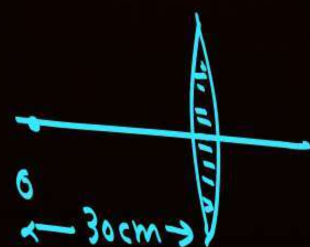
Image location = ?

"Liquid lens"

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

$$\frac{1}{f} = \frac{2}{20}$$

$$\boxed{f = +10\,cm}$$



f = +10cm

$u = -30$

$f = +10$

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

$v = \underline{+15}\,cm$

Combination of Lenses

When two thin are in Contact

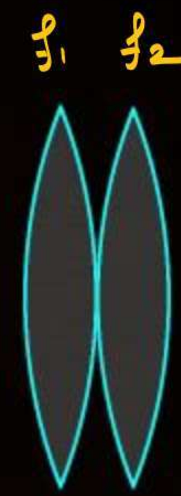
we Can replace them with an equivalent Lens

$$\boxed{\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}}$$

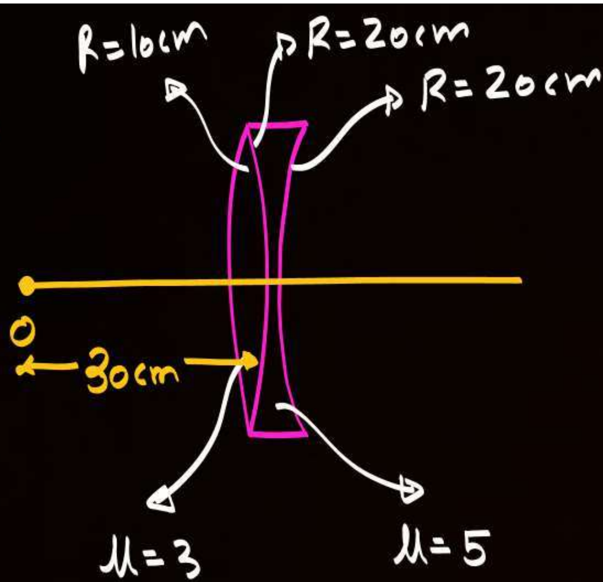
with Sign

f_{eq} = +ve Converging lens will Replace both

= −ve diverging " " " "



Ex



Location of Image.

Convex lens $\frac{1}{f} = (3-1)\left[\frac{1}{+10} - \frac{1}{-20}\right]$

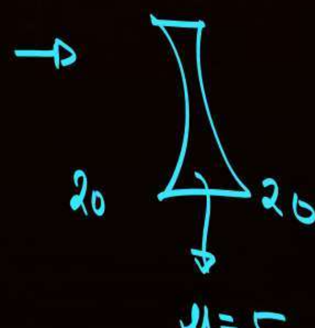
$$\frac{1}{f} = 2\left[\frac{2+1}{20}\right] \Rightarrow f = +\frac{10}{3}$$

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{3}{10} - \frac{2}{5}$$

$$= \frac{3-4}{10}$$

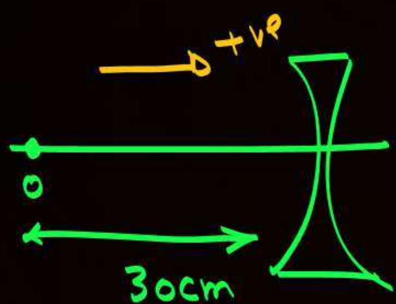
$$\boxed{f_{eq} = -10}$$

Concave lens:- $\frac{1}{f_2} = (5-1)\left[\frac{1}{-20} - \frac{1}{20}\right]$



$$\frac{1}{f_2} = \frac{-4\times 2}{20}$$

$$\boxed{f_2 = -\frac{5}{2}}$$



$f = -10\,\text{cm}$

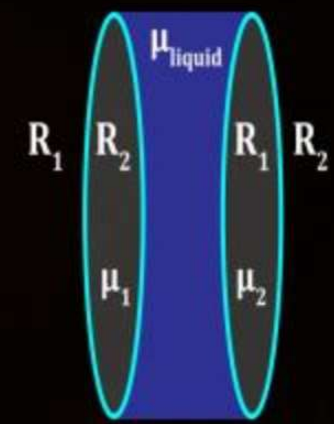
$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$-\frac{1}{10} = \frac{1}{v} - \frac{1}{-30}$$

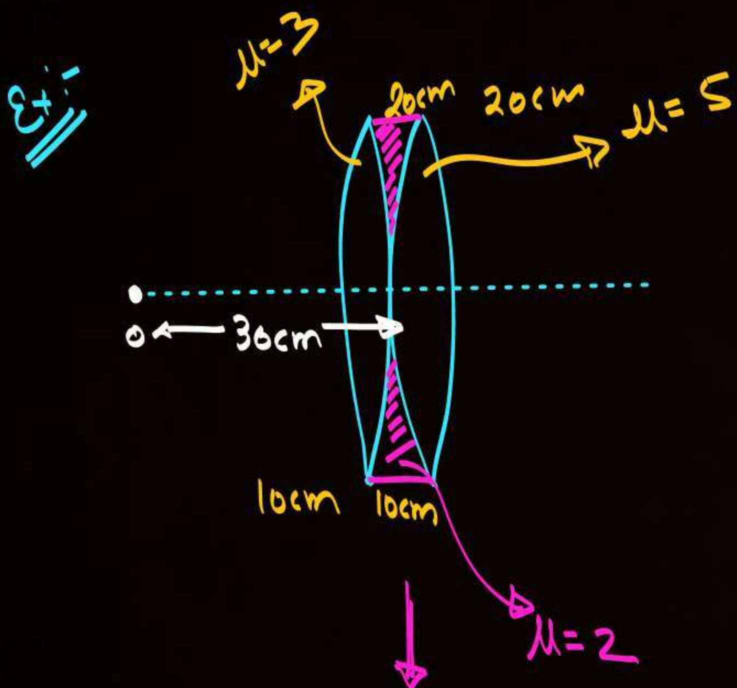
$$v = \underline{\qquad\qquad}$$

Combination of Lenses

Two convex lenses are placed, the gap between them is filled with a liquid of refractive index μ liquid. This combination is placed in the air then. The system is equal to combination of three thin lenses in contact, then



Ex:

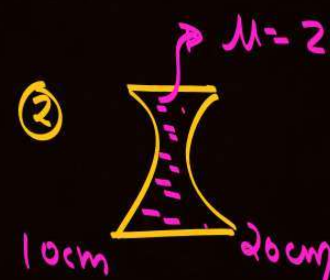


Three thin lenses in Contact.

① lens $\frac{1}{f_1} = (3-1)\left[\frac{1}{+10} - \frac{1}{-10}\right]$

$\frac{1}{f_1} = 2\times\frac{2}{10}$ $\boxed{f_1 = +\frac{5}{2}}$

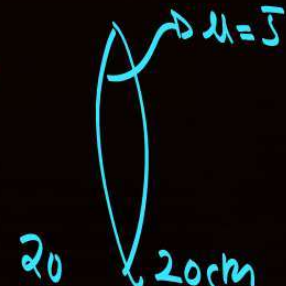
②



$\frac{1}{f_2} = (2-1)\left[-\frac{1}{10} - \frac{1}{20}\right]$

$\frac{1}{f_2} = \frac{-3}{20}$ $\boxed{f_2 = -\frac{20}{3}}$

③



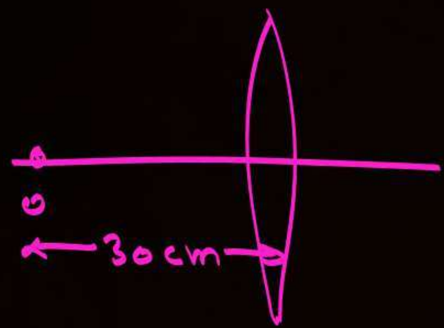
$\frac{1}{f_3} = (5-1)\left[\frac{1}{20} - \frac{1}{-20}\right]$ $\frac{1}{f_2} = \frac{\cancel{4}\times 2}{\cancel{20}\,5}$

$f_2 = 5/2$

$\frac{1}{f_{eq}} = \frac{2}{5} + \frac{2}{5} - \frac{3}{20}$

$\frac{1}{f_{eq}} = \frac{8+8-3}{20} = \frac{13}{20}$

$f_{eq} = +\frac{20}{13}$



$$f = +\frac{20}{13}$$

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

$u = -30$

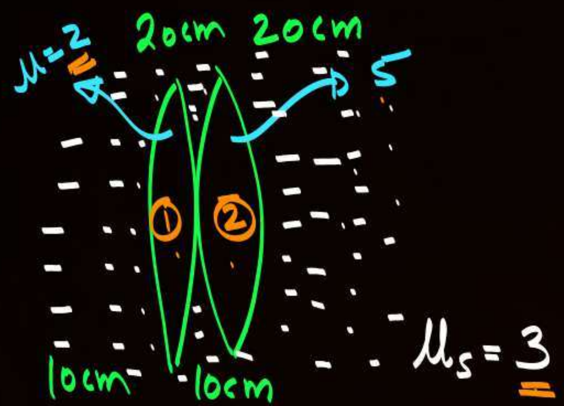
$f = +\frac{20}{13}$

$v =$ ________

Combination of Lenses

Two convex lenses are kept in contact and the whole arrangement is placed in a liquid of refractive index μ_{liquid} then this is equivalent to combination of two lenses kept in contact in a medium.

Ex



$\Downarrow$

Combination

$$\frac{1}{f_{eq}} = \frac{1}{+15} + \frac{1}{-15} = 0$$

$$f_{eq} = \infty$$

Kisi Kaam Ke Nahi hai ye dono.

Lens-①

$$\frac{1}{f_1} = \left(\frac{2}{3} - 1\right)\left[\frac{1}{10} - \frac{1}{-10}\right]$$

$$\frac{1}{f_1} = -\frac{1}{3} \times \frac{2}{10} \qquad f_1 = -15\,cm \text{ divergin}$$

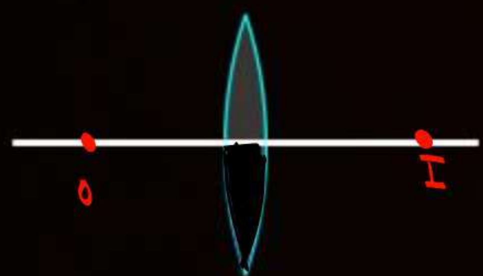
Lens-②

$$\frac{1}{f_2} = \left(\frac{5}{3} - 1\right)\left[\frac{1}{+20} - \frac{1}{-20}\right]$$

$$\frac{1}{f_2} = \frac{\cancel{2}}{3} \times \frac{\cancel{2}}{\cancel{20}\,10} = \boxed{f_2 = +15\,cm} \text{ (Converging)}$$

Important Points

Every part of a lens forms complete image. If a portion of lens is obstructed full image will be formed but the intensity will be reduced.



Mirror | Lens

Image → complete

Brightness → ↓.

White Light (VIBGYOR)

$\xrightarrow{\quad} \lambda$

$\mu \xleftarrow{\quad}$

$\xrightarrow{\quad} f$

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

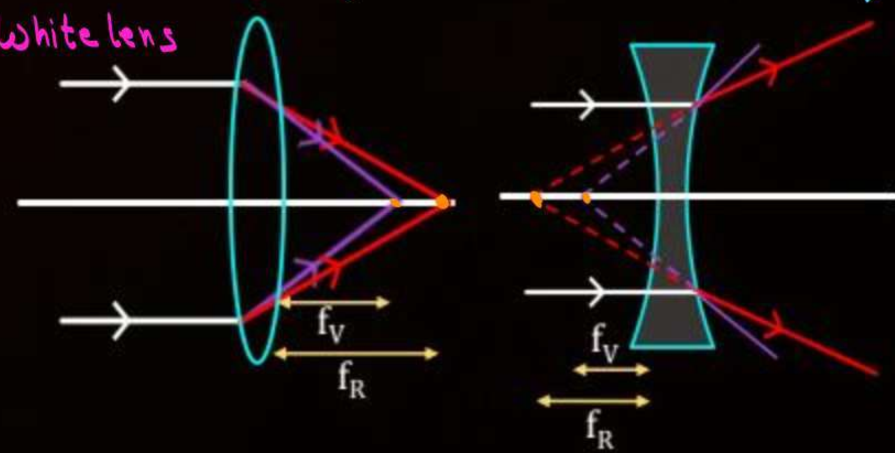
$f_R > f_V$

The focal length of a lens depends on its refractive index i.e.,

$$\frac{1}{f} \propto (\mu - 1)$$

(Chromatic Abberations)

White lens



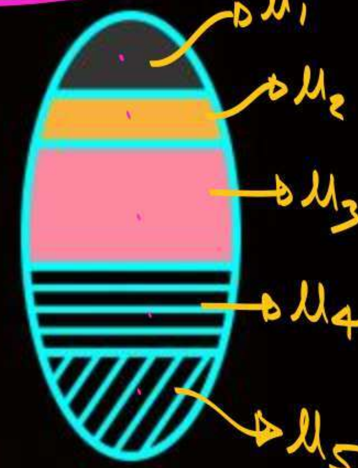
Important Points

Filling up of a lens

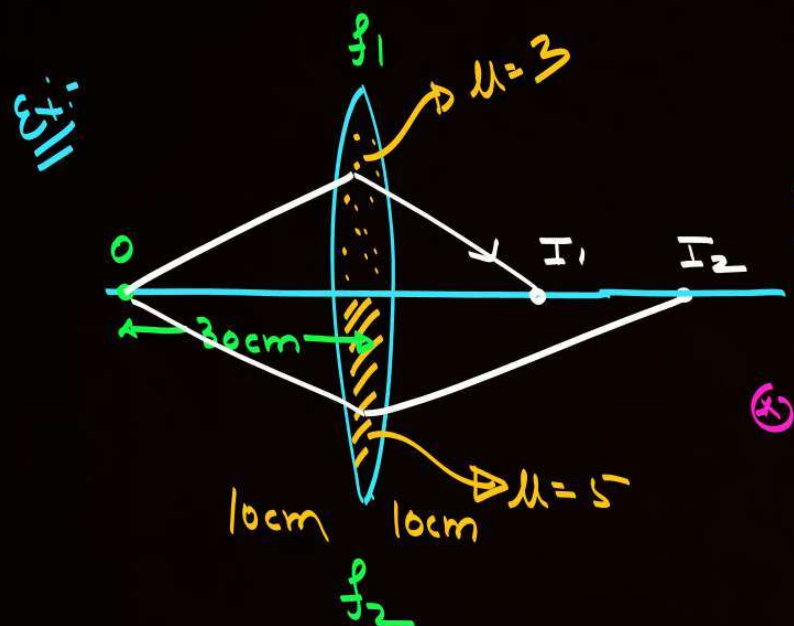
If a lens made a number of layers of different refractive indices as shown in figure for a given wavelength of light it will have many focal lengths

No of I = 5

$$\frac{1}{f} \propto (\mu - 1)$$



No of Images = No of RI



$\Rightarrow \boxed{\text{No of Images} = 2}$

$$\frac{1}{f} = \left(\frac{\mu_L}{\mu_s} - 1\right)\underbrace{\left[\frac{1}{R_1} - \frac{1}{R_2}\right]}_{\text{Same.}}$$

$$\frac{1}{f_1} = (3-1)\left[\frac{1}{10} - \frac{1}{-10}\right] = \quad \frac{1}{f_1} = 2\times\frac{2}{10}$$

$$\boxed{f_1 = \frac{5}{2}}$$

$$\frac{1}{f_2} = (5-1)\left[\frac{1}{10} - \frac{1}{-10}\right]$$

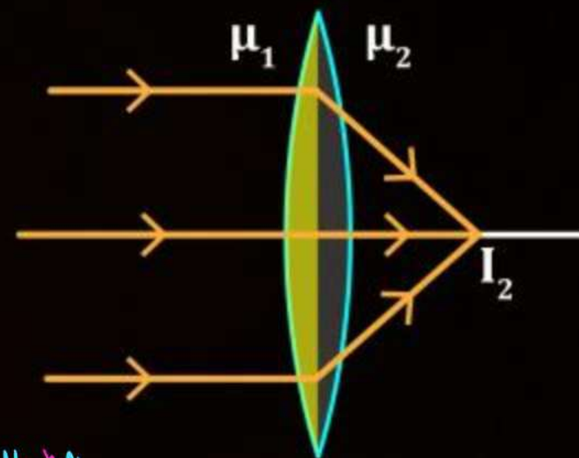
$$\frac{1}{f_2} = 4\times\frac{2}{10} \qquad f_2 = 5/4$$

$u_1 = -30$	$u_2 = -30$
$f_1 = +\frac{5}{2}$	$f_2 = +5/4$
$v_1 =$ ___	$v_2 =$ ___

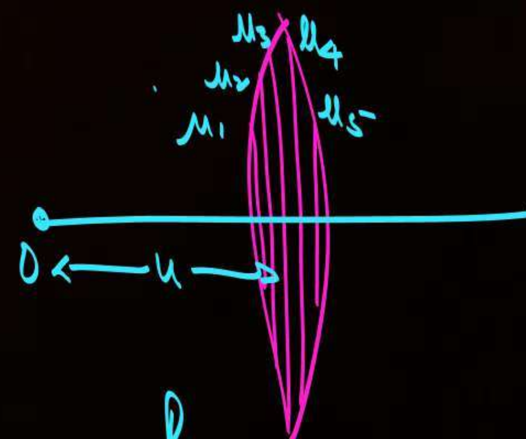
Important Points

Filling up of a lens

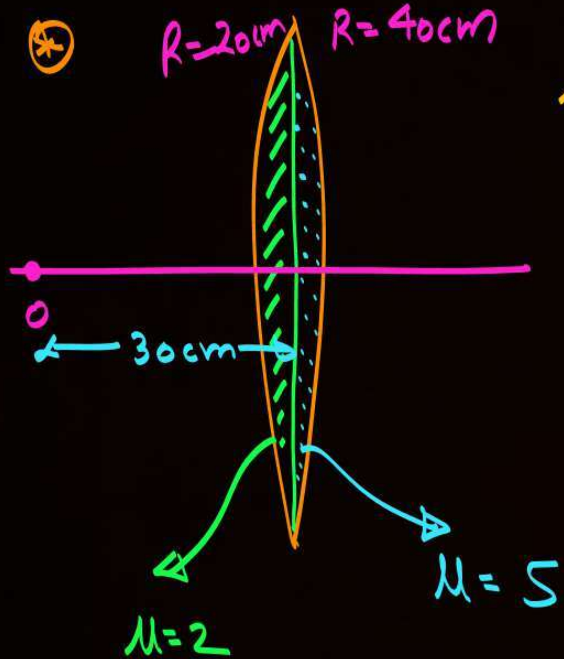
If a lens is made of two or more materials and are placed side by side as shown in figure, then there will be one focal length and hence one image.



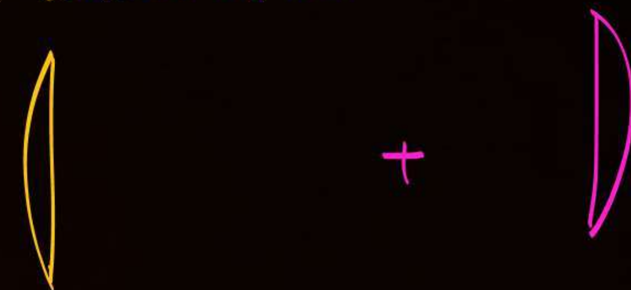
No of I = 1



f_{eq} = ✓



Two thin Lenses in Contact



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

$$\boxed{f_1 = +20}$$

$$\frac{1}{f_2} = (5-1)\left[\frac{1}{\infty} - \frac{1}{-40}\right]$$

$$\boxed{f_2 = +10\text{ cm}}$$

Contact

$$\frac{1}{f_{eq}} = \frac{1}{20} + \frac{1}{10} = \frac{3}{20}$$

$$f_{eq} = 20/3$$

No of Images = 1

$u = -30$

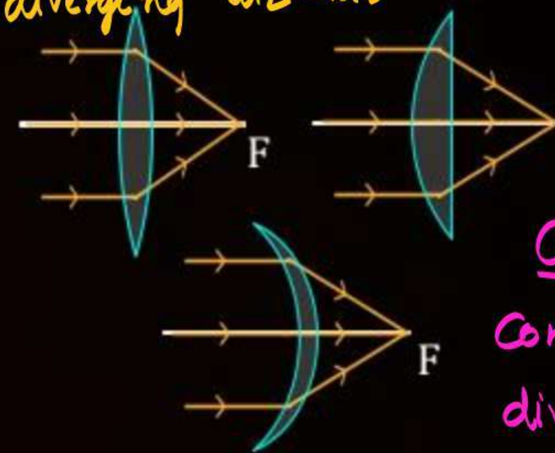
$f = +20/3$ $\quad v =$ ____

Important Points

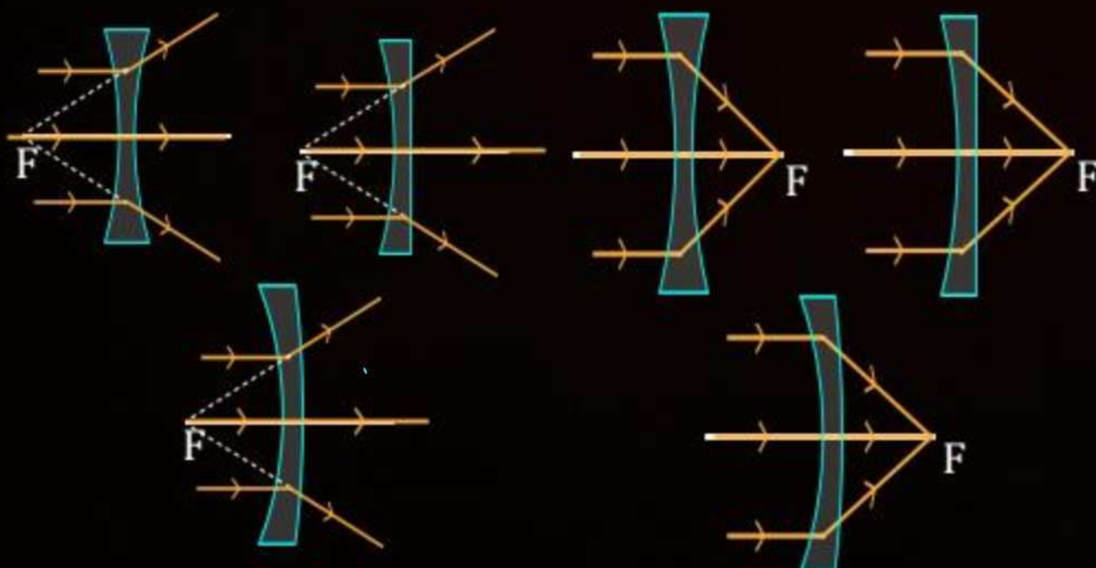
Convex → Converging $\mu_L > \mu_s$
diverging $\mu_L < \mu_s$

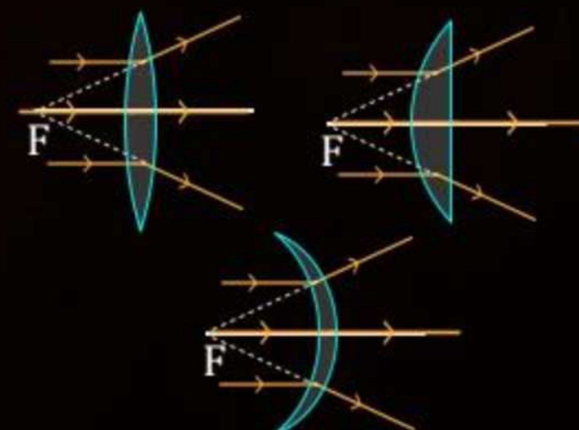
Lens immersed in a liquid

If a lens made of material of refractive index μ_{lens} is immersed in a liquid of refractive index μ_{liquid},

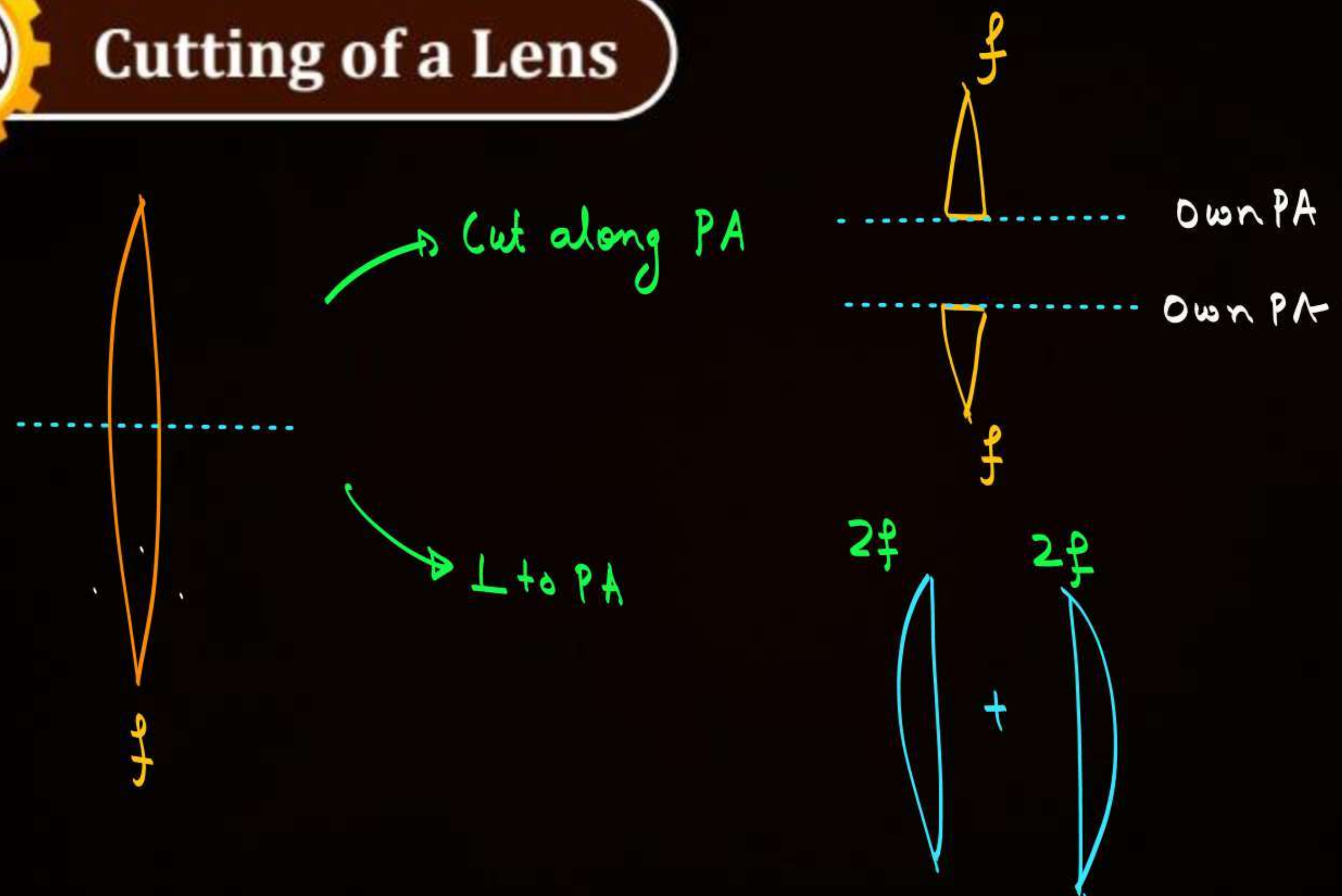


Concave.
Conver $\mu_L < \mu_s$
diver $\mu_L > \mu_s$





Cutting of a Lens



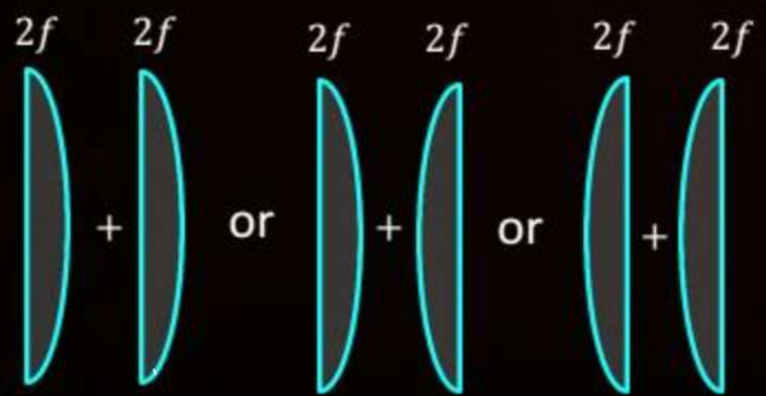
when Combined back

$$\frac{1}{f_{eq}} = \frac{1}{2f} + \frac{1}{2f}$$

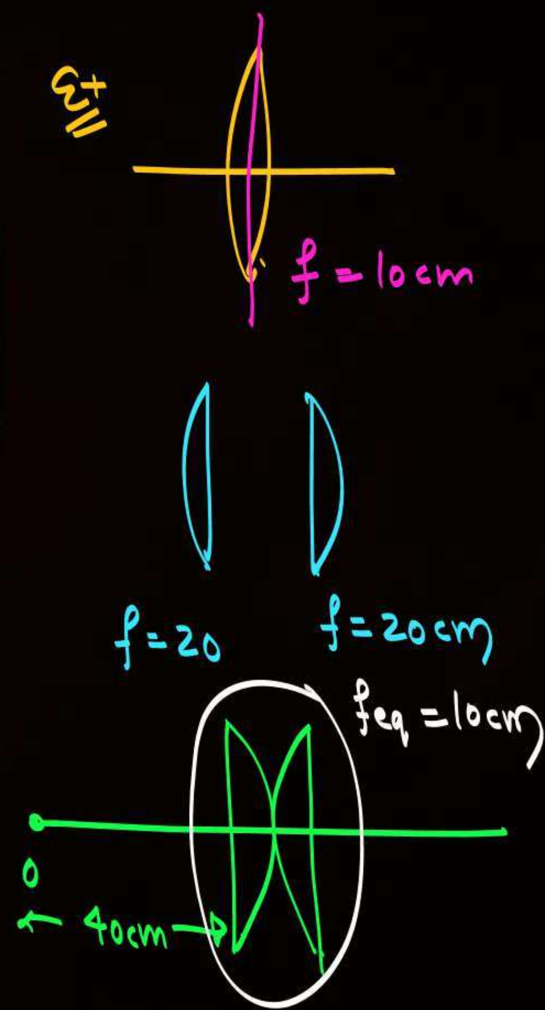
$$f_{eq} = f$$

Cutting of a Lens

Equi-convex lens is divided into two equal parts transverse to the principal axis. The focal length of each part is 2f. If these two parts are put in contact in a different combination, then

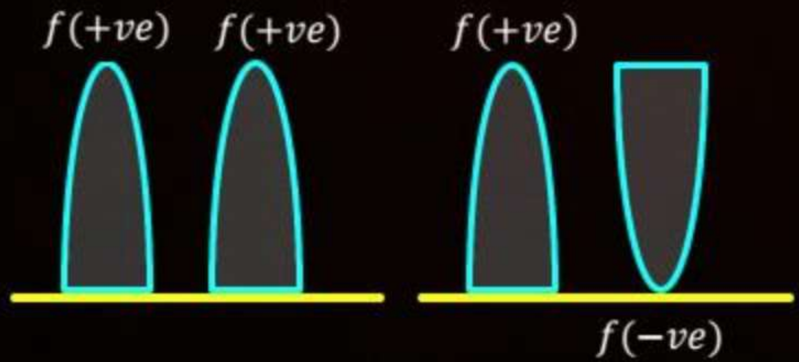


$f_{eq} = f$ $f_{eq} = f$ $f_{eq} = f$.



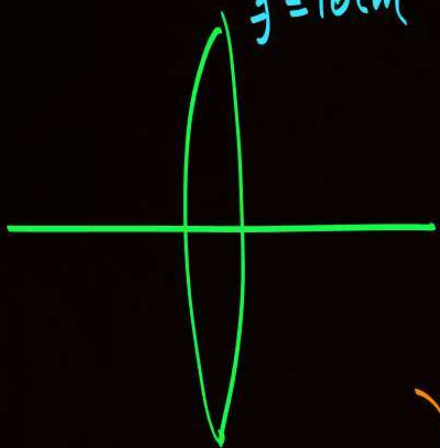
Cutting of a Lens

Equi-convex lens is divided into two equal parts along its principal axis, the focal length of each part is f. If these two parts are put in contact in different combination, then

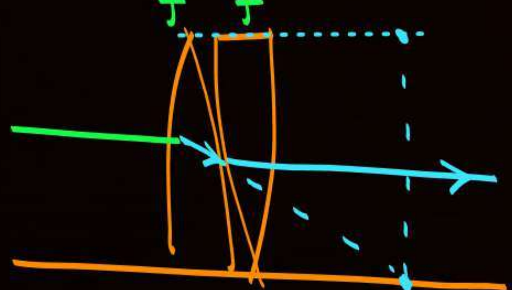


Ex:

$f = 10\,cm$



Cut along PA

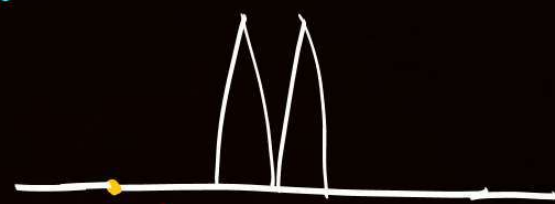


No Convergence No divergence

Converging Converging

Effect Cancelled out. $f_{eq} = \infty$

$f = 10\,cm$ $f = 10\,cm$



find location of Image.

→ Two thin lenses in Contact

$u = -30\,cm$

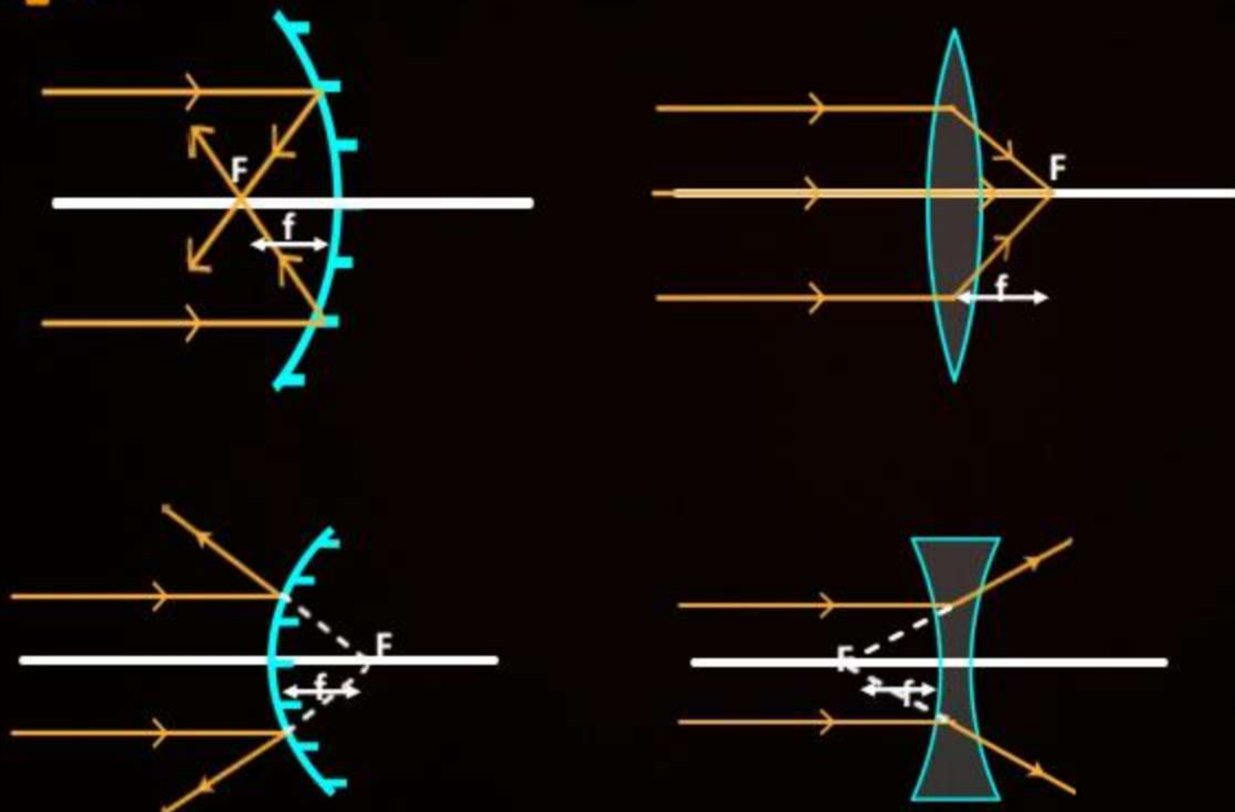
$f = +5$

$v = \_\_\_\_$.

$$\frac{1}{f_{eq}} = \frac{1}{10} + \frac{1}{10}$$

$f_{eq} = 5$

Power of Concave Mirror and Convex Lens



$$P_M = -\frac{1}{f(m)}$$

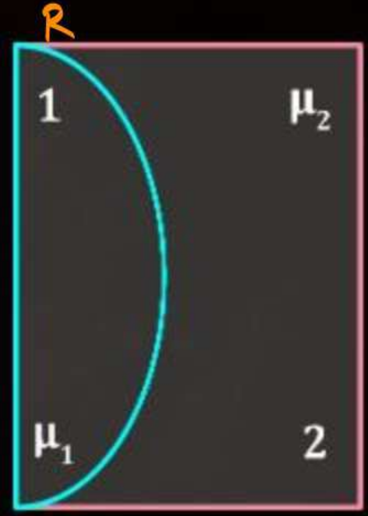
$$P_L = \frac{1}{f(m)}$$

Converging Mirror | lens $P = +ve$

diverging Mirror | lens $P = -ve$

Question 48

One plano-convex and one plano-concave lens of same radius of curvature R but of different materials are joined side by side as shown in figure. If the refractive index of the material 1 is μ_1 and that of 2 is μ_2, then the focal length of the combination is



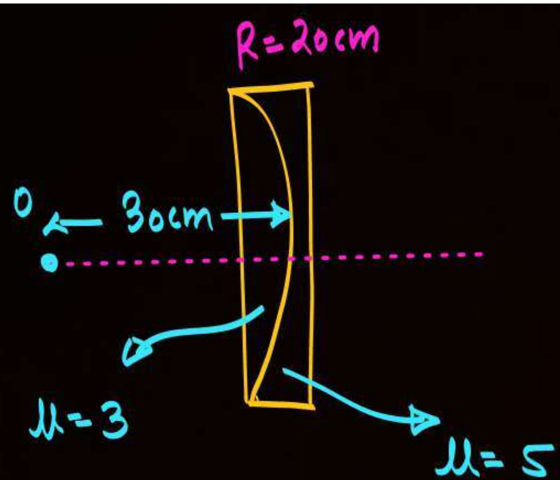
1. $\dfrac{2R}{\mu_1 - \mu_2}$

2. $\dfrac{R}{2-(\mu_1 - \mu_2)}$

3. $\dfrac{R}{2(\mu_1 - \mu_2)}$

4. $\dfrac{R}{\mu_1 - \mu_2}$

Ex

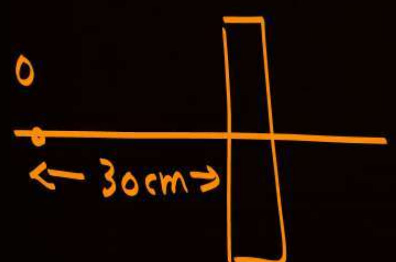


Plano Concave & Plano Convex Lens

$$\frac{1}{f_1} = (3-1)\left[\frac{1}{\infty} - \frac{1}{-20}\right] \qquad \boxed{f_1 = 10\text{ cm}}$$

$$\frac{1}{f_2} = (5-1)\left[-\frac{1}{20} - \frac{1}{\infty}\right] \qquad \boxed{f_2 = -5\text{ cm}}$$

Find Location of Image =



$u = -30$
$f = -10$
$v = \_\_$

$f = -10$ cm

Combination → Slab

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{10} - \frac{1}{5} = \frac{1-2}{10}$$

$f_{eq} = -10$

diverging

Question 49

An equi-convex lens of refractive index (3/2) and focal length 10 cm is held with its axis vertical and its lower surface immersed in water ($\mu = 4/3$), the upper surface being in air. At what distance from the lens, will a vertical beam of parallel light incident on the lens be focused?

Question 50

HW

When a beam of white light is allowed to pass through convex lens parallel to principal axis, the different colours of light converge at different point on the principle axis after refraction. This is called [Main 24th Jan 2nd Shift 2023]

1. scattering
2. chromatic aberration
3. spherical aberration
4. polarisation

[Ans: 2]

Question 51

The power of a lens (biconvex) is $1.25\ m^{-1}$ in particular medium. Refractive index of the lens is 1.5 and radii of curvature are 20 cm and 40 cm respectively. The refractive index of surrounding medium **[Main 28th July 2nd Shift 2022]**

1. 1.0
2. $\frac{9}{7}$
3. $\frac{3}{2}$
4. $\frac{4}{3}$

$P_L = 1.25\ D = \frac{100}{f(cm)}$

$\mu_L = 1.5$

$R_1 = 20$

$R_2 = 40 cm$

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

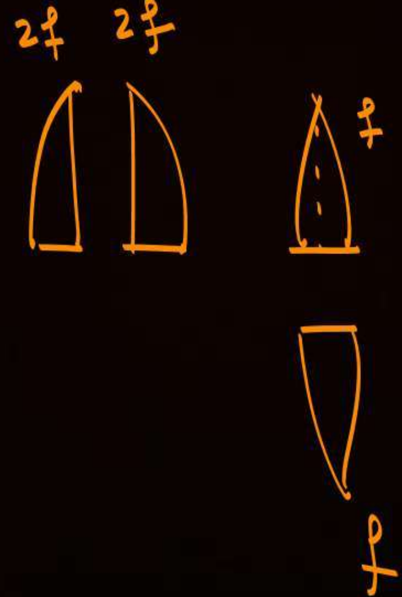
?

[Ans: 2]

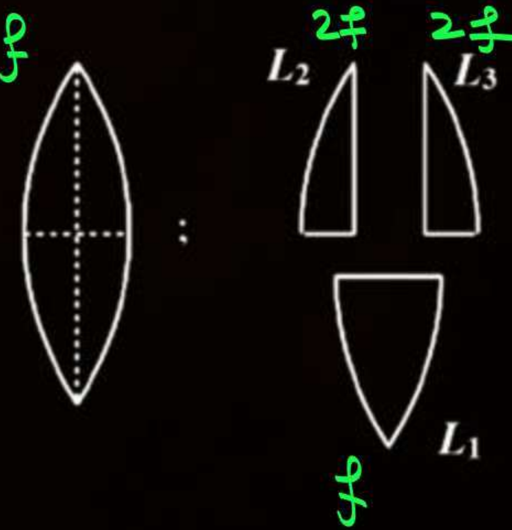
Question 52

A convex lens has power P. It is cut into two halves along its principal axis. Further one piece (out of the two halves) is cut into two halves perpendicular to the principal axis (as shown in figure). Choose the incorrect option for the reported pieces.

[Main 27th June 2nd Shift 2022]



$P \leftarrow f$



1. Power of $L_1 = \frac{P}{2}$
2. Power of $L_2 = \frac{P}{2}$
3. Power of $L_3 = \frac{P}{2}$
4. Power of $L_1 = P$

[Ans: 1]

Question 53

Find the distance of the image from object O, formed by the combination of lenses in the figure.

[Main 27^{th} Aug 1^{st} Shift 2021]

1. 75cm Ans
2. 10 cm
3. infinity
4. 20 cm

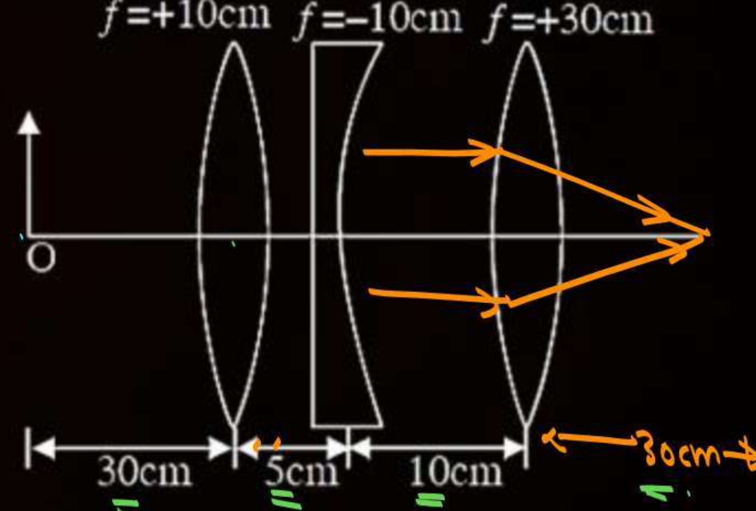
$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\frac{1}{+10} = \frac{1}{v} - \frac{1}{-30}$

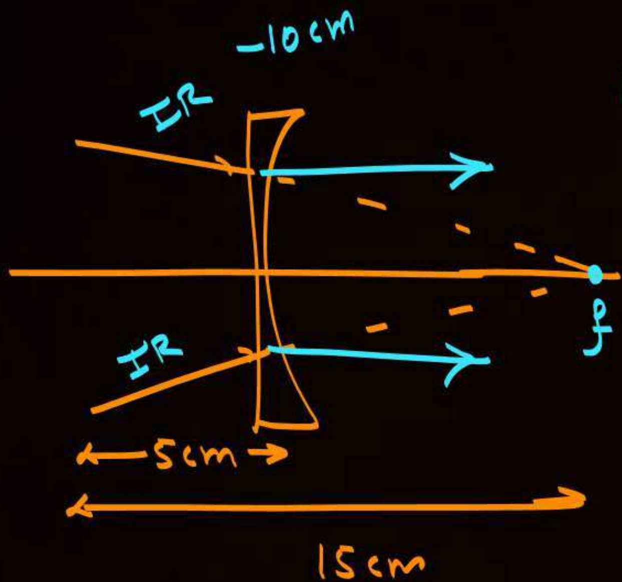
$\frac{1}{10} - \frac{1}{30} = \frac{1}{v}$

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

$v = +15$



[Ans: 1]



(I) $u = +10\,cm$

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

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

$$\boxed{v = \infty}$$

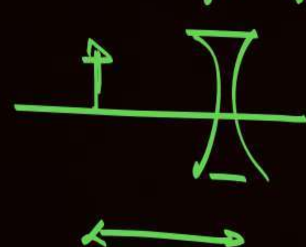
Question 54

HW

An object is placed at the focus of concave lens having focal length f. What is the magnification and distance of the image from the optical centre of the lens?

[Main 31th Aug 1st Shift 2021]

$f = -f$



$u = -f$

1. $\frac{1}{4}, \frac{f}{4}$

2. $\frac{1}{2}, \frac{f}{2}$

3. Very high, ∞

4. $1, \infty$

[Ans: B]

Question 55

The refractive index of a converging lens is 1.4. What will be the focal length of this lens if it is placed in a medium of same refractive index? Assume the radii of curvature of the faces of lens are R_1 and R_2 respectively.

[Main 16th March 2nd Shift 2021]

$\mu_L = \mu_S$

$\boxed{f = \infty}$

1. Zero
2. $\dfrac{R_1 R_2}{R_1 - R_2}$
3. 1
4. Infinite

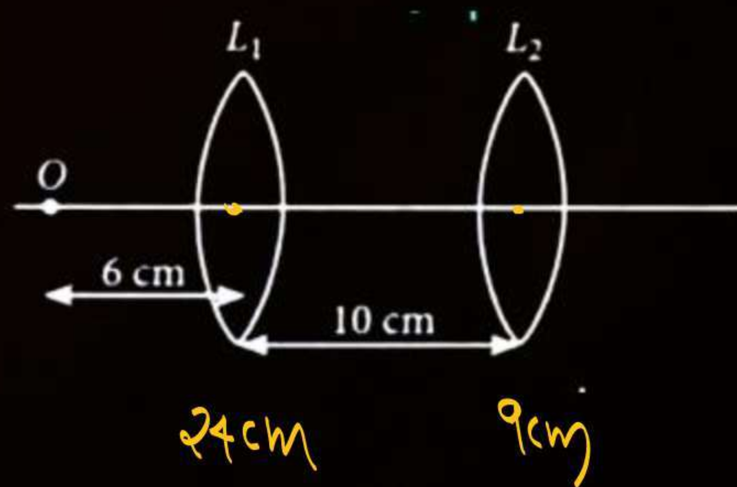
[Ans: D]

Question 56

HW

A point object, 'O' is placed in front of two thin symmetrical coaxial convex lenses L_1 and L_2 with focal length 24 cm and 9 cm respectively. The distance between two lenses is 10 cm and the object is placed 6 cm away from lens L_1 as shown in the figure. The distance between the object and the image formed by the system of two lenses is ________ cm.

[Main 10th April 2nd Shift 2023]

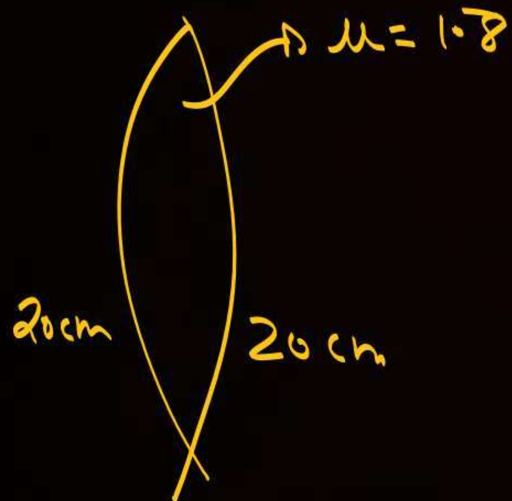


[Ans: 34]

Question 57

The radius of curvature of each surface of a convex lens having refractive index 1.8 is 20 cm. The lens is now immersed in a liquid of refractive index 1.5. The ratio of power of lens in air to its power in the liquid will be $x : 1$. The value of x is ______.

[Main 11th April 1st Shift 2023]

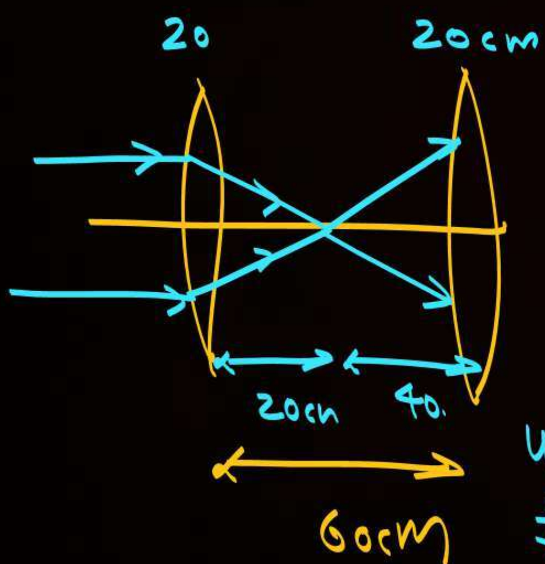


$\mu_s = 1.5$

[Ans: 4]

Question 58

Two convex lenses of focal length 20 cm each are placed coaxially with a separation of 60 cm between them. The image of the distant object formed by the combination is at _______ cm from the first lens. **[Main 12th April 1st Shift 2023]**



$u = -40$

$f = +20$

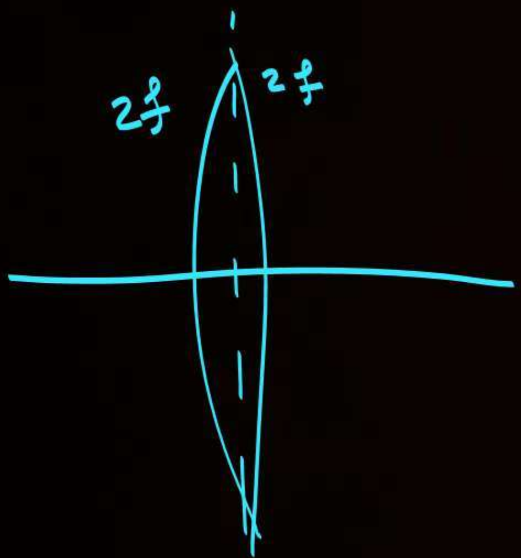
$v = \_\_\_$

[Ans: 100]

Question 59

A bi convex lens of focal length 10 cm is cut in two identical parts along a plane perpendicular to the principal axis. The power of each lens after cut is ______D.

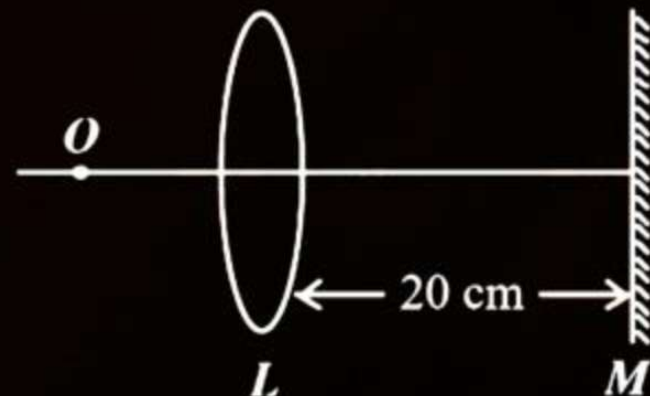
[Main 13^{th} April 2^{nd} Shift 2023]



[Ans: 5]

Question 60

An object is placed on the principal axis of convex lens of focal length 10 cm as shown. A plane mirror is placed on the other side of lens at a distance of 20 cm. The image produced by the plane mirror is 5 cm inside the mirror. The distance of the object from the lens is ______cm. **[Main 25th Jan 2nd Shift 2023]**

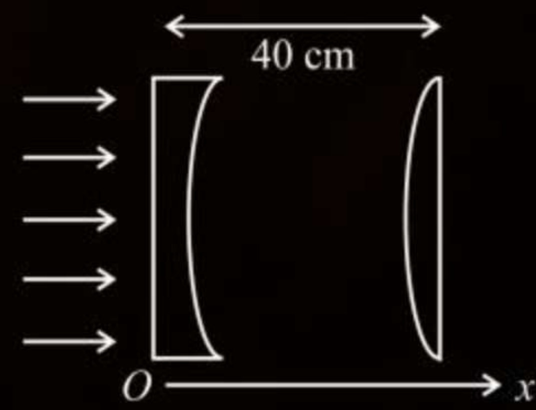


[Ans: 30]

Question (Homework)

As shown in the figure, a combination of a thin plano concave lens and a thin plano convex lens is used to image an object placed at infinity. The radius of curvature of both the lenses is 30cm and refraction index of the material for both the lenses is 1.75. Both the lenses are placed at distance of 40 cm from each other. Due to the combination, the image of the object is formed at distance x = ______ cm, from concave lens.

[Main 24^{th} Jan 1^{st} Shift 2023]



[Ans: 120]

Question (Homework)

A convex lens of focal length 20 cm is placed in front of a convex mirror with principal axis coinciding each other. The distance between the lens and mirror is 10 cm. A point object is placed on principal axis at a distance of 60 cm from the convex lens. The image formed by combination coincides the object itself. The focal length of the convex mirror is _______ cm. **[Main 25th July 2nd Shift 2022]**

[Ans: 10]

Question (Homework)

For an object placed at a distance 2.4 m from a lens, a sharp focused image is observed on a screen placed at a distance 12 cm form the lens. A glass plate of refractive index 1.5 and thickness 1 cm is introduced between lens and screen such that the glass plate faces parallel to the screen. By what distance should the object be shifted so that a sharp focused image is observed again on the screen?

[Main 25^{th} July 2^{nd} Shift 2022]

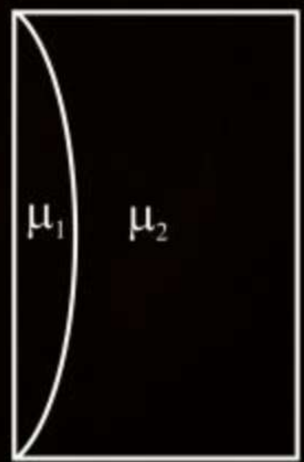
1. 0.8 m
2. 3.2 m
3. 1.2 m
4. 5.6 m

[Ans: 2]

Question (Homework)

Curved surfaces of a plano-convex lens of refractive index μ_1 and a plano-concave lens of refractive index μ_2 have equal radius of curvature as shown in figure. Find the ratio of radius of curvature to the focal length of the combined lenses.

[Main 27th Aug 2nd Shift 2021]



1. $\frac{1}{\mu_2 - \mu_1}$
2. $\frac{1}{\mu_1 - \mu_2}$
3. $\mu_2 - \mu_1$
4. $\mu_1 - \mu_2$

[Ans: D]

Homework

- Complete Homework Questions