PRACHAND NEET

ONE SHOT

PHYSICS

Ray Optics and Optical Instruments

TANUJ BANSAL SIR (TBS)

Topics *to be covered*

1. Reflection from Plane and Curved Mirrors
2. Refraction, Apparent Depth & Height, Glass Slab
3. TIR, Prism, Lenses
4. Optical Instruments

चलिए शुरू करते हैं


TBS Army – Tanuj Sir
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PRACHAND SERIES
TELEGRAM CHANNEL
@PW_YAKEENDROPPER

* Weightage → 3 ones expected
(2-3)

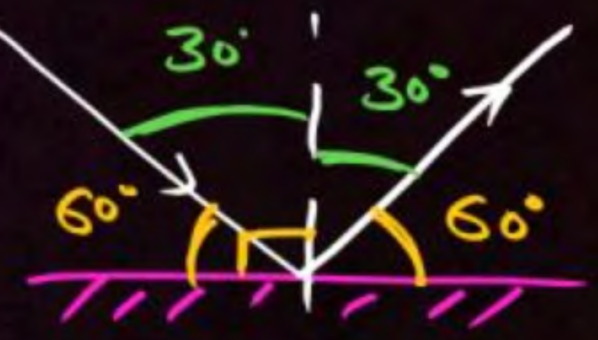
* Formula Based

* Easy

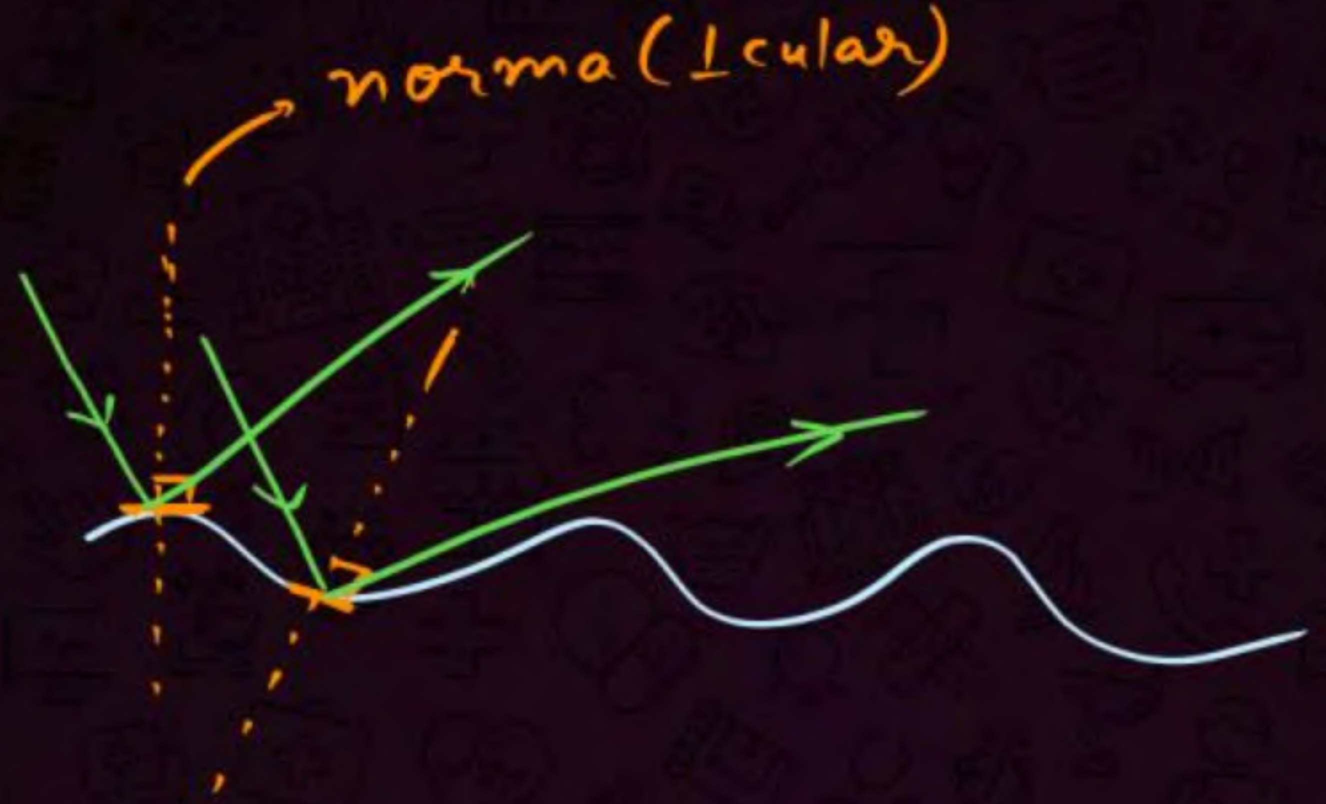
Laws of Reflection

1. The angle of incidence is always equal to the angle of reflection.

2. The incident ray, the reflected ray and the normal all lie in the same plane.

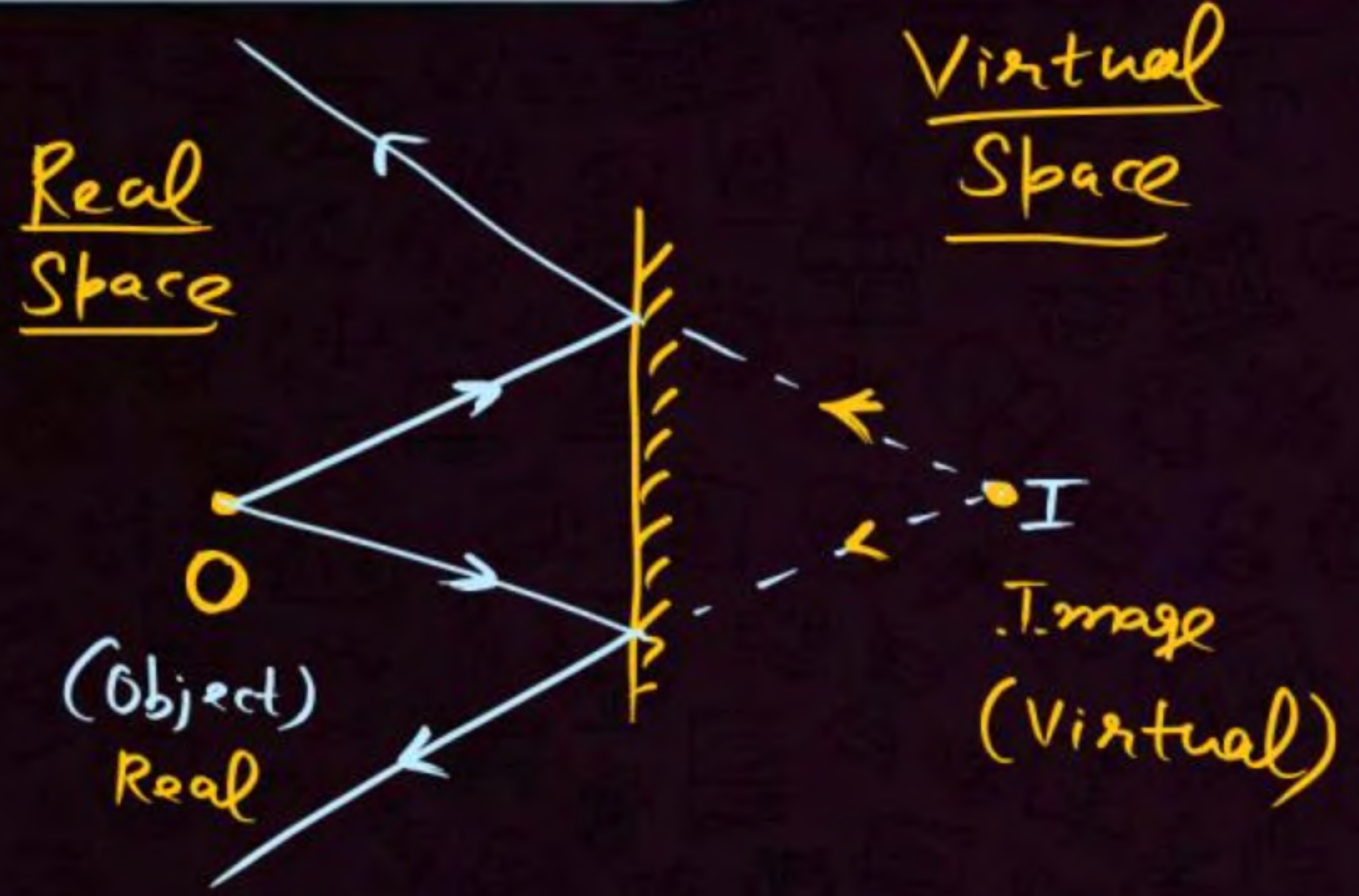


- Valid for all types of surfaces (smooth, curved, rough)



normal (⊥cular)

Plane Mirror



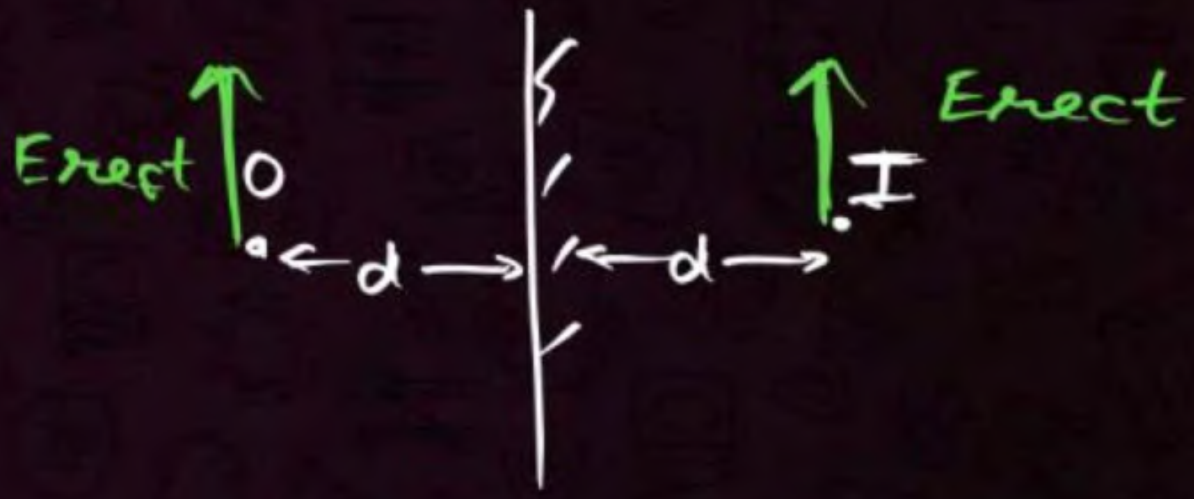
- Real Image: Rays actually meet after reflection.

- Virtual Image: Rays appear to be coming from a point after reflection.

Properties of image formed from Plane Mirror

1. Distance of object from mirror = Distance of image from mirror

2. Size of image = Size of an object

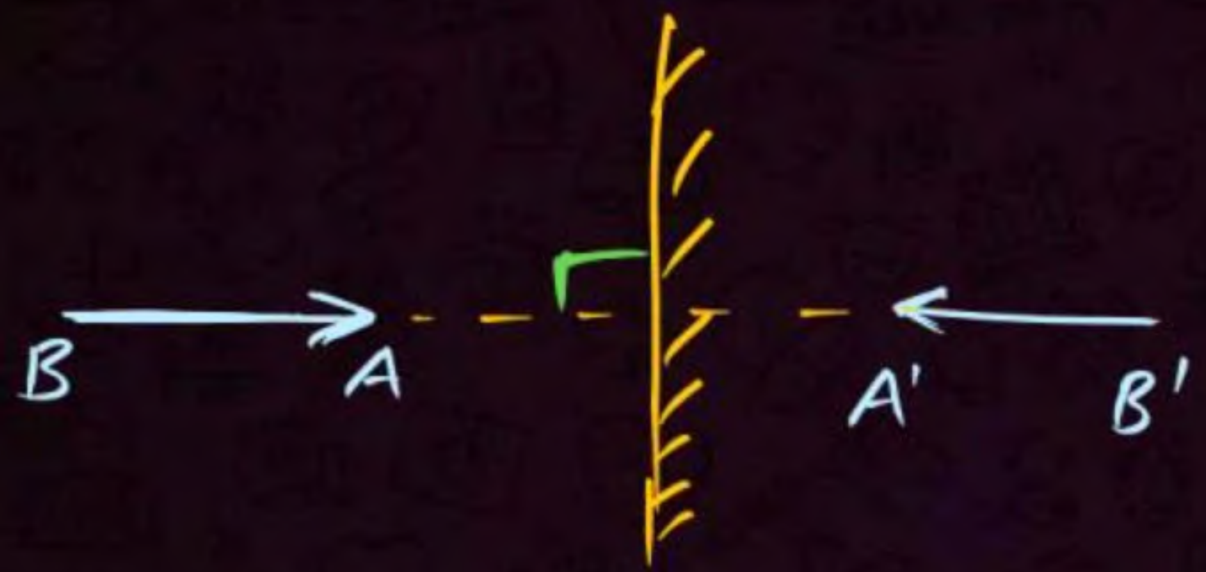


3. Virtual Image for a real object.

4. Image is erect (parallel to mirror)

↦ Late Jana.

5. Image is laterally inverted (perpendicular to mirror)

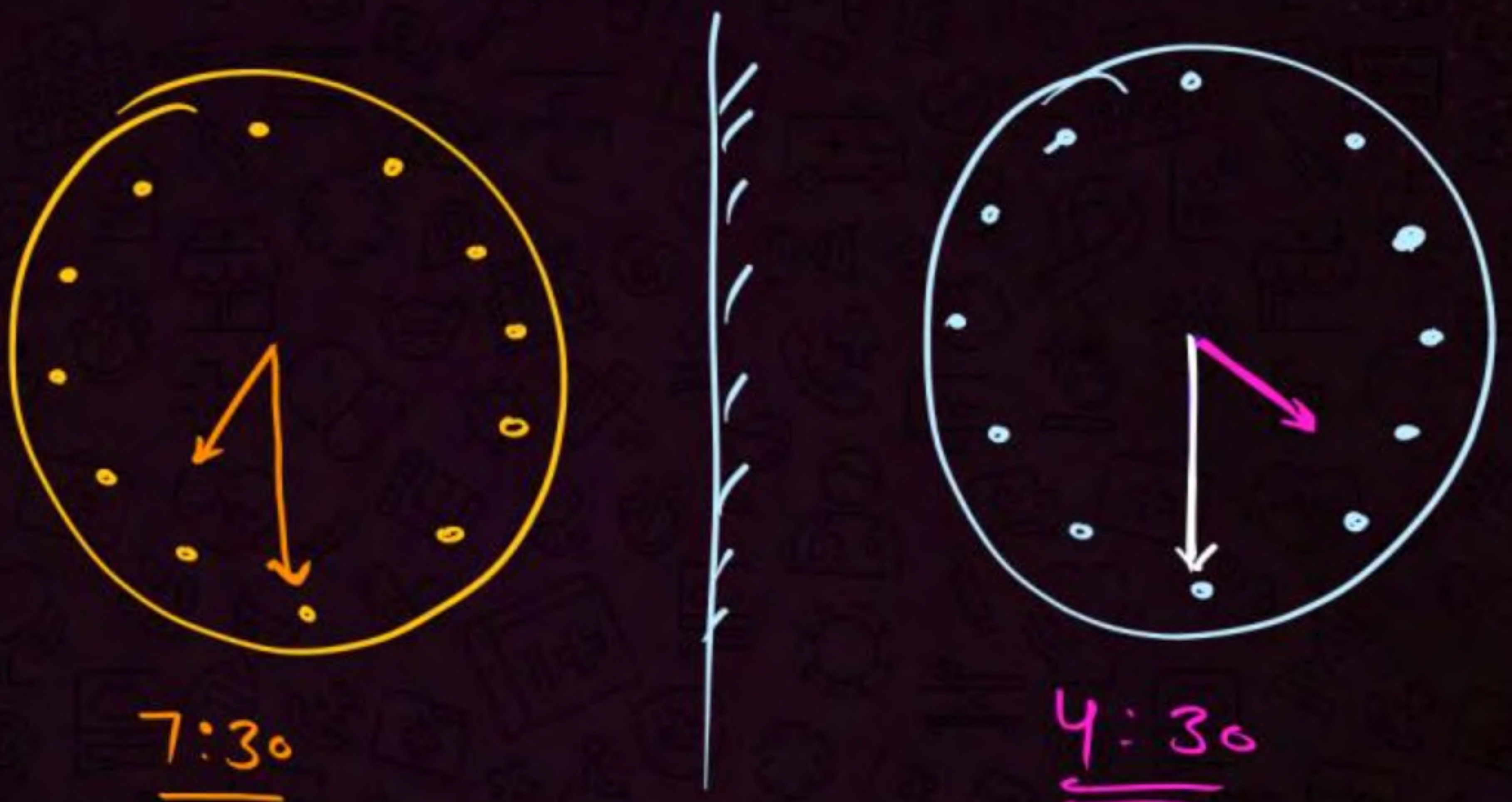


Eg:-

Ques

Ques 3:25
↓ Mirror

11:60
− 3:25
8:35



7:30

4:30

TBS → 12:00
− 7:30

⇒
11:60
− 7:30
4:30

QUESTION

The light rays from an object have been reflected towards an observer from a standard flat mirror, the image observed by the observer are: **[25 Jan, 2023 (Shift-II)]**

A. Real

B. Erect

C. Smaller in size then object

D. Laterally inverted

Choose the most appropriate answer from the options given below:

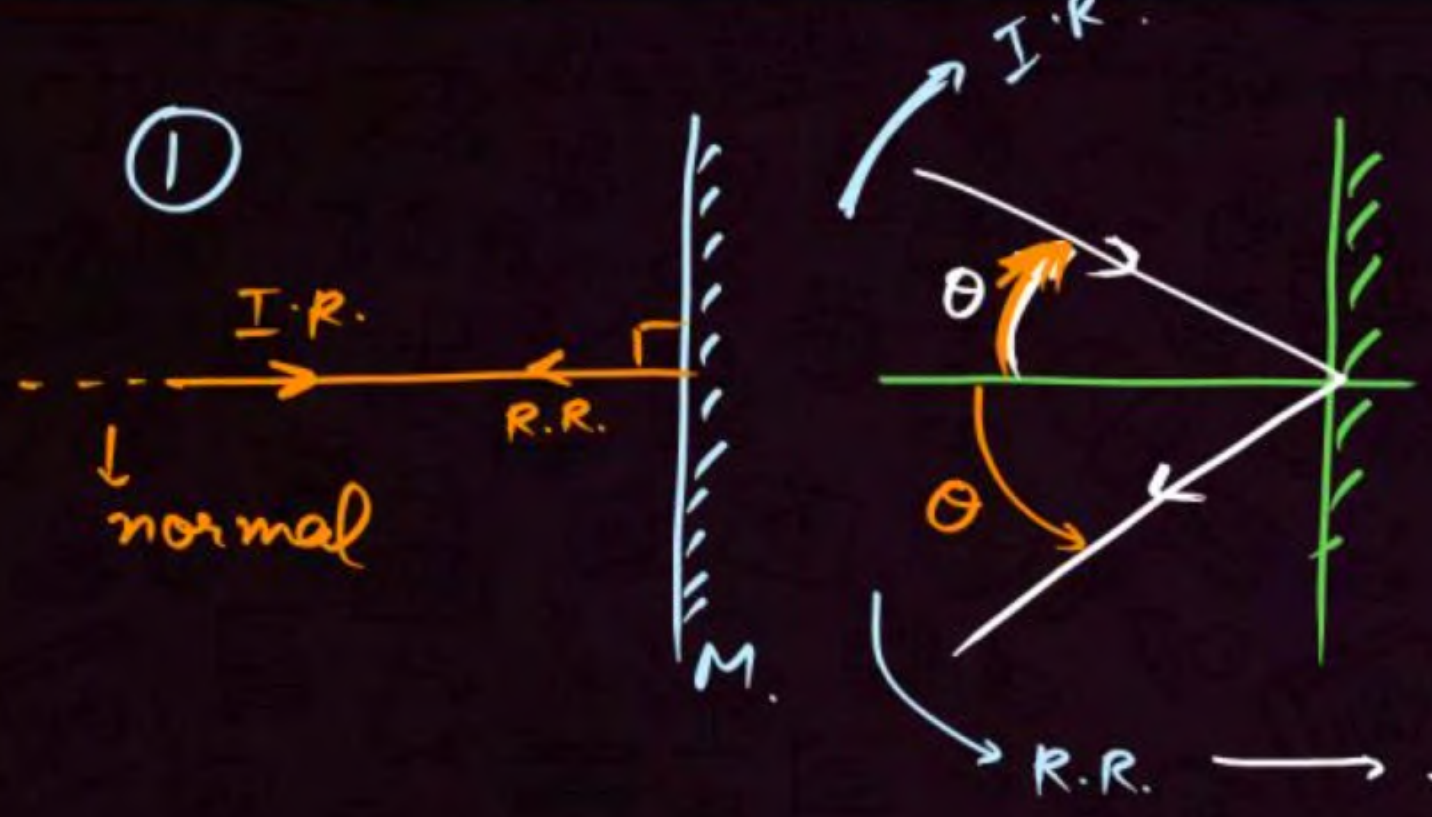
(1) B and D only

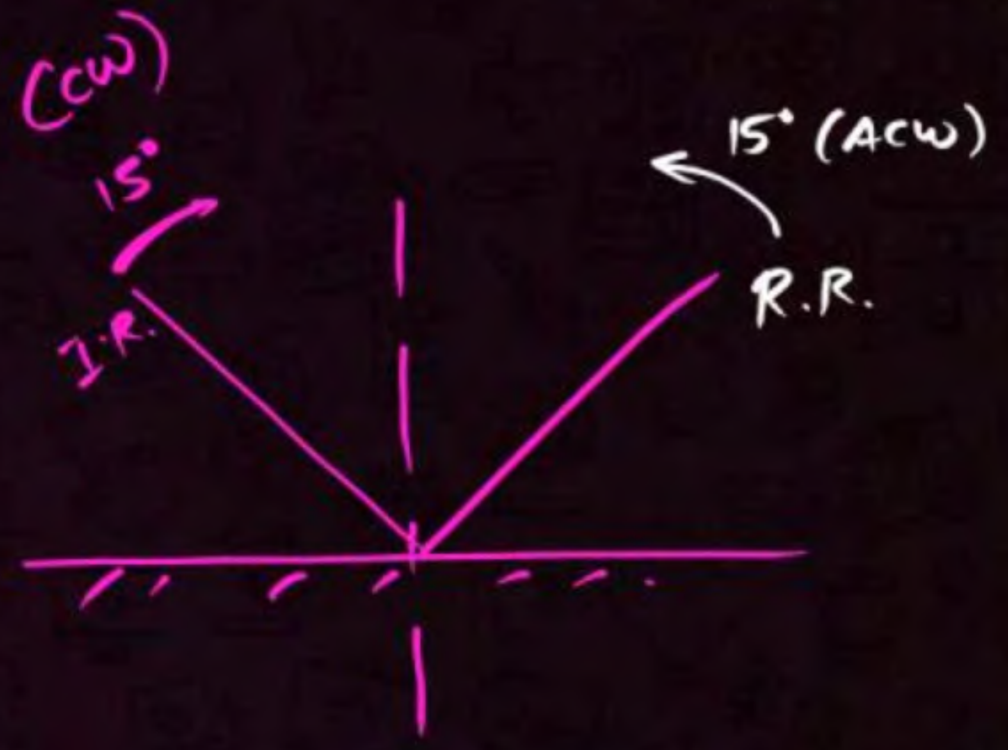
(2) B and C only

(3) A and D only

(4) A, C and D only

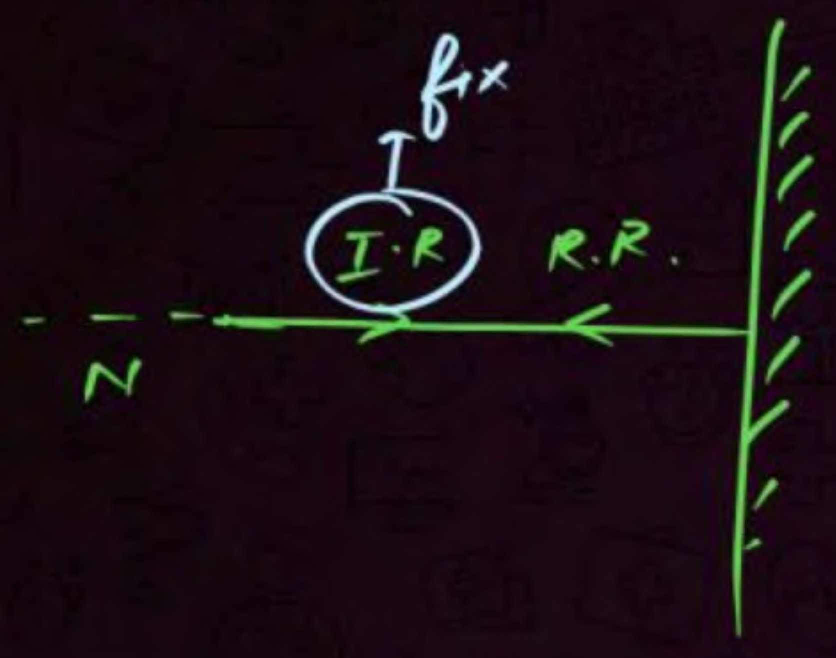
Rotation of rays and mirror

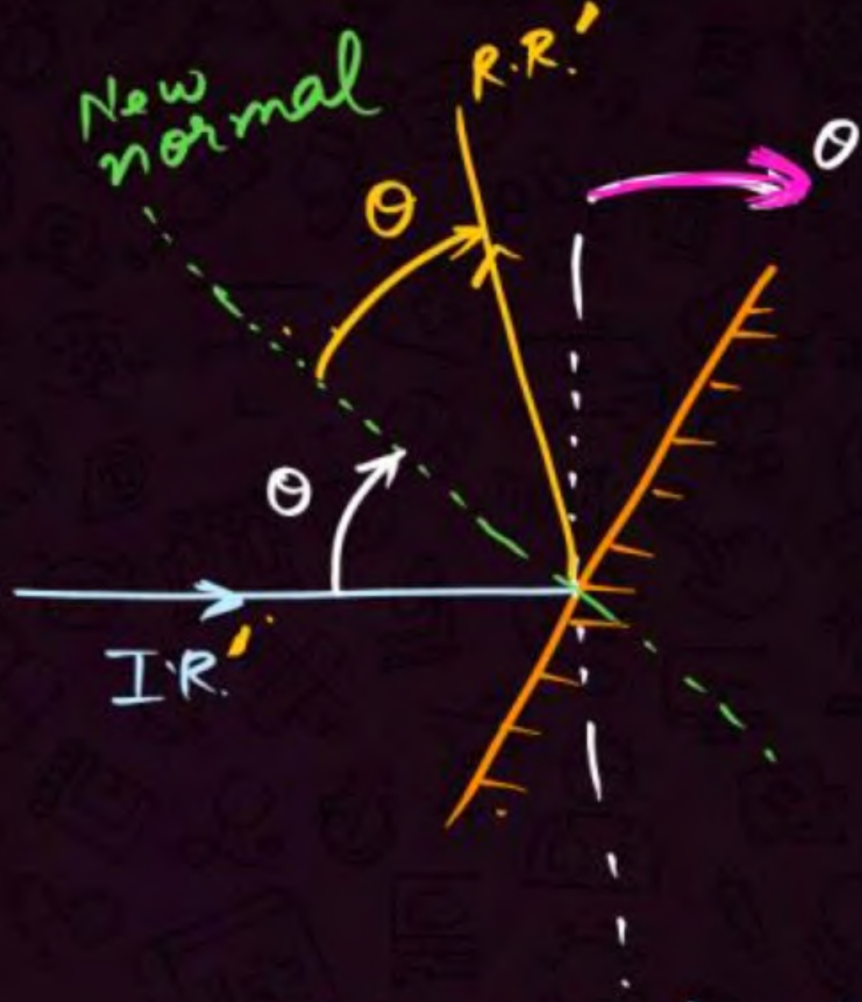


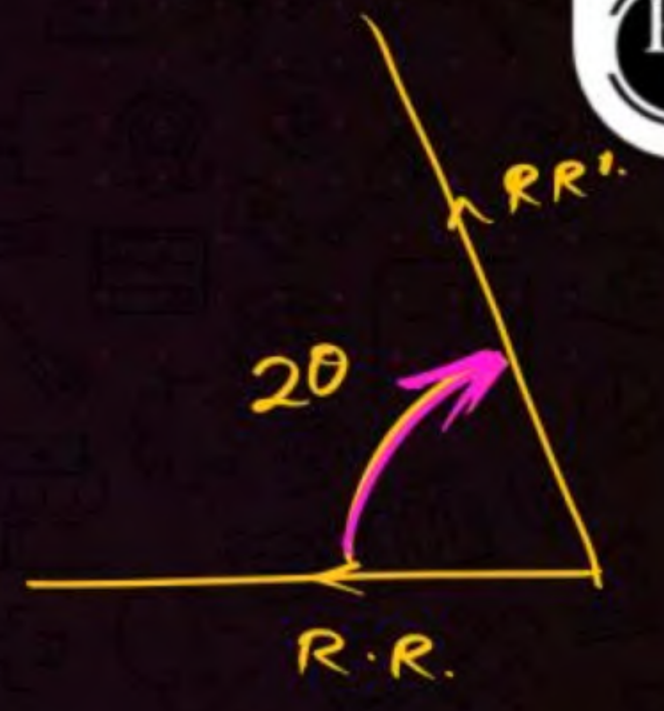


R.R. ⟶ rotates by same angle but in opposite sense.

②







R.R. rotates by double angle in the same sense

Ques

$\Longrightarrow$ R.R $\Rightarrow 2 \times 14° = 28°$

QUESTION

Figure shows a plane mirror on which a light ray is incident. If the incident light ray is turned by $10°$ and the mirror by $20°$, as shown, find the angle turned by the reflected ray.

(1) $30°$ cw

(2) $60°$ cw

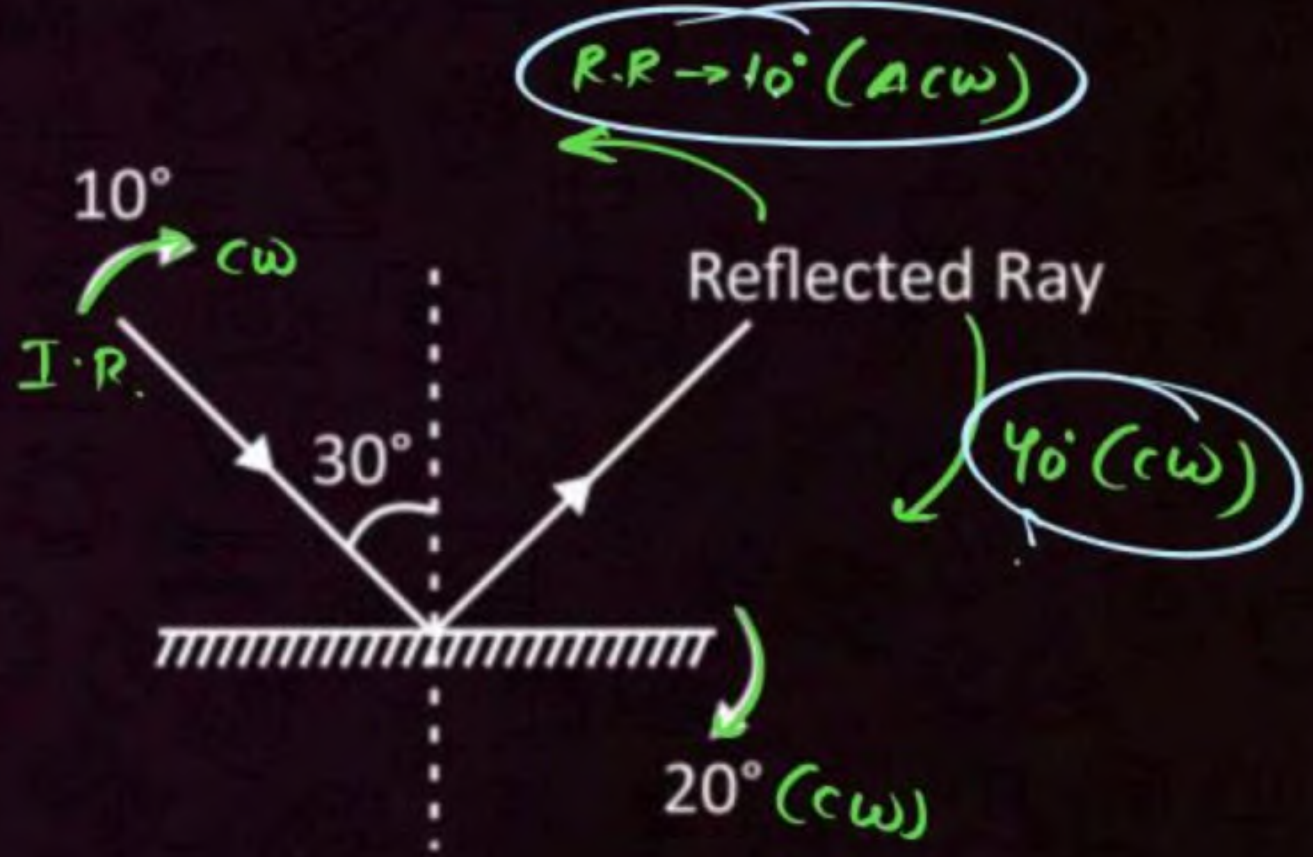
(3) $90°$ cw

(4) $120°$ cw

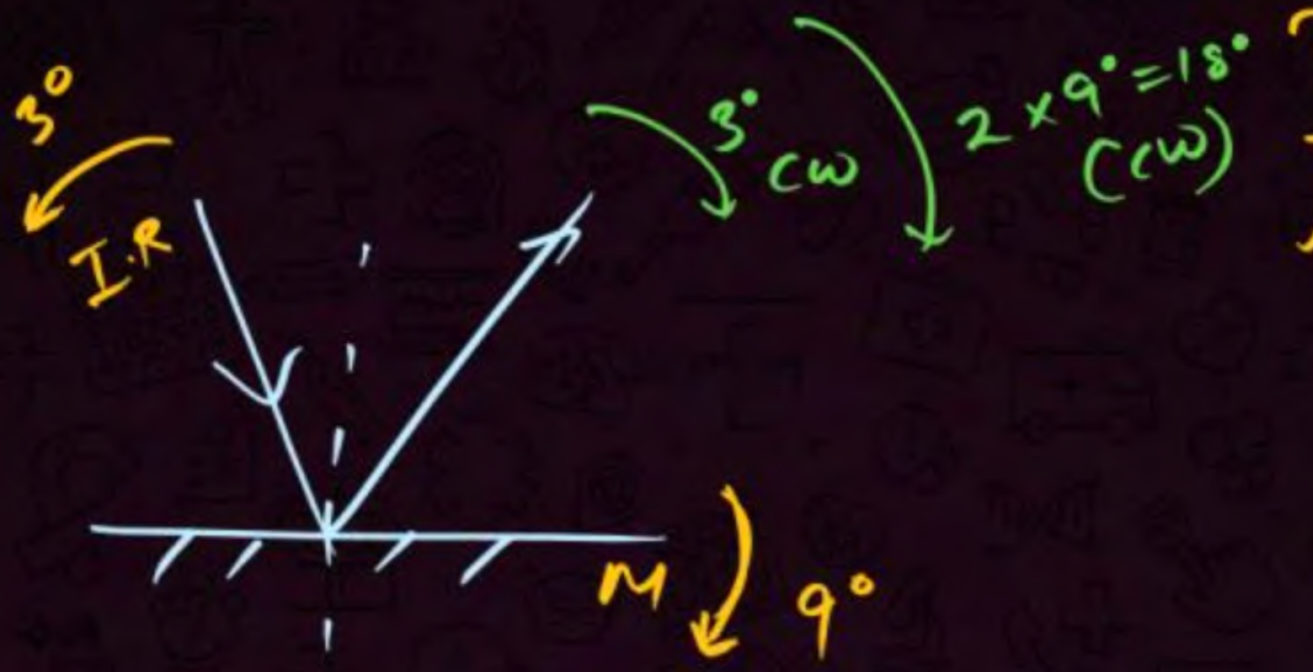
$= 2 \times 20° - 10°$

Net $\theta = 40° - 10°$

$= 30° \text{ (cw)}$



Ques



$\rightarrow 2\times 9° + 3°$

$\Rightarrow 21° (CW)$

Net Rotation of R.R. = ?

QUESTION

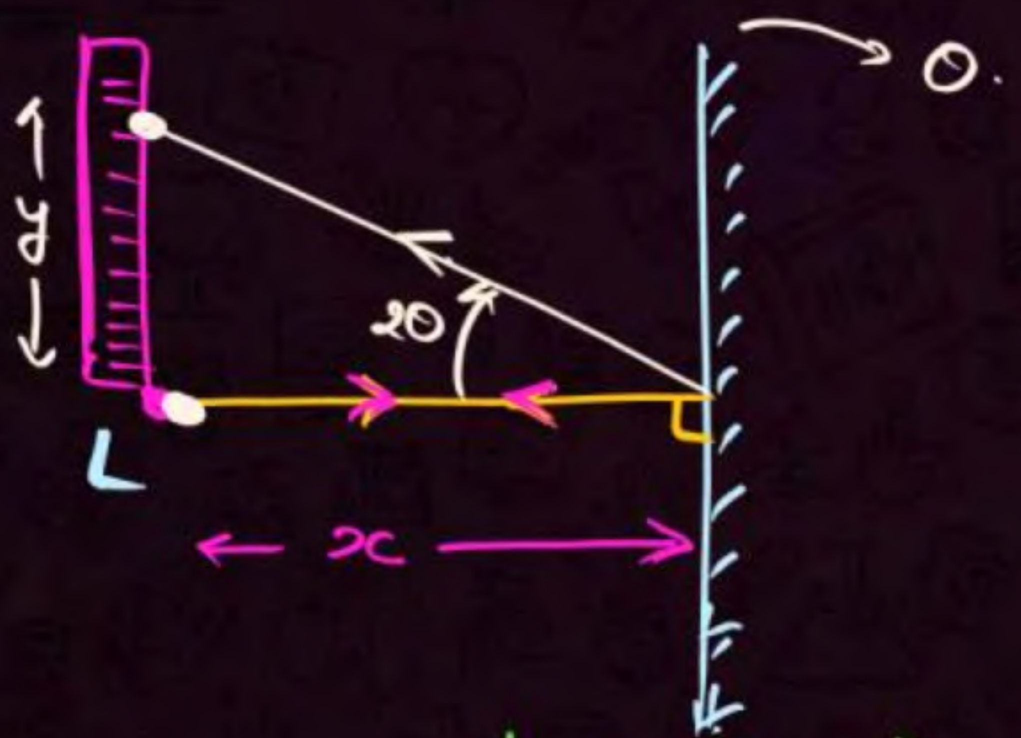
A beam of light from a source L is incident normally on a plane mirror fixed at a certain distance x from the source. The beam is reflected back as a spot on a scale placed just above the source L. When the mirror is rotated through a small angle θ, the spot of the light is found to move through a distance y on the scale. The angle θ is given by: **[2017]**

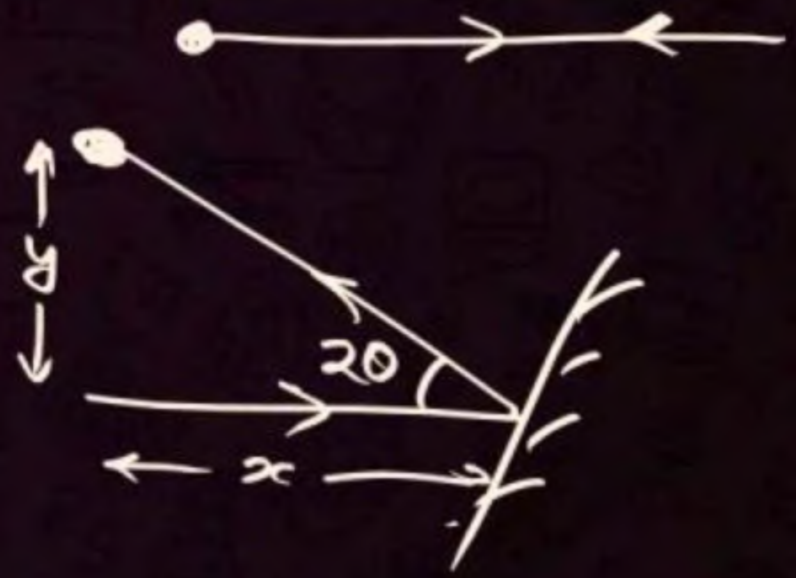
(1) y / 2x

(2) y / x

(3) x / 2y

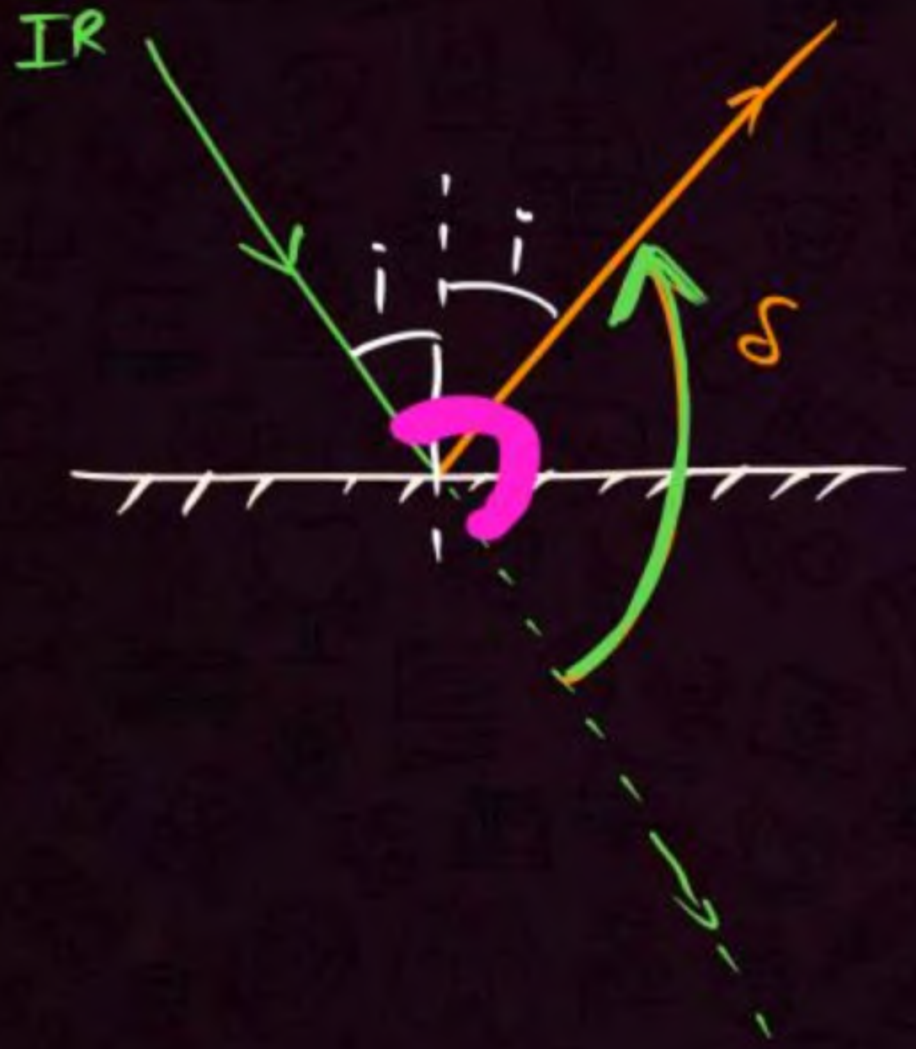
(4) x / y





$$\tan 2\theta = \frac{y}{x} \Rightarrow 2\theta \simeq \frac{y}{x} \Rightarrow \theta \simeq \frac{y}{2x}$$

Angle of Deviation(δ)



$2i + \delta = 180°$

$$\boxed{\delta = 180° - 2i}$$

QUESTION

BPV

A ray of light incidents on a plane mirror at an angle of incidence 30°. The deviation produced in the ray is:

(1) 30°

(2) 60°

(3) 90°

(4) 120°

$$\delta = 180 - 2i$$
$$= 180 - 2 \times 30^\circ$$
$$= 180 - 60^\circ$$
$$= 120^\circ$$

QUESTION

A ray of light strikes a plane mirror at an angle 30° with the mirror. The deviation produced in the ray is:

$\delta = 180 - 2i$
$= 180 - 2 \times 60°$
$= 180 - 120°$
$= 60°$

(1) 30°

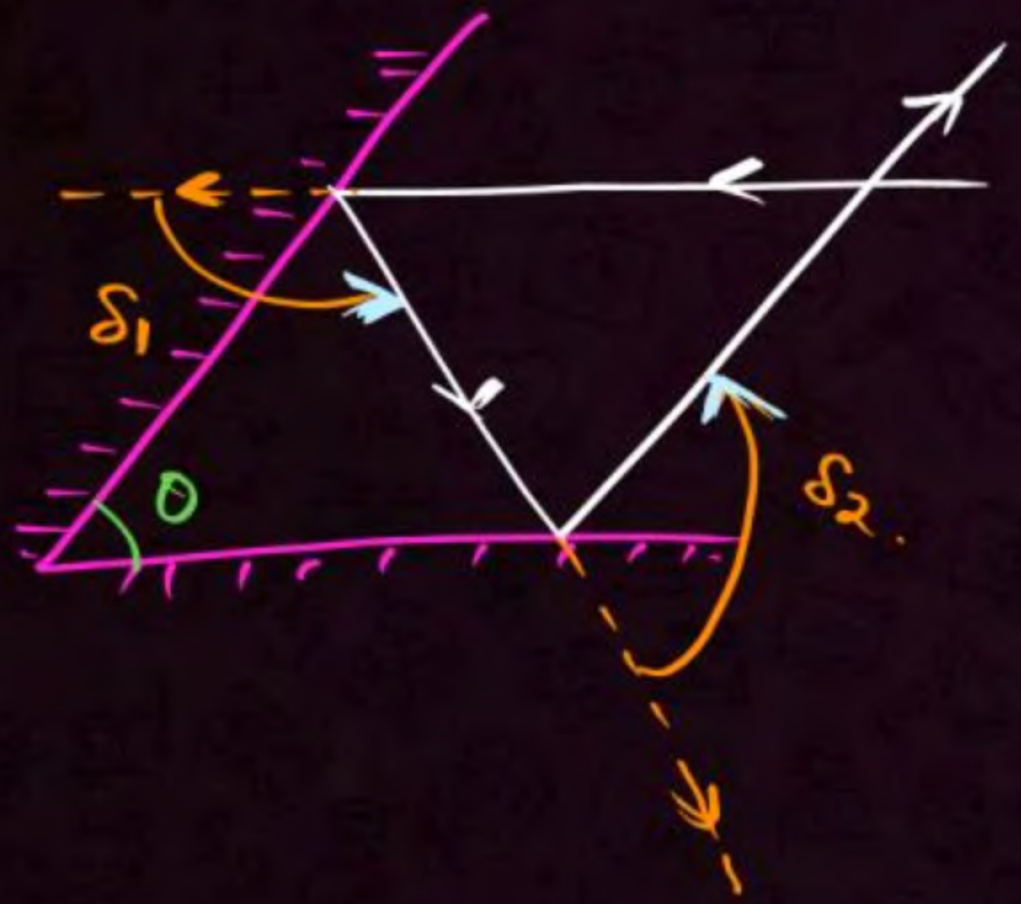
(2) 60°

(3) 90°

(4) 120°

Deviation in multiple reflections

$\rightarrow$ $\boxed{\delta_{net} = \delta_1 + \delta_2 + \cdots}$ → with sign. (algebraically)



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

$\boxed{\delta_{net} = 360° - 2\theta}$ → Two mirrors

(TBS)

$\theta \Rightarrow$ angle b/w mirrors

QUESTION

A light ray is incident, at an incident angle θ_1, on the system of two plane mirrors M_1 and M_2 having an inclination angle 75° between them (as shown in figure). After reflecting from mirror M_1 it gets reflected back by the mirror M_2 with an angle of reflection 30°. The total deviation of the ray will be _____ degree.

[26 June, 2022 (Shift-I)]

A) 150°

B) 210°

C) 60°

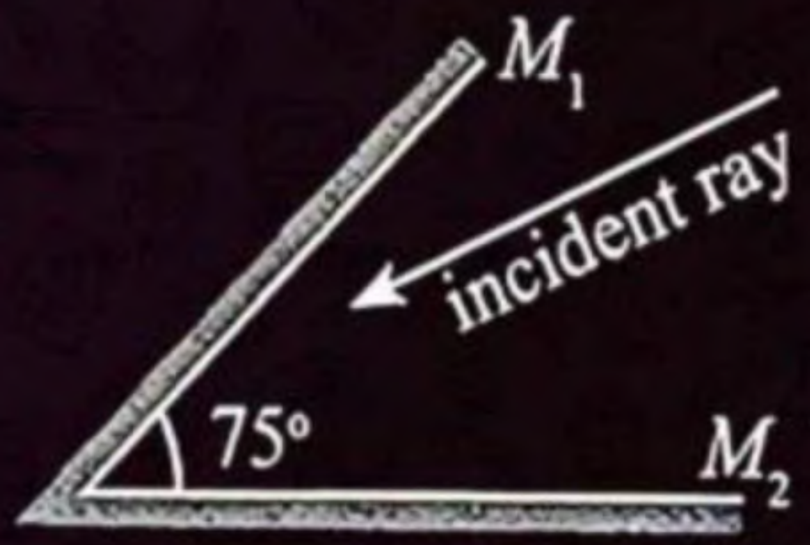
D) 30°

$\delta = 360° - 2\theta$

$= 360 - 2 \times 75°$

$= 360° - 150°$

$= 210°$

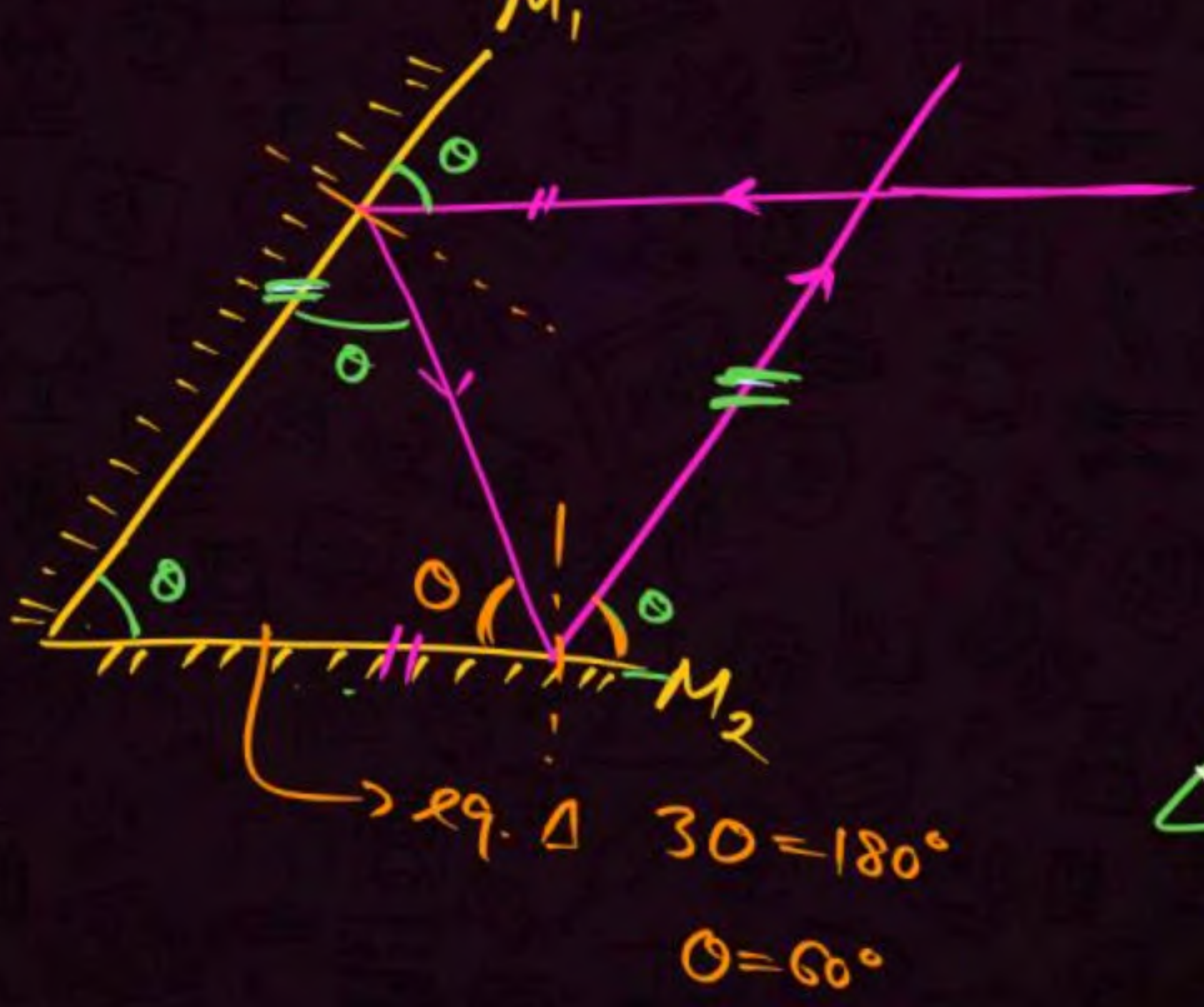


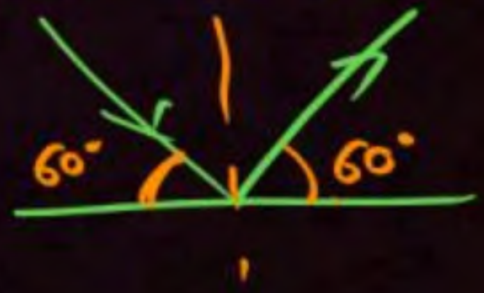
QUESTION

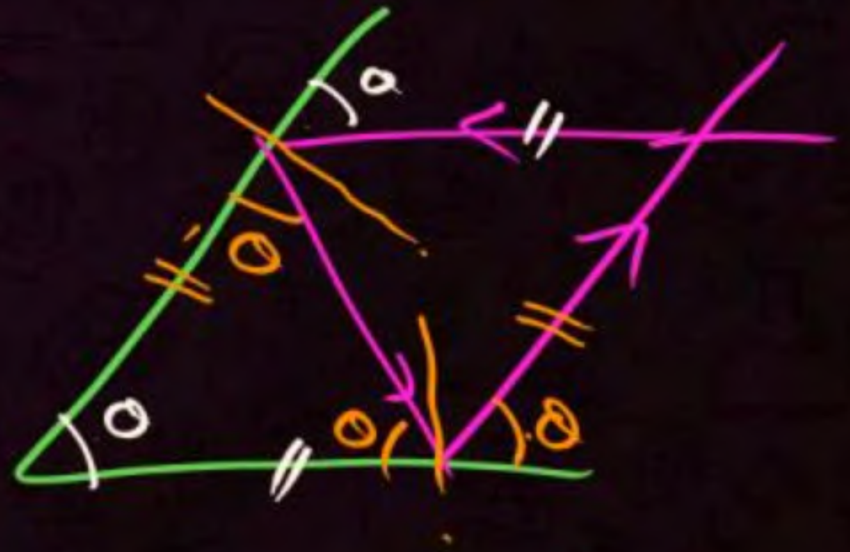
→ as a Theory Learn

Two plane mirrors are inclined to each other such that a ray of light incident to the first mirror (M_1) and parallel to the second mirror (M_2) is finally reflected from the second mirror (M_2) parallel to the first mirror (M_1). The angle between the two mirrors will be:

[9 Jan, 2019 (Shift-II)]







(1) 45°

(2) 60°

(3) 75°

(4) 90°

QUESTION

Two plane mirrors are inclined at 70°. A ray incident on one mirror at angle θ after reflection falls on second mirror and is reflected from there parallel to first mirror. The value of θ is

(1) 50°

(2) 45°

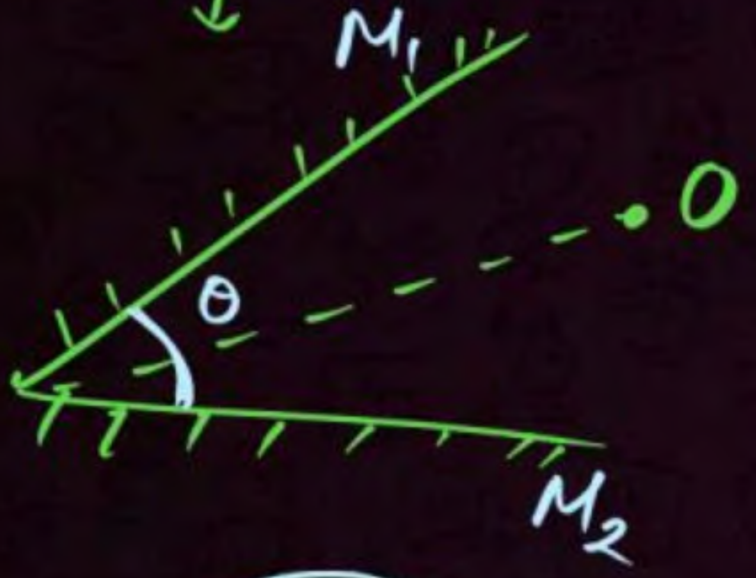
(3) 30°

(4) 55°

$70° + 70° + x = 180°$

$x = 40°$

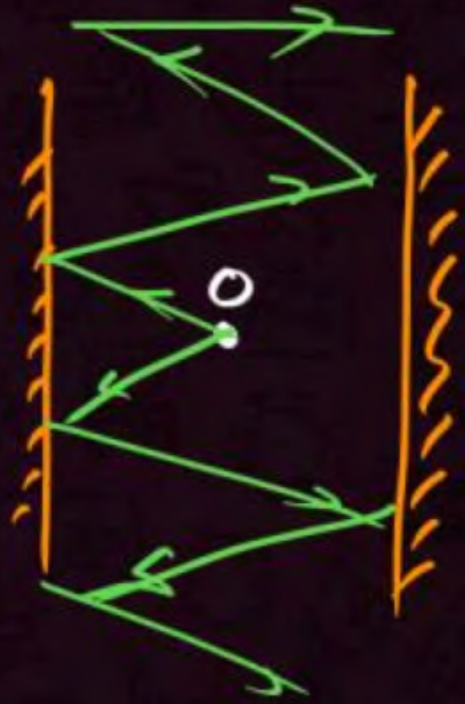
Number of Images formed



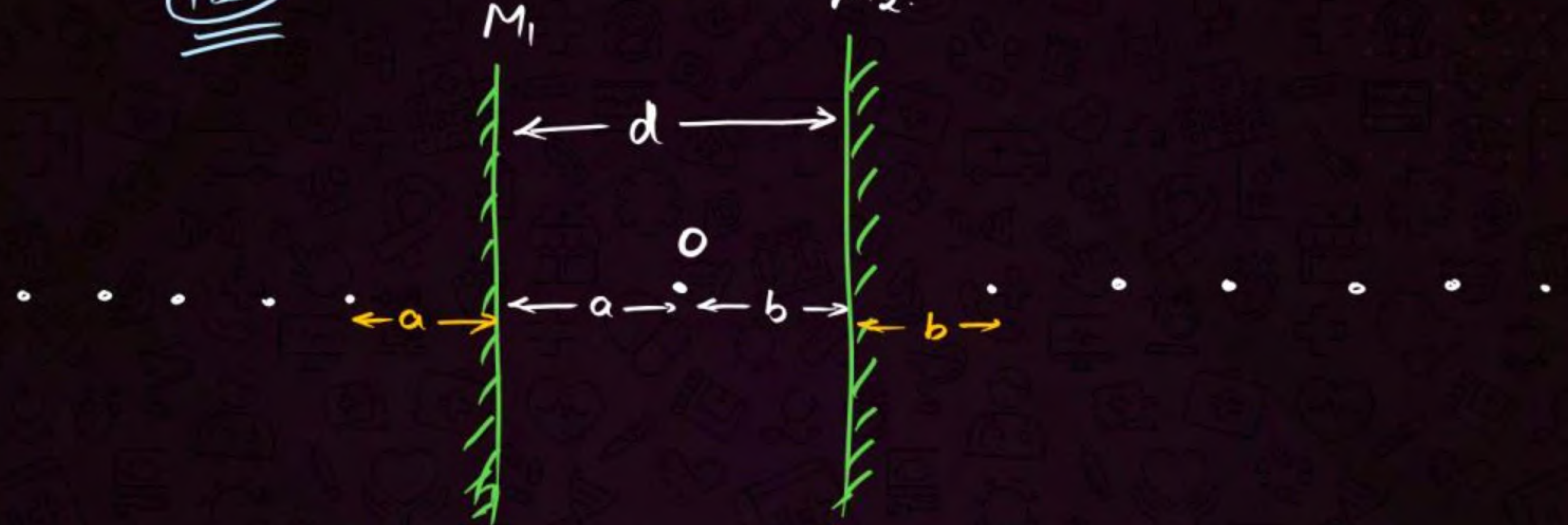
$$n = \frac{360^\circ}{\theta}$$

(i) ||el mirrors $\longrightarrow \theta = 0^\circ \Rightarrow n = \frac{360^\circ}{0}$

$\boxed{n \to \infty}$



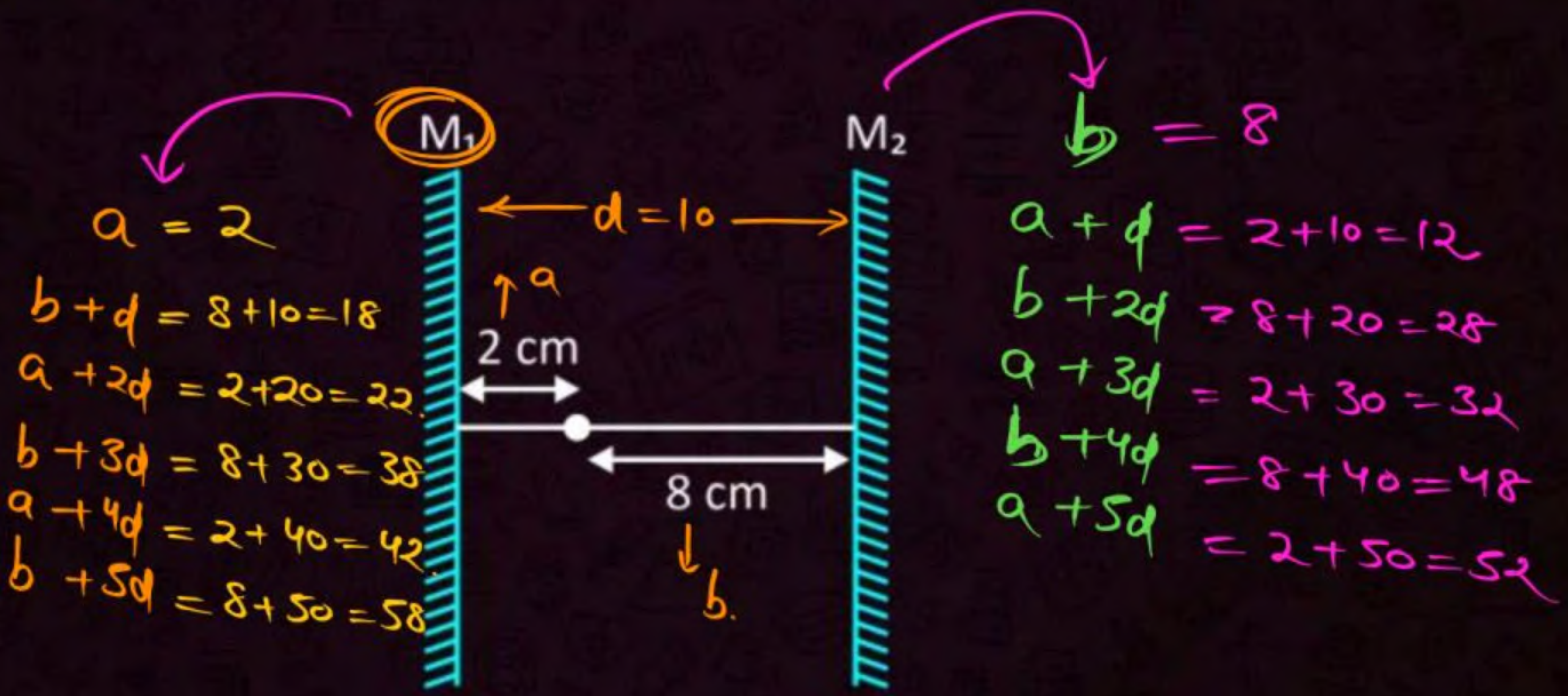
TBS



a	b
$b+d$	$a+d$
$a+2d$	$b+2d$
$b+3d$	$a+3d$
$a+4d$	$b+4d$
$b+5d$	$a+5d$

QUESTION

Figure shows a point object placed between two parallel mirrors. Its distance from M_1 is 2 cm and that from M_2 is 8 cm. Find the distance of images formed from the mirror M_1.



QUESTION

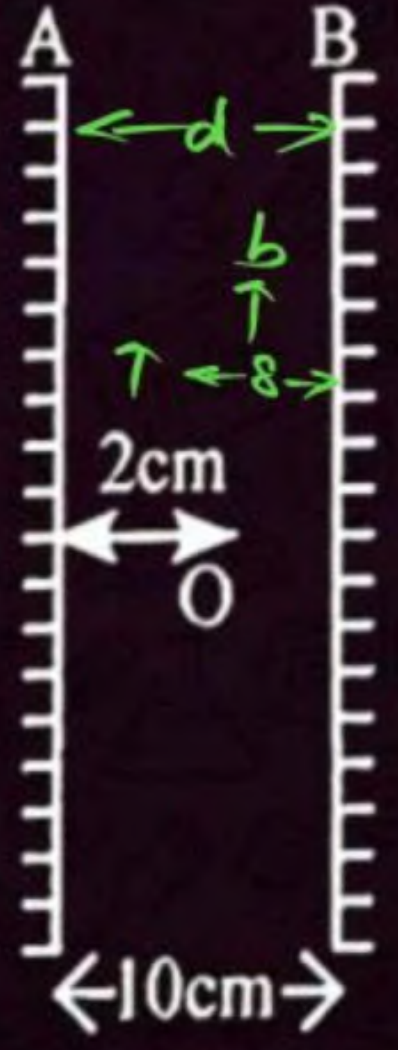
Two vertical parallel mirrors A and B are separated by 10 cm. A point object O is placed at a distance of 2 cm from mirror A. The distance of the second nearest image behind mirror A from the mirror A is 18 cm.

[8 Apr, 2023 (Shift-I)]

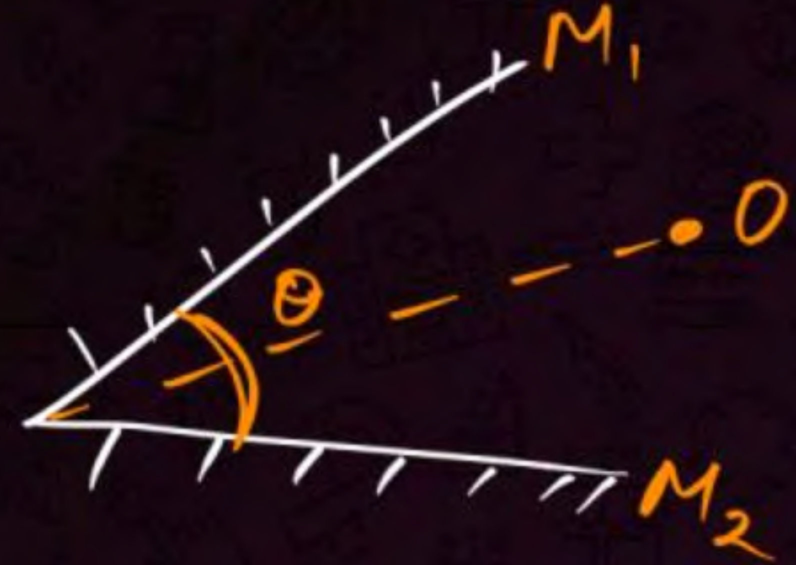
$b+d$

$= 8+10$

$= 18$



(ii)



→ bisector.
→ symmetrical.

$n = \frac{360°}{\theta}$

→ even ⇒ $N = n-1$

→ odd → symmetrical ⇒ $N = n-1$

odd → asymmetrical ⇒ $N = n$.

→ decimal/fraction ⇒ Chhota Integer eg: 5.7 ⇒ $N = 5$

6.3 ⇒ 6.
7.9 ⇒ 7

QUESTION

Two plane mirrors inclined to each other at an angle 72°. What is the number of images formed?

(1) 3

(2) 5

(3) 9

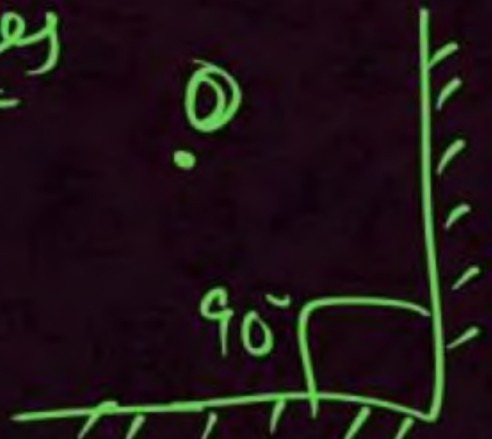
(4) 7

$$n = \frac{360°}{72°} = 5 \rightarrow \text{odd}$$

symm ⇒ $N = 5 - 1 = 4$ (not in option)

asymm ⇒ $N = 5$

ques



$$n = \frac{360°}{90°} = 4 \rightarrow \text{even.}$$

$$N = 4 - 1 = 3$$

QUESTION

If two mirrors are kept at 60° to each other and a body is placed at the middle, then total number of images formed, is [AIIMS 1997]

↓ No need

$\frac{360°}{60} = 6 \rightarrow$ even

$N = 6 - 1 = 5.$

(1) six

(2) five

(3) four

(4) three

QUESTION

HW

Two mirrors are placed at an angle of $\theta = 60°$. The number of images produced when θ is decreased to $\theta - 30°$ is

(1) 9

(2) 10

(3) 11

(4) 12

QUESTION

If the total deviation produced by two mirrors is 300^0. Find number of images made by them when object placed symmetrically.

(1) 5

(2) 6

(3) 11

(4) 12

$\delta = 360 - 2\theta$

$300 = 360 - 2\theta$

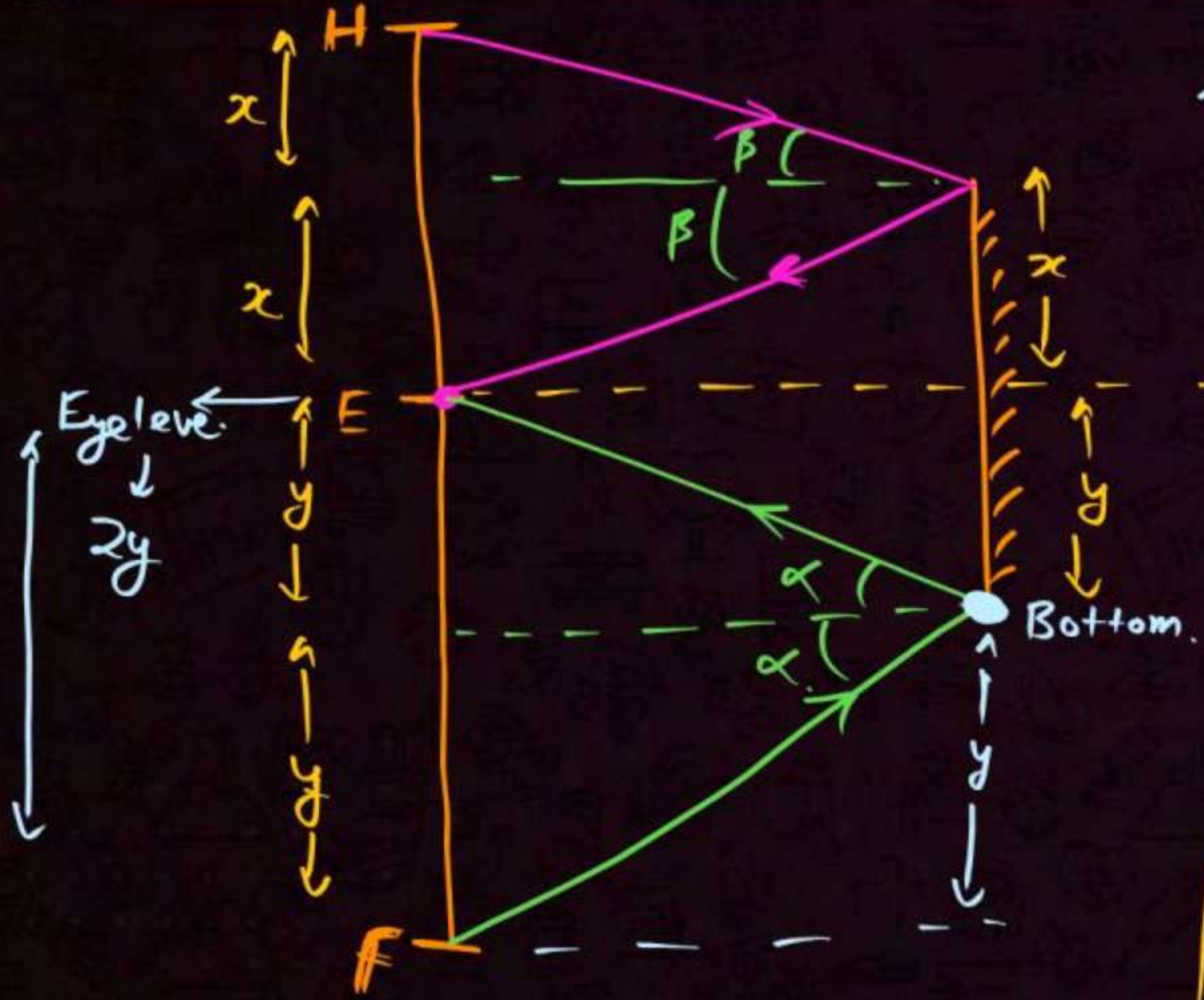
$2\theta = 60^\circ$

$\theta = 30^\circ$

$n = \frac{360}{30} = 12$ → even

$N = 12 - 1 = 11$

Size of Mirror required to see full image



→ Person = 2x + 2y

= 2(x + y)

→ Mirror = x + y

Mirror height min^m
⇒ half of person's height

&

The bottom of mirror must be at half of eye-level

Ques

Man

Height = 180 cm.

Eye Level = 160 cm

Mirror

90 cm

Bottom = 75 cm.

A) Full image see

~~B)~~ can't see hair

C) can't see feet

D) can't say

QUESTION

A tall man of height 6 feet, want to see his full image. Then required minimum length of the mirror will be: [2000]

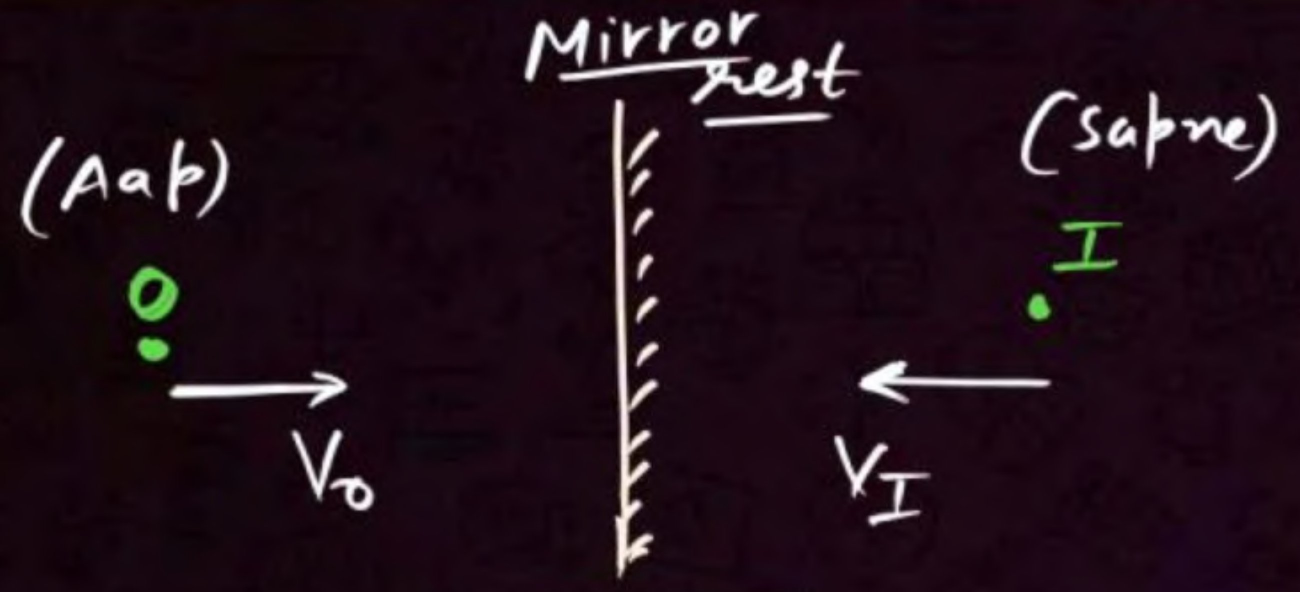
(1) 12 feet

(2) 3 feet

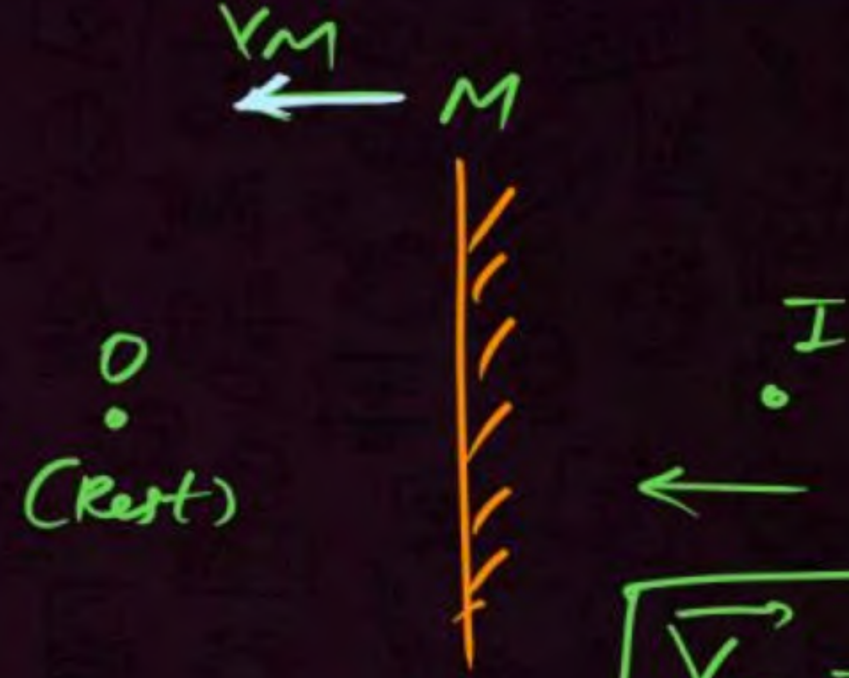
(3) 6 feet

(4) Any length

Velocity of Image – a) Perpendicular to mirror



$$\boxed{\vec{V_I} = -\vec{V_0}}$$



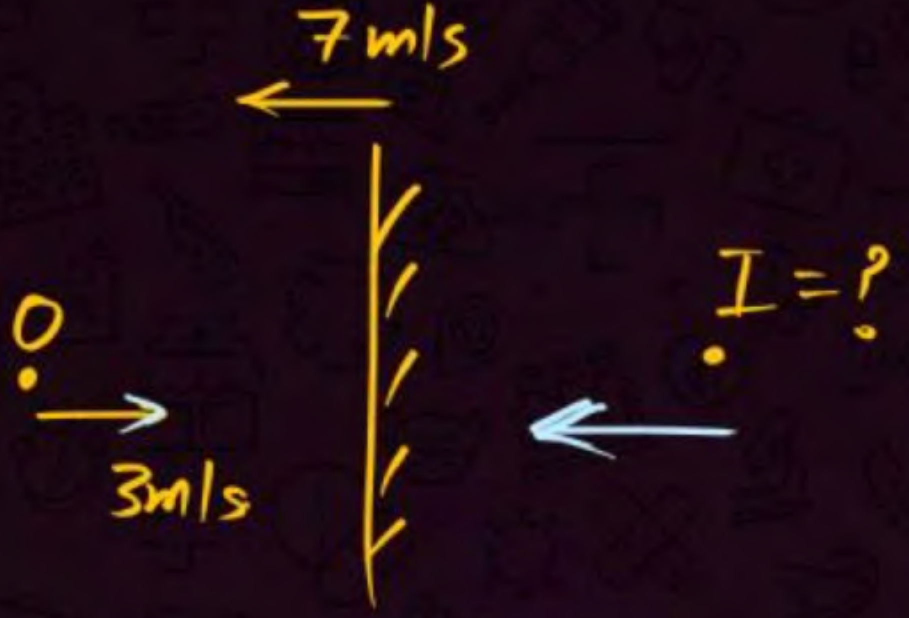
$$\boxed{\vec{V_I} = 2\vec{V_M}}$$

Combined $\boxed{\vec{V_I} = 2\vec{V_M} - \vec{V_0}}$

OR

wrt mirror → $\boxed{\vec{V_{I/M}} = -\vec{V_{O/M}}}$

Ques



$$V_I = 2V_M - V_O$$

$$= 2(-7) - (3)$$

$$= -14 - 3$$

$$= -17 \text{ m/s}$$

Ques

$$V_I = 2V_M - V_O$$

$$= 2(-5) - (-2)$$

$$= -10 + 2 = -8 \text{ m/s}$$

QUESTION

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:

[10 Apr, 2023 (Shift-I)]

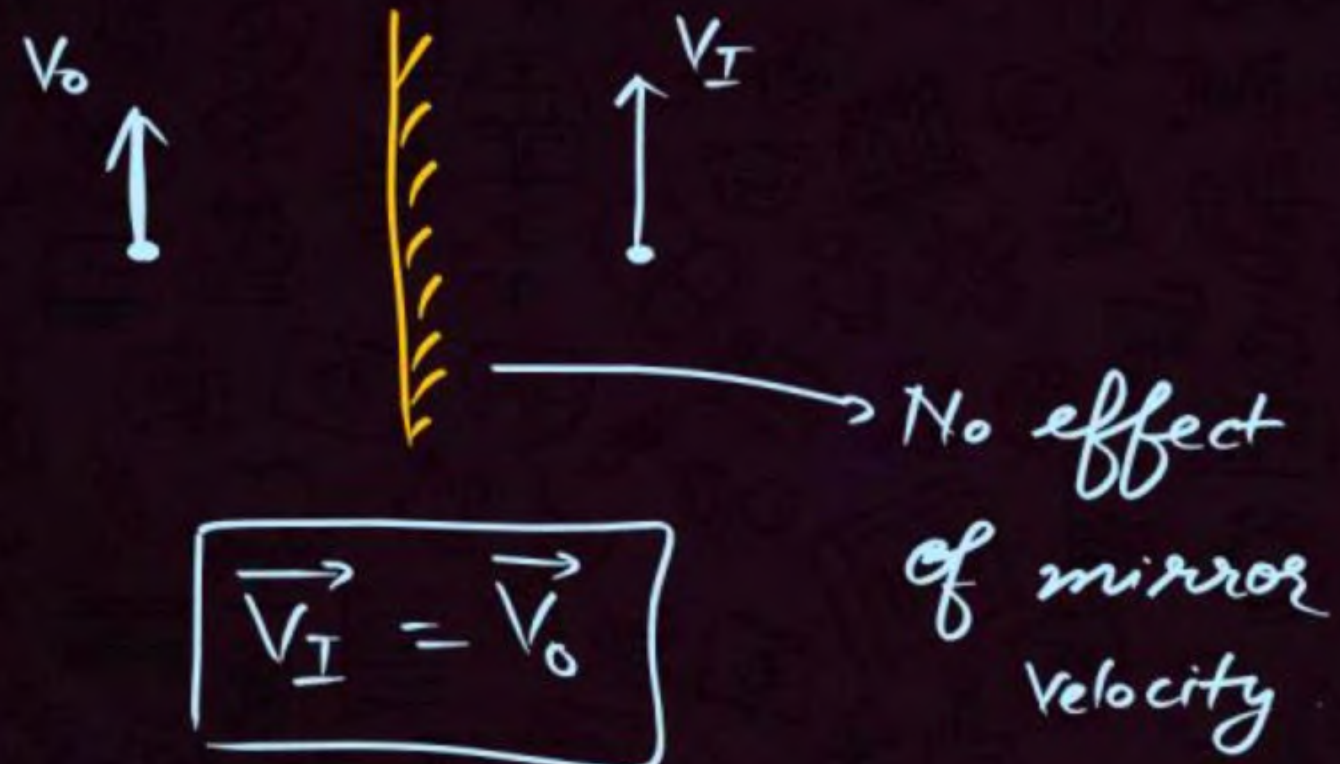
(1) 4 cm towards mirror

(2) 8 cm towards mirror

(3) 8 cm away from mirror

(4) 2 cm towards mirror

Velocity of Image – b) Parallel to mirror

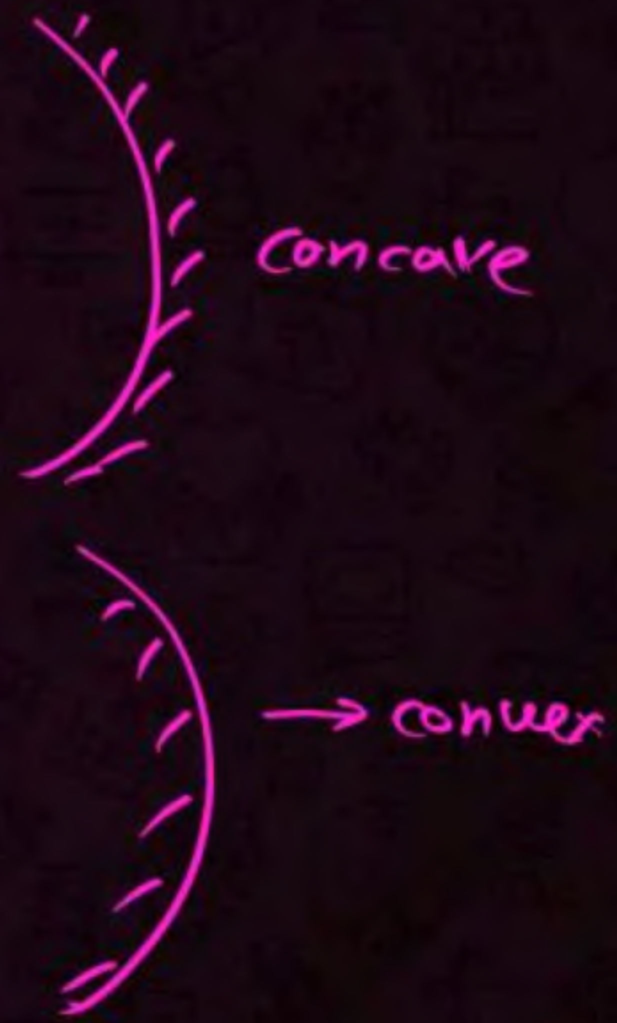


$$\vec{V_I} = \vec{V_o}$$

Curved Spherical Mirrors

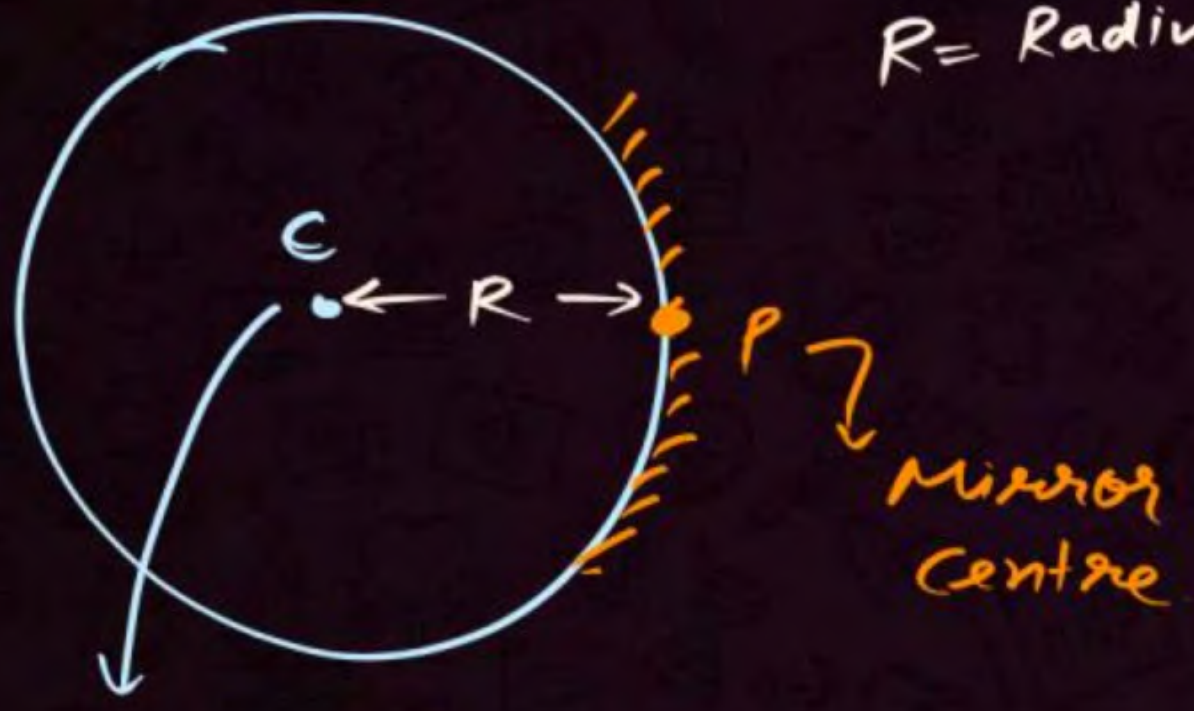
a) Concave

b) Convex



Terminology

R= Radius of curvature

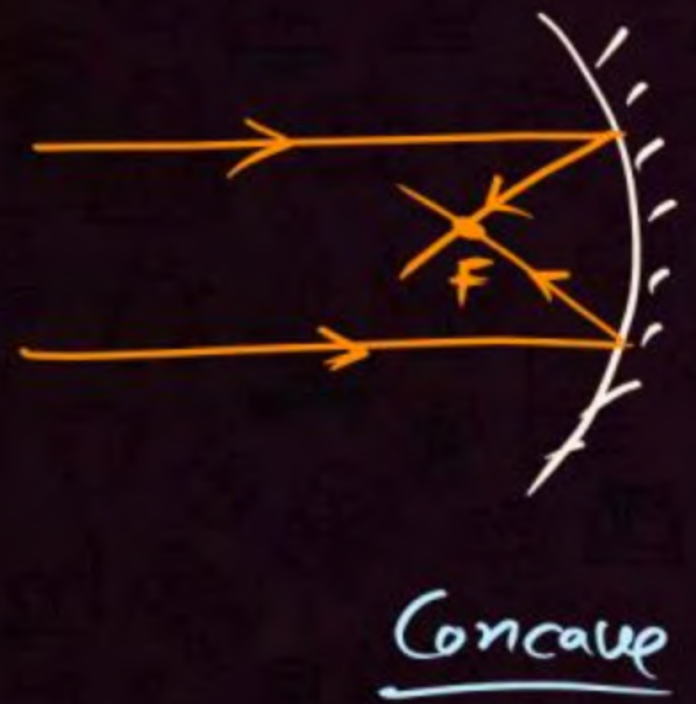


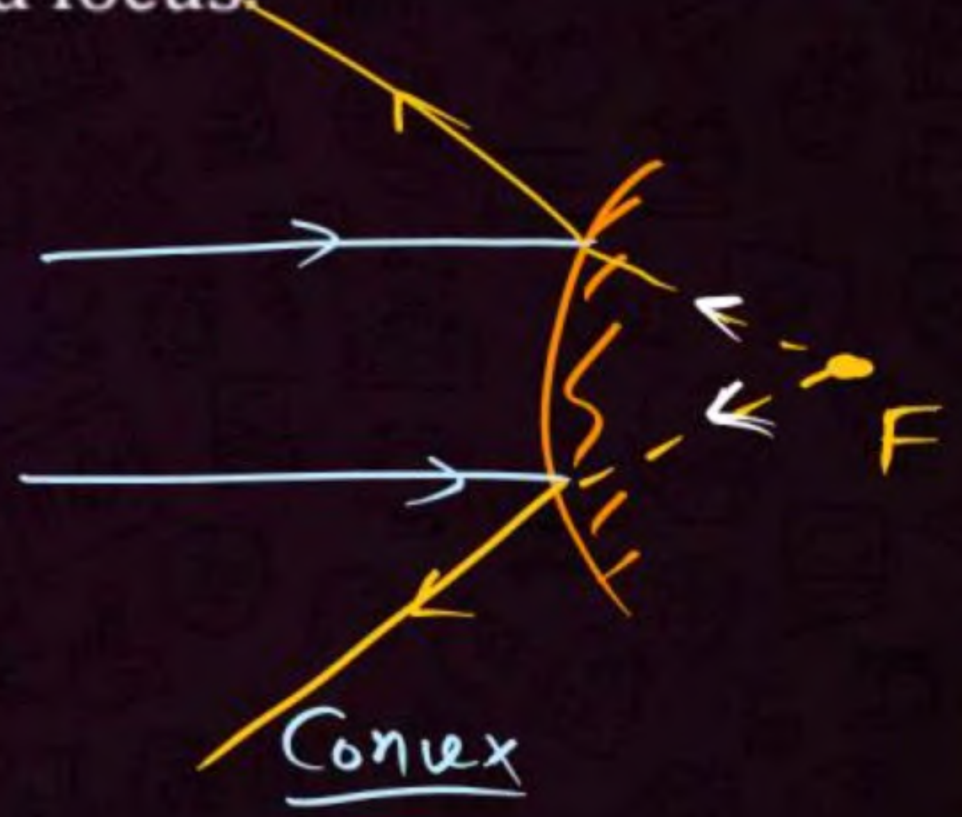
center of curvature

(sphere center)

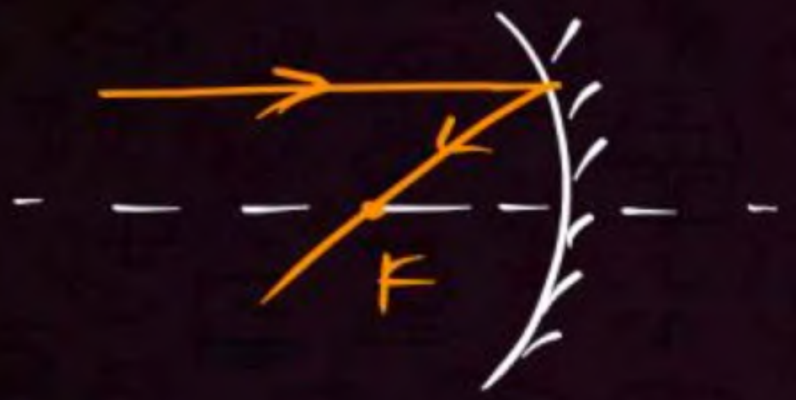
Focus

The rays coming parallel to principal axis, after reflection, actually meet or appear to be coming from a point, that point is called focus.





Rules for Image Formation

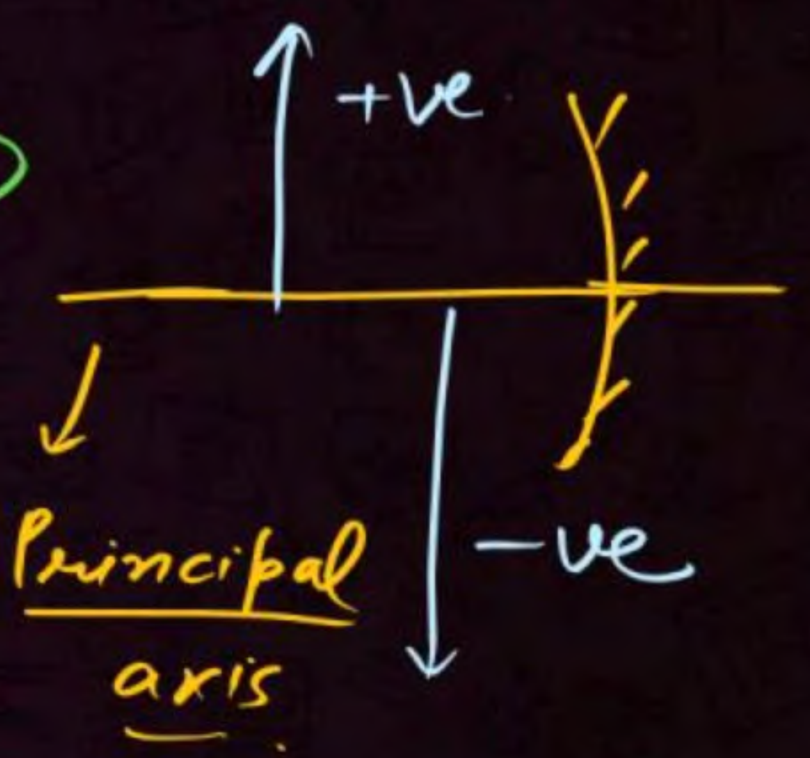


Sign Conventions

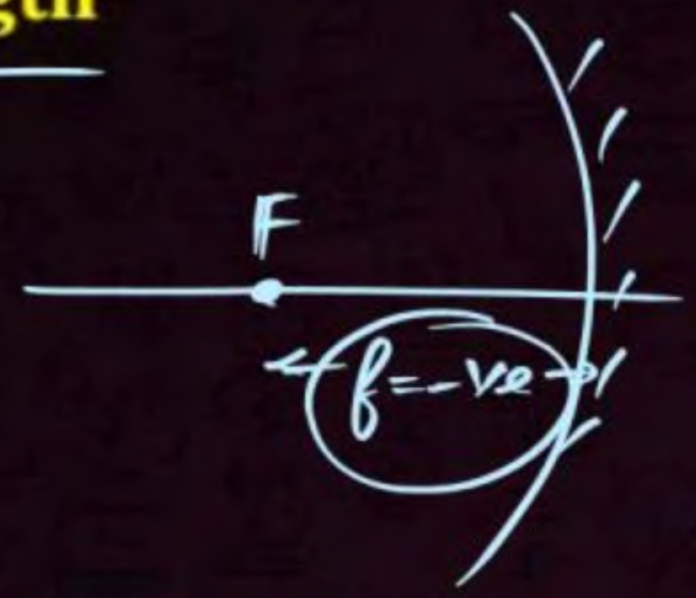
(1) Distances measured from pole.

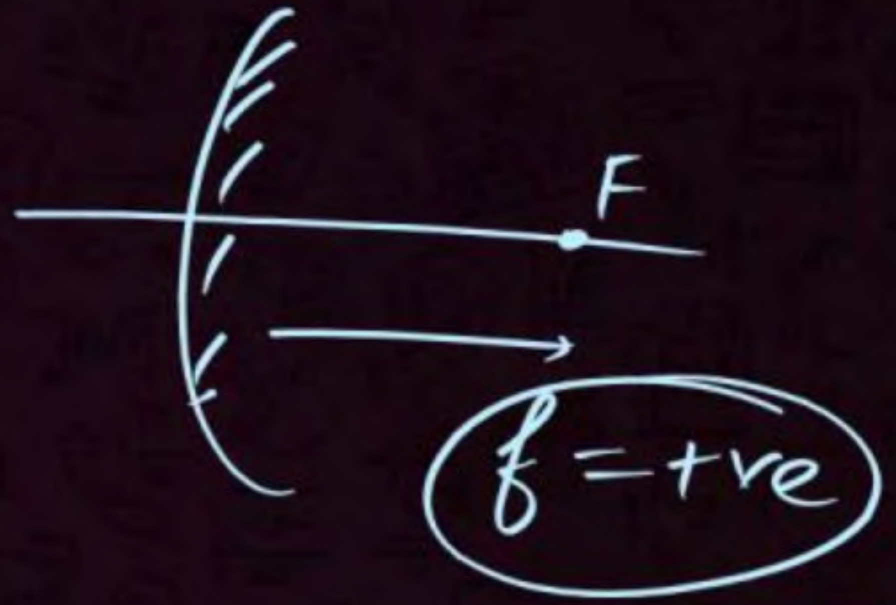
(2)

(3)



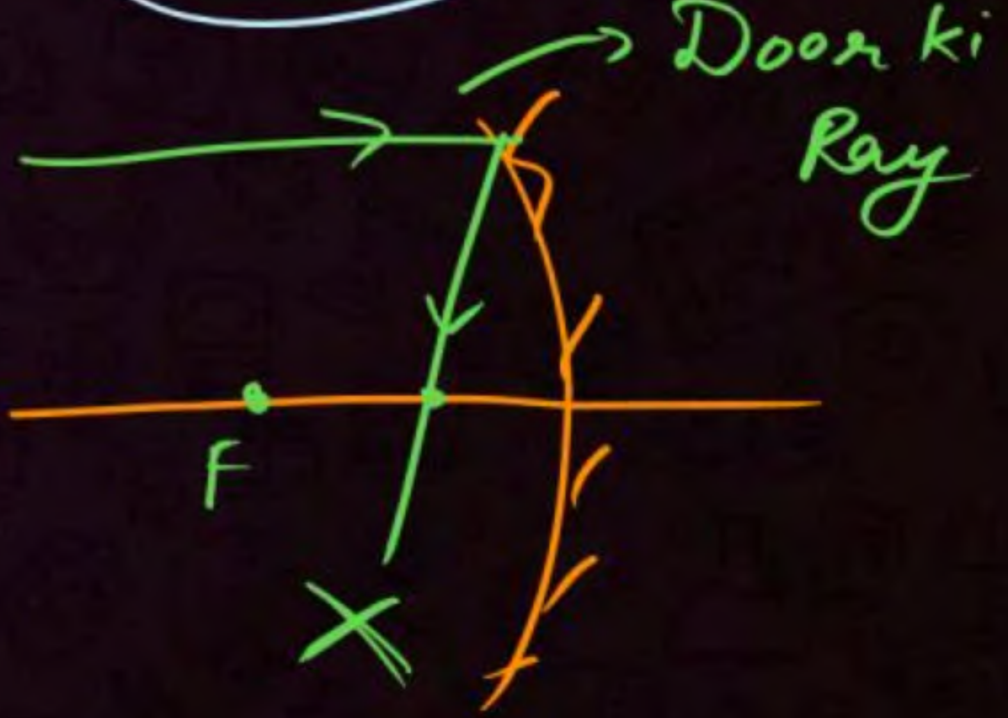
Sign of focal length



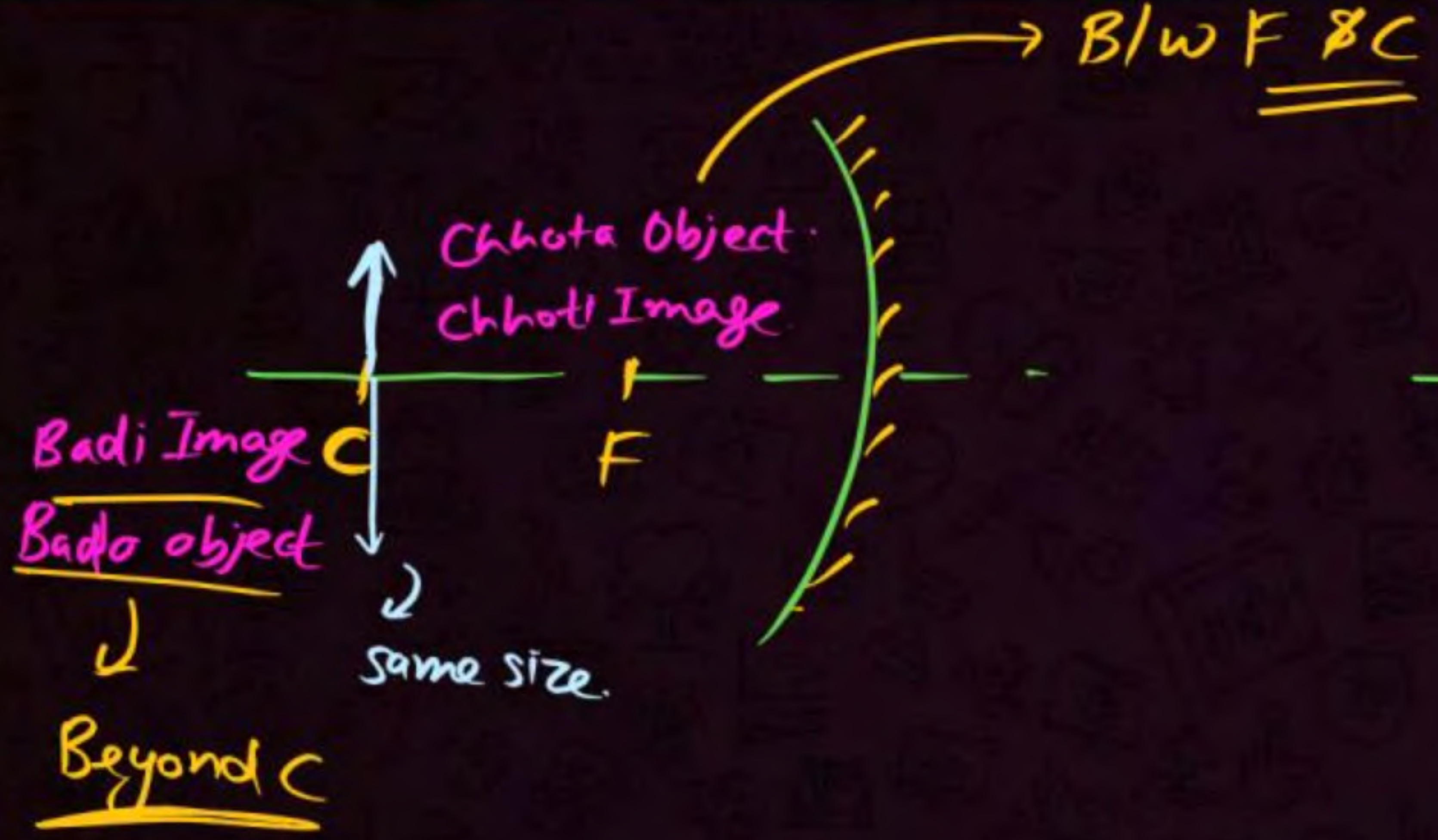


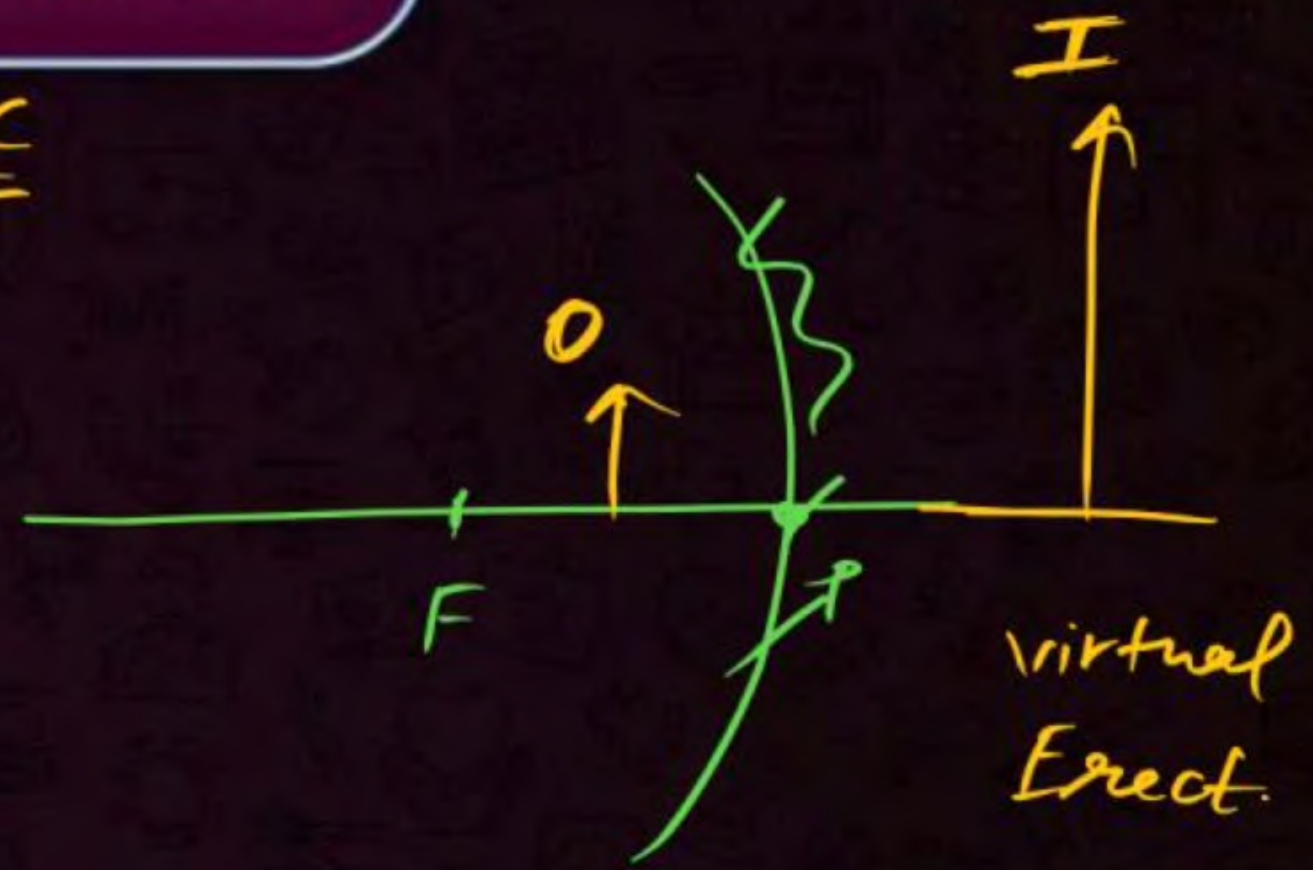
Paraxial Rays assumption: Very near to principal axis

Or chhote mirrors
(small)



Ray Diagrams – a) Concave Mirror



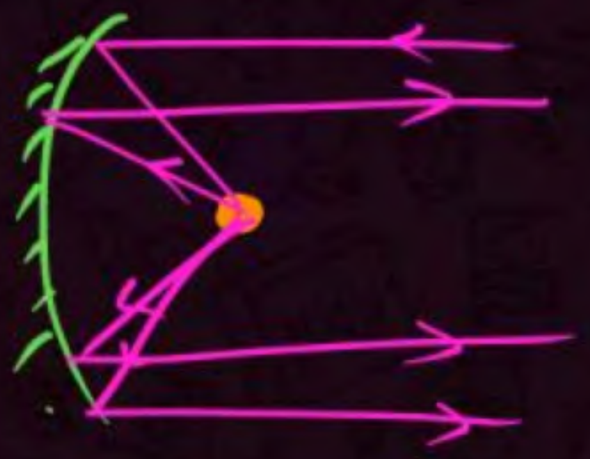


Object	Image	Exact/ Inverted	Real/Virtual	Size
1. ∞	F	Inverted	Real	Highly Diminished
2. Beyond C	B/w F and C	Inverted	Real	Diminished
3. C	C	Inverted	Real	Same Size
4. B/w F and C	Beyond C	Inverted	Real	Enlarged
5. F	∞	Inverted	Real	Highly Enlarged
6. B/w F and P	Beyond Mirror	Erect	Virtual	Enlarged (Magnified)

Uses of Concave Mirror

Evenly spread

It is used in ENT, as shaving mirror, headlight.



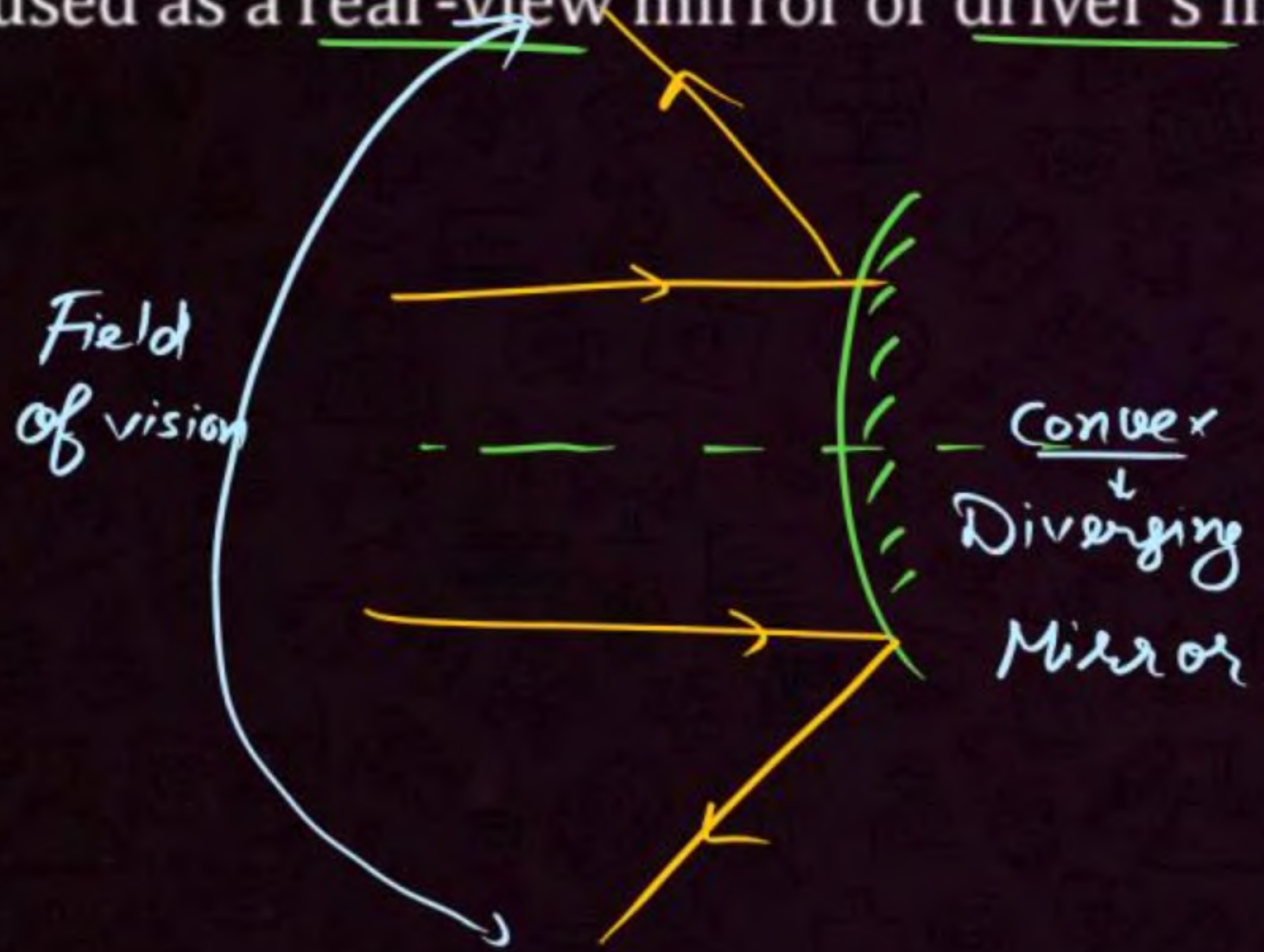
Ray Diagrams – b) Convex Mirror

① Object ∞ | Image F (behind) | Virtual | Erect | Highly Diminished.

② Object b/w ∞ & P | Image b/w F & P. (behind) | Virtual | Erect | Diminished

Uses of Convex Mirror

It is used as a rear-view mirror or driver's mirror.

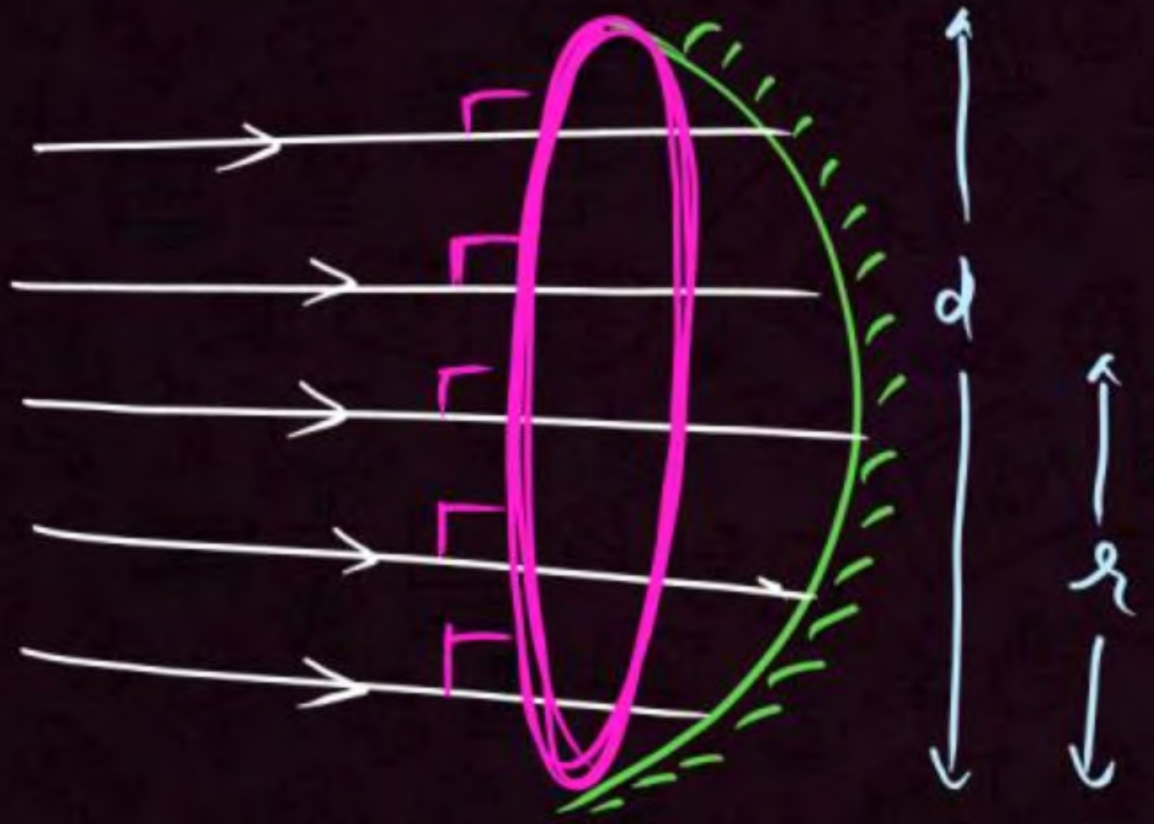


Bcoz → Image small, Erect

Field of vision more

Aperture of mirror

Area perpendicular to rays where light can enter.



$A = \pi r^2$

↳ Area of aperture

- Bada Area → Bada Mirror ↓ Jyada Rays → Image Brightness

Formulae

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

↳ mirror formula $\Rightarrow \frac{1}{v}=\frac{u-f}{fu}$

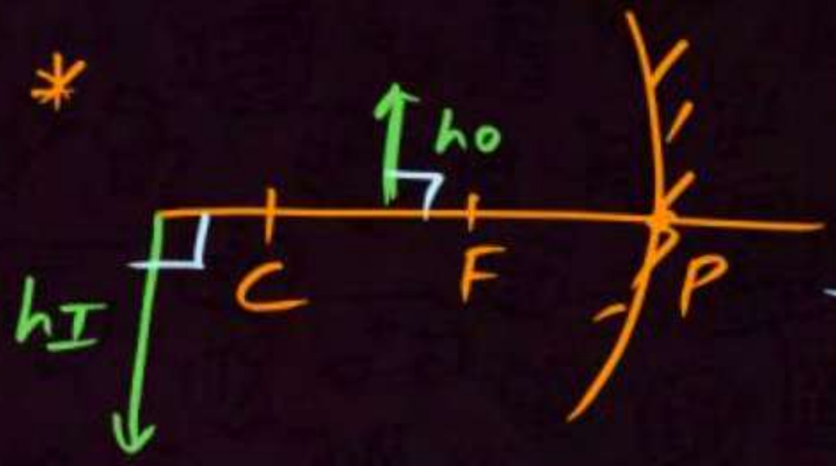
TBS $\boxed{v=\frac{uf}{u-f}}$

* Put with sign.

Ques Plane mirror

$m=1$

*



$\boxed{m=\frac{h_I}{h_o}}$

⊥cular to principal axis

$$m_{lat}=m=-\frac{v}{u}=\frac{f}{f-u}=\frac{f-v}{f}$$

$|m|>1 \Rightarrow$ Enlarged

$|m|<1 \Rightarrow$ Diminished

$|m|=1 \Rightarrow$ same size

$m=+ve \Rightarrow$ Erect

$m=-ve \Rightarrow$ Inverted

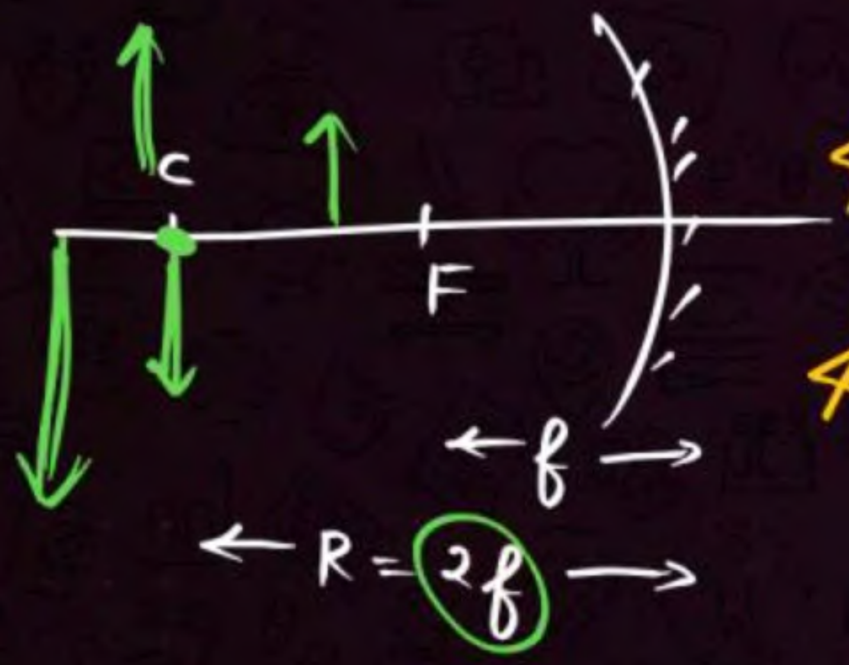
* $\boxed{f=\frac{R}{2}} \Rightarrow \boxed{R=2f}$

TBS shortcuts

↓

Most used

Concave mirror



$u = -2f,\ v = -2f \Rightarrow m = -1$

$u = -\frac{3f}{2},\ v = -3f \Rightarrow m = -2$

$u = -3f,\ v = -\frac{3f}{2} \Rightarrow m = -\frac{1}{2}$

QUESTION

Statement-I: The formula connecting u, v and f for a spherical mirror is valid only for mirrors whose sizes are very small compared to their radii of curvature.

Statement-II: Laws of reflection are strictly valid for plane surfaces, but not for large spherical surfaces.

↳ all type of surfaces

1. Both statement I and II are correct
2. Both statement I and II are incorrect
3. Statement I is correct and statement II is incorrect
4. Statement I is incorrect and statement II is correct

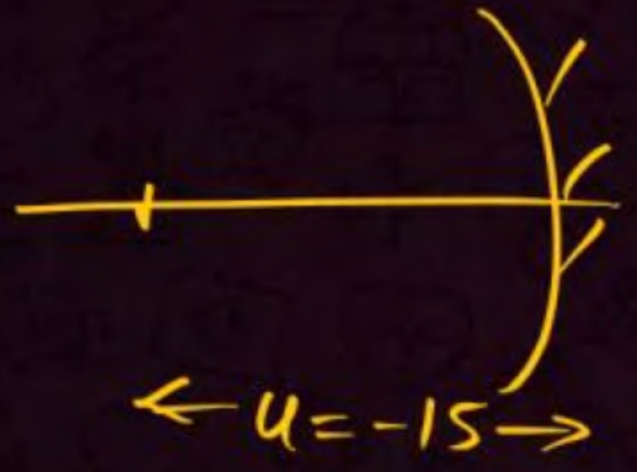
QUESTION

BPU

Double → 30cm

An object is placed at a distance of 15 cm in front of concave mirror of focal length 10 cm. Describe the image formed and calculate its distance from the mirror.

1. 20 cm
2. 30 cm ✓
3. 40 cm
4. 60 cm



$f = -10\ cm$

TBSS

$\frac{u}{f} = \frac{15}{10} = \frac{3}{2} \Rightarrow u = \frac{3f}{2}$

$v = -3f = -3 \times 10$

$= -30\ cm$

$v = \frac{uf}{u-f} = \frac{(-15)(-10)}{-15-(-10)} = \frac{150}{-5}$

$v = -30$

$m = -\frac{v}{u} = \frac{-(-30)}{-15}$

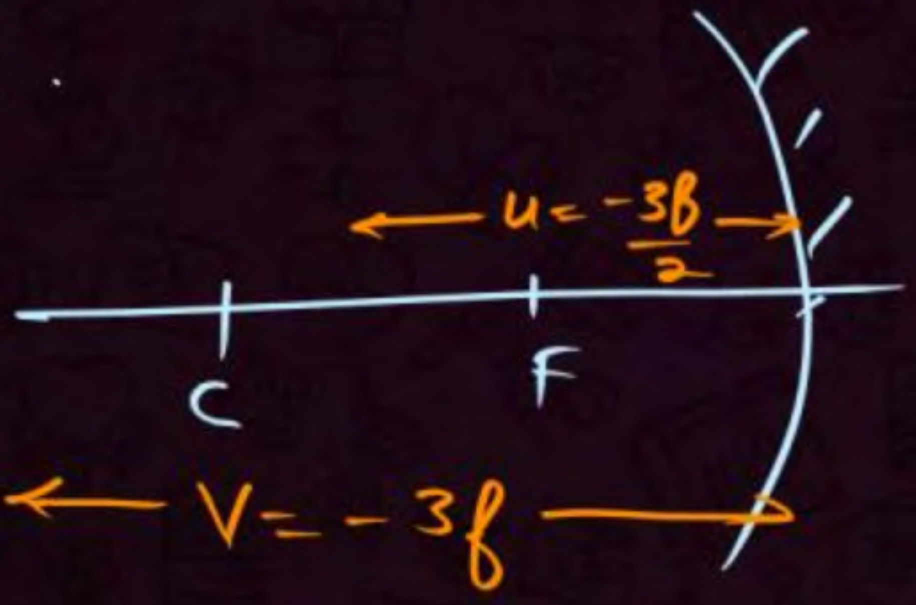
$m = -2$

QUESTION

An object is placed on the principal axis of a concave mirror at a distance of 1.5f (f is the focal length). The image will be at

[NEET (Oct.) 2020]

$\frac{3f}{2}$



(1) $-3f$

(2) $1.5f$

(3) $-15f$

(4) $3f$

QUESTION

A concave mirror for face viewing has focal length of 0.4 m. The distance at which you hold the mirror from your face in order to see your image upright with a magnification of 5 is

[9 April, 2019 (Shift-I)]

(1) 0.16 m

(2) 1.6 m

(3) 0.32 m

(4) 0.24 m

40 cm

Erect. ($m = +$)

$u = ?$

$m = +5 = \frac{f}{f-u}$

$5 = \frac{-0.4}{-0.4-u}$

$\Rightarrow 5 = \frac{-40}{-40-u}$

$-40-u = -8$

$40+u = 8 \Rightarrow u = 8-40 = -32$

Aalsi Logic $u = f\left(1 - \frac{1}{m}\right)$ → optional

↓

if m, f (given)

$$= -40\left(1 - \frac{1}{5}\right)$$

$$= -\cancel{40}^{8} \times \frac{4}{\cancel{5}}$$

$$= -32\,cm = -0.32\,m$$

QUESTION

An object 5 cm tall is placed 1 m from a concave spherical mirror which has a radius of curvature of 20 cm. The size of the image is [AIIMS 2008]

(1) 0.11 cm

(2) 0.50 cm

(3) 0.55 cm

(4) 0.60 cm

$u = -1\,m = -100\,cm$

$R = -20\,cm$

$f = \frac{R}{2} = -10\,cm$

$h_0 = 5\,cm$

$h_I = ?$

$m = \frac{f}{f-u} = \frac{-10}{-10-(-100)} = \frac{-10}{90}$

$m = \frac{-1}{9} = \frac{h_I}{h_0}$

$h_I = \frac{-h_0}{9} = \frac{-5}{9}\,cm = -0.55\,cm$

$$\frac{1}{9} = 0.\underline{11}$$

$$\frac{2}{9} = 0.\underline{22}$$

$$\frac{3}{9} = 0.\underline{33}$$

$$\frac{4}{9} = 0.\underline{44}$$

$$\frac{5}{9} = 0.\underline{55}$$

QUESTION

A spherical mirror forms an image of magnification 3. The object distance, if focal length of mirror is 24 cm, may be [AIIMS 2019]

(1) 32 cm, 24 cm

(2) 32 cm, 16 cm

(3) 32 cm only

(4) 16 cm only

→ concave

$m = \pm 3$

$m = \frac{f}{f-u}$ or $u = f\left(1 - \frac{1}{m}\right)$ → optional.

$3 = \frac{-24}{-24-u}$

$24 + u = 8$

$u = -16$

$-3 = \frac{-24}{-24-u}$

$24 + u = -8$

$u = -8 - 24 = -32$

QUESTION

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: [1 Feb, 2023 (Shift-II)]

(1) 40 cm

(2) 60 cm

(3) 160 cm ✓

(4) 100 cm

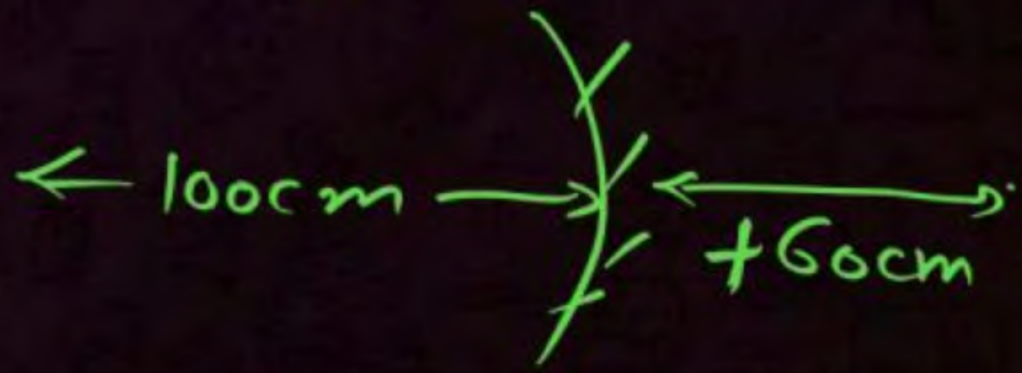
$u = -15$, $u = -25$

$f = -\frac{40}{2} = -20$

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

$$v = \frac{(-15)(-20)}{-15-(-20)} = \frac{300}{-15+20} = \frac{300}{5} = +60$$

$$v = \frac{(-25)(-20)}{-25-(-20)} = \frac{500}{-25+20} = +\frac{500}{-5} = -100\text{ cm}$$



Question

HW

An object is placed at a distance of 40 cm from a concave mirror of focal length 15 cm. If the object is displaced through a distance of 20 cm towards the mirror, the displacement of the image will be [NEET 2018]

1. 30 cm towards the mirror
2. 36 cm away from the mirror
3. 30 cm away from the mirror
4. 36 cm towards the mirror

QUESTION

HW

The focal length f is related to the radius of curvature r of the spherical convex mirror by:

[24 Feb, 2021 (Shift-I)]

(1) $f = r$

(2) $f = -1/2\, r$

(3) $f = -r$

(4) $f = +1/2\, r$

QUESTION

Match the corresponding entries of column 1 with column 2. [Where m is the magnification produced by the mirror] [NEET 2016]

Column 1		Column 2	
A.	m = –2	a.	Convex mirror
B.	m = –1/2	b.	Concave mirror
C.	m = + 2	c.	Real image
D.	m = + ½	d.	Virtual image

(1) A → a and c; B → a and d; C → a and b; D → b and c

(2) A → a and d; B → b and c; C → b and d; D → a and d

(3) A → c and d; B → b and d; C → b and c; D → a and d

(4) A → b and c; B → b and c; C → b and d; D → a and d

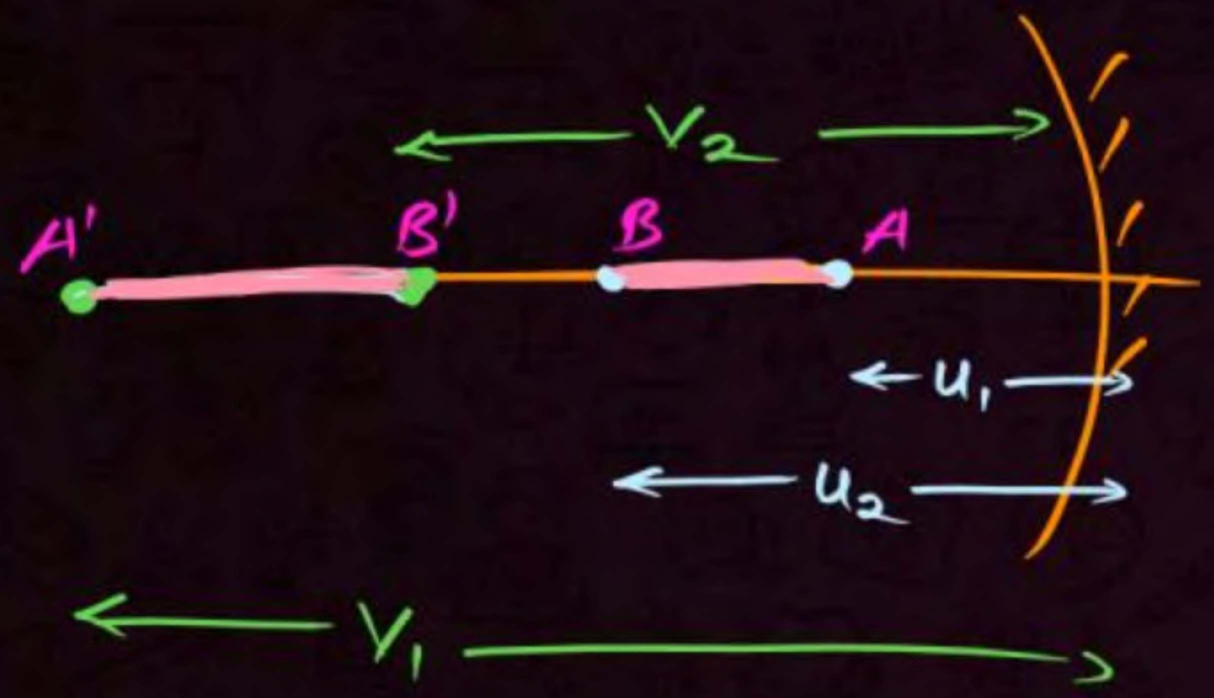
A → b, c
B → b, c
C → b, d
D → a, d

Convex → Erect } → $m = +ve$, $m < 1$

Concave → Inverted } → $m = -ve$; → $m < 1$ or $m > 1$ or $m = 1$

Erect } → $m = +ve$; → $m > 1$

Longitudinal Magnification (along principal axis)



$$m_{long} = \frac{\text{Size of image}}{\text{Size of object}} = \frac{v_1 - v_2}{u_2 - u_1}$$

For small objects ☆

$$|m_{long}| = m_{lat}^2 = m^2$$

QUESTION

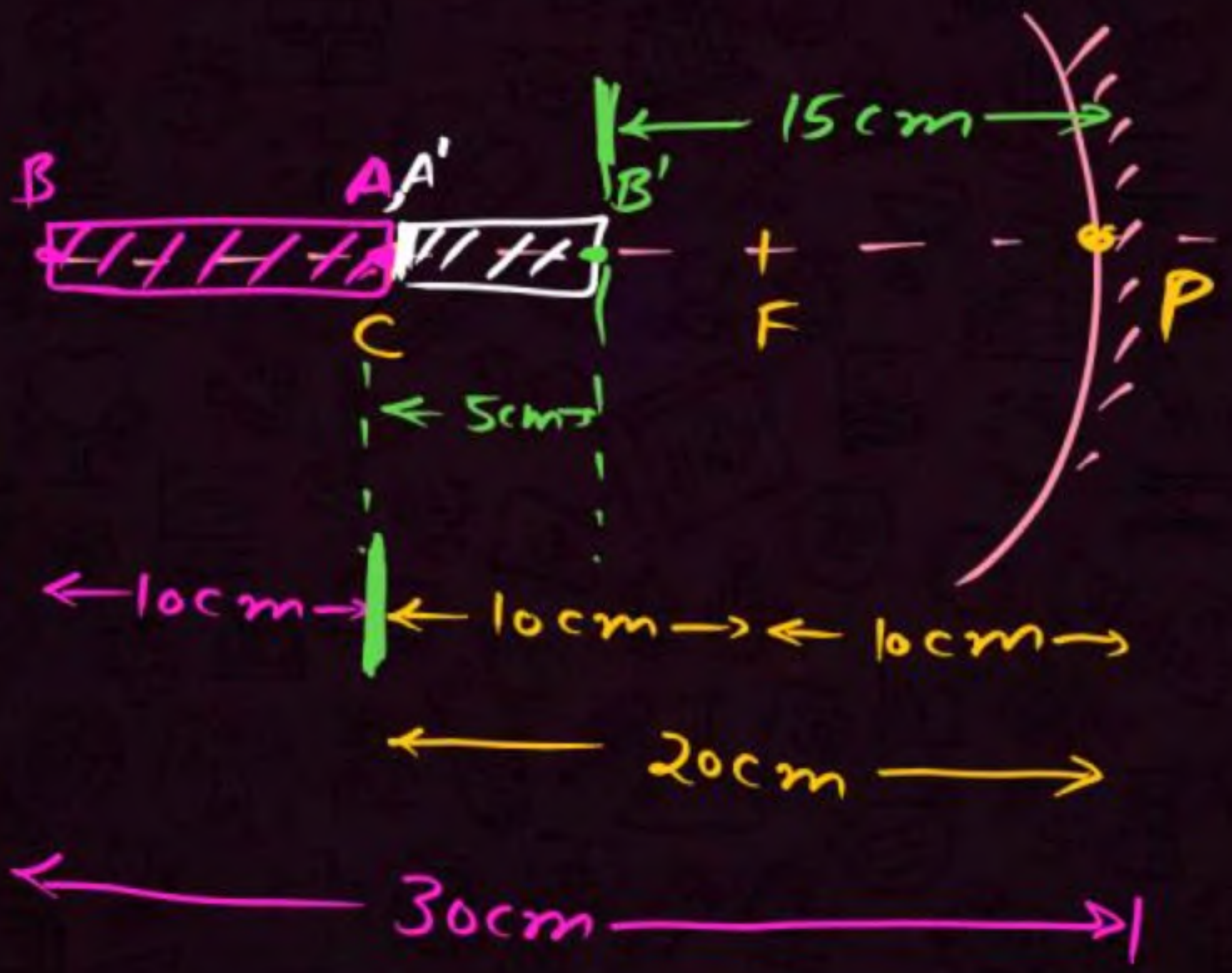
A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that its end closer to the pole is 20 cm away from the mirror. The length of the image is:

(1) 10 cm

(2) 15 cm

(3) 2.5 cm

(4) 5 cm



$f = 10\,cm$

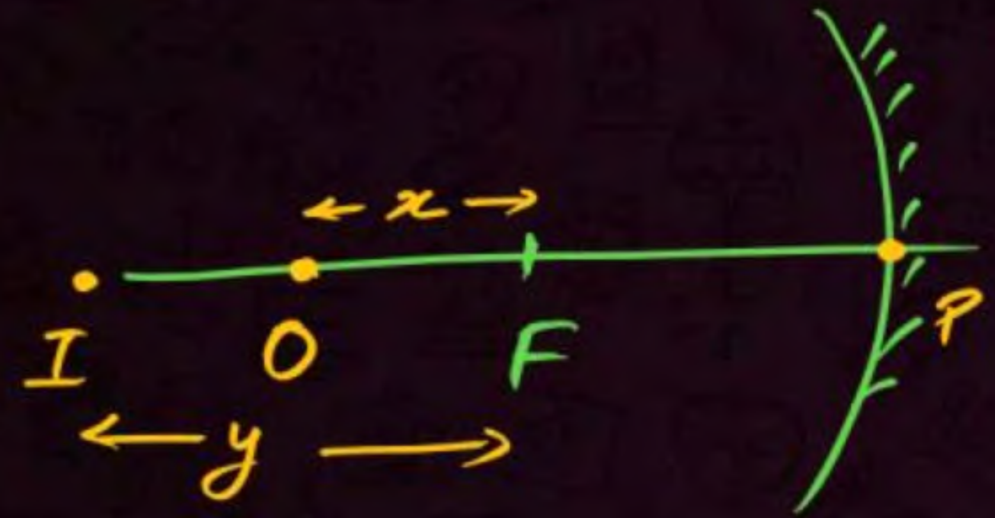
$30\,cm = 3f$

$u = 3f$

$v = \frac{3f}{2} = \frac{30}{2} = 15.$

$|m_{long}| = \frac{5}{10} = \frac{1}{2}$

Newton's Formula



$$xy = f^2$$

$$f = \sqrt{xy}$$

$x, y \Rightarrow$ Distances of object/Image from focus.

Ques From focus

Object $\Rightarrow$ 9 cm.

Image $\Rightarrow$ 4 cm

$f = ?$

$$f = \sqrt{9 \times 4} = \sqrt{36} = 6$$

Velocity of image in curved mirrors–
a) Parallel to Principal axis

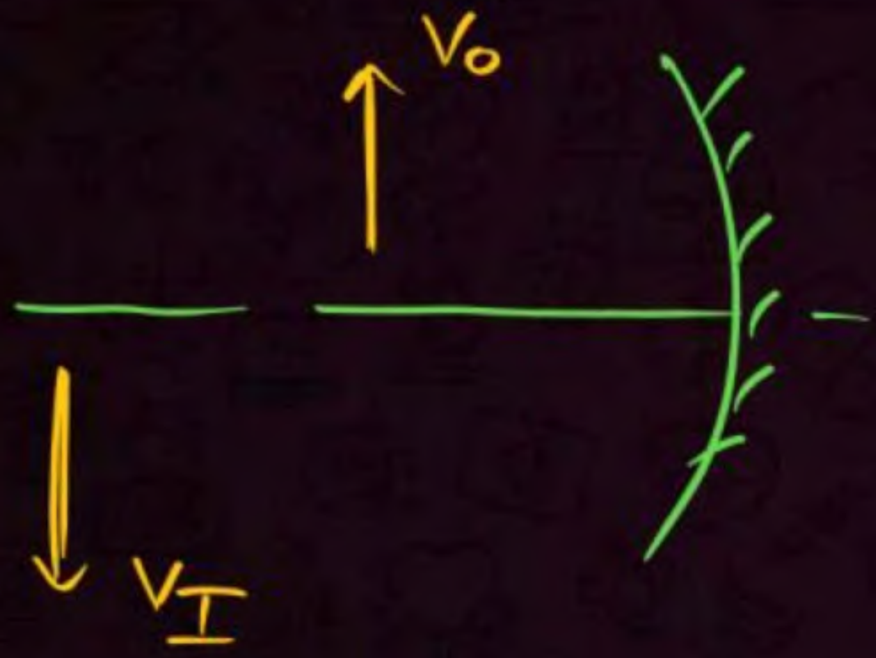
$$V_I = -m_{lat}^2 V_0 = -m^2 V_0$$

↳ also valid wrt mirror

$$V_I = -\left(\frac{-v}{u}\right)^2 V_0$$

$$V_I = -\frac{v^2}{u^2} V_0$$

b) Velocity of image perpendicular to Principal axis



$$V_I = -\frac{v}{u} V_0$$

$$V_I = m_{lat} V_0 = m V_0$$

→ Rare Chance

QUESTION

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 s^{-1}, the speed (in cm s^{-1}) with which image moves at that instant is ______.

[3 Sep, 2020 (Shift-II)]

(1) 9

(2) 3

(3) 1

(4) 81

$u = -30$ $\quad m = -\frac{v}{u} = \frac{-(-10)}{-30} = \frac{-1}{3}$

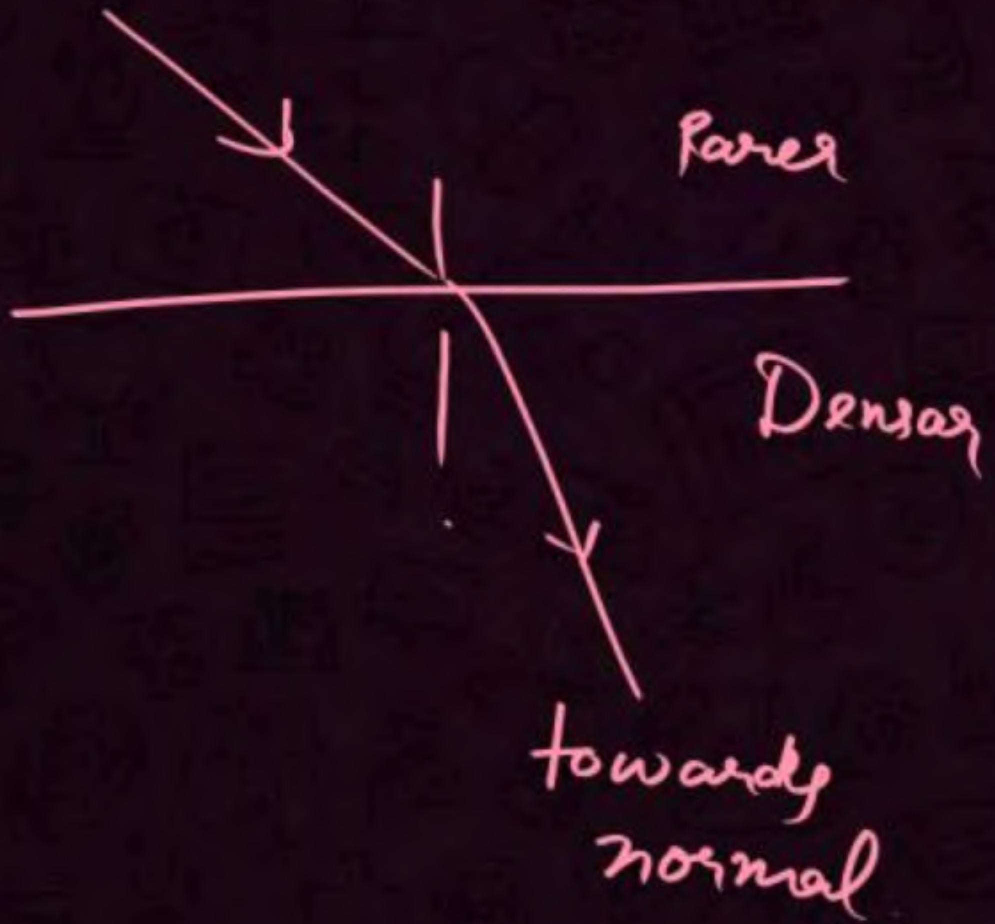
$v = -10$

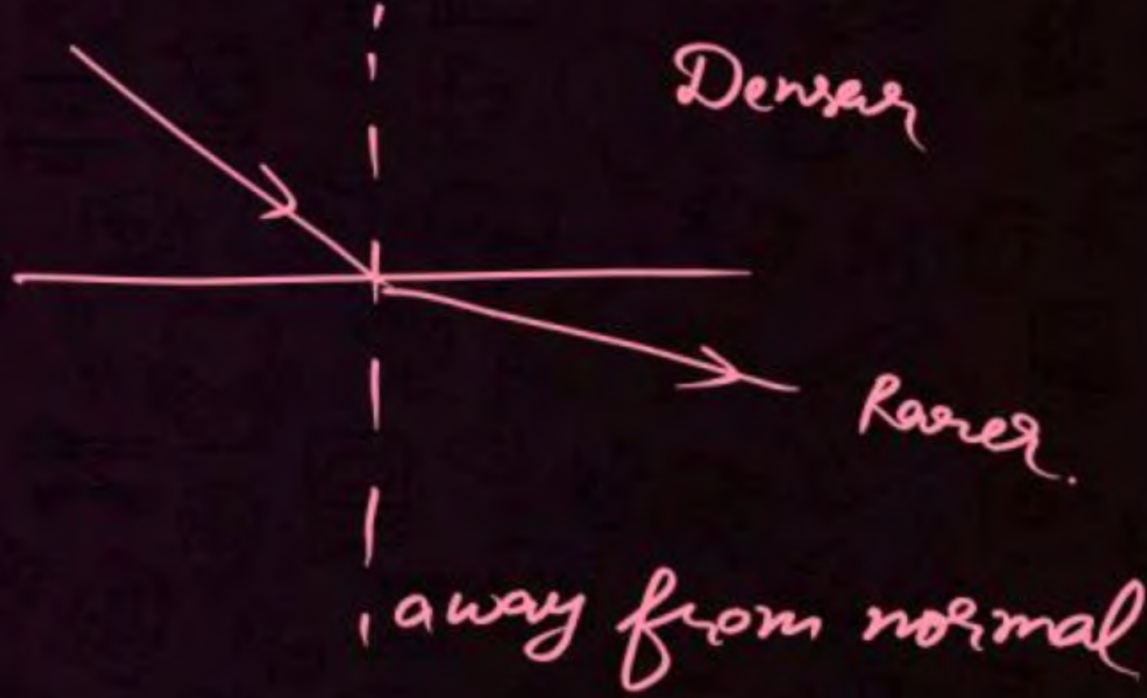
$V_0 = 9$ $\quad V_I = m^2 V_0 = \frac{1}{9} \times 9 = 1$

$V_I = ?$

Refraction

Light does not reflect back, it transmits to the other medium





Laws of Refraction

1. The incident ray (IR), refracted ray (RR) and the normal (N) all lie in the same plane.

2. The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant for a light of given colour and given pair of media. This law is also known as 'Snell's Law'.

$$\frac{\sin i}{\sin r} = \text{const.}$$

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

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1} = \text{const.}$$

Refractive Index

don't confuse with mass density

Also known as optical density.

It compares speed of light in a given medium w.r.t. vacuum

For any wave

$v = f\lambda$

$$\mu = n = \frac{c}{v} = \frac{c}{f\lambda}$$

$\mu = 1$ (vacuum)

$\mu \simeq 1$ (air)

$\mu > 1$ (medium)

$$\mu = \frac{c}{v} = \frac{c}{f\lambda}.$$

$\mu \propto \frac{1}{v}$ $\quad$ $\mu \propto \frac{1}{\lambda}$

$v \uparrow \Rightarrow \mu \downarrow$

$\lambda \uparrow \Rightarrow \mu \downarrow$

$$\frac{\mu_1}{\mu_2} = \frac{v_2}{v_1} = \frac{\lambda_2}{\lambda_1}$$

QUESTION

The refractive index of glass is 1.5. The speed of light in glass is

(1) 3×10^3 m/s

(2) 2×10^8 m/s

(3) 1×10^8 m/s

(4) 4×10^8 m/s

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

$$1.5 = \frac{3}{2} = \frac{3 \times 10^8}{v}$$

$$v = 2 \times 10^8 \text{ m/s}$$

QUESTION

The frequency of a light wave in a material is 2×10^{14} Hz and wavelength is 5000 Å. The refractive index of material will be: **[2007]**

(1) 1.33

(2) 1.40

(3) 1.50

(4) 3.00

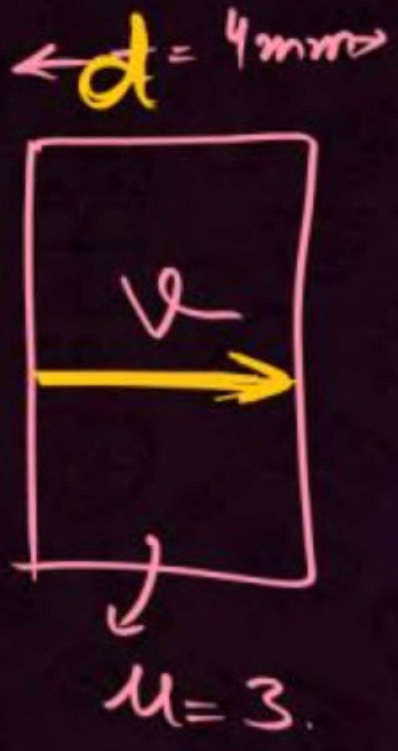
$$\mu = \frac{c}{v} = \frac{c}{f\lambda} = \frac{3 \times 10^8}{2 \times 10^{14} \times 5000 \times 10^{-10}}$$

$$= \frac{3 \times 10^8}{10 \times 10^{14} \times 10^{-7}} = 3$$

QUESTION

What is the time taken (in seconds) to cross a glass of thickness 4 mm and $\mu = 3$ by light

1. 4×10^{-11} ✓
2. 2×10^{-11}
3. 16×10^{-11}
4. 8×10^{-10}



t = time

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

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

$$t = \frac{d}{v} = \frac{d}{c/\mu}$$

$$t = \frac{\mu d}{c} = \frac{3 \times 4 \times 10^{-3}}{3 \times 10^{8}}$$

$$= 4 \times 10^{-11} \text{ sec.}$$

QUESTION

(single colour)

A beam of monochromatic light is refracted from vacuum into a medium of refractive index 1.5. The wavelength of refracted light will be [CBSE AIPMT 1991, 1992]

1. dependent on intensity of refracted light
2. same
3. smaller
4. larger

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

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

vacuum → medium

$\mu \rightarrow$ inc

$\lambda \rightarrow$ dec

QUESTION

When light rays enter in a glass slab, their wavelength

[AIIMS 1996]

1. remains unchanged
2. decreases
3. increases
4. either (a) or (b).

TBS Note:- frequency doesn't change with medium.

It is a property of source.

* $\lambda, v \rightarrow$ change

QUESTION

Electromagnetic radiation of frequency ν, velocity v and wavelength λ, in air, enters a glass slab of refractive index μ. The frequency, wavelength and velocity of light in the glass slab will be, respectively [CBSE AIPMT 1997]

1. $\frac{\nu}{\mu}, \frac{\lambda}{\mu}, v$
2. $\nu, \lambda, \frac{v}{\mu}$
3. $\nu, \frac{\lambda}{\mu}, \frac{v}{\mu}$
4. $\frac{\nu}{\mu}, \frac{\lambda}{\mu}, \frac{v}{\mu}$

ν or f $\quad v$

$(\nu) \quad \frac{\lambda}{\mu} \quad \frac{v}{\mu}$

TBS → air (vacuum) → medium.

$\nu \rightarrow$ same

$v \rightarrow \frac{v}{\mu}$

$\lambda \rightarrow \frac{\lambda}{\mu}$

air → glass

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

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

QUESTION

A ray of light having wavelength 720 nm enters in a glass of refractive index 1.5. The wavelength of the ray within the glass will be [AIIMS 1995]

(1) 720 nm

(2) 360 nm

(3) 1080 nm

(4) 480 nm

$$\frac{\lambda}{\mu} = \frac{720}{3/2} = 240 \times 2 = 480$$

QUESTION

Red light differs from blue light as they have [16 March, 2021 (Shift-II)]

1. Different frequencies and different wavelengths
2. Different frequencies and same wavelengths
3. Same frequencies and same wavelengths
4. Same frequencies and different wavelengths

Properties of Refractive Index

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

1. It is a dimensionless constant., unitless

2. It is a property of a medium. It doesn't depend on shape, size, mass or density of medium. It depends on electric and magnetic properties of medium.

$$n = \mu = \sqrt{\mu_r \epsilon_r}$$ → in EM Waves

QUESTION

As shown in the figure, after passing through the medium 1. The speed of light v_2 in medium 2 will be: (Given $c = 3 \times 10^8$ ms^{-1})

[28 July, 2022 (Shift-I)]

(1) 1.0×10^8 ms^{-1}

(2) 0.5×10^8 ms^{-1}

(3) 1.5×10^8 ms^{-1}

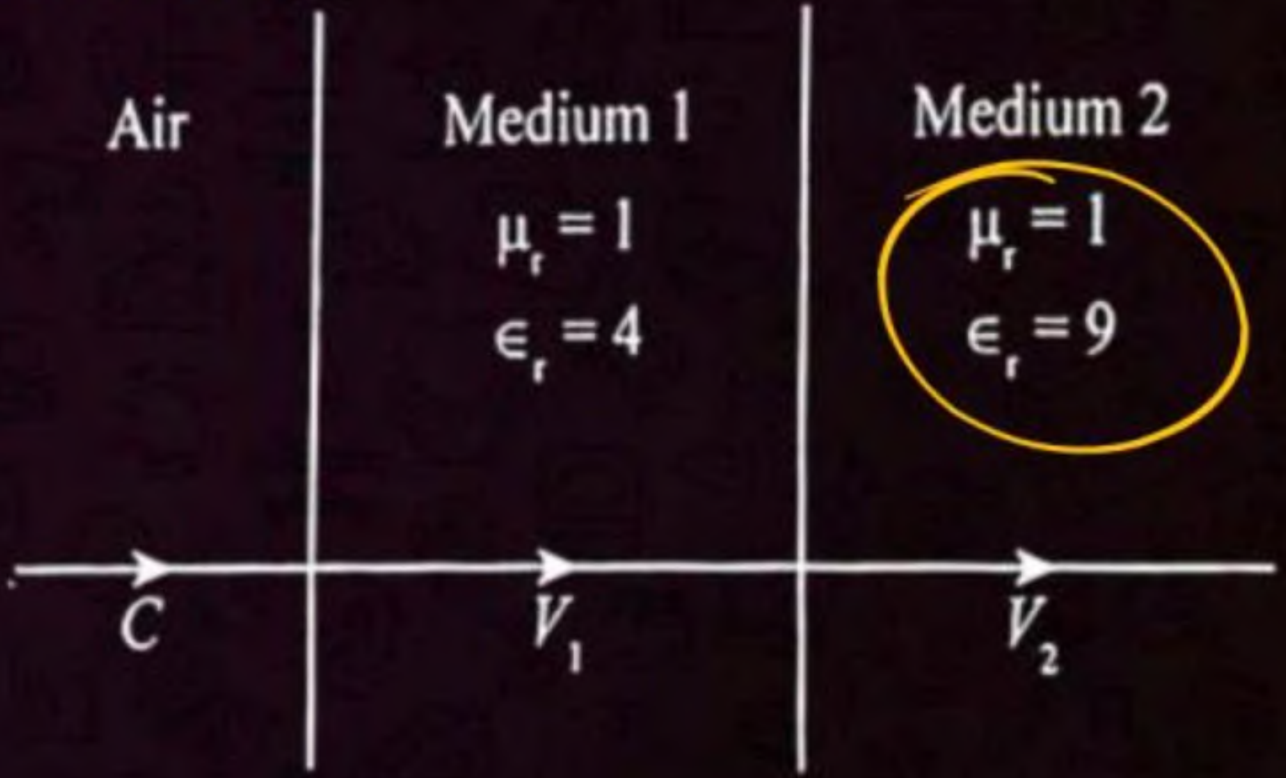
(4) 3.0×10^8 ms^{-1}

$\mu = n = \sqrt{1 \times 9} = \sqrt{9} = 3$

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

$v = \frac{c}{\mu} = \frac{3 \times 10^8}{3}$

$= 10^8$



Some Values to learn

Glass $\Rightarrow \mu_g = \frac{3}{2} = 1.5$

Water $\Rightarrow \mu_w = \frac{4}{3} = 1.33$

Relative Refractive Index

* $\mu_{12} = {}_2\mu_1 = \frac{\mu_1}{\mu_2}$

eg:- $\mu_{gw} = \frac{\mu_g}{\mu_w} = \frac{3/2}{4/3} = \frac{3}{2} \times \frac{3}{4} = \frac{9}{8}$

$\mu_{wg} = \frac{\mu_w}{\mu_g} = \frac{8}{9}$

$$\mu_{12} = \frac{1}{\mu_{21}}$$

QUESTION

HW

If ${}_i\mu_j$ represents refractive index when a light ray goes from medium i to medium j, then the product ${}_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3$ is equal to

(1) ${}_3\mu_1$

(2) ${}_3\mu_2$

(3) $\frac{1}{{}_1\mu_4}$

(4) ${}_4\mu_2$

Perpendicular Rays Condition

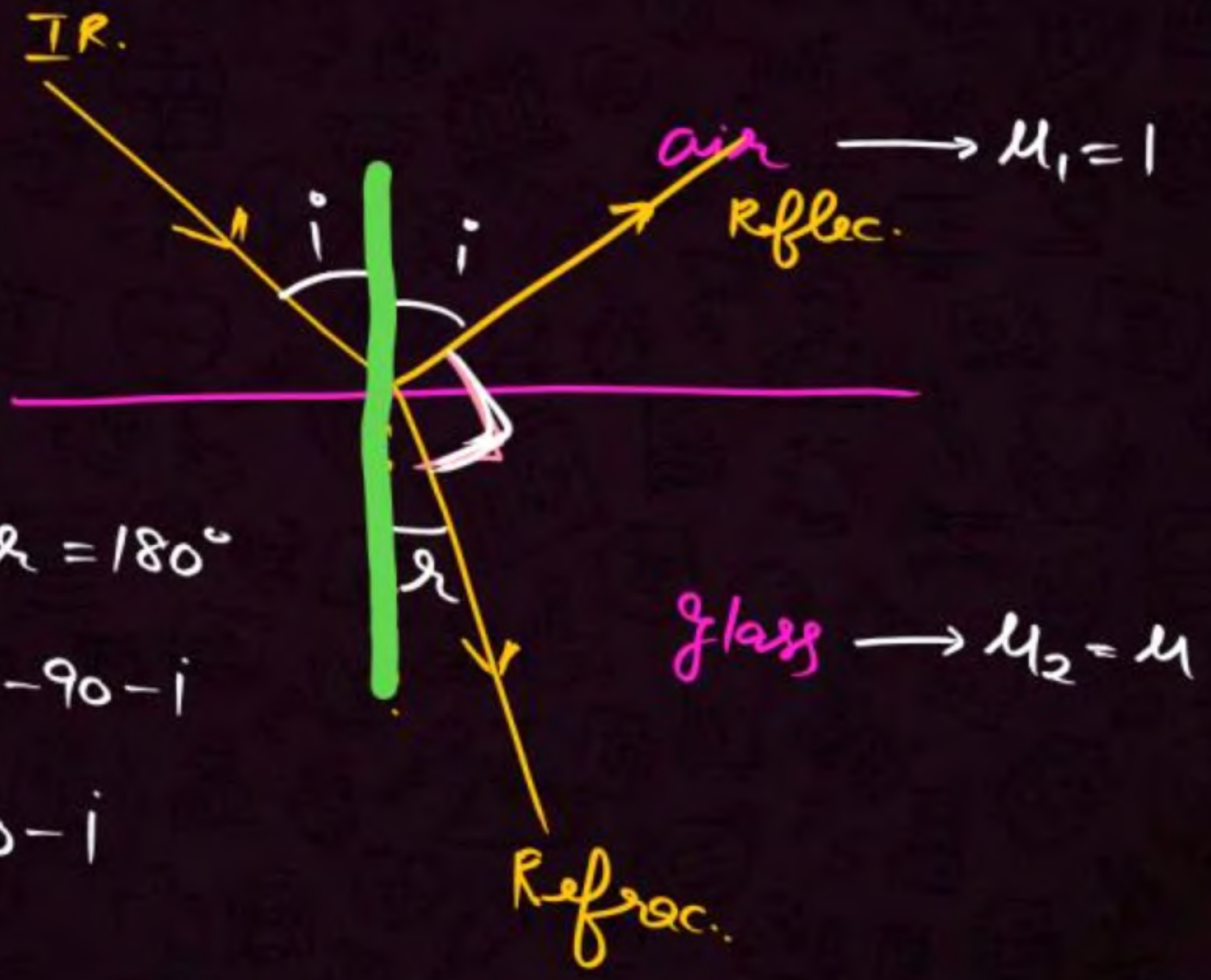
A light ray is travelling from air to glass. The reflected and refracted rays are perpendicular to each other. If the angle of incidence in air is i, refractive index of glass is

(1) $\sin i$

(2) $\cos i$

(3) $\tan i$ ✓

(4) $\cot i$



$i + 90 + r = 180°$

$r = 180 - 90 - i$

$r = 90 - i$

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

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

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

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

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

When Refl. & Refrac. rays are ⊥cular

QUESTION

A ray of light strikes a glass plate at an angle 60°. If the reflected and refracted rays are perpendicular to each other, the index of refraction of glass is

(1) $\sqrt{3}$

(2) $\sqrt{1.5}$

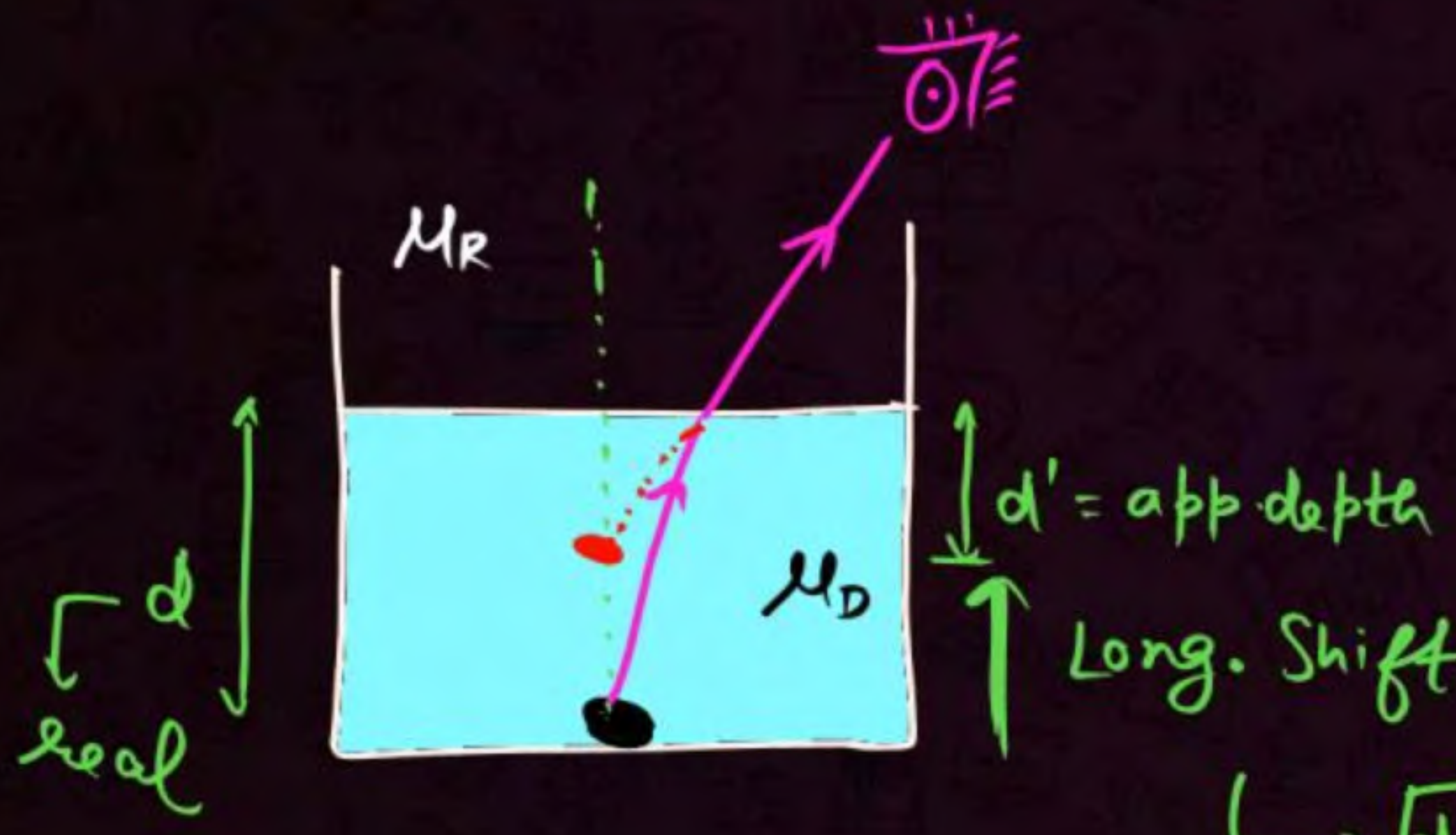
(3) $3/2$

(4) $1/2$

$\mu = \tan 60° = \sqrt{3}$

Break → 20 min

Apparent Depth



For small angles / just normal incidence

$$d' = \frac{d}{\mu}$$ → decreases

where $\frac{\mu_D}{\mu_R} = \mu$.

Long. Shift $= d - d' = d - \frac{d}{\mu}$.

→ $d\left(1 - \frac{1}{\mu}\right)$

* Denser to Rarer

↓

Shift in the direction of IR.

Apparent Height

$\boxed{h' = \mu h}$ where $\frac{\mu_D}{\mu_R} = \mu$.

L.Shift $= h' - h$.

$= \mu h - h$.

$\boxed{\text{L.shift} = h(\mu - 1)}$

Rarer to Denser

↓

L.Shift → opposite to IR

QUESTION

A rectangular tank of depth 8 meter is full of water ($\mu = 4/3$), the bottom is seen at the depth

(1) 6 m

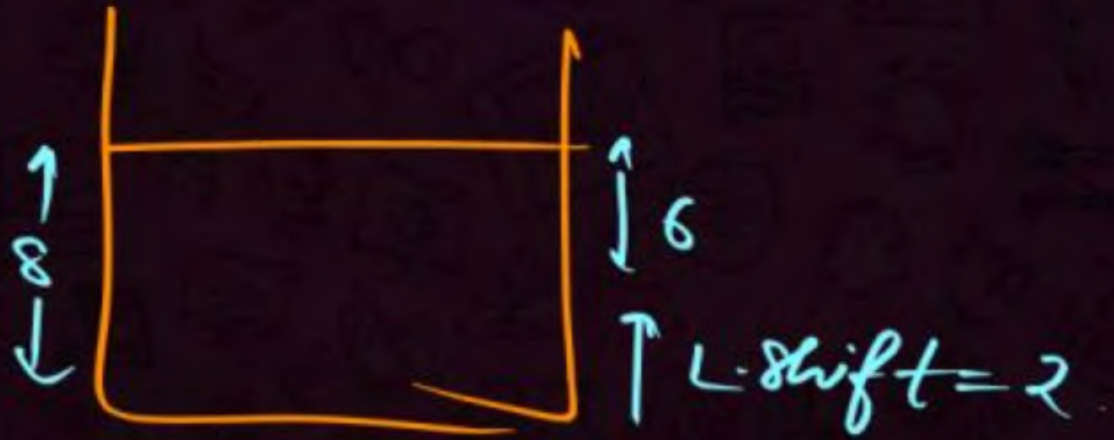
(2) 8/3 m

(3) 8 cm

(4) 10 cm

$$d' = \frac{d}{\mu} = \frac{8}{4/3} = 6\,m.$$

$$L.\text{shift} = d\left(1 - \frac{1}{\mu}\right) = 8\left(1 - \frac{3}{4}\right) = 8 \times \frac{1}{4} = 2$$



QUESTION

A vessel of depth 'd' is half filled with oil of refractive index n_1 and the other half is filled with water of refractive index n_2. The apparent depth of this vessel when viewed from above will be

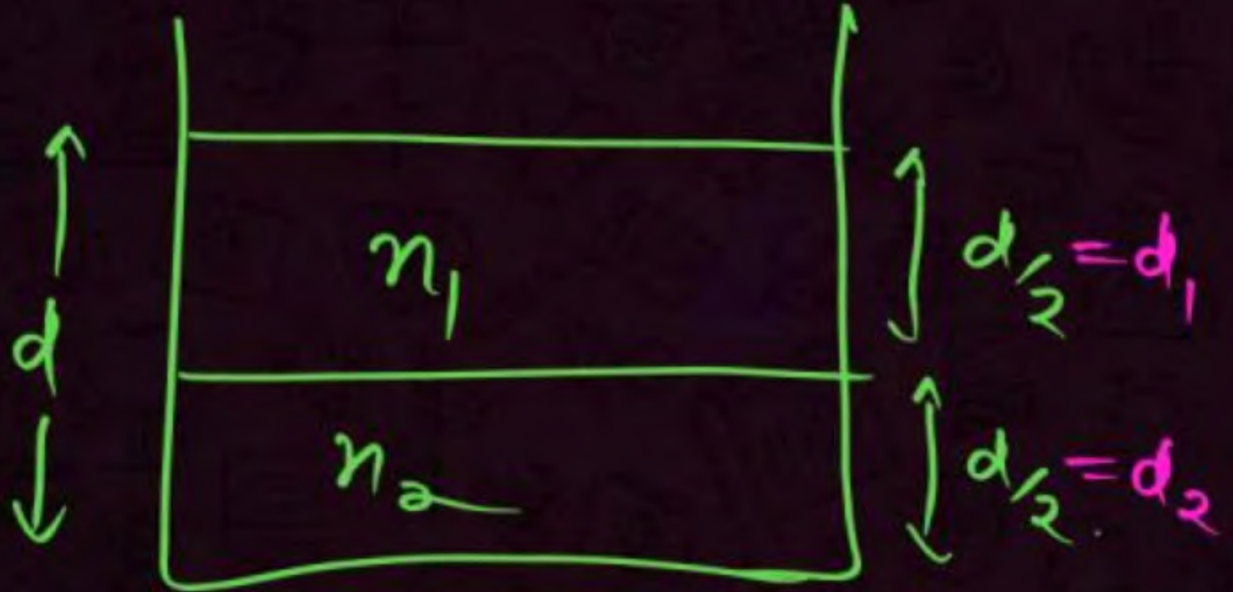
[13 Apr 2023 (Shift-I)]

(1) $\dfrac{dn_1n_2}{(n_1+n_2)}$

(2) $\dfrac{d(n_1+n_2)}{2n_1n_2}$

(3) $\dfrac{dn_1n_2}{2(n_1+n_2)}$

(4) $\dfrac{2d(n_1+n_2)}{n_1n_2}$



$$d' = \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2}$$

$$= \frac{d}{2n_1} + \frac{d}{2n_2}$$

$$= \frac{d}{2}\left(\frac{n_1+n_2}{n_1n_2}\right)$$

QUESTION

A bird is flying at the height of 12 cm from the surface of a lake and a fish is swimming at a depth of 24 cm from the surface. (Take is $\mu = 4/3$)

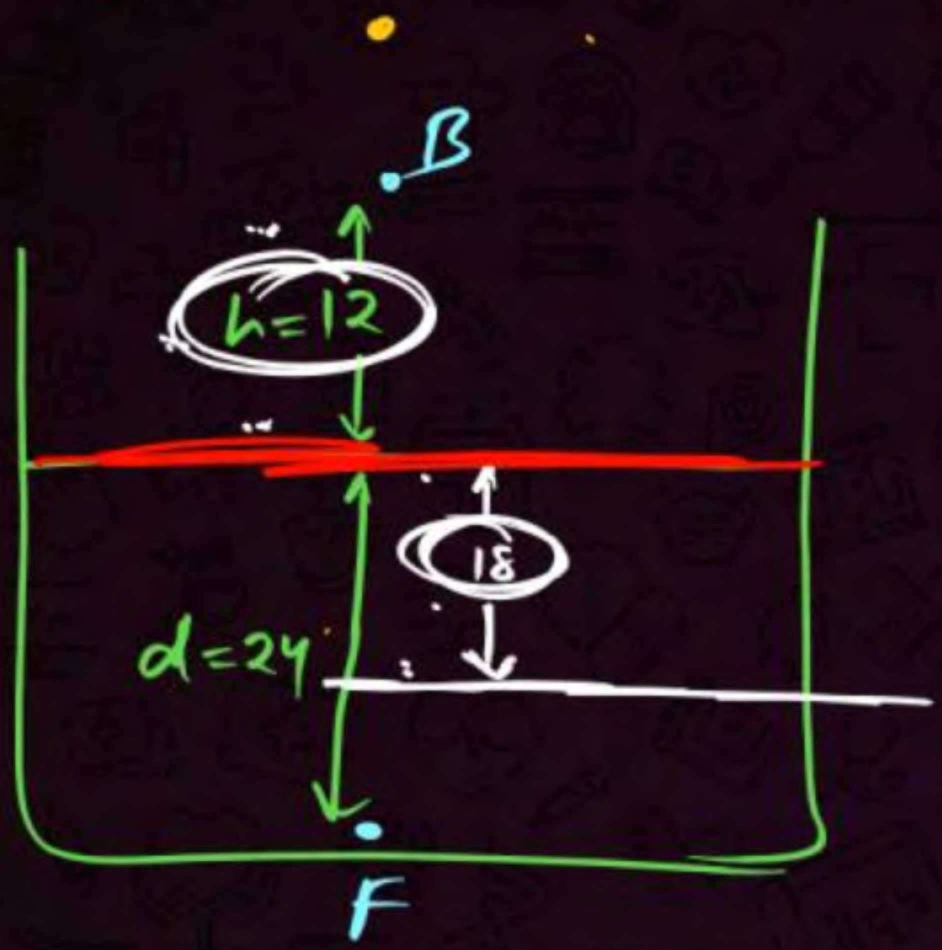
(1) A-(p); B-(r); C-(s); D-(q)

(2) A-(r); B-(p); C-(q); D-(s)

(3) A-(r); B-(p); C-(s); D-(q)

(4) A-(p); B-(r); C-(q); D-(s)

Column-I		Column-I	
A.	Distance of fish from the surface as seen by bird	p.	16 cm
B.	Distance of bird from the surface as seen by fish	q.	40 cm
C.	Distance between fish and bird as seen by bird	r.	18 cm
D.	Distance between fish and bird as seen by fish	s.	30 cm



1) $\frac{24}{\mu} = \frac{24}{4/3} = 18$ cm.

2) $\mu h = \frac{4}{3} \times 12 = 4 \times 4 = 16$.

3) $h + \frac{d}{\mu} = 12 + 18 = 30$

4) $\mu h + d = 16 + 24 = 40$

QUESTION

(Famous type)

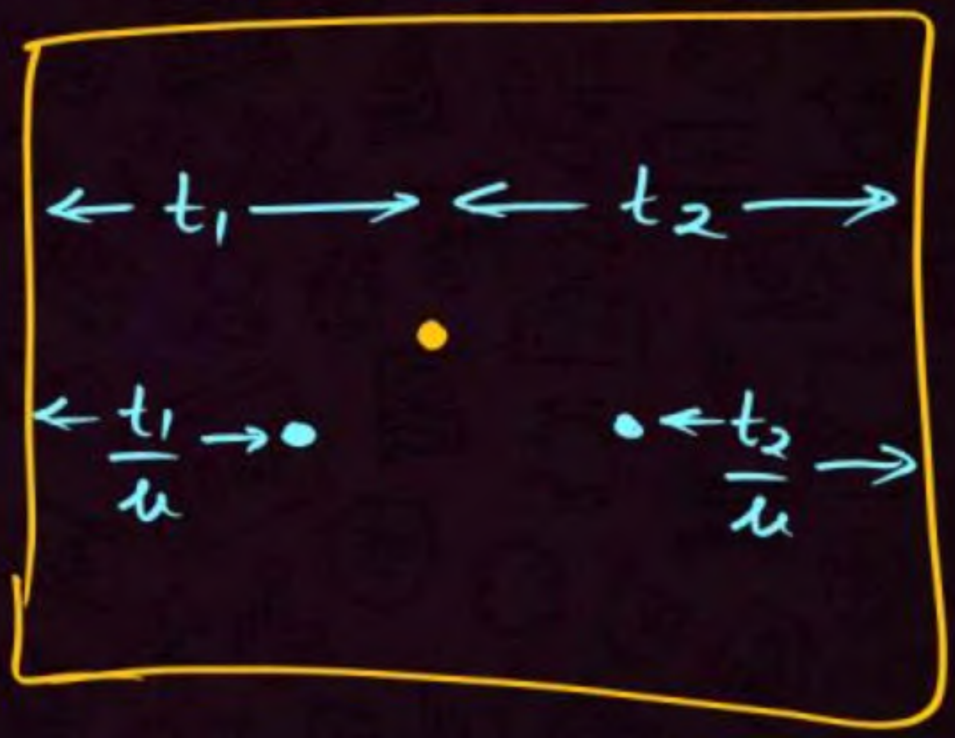
A bubble in glass slab ($\mu = 1.5$) when viewed from one side appears at 5 cm and 2 cm from other side, then thickness of slab is: [2000]

1. 3.75 cm
2. 3 cm
3. 10.5 cm
4. 2.5 cm

TBS

$(5+2)\mu$

$\leftarrow t = t_1 + t_2 \rightarrow$



(I)

$\frac{t_1}{\mu} = 5$

$t_1 = 5\mu$

(II) $\frac{t_2}{\mu} = 2$

$t_2 = 2\mu$

$t = 5\mu + 2\mu = 7\mu = 7 \times \frac{3}{2} = 10.5$

QUESTION

An air bubble in a glass slab with refractive index 1.5 (near normal incidence) is 5 cm deep when viewed from one surface and 3 cm deep when viewed from the opposite face. The thickness (in cm) of the slab is [NEET 2016]

(1) 8

(2) 10

(3) 12

(4) 16

$$(5+3)\mu = 8\mu = 8 \times \frac{3}{2} = \frac{24}{2} = 12$$

QUESTION

An ice cube has a bubble inside. When viewed from one side the apparent distance of the bubble is 12 cm. when viewed from the opposite side, the apparent distance of the bubble is observed as 4 cm. If the side of the ice cube is 24 cm, the refractive index of the ice cube is

[12 Apr, 2023 (Shift-I)]

(1) 4/3

(2) 3/2

(3) 2/3

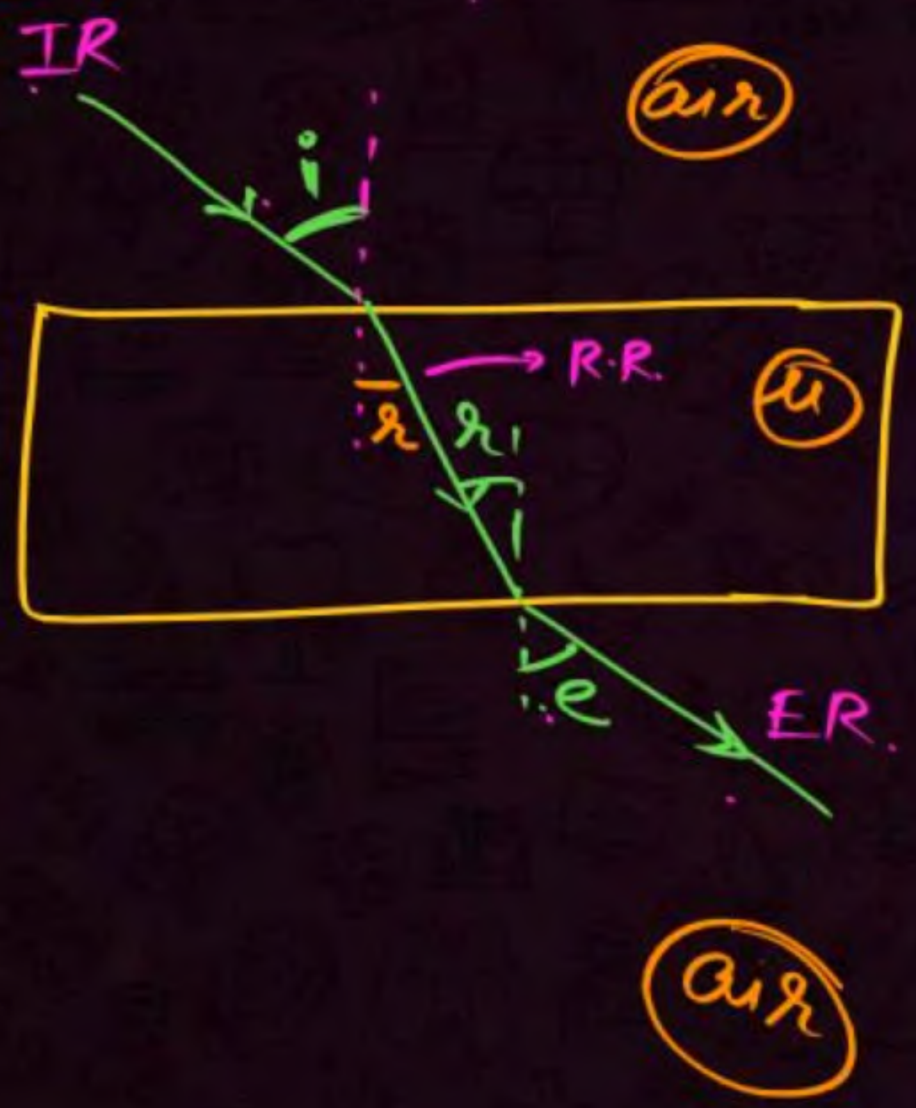
(4) 6/5

$$(12+4)\mu = t = 24$$

$$16\mu = 24$$

$$\mu = \frac{24}{16} = \frac{3}{2}$$

Refraction through glass slab

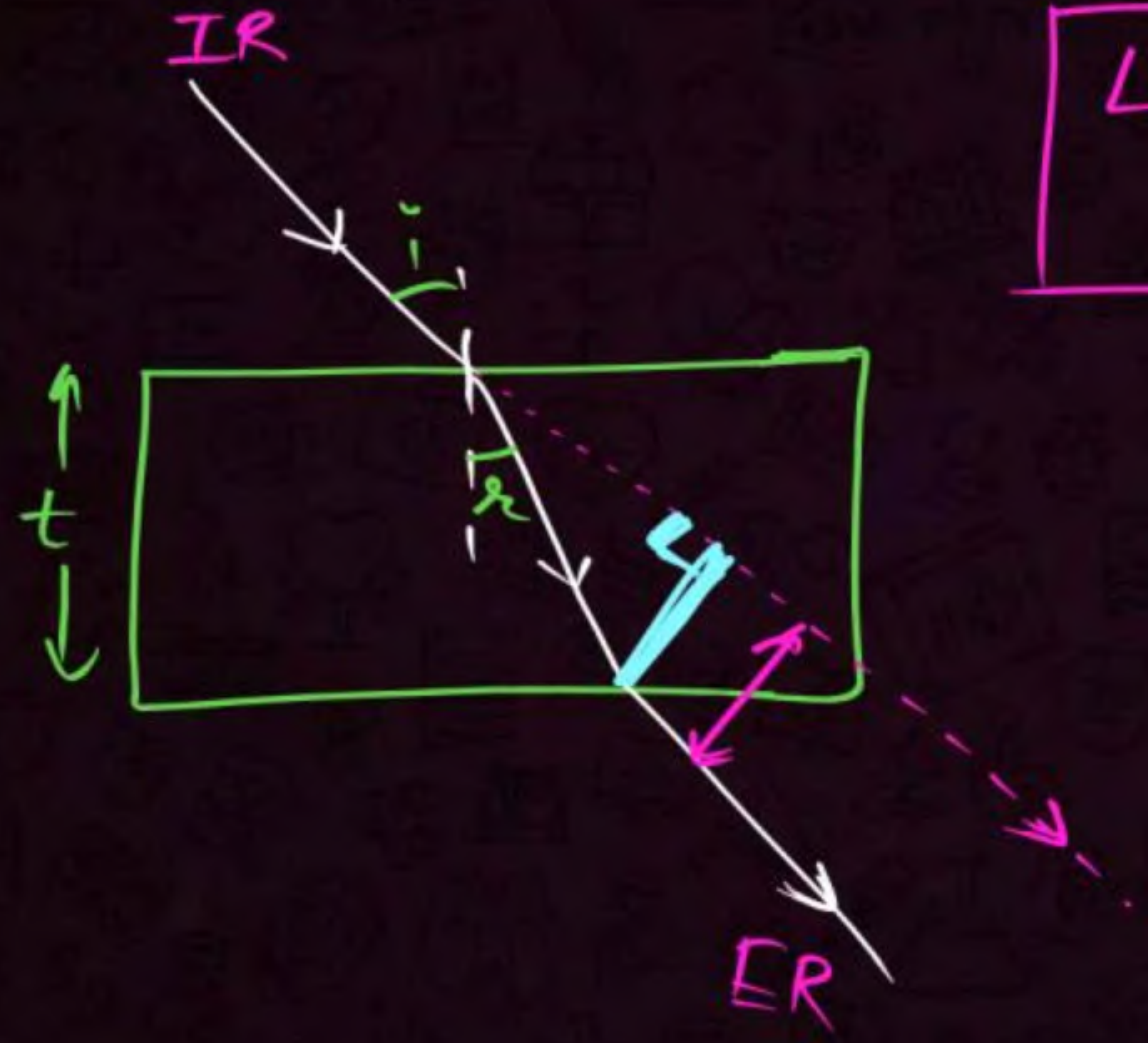


↳ If medium on both sides of glass slab is same, then

$\angle i = \angle e$

$IR \parallel ER$

Lateral Shift through glass slab



$$\text{Lat. shift} = t\,\frac{\sin(i-r)}{\cos r}$$

For small angles

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

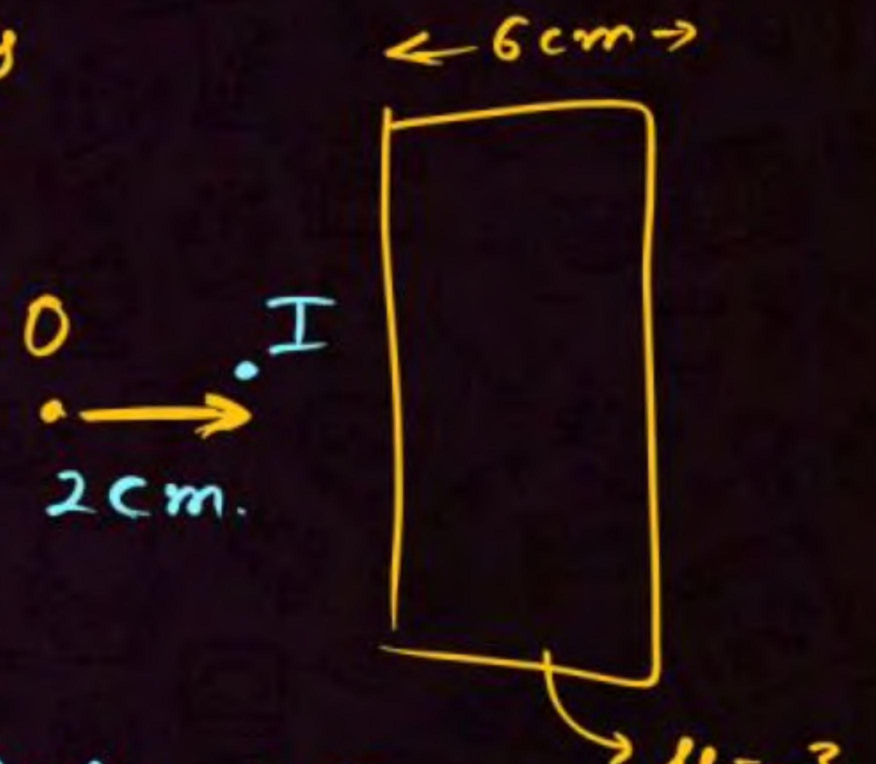
Rare Chance

radian

Longitudinal Shift through glass slab

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

Ques



$$\text{L. shift} = 6\left(1-\frac{2}{3}\right)$$

$$= 6\times\frac{1}{3} = 2\text{ cm}$$

QUESTION

A ray of light is incident upon a parallel sided transparent slab of thickness 9 cm at an angle of incidence 60°. If the angle of refraction is 30°, the lateral displacement of the light ray is

(1) $\sqrt{3}$ cm

(2) $3\sqrt{3}$ cm

(3) 3 cm

(4) $2\sqrt{3}$ cm

$t = 9$ cm.

$i = 60°$

$r = 30°$

$i - r = 30°$

$$\frac{t\sin(i-r)}{\cos r} = \frac{9\sin 30°}{\cos 30°}$$

$$= \frac{9 \times 1/2}{\sqrt{3}/2} = \frac{9}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

$$= \frac{9\sqrt{3}}{3} = 3\sqrt{3} \text{ cm}$$

QUESTION

A ray of light is incident at an angle of incidence 60^0 on the glass slab of refractive index $\sqrt{3}$. After refraction, the light ray emerges out from other parallel faces and lateral shift between incident ray and emergent ray is $4\sqrt{3}$ cm. The thickness of the glass slab is

(1) 14 cm

(2) 11 cm

(3) 12 cm

(4) 15 cm

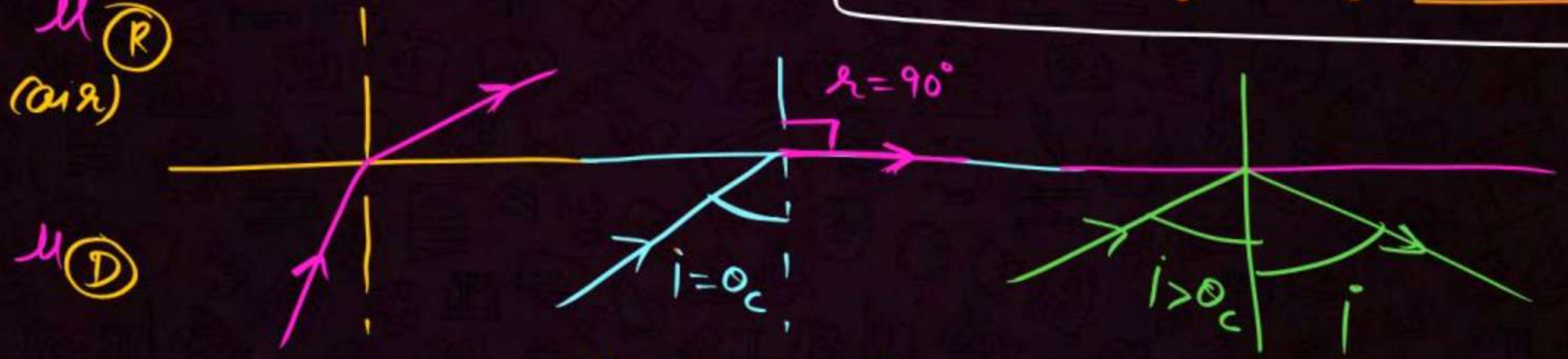
Hint:- r khud Nikalna Pdega
Snell's law.

Total Internal Reflection (TIR)

(1) Denser to rarer.

(2) $i > \theta_c$ (critical angle)

TIR:
- → No energy loss
- → most of the light is reflected.
- → Image very bright/shinier



$\mu_D \times \sin\theta_c = \mu_R \times \sin 90^\circ$

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

$\mu = \frac{\mu_D}{\mu_R} \Rightarrow \frac{\mu_D}{1} = \mu_D$

* $\mu \uparrow \Rightarrow \theta_c \downarrow$.

QUESTION

Assertion: The images formed by total internal reflections are much brighter than those formed by mirror or lenses.

Reason: There is no loss of intensity in total internal reflection.

(1) Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)

(2) Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)

(3) Assertion (A) is True, Reason (R) is False.

(4) Assertion (A) is False, Reason (R) is True.

QUESTION

In total internal reflection, when the angle of incidence is equal to the critical angle for the pair of media in contact, what will be angle of refraction?

$i = \theta_c$

$r = 90°$

1. 0°
2. Equal to angle of incidence
3. 90°
4. 180°

QUESTION

Relation between critical angles of water and glass is

1. $C_w > C_g$
2. $C_w < C_g$
3. $C_w = C_g$
4. $C_w = C_g = 0$

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

$\mu_g > \mu_w$

$C_g < C_w$

QUESTION

If the critical angle for total internal reflection from a medium to vacuum is 45°, then velocity of light in the medium is [NEET (Oct.) 2020]

1. 15×10^8 m/s
2. $\frac{3}{\sqrt{2}} \times 10^8$ m/s
3. $\sqrt{2} \times 10^8$ m/s
4. 3×10^8 m/s

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

$\sin 45° = \frac{1}{\mu}$

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

$\mu = \sqrt{2} = \frac{c}{v}$

$v = \frac{c}{\mu} = \frac{c}{\sqrt{2}}$

$= \frac{3 \times 10^8}{\sqrt{2}}$

QUESTION

The critical angle for a denser-rarer interface is 45°. The speed of light in rarer medium is 3×10^8 m/s. The speed of light in the denser medium is:

[11 Apr 2023 (Shift-I)]

(1) 7.5×10^7 m/s

(2) 2.12×10^8 m/s

(3) 3.12×10^7 m/s

(4) $\sqrt{2} \times 10^8$ m/s

$$v = \frac{3}{\sqrt{2}} \times 10^8$$

$$= \frac{3}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} \times 10^8$$

$$= \frac{3}{2} \times \sqrt{2} \times 10^8$$

$$= \frac{3 \times 1.4}{2} \; 0.7 = 2.1 \times 10^8$$

$$\frac{1}{\sqrt{2}} = 0.7$$

$$i_{rms} = \frac{i_0}{\sqrt{2}} = 0.707 i_0$$

QUESTION

The wavelength of light in two liquids 'x' and 'y' is 3500 Å and 7000 Å, then the critical angle of x relative to y will be

(1) 60°

(2) 45°

(3) 30°

(4) 15°

TBS

$$\sin\theta_C = \frac{1}{\mu} = \frac{\mu_R}{\mu_D} = \frac{\text{Chhota } \mu}{\text{Bada } \mu} = \frac{\text{Chhota } \lambda}{\text{Bada } \lambda} = \frac{\text{Chhoti } v}{\text{Badi } v}$$

$$\sin\theta_c = \frac{7000}{3500} = 2 \quad \times$$

$$\sin\theta_c = \frac{3500}{7000} = \frac{1}{2}$$

$$\theta_c = 30^\circ$$

QUESTION

The speed of light in media 'A' and 'B' are 2.0×10^{10} cm/s and 1.5×10^{10} cm/s respectively. A ray of light enters from the medium B to A an incident angle 'θ'. If the ray suffers total internal reflection, then

[29 June, 2022 (Shift-II)]

1. $\theta = \sin^{-1}\left(\frac{3}{4}\right)$
2. $\theta \geq \sin^{-1}\left(\frac{2}{3}\right)$
3. $\theta < \sin^{-1}\left(\frac{3}{4}\right)$
4. $\theta > \sin^{-1}\left(\frac{3}{4}\right)$

TIR

$\theta > \theta_c$

$\sin\theta_c = \frac{1.5}{2} = \frac{15}{20} = \frac{3}{4}$

$\theta > \sin^{-1}\left(\frac{3}{4}\right)$

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

QUESTION

HW

Light travels in two media M_1 and M_2 with speeds 1.5×10^8 ms^{-1} and 2.0×10^8 ms^{-1} respectively. The critical angle between them is: [26 July, 2022 (Shift-II)]

(1) $\tan^{-1}\left(\frac{3}{\sqrt{7}}\right)$

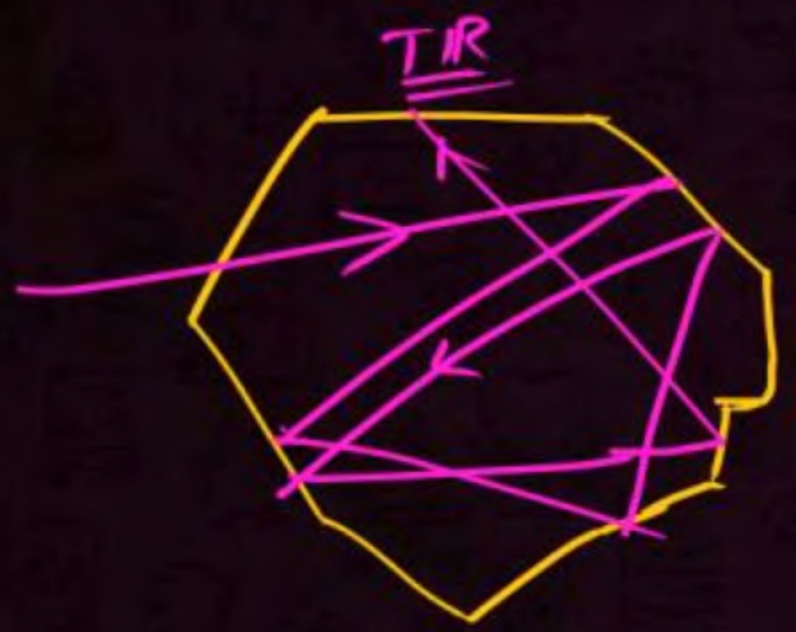
(2) $\tan^{-1}\left(\frac{2}{3}\right)$

(3) $\cos^{-1}\left(\frac{3}{4}\right)$

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

Applications of TIR

1. <u>Glittering (Sparkling) of Diamond</u>



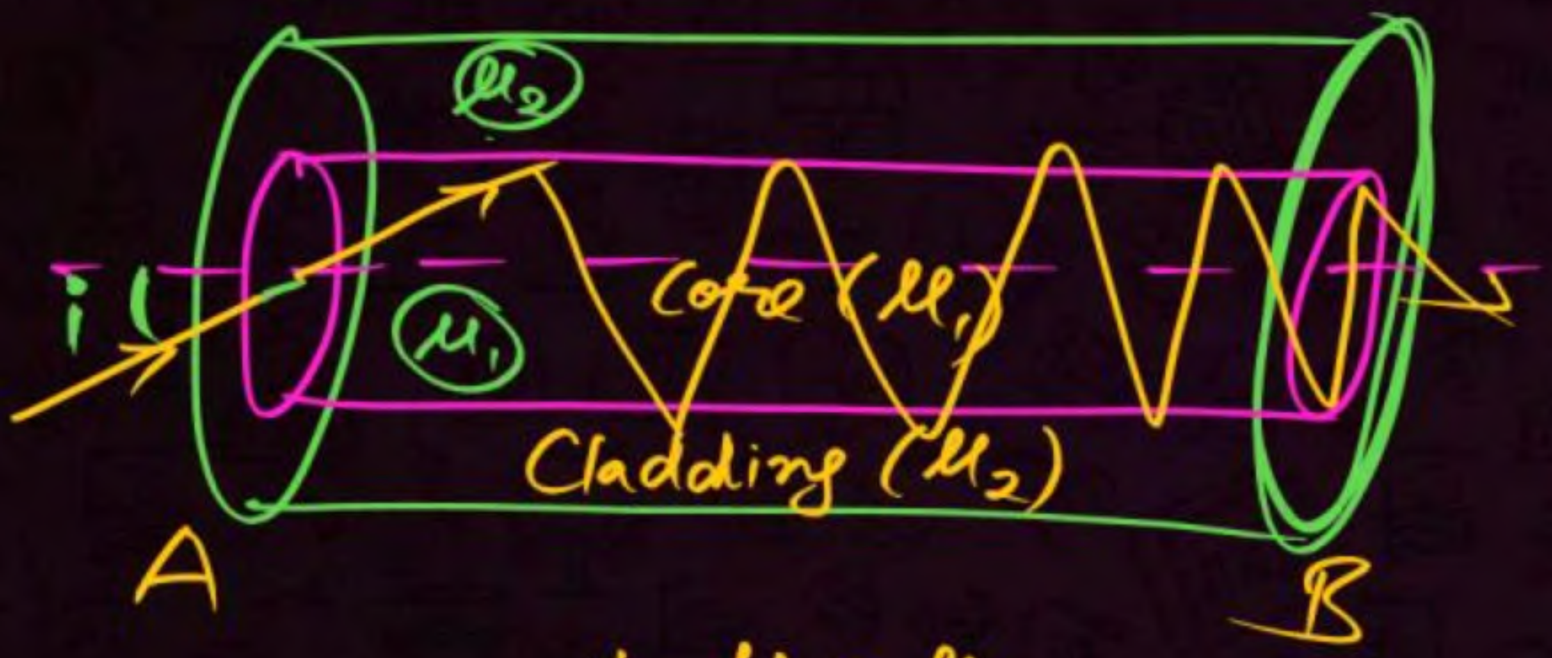
→ $\mu = 2.5$ (high)

$\theta_c \simeq 24^\circ$

2. Optical Fibres

→ Telecommunicatio
↳ Revolutionise

zoom.



$* \mu_1 > \mu_2$

Diwali

Decoractive lamp

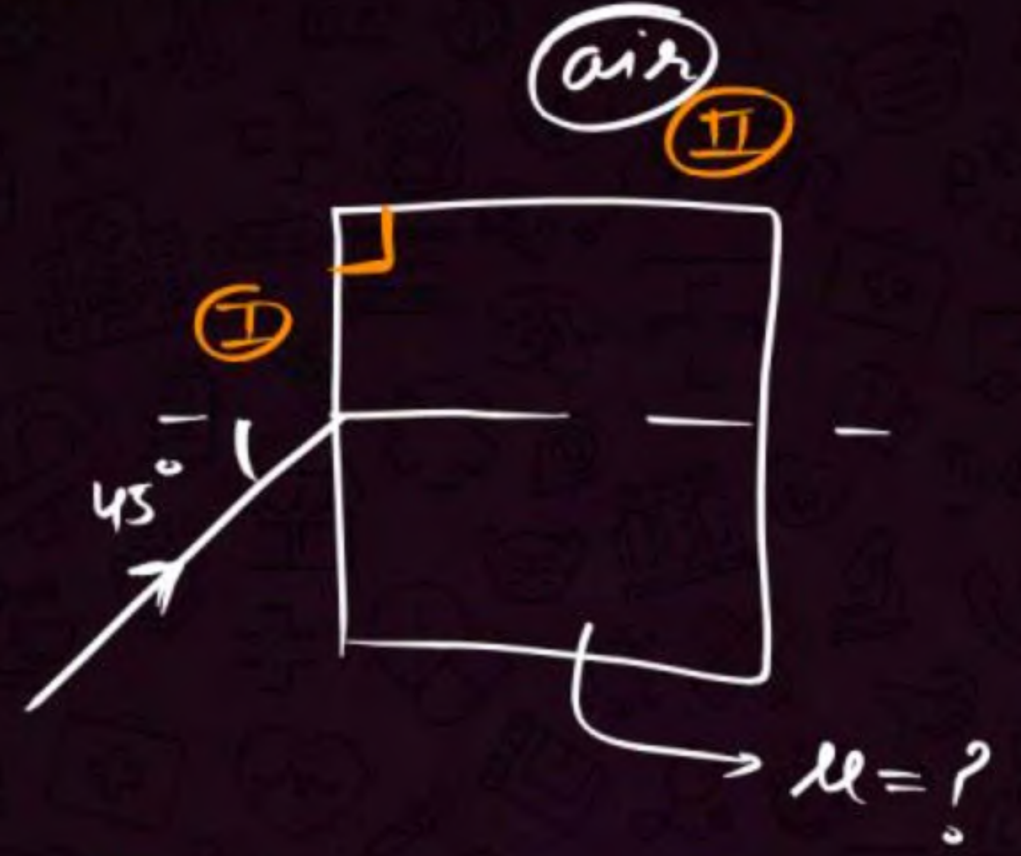
* Imp. Formula →

$$\sin i_{max} = \sqrt{\mu_1^2 - \mu_2^2}$$

↳ Principle of optical fibre

For TIR

Ques
JEE
Ques



Find μ so that TIR occurs at face II

$\sin i = \sqrt{\mu_1^2 - \mu_2^2}$

$\mu_1 = \mu$
$\mu_2 = 1$

$\sin 45° = \sqrt{\mu^2 - 1^2}$

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

$\frac{1}{2} = \mu^2 - 1$

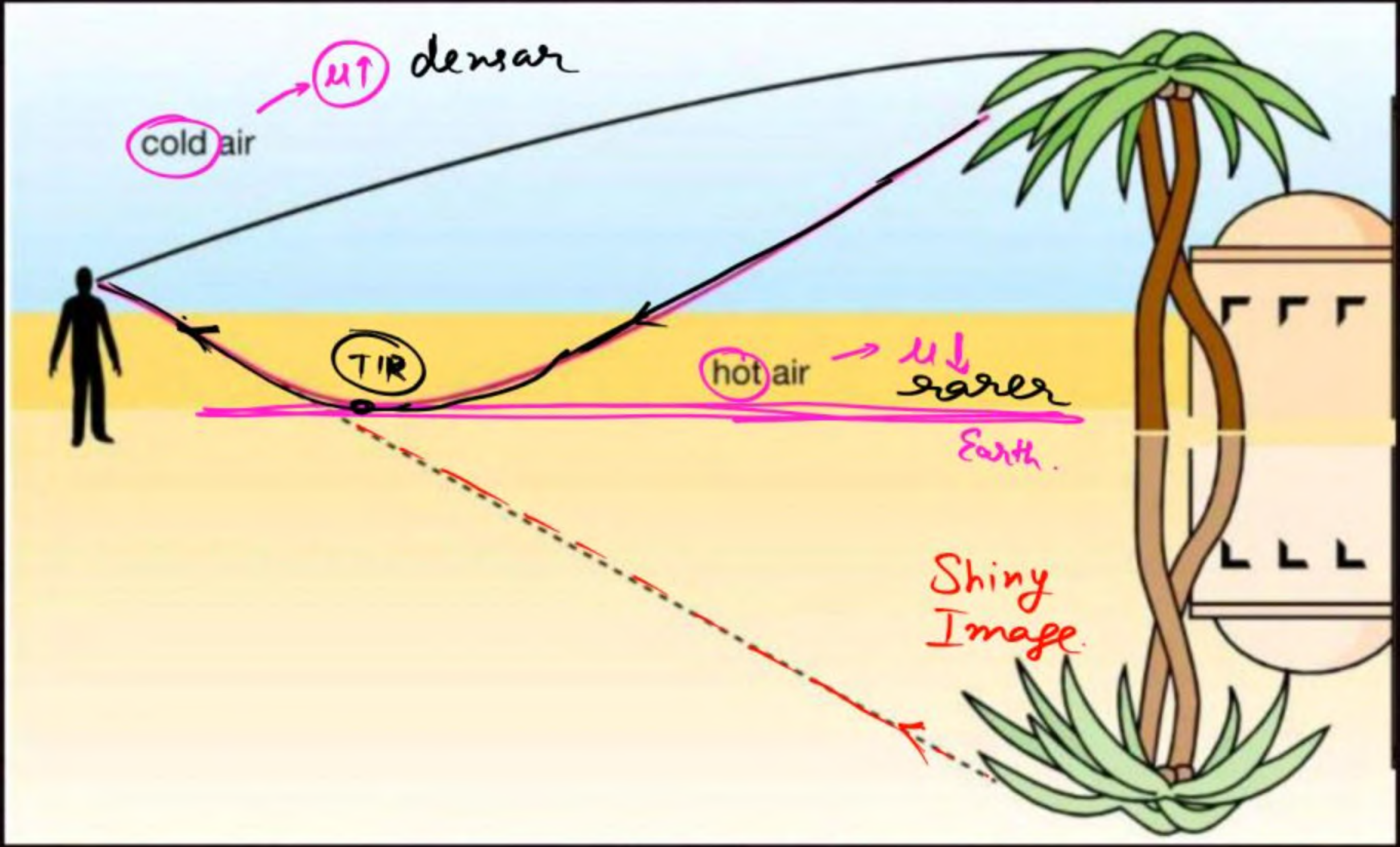
$\frac{1}{2} + 1 = \mu^2$

$\frac{3}{2} = \mu^2$

$\mu = \sqrt{\frac{3}{2}}$ Ans

3. Mirage

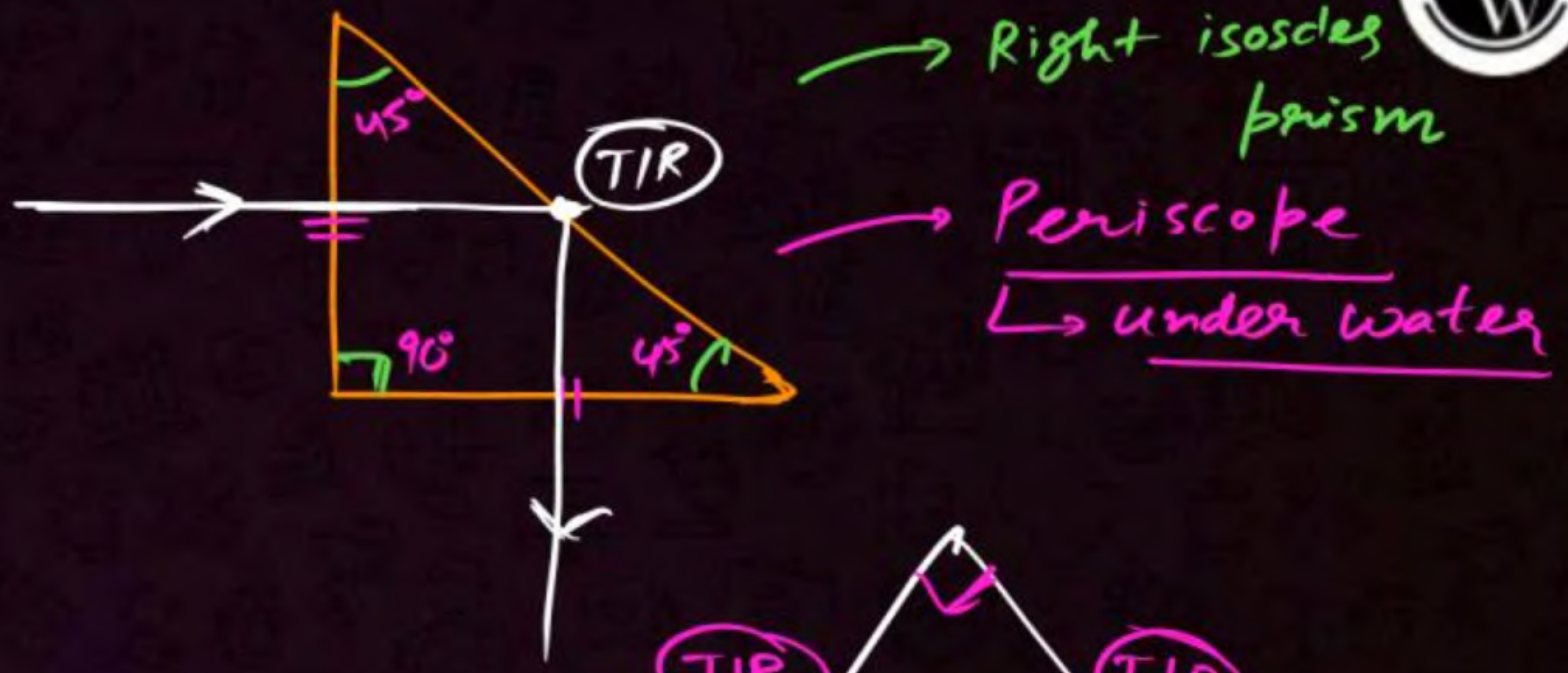
Hot summer days

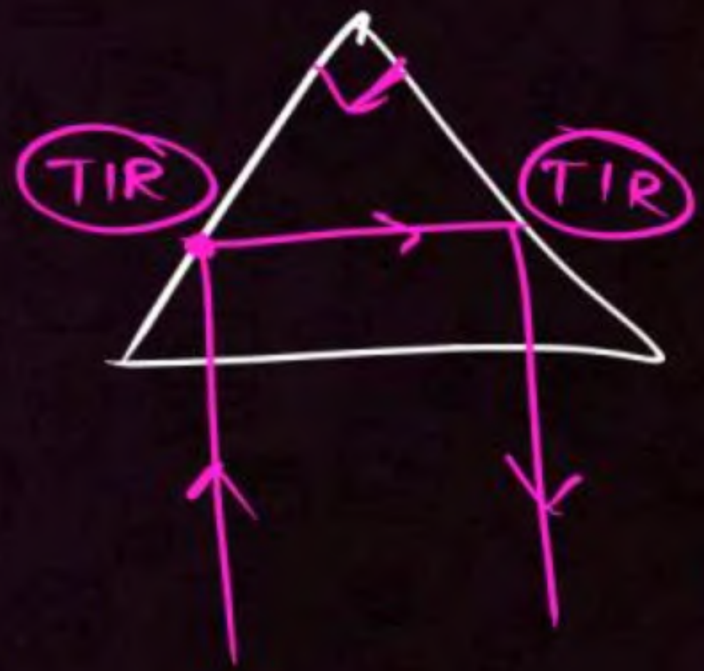


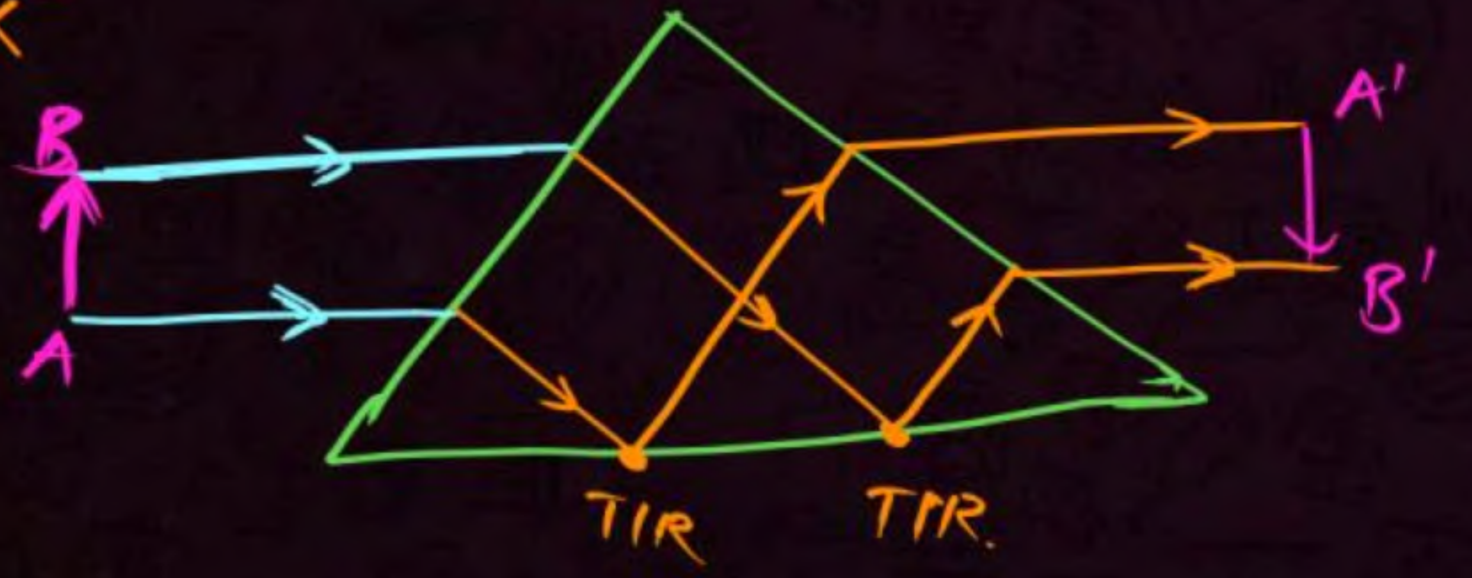
μ↑ densar
cold air
TIR
hot air
μ↓ rarer
Earth.
Shiny
Image.

4. Prisms

- Deviate a ray by 90^0
- Deviate a ray by 180^0
- Invert the image without deviation and changing the size.







QUESTION

Which one of the following is not associated with the total internal reflection?

1. The mirage formation
2. Optical fiber communication
3. The glittering of diamond
4. Dispersion of light

→ 7 colour split

QUESTION

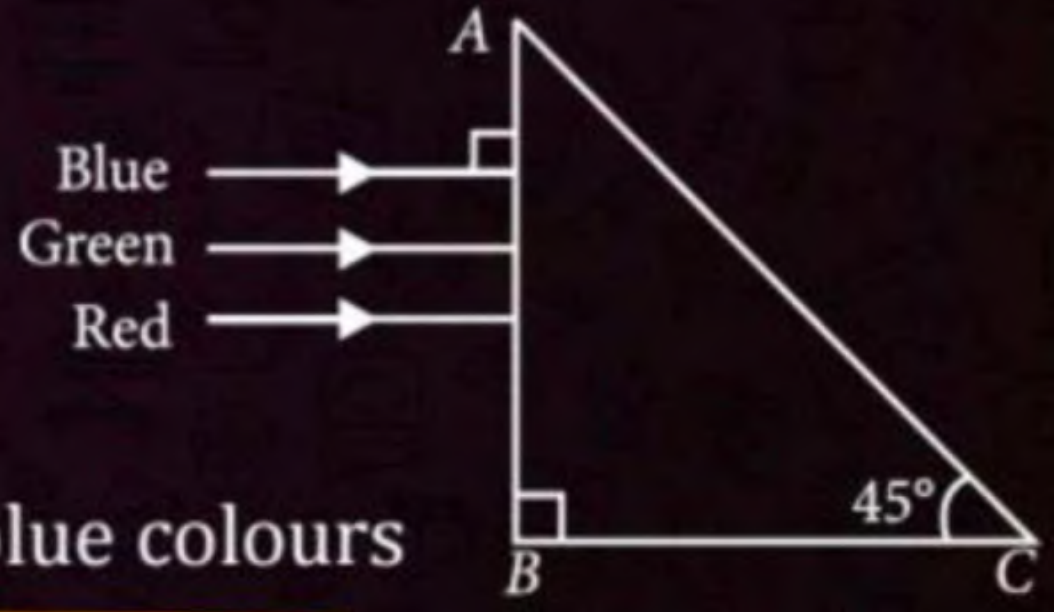
A beam of light consisting of red, green and blue colours is incident on a right angled prism. The refractive index of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. This prism will [2015]

(1) separate all the three colours from one another

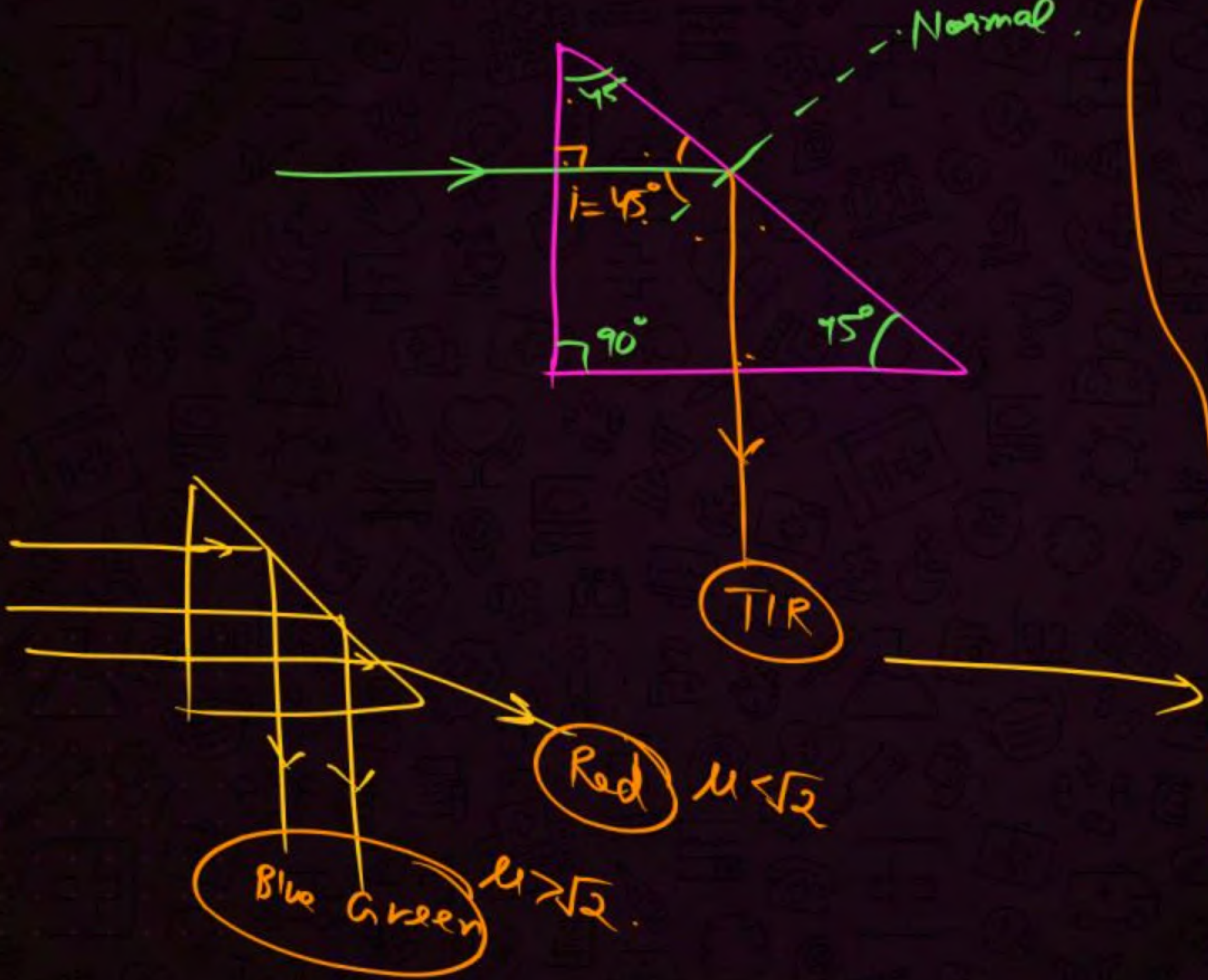
(2) not separate the three colours at all

(3) separate the red colour part from the green and blue colours

(4) separate the blue colour part from the red and green colours



$\mu_g = \frac{3}{2}$, $\mu_w = \frac{4}{3}$ → avg. for all colours



For TIR.

$$i > \theta_c$$

$$\sin i > \sin\theta_c$$

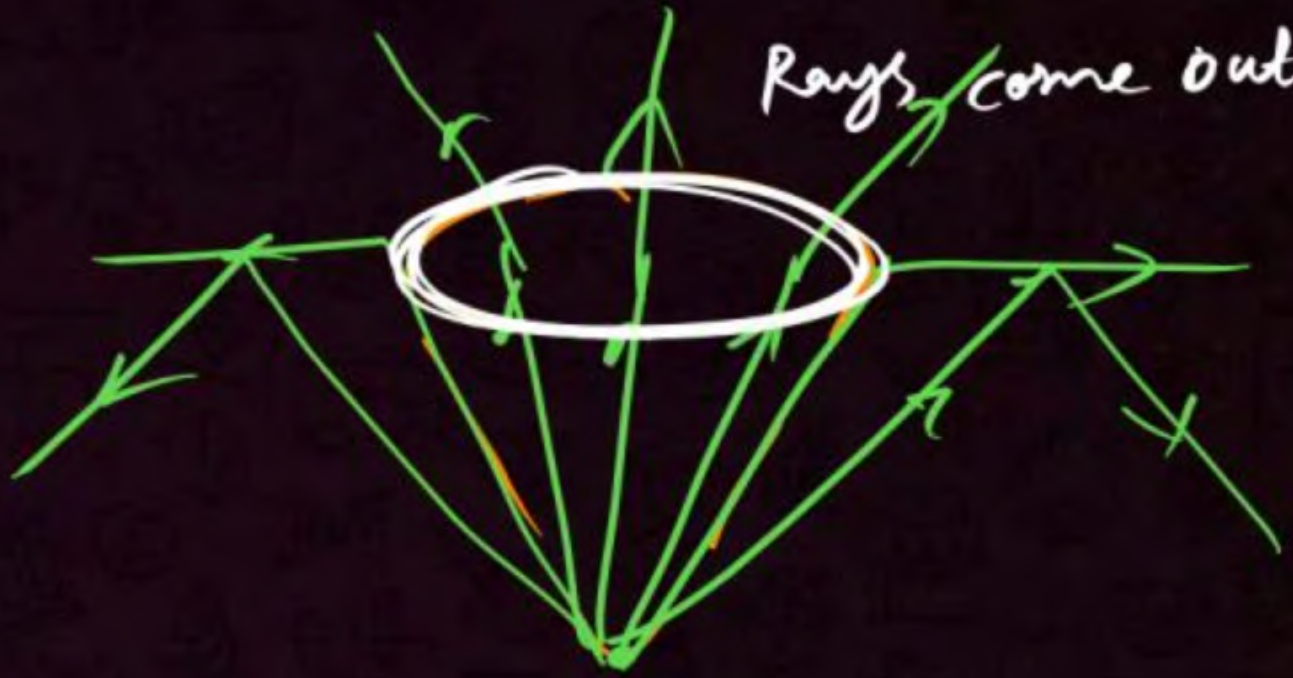
$$\sin 45° > \frac{1}{\mu}$$

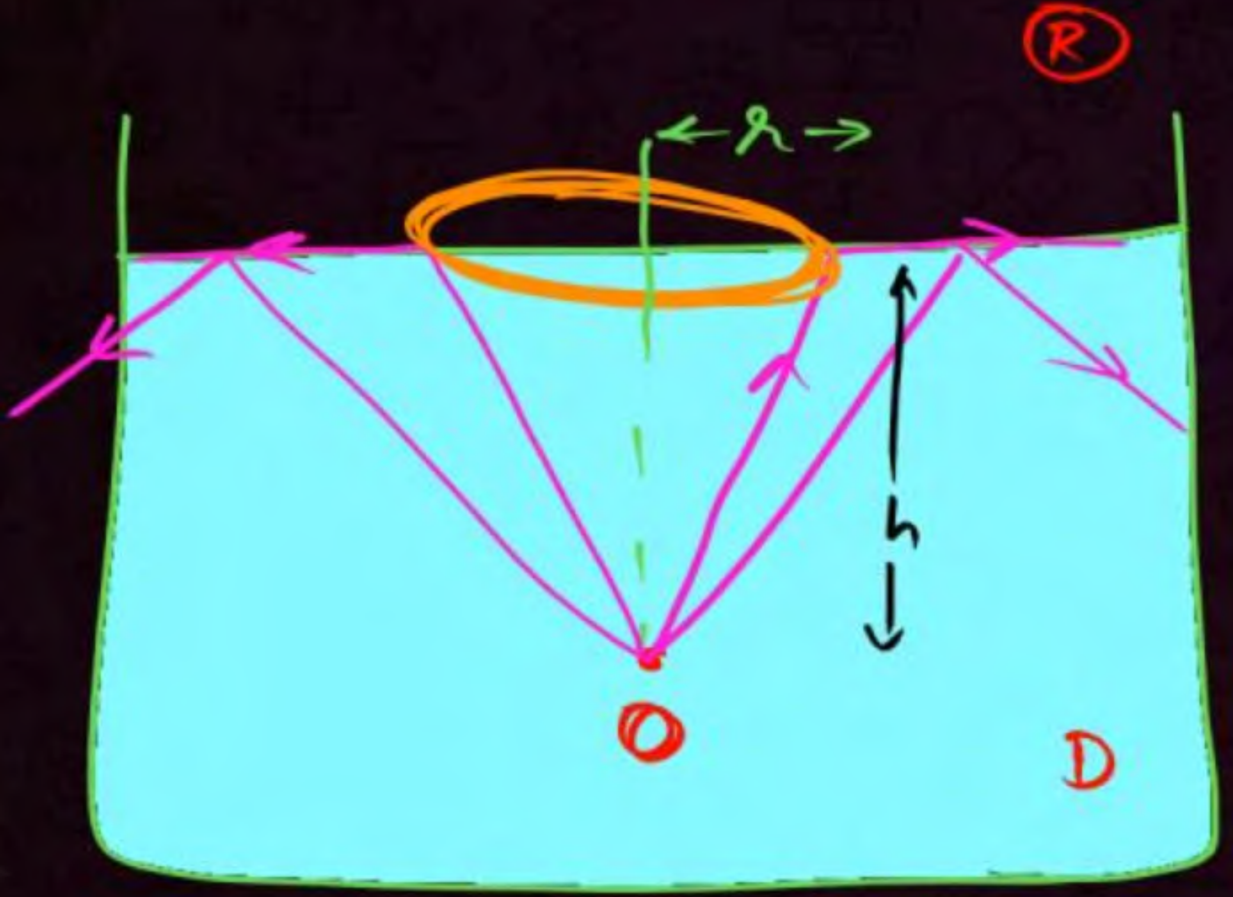
$$\frac{1}{\sqrt{2}} > \frac{1}{\mu}.$$

$$\mu \times 1 > \sqrt{2} \times 1$$

$$\boxed{\mu > \sqrt{2}} \Rightarrow \mu > 1.414$$

Circle of Vision





h = depth of object

$$r = \frac{h}{\sqrt{\mu^2 - 1}}$$

$$A = \pi r^2$$

Area.

QUESTION

A small bulb is placed at the bottom of a tank containing water to a depth of $\sqrt{7}$ m. The refractive index of water is 4/3. The area of the surface of water through which light from the bulb can emerge out is $x\,\pi$ m^2. The value of x is 9.

[26 June, 2022 (Shift-II)]

(1) 7

(2) 9

(3) 4

(4) 3

$$r = \frac{h}{\sqrt{\mu^2-1}} = \frac{\sqrt{7}}{\sqrt{\frac{7}{9}}} = \sqrt{9} = 3$$

$$\mu^2 - 1 = \frac{16}{9} - 1 = \frac{7}{9}$$

$$r = 3$$

$$A = \pi r^2 = \pi (3)^2 = 9\pi$$

QUESTION

HW

A disc is placed on a surface of pond which has refractive index 5/3. A source of light is placed 4 m below the surface of liquid. The minimum radius of disc will be so light is not coming out.

[2001]

1. ∞
2. 3 m
3. 6 m
4. 4 m

QUESTION

HW

A point source of light is placed 4 m below the surface of water of refractive index $\frac{5}{3}$. The minimum diameter of a disc, which should be placed over the source, on the surface of water to cut off all light coming out of water is [CBSE AIPMT 1994]

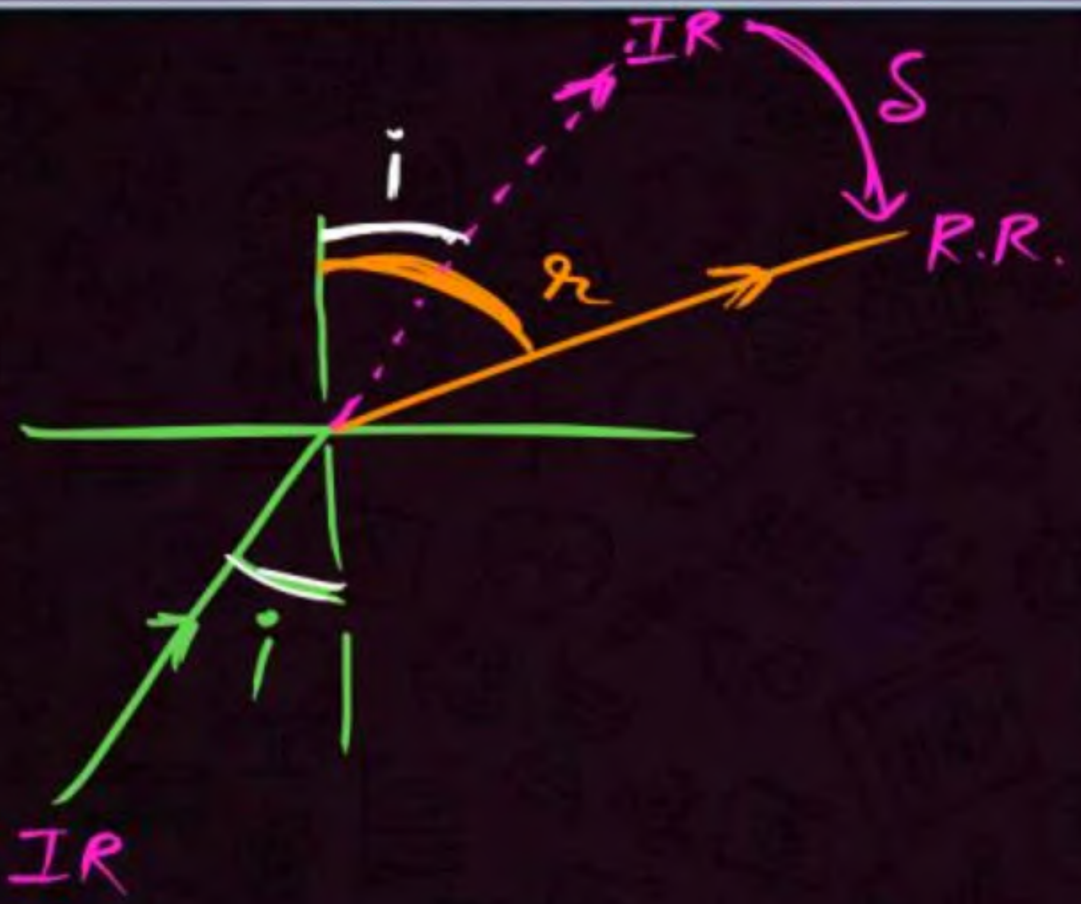
(1) Infinite

(2) 6 m

(3) 4 m

(4) 3 m

Angle of Deviation in Refraction



$$\delta = r - i$$

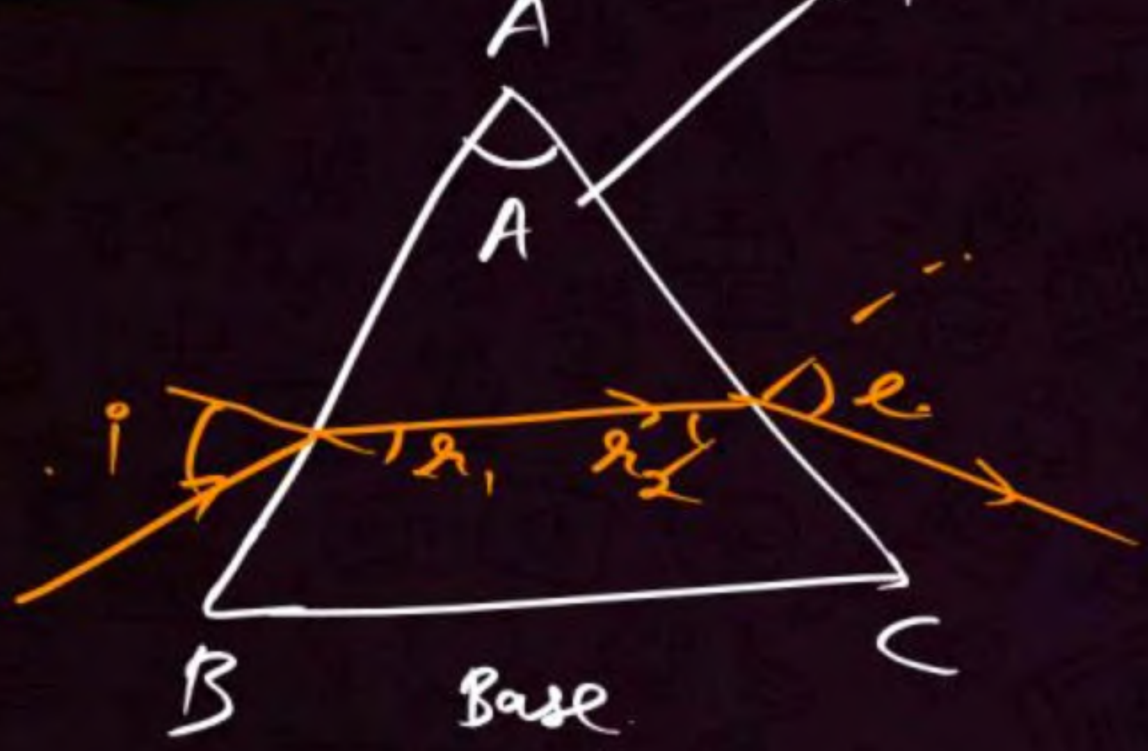
or

$$\delta = i - r$$

→ Bada - Chhota

Prisms

prism/refracting angle



$$r_1 + r_2 = A$$

$$\delta = \delta_1 + \delta_2$$

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

$$\delta_{min} = i + i - A$$

$$\delta_{min} = 2i - A$$

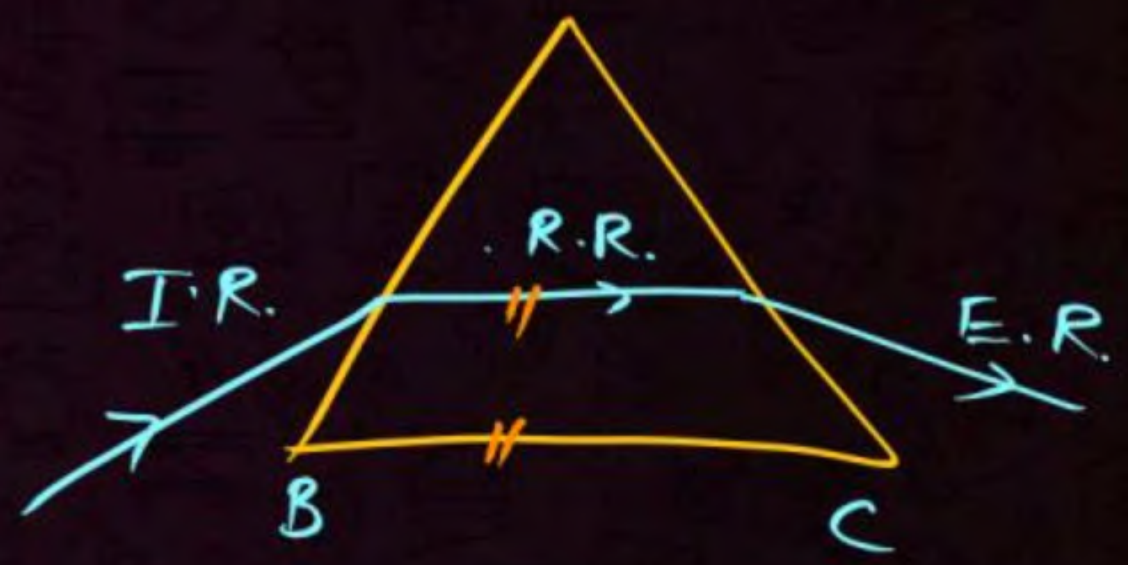
Min^m deviation (δ_{min}) $\Rightarrow$ $i = e$

Snell's law $\Rightarrow$ $r_1 = r_2$

Prism formula

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

Graph



TBS Note: In case of minimum deviation, the refracted ray is parallel to the base of prism if prism is equilateral or isosceles.

QUESTION

The angle of incidence for a ray of light at a refracting surface of a prism is 45°. The angle of prism is 60°. If the ray suffers minimum deviation through the prism, the angle of minimum deviation and refractive index of the material of the prism respectively, are:

(1) $45°, \frac{1}{\sqrt{2}}$

(2) $30°, \sqrt{2}$

(3) $45°, \sqrt{2}$

(4) $30°, \frac{1}{\sqrt{2}}$

$\frac{1}{\sqrt{2}} < 1$ TBS

$i = 45°$

$A = 60°$

$\delta_{min} = 2i - A$

$= 2 \times 45° - 60°$

$= 90° - 60°$

$= 30°$

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

QUESTION

Famous type → one of r_1 & $r_2 = 0$

The refractive index of the material of a prism is $\sqrt{2}$ and the angle of the prism is $30°$. One of the two refracting surfaces of the prism is made a mirror inwards, by silver coating. A beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface) if its angle of incidence on the prism is

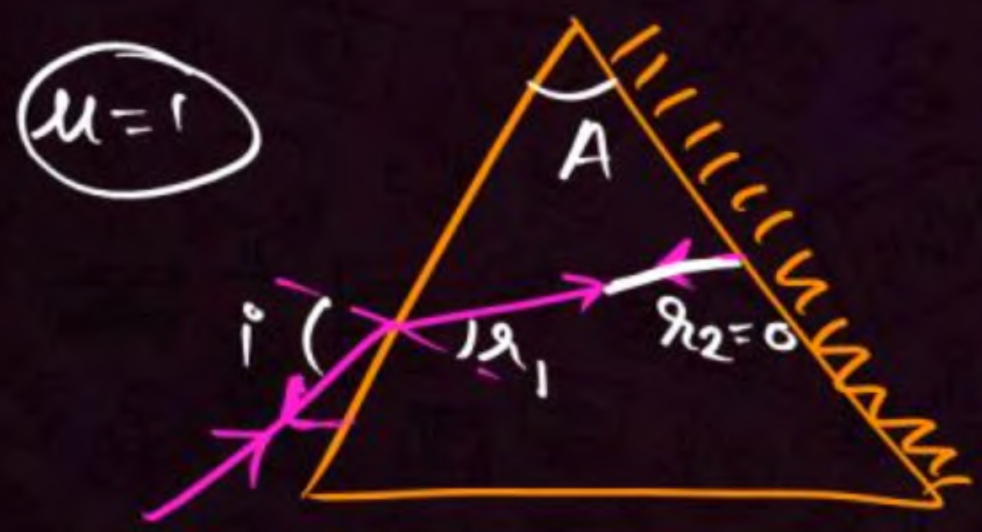
[NEET 2018, 2004, 1992]

(1) 30°

(2) 45° ✓

(3) 60°

(4) Zero



$A = r_1 + r_2$, $r_2 \to 0$

$A = r_1$

$1 \times \sin i = \mu \times \sin r_1$

$\sin i = \mu \times \sin A$

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

$i = 45°$

QUESTION

The angle of a prism is 'A', One of its refracting surfaces is silvered. Light rays falling at an angle of incidence 2A on the first surface returns back through the same path after suffering reflection at the silvered surface. The refractive index μ, of the prism is:

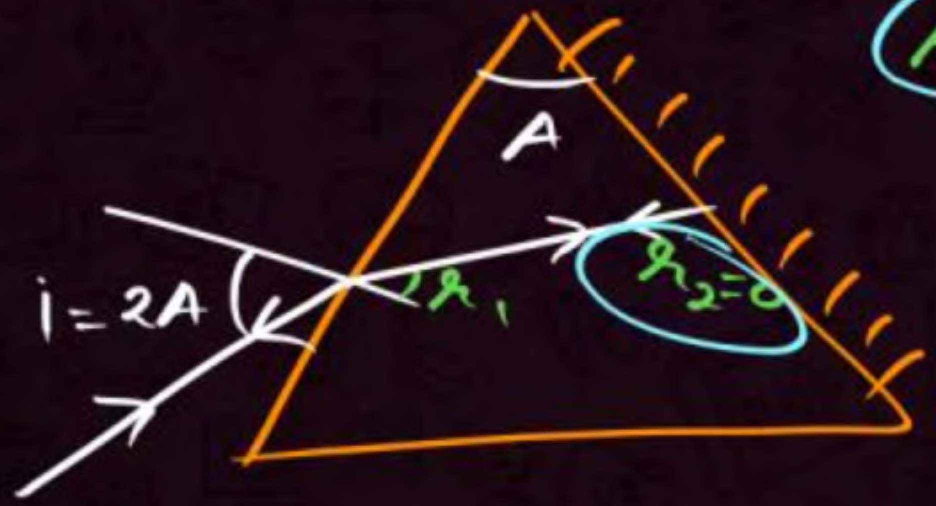
[2014]

(1) $2 \sin A$

(2) $2 \cos A$

(3) $\frac{1}{2} \cos A$

(4) $\tan A$



$A = r_1$

$1 \times \sin i = \mu \times \sin r_1$

$\sin 2A = \mu \times \sin A$

$2 \sin A \cos A = \mu \times \sin A$

$\mu = 2 \cos A$

QUESTION

(HW)

A ray of light passing through a prism ($\mu = \sqrt{3}$) ~~surface~~ suffers minimum deviation. It is found that the angle of incidence is double the angle of refraction within the prism. Then, the angle of prism is ______ (in degrees). [22 July, 2021 (Shift-II)]

(1) 30°

(2) 45°

(3) 60°

(4) None of these

Thin Prisms

$1 \times \sin i = \mu \times \sin r_1$

$$i \simeq \mu r_1$$

$1 \times \sin e = \mu \times \sin r_2$

$$e = \mu r_2$$

$\delta = i + e - A$

$\delta = \mu r_1 + \mu r_2 - A$

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

$\delta = \mu A - A$

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

↓ small angled prisms

QUESTION

The angle of a prism is 6° and its refractive index for green light is 1.5. If a green ray passes through it, the deviation will be [AIIMS 1994]

(1) 3°

(2) 30°

(3) 0°

(4) 15°

$$\delta = (1.5-1)\times 6^\circ$$

$$= 0.5 \times 6^\circ$$

$$= 3^\circ$$

QUESTION

A ray is incident at an angle of incidence i on one surface of a small angle prism (with angle of prism A) and emerges normally from the opposite surface. If the refractive index of the material of the prism is μ, then the angle of incidence is nearly equal to:

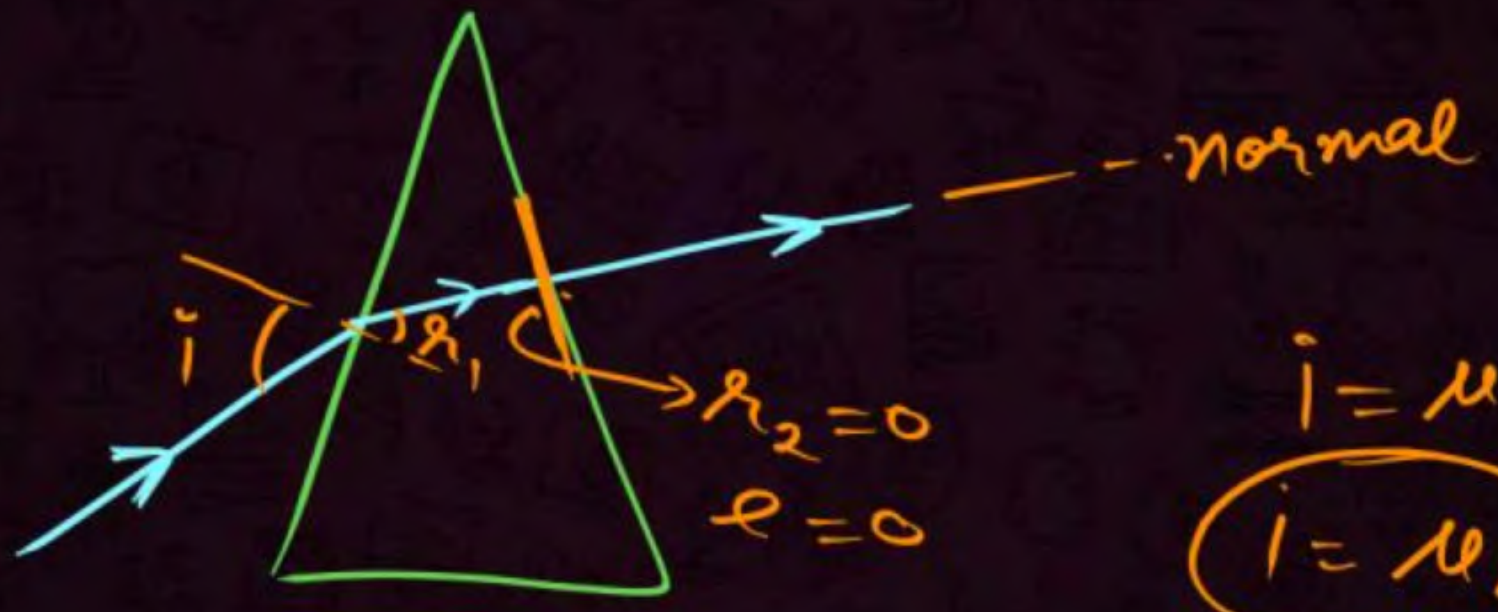
[2012, 1989]

(1) $2A/\mu$

(2) μA

(3) $\mu A/2$

(4) $A/2\mu$



$i = \mu r_1$

$i = \mu A$

$r_2 = 0$

$r_1 = A$

QUESTION

HW

A prism of angle $A = 1°$ has a refractive index $\mu = 1.5$, A good estimate for the minimum angle of deviation (in degrees) is close to N/10. The value of N is _____.

[5 Sep, 2020 (Shift-II)]

(1) 1

(2) 5

(3) 2

(4) 10

Dispersion

The splitting of white light into seven colours

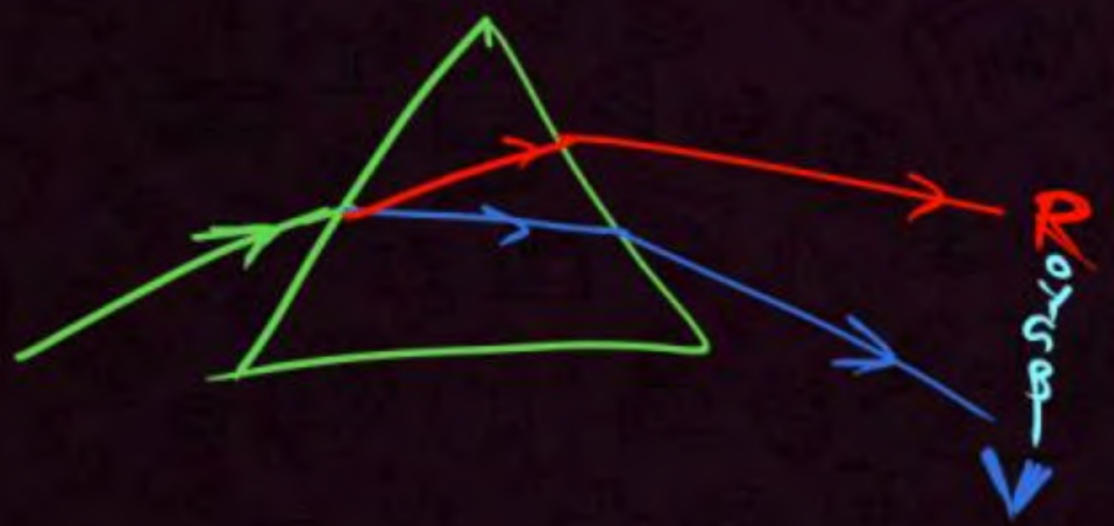
↳ Newton

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

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

$\lambda \uparrow \Rightarrow \mu \downarrow \Rightarrow \delta \downarrow \Rightarrow$ Red $\longrightarrow \delta_{min}$

$\lambda \downarrow \Rightarrow \mu \uparrow \Rightarrow \delta \uparrow \Rightarrow$ Violet $\longrightarrow \delta_{max}$



Angle of dispersion

$$\delta_{max} = (\mu_V - 1)A = \delta_V$$

$$\delta_{min} = (\mu_R - 1)A = \delta_R$$

$$\boxed{\theta = \delta_{max} - \delta_{min} = \delta_V - \delta_R = (\mu_V - \mu_R)A}$$

QUESTION

When white light passes through a prism, the deviation is maximum for [AIIMS 2008]

(1) violet light

(2) green light

(3) red light

(4) yellow light

Dispersive Power(ω)

$$\omega = \frac{\theta}{\delta_{av}} = \frac{\delta_V - \delta_R}{\delta_{av}} \Rightarrow \frac{(\mu_V - \mu_R)A}{(\mu_{av} - 1)A} \Rightarrow \omega = \frac{\mu_V - \mu_R}{\mu_{av} - 1}$$

independent of A

Yellow
↓
average colour

$$\delta_{av} = \frac{\delta_V + \delta_R}{2}$$

OR

$$\delta_{av} = \frac{\delta_b + \delta_R}{2}$$

OR

$$\delta_{av} = \delta_Y$$

$$\mu_{av} = \frac{\mu_V + \mu_R}{2}$$

or

$$\frac{\mu_b + \mu_R}{2} \text{ or } \mu_Y$$

Ques

	Violet (δ_V)	Red (δ_R)
Prism 1	8°	6°
Prism 2.	10°	8°

→ $\delta_{av} = \frac{8+6}{2} = 7$

→ $\delta_{av} = 9$.

Which prism has more dispersive power = ?

* $\omega_1 = \frac{\theta}{\delta_{av}} = \frac{\delta_V - \delta_R}{\delta_{av}} = \frac{8-6}{7} = \frac{2}{7}$

$\omega_2 = \frac{10-8}{9} = \frac{2}{9}$

$\omega_1 > \omega_2$.

QUESTION

(HW)

A prism of certain angles deviates the red and violet rays by 8^o and 12^o respectively. Another prism of the same angle deviates the red and violet rays by 10° and 14° respectively. The prisms are small angled and made of different materials. The dispersive powers of the materials of the prism are in the ratio

(1) 5 : 6

(2) 9 : 11

(3) 6 : 5

(4) 11 : 9

QUESTION

The refractive indices of a prism for red, yellow and violet colours are 1.52, 1.57 and 1.62 respectively, then the dispersive power of the material of prism will be

μ_{av}

$$\omega = \frac{\mu_v - \mu_R}{\mu_{av} - 1} = \frac{1.62 - 1.52}{1.57 - 1} = \frac{0.10}{0.57} = \frac{10}{57}$$

(1) 1.57

(2) 1/5.7 $\rightarrow \frac{1}{5.7} = \frac{10}{57}$

(3) 5.7

(4) 1

Combination of Prisms

Similar Prisms → (μ, A same)

→ even →

→ $\delta_{net} = 0$, $\theta_{net} = 0$ → No diff b/w prism & glass slab

→ odd →

⇓

θ_{net} & δ_{net} of last prism.

Dis-similar Prisms

a) Deviation without dispersion (Achromatic Combination)

Bina Clour K

$\delta_{net} \neq 0$ $\quad$ $\theta_{net} = 0$ $\longrightarrow$ $\theta_1 + \theta_2 = 0$

AB ∥ CD.

$$\theta_2 = -\theta_1$$

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

second prism is inverted

b) Dispersion without deviation (average)

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

$\Downarrow$

$\theta_{net} \neq 0$

$\hookrightarrow \delta_{net} = 0$

$\delta_1 + \delta_2 = 0$

$\delta_2 = -\delta_1$

$$\boxed{(\mu_2 - 1)A_2 = -(\mu_1 - 1)A_1}$$

QUESTION

A thin prism P_1 with an angle $6°$ 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: **[30 Jan, 2023 (Shift-II)]**

(1) $6°$

(2) $1.3°$

(3) $7.8°$

(4) $4.5°$

$\delta_{net} = 0$

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

$(1.72 - 1)A_2 = -(1.54 - 1) \times 6$

$0.72 \times A_2 = -0.54 \times 6$

$A_2 = -\frac{3 \times 6}{4} = -\frac{9}{2} = -4.5°$

QUESTION

HW

A thin prism having refracting angle 10° is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be [NEET 2017]

(1) 6°

(2) 8°

(3) 10°

(4) 4°

QUESTION

HW

A crown glass prism of angle 5° is to be combined with a flint glass prism in a such a way that the dispersion is zero. The refractive indices for violet and red lights are 1.523 and 1.514 respectively for crown glass and for flint glass are 1.632 and 1.614, then the angle of the flint glass prism is

(1) 10°

(2) 2.5°

(3) 2°

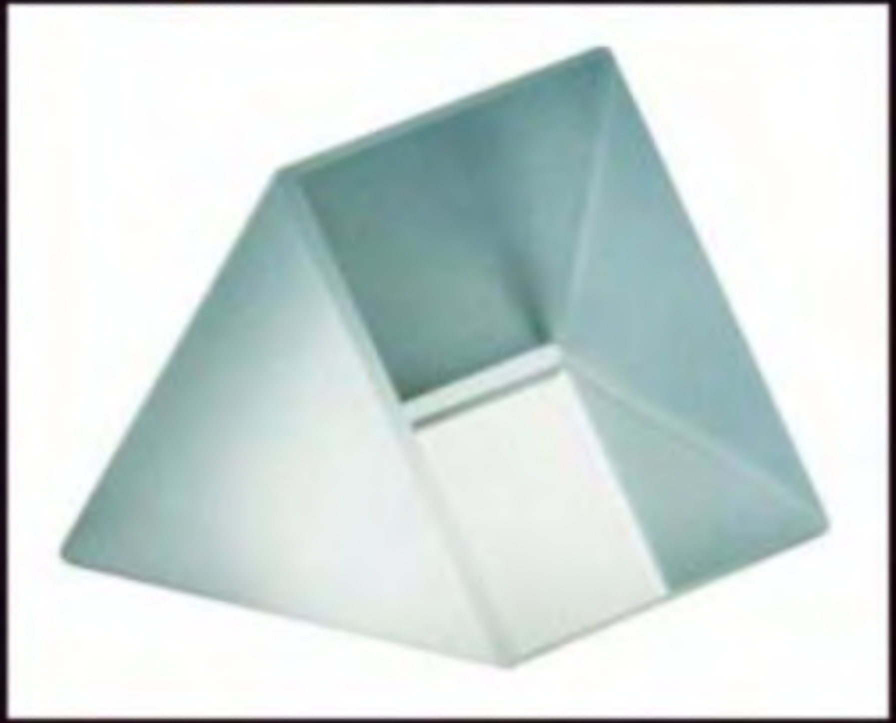
(4) 5.45°

Crown Glass and Flint Glass Prism

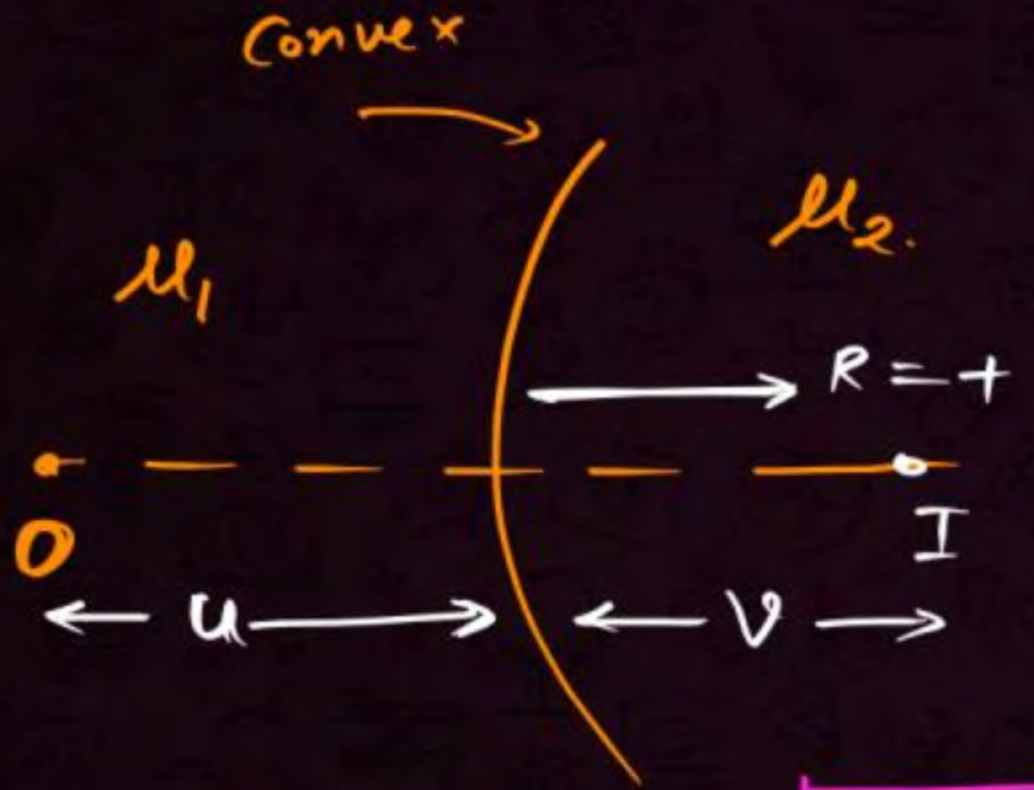
Crown glass is more clear than flint glass.

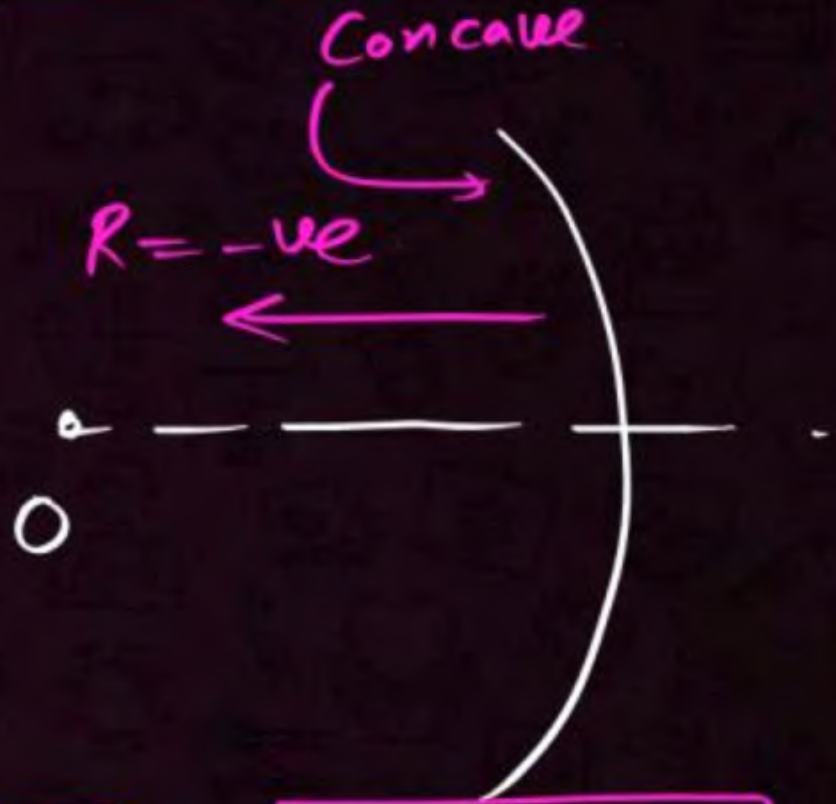
Flint glass prism has more dispersive power than crown glass prism.

$\omega_1 < \omega_2$



Refraction through curved surface



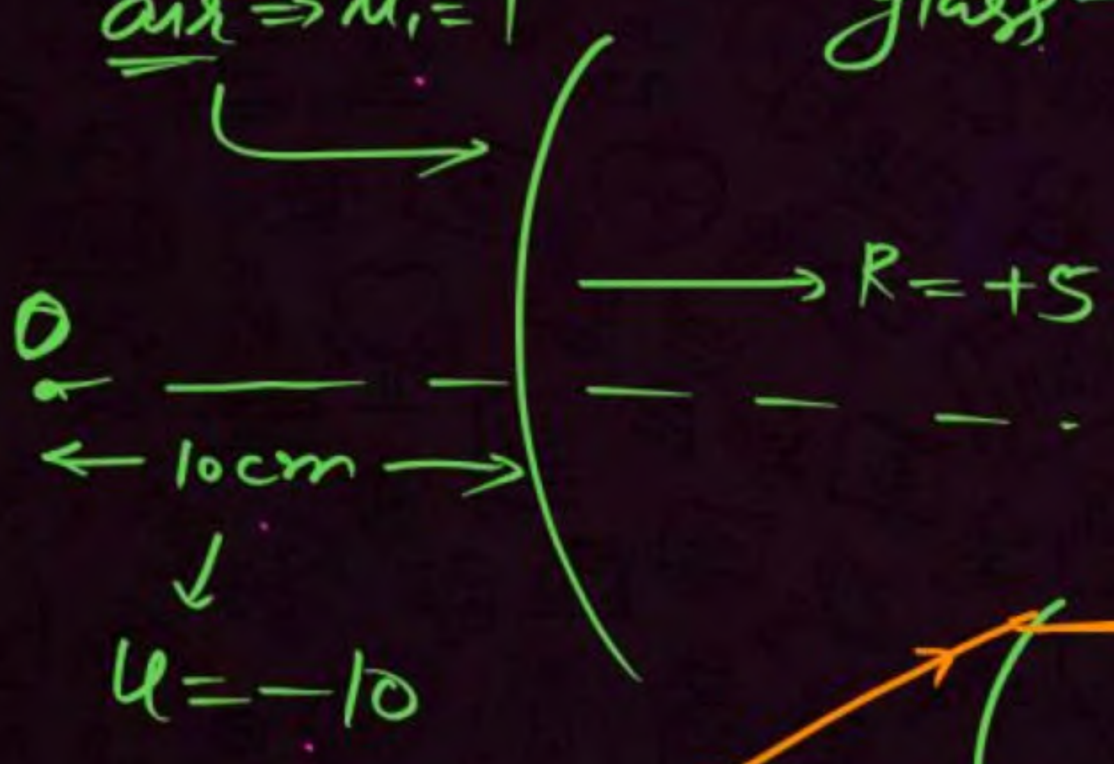


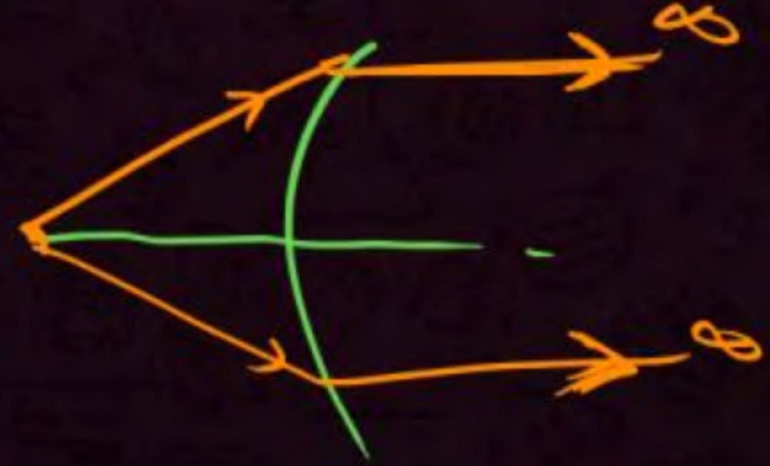
$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

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

QUESTION

An object is placed in air at a distance of 10 cm from the boundary of air and glass. The surface is convex towards the side of air. The radius of curvature of surface is 5 cm. Find the final image position.





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

$$\frac{3}{2v} - \frac{1}{(-10)} = \frac{3/2 - 1}{5}$$

$$\frac{3}{2v} + \frac{1}{10} = \frac{1/2}{5}$$

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

$$\frac{3}{2v} = \frac{1}{10} - \frac{1}{10} = 0$$

$$v \to \infty$$

Question

Find the size of the image formed in the situation shown.

a. 0.5 cm

b. 0.7 cm

c. 0.9 cm

d. 0.6 cm

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

$$\frac{4}{3v} - \frac{1}{(-40)} = \frac{4/3 - 1}{(-20)}$$

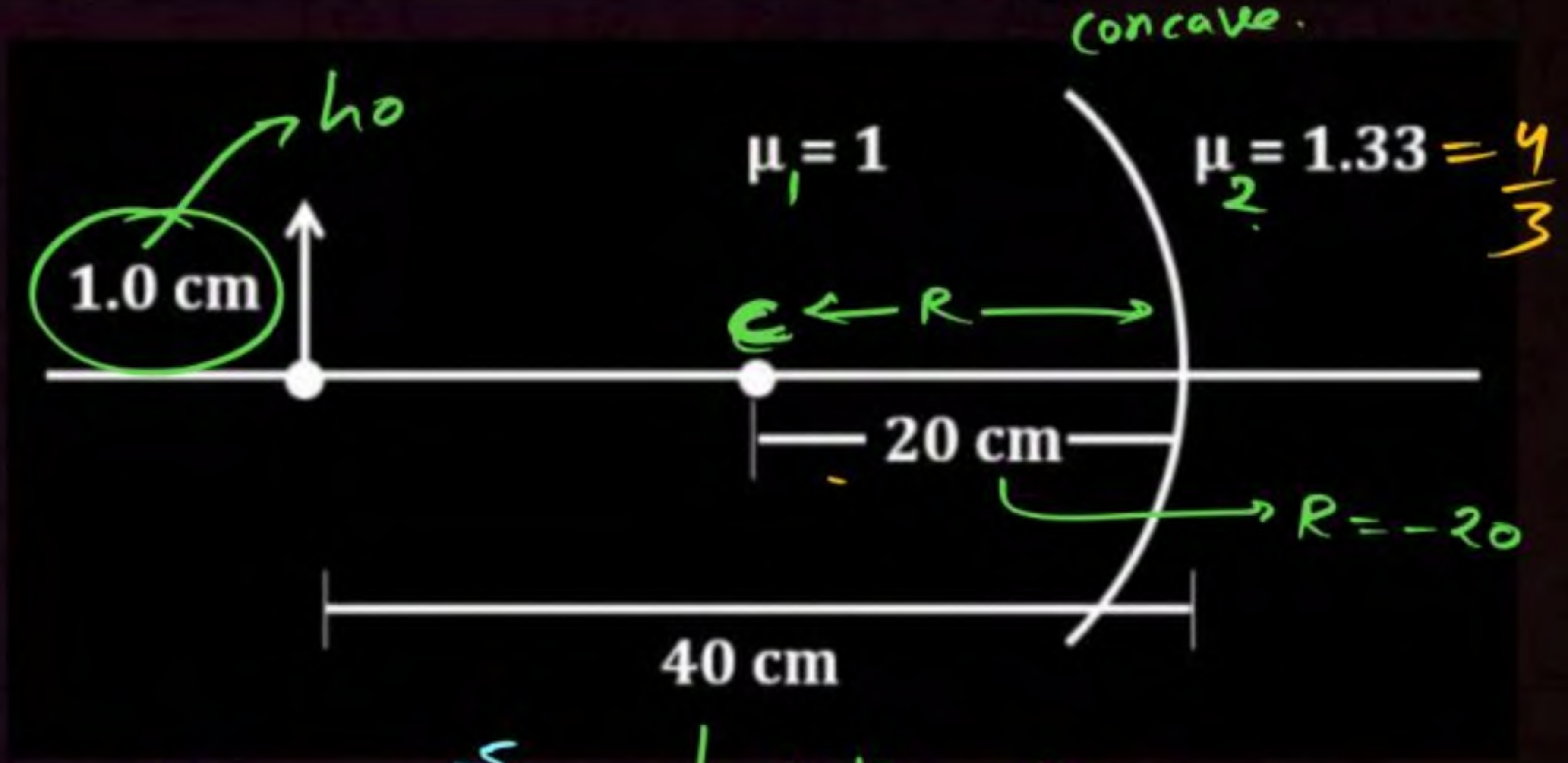
$$\frac{4}{3v} + \frac{1}{40} = \frac{1/3}{-20}$$

$$\frac{4}{3v} = \frac{-1}{60} - \frac{1}{40}$$

$$\frac{4}{3v} = \frac{-40 - 60}{60 \times 40}$$

$$\frac{4}{3v} = \frac{-100}{60 \times 40}$$

$$v = -32$$



$u = -40$

$$m = \frac{h_I}{h_0} = \frac{v/\mu_2}{u/\mu_1} = \frac{v \times \mu_1}{\mu_2 \times u} = \frac{-32 \times 1}{\frac{4}{3} \times (-40)}$$

$$= \frac{32 \times 3}{4 \times 40} = \frac{3}{5}$$

$$\frac{h_I}{h_0} = \frac{3}{5}$$

$$\frac{h_I}{1} = \frac{3}{5}$$

$$h_I = \frac{3}{5} = 0.6\,cm$$

QUESTION

(Calculative Ones) (HW)

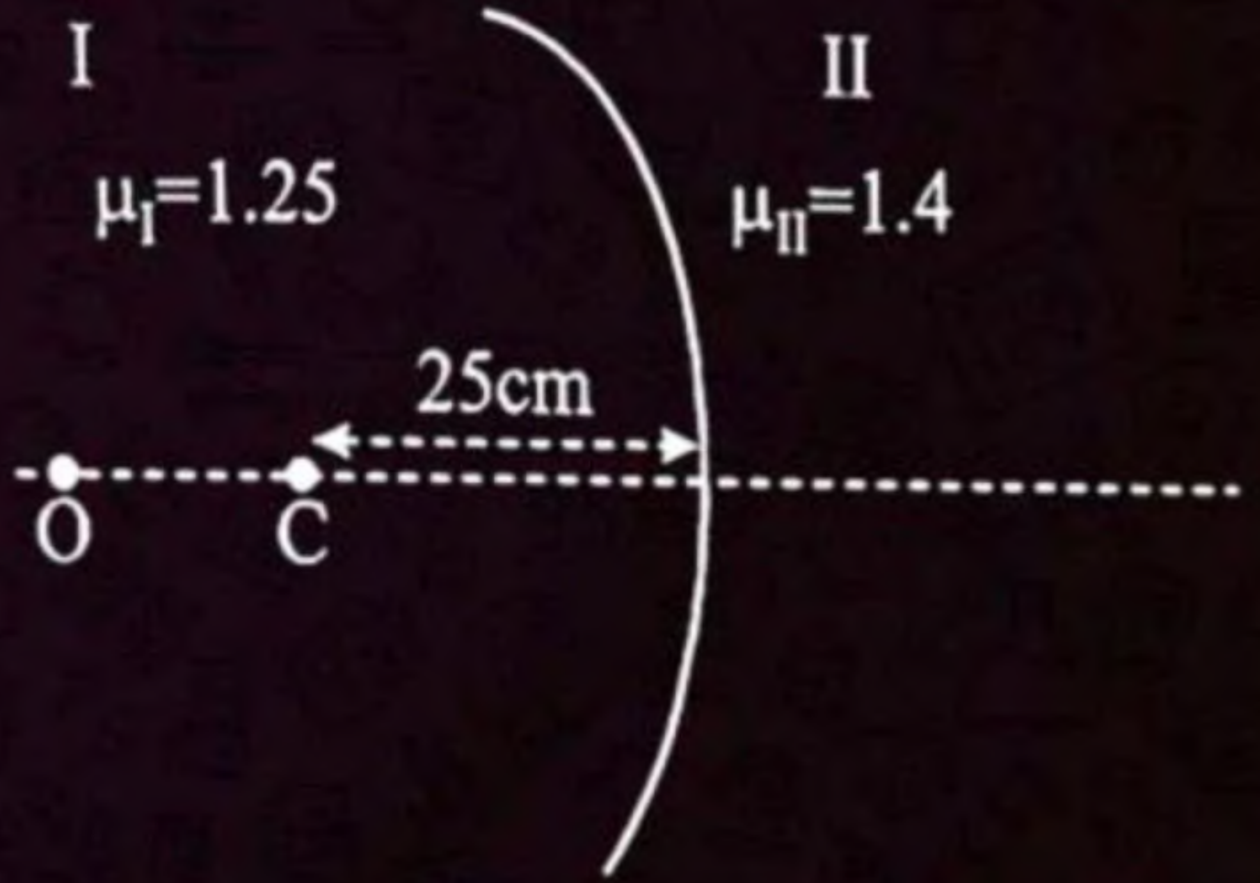
Region I and II are separated by a spherical surface of radius 25 cm . An object is kept in region I at a distance of 40 cm from the surface. The distance of the image from the surface is:

[20 July, 2021 (Shift-I)]

* Lens & optical Instruments

PPt change break

* 10 min



(1) 9.52 cm

(2) 18.23 cm

(3) 37.58 cm

(4) 55.44 cm

Lenses

V. Imp.

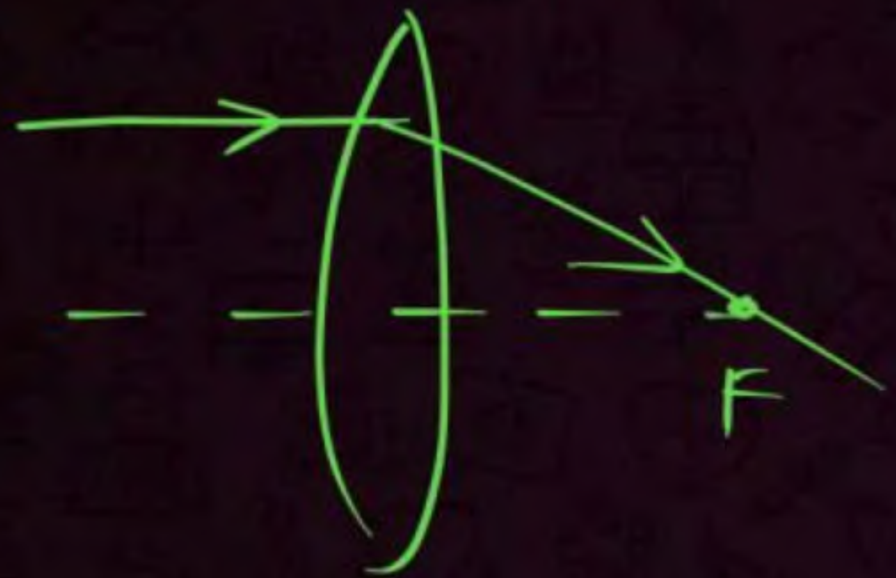
① Convex (Thick at middle)

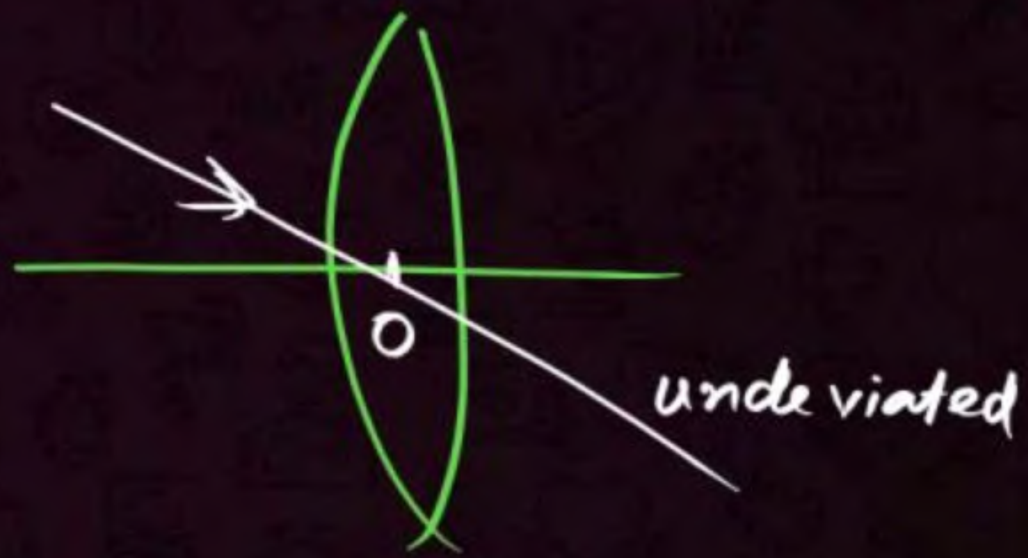
Bi-convex | Plano-convex | Concavo-convex

② Concave (Thin at middle)

Bi-concave | Plano Concave | Convexo-concave

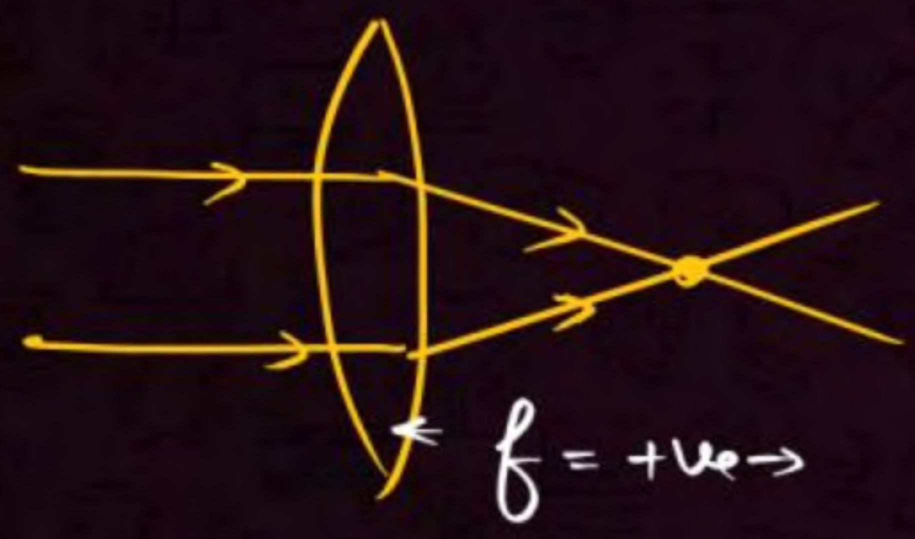
Rules for image formation

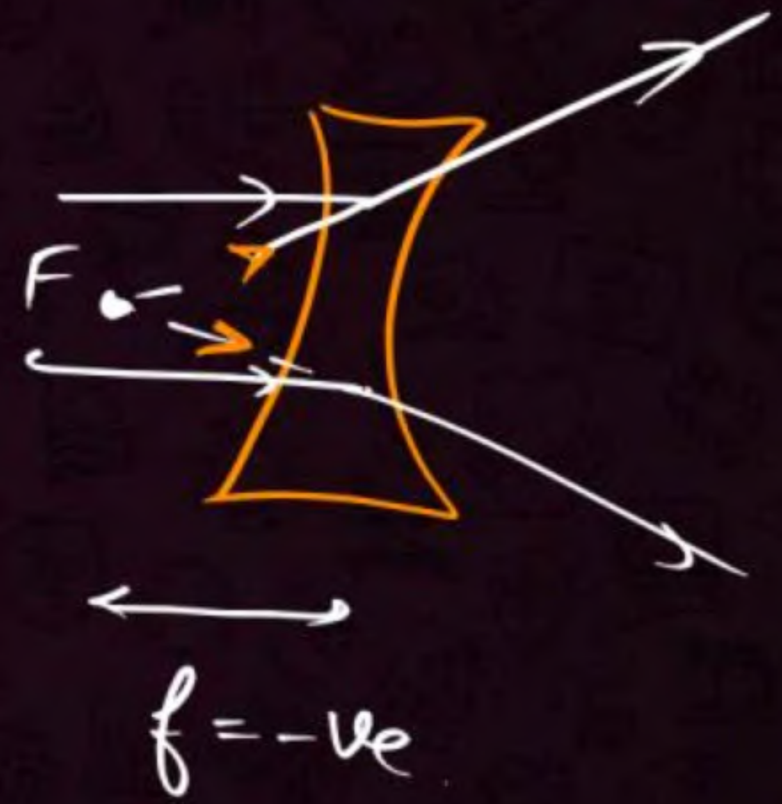




Focii of lens

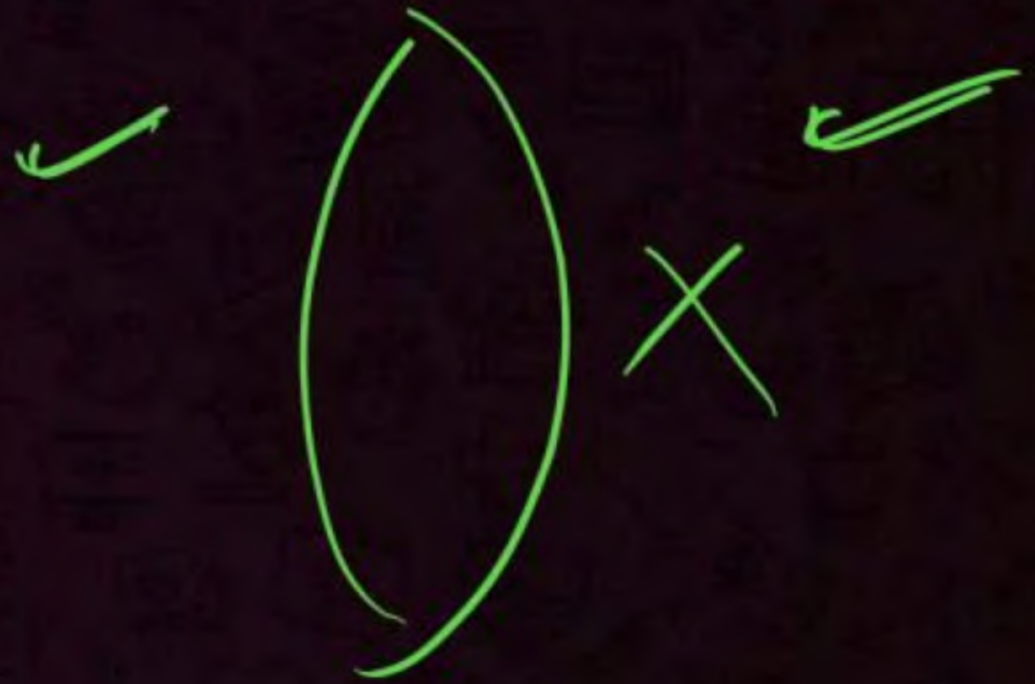
Convex lens are converging and concave lens are diverging in air.





Assumptions

1. Our discussion will be limited to thin lenses
2. Medium on both sides of lens is same.
3. The rays are assumed paraxial for formulae.



*C & 2f alag alg Hota Hai Lens Mein.

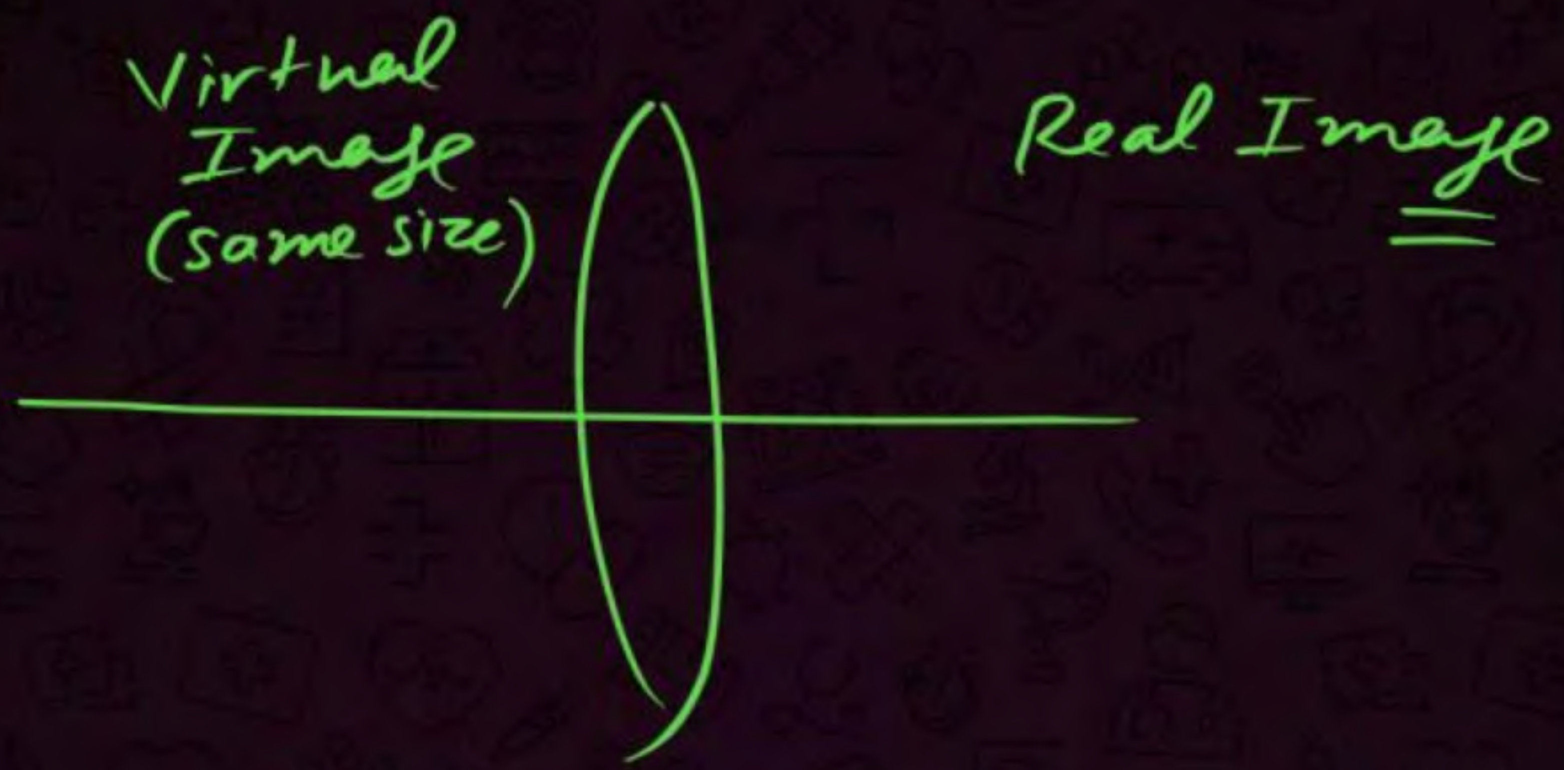
* $f \neq \frac{R}{2}$

$R \neq 2f$

Image formation through convex lens

→ similar to concave mirror

Object	Image	Exact/ Inverted	Real/Virtual	Size
1. ∞	F	Inverted	Real	Highly Diminished
2. Beyond 2F	B/w F and 2F	Inverted	Real	Diminished
3. 2F	2F	Inverted	Real	Same Size
4. B/w F and 2F	Beyond 2F	Inverted	Real	Enlarged
5. F	∞	Inverted	Real	Highly Enlarged
6. B/w F and O	Same side of lens	Erect	Virtual	Enlarged (Magnified)


Virtual Image (same size)
Real Image


Real
Virtual.

Image formation through concave lens → convex mirror

Object	Image	Nature		Size
* object ∞	Image F (same side)	Virtual	Erect	Highly Diminished
* Object ∞ and O	Image F and O (same side)	virtual	Erect	Diminished

Lens Formula and Magnification

* $\boxed{\frac{1}{v} - \frac{1}{u} = \frac{1}{f}} \longrightarrow \frac{1}{v} = \frac{1}{u} + \frac{1}{f} \Rightarrow \boxed{v = \frac{uf}{u+f}}$

* $m_{lat} = m = \frac{v}{u} = \frac{f}{f+u} = \frac{f-v}{f}$

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

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

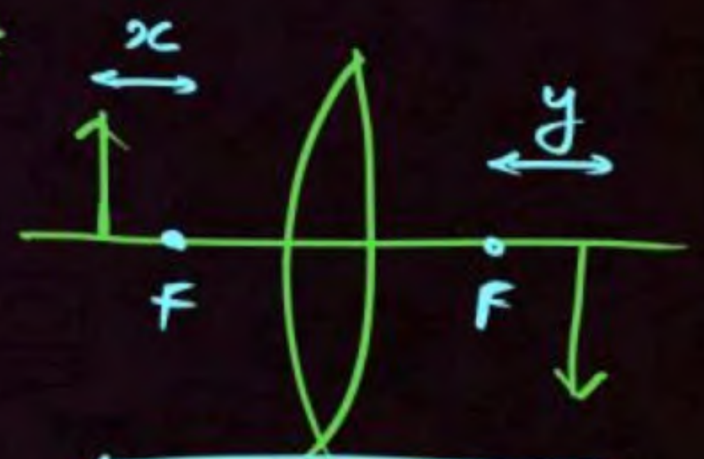
* $|m_{long}| = m_{lat}^2 = m^2$

(small objects)

$$V_I = m_{lat}^2 V_0$$

$$\boxed{V_I = \frac{v^2}{u^2} V_0}$$

*



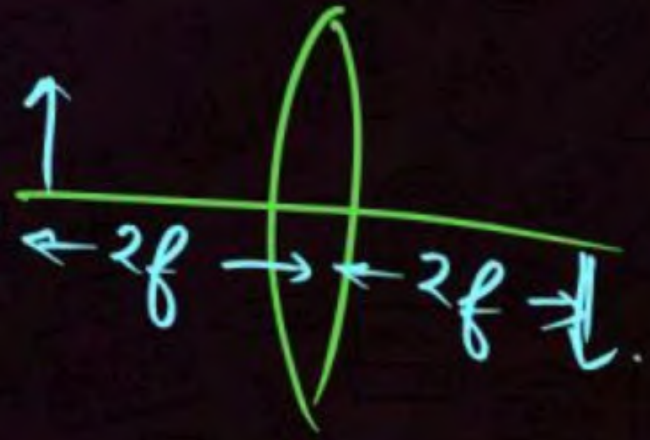
$$\boxed{xy = -f^2}$$

TBS

Convex Lens

	m
→ $u = -2f$, $v = +2f$	-1
→ $u = -\frac{3f}{2}$, $v = +3f$	-2
→ $u = -3f$, $v = +\frac{3f}{2}$	$-\frac{1}{2}$

TBS Note: Min^{m} distance b/w real image & real object in convex lens is $4f$



QUESTION

A wire mesh consisting of very small squares is viewed at a distance of 8 cm through a magnifying converging lens of focal length 10 cm, kept close to the eye. The magnification produced by the lens is [AIIMS 2006]

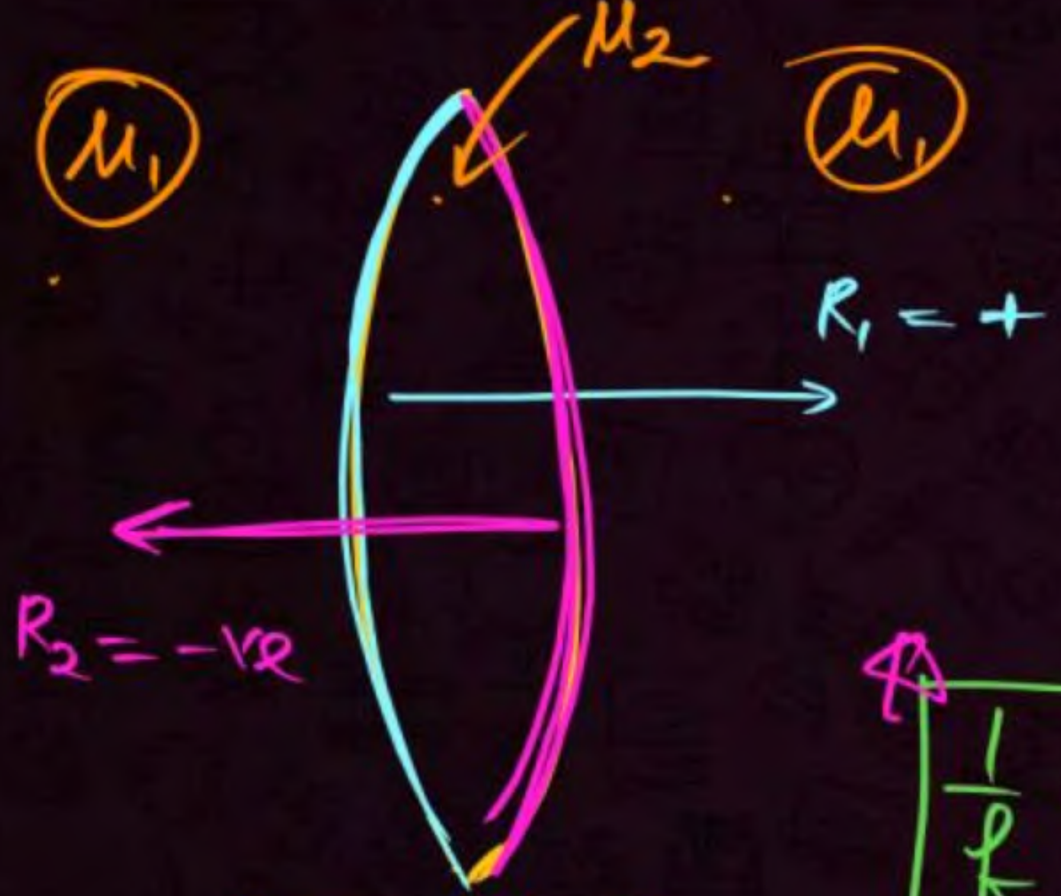
(1) 5
(2) 8
(3) 10
(4) 20

$u = -8$

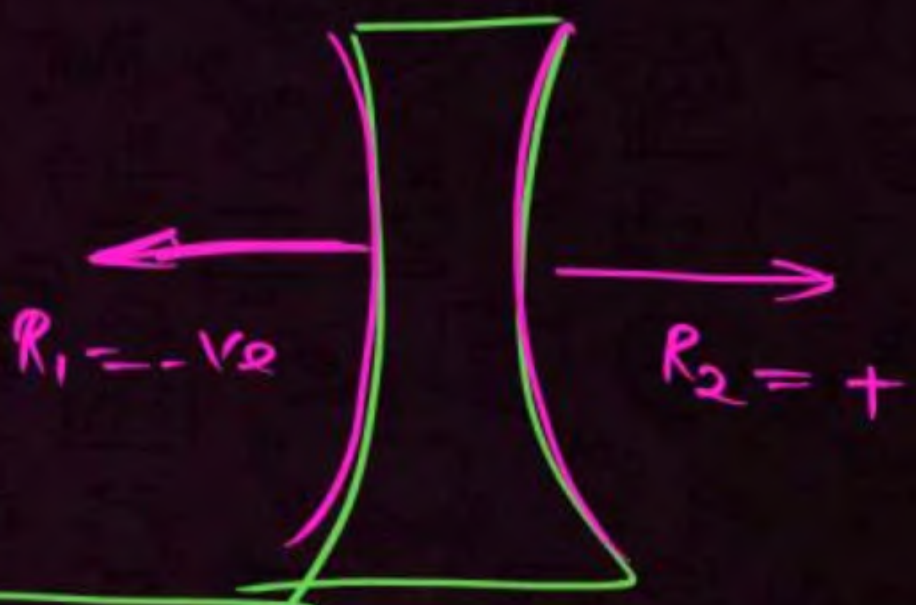
$f = +10$

$$m = \frac{f}{f+u} = \frac{10}{10+(-8)} = \frac{10}{2} = 5.$$

Lens Maker's Formula



$$\mu = \frac{\mu_2}{\mu_1}$$



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

QUESTION

A thin biconvex lens is bounded by two curved surfaces of radii of curvature 15 cm and 30 cm. If refractive index of glass is 3/2, find the focal length of the lens.

(1) 20 cm

(2) 30 cm

(3) 40 cm

(4) 10 cm

$R_1 = +15$ OR $R_1 = +30$

$R_2 = -30$ $\quad R_2 = -15$

$$\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{15} - \frac{1}{-30}\right)$$

$$\frac{1}{f} = \frac{1}{2} \times \left(\frac{1}{15} + \frac{1}{30}\right)$$

$$\frac{1}{f} = \frac{1}{2} \times \left(\frac{2+1}{30}\right)$$

$$\frac{1}{f} = \frac{1}{2} \times \frac{3}{30}$$

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

$$f = 20$$

QUESTION

Focal length of a convex lens will be maximum for [CBSE AIPMT 1994]

1. Blue light
2. Yellow light
3. Green light
4. Red light ✓

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

$f_{Red} \rightarrow$ maxm

Dost

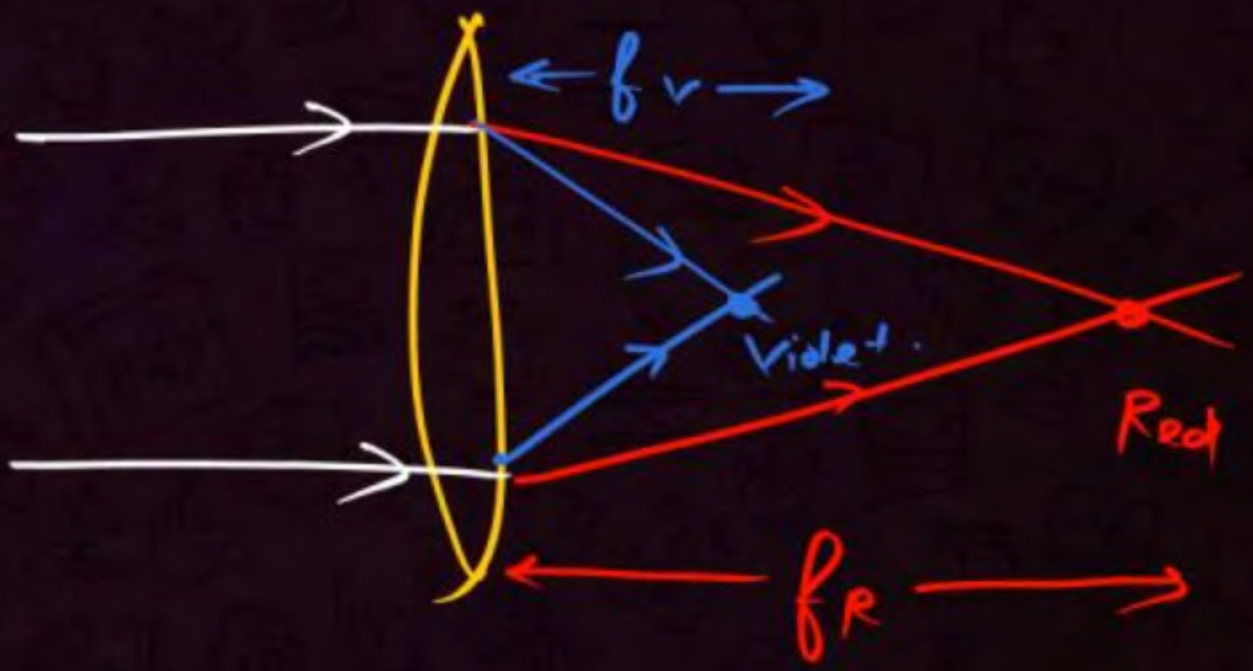
$\lambda \uparrow \Rightarrow \mu \downarrow \Rightarrow f \uparrow$

Dushman Dushman.

QUESTION

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: [24 Jan, 2023 (Shift-II)]

1. Scattering
2. Chromatic aberration
3. Spherical aberration
4. Polarisation



QUESTION

HW

Assertion: Chromatic aberration occur in simple lenses but not in mirrors.

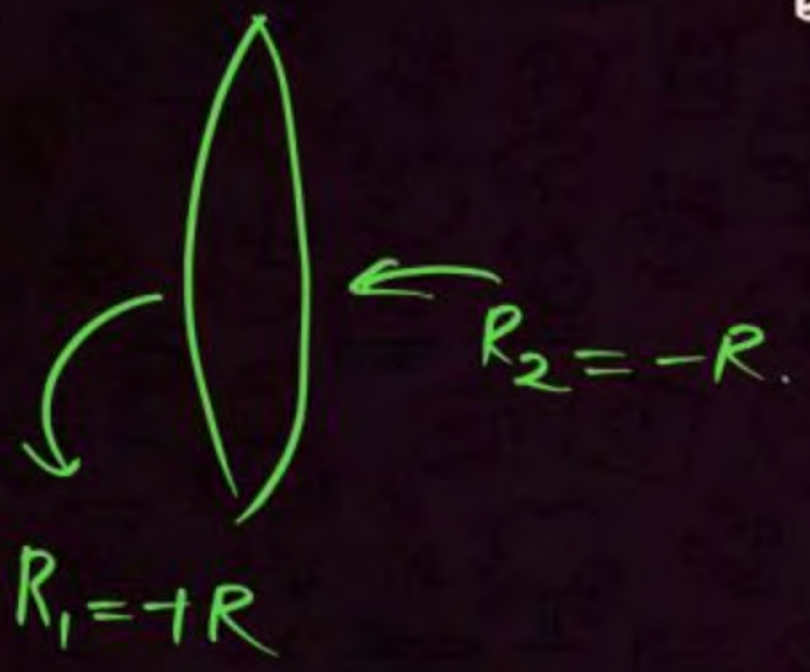
Reason: Focal length varies with wavelength in case of lenses and not in Mirrors.

1. Assertion (A) is True, Reason (R) is True; Reason (R) is a correct explanation for Assertion (A)
2. Assertion (A) is True, Reason (R) is True; Reason (R) is not a correct explanation for Assertion (A)
3. Assertion (A) is True, Reason (R) is False.
4. Assertion (A) is False, Reason (R) is True.

Equi-Convex / Equi-concave Lens

→ R = equal.

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



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

convex

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

concave

TBS

Ultra

→ glass - equi-convex lens $\left(\mu = \frac{3}{2}\right) \Rightarrow \boxed{f = R}$

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

glass → equi-convex → $\mu = \frac{3}{2} \Rightarrow \boxed{f = -R}$

QUESTION

(BPU) (BPU)

$\Gamma \rightarrow f = 20$ TBS Ultra

A biconvex glass lens has a radius of curvature of magnitude 20 cm. Which one of the following options best describe the image formed of an object of height 2 cm placed 30 cm from the lens?

1. Virtual, upright, height = 1 cm
2. Virtual, upright, height = 0.5 cm
3. Real, inverted, height = 4 cm
4. Real, inverted, height = 1 cm

$u = 30$

$f = 20$

$\frac{u}{f} = \frac{3}{2}$

$u = \frac{3f}{2}$

$v = +3f = +3 \times 20$

$= +60\,cm$

$m = \frac{v}{u} = \frac{60}{-30} = -2.$

Medium around the lens is changed

↳ f change

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

Ques: f in air. (glass $= \frac{3}{2}$)

f' in water = ? → **4f** — Learn

↳ Famous Ques

air ⇒ TBS Ultra. ⇒ $f = R$.

water → $\mu = \frac{\mu_2}{\mu_1} = \frac{3/2}{4/3} = \frac{9}{8}$

$$f' = \frac{R}{2\left(\frac{9}{8}-1\right)} = \frac{R}{2 \times \frac{1}{8}} = 4R$$

QUESTION

A lens is made of flint glass (refractive index = 1.5). When the lens is immersed in a liquid of refractive index 1.25, the focal length [AIIMS 2006]

$\downarrow 5/4$

1. increases by a factor of 1.25
2. increases by a factor of 2.5
3. increases by a factor of 1.2
4. decreases by a factor of 1.2

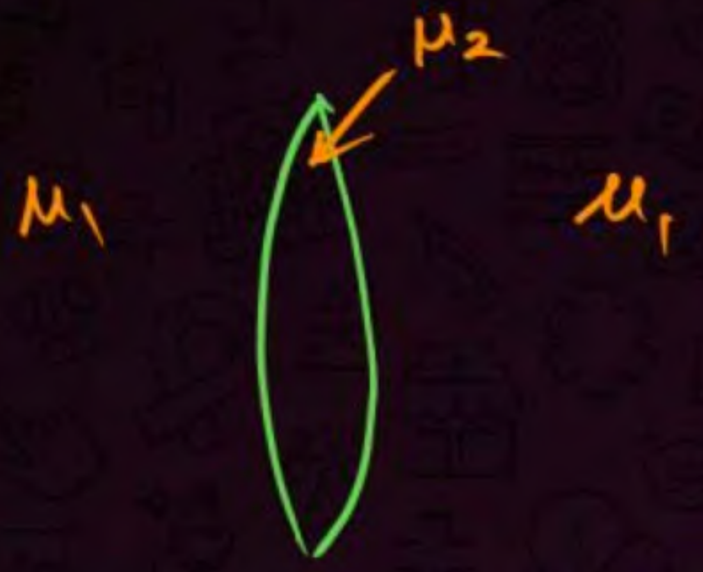
air $f = R$.

Liquid $\mu = \frac{\mu_2}{\mu_1} = \frac{3/2}{5/4} = \frac{3\times4}{2\times5} = \frac{12}{10} = \frac{6}{5}$

$f' = \frac{R}{2\left(\frac{6}{5}-1\right)} = \frac{R}{2\times\frac{1}{5}} = \frac{5R}{2}$

$f' = \frac{5f}{2} = 2.5f$

*



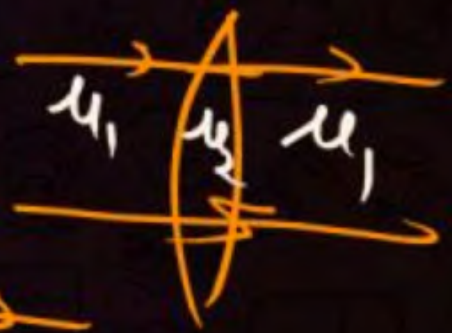
If $\mu_2 < \mu_1$ → Convex → $f = -ve$; Concave → $f = +ve$

If $\mu_1 = \mu_2$

Converging ×
Diverging ×
Behaves as glass slab.

$\mu = \frac{\mu_2}{\mu_1} = 1$

$$f = \frac{R}{2(\mu-1)} = \frac{R}{2(1-1)} = \frac{R}{0} \Rightarrow \infty$$



TBS Points

1. Convex lens behave as diverging and concave lens behave as converging lens if they are placed in a medium denser as compared to themselves.

Done

QUESTION

When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index

[CBSE AIPMT 2012]

(1) equal to that of glass

$\mu_1 = \mu_2$

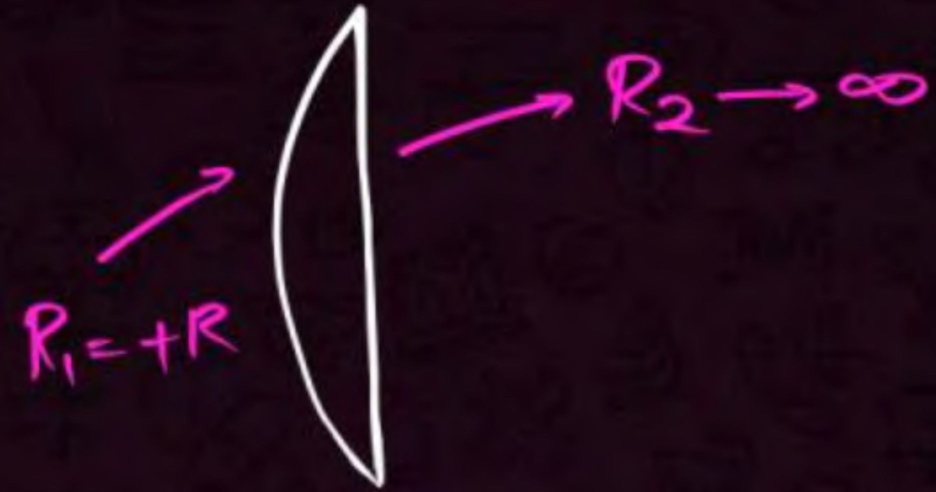
(2) less than one

(3) greater than that of glass

(4) less than that of glass

2. Vertical Cutting of lens (perpendicular to principal axis)

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

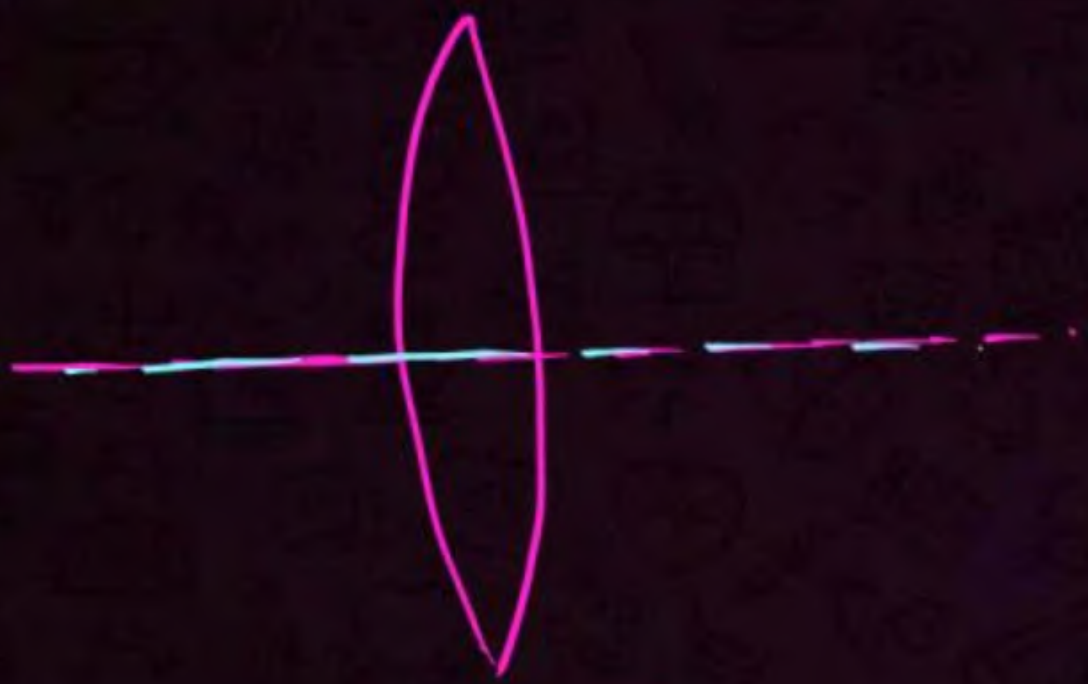


$$f' = \frac{R}{(\mu - 1)}$$

$$f' = 2f$$

Vertical cutting of equi-convex / equi-concave

3. Horizontal Cutting of lens (parallel to principal axis)



$f' = f$ → same

* Image → Intensity / Brightness decreases

QUESTION

A plano-convex lens is made of material of refractive index 1.6. The radius of curvature of the curved surface is 60 cm. The focal length of the lens is

(1) 50 cm

(2) 100 cm

(3) 200 cm

(4) 400 cm

$$f = \frac{R}{\mu - 1} = \frac{60}{1.6 - 1} = \frac{60}{0.6}$$

$$= \frac{60}{6} \times 10$$

$$= 100 \text{ cm}$$

QUESTION

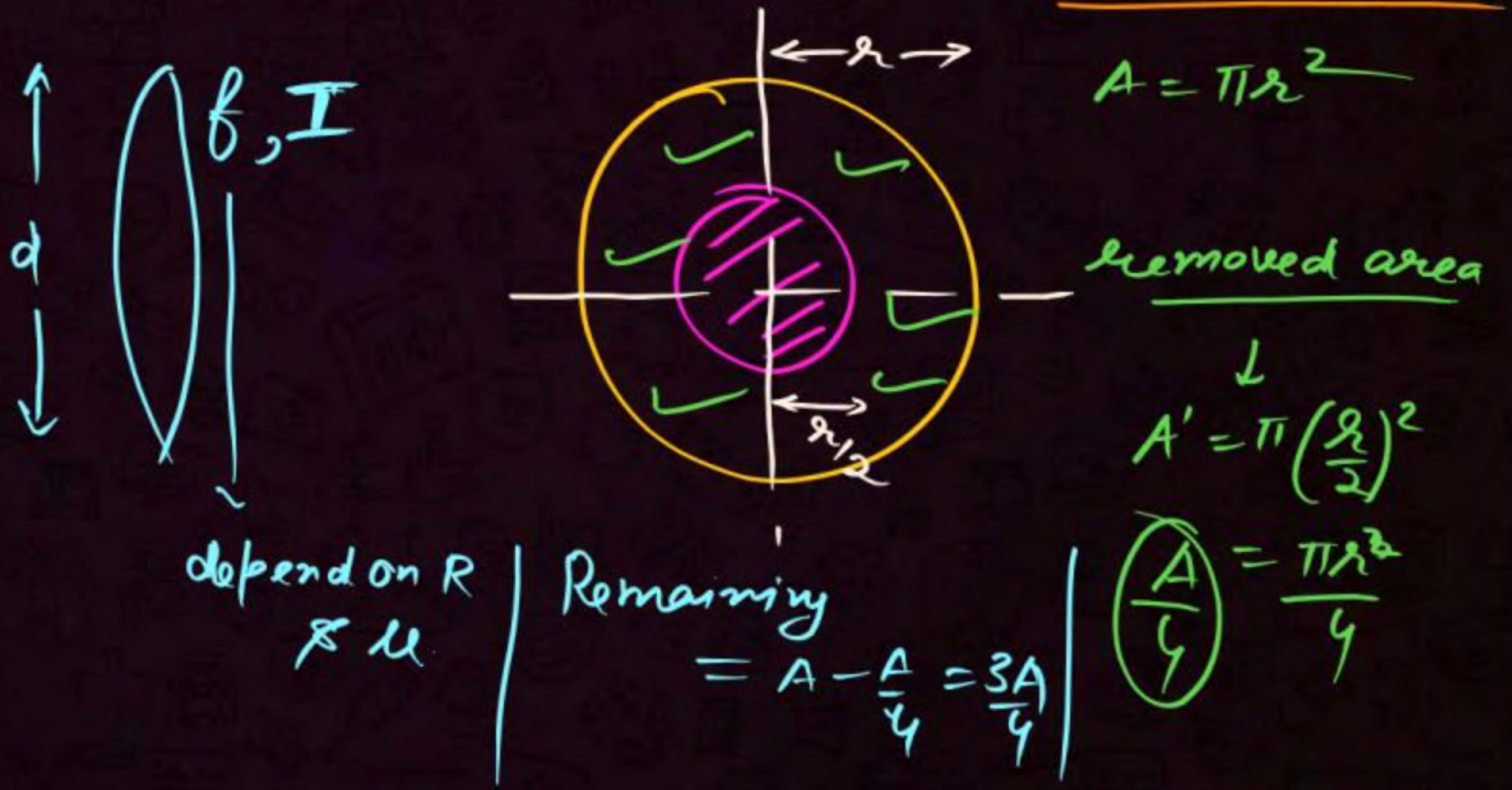
A lens having focal length f and aperture of diameter d forms an image of intensity I. Aperture of diameter $d/2$ in central region of lens is covered by a black paper. Focal length of lens and intensity of image now will be respectively **[CBSE AIPMT 2010]**

(1) f and $I/4$

(2) $3f/4$ and $I/2$

(3) f and $3I/4$

(4) $f/2$ and $I/2$



Power of a lens

It is the ability of a lens to converge or diverge the rays.

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

f → metre

P → diopter (D)

or

$$P = \frac{100}{f}$$

f → cm

P → dioptre (D)

QUESTION

The power of a biconvex lens is 10 D and the radius of curvature of each surface is 10 cm. Then, the refractive index of the material of the lens is [NEET (Oct.) 2020]

1. 4/3
2. 9/8
3. 5/3
4. 3/2

$P = \frac{100}{f} \Rightarrow f = \frac{100}{P} = \frac{100}{10} = 10\,cm$

$R = 10\,cm$

$\rightarrow \mu = \frac{3}{2}$

TBS Ultra

QUESTION

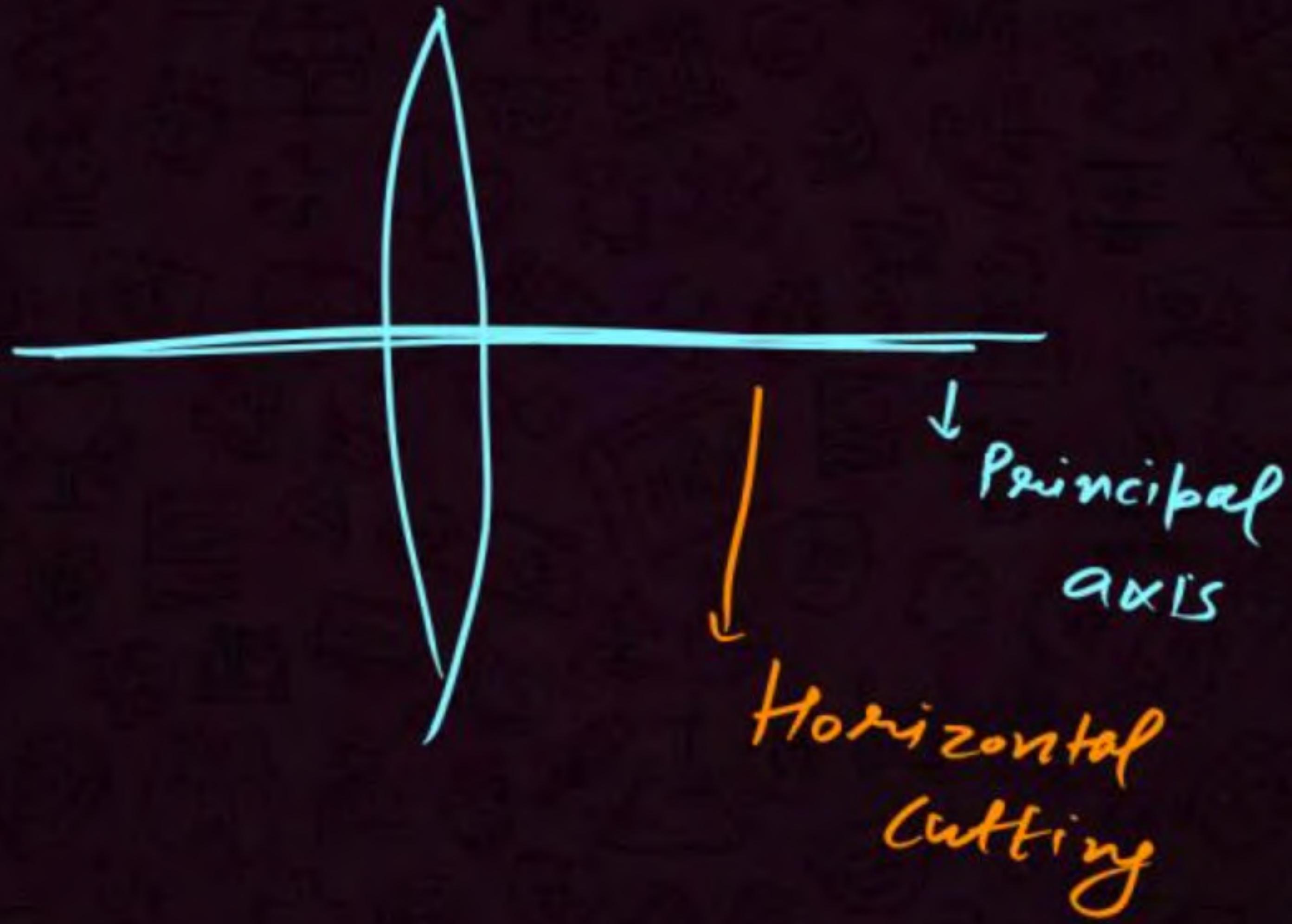
An equi-convex lens has power P it is cut into two symmetrical halves by a plane containing the principal axis. The power of one part will be [NEET (Odisha) 2019]

(1) 0

(2) P/2

(3) P/4

(4) P



$f' = f$

$P' = P$

Power of a lenses in contact (Thin lenses)

$$P = P_1 + P_2 + P_3 + \cdots$$

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \cdots$$

[with sign]

$$m = m_1 \times m_2 \times m_3 \times \cdots$$

QUESTION

A convex lens and a concave lens, each having same focal length of 25 cm, are put in contact to form a combination of lenses. The power in diopters of the combination is

1. 50
2. infinite
3. zero
4. 25

$$\frac{1}{f} = \frac{1}{25} + \frac{1}{-25} = \frac{1}{25} - \frac{1}{25} = 0 = P.$$

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

QUESTION

If two lenses of power +1.5D and +1.0D are placed in contact, then the effective power of combination will be [AIIMS 1995]

$1.5 + 1 = 2.5$

(1) 4.5 D

(2) 2.5 D

(3) 5.4 D

(4) 4.2 D

QUESTION

Two lenses of power +12 D and –2 D are combined together. What is their equivalent focal length? [AIIMS 1994]

1. 16.6 cm
2. 10 cm
3. 8.33 cm
4. 12.5 cm

$P = 12 + (-2) = 12 - 2 = 10\,D$

$P = \frac{100}{f}$

$f = \frac{100}{P} = \frac{100}{10} = 10\,cm.$

QUESTION

HW

A plano-convex lens fits exactly into a plano concave lens. Their plane surfaces are parallel to each other. If the lenses are made of different materials of refractive indices μ_1 and μ_2 and R is the radius of curvature of curved surface of the lenses, then find the focal length of the combination. [2013]

(1) $\frac{R}{(\mu_1-\mu_2)}$

(2) $\frac{R}{(\mu_1+\mu_2)}$

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

(4) $\frac{R}{2(\mu_1+\mu_2)}$

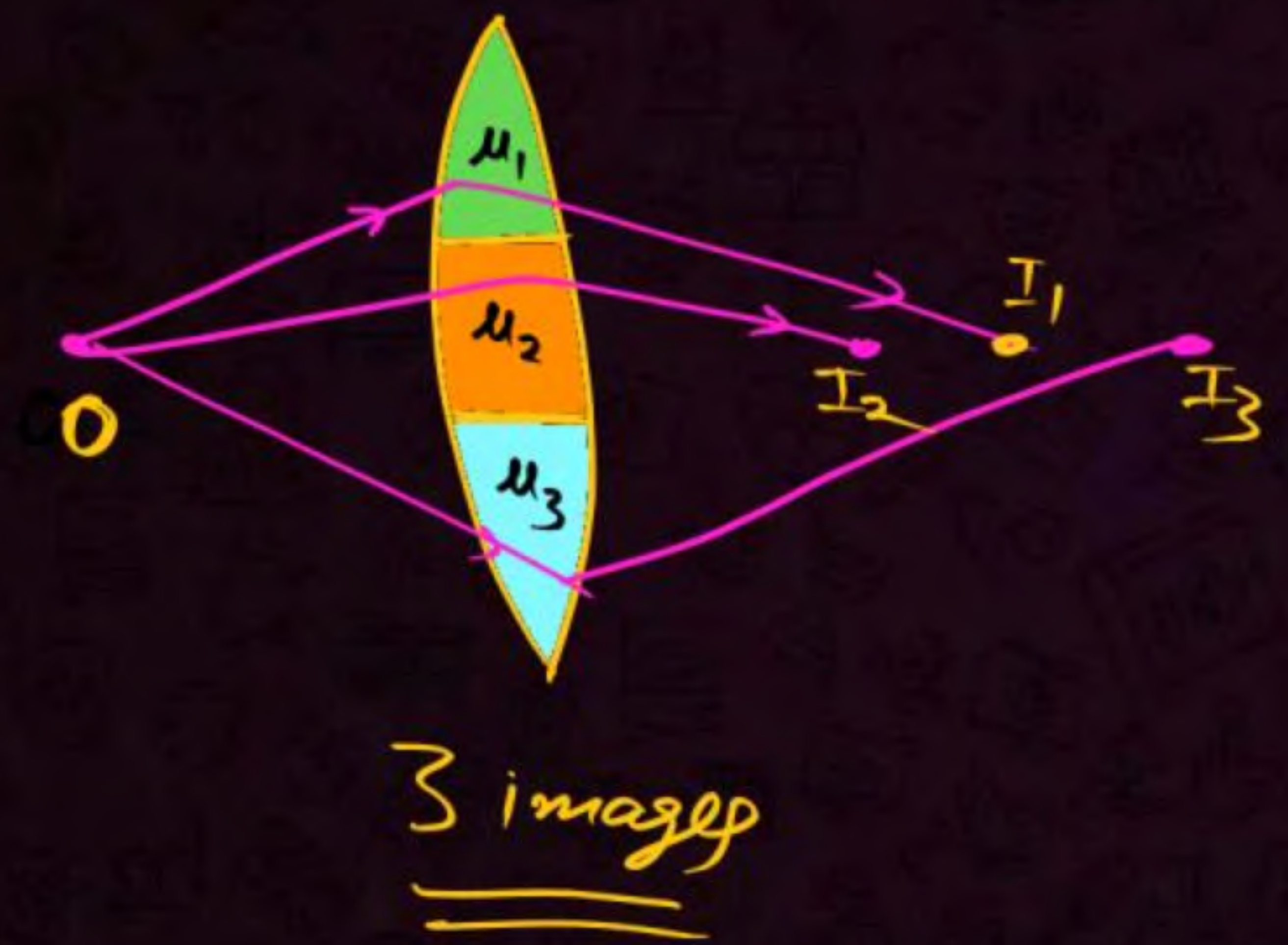
Lens at a distance

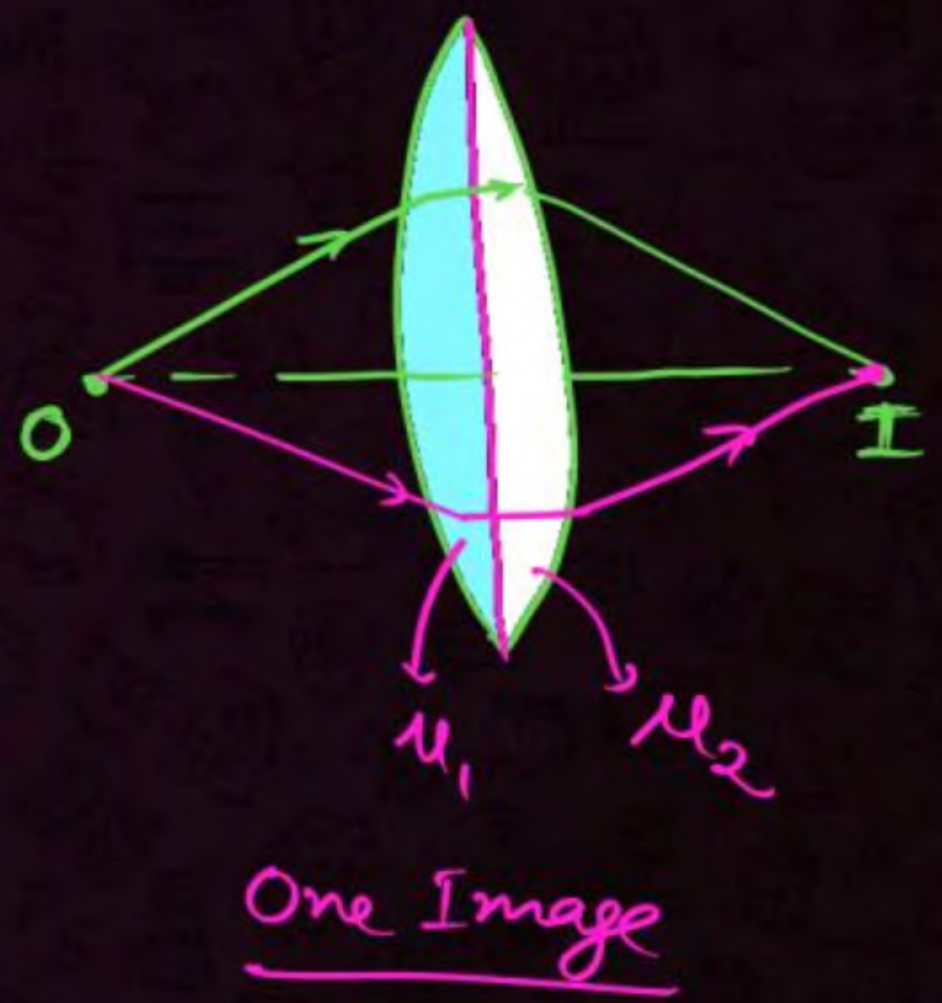
$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$$

$\frac{1}{f}$ → focal length of combination.

$\frac{d}{f_1 f_2}$ → Chances Less

Number of images from a lens of variable μ





Silvering of lens

2 refraction
1 reflection

$$P_{comb} = 2P_{Lens} + P_{mirror}$$

$$-\frac{1}{f_{comb}} = 2 \times \frac{1}{f_L} - \frac{1}{f_m}$$

* combination behaves as mirror.

Mirror

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

Ques

Equi-convex → R = 20 cm

$f_{comb} = ?$

$P_L = \frac{1}{f_L} = \frac{1}{20}$

$P_m = \frac{-1}{f_m} = \frac{-1}{-10} = +\frac{1}{10}$

TBS Ultra

$f = 20$

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

$= -10 cm$

$$P_{comb} = 2P_L + P_m$$

$$= 2 \times \frac{1}{20} + \frac{1}{10}$$

$$\frac{-1}{f_{comb}} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10}$$

$$\frac{-1}{f_{comb}} = \frac{1}{5}$$

$$f_{comb} = -5\,cm$$

Question

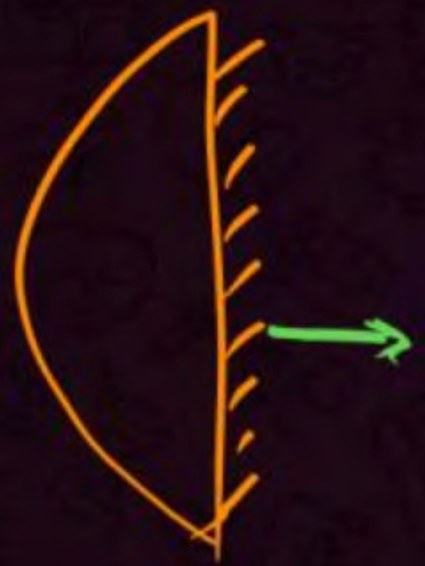
A planoconvex lens is made of a material of refractive index $\mu = 1.5$ The radius of curvature of curved surface of the lens is 20 cm. If its plane surface is silvered, the focal length of the silvered lens will be [CBSE AIPMT 2000]

a. 10 cm

b. 20 cm

c. 40 cm

d. 80 cm



$$P_L = \frac{1}{f_L} = \frac{1}{40}$$

$R \to \infty$, $f \to \infty$

$$P_m = \frac{-1}{f_m} = \frac{-1}{\infty} = 0$$

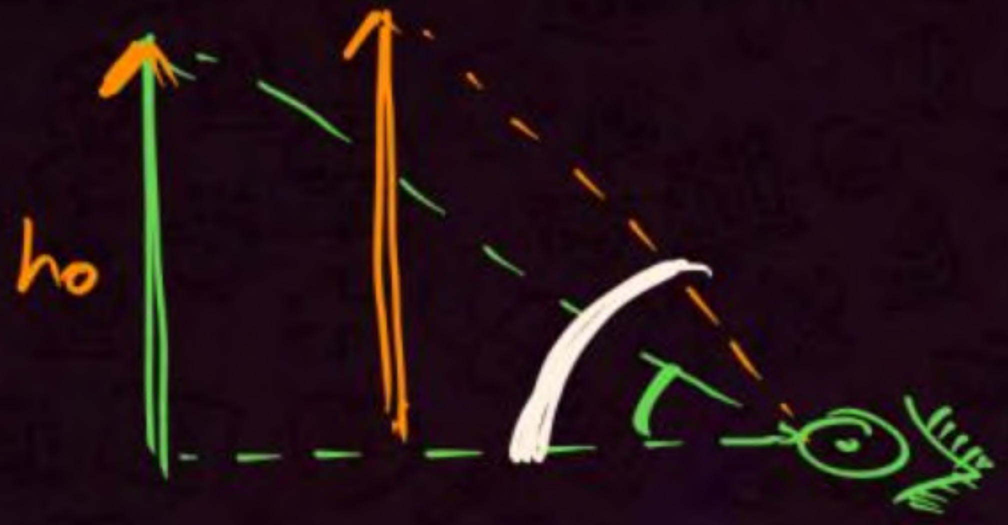
$$f_L = \frac{R}{\mu - 1} = \frac{20}{\frac{3}{2} - 1} = \frac{20}{1/2} = 40$$

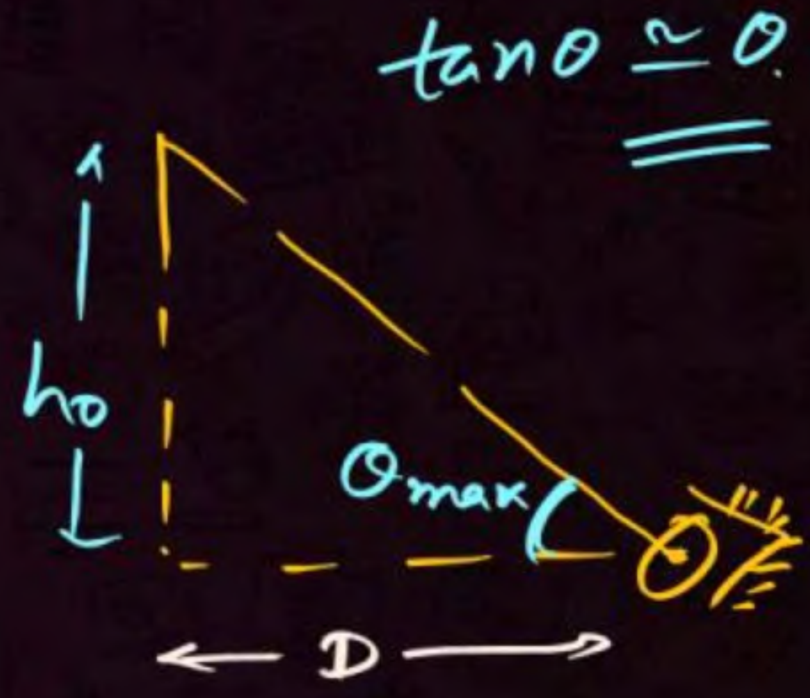
$$P_{comb} = 2P_L + P_m$$

$$\frac{-1}{f_{comb}} = 2 \times \frac{1}{40} + 0$$

$$f_{comb} = -20\text{ cm}$$

Optical Instruments





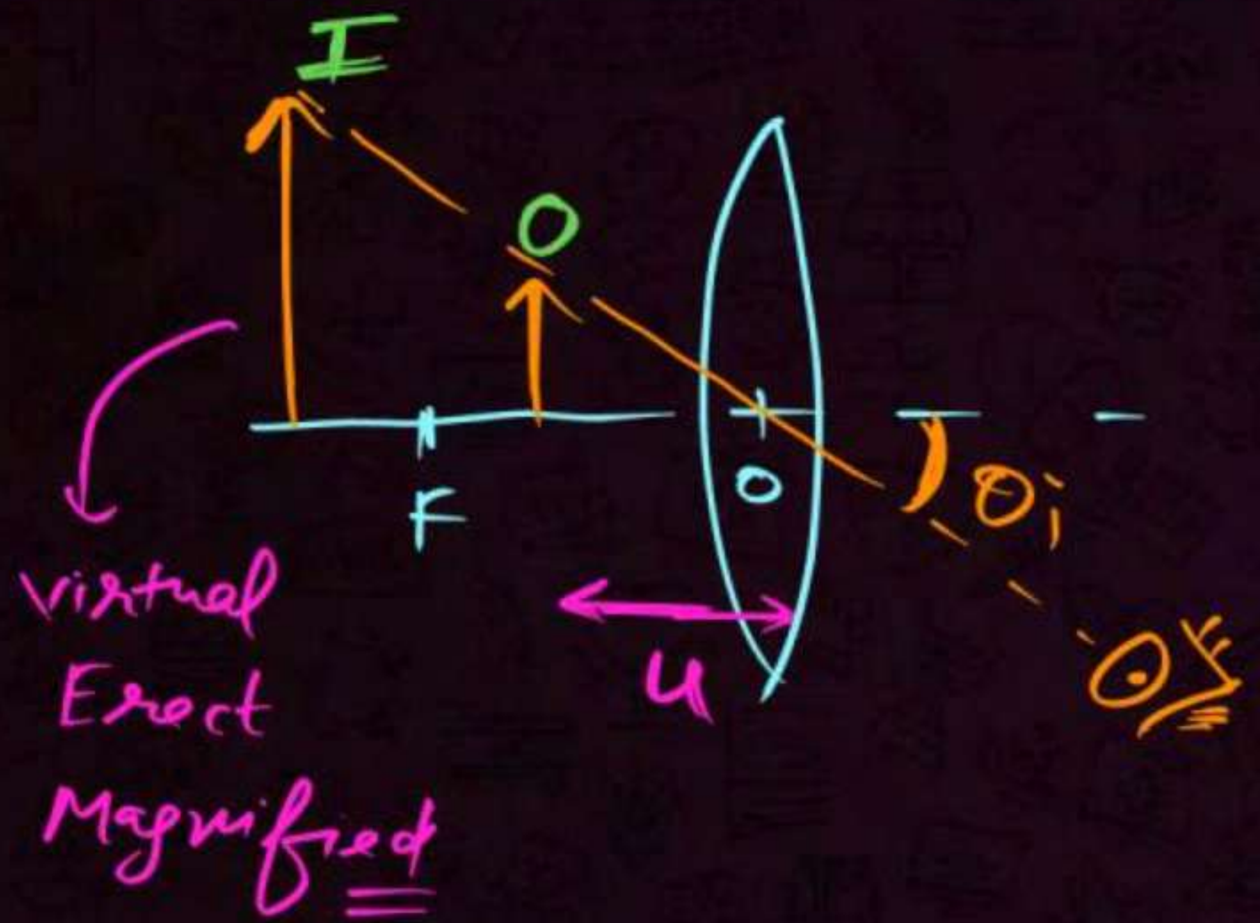
$$\theta_{max} = \frac{h_o}{D}$$

↳ maxm angle at our unaided/naked eye

D ↳ 25cm → near point
↳ LDDV → least distance of distinct vision.

far point → infinity

a) Simple Microscope



M.P = Magnifying power.

$$M.P = \frac{\theta_i}{\theta_{max}}$$

$$M.P = \frac{D}{u}$$

a) Relaxed Eye

⇓

Final image → ∞

$u \simeq f$

$$M.P = \frac{D}{f}$$ → min^m

b) Strained Eye

⇓

Final image → D

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow u = \frac{Df}{D+f}$

$$M.P = 1 + \frac{D}{f}$$ → max^m.

QUESTION

In a simple microscope of focal length 5 cm, final image is formed at the least distance of distinct vision, then its magnification will be [AIIMS 2018]

1. 6
2. 5
3. 2
4. 1

$$M = 1 + \frac{D}{f} = 1 + \frac{25}{5}$$

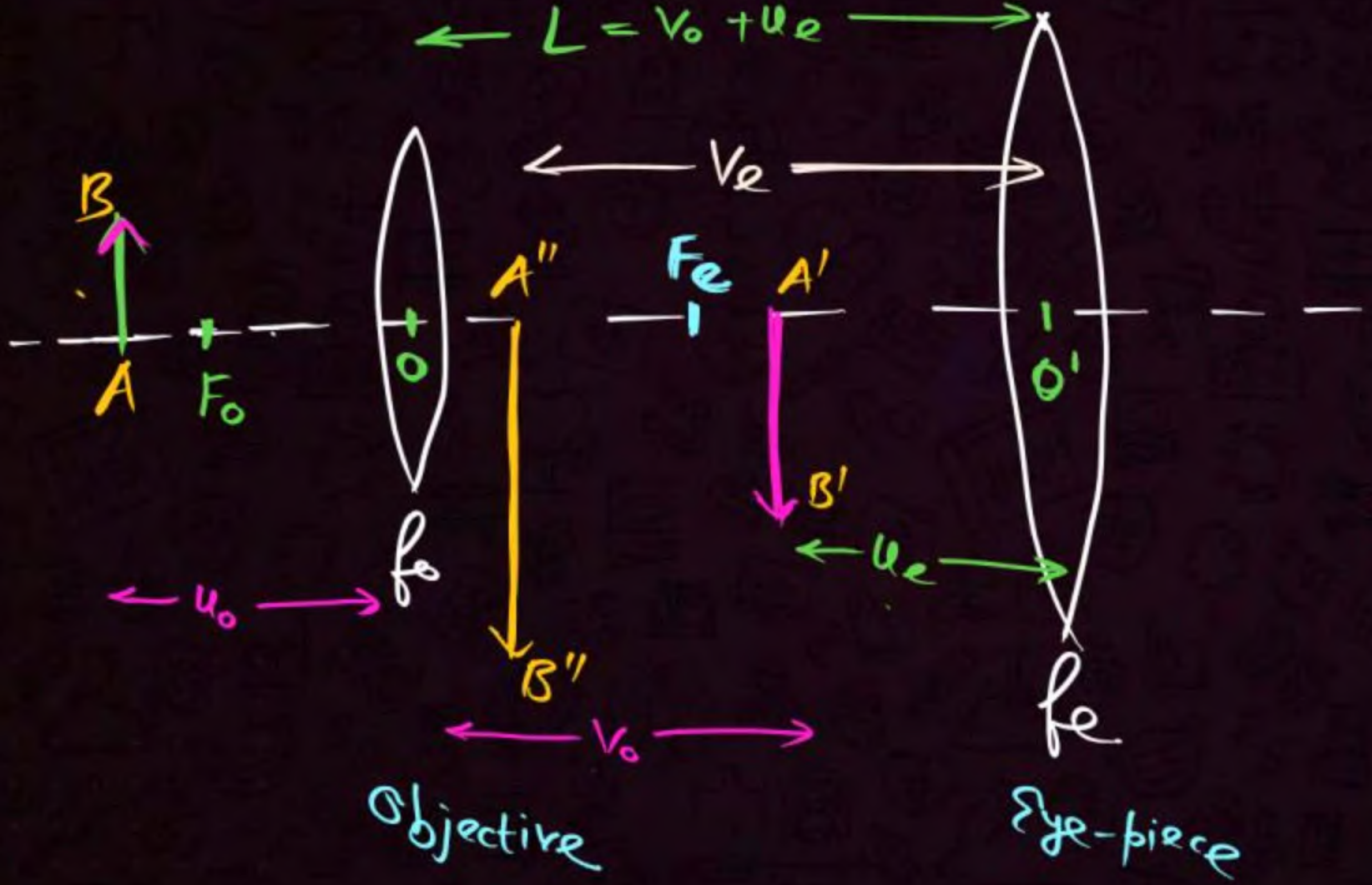
$$= 1 + 5 = 6$$

QUESTION

A person using a lens as a simple microscope sees an [AIIMS 1998]

1. upright virtual image
(Erect)
2. inverted real magnified image
3. inverted virtual image
4. upright real magnified image.

b) Compound Microscope



AB → object.

A'B' → Intermediate image.

A''B'' → Final Image.

$$M.P = \frac{V_0}{u_0} \times \frac{D}{u_e}$$

$$MP = \frac{v_o}{u_o} \times \frac{D}{u_e}$$

$$L = v_o + u_e$$

overall −ve ← bcoz inverted

1) Relaxed eye

Image → ∞

$u_e \simeq f_e$

$$M.P = \frac{v_o}{u_o} \times \frac{D}{f_e}$$ → min^m

$$L = v_o + f_e$$ → max^m

b) Strained eye

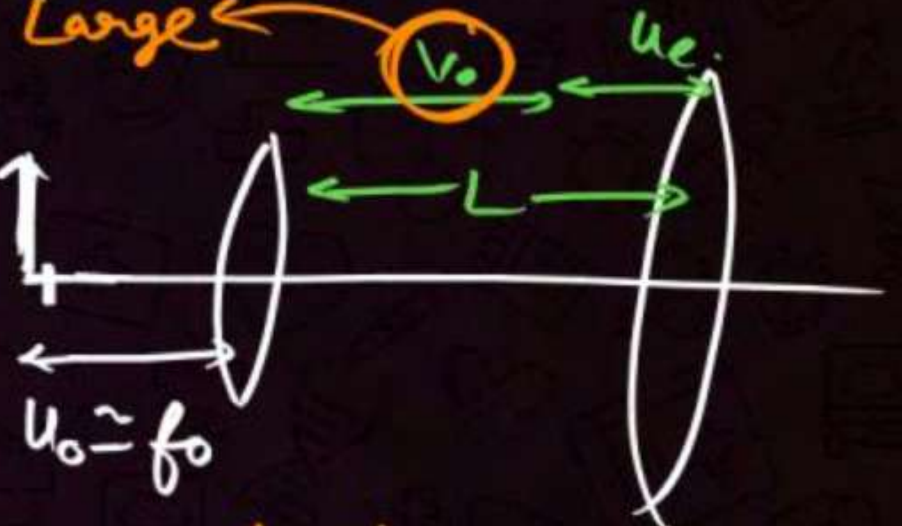
Image → D

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

$$MP = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right)$$ → max^m

$$L = v_o + \frac{Df_e}{D+f_e}$$

c) Normal adjustment.



$$L = v_o + u_e$$

$$L \simeq v_o$$

$$MP = \frac{L}{f_o} \times \frac{D}{f_e}$$

$$MP \propto \frac{1}{f_o f_e}$$

QUESTION

The magnifying power of a compound microscope increases with [AIIMS 2008]

1. the focal length of objective lens is increased and that of eye lens is decreased
2. the focal length of eye lens is increased and that of objective lens is decreased
3. focal lengths of both objects and eyepiece are increased
4. focal lengths of both objects and eyepiece are decreased.

$MP \propto \frac{1}{f_o f_e}$

$f_o \downarrow$ $f_e \downarrow$

$MP \uparrow$ $MP \uparrow$

QUESTION

A compound microscope has an objective of focal length 1 cm and an eyepiece of focal length 2.5 cm. An object has to be placed at a distance of 1.2 cm away from the objective, find the angular magnification and the length of the microscope tube in case least strained eye.

Relaxed

(1) 50, 8.5 cm ✓ (↓ No need)

(2) 30, 8.5 cm

(3) 20, 6.5 cm

(4) 45, 7.5 cm

$f_o = 1$

$f_e = 2.5$

$u_o = -1.2\text{ cm}$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow v_o = \frac{u_o f_o}{u_o + f_o}$

$\Rightarrow v_o = \frac{(-1.2)(1)}{-1.2+1}$

$v_o = \frac{-1.2}{-0.2} = 6$

$MP = \frac{v_o}{u_o} \times \frac{D}{f_e} = \frac{6}{-1.2} \times \frac{25}{2.5} = -50$

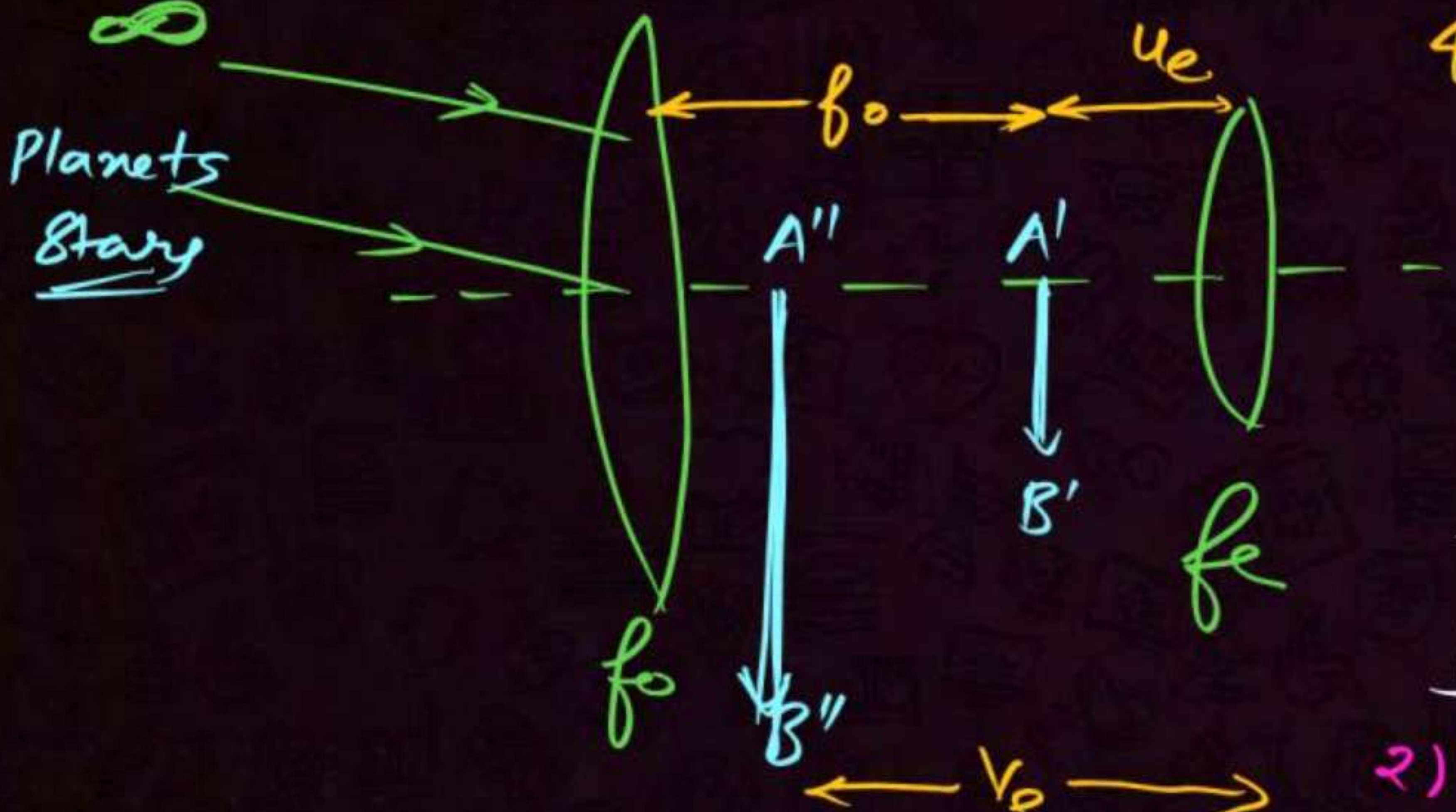
$L = v_o + f_e$

$= 6 + 2.5 = 8.5$

c) Astronomical Telescope

$M.P = \frac{f_o}{u_e}$ → (−ve)

$L = f_o + u_e$



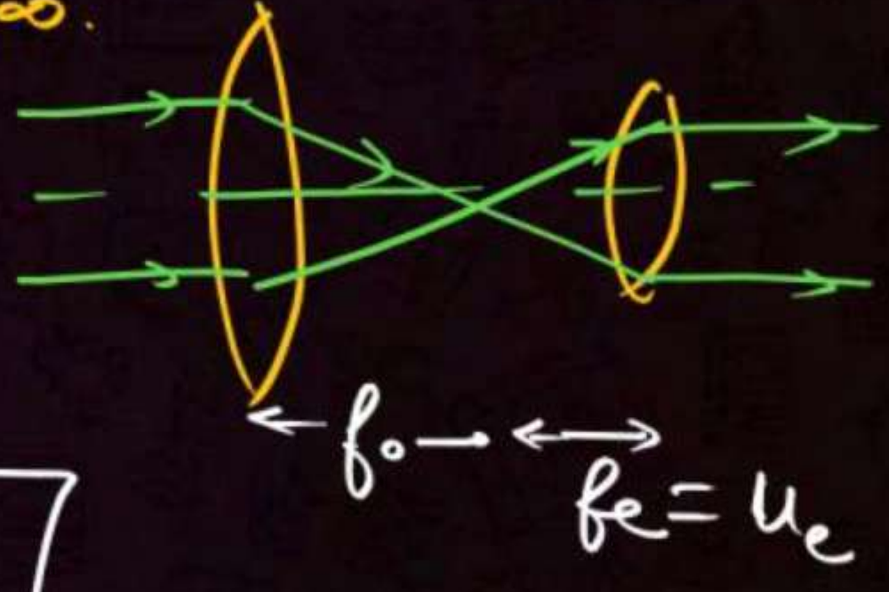
1) Relaxed eye (Normal adjustment)

Image ∞.

$u_e \simeq f_e$

$M.P = \frac{f_o}{f_e}$

$L = f_o + f_e$



2) Strained eye → Final image → D → $u_e = \frac{Df_e}{D+f_e}$

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

$L = f_o + \frac{Df_e}{D+f_e}$

QUESTION

Focal length of objective and eye piece of telescope are 200 cm and 4 cm respectively. What is the length of telescope for normal adjustment? [AIIMS 2016]

$L = f_o + f_e = 200 + 4 = 204$

(1) 196 cm

(2) 204 cm

(3) 250 cm

(4) 225 cm

QUESTION

BPU

normal

The magnifying power of a telescope is 9 . When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. The focal length of lenses are:

[2012]

1. 18 cm, 2 cm → $\frac{18}{2} = 9$
2. 11 cm, 9 cm → $\frac{11}{9}$
3. 10 cm, 10 cm → $\frac{10}{10} = 1$
4. 15 cm, 5 cm → $\frac{15}{5} = 3$

$L = 20 = f_o + f_e$

$MP = 9 = \frac{f_o}{f_e}$

$f_o = 9 f_e$

QUESTION

If the focal length of objective lens is increased, then magnifying power of

[CBSE AIPMT 2014]

1. microscope will increase but that of telescope decrease
2. microscope and telescope both will increase
3. microscope and telescope both will decrease
4. microscope will decrease but that of telescope will increase

$M.P = \frac{f_o}{f_e}$

$M.P \propto f_o$

$\propto \frac{1}{f_e}$

QUESTION

A lens of large focal length and large aperture is best suited as an objective of an astronomical telescope, since [NEET 2021]

(1) A large aperture contributes to the quality and visibility of the images

(2) a large area of the objective ensures better light gathering power

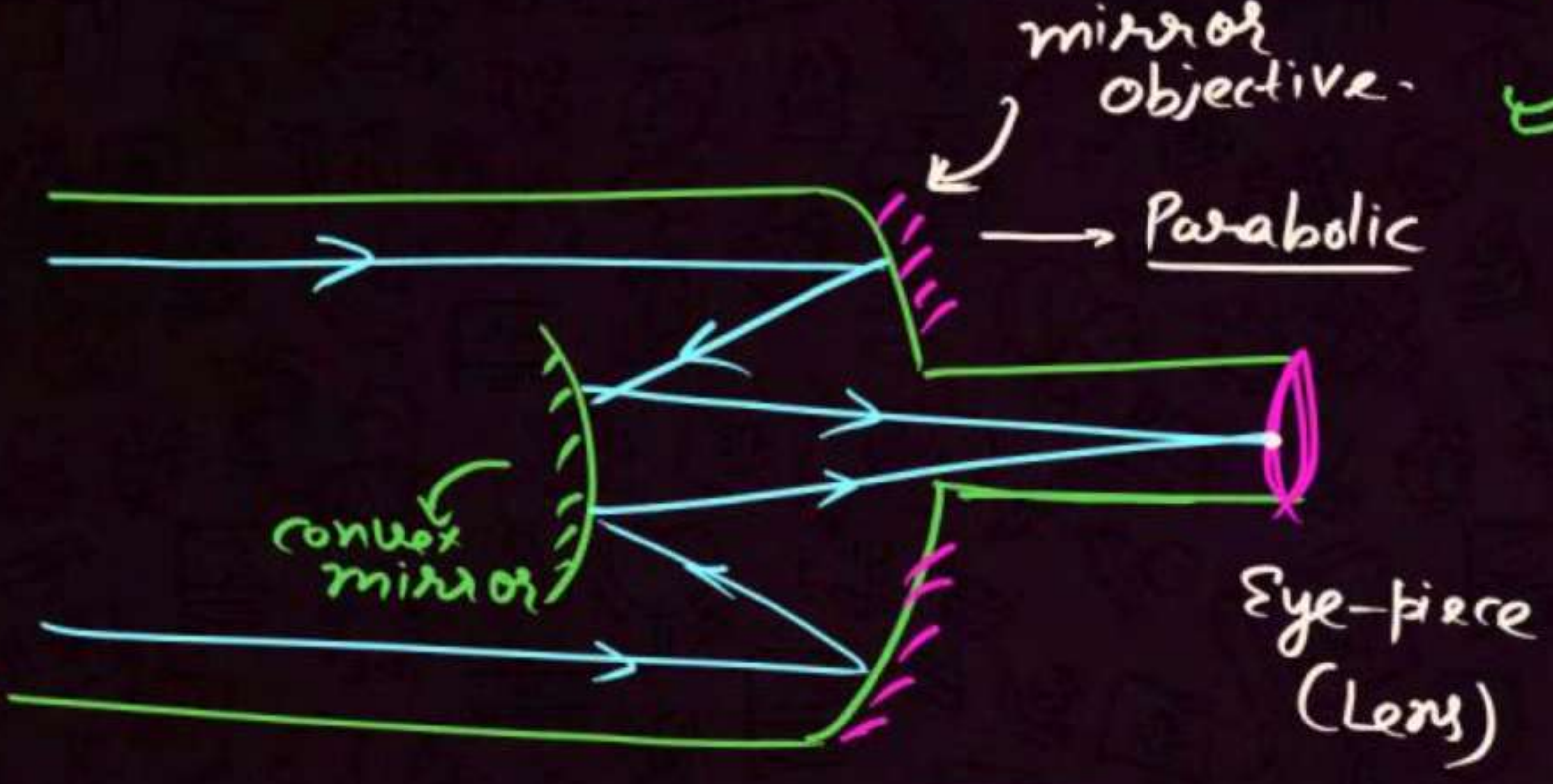
(3) a large aperture provides a better resolution

(4) All of the above

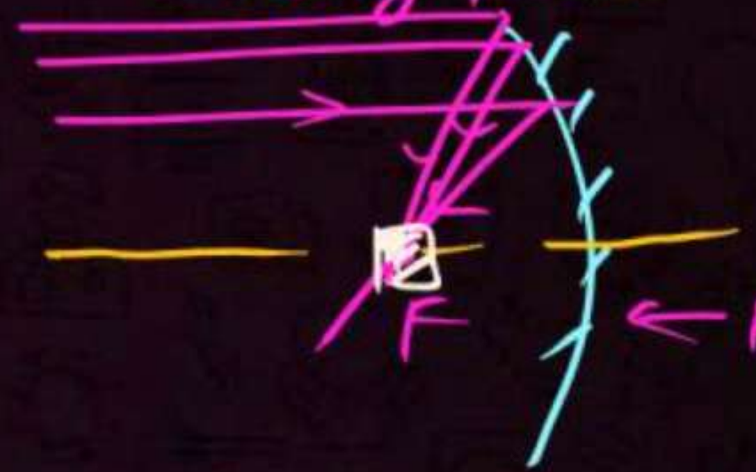
distinguish b/w objects

d) Reflecting Type (Cassegrain) Telescope

↳ Newtonian Type.



① Spherical abberation (defect)
↳ only paraxial rays meet at focus.

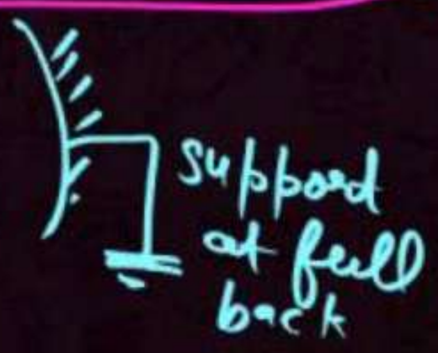


↳ all parallel rays meet at focus

② mirror objective
↓ Lens ✗
Chromatic abberation removed

③ Lens → heavy
Mirror → Light

④



Lens → support at edge.

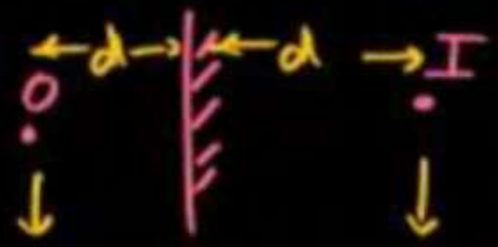
TBS Capsule (1)

* Laws of Reflection

- $\angle i = \angle r$
- IR, RR & Normal all in same plane

* valid for any type of surface - smooth or irregular.
  ↓
  Called diffuse reflection

* Plane mirror



Real Object — Virtual image

- same distance
- same size
- Erect (||el to mirror)
- Laterally inverted (⊥cular to mirror)

Rotation of rays

- Rotation of I.R → then rotation of R.R. in opposite sense
- Rotation of mirror → Rotation of R.R. by double angle in same sense.

---

* $\delta = 180 - 2i$ (Angle of deviation)
* $\delta_{net} = \delta_1 + \delta_2 - - - -$ (algebraically added)

$\boxed{\delta_{net} = 360^\circ - 2\theta}$ → TBS

Note ÷ Ray ||el to one mirror, after reflections, become ||el to other mirror. (if $\theta = 60^\circ$)

* No. of images

$$n = \frac{360^\circ}{\theta}$$

a) $n \to$ even $\Rightarrow N = n - 1$

b) $n \to$ odd $\longrightarrow$ symmetrical
$N = n - 1$
$\downarrow$
asymmetrical $\Rightarrow N = n$

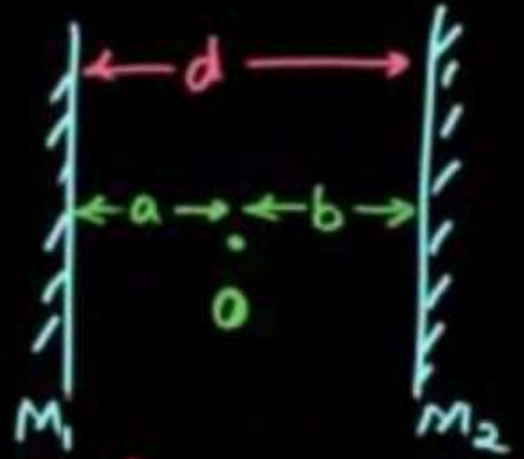
c) $n \to$ decimal $\Rightarrow$ Take small integer value

eg: $n = 5.7$
$N = 5$

* ||el mirrors

$\Downarrow$

$\theta = 0^\circ$



No. of images $\to \infty$

Distances of images from

M_1	M_2
a	b
$b + d$	$a + d$
$a + 2d$	$b + 2d$
$b + 3d$	$a + 3d$
⋮	⋮

* Min^m size of mirror

= Half of size of person.
(To see full image)
↓
- The bottom point of mirror must be at half of eye level.

* Velocity of image

a) ⊥cular to mirror: $V_I = 2V_M - V_O$

If $V_M = 0 \Rightarrow V_I = -V_O$

w.r.t. mirror $\Rightarrow V_{I/M} = -V_{O/M}$

b) ||el to mirror $\Rightarrow V_I = V_O$

No effect of mirror velocity

TBS capsule (2)

* Curved spherical mirror

(P) Pole → center of mirror

C → center of sphere

Distance b/w P & C ⇒ R.

* ||el rays pass through focus
* Through C, ray passes undeviated.
* • All Distances from pole.
  - → + ← −
  - ↑ + ↓ −
  - Concave ⇒ $f = -ve$
    Convex ⇒ $f = +ve$

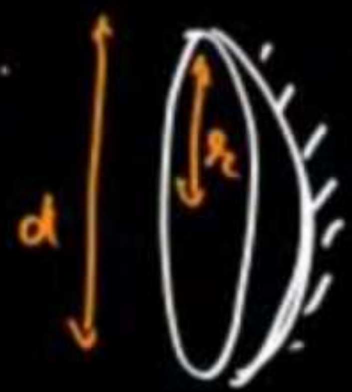
* Concave mirror

Object	Image	Exact/ Inverted	Real/Virtual	Size
1. ∞	F	Inverted	Real	Highly Diminished
2. Beyond C	B/w F and C	Inverted	Real	Diminished
3. C	C	Inverted	Real	Same Size
4. B/w F and C	Beyond C	Inverted	Real	Enlarged
5. F	∞	Inverted	Real	Highly Enlarged
6. B/w F and P	Beyond Mirror	Erect	Virtual	Enlarged (Magnified)

* Uses → ENT, Shaving mirror, headlight (Light evenly dispersed)

* Aperture → area ⊥ular to rays where light can enter.

$A = \pi r^2$



Convex

a) Object ∞
Image F (behind)
Virtual, Erect
Highly Diminished

b) Object b/w ∞ & P
Image b/w P & F (behind)
Virtual, Erect
Diminished

- rear view (driver's)
- Bcoz → Erect, Diminished, Large Field of vision

* Formulae

- valid for paraxial rays

- $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ → (TBS) $v=\frac{uf}{u-f}$

Mirror formula

* $m_{lat}=m=\frac{h_I}{h_o}=\frac{-v}{u}=\frac{f}{f-u}=\frac{f-v}{f}$

* $|m|>1$ → Enlarged
  $|m|<1$ → Diminished
  $|m|=1$ → Same Size

* $m=+ve$ → Erect
  $m=-ve$ → Inverted

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

* Aalsi Logo ka Formula

$u=f\left(1-\frac{1}{m}\right)$

* $m_{long}=\frac{v_2-v_1}{u_1-u_2}$ ⇒ $|m_{long}|=m_{lat}^2$ for small objects

* Velocity of image

a) Parallel to principal axis

$$V_I=-\frac{v^2}{u^2}V_o=-m_{lat}^2V_o$$ (wrt mirror also)

b) ⊥cular to principal axis

$$V_I=-\frac{v}{u}V_o=m_{lat}\times V_o$$

* Newton's formula ⇒ $xy=f^2$

* TBS Shortcuts (concave mirror)

$u=-2f \rightarrow v=-2f \Rightarrow m=-1$

$u=-\frac{3f}{2} \rightarrow v=-3f \Rightarrow m=-2.$

$u=-3f \rightarrow v=-\frac{3f}{2} \Rightarrow m=-1/2$

TBS Capsule ③

* Rarer to Denser
  ↓
  towards normal
* Denser to Rarer
  ↓
  away from normal

* Laws of Refraction
  * IR, RR & N in same plane
  * $\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$ = constant

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

↳ Snell's law

* $\boxed{\mu = n = \frac{c}{v}}$
  ↓
  optical density/ refractive index
* $\boxed{n = \sqrt{\mu_r \epsilon_r}}$
* $\mu = 1$ (vacuum)
  $\mu \simeq 1$ (air)
  $\mu > 1$ (medium)
* $\boxed{\mu = \frac{c}{v} = \frac{c}{f\lambda}}$
* $\mu \propto \frac{1}{v}$ & $\mu \propto \frac{1}{\lambda}$

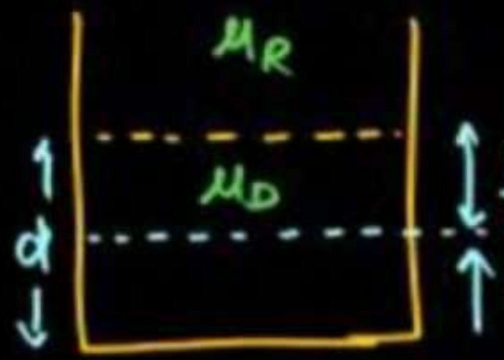
$\frac{\mu_2}{\mu_1} = \frac{v_1}{v_2}$ | $\frac{\mu_2}{\mu_1} = \frac{\lambda_1}{\lambda_2}$

* $\mu_{12} = {}_2\mu_1 = \frac{\mu_1}{\mu_2}$ → Relative μ
* $\mu_g = \frac{3}{2} = 1.5$ * $\mu_w = \frac{4}{3} = 1.33$

* App. depth & height
  ↓ decreases ↓ increases

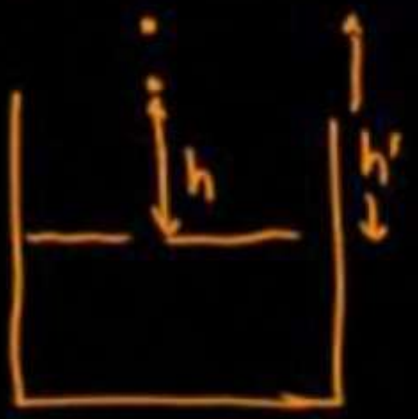
air to medium
$f' = f$, $v' = \frac{v}{\mu}$, $\lambda' = \frac{\lambda}{\mu}$

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



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

L.Shift $= d\left(1 - \frac{1}{\mu}\right)$
in direction of IR.



$h' = \mu h$.
L.Shift $= h(\mu - 1)$
opposite to IR.

* Reflected & Refracted rays are ⊥cular

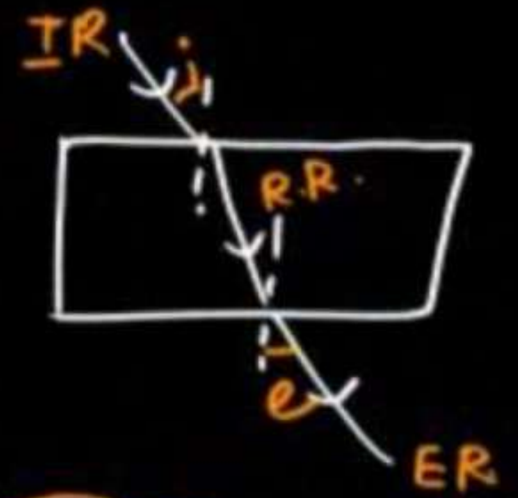
$$\mu = \tan i$$

*

App. thickness from both sides → t_1' & t_2'

TBS $t = (t_1' + t_2')\mu$.

*



$\angle i = \angle e$

IR || ER → if medium on both sides of glass slab are same.

• Lat. Shift $= t\dfrac{\sin(i-r)}{\cos r}$

small angles → $i\,t\left(1-\dfrac{1}{\mu}\right)$

i ↓ radian

* Long. Shift $= t\left(1-\dfrac{1}{\mu}\right)$

↳ similar to app. depth

TBS capsule (4)

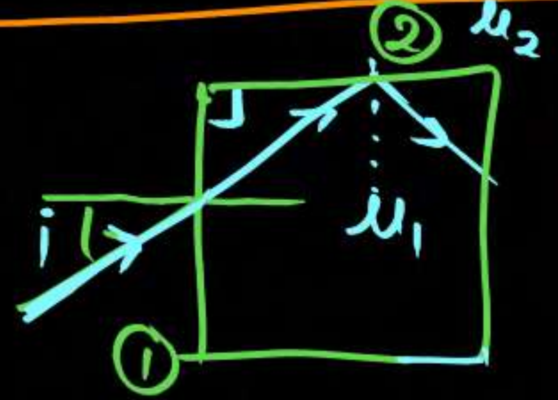
* TIR → conditions

1) Denser to rarer
2) $i > \theta_c$

* negligible energy loss

Image Bright

* $\boxed{\sin\theta_c = \frac{1}{\mu}}$ → $\mu = \frac{\mu_D}{\mu_R}$



Face ① ⊥ Face ②

Principle used in optical fibre ← $\boxed{\sin i_{max} = \sqrt{\mu_1^2 - \mu_2^2}}$

Applications

① Diamond

↓

glitter/sparkle

$\mu = 2.5$

$\theta_c \simeq 24°$

② Optical Fibre

* $\mu_1 > \mu_2$

- Telecommunication
- Decorative lamps

③ Prisms

Right Isosceles.

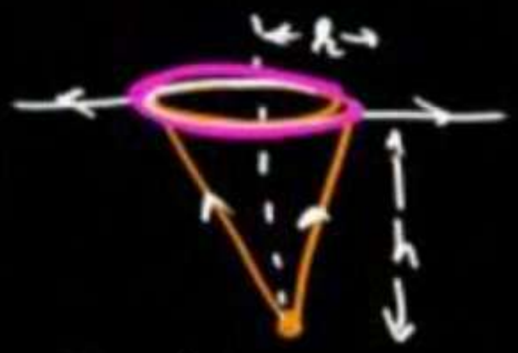
Inversion without size change or deviation.

④ Mirage

- Hot summer days
- Near earth
  ↓
  air hot (μ↓)
- Away ⇒ air cooler (μ↑)

(Circle)

- Cone of Vision



$r = \frac{h}{\sqrt{\mu^2 - 1}}$ * $A = \pi r^2$

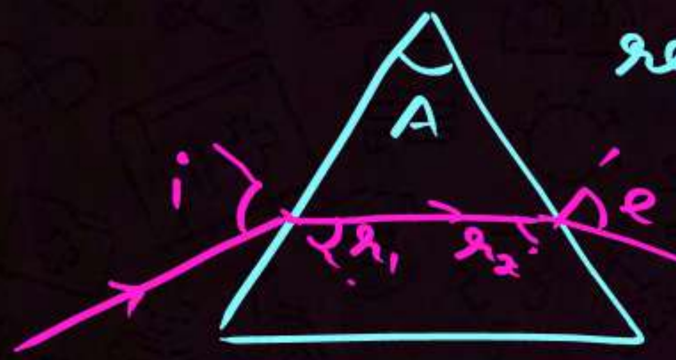
* TBS capsule ⑤

* δ in refraction

$$\delta = i - r \text{ or } r - i$$

* Prism

A = Prism angle/ refracting angle



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

$$A = r_1 + r_2$$

For δ_{min}

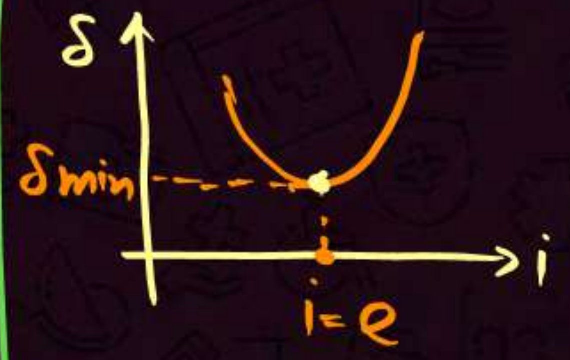
⇓

$$i = e \ \& \ r_1 = r_2$$

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

↓

Prism formula



In case of min^m deviation, refracted is ||el to base of prism for isosceles or equilareal triangle

* Thin Prisms

$$i = \mu r_1 \ \& \ e = \mu r_2$$

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

* $\lambda \Downarrow \Rightarrow \mu\uparrow \Rightarrow \delta\uparrow \Rightarrow$ violet.

$\lambda\uparrow \Rightarrow \mu\downarrow \Rightarrow \delta\uparrow \Rightarrow$ Red

* $$\theta = \delta_V - \delta_R = (\mu_V - \mu_R)A$$

* $$\omega = \frac{\theta}{\delta_{av}} = \frac{\delta_V - \delta_R}{\delta_{av}} = \frac{\mu_V - \mu_R}{\mu_{av} - 1}$$

↓ independent of A

* $\delta_{av} = \frac{\delta_V + \delta_R}{2}$ or $\frac{\delta_b + \delta_R}{2}$ or δ_Y

* $\mu_{av} = \frac{\mu_V + \mu_R}{2}$ or $\frac{\mu_b + \mu_R}{2}$ or μ_Y

Combination of prisms

1) Similar prisms (μ, A same)

even → $\delta_{net} = 0$ & $\theta_{net} = 0$

odd → δ and θ due to Last prism only

2) Dis-similar prisms

a) Deviation without Dispersion (Achromatic combination)

$\delta_{net} \neq 0$, $\theta_{net} = \theta_1 + \theta_2 = 0$

$\theta_2 = -\theta_1$

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

b) Dispersion without deviation (Average)

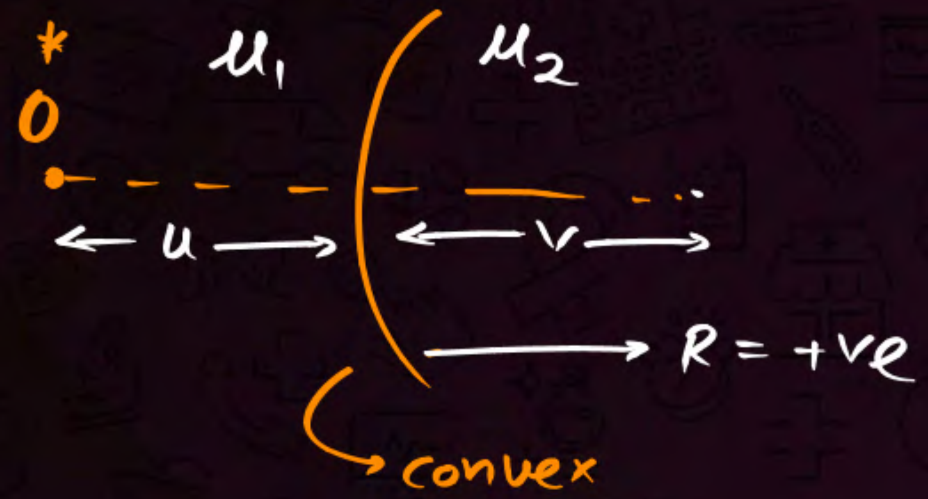
$\theta_{net} \neq 0$, $\delta_{net} = \delta_1 + \delta_2 = 0$

$\delta_2 = -\delta_1 \Rightarrow$ $\boxed{(\mu_2 - 1)A_2 = -(\mu_1 - 1)A_1}$

* Crown Glass → more clear

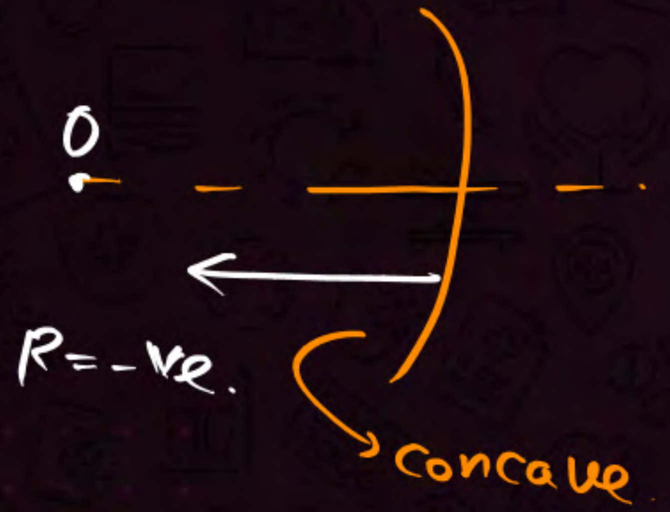
Flint Glass → more dispersive power

TBS Capsule ⑥



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

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



TBS capsule (7)

* **Convex Lens**

Bi-convex | Plano-convex | Concavo-convex

* **Concave Lens**

Bi-concave | Plano-concave | Convexo-concave

* ||el rays pass through focus.
* Through optical center, ray pass undeviated

* **Assumptions**

① Thin Lens
② Paraxial rays
③ Medium on both side of lens is same.

* Convex → converging
  in air ⇒ f = +ve
  Concave → Diverging
  in air ⇒ f = −ve

* $\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \boxed{v = \frac{uf}{u+f}}$ ↳ TBS

* $m_{lat} = m = \frac{v}{u} = \frac{f}{f+u} = \frac{f-v}{f}$

* $|m_{long}| = m^2$ (for small objects)

* **Velocity of image**

a) Along principal axis
↳ $V_I = m^2 V_0 \Rightarrow V_I = \frac{v^2}{u^2} V_0$

b) ⊥ular to principal axis
↳ $V_I = m V_0$

* **Newton's formula**

$xy = -f^2$

Convex Lens → similar to concave mirror

Object	Image	Exact/ Inverted	Real/Virtual	Size
1. ∞	F	Inverted	Real	Highly Diminished
2. Beyond 2F	B/w F and 2F	Inverted	Real	Diminished
3. 2F	2F	Inverted	Real	Same Size
4. B/w F and 2F	Beyond 2F	Inverted	Real	Enlarged
5. F	∞	Inverted	Real	Highly Enlarged
6. B/w F and O	Same side of lens	Erect	Virtual	Enlarged (Magnified)

* TBS shortcuts (convex lens)

$u = -2f \rightarrow v = +2f \rightarrow m = -1$

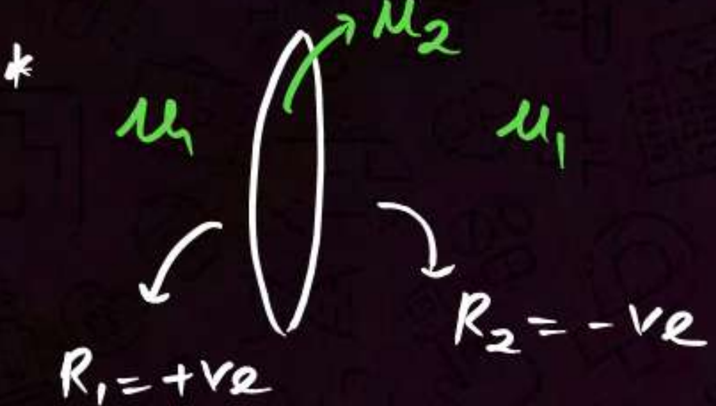
$u = -\frac{3f}{2} \rightarrow v = +3f \rightarrow m = -2$

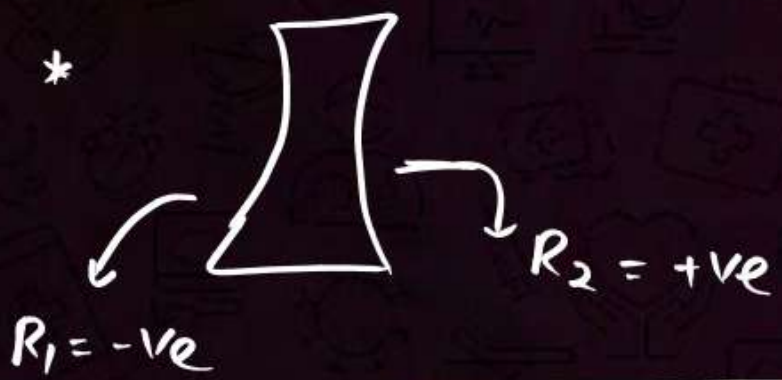
$u = -3f \rightarrow v = +\frac{3f}{2} \rightarrow m = -\frac{1}{2}$

* Concave Lens → similar to convex mirror

1) Object at ∞	Image F (same side)	Erect	Virtual	Highly Diminished
2) Object b/w ∞ & O	Image b/w F & O (same side)	Erect	Virtual	Diminished

TBS capsule (8)

* 

* 

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

* $\mu = \dfrac{\mu_2}{\mu_1}$ * $\lambda \uparrow \Rightarrow f \uparrow$

* Equi-convex / Equi-concave
⇓
R equal in value.

$f = \dfrac{R}{2(\mu-1)}$ ⇓ Equi-convex

$f = \dfrac{-R}{2(\mu-1)}$ ⇓ equi-concave

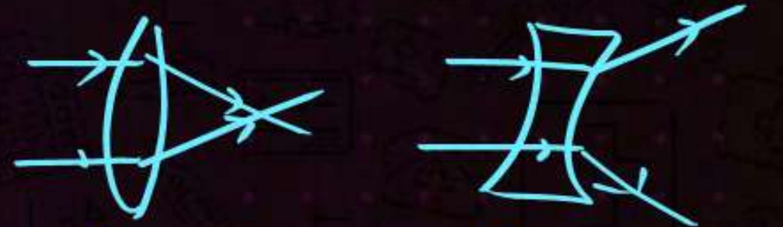
* TBS Ultra → $\mu = \dfrac{3}{2}$

$f = R$ ↓ equi-convex

$f = -R$ ↓ equi-concave

* glass Lens in air ⇒ f
glass lens in water ⇒ $f' = 4f$

• If $\mu_2 > \mu_1$



$f = +ve$ $f = -ve$

• If $\mu_2 < \mu_1$

$f = -ve$ $f = +ve$

• If $\mu_2 = \mu_1$ → $f \to \infty$

* Vertical cutting
(⊥cular to principal axis)

⇓

→ equi-convex (f)

→ plano-convex (f')

Plano-concave

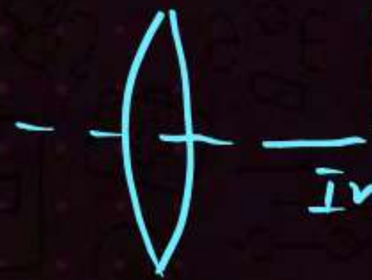
↑

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

plano-convex

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

* Horizontal cutting (||el to principal axis)



$f' = f$

Intensity, Brightness decreases.

* Power

Lens → $P = \frac{1}{f}$

dioptre (D) — metre

$P = \frac{100}{f}$ — dioptre, cm.

Mirror ⇒ $P = -\frac{1}{f}$

Plane Mirror → $f \to \infty$

$R \to \infty$

$P = 0$

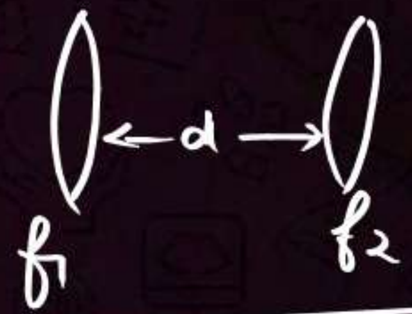
* Lens in contact

$P = P_1 + P_2 + P_3 + \ldots$

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \ldots$ [with sign]

$m = m_1 \times m_2 \times m_3 \times \ldots$

* Lens at distance



$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

* Silvering of Lens

combination behaves as mirror

$P_{comb} = 2P_L + P_m$

$-\frac{1}{f_{comb}} = \frac{2}{f_L} - \frac{1}{f_m}$

* Variable μ

3 images

1 image

TBS capsule (9)

* Optical instruments

(1) Simple microscope

$$M.P = \frac{\theta_i}{\theta_{max}} \quad \text{where } \theta_{max} = \frac{h_o}{u}$$

$$\boxed{M.P. = \frac{D}{u}}$$

Virtual, erect image

Relaxed eye

Image ∞

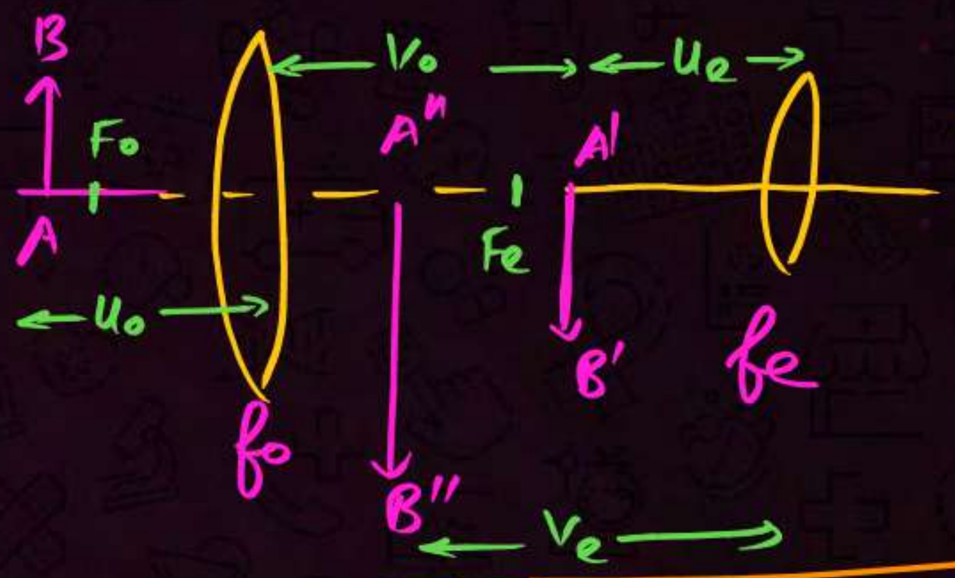
$$\boxed{M.P = \frac{D}{f}} \rightarrow \text{min}^m$$

Strained eye

Image at D → $u = \frac{Df}{D+f}$

$$\boxed{MP = 1 + \frac{D}{f}} \rightarrow \text{max}^m$$

(2) Compound Microscope



$$\boxed{MP = \frac{V_o}{u_o} \times \frac{D}{u_e}}$$

u_e → −ve

$$\boxed{L = V_o + u_e}$$

(1) Relaxed eye

Image → ∞

$u_e = f_e$

$MP = \frac{V_o}{u_o} \times \frac{D}{f_e}$ (min^m)

$L = V_o + f_e$ → max^m

(2) Strained eye

Image at D

$MP = \frac{V_o}{u_o} \times \left(1 + \frac{D}{f_e}\right)$ (max^m)

$L = V_o + \frac{Df_e}{D+f_e}$ (min^m)

(3) Normal adjustment

$V_o \simeq L_o$

$u_o \simeq f_o$

$u_e \simeq f_e$

$$\boxed{MP = \frac{L}{f_o} \times \frac{D}{f_e}}$$

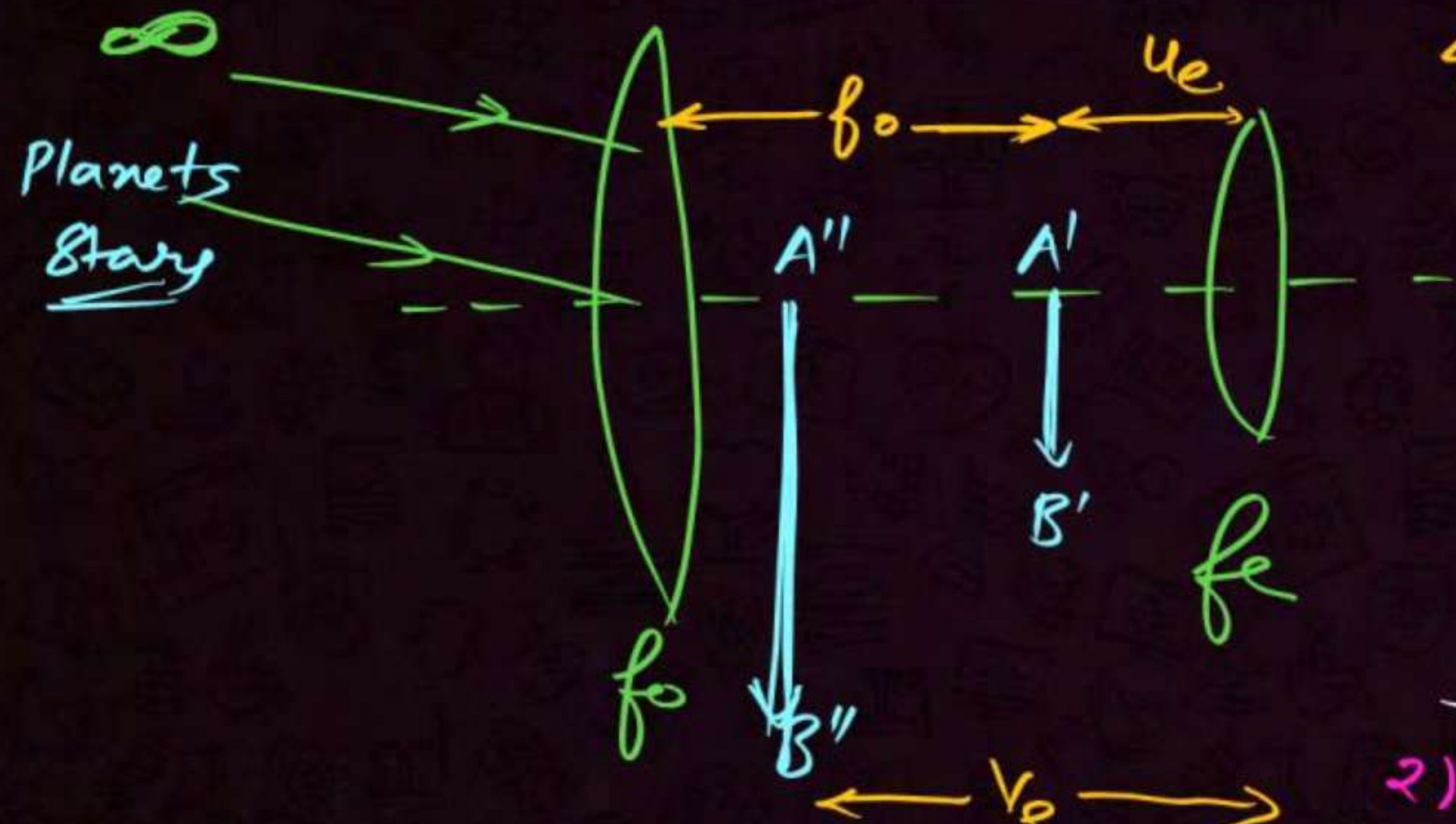
⇓

$$MP \propto \frac{1}{f_o f_e}$$

c) Astronomical Telescope

$$M.P = \frac{f_o}{u_e}$$ → (−ve)

$$L = f_o + u_e$$



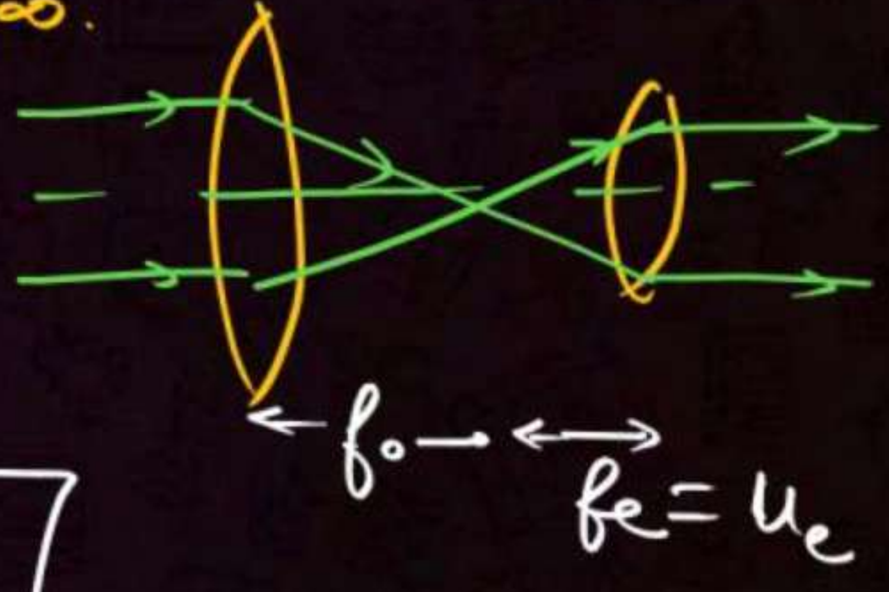
1) Relaxed eye (Normal adjustment)

Image ∞.

$u_e \simeq f_e$

$$M.P = \frac{f_o}{f_e}$$

$$L = f_o + f_e$$



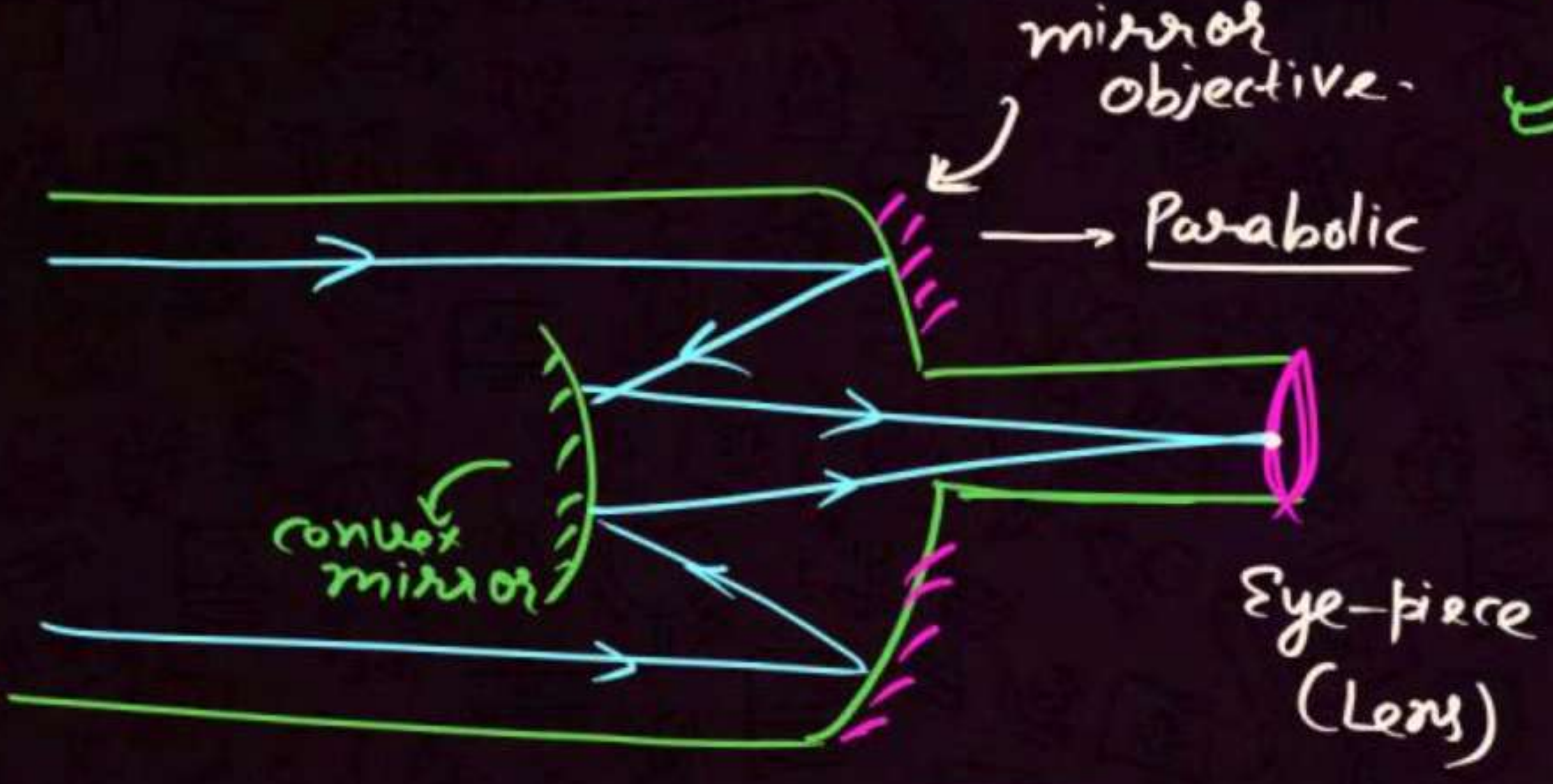
2) Strained eye → Final image → D → $u_e = \frac{Df_e}{D+f_e}$

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

$$L = f_o + \frac{Df_e}{D+f_e}$$

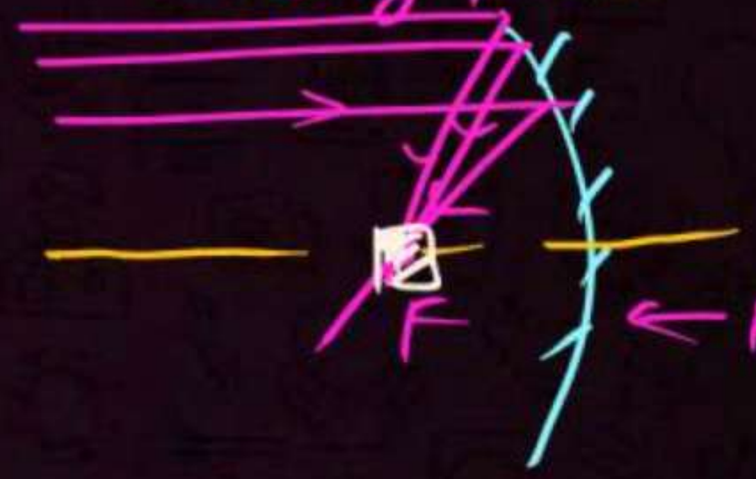
d) Reflecting Type (Cassegrain) Telescope

↳ Newtonian Type.



① Spherical abberation (defect)

↳ only paraxial rays meet at focus.



← Parabolic

↳ all parallel rays meet at focus

② mirror objective

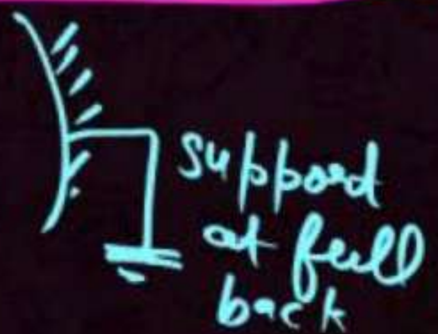
↓ Lens ✗

Chromatic abberation removed

③ Lens → heavy

Mirror → Light

④



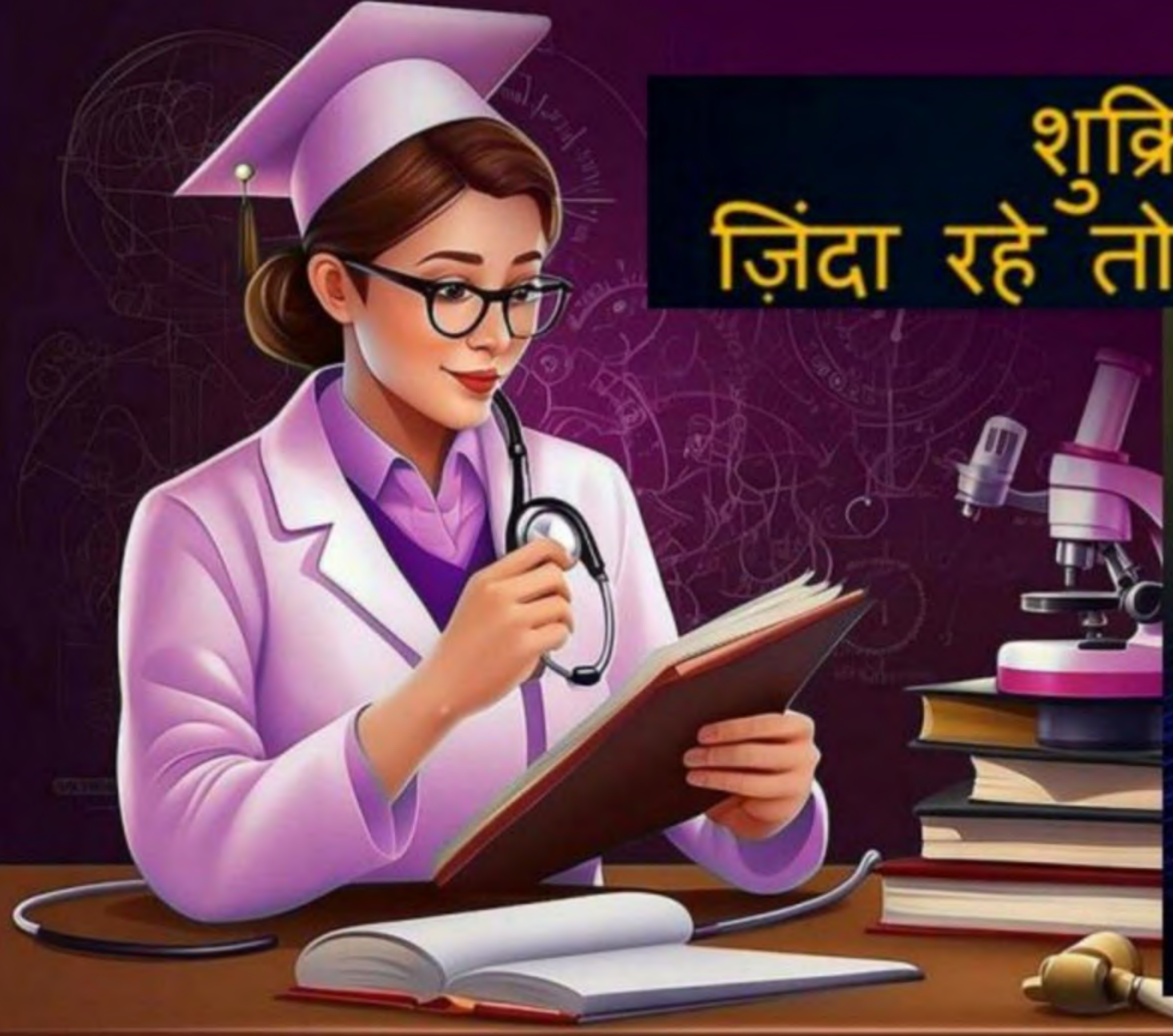
Lens → support at edge.

Homework

Kal Subah DPP Battle – Ground

Slide No.	Option
33	3
65	2
66	4
85	1
89	3
105	3
114	1
129	2
130	2
137	3
141	2
147	3
153	1
154	2
160	3
175	1
195	1

FOR NOTES & DPP CHECK DESCRIPTION



शुक्रिया !
ज़िंदा रहे तो फिर मिलेंगे

@PHYSICSBY_TANUJSIR