PARISHRAM

2026

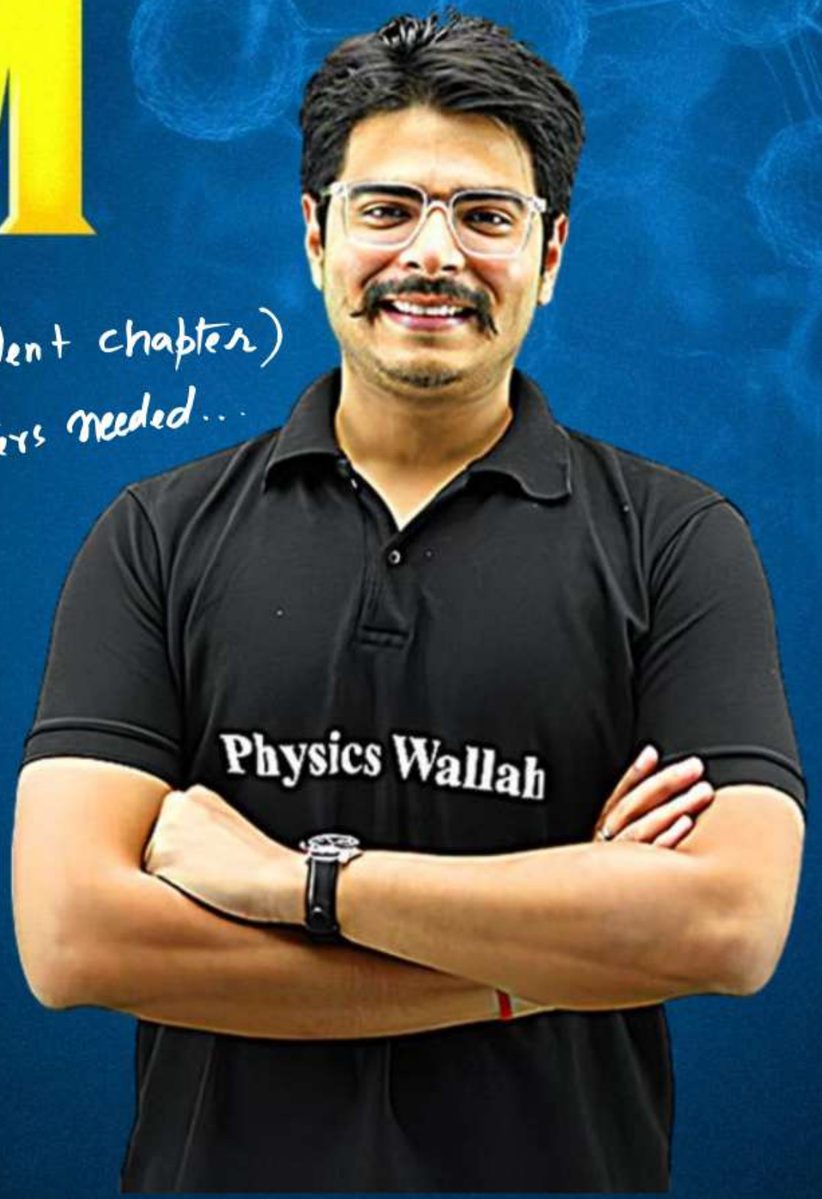
Lecture - 01

Ray Optics and Optical Instruments

(Independent chapter)
No chapters needed...

PHYSICS | **Lecture - 1**

BY - RAKSHAK SIR



Topics *to be covered*

1 Plane Mirror

Laws of Reflection

a) No Backlogs (All up-to-date) — 48%

b) Lectures ka Backlog — 20%

c) Chapters ka Backlog — 25%

d) Book-I Backlog

B.K.S.

→ Lecture Notes

→ recorded Lectures

↳ 1.25x or 1.5x

Min 3 lectures / day

Chutti – 5 lec / day

Unit–V	**Electromagnetic Waves**	18
	Chapter–8: Electromagnetic Waves — 3 Marks	
Unit–VI	**Optics**	
	Chapter–9: Ray Optics and Optical Instruments — 9 Marks	
	Chapter–10: Wave Optics — 5-6 Mark	

Unit VI: **Optics**

Chapter–9: Ray Optics and Optical Instruments

Ray Optics: Reflection of light, spherical mirrors, mirror formula, refraction of light, total internal reflection and optical fibers, refraction at spherical surfaces, lenses, thin lens formula, lens maker's formula, magnification, power of a lens, combination of thin lenses in contact, refraction of light through a prism.

* Optical instruments: Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.

OPTICS

Reflection, Refraction, Dispersion

It is the study of Light

"particle" Nature → Ray optics / Geometrical optics

"Wave" Nature → Wave optics

Interference, Diffraction, Polarisation ✗

→ Ray

} Bunch of Rays = Beam

→ Rectilinear motion

* **Ray of Light :-**

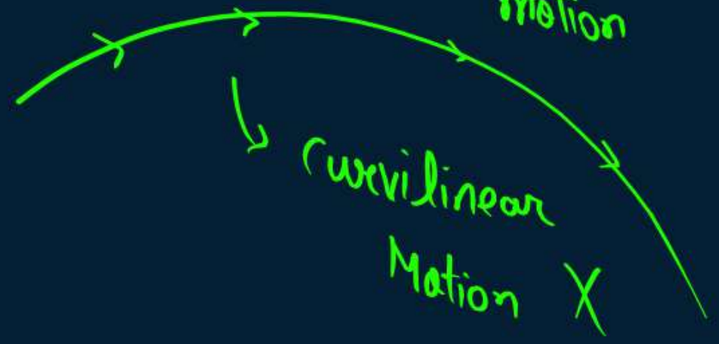
It gives the direction of propagation of Light.

→ Arrow

- **Rectilinear Propagation** :-

↓ straight forward

↓ travel karna



↳ curvilinear Motion ✗

OBJECT

It is the thing out of where Incident Light emerges → emit-out

Luminous

The object through which internal energy changes into light energy and this light is emitted out.

(Bulb, Sun, stars, Candle wick)

Non-Luminous

Those objects which reflects light from other sources (Luminous)

(Book, Table, chair etc.)

IMAGE

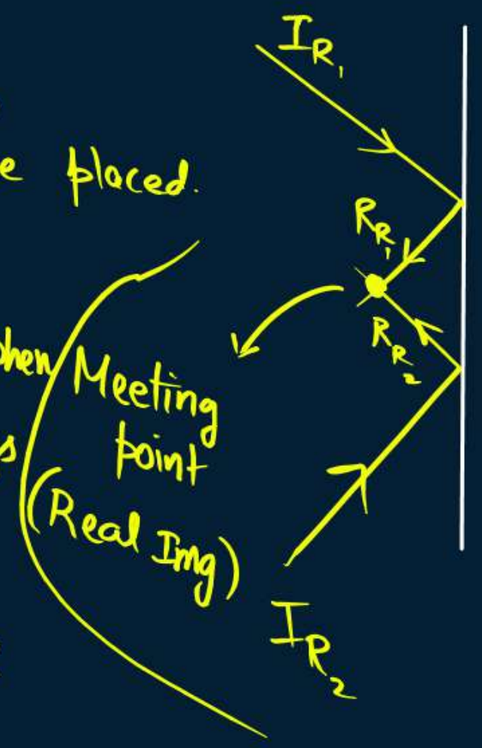
Milna

Esa lage ki Mili

It is the thing where Reflected Light rays meet or Appear to meet

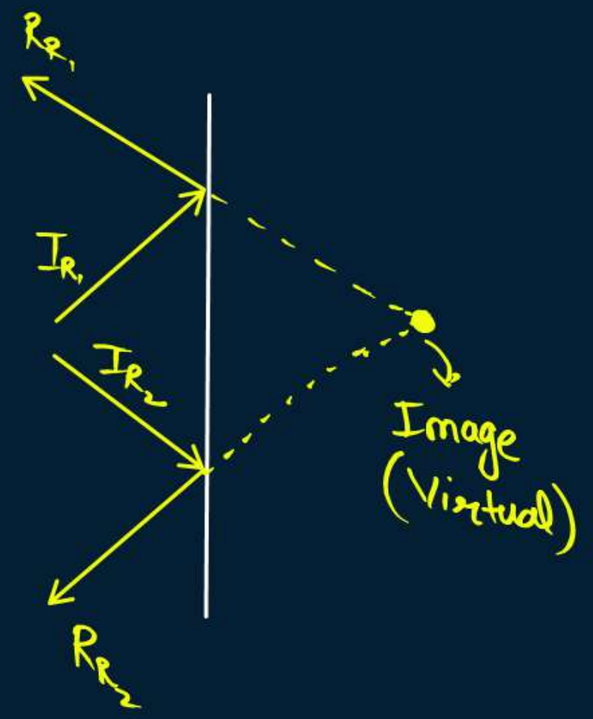
Real

1. To see real image, screen should be placed.
2. It forms only when real reflected rays actually meet.
3. Inverted Image



Virtual

1. To see Virtual image, no screen is required.
2. It forms when Reflected Rays are extended backwards and meet.
3. Erect



Laws of Reflection

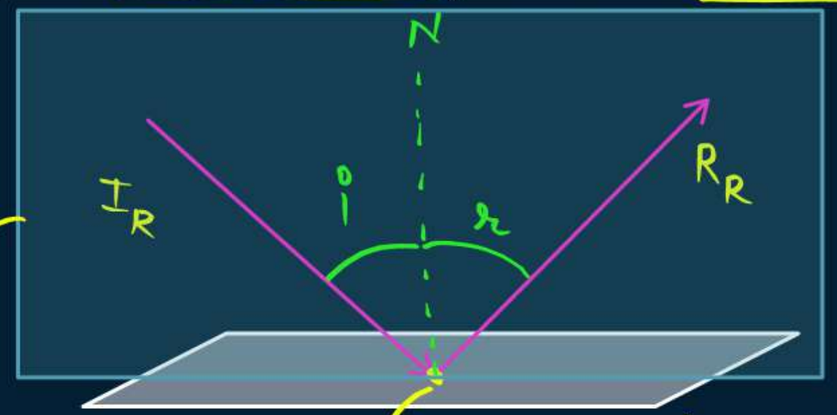
θ_i θ_r

1. The angle of incidence is always equal to the angle of reflection. $(\theta_i = \theta_r)$

I_R R_R N

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

imaginary (khada Plane)

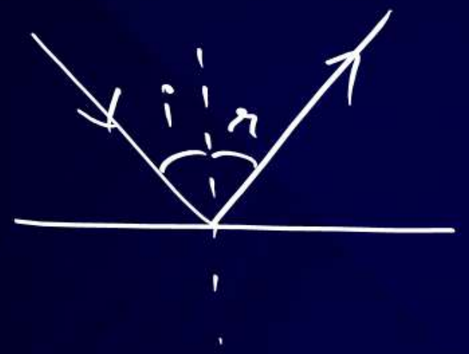


Imaginary plane

Point of Incidence

Mirror or Surface

Valid for All Mirrors and Surfaces (Specular or Diffused)



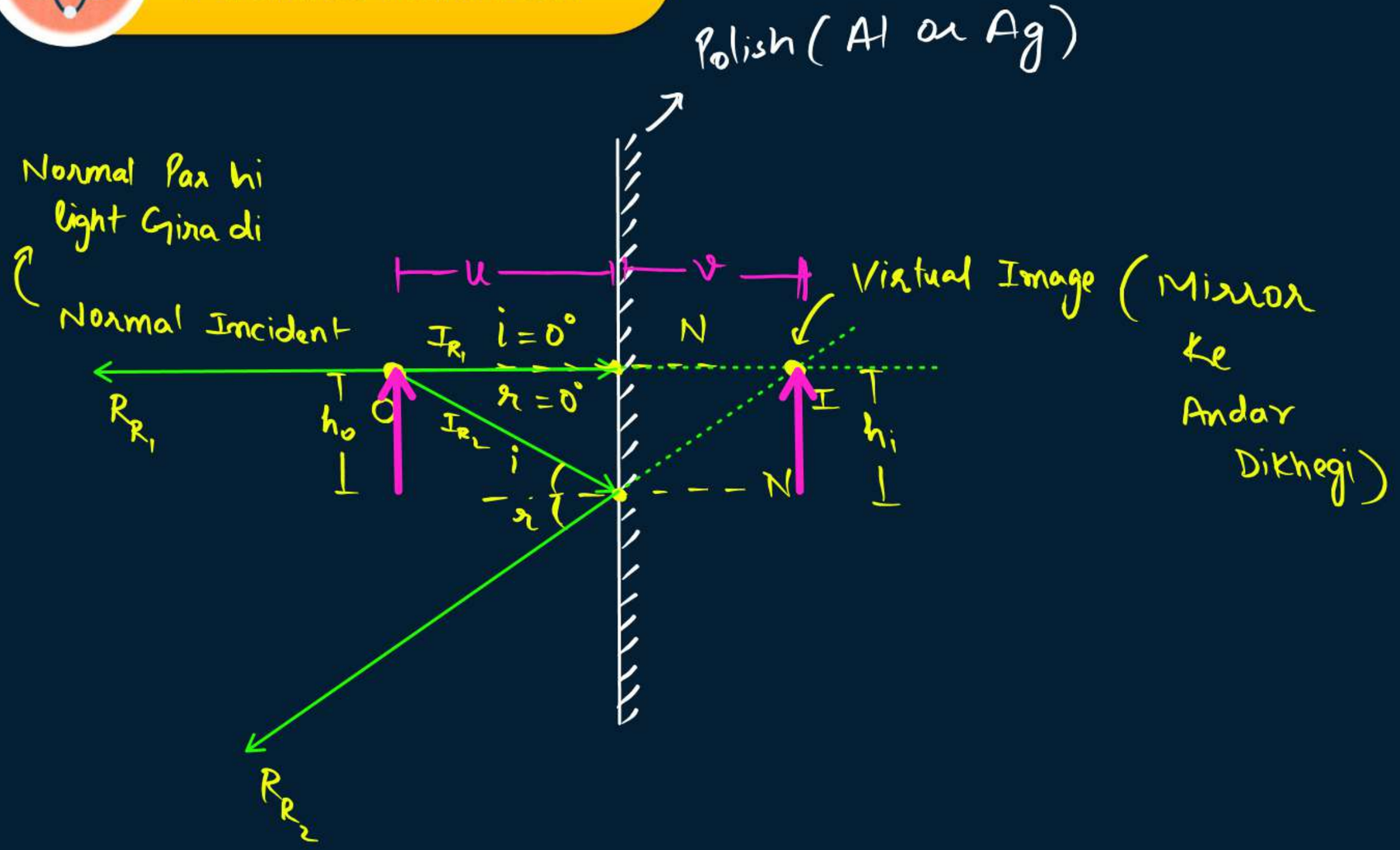
Smooth

Specular reflection

Rough

Diffused reflection

Plane Mirror



Properties of image formed from Plane Mirror

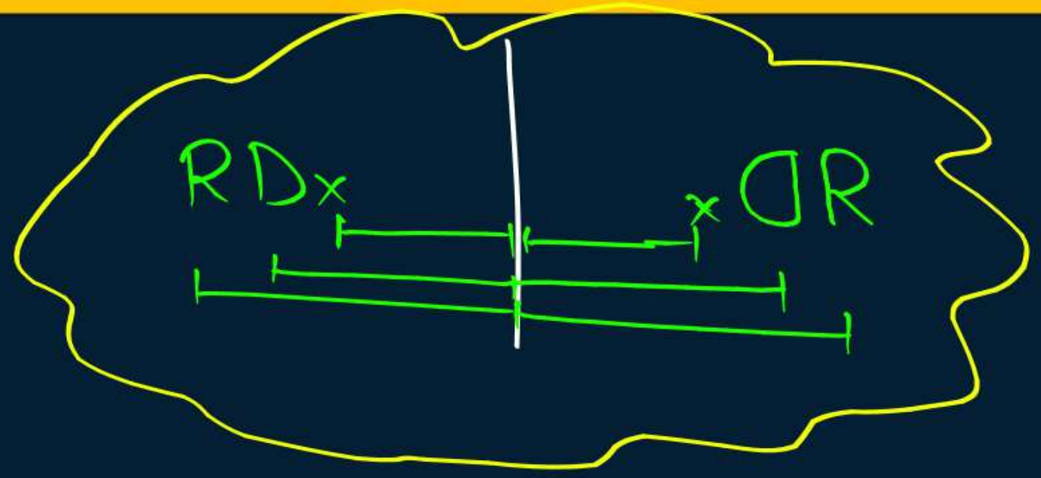
Same Size $(h_o = h_i)$

Same Distance $(u = v)$

Virtual ✓

Erect ✓

Laterally Inverted



A

Inverted ✓

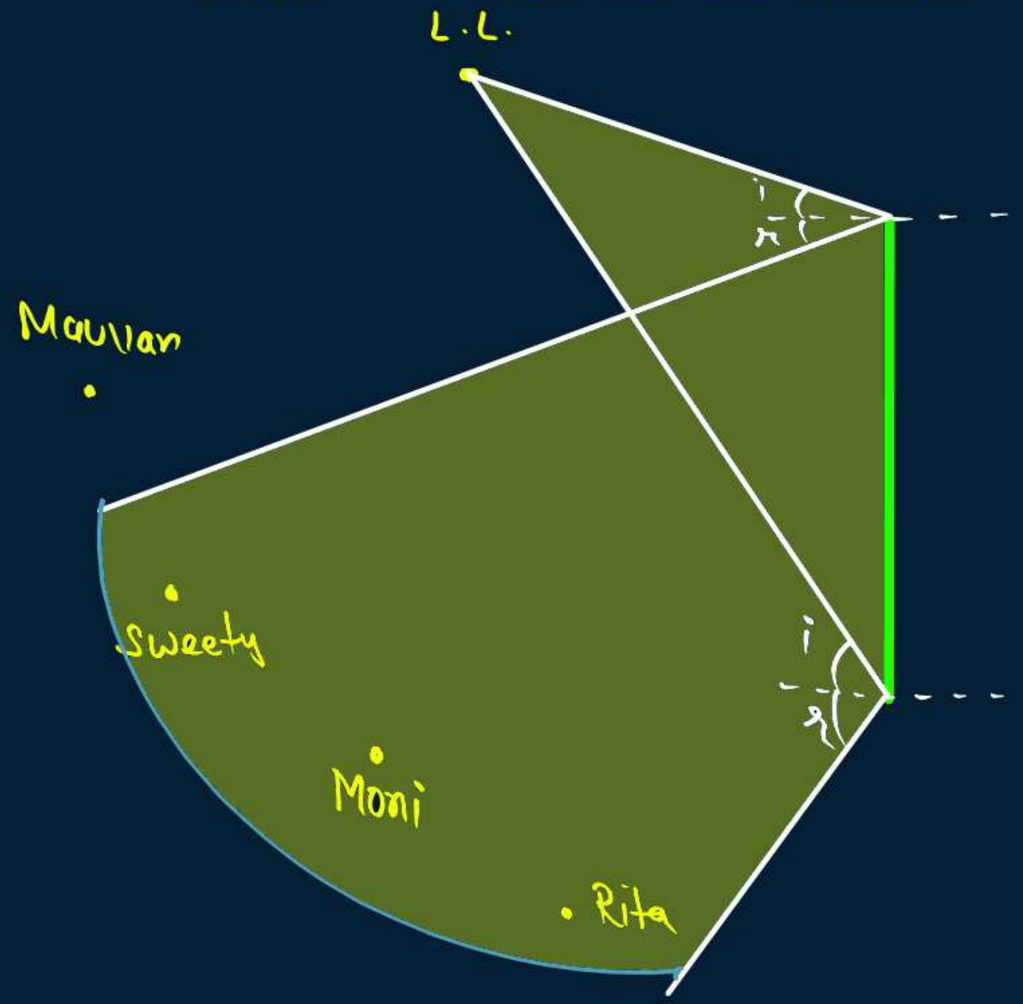
B

Laterally invert (LHS = RHS)

Field of View

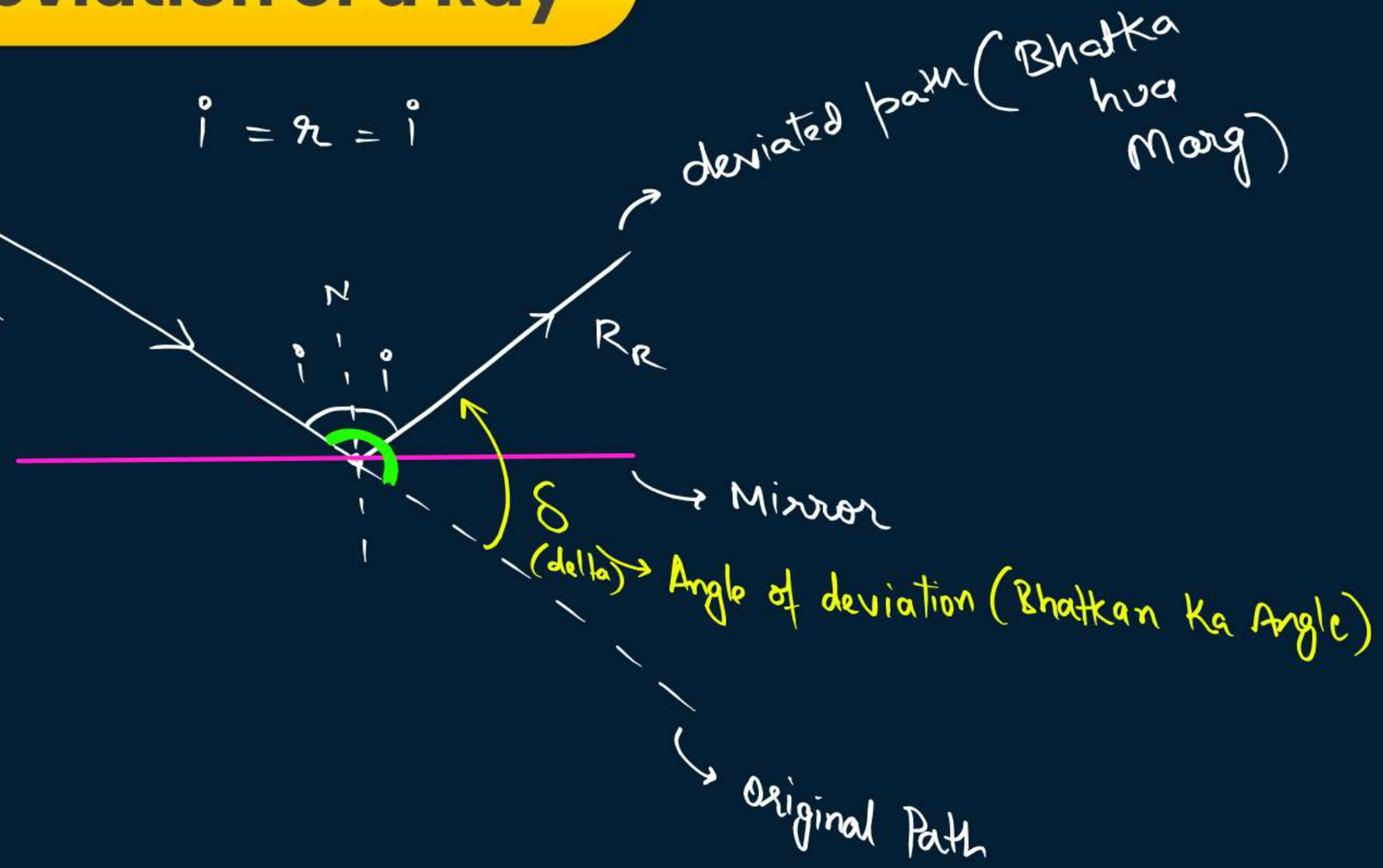
हद

The extent of an observable space that is seen at any given moment



Angle of Deviation of a Ray

$i = r = i$



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

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

QUESTION

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

(A) 30°

(B) 60°

(C) 90°

(D) 120°

$i = 30°$

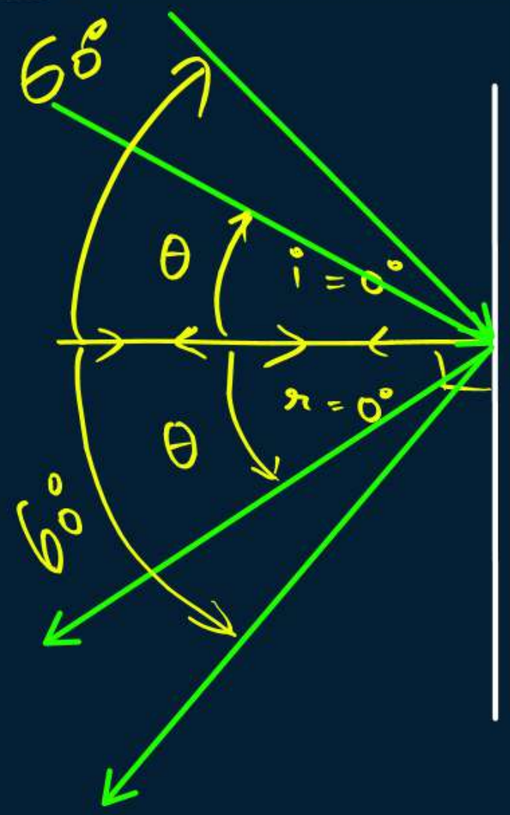
$\delta = ?$

$\delta = 180 - 2i$

$= 180 - 2(30)$

$= 180 - 60 = 120°$

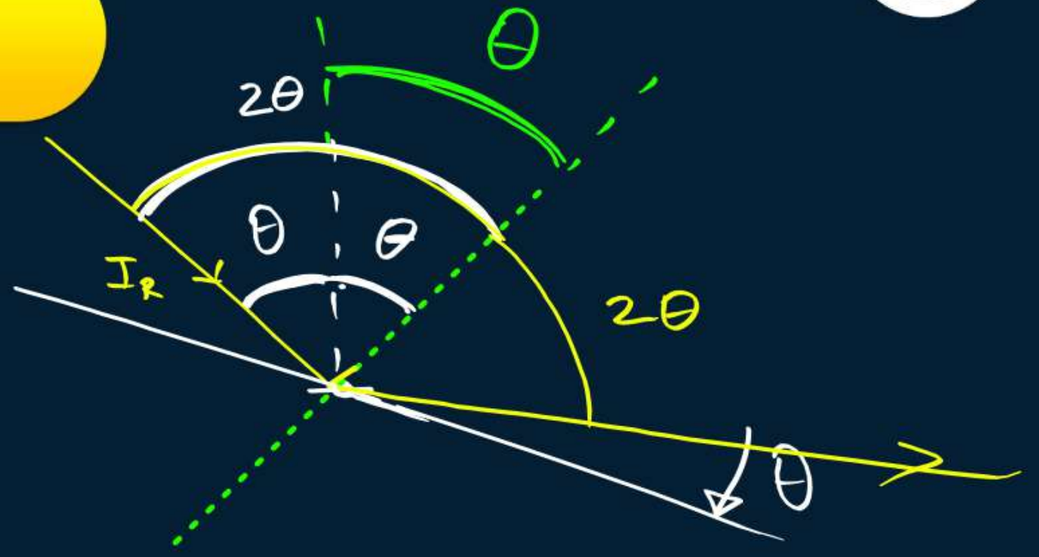
Rotation of rays and mirror



RDx :-

if I_R is rotated by θ
R_R is also rotated by θ

if Mirror is rotated by θ
R_R is rotated by 2θ



$i = 2\theta$

$r = 2\theta$

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.

(A) 30° cw

(B) 60° cw

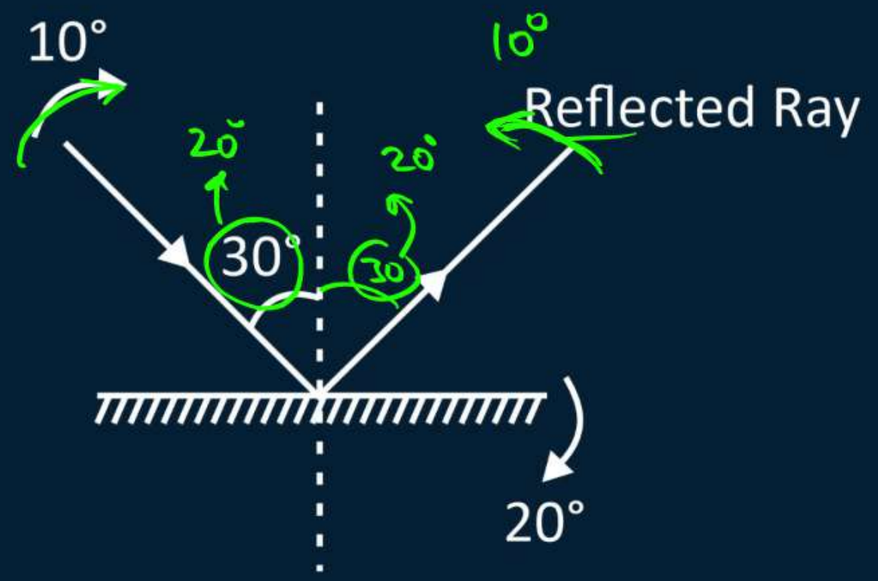
(C) 90° cw

(D) 120° cw

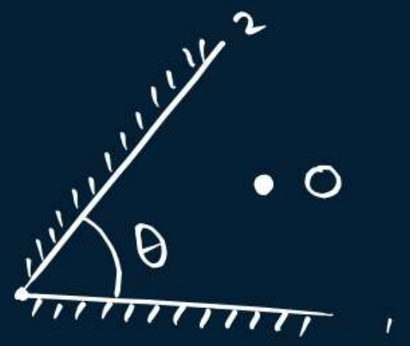
$40^\circ - 10^\circ = 30^\circ$

increase by Mirror

decrease by I_R



Reflection with 2 Mirrors

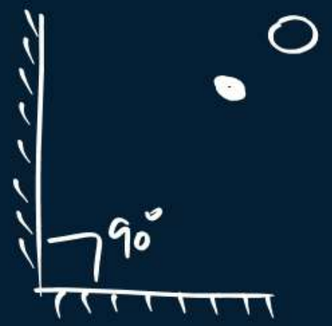


No. of Images Nikalna

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

even − 1 = ☐ Ans

Odd = ☐ Ans



$\frac{\cancel{360}^{4}}{\cancel{90}} = 4 - 1 = 3$

Ans

QUESTION

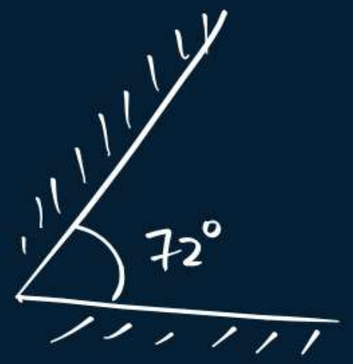
Two plane mirrors inclined to each other at an angle 72°. What is the number of images formed?

(A) 3

(B) 5

(C) 9

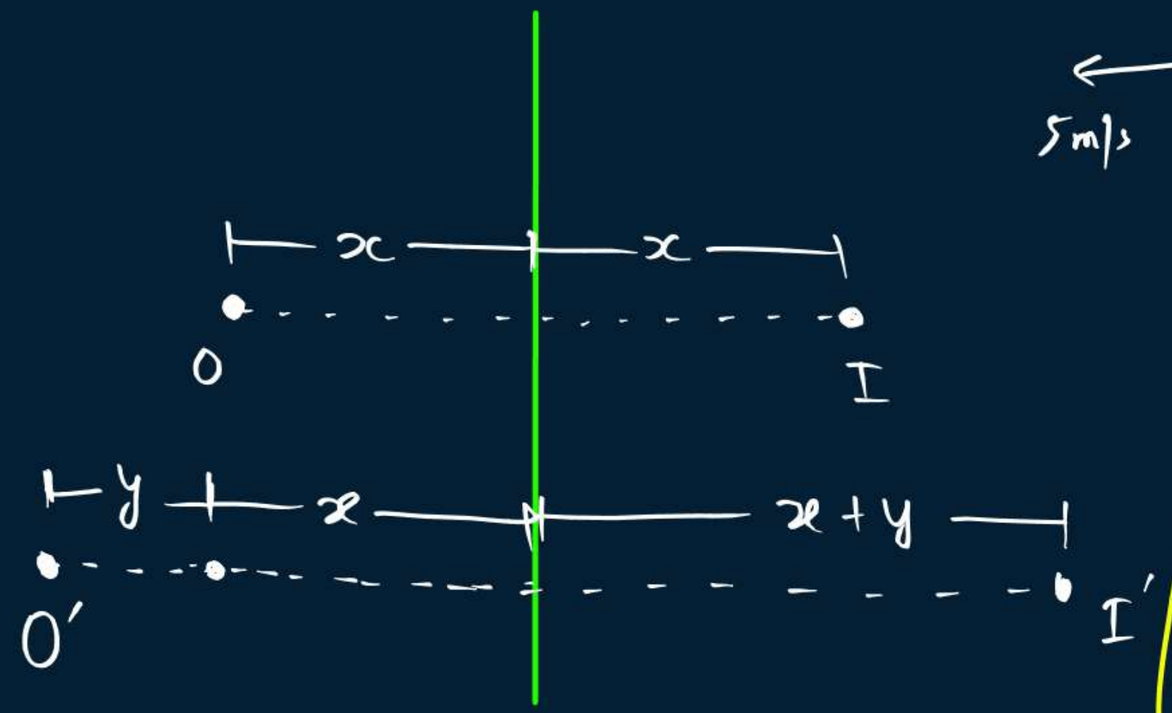
(D) 7

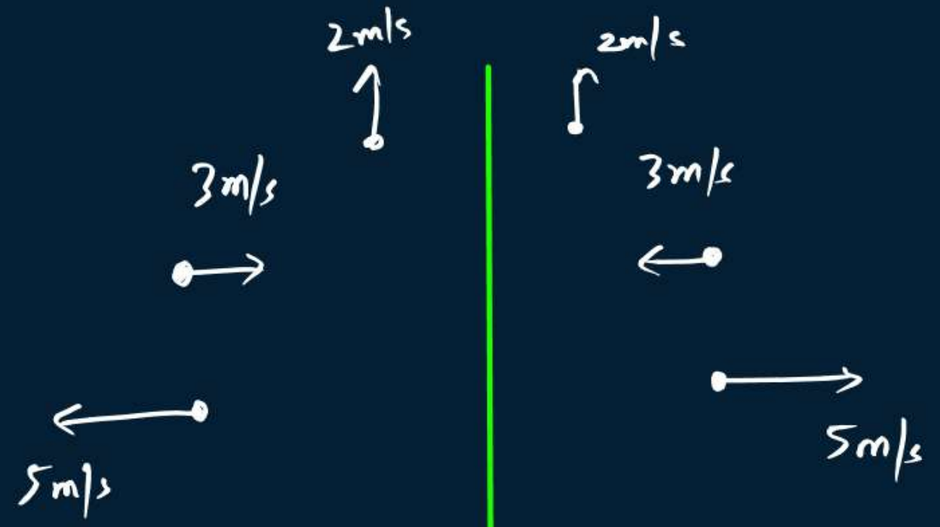


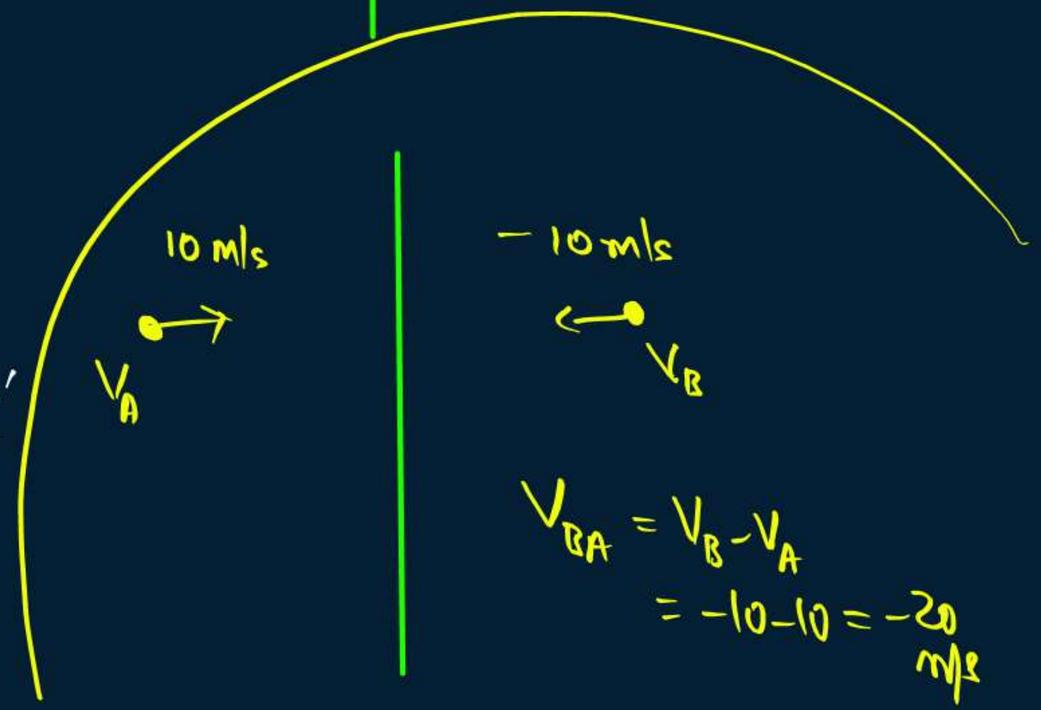
$\frac{360}{72} = 5$ → odd ✓

Ans = 5

Velocity of Image







$$V_{BA} = V_B - V_A$$
$$= -10 - 10 = -20 \text{ m/s}$$

Homework

Notes ✓

Revision ✓

AAKHRI SAAL HAI JAAN LAGA DE

PARISHRAM

2026

Lecture - 02

Ray Optics and Optical Instruments

PHYSICS | **Lecture - 2**

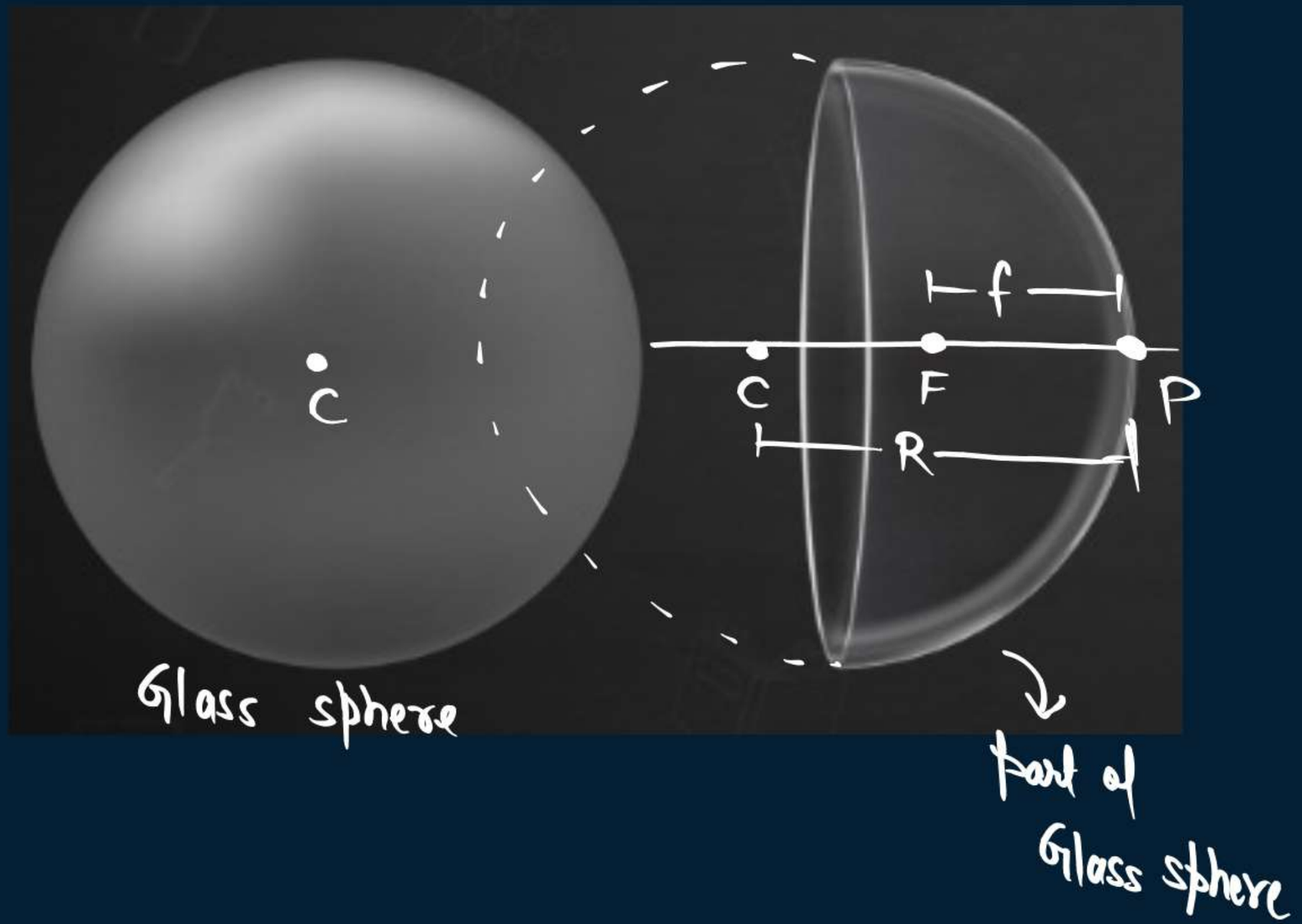
BY - RAKSHAK SIR

Topics *to be covered*

1 Spherical Mirrors → Concave
→ Convex

Concave Mirror

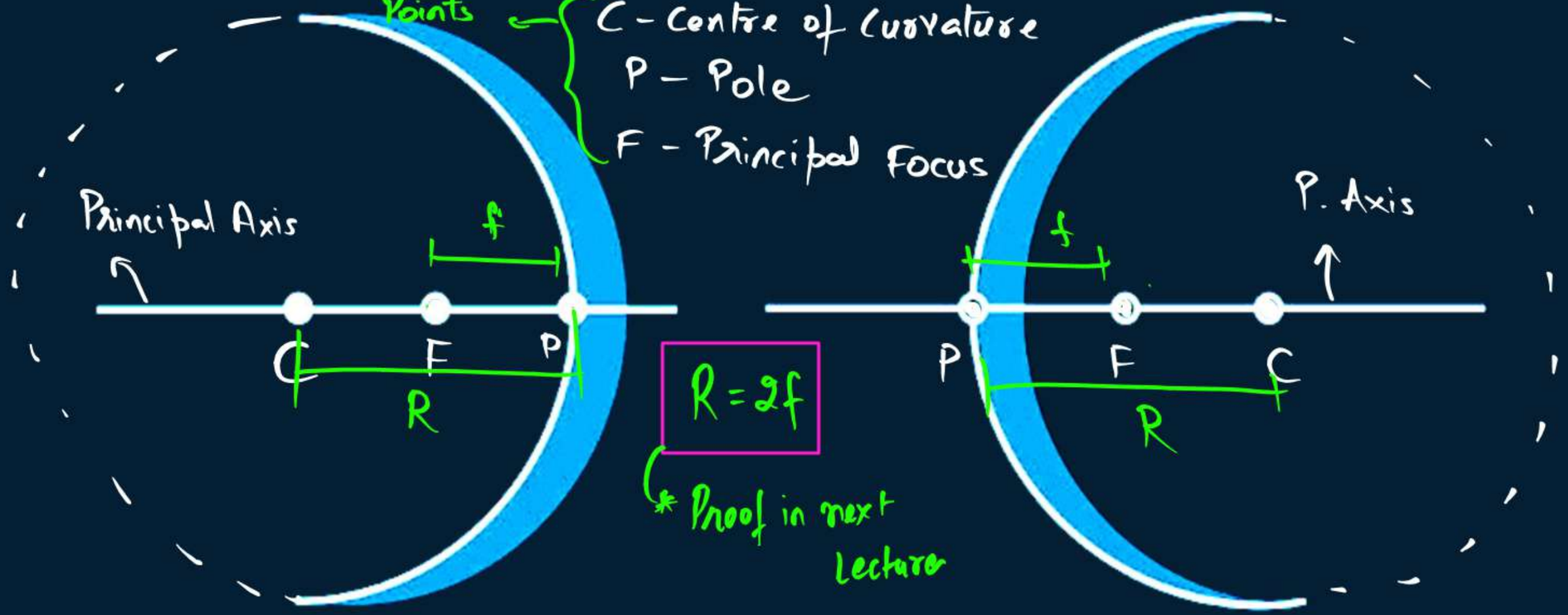
Convex Mirror


C
Glass sphere
f
C
F
P
R
Part of
Glass sphere

Curved Spherical Mirrors ki Geometry

lengths ← { f → focal length (cm)
R → Radius of curvature (cm) }

Points ← { C - Centre of curvature
P - Pole
F - Principal Focus }

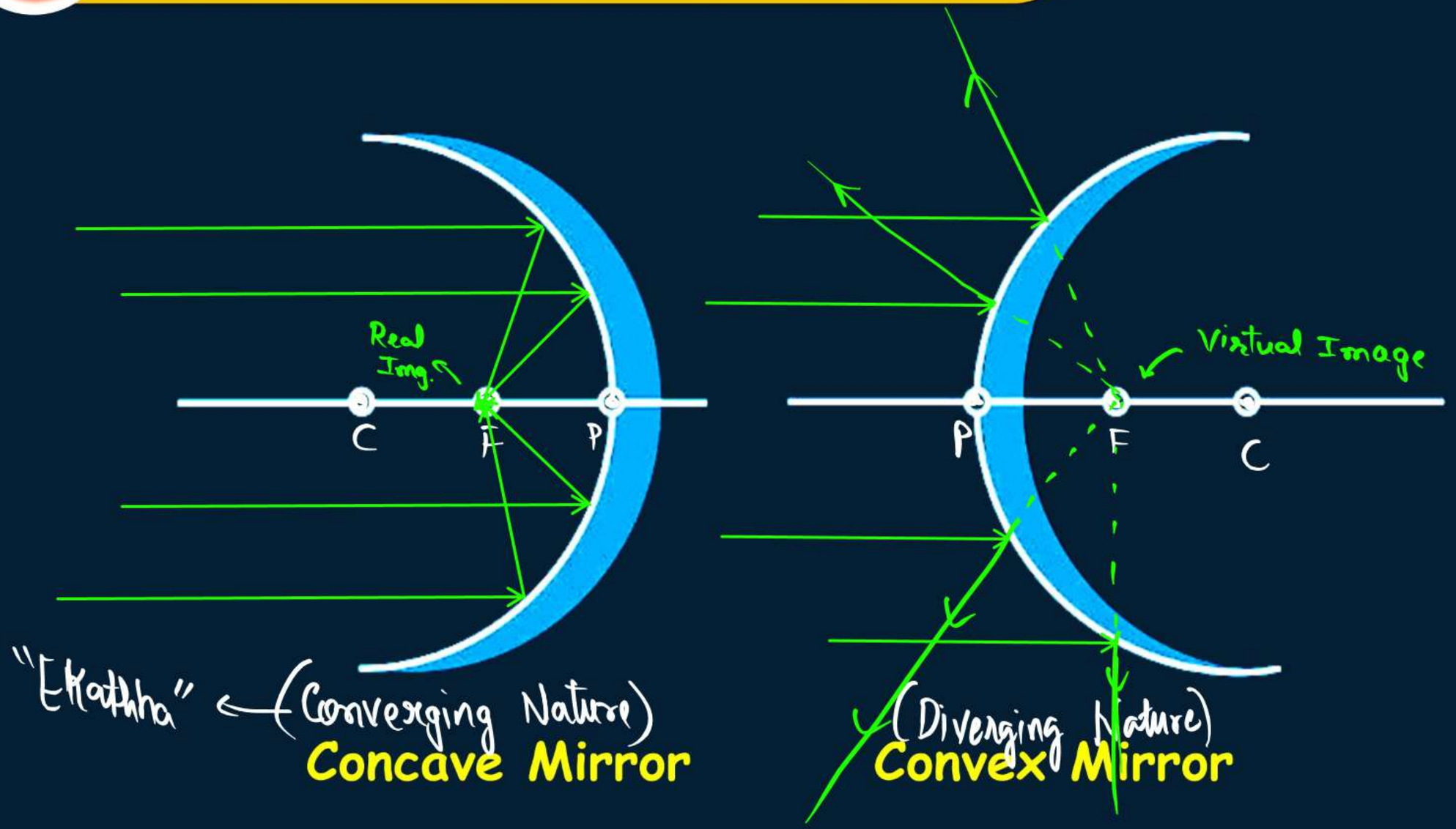


$R = 2f$

* Proof in next Lecture

Concave Mirror **Convex Mirror**

Spherical Mirrors ka Nature

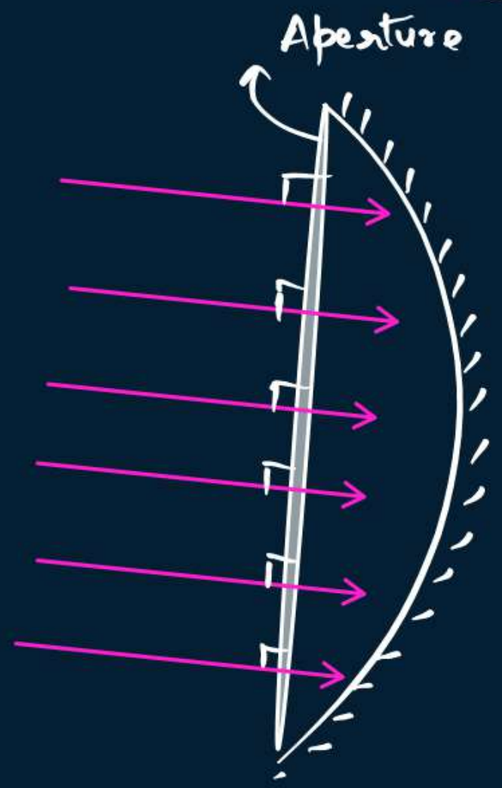


Aperture of mirror

Size of the Mirror ↑
(Area)

Brightness ↑ Rays Adhik Capture ↑

Area perpendicular to rays where light can enter.



Terminology

1. **Centre of curvature** the centre of a hollow sphere of which the spherical mirror forms a part is called centre of curvature it is denoted by c.
2. **Radius of curvature** the radius of a hollow sphere of which the spherical mirror forms a part is called radius of curvature it is denoted by R.
3. **Pole** the midpoint of a spherical mirror is called pole it is denoted by P.
4. **Aperture** the part of a spherical mirror exposed to the incident light is called the aperture of the mirror.

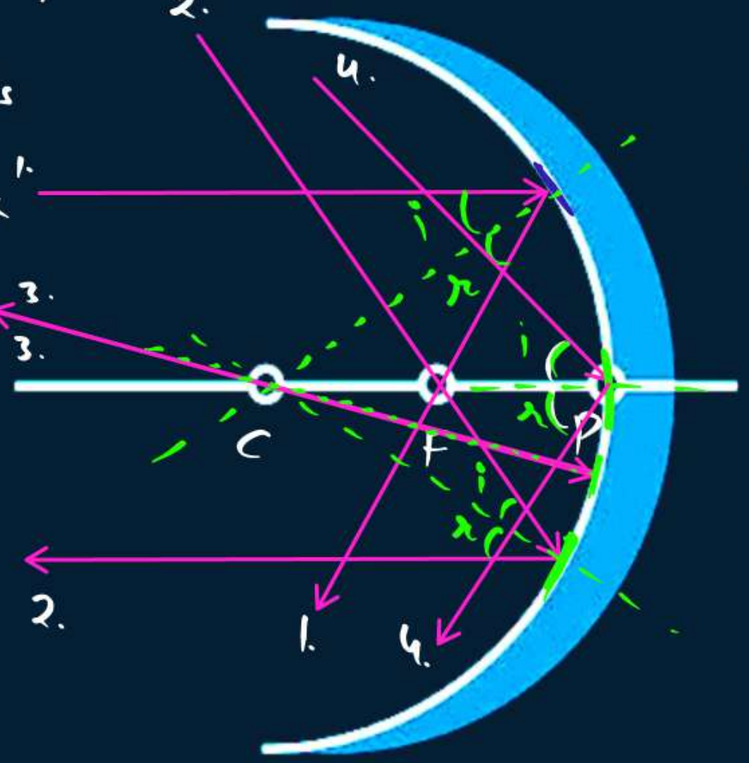
Terminology

5. **Principal axis** a line joining the centre of curvature and pole is called principal axis.
6. **Principal focus** a point on the principal axis of a spherical mirror where the rays of light parallel to the principal axis meet or appear to meet after reflection is called principal focus it is denoted by F.
7. **Focal length** the distance between the pole and principal focus of a spherical mirror is called focal length.
8. **Optical centre** it is a point on the principal axis of the lens such that a ray passing through goes undeviated.

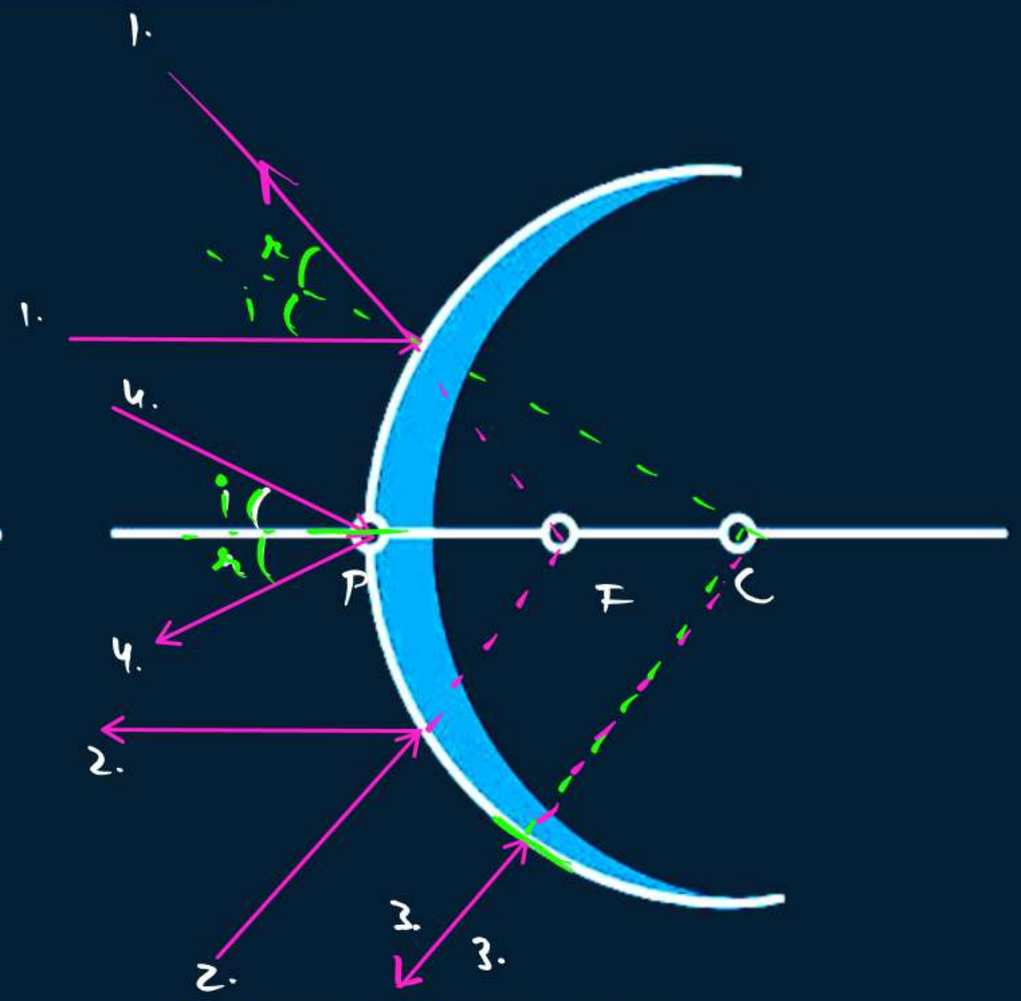
Lens

Rules for Image Formation

1) ∥ to P.Axis → F
2) F → ∥ to P.Axis
3) C → Backtrack
4) P → $\angle i = \angle r$



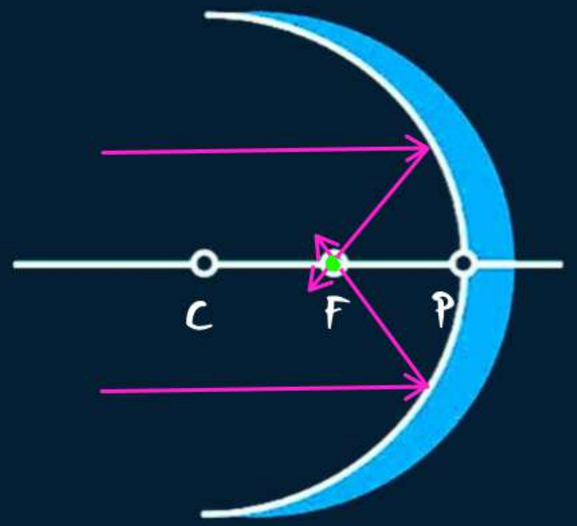
Concave Mirror



Convex Mirror

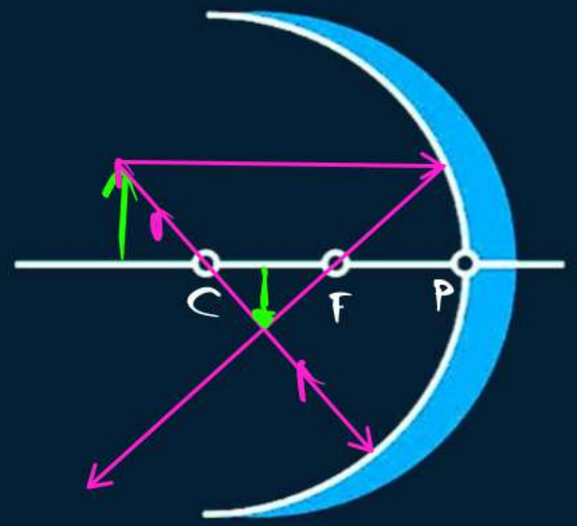
Ray Diagrams – Concave Mirror

Object at Infinity



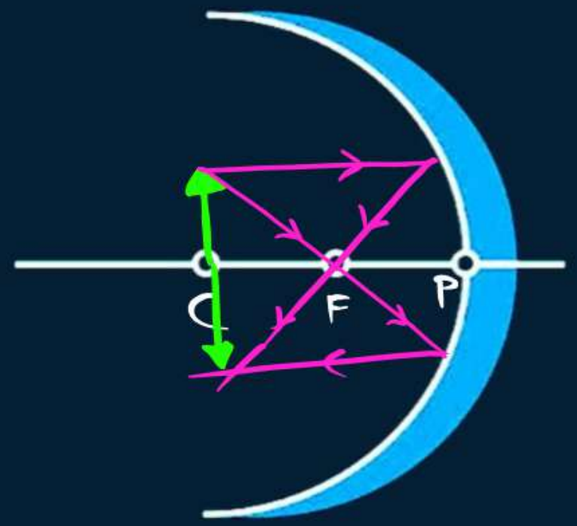
1) At F
2) Highly diminished
3) Real
4) Inverted

Object beyond C



1) B/w C & F
2) Diminished
3) Real
4) Inverted

Object at C

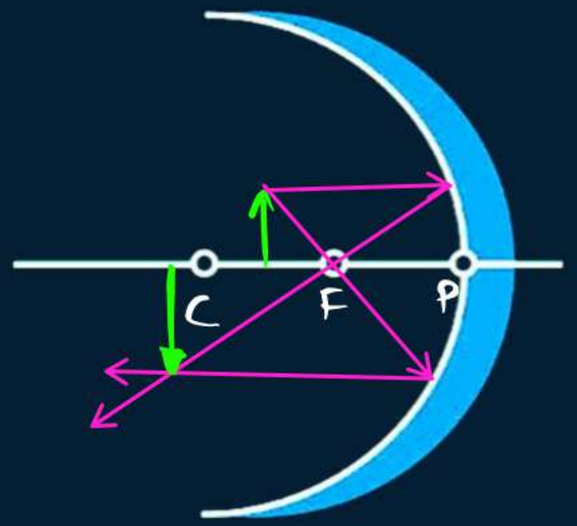


1) At C
2) Same Size
3) Real
4) Inverted

Ray Diagrams – Concave Mirror

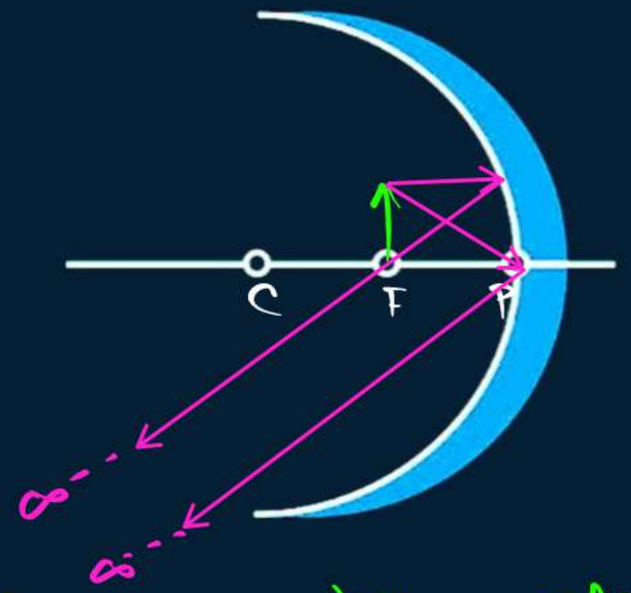
V.V.I.P.

Object b/w C & F



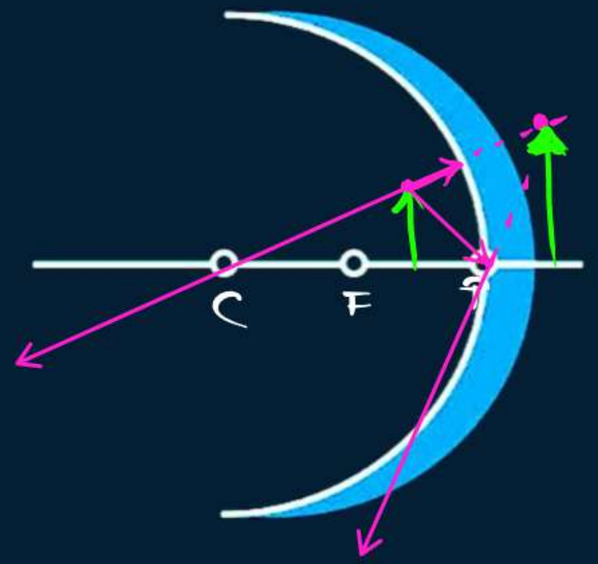
1) Beyond C
2) Enlarged (magnified)
3) Real
4) Inverted

Object at F



1) At ∞
2) Highly Enlarged
3) Real
4) Inverted

Object b/w F & P

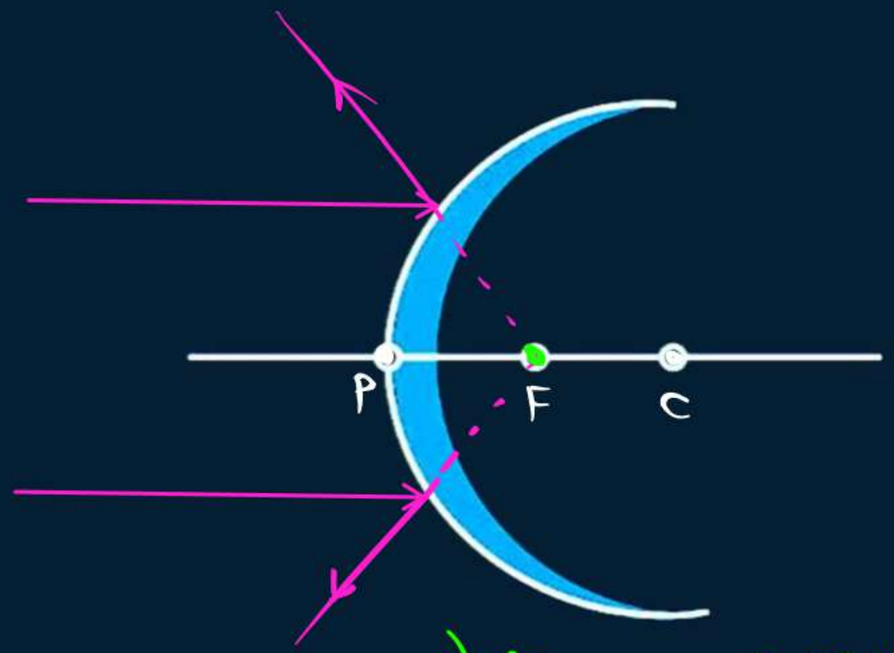


1) Behind the Mirror
2) Magnified
3) Virtual
4) Erect

Ray Diagrams – Convex Mirror

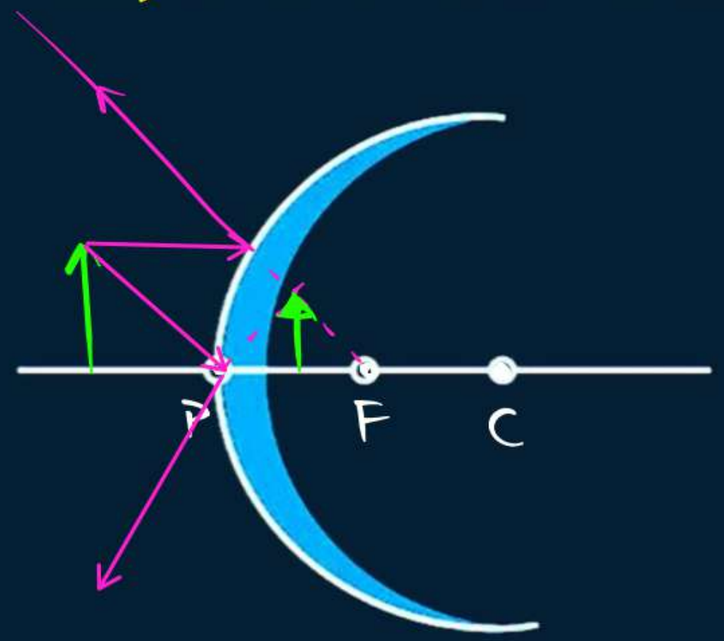
RDx → V.E.D.

Object at Infinity



1) At F 2) Highly diminished
3) Virtual 4) Erect

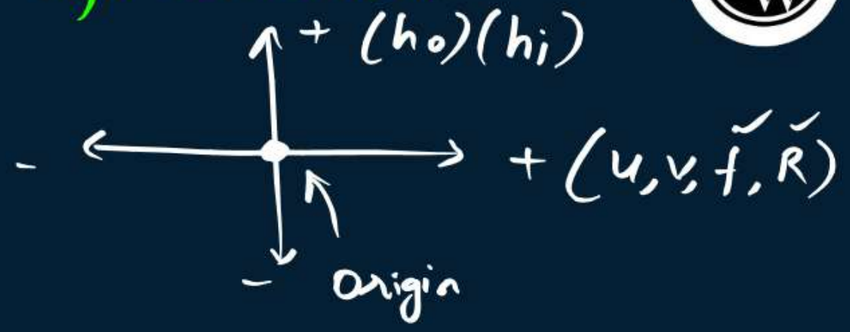
Object at Finite Distance



1) B/w P & F 2) Diminished
3) Virtual 4) Erect

Sign Conventions

New Cartesian Sign convention

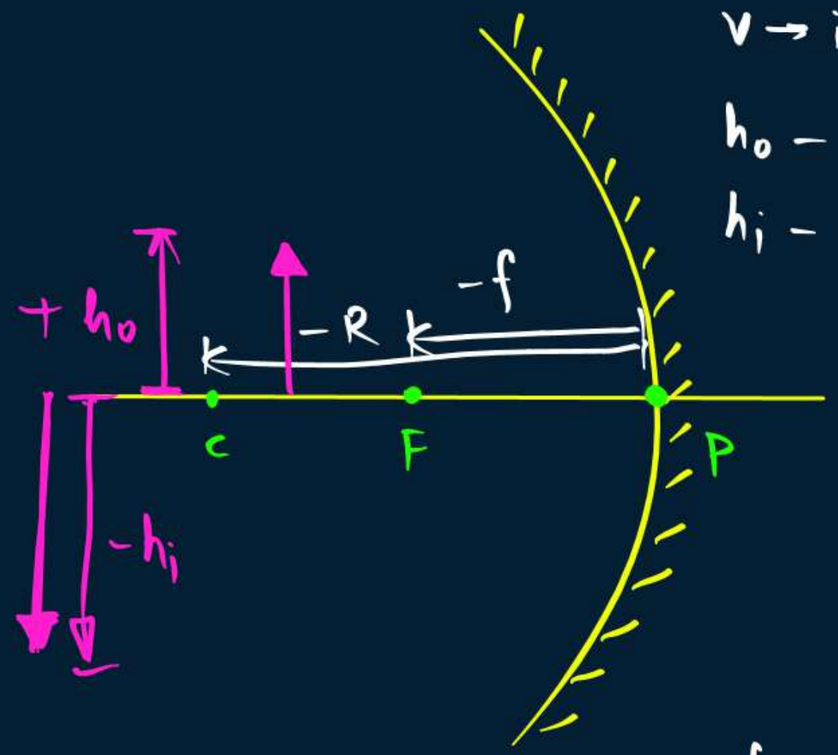


u → obj dist (−ve Always)

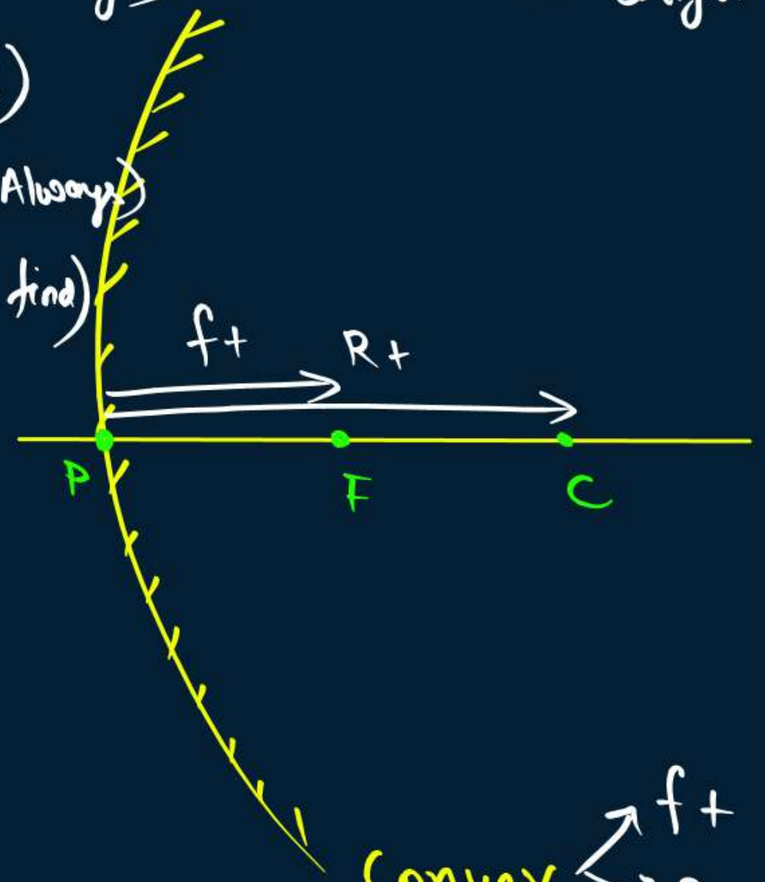
v → img dist. (To find)

h_o – height of obj (+ve Always)

h_i – height of Img (To find)



Concave → f− , R−



Convex → f+ , R+

Formulae

① Mirror formula :-

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

Derivation in next lec.

② Magnification (m) → unitless, Dimensionless

By definition

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

$h_i \rightarrow cm$, $h_o \rightarrow cm$

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

(m) → magnification is a ratio of height of image to height of object.

$m = -0.4$

$m = -3$

→ Case Pta karna !!!!

'm' ki mahima ka Gungaon RDx

$0 < m < 1$: Diminished

$m = 1$: Same size

$m > 1$: Enlarged

m → + Virtual Erect

m → − Real Inverted

QUESTION

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.

$u = -15\,cm$

$f = -10\,cm$

$v = ?$

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

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

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

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

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

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

Nature ??

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

$m = -\frac{(-30)}{(-15)}$ 2

$\boxed{m = -2}$

Real

Inv

Enlarged

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]**

(A) $-3f$

(B) $1.5f$

(C) $-15f$

(D) $3f$

$u = -1.5f$

$f = -f$

$v = ?$

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

$$\frac{1}{-f} = \frac{1}{v} + \frac{1}{-1.5f}$$

$$\frac{1}{v} = \frac{1}{1.5f} - \frac{1}{f}$$

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

$$= \frac{1}{f}\left(\frac{1-1.5}{1.5}\right) = \frac{1}{f}\left(\frac{-0.5}{1.5}\right)$$

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

$$v = -3f$$

QUESTION

A concave mirror for face viewing has focal length of 40 cm. The distance at which you hold the mirror from your face in order to see your image upright with a magnification of 5 is

→ Erect

(A) 0.16 m

(B) 1.6 m

(C) 0.32 m

(D) 0.24 m

$f = -40\,cm = -\frac{40}{100} = -0.4\,m$

$m = +5$

$u = ??$

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

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

$-5u = v$

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

$\frac{1}{-0.4} = \frac{1}{-5u} + \frac{1}{u}$

$-\frac{\cancel{10}^{5}}{\cancel{4}_{2}} = \frac{1}{u}\left(-\frac{1}{5}+1\right)$

$-\frac{5}{2} = \frac{1}{u}\left(\frac{4}{5}\right) \rightarrow u = -\frac{8}{25} \times \frac{4}{4} = -\frac{32}{100}$

$= -0.32\,m$

QUESTION

A → b, A → c

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

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

Convex → finite

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

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

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

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

QUESTION XII

Self help

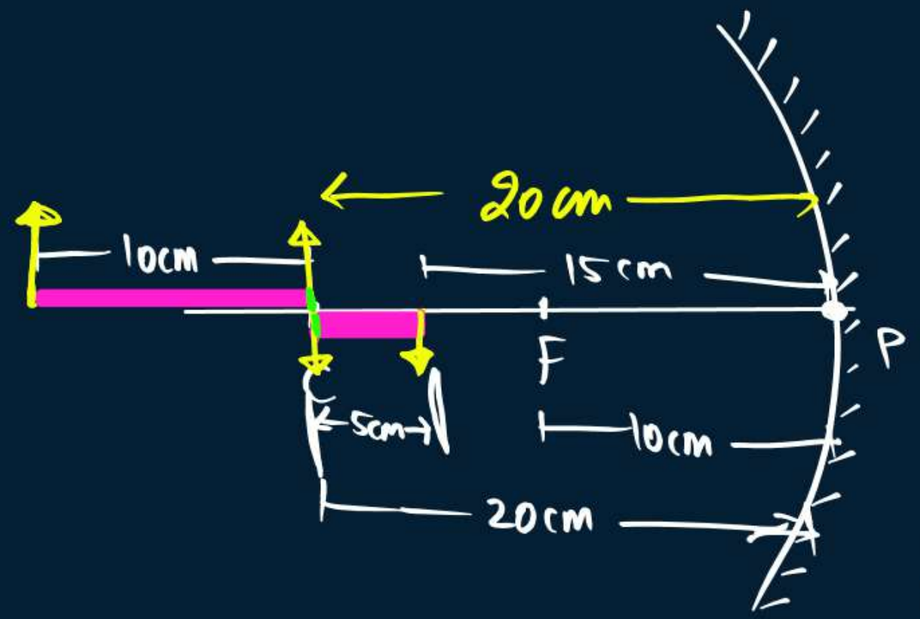
A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that its end closer to the pole is 20 cm away from the mirror. The length of the image is:

(A) 10 cm

(B) 15 cm

(C) 2.5 cm

(D) 5 cm



At C

$u = -20cm$
$f = -10cm$
$v = ?$

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

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

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

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

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

$v = -20cm$

Beyond C

$u = -30cm$
$f = -10cm$
$v = ?$

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

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

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

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

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

$v = -15cm$

Homework

- Notes ✓
- 5 Ques.. (retry)

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PARISHRAM

2026

Lecture - 03

Ray Optics and Optical Instruments

PHYSICS | **Lecture - 3**

BY - RAKSHAK SIR

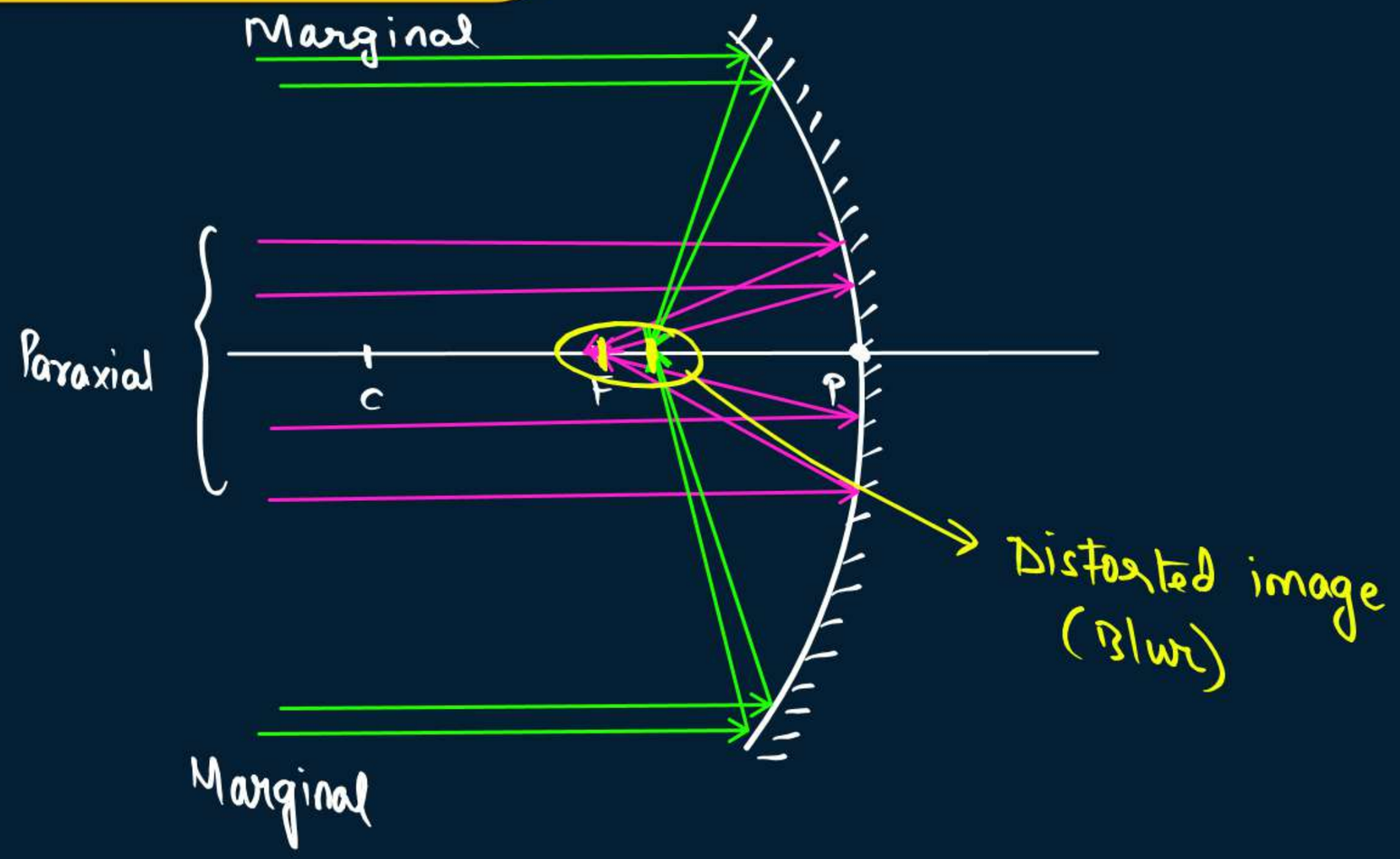
Topics *to be covered*

1 Derivations related to Reflection

Important Derivations Related To Mirrors

Types of Parallel Rays

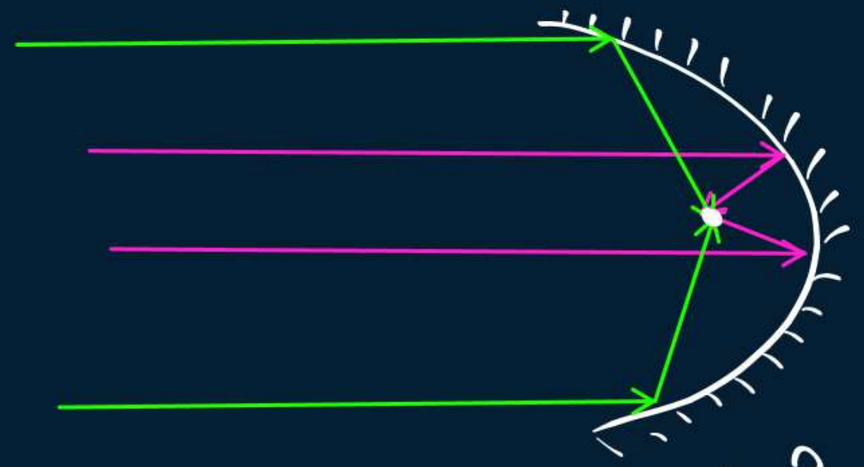
1. Paraxial
2. Marginal

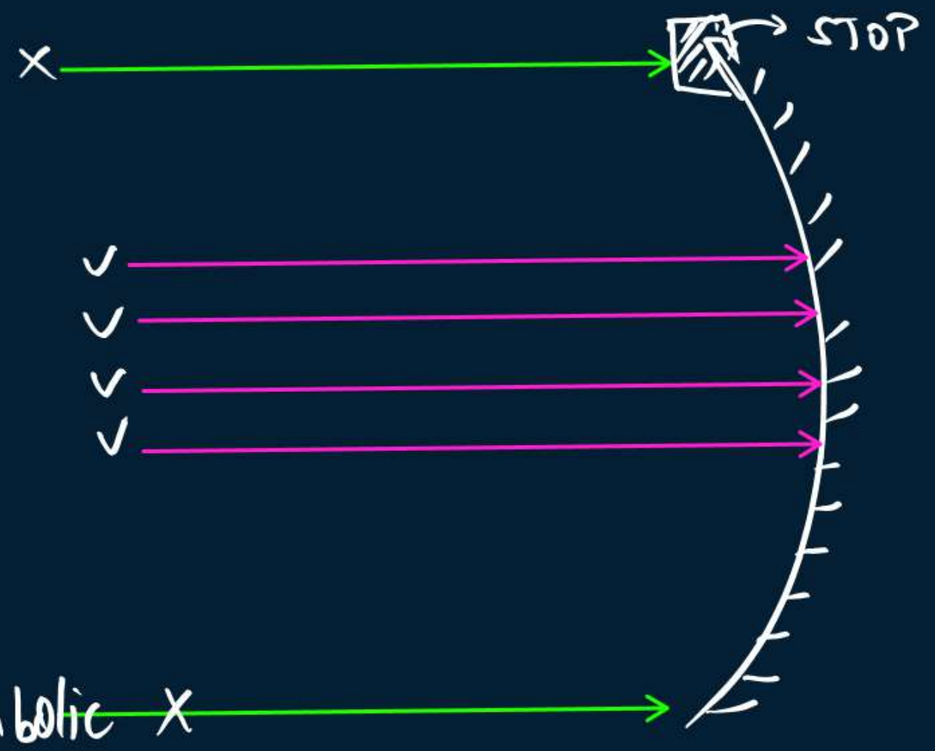


Spherical Aberration & Correction

The **Inability** of a spherical mirror of large aperture bring all rays to a **single focal point.**

1. Small Aperture
2. Stoppers to cut marginal rays.
3. Parabolic Mirrors.





Prove $R = 2f$:-

To Prove : Radius of Curvature = 2 × focal length

from Law of Reflection :-

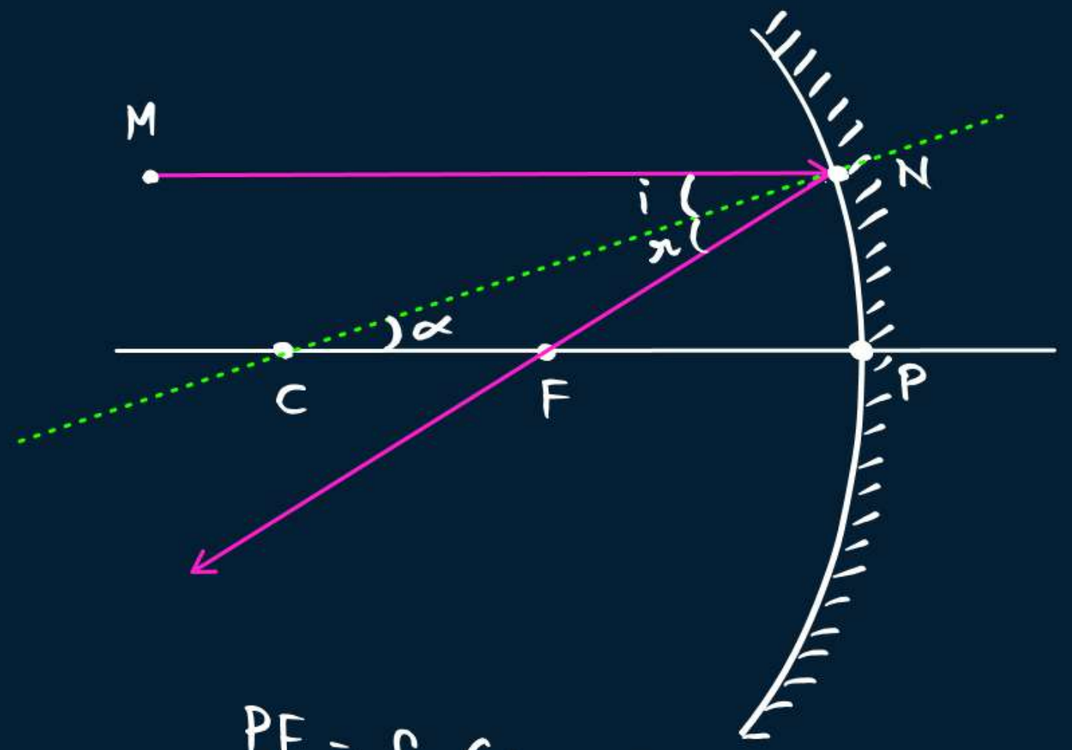
$\angle i = \angle r$ ..... (1)

from MN ∥ CP :-

$\angle \alpha = \angle i$ ..... (2)

from eq (1) and (2)

$\angle r = \angle \alpha$



PF = f (focal length)

PC = R (Radius of Curvature)

In ΔNFC,

$\angle r = \angle \alpha$

$FC = FN$ ($\because$ Isocales property)

Assuming the rays are paraxial for a small Aperture.

$FN \approx FP$

We can say,

$FC = FN \approx FP$

$FC = FP$

$PC = PF + FC$

$PC = PF + PF$

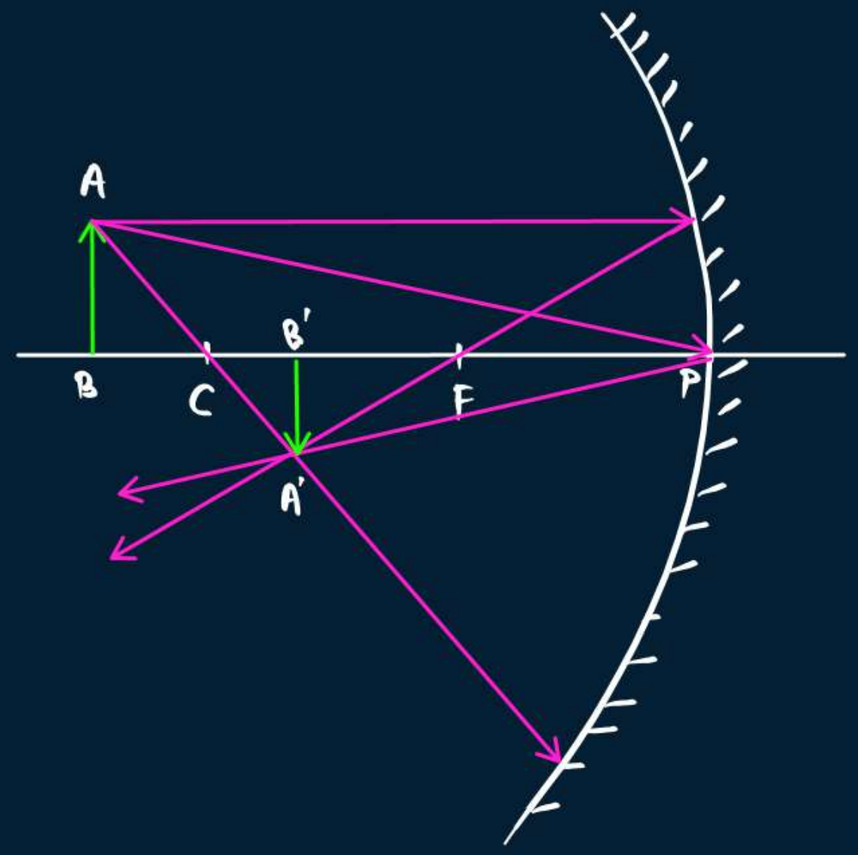
$PC = 2PF$

$$\boxed{R = 2f \quad \text{or} \quad \frac{R}{2} = f}$$

Derivation : Mirror Formula

Assumptions :-

1. All rays are Paraxial
2. Aperture is small
3. Object placed is small in size.



To prove :- $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

Given :-

$PF = -f$ ( ) $AB = h_0$ ( )

$PC = -R$ ( ) $A'B' = -h_i$ ( )

$PB = -u$ ( )

$PB' = -v$ ( )

Derivation : Mirror Formula

$\angle ABC = \angle A'B'C = 90^\circ$

$\angle ACB = \angle A'CB'$ (Vertically opp)

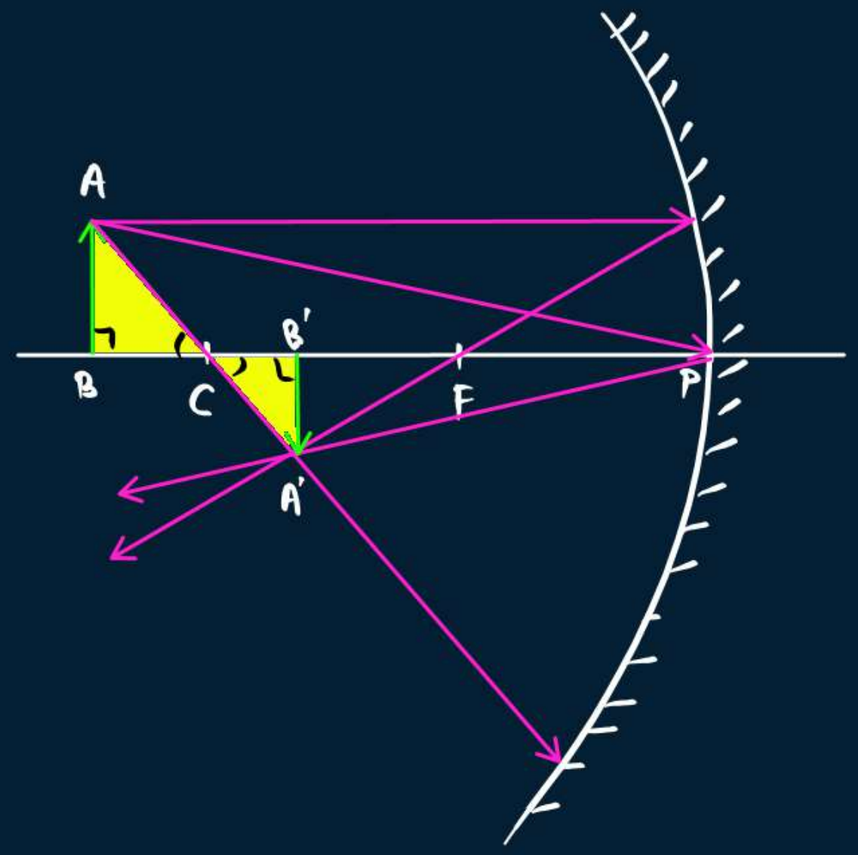
by 'AA' similarity

$\triangle ABC \sim \triangle A'B'C$

$$\frac{AB}{A'B'} = \frac{BC}{B'C}$$

$$\frac{AB}{A'B'} = \frac{BP - PC}{PC - PB'}$$

$$\frac{AB}{A'B'} = \frac{-u - (-R)}{-R - (-v)} = \frac{-u + R}{-R + v} \quad \cdots\cdots (1)$$



Derivation : Mirror Formula

$\angle ABP = \angle A'B'P = 90^\circ$

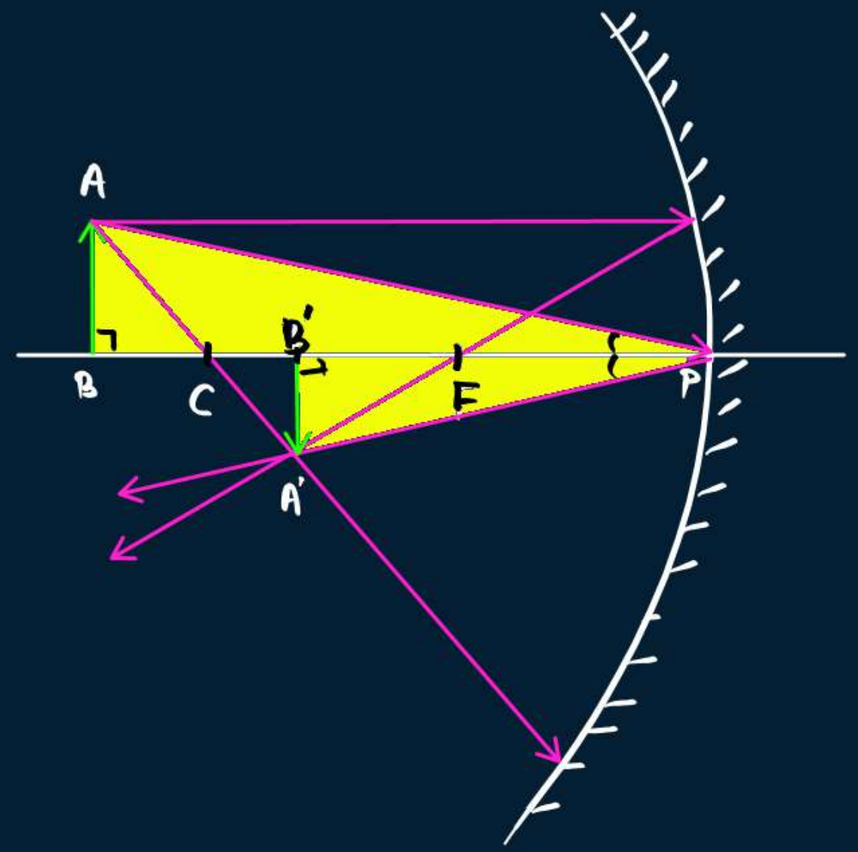
$\angle APB = \angle A'PB'$ (Law of reflection)

By 'AA' similarity..

$\triangle ABP \sim \triangle A'B'P$

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

$$\frac{AB}{A'B'} = \frac{u}{v} \quad \ldots (2)$$



④

equating ① & ② ....

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

$$-uv + vR = -uR + uv$$

$$uR + vR = uv + uv$$

$$uR + vR = 2uv$$

divide both sides by 'uvR'

$$\frac{\cancel{u}\cancel{R}}{\cancel{u}v\cancel{R}} + \frac{\cancel{v}\cancel{R}}{u\cancel{v}\cancel{R}} = \frac{2\cancel{u}\cancel{v}}{\cancel{u}\cancel{v}R}$$

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

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

hence, proved.

⑤ Linear Magnification (m)

Derivation : Mirror Formula

To prove :- $m = \frac{-v}{u}$

$\angle ABP = \angle A'B'P = 90^\circ$

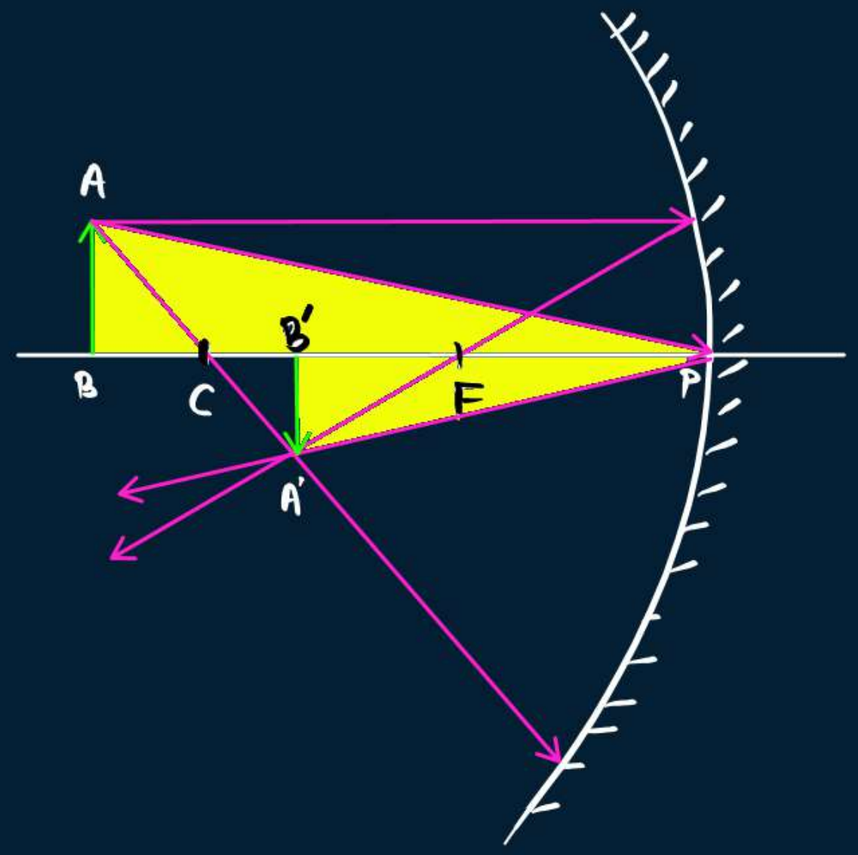
$\angle APB = \angle A'PB'$ (law of reflection)

$\Delta ABP \sim \Delta A'B'P$

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

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

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



reciprocal :-

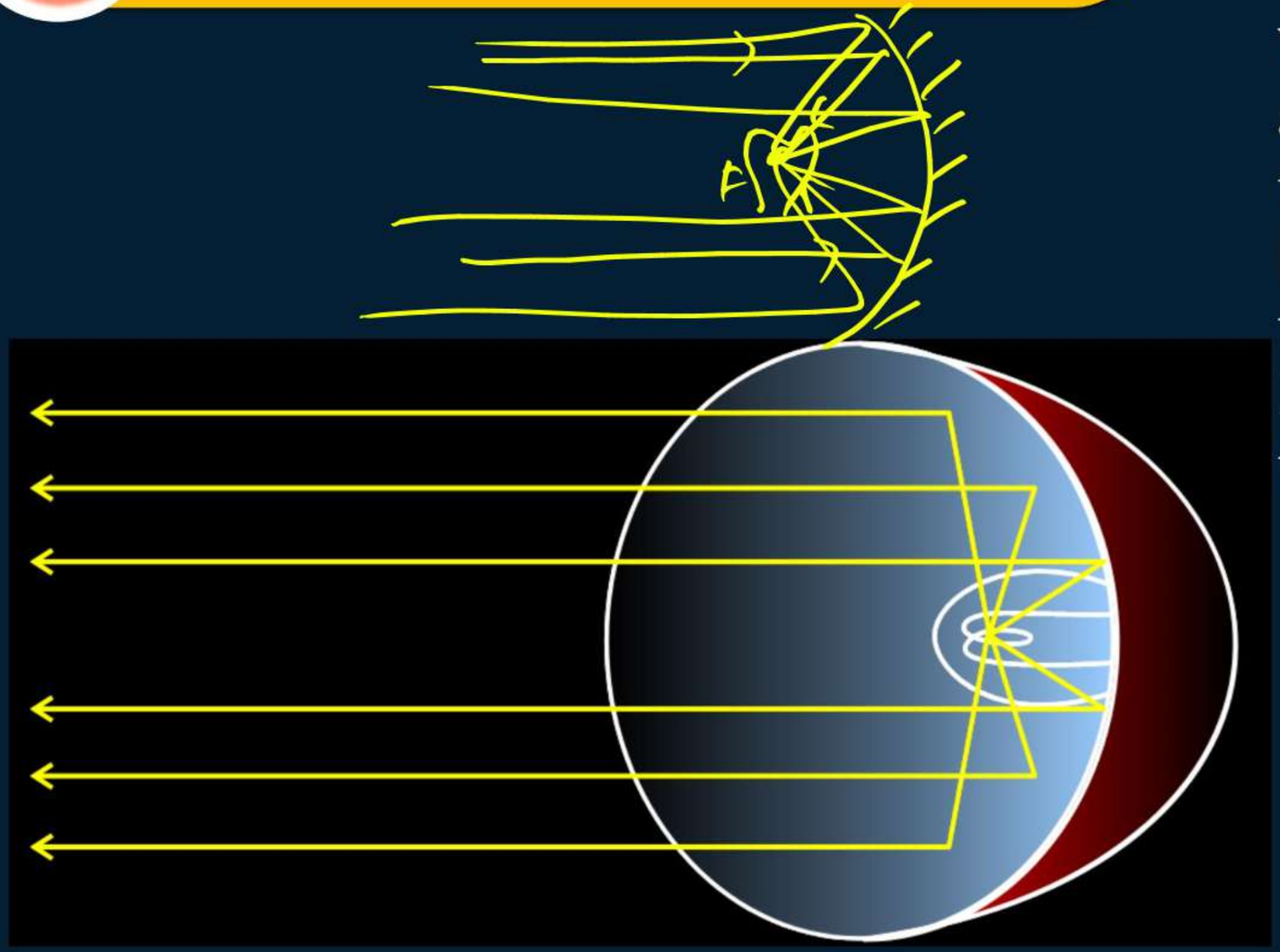
$$\frac{h_i}{h_o} = -\frac{v}{u}$$

from definition of $\left(m = \frac{h_i}{h_o}\right)$

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

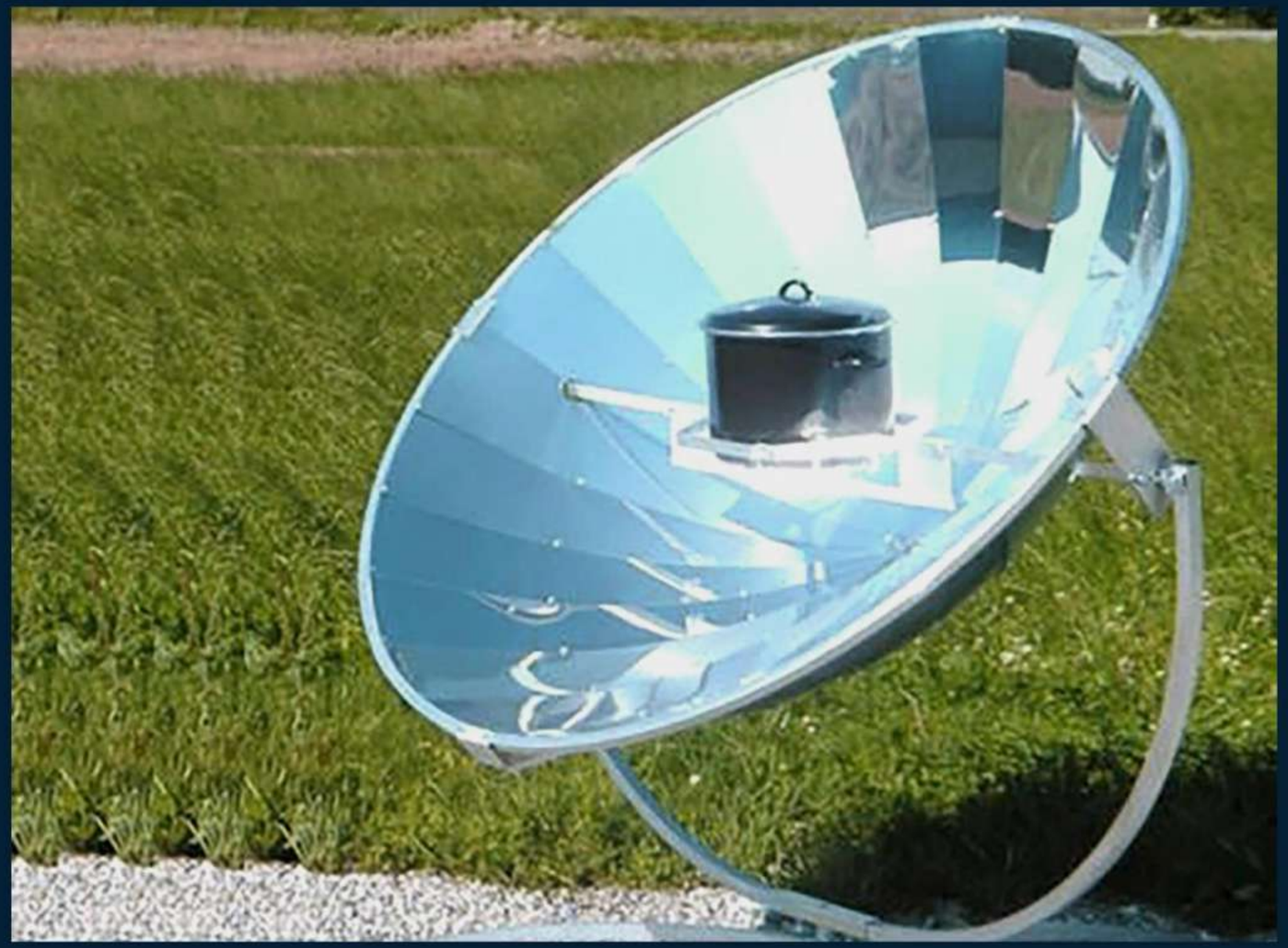
hence, proved.

Uses of Curved Mirrors



When the bulb of headlight is placed at focus of concave mirror, it allows the light to spread out to infinity (longer distances) and at infinity they are approximately parallel. Hence, concave mirrors are used in the headlights of vehicles.

Uses of Curved Mirrors



In solar cookers, we use concave mirrors.

Concave mirrors reflect light falling on it to a single focal point. The radiation at the focal point is very powerful as it contains a lot of concentrated thermal energy. Now when we place a cooking pot on the focal point where the light is concentrated the energy is powerful enough to cook food.

Uses of Curved Mirrors

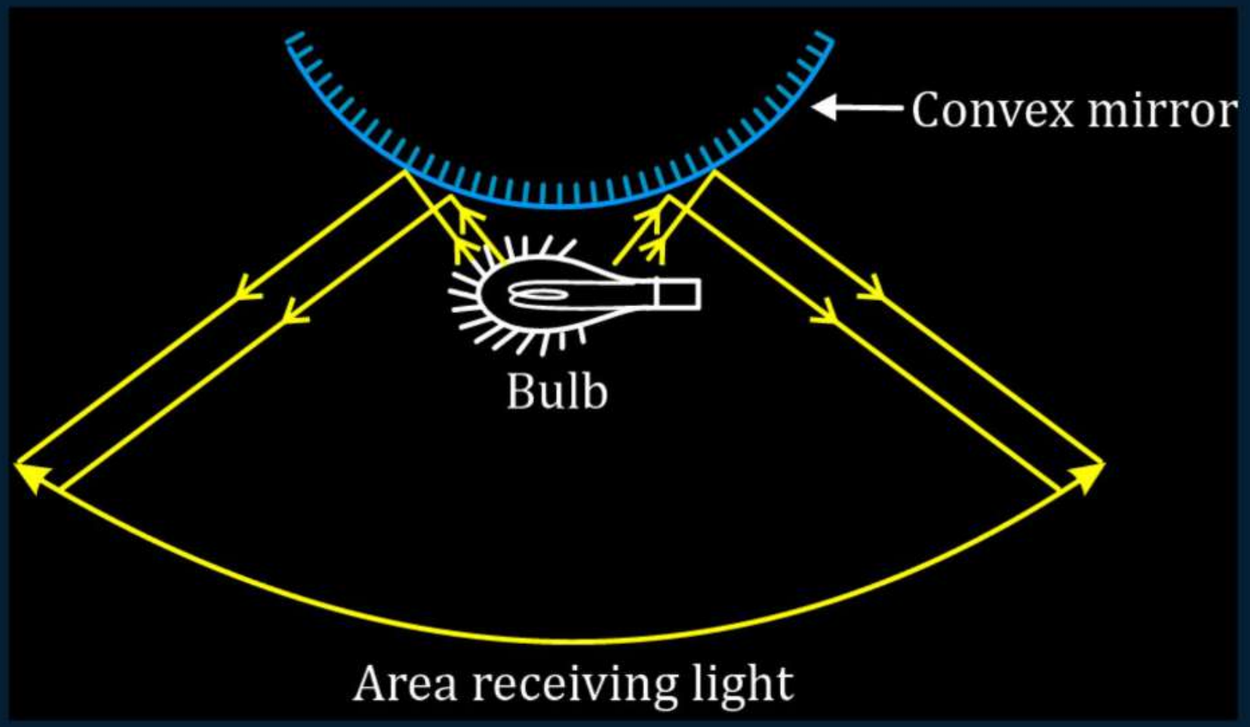
6th Case B/w F & P

Concave mirrors are used as shaving mirrors because when the face is placed close to a concave mirror (so that the face is within its focus) the concave mirror produces a magnified and erect image of the face. Since a large image of the face is seen in the concave mirror, it becomes easier to make a smooth shave.

Uses of Curved Mirrors

Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles because they give an **erect, virtual, full size diminished image** of distant objects with a **wider field of view**. Thus, convex mirrors enable the driver to view much larger area than would be possible with a plane mirror.

Uses of Curved Mirrors



Convex mirror diverges the light rays incident on it, enables us to use it as a reflector in street lamps. The light from a bulb placed infront of a convex mirror diverges over a large area in the street.

Uses of Curved Mirrors

Homework

- Reflection Pakka
- Notes

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PARISHRAM

2026

Lecture - 04

Ray Optics and Optical Instruments

PHYSICS | **Lecture - 4**

BY - RAKSHAK SIR

Topics *to be covered*

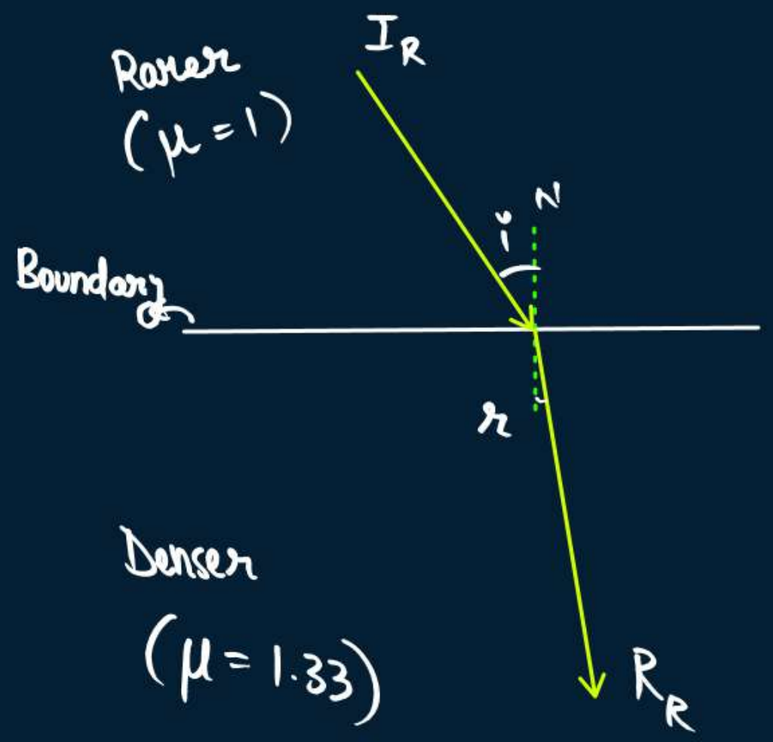
1 Refraction of Light (50%) — Snell's Law
— TIR
Prisms
Lenses

Refractive Index

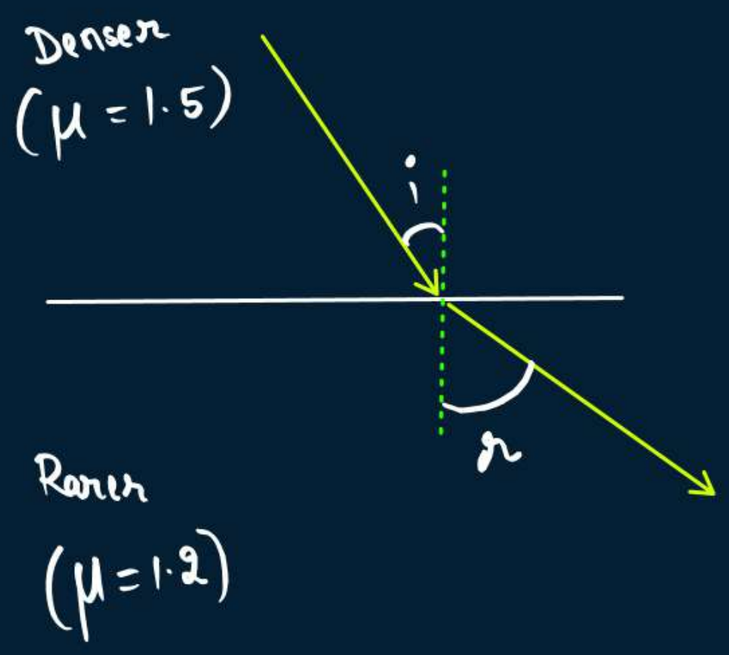
Refraction (all 3 cases)

→ Bending of light when it changes the transparent med.

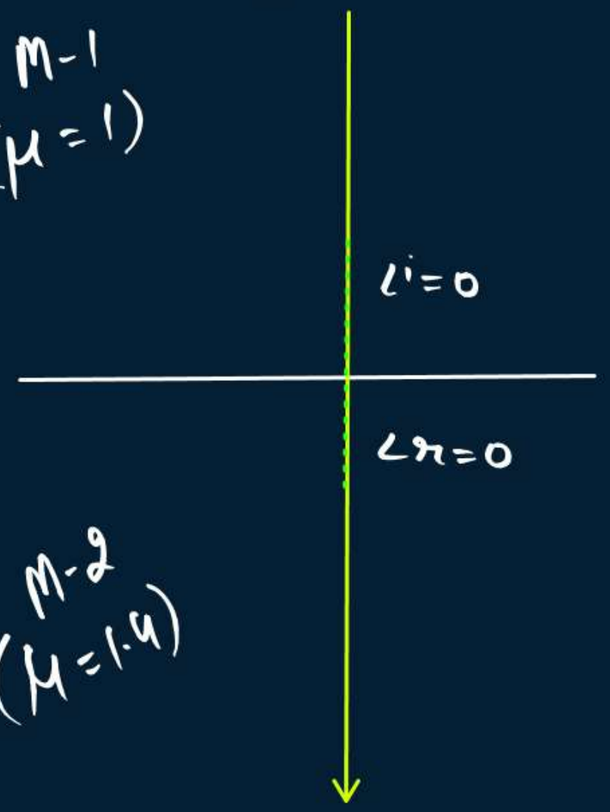
① Rarer to Denser (Bend towards N)



② Denser to Rarer (Bend away from N)



③ No Bending : Normal incidence



Laws of Refraction

I_R R_R N

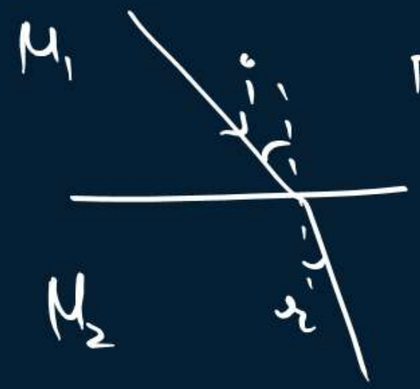
1. The incident ray, refracted ray and the normal all lie in the same plane.

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 wavelength and given pair of media. This law is also known as 'Snell's Law'.

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

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1} = \mu_{2,1}$$

R.I. of 2 w.r.t. 1



RDx

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

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

Refractive Index

μ or $n = \frac{c}{v}$ → speed of light in Vacuum ($c = 3\times10^8$ m/s)
→ " " " " a medium

- Also known as optical density. (Not a mass density)
- It compares speed of light in a given medium w.r.t. vacuum
- Factors :-
  1. Nature of the medium
  2. Wavelength of the incoming light
  3. Temperature
  4. Nature of the surrounding medium

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

$\mu \uparrow \propto \frac{1}{v\downarrow} \propto \frac{1}{\lambda\downarrow}$

Y.K.B.

$v = \lambda\nu$

↓

for any wave

→ frequency = Const. (Source dependent)

* for denser : $\mu\uparrow$ $v\downarrow$ $\lambda\downarrow$
* for rarer : $\mu\downarrow$ $v\uparrow$ $\lambda\uparrow$

Cause of Refraction

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

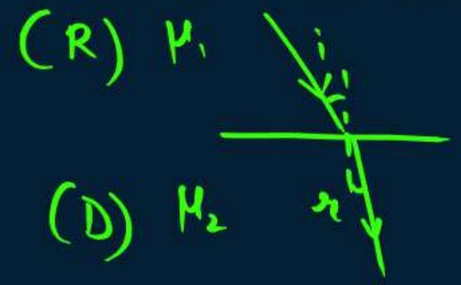
$\mu_{2,1} = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$

- The bending of light or refraction occurs due to change in speed of light when it passes from one medium to another,
- Frequency remains constant always (Source Dependent)

Snell's Law

$\frac{\sin i}{\sin r} = \mu_{2,1} = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$

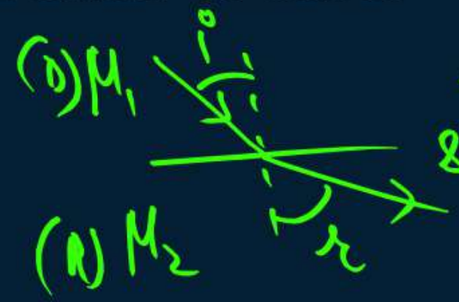
- Rarer to Denser –



$i > r$
$\sin i > \sin r$

$\mu_2 > \mu_1$
$v_1 > v_2$
$\lambda_1 > \lambda_2$

- Denser to Rarer –



$r > i$
$\sin r > \sin i$

$\mu_1 > \mu_2$
$V_2 > V_1$
$\lambda_2 > \lambda_1$

Principle of Reversibility of Light

A ray of light will follow the same path when its direction is reversed.

Combination of Media –

$n_{2,1}$ or $\mu_{2,1}$ or ${}^{1}\mu_2$ or ${}_{1}\mu_2$

↓

R.I. of 2 w.r.t. 1

QUESTION

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

(A) 3×10^3 m/s

(B) 2×10^8 m/s

(C) 1×10^8 m/s

(D) 4×10^8 m/s

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

$\mu_g = 1.5$

$V_g = ?$

$\mu_g = \frac{c}{V_g}$

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

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

$V_g = 2 \times 10^8$ 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]

(A) 1.33

(B) 1.40

(C) 1.50

(D) 3.00

$$\mu = \frac{c}{v} \quad \frac{\rightarrow m/s}{\rightarrow m/s}$$

$$\mu = \frac{c}{\lambda \nu}$$

$$= \frac{3 \times 10^{8}}{5000 \times 10^{-10} \times 2 \times 10^{14}}$$

$$=$$

QUESTION

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

(A) 4×10^{-11}

(B) 2×10^{-11}

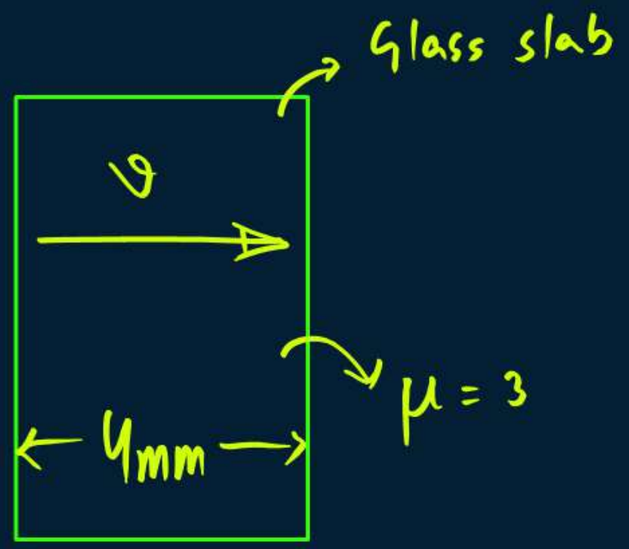
(C) 16×10^{-11}

(D) 8×10^{-10}

$S = \frac{D}{t}$

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

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



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

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

$v = 10^8$ m/s

QUESTION

One- wavelength

rarest

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]

(A) dependent on intensity of refracted light

(B) same

(C) smaller

(D) larger

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

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]

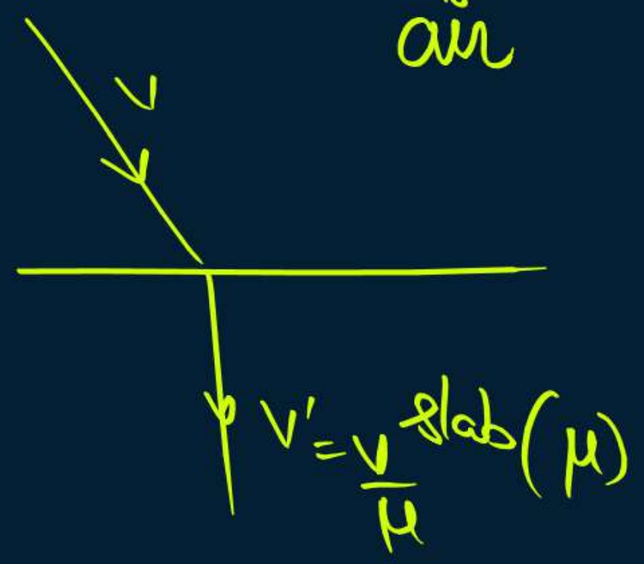
ν λ V

(A) $\frac{\nu}{\mu}, \frac{\lambda}{\mu}, \nu$

(B) $\nu, \lambda, \frac{v}{\mu}$

(C) $\nu, \left(\frac{\lambda}{\mu}\right), \left(\frac{v}{\mu}\right)$

(D) $\frac{\nu}{\mu}, \frac{\lambda}{\mu}, \frac{v}{\mu}$



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

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

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

Some Values to learn

$\mu = 1$ (Vacuum)

$\mu \approx 1$ (Air)

$\mu > 1$ (for any other med)

$\mu_g = 1.5$

$\mu_w = 1.33$

\# Not possible :-

$\mu < 0$ (-ve)

$\mu = 0$

$0 < \mu < 1$

Relative Refractive Index

$\mu_{2,1} = {}^{1}\mu_2 = {}_{1}\mu_2$

$\mu_{2,1} = \frac{\mu_2}{\mu_1}$

${}_{2}\mu_1 = {}^{2}\mu_1 = \mu_{1,2} = \frac{\mu_1}{\mu_2}$

$\mu_{1,2} \times \mu_{2,1} = 1$

$\frac{\cancel{\mu_1}}{\cancel{\mu_2}} \times \frac{\cancel{\mu_2}}{\cancel{\mu_1}} = 1$

$\mu_{1,2} = \frac{1}{\mu_{2,1}}$

QUESTION

$\mu_{2,1} = {}^{1}\mu_2 = {}_1\mu_2$

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

(A) ${}_3\mu_1$

(B) ${}_3\mu_2$

(C) $\frac{1}{{}_1\mu_4} = \frac{1}{\mu_{4,1}} = \mu_{1,4}$

(D) ${}_4\mu_2$

${}_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3$

$\mu_{1,2} \times \mu_{2,3} \times \mu_{3,4}$

$\frac{\mu_1}{\cancel{\mu_2}} \times \frac{\cancel{\mu_2}}{\cancel{\mu_3}} \times \frac{\cancel{\mu_3}}{\mu_4}$

$\frac{\mu_1}{\mu_4} = \mu_{1,4} = {}^{4}\mu_1 = {}_4\mu_1$

Real and Apparent Depth

MO = Real depth

MI = Apparant depth

Applying Snell's Law at point N

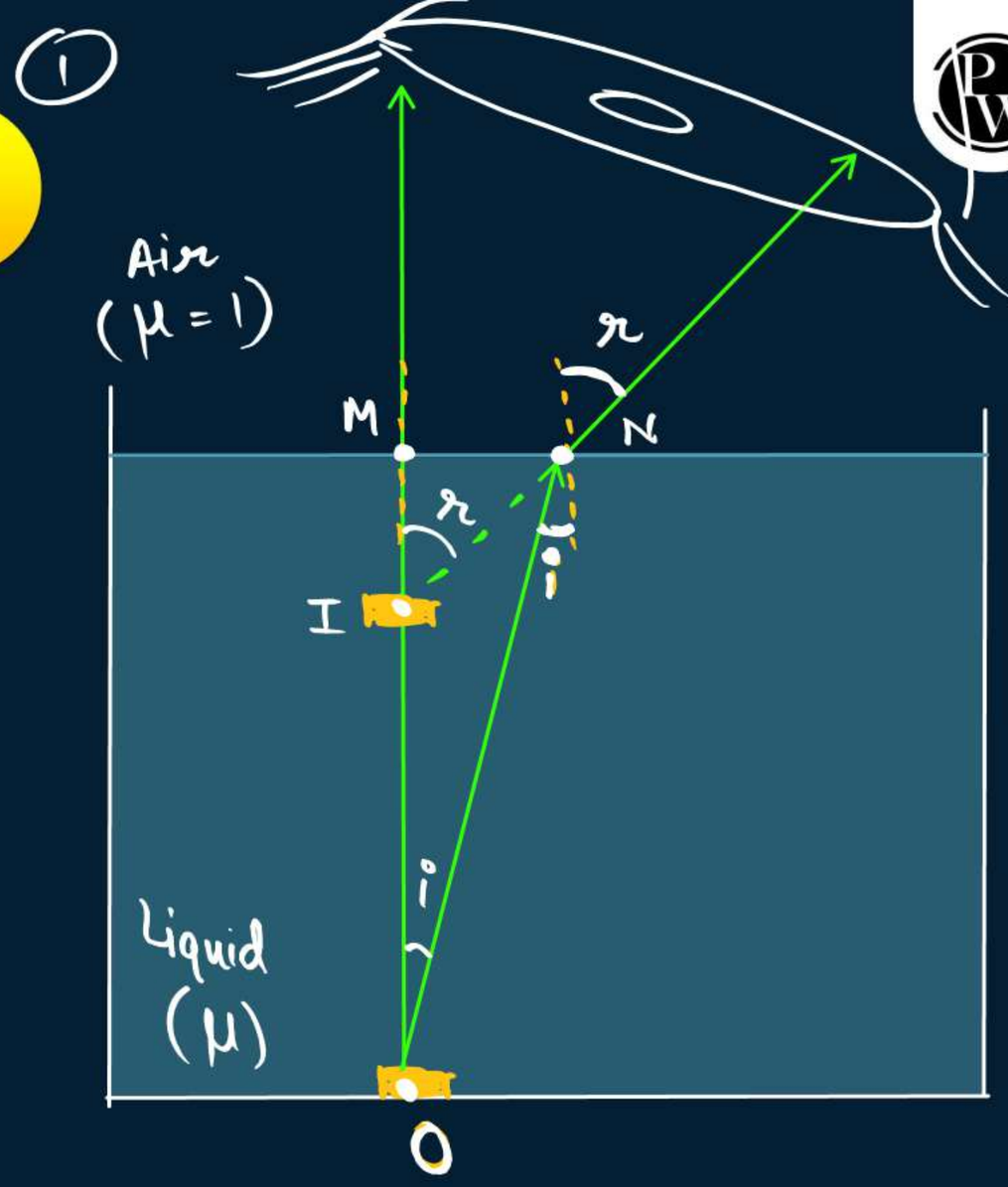
$$\mu_1 \sin i = \mu_2 \sin r$$

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

$$\frac{\sin i}{\sin r} = \frac{1}{\mu} \quad \text{.... (1)}$$

$\angle MON = \angle i$ (Vertically opp.)

$\angle MIN = \angle r$ (Corresponding)



Real and Apparent Depth

In ΔMON,

$$\sin i = \frac{P}{H}$$

$$\sin i = \frac{MN}{ON}$$

In ΔMIN,

$$\sin r = \frac{P}{H}$$

$$\sin r = \frac{MN}{IN}$$

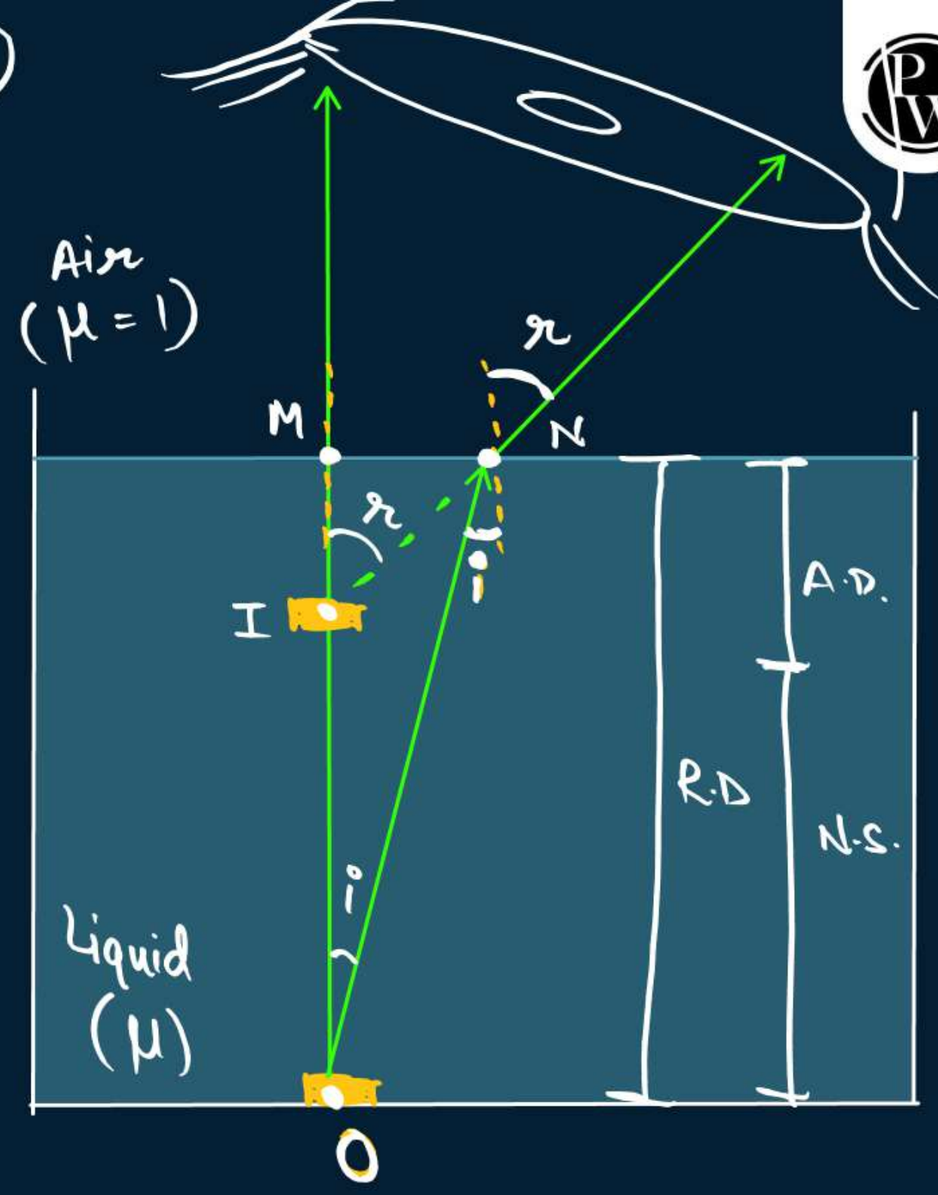
Assuming $ON \approx OM$ and $IN \approx IM$

because the size of eye's pupil is very small

M and N are very close to each other

$$\sin i = \frac{MN}{OM}$$

$$\sin r = \frac{MN}{IM}$$



put the value of sin i and sin r in eq ①

$$\frac{\frac{\cancel{MN}}{OM}}{\frac{\cancel{MN}}{IM}} = \frac{1}{\mu}$$

$$\frac{IM}{OM} = \frac{1}{\mu}$$

$$\frac{MO}{MI} = \mu$$

$$\boxed{\frac{\text{Real Depth}}{\text{Apparant Depth}} = \mu_{med}}$$

RDx for CUET, NDA, NEET

$$\boxed{\frac{\text{Real depth}}{\text{App. depth}} = \mu_{liq.}}$$

$$\boxed{* \text{ Normal shift} = \text{Real depth} - \text{Apparant Depth}}$$

$$\text{Normal shift} = R.D. - A.D.$$

$$= R.D. - \frac{R.D.}{\mu}$$

$$\frac{R.D.}{A.D.} = \mu$$

$$\frac{R.D.}{\mu} = A.D.$$

RD_x

$$\boxed{\text{Normal shift} = R.D.\left(1 - \frac{1}{\mu}\right)}$$

QUESTION

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

(A) 6 m

(B) 8/3 m

(C) 8 cm

(D) 10 cm

$R.D. = 8m$

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

$A.D. = ?$

$\frac{R.D.}{A.D.} = \mu$

$\frac{\cancel{8}^{2}}{A.D.} = \frac{\cancel{4}}{3}$

$A.D. = 6m$

QUESTION

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

(A) 3.75 cm

(B) 3 cm

(C) 10.5 cm

(D) 2.5 cm

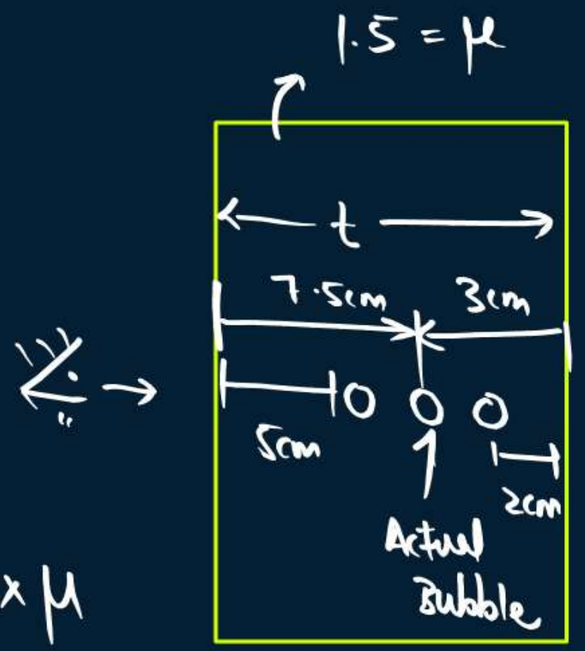
A.D. = 5cm

$\mu = 1.5$

R.D. = A.D. × μ

= 5 × 1.5

= 7.5 cm



A.D. = 2cm

$\mu = 1.5$

R.D. = A.D × μ

= 2 × 1.5

R.D. = 3cm

QUESTION

H.W.

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]**

A. 8

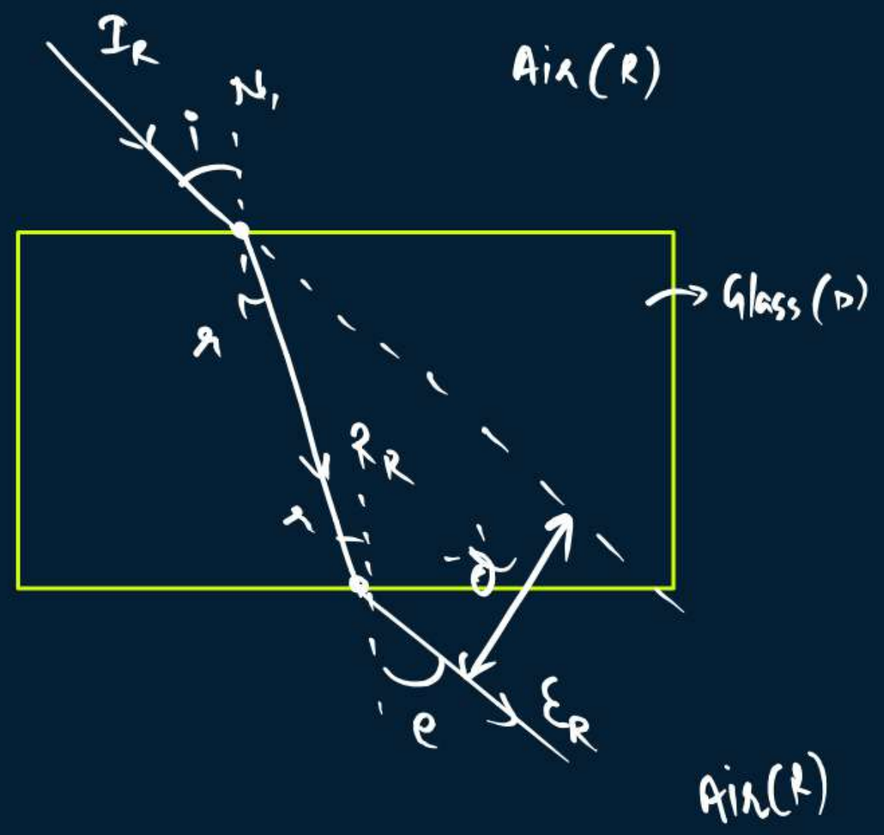
B. 10

C. 12

D. 16

Refraction through glass slab

* $i = e > r$



Homework

Notes ✓

Revision ✓

PARISHRAM

2026

Lecture - 05

Ray Optics and Optical Instruments

PHYSICS | **Lecture - 5**

BY - RAKSHAK SIR

Topics *to be covered*

1 Total Internal Reflection, Prisms

(TIR)

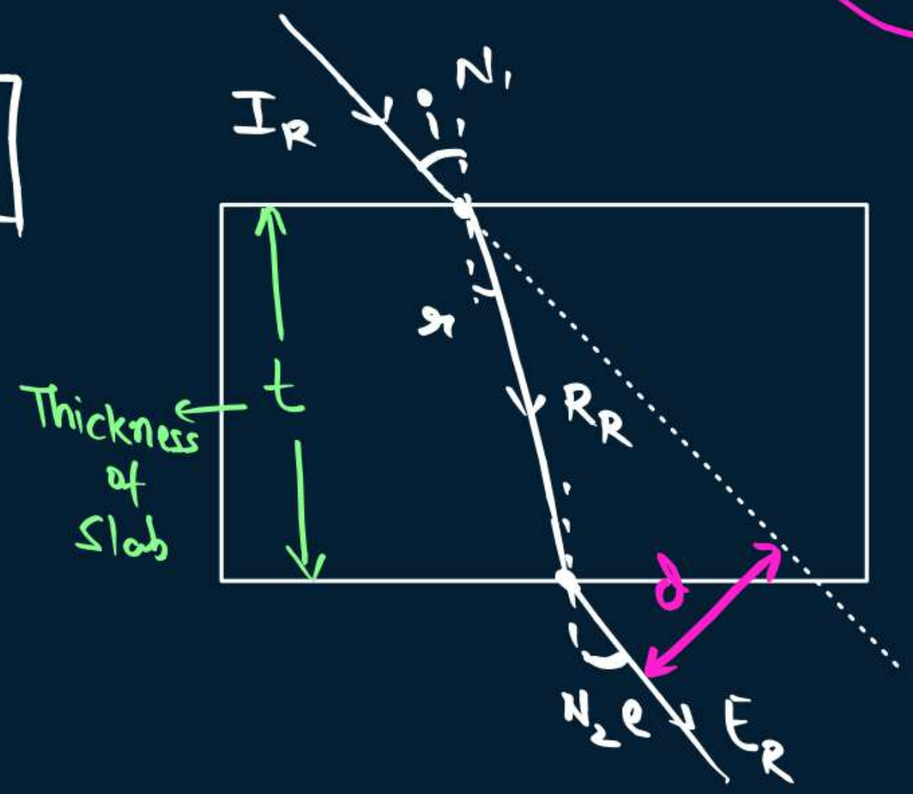
Lateral Displacement in Glass Slab

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

thickness of slab

Lateral disp

$$i = e > r$$



QUESTION

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

(A) $\sin i$

(B) $\cos i$

(C) $\tan i$

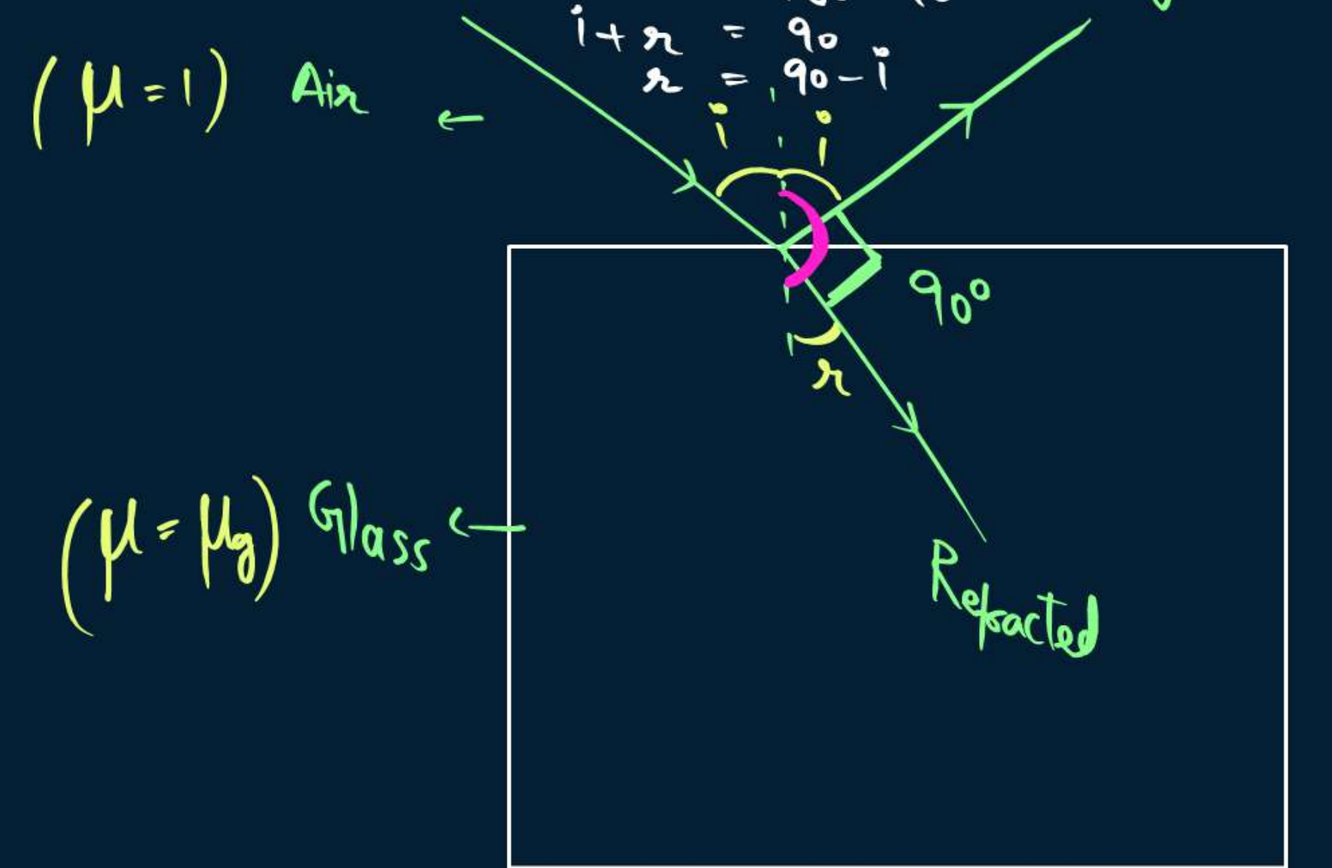
(D) $\cot i$

$i + 90^\circ + r = 180^\circ$

$i + r = 180 - 90$

$i + r = 90$

$r = 90 - i$



Snell's Law :-

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

$(1) \sin i = \mu_g \sin r$

$\sin i = \mu_g \sin(90 - i)$

$\sin i = \mu_g \cos i$

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

$\tan i = \mu_g$

Total Internal Reflection (TIR)

It is a condition where the refracted ray reflects in the same medium from which the light is incoming.

Conditions for TIR :-

i) Denser to Rarer.

ii) Angle of incidence > Critical Angle

$$i > i_c$$

Critical Angle (i_c)

When the refracted Angle turns 90°, the refracted ray moves along the boundary b/w two media, the angle of incidence is said to be Critical Angle (i_c)

When, $r = 90°$

$i = i_c$

Applying Snell's Law :-

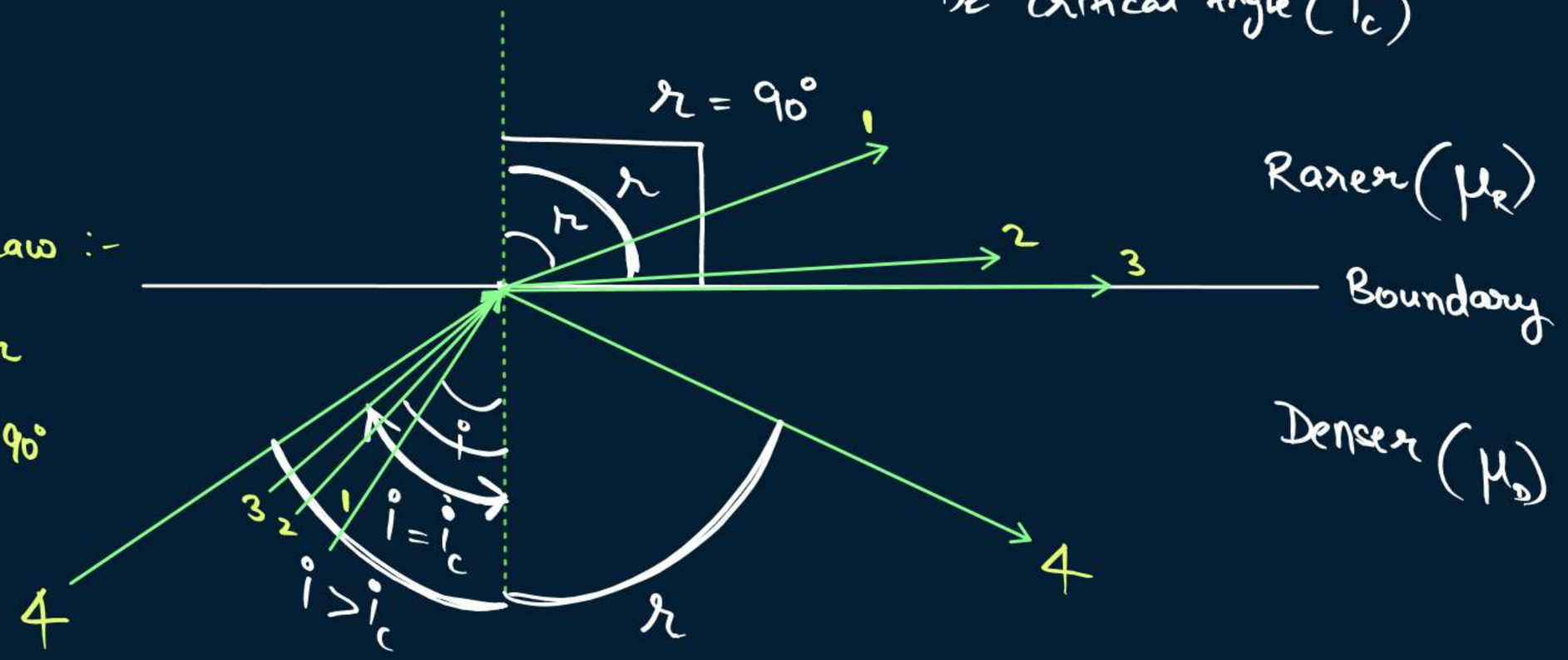
$\mu_1 \sin i = \mu_2 \sin r$

$\mu_D \sin i_c = \mu_R \sin 90°$

$\mu_D \sin i_c = \mu_R$

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

$\sin i_c = \mu_{R,D} \Rightarrow \boxed{i_c = \sin^{-1}(\mu_{R,D})}$



Spl. Case :-

When rarer medium is air ($\mu_R = 1$)

$$i_c = \sin^{-1}(\mu_{R,D})$$

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

याद

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

QUESTION

$i = i_c$

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?

$r = 90°$

A. 0°

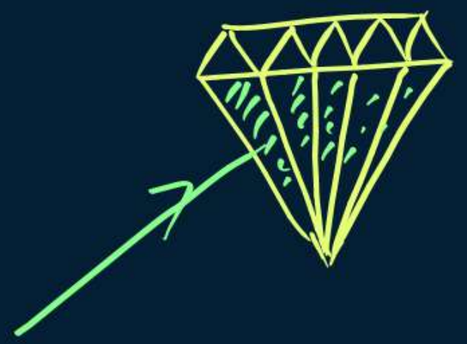
B. Equal to angle of incidence

C. 90°

D. 180°

Applications of TIR

1. Diamond

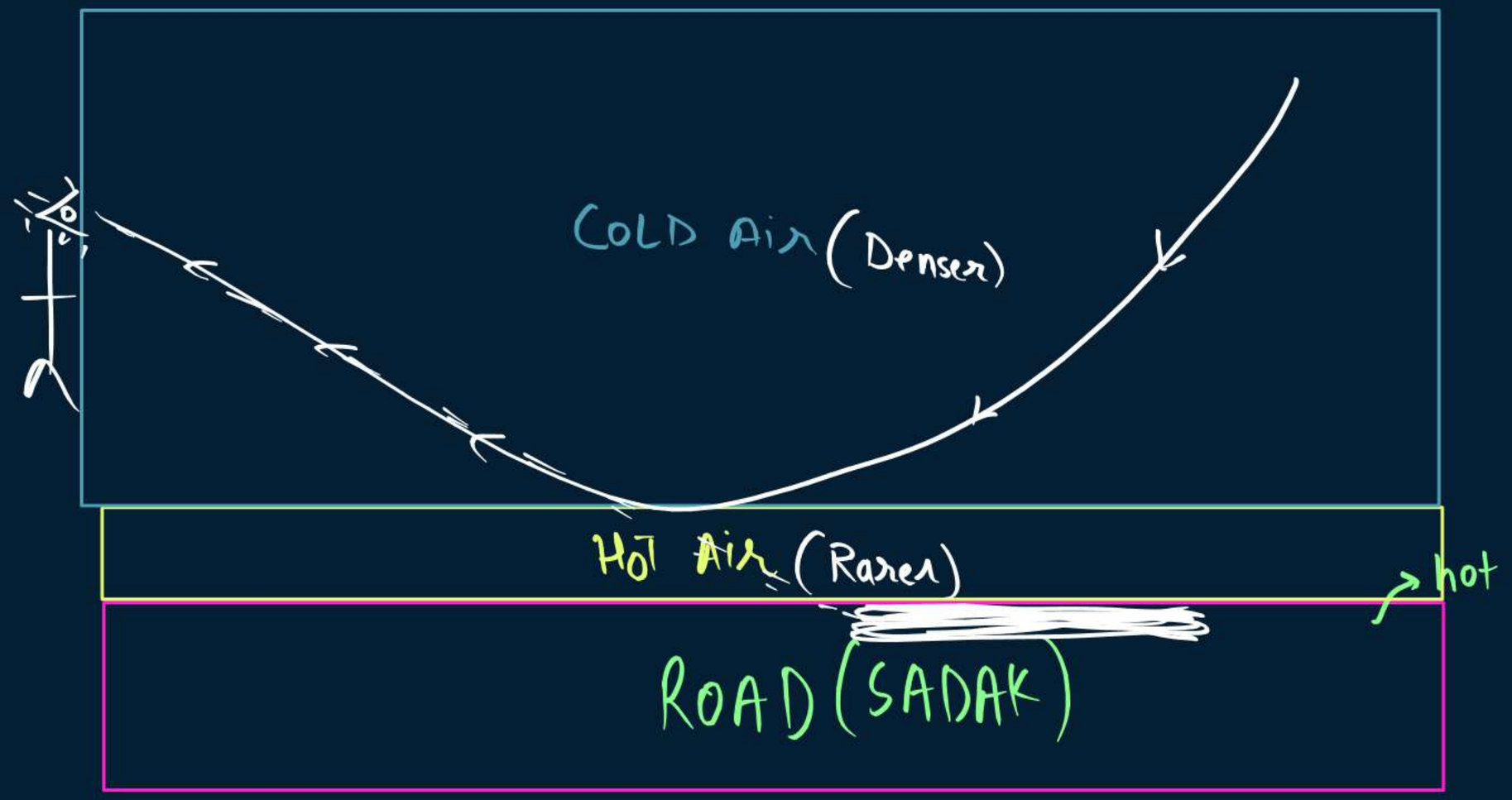


Multiple TIR ↑ Brilliance ↑

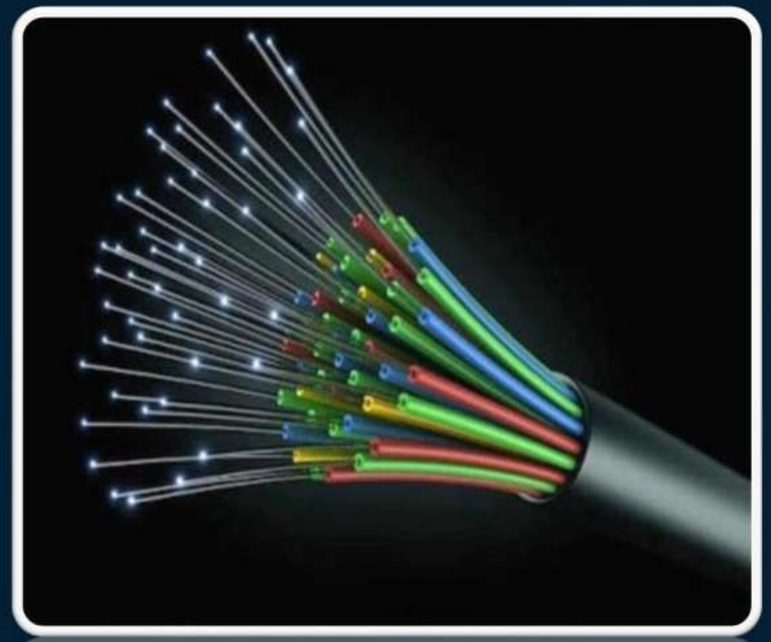
Price ↑

2. Mirage

T.I.R.



3. Optical Fibres



0.01%

Very Less Data Loss

High Speed internet

QUESTION

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

A. The mirage formation

B. Optical fiber communication

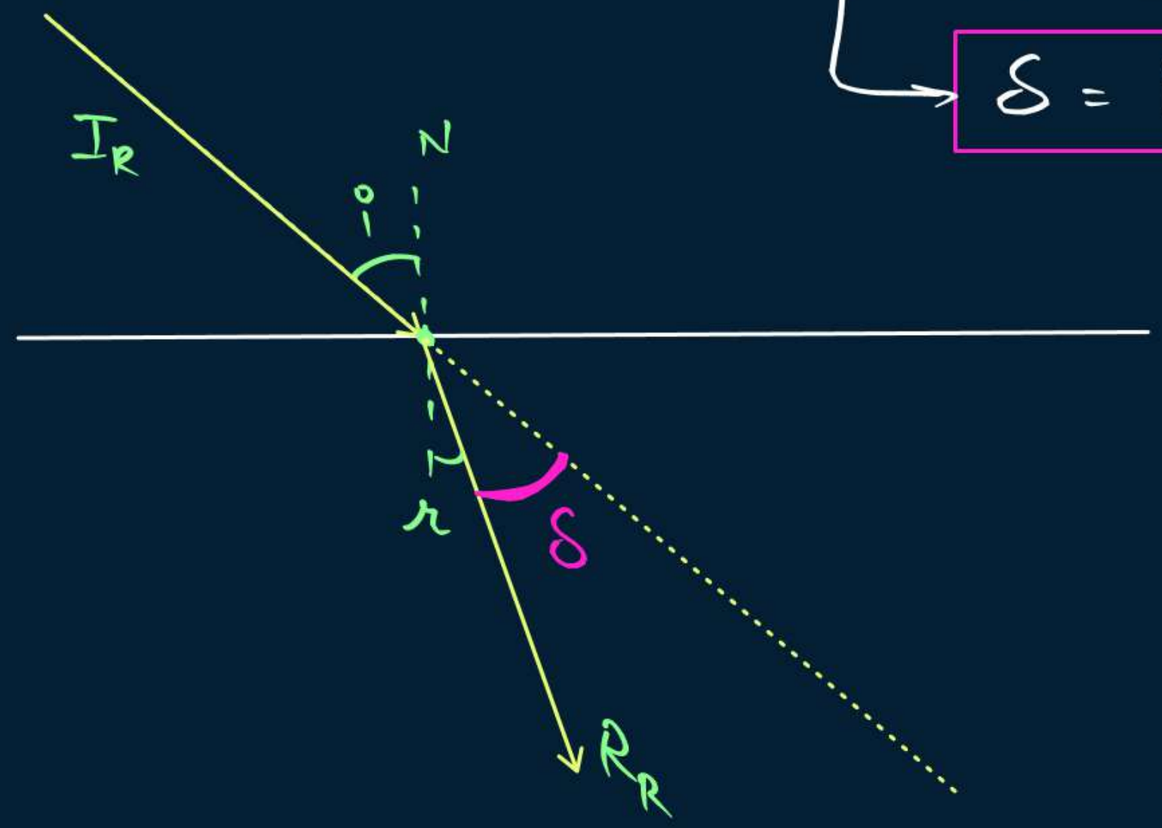
C. The glittering of diamond

D. Dispersion of light

Angle of Deviation in Refraction

$i = r + \delta$ (Vertically opp")

$$\boxed{\delta = i - r}$$

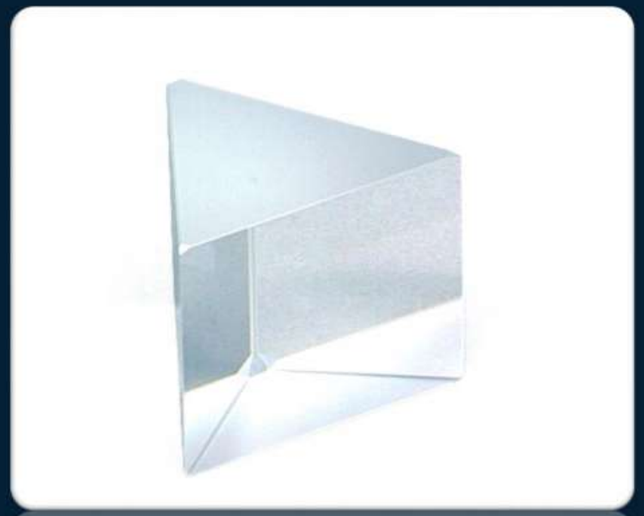


Crown Glass and Flint Glass Prism

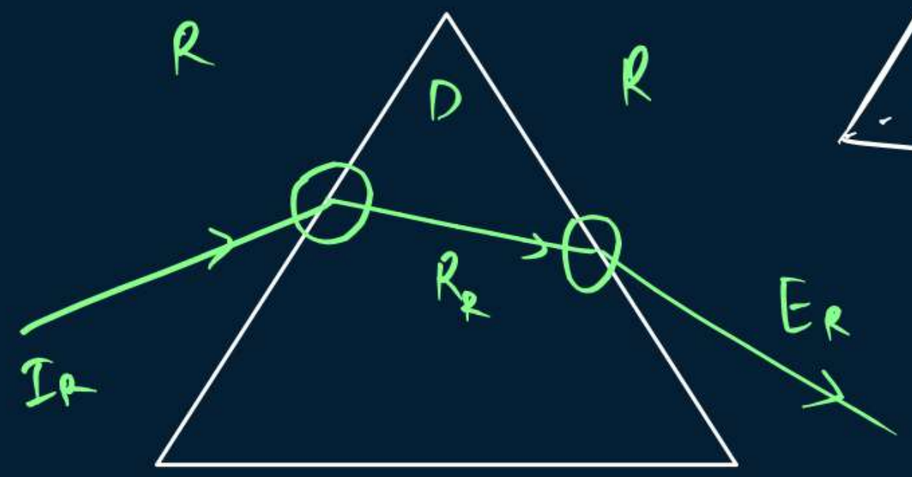
Crown glass is more clear than flint glass.

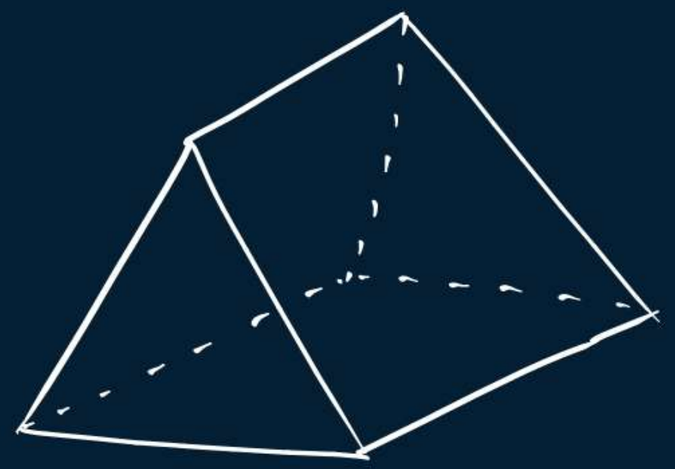
Flint glass prism has more dispersive power than crown glass prism.

We will know



Prisms





Deviation through prism

→ relation b/w i, e, A, δ

finding $\angle QMO$:-

$i = r_1 + \angle QMO$ (Vertically opp.)

$\angle QMO = i - r_1$

finding $\angle QOM$:-

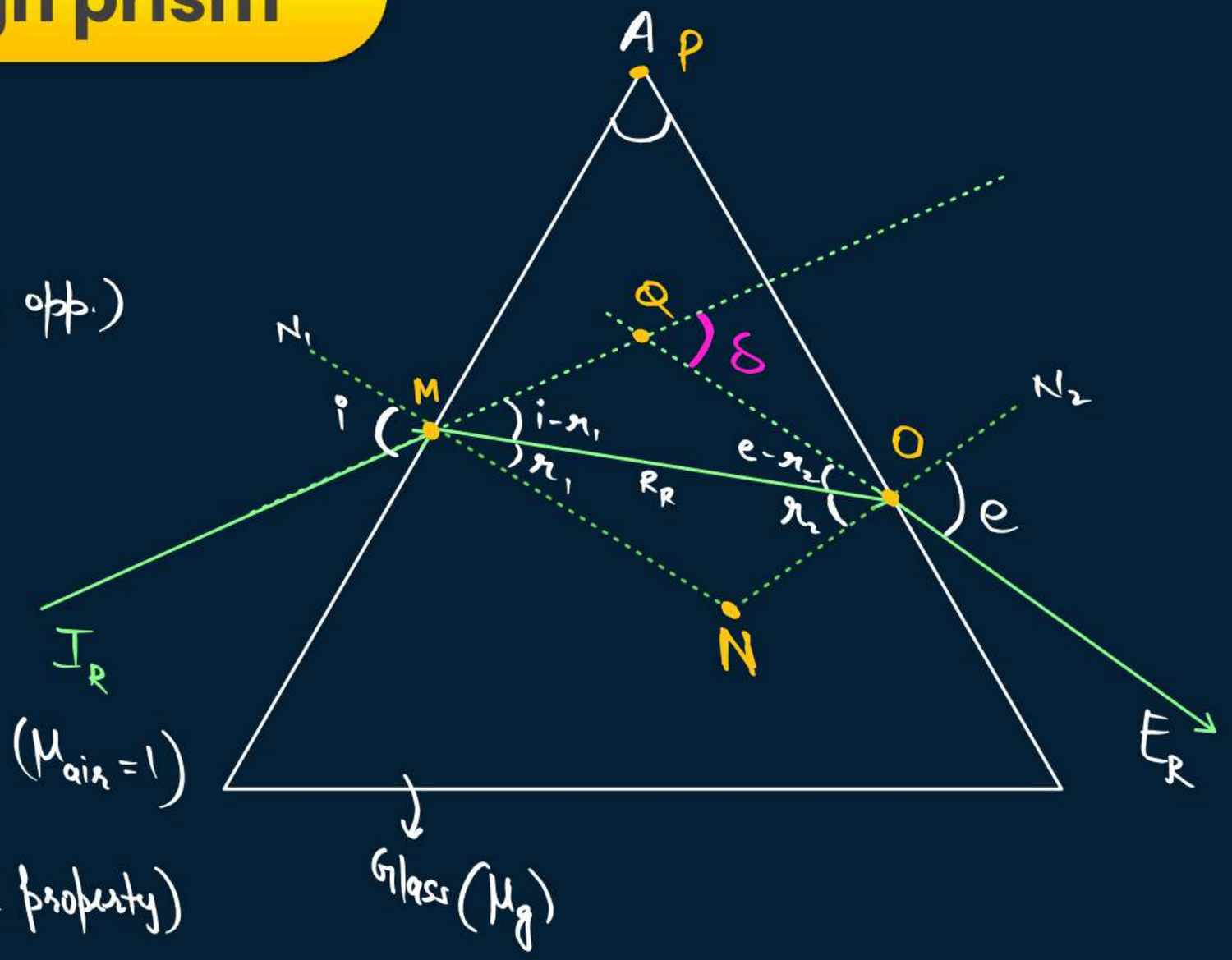
$e = r_2 + \angle QOM$

$\angle QOM = e - r_2$

In ΔQMO,

$\delta = i - r_1 + e - r_2$ (ext. Angle property)

$\delta = i + e - r_1 - r_2$ .... (1)



Deviation through prism

→ relation b/w i, e, A, δ

In Quad. MNOP,

$$\angle A + \angle x + \angle PMN + \angle PON = 360^\circ$$

$$A + x + 90 + 90 = 360$$

$$A + x = 180$$

$$x = 180 - A \quad \ldots\ldots (2)$$

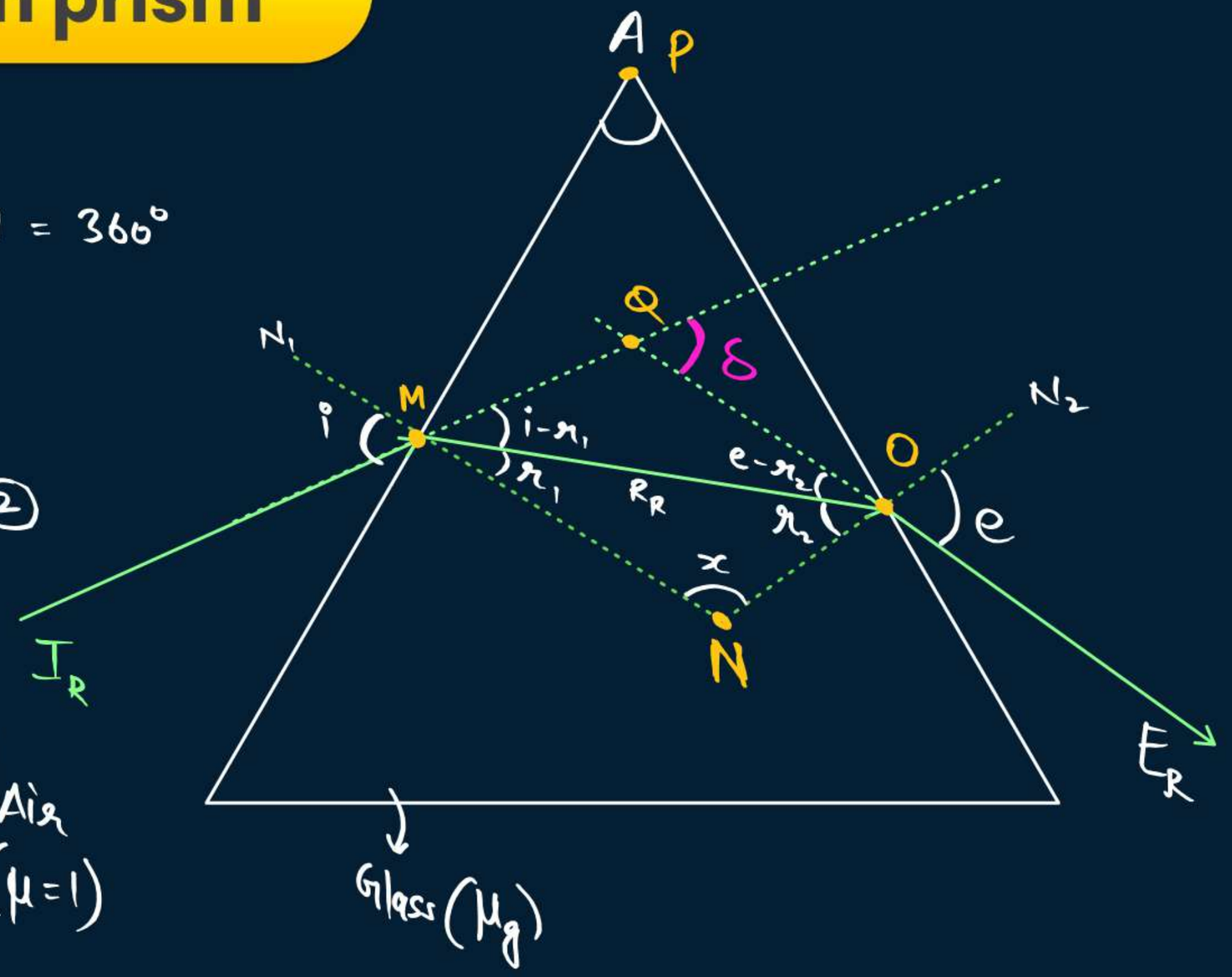
In ΔMNO,

$r_1 + r_2 + x = 180^\circ$ (Angle sum Prop)

put 'x' from eq (2)

$$r_1 + r_2 + \cancel{180} - A = \cancel{180}$$

$$r_1 + r_2 = A \quad \ldots\ldots (3)$$



Now, using eq ③ in ①

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

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

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

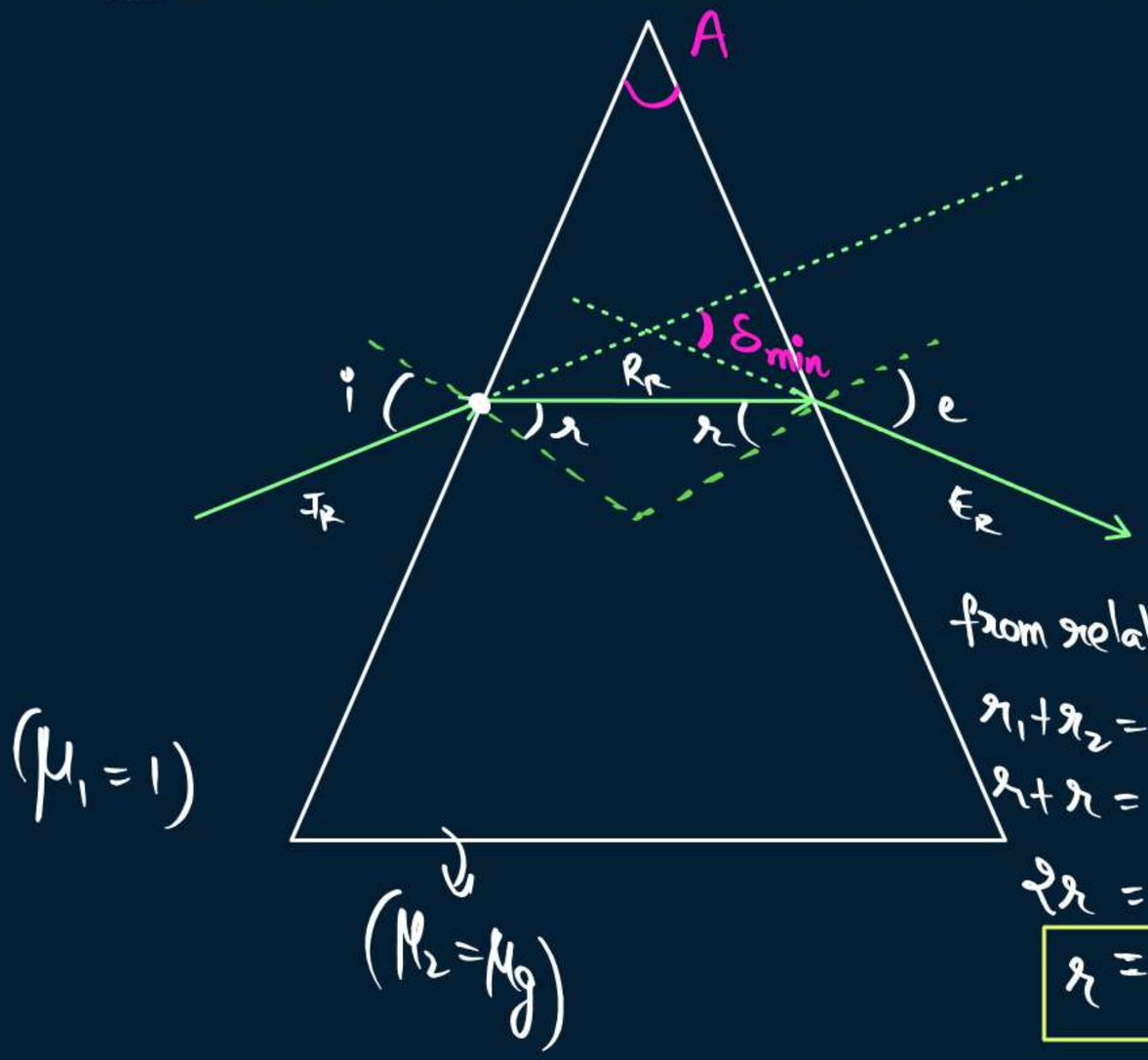
$$\delta + A = i + e$$

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

→ Relation b/w Angles of Deviation, Prism, incidence and emergence

* Spl. case :-

Minimum Deviation and Prism Formula



from relation,

$r_1 + r_2 = A$

$r + r = A$

$2r = A$

$$\boxed{r = A/2}$$

for minimum deviation :-

$\delta = \delta_{min}$

$i = e$

$r_1 = r_2 = r$

from relation,

$i + e = \delta + A$

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

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

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

Applying Snell's law :-

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

$1 \times \sin i = \mu_g \sin r$

$\frac{\sin i}{\sin r} = \mu_g$

put i and r,

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

Thin Prisms

if we consider,
thin prism,
then Angles are
relatively very small

from small Angle Approximation,

Y.K.B.

$\sin\theta \approx \theta$

degree ← θ → radian

$\tan\theta \approx \theta$

$\cos\theta \approx 1$

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

for small Angle,

$$\frac{\frac{\delta_{min}+A}{\cancel{2}}}{\frac{A}{\cancel{2}}} = \mu$$

$$\frac{\delta_{min}+A}{A} = \mu$$

$$\delta_{min}+A = \mu A$$

$$\delta_{min} = \mu A - A$$

for thin prism only

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

↓

Minimum deviation

Homework

→ Derivations x 3

PARISHRAM

2026

Lecture - 06

Ray Optics and Optical Instruments

PHYSICS | **Lecture - 6**

BY - RAKSHAK SIR

Topics *to be covered*

* Dispersion

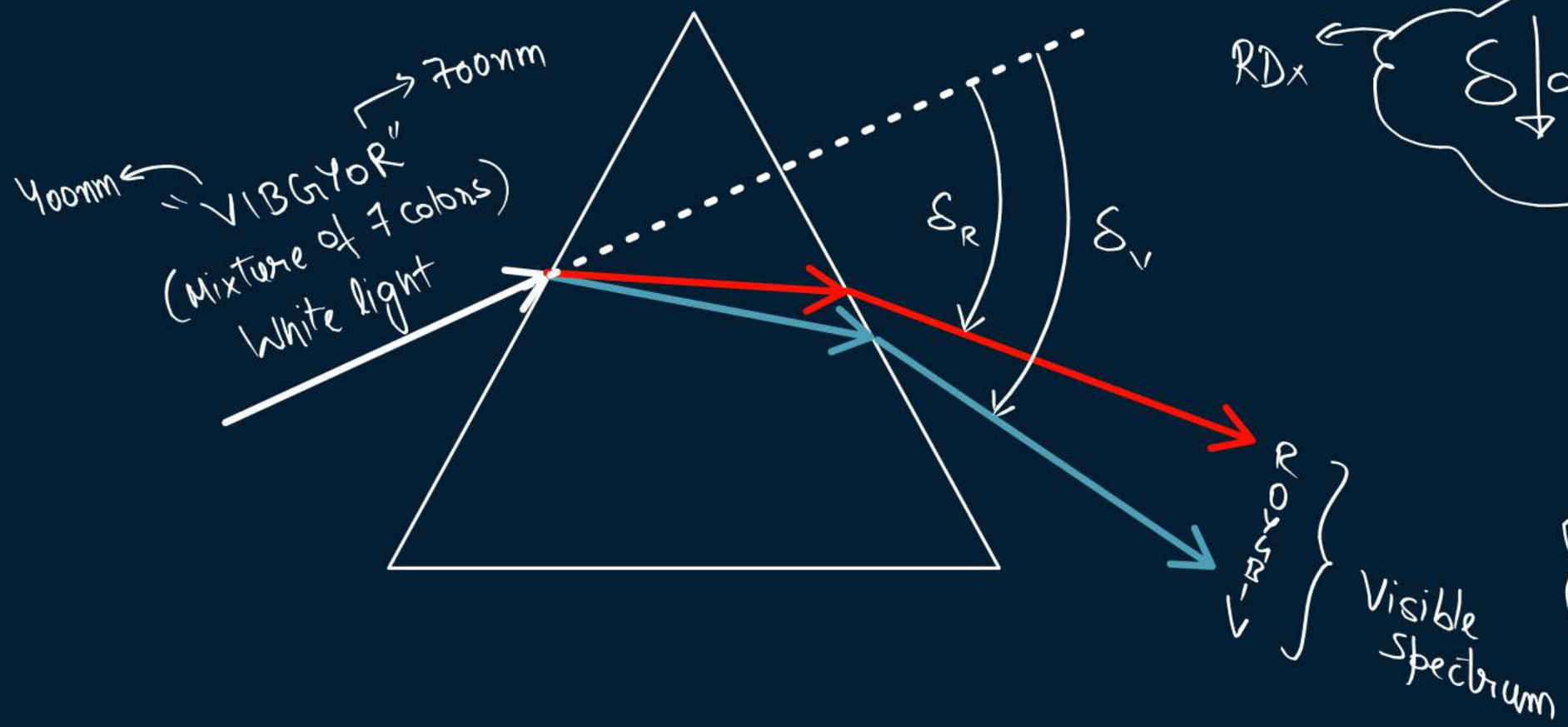
1. Refraction through Spherical Surfaces

2. Lenses

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

Dispersion of Light

- splitting of white light into its constituent colours (VIBGYOR)



RDx

$$\delta \downarrow \propto \mu \downarrow \propto \frac{1}{\lambda \uparrow}$$

$\lambda_R \uparrow \quad \mu_R \downarrow \quad \delta_R \downarrow$

$\lambda_V \downarrow \quad \mu_V \uparrow \quad \delta_V \uparrow$

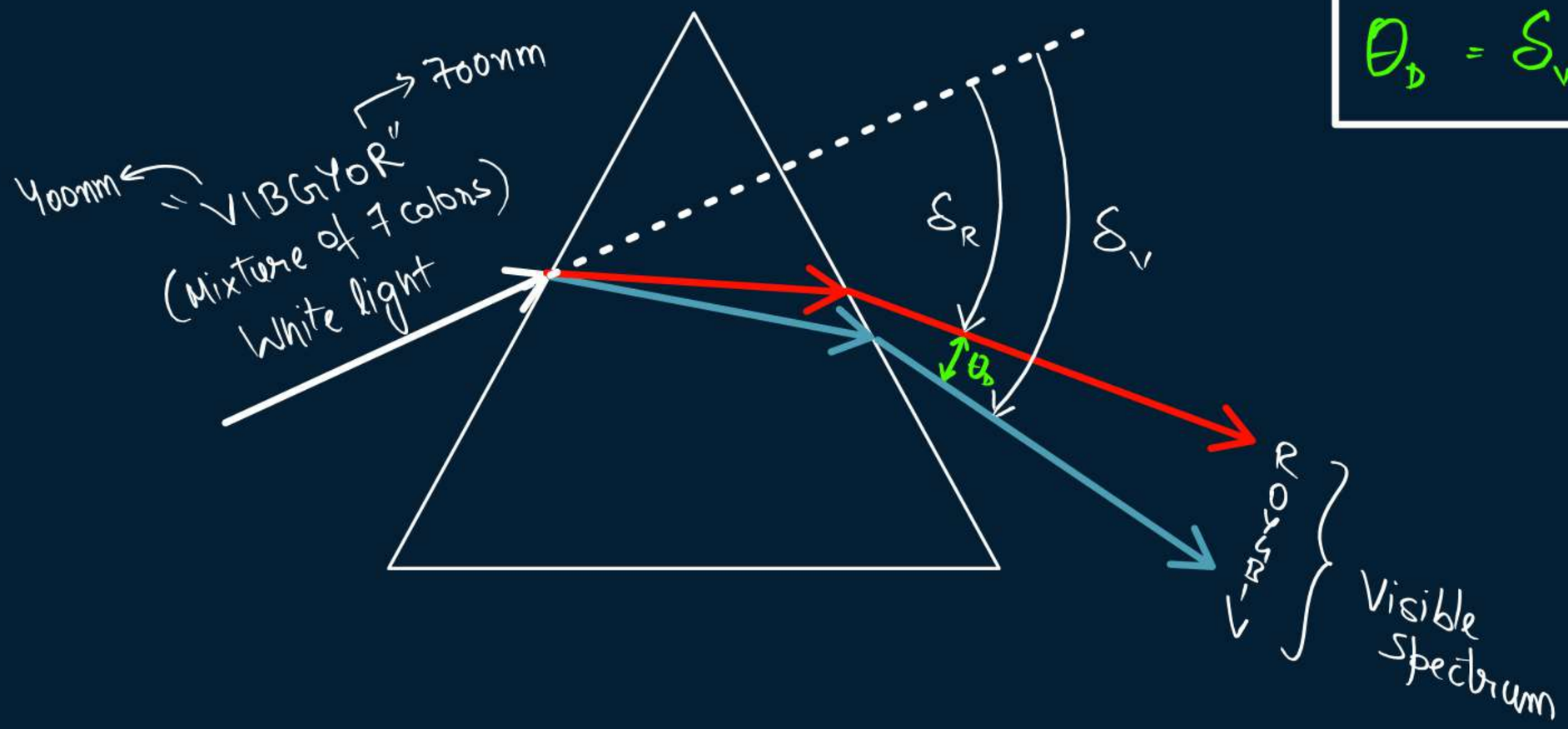
$\lambda_R > \lambda_V$

$\mu_R < \mu_V$

$\delta_R < \delta_V$

* Angular Dispersion (θ_D) → The angle about which all 7 colours are dispersed.

$$\theta_D = \delta_V - \delta_R$$



Dispersive Power (ω) = $\dfrac{\text{Angular Dispersion}}{\text{Average Dispersion}}$

↳ it is the angle of deviation of Yellow

$$\omega = \frac{\theta_D}{\delta_Y}$$

$$\boxed{\omega = \frac{\delta_V - \delta_R}{\delta_Y}}$$

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

$$\omega = \frac{(\mu_V - 1)A - (\mu_R - 1)A}{(\mu_Y - 1)A}$$

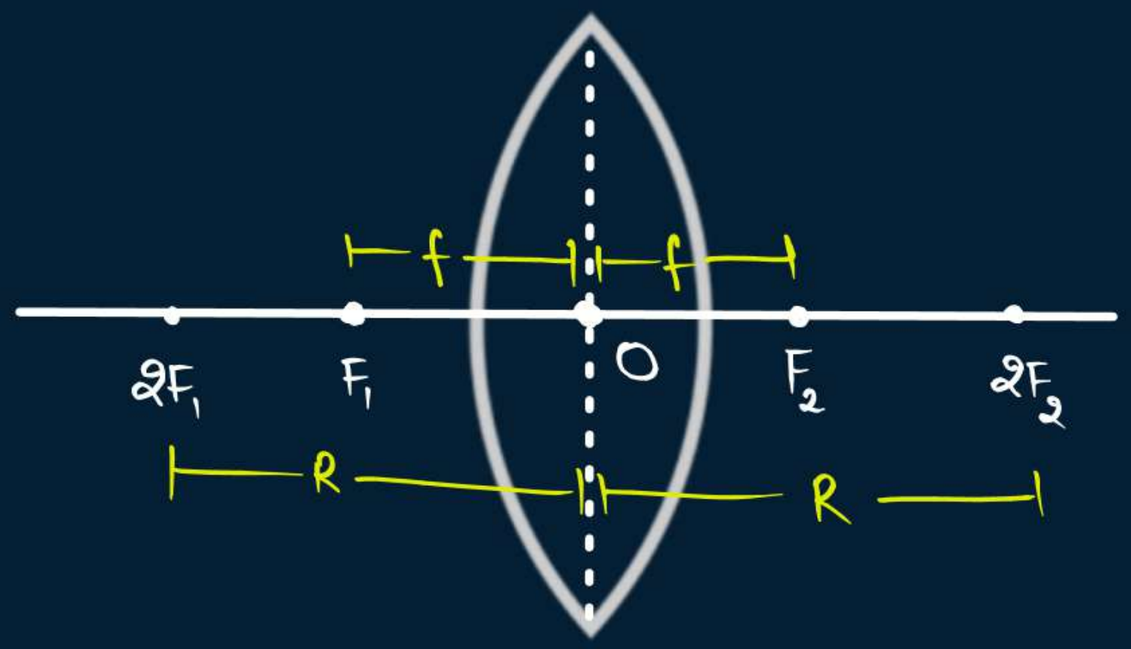
$$= \frac{[(\mu_V - 1) - (\mu_R - 1)]\cancel{A}}{(\mu_Y - 1)\cancel{A}} = \frac{\mu_V \cancel{-1} - \mu_R \cancel{+1}}{\mu_Y - 1} = \frac{\mu_V - \mu_R}{\mu_Y - 1}$$

Lenses

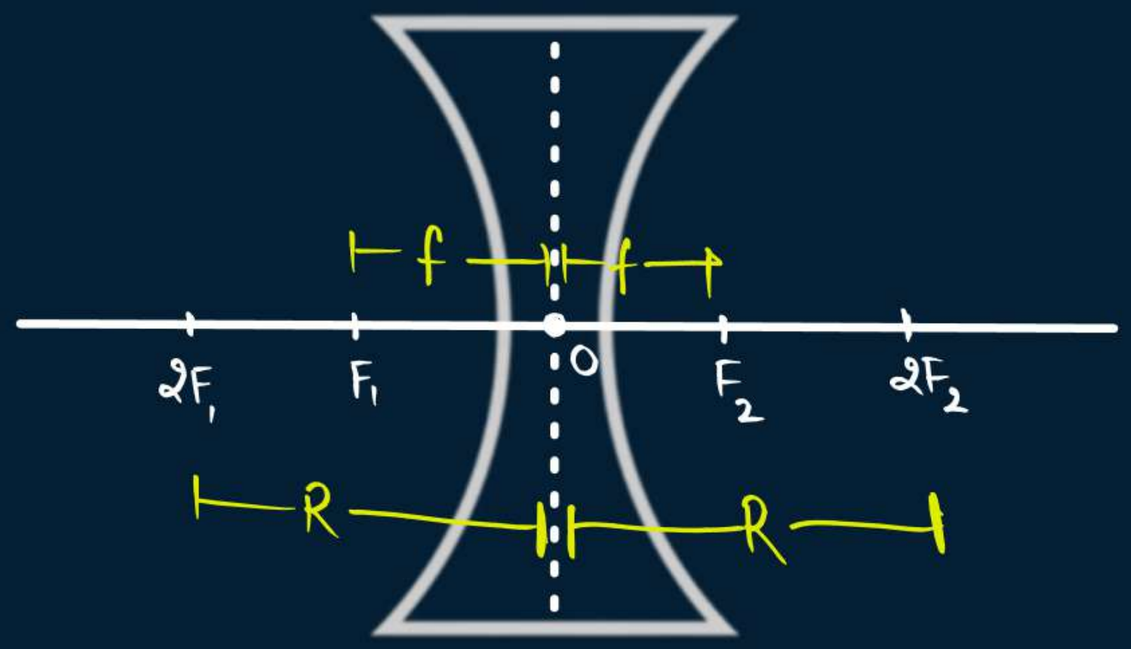
CONVEX

CONCAVE

Geometry of Lenses

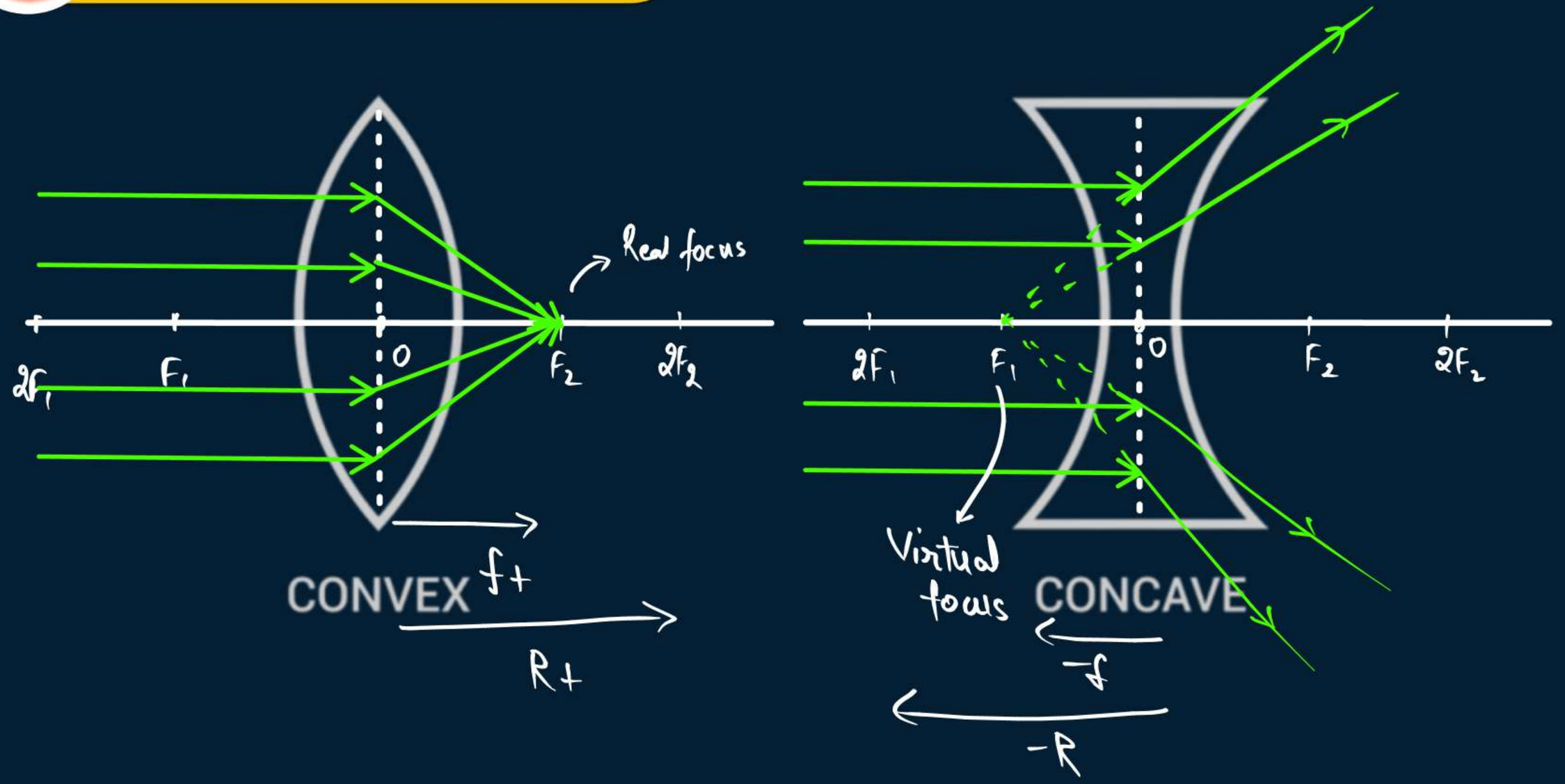


CONVEX



CONCAVE

Nature of Lenses



Lens Formula

1) $\boxed{\frac{1}{f} = \frac{1}{v} - \frac{1}{u}}$ 2) $\boxed{m = \frac{v}{u}}$

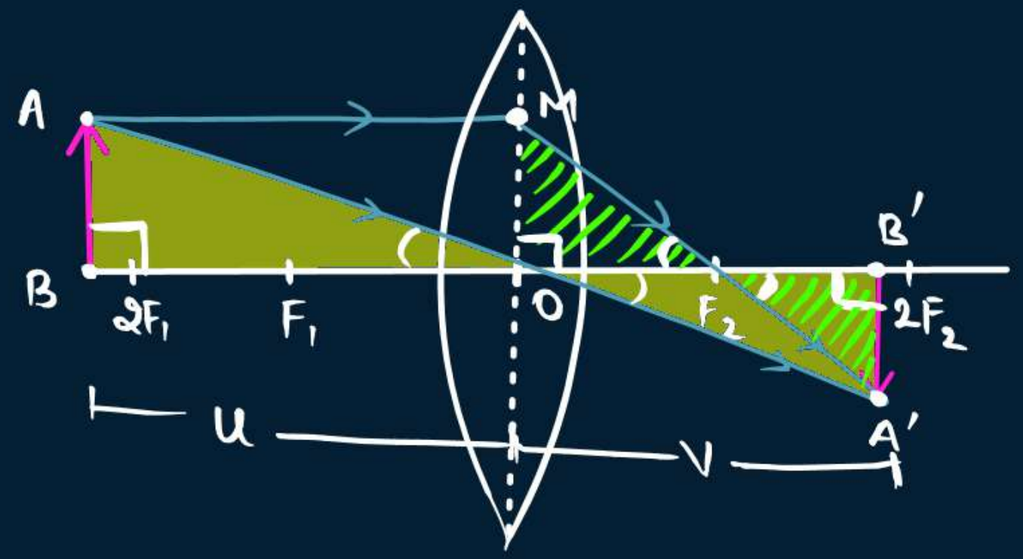
In ΔAOB and $\Delta A'OB'$

$\angle AOB = \angle A'OB'$ (Vertically opp")

$\angle ABO = \angle A'B'O = 90°$

By 'AA', both Δ are similar

$$\frac{AB}{A'B'} = \frac{OB}{OB'} \quad \cdots\cdots (1)$$



In ΔMOF_2 and $\Delta A'B'F_2$

$\angle MF_2O = \angle A'F_2B'$ (Vert. opp.)

$\angle MOF_2 = \angle A'B'F_2 = 90°$

By 'AA' similarity

$$\frac{OM}{A'B'} = \frac{OF_2}{B'F_2}$$

object distance $= OB = -u$

image distance $= OB' = +v$

object height $= AB = +h_o$

image height $= A'B' = -h_i$

Lens Formula

1) $\boxed{\frac{1}{f} = \frac{1}{v} - \frac{1}{u}}$ 2) $\boxed{m = \frac{v}{u}}$

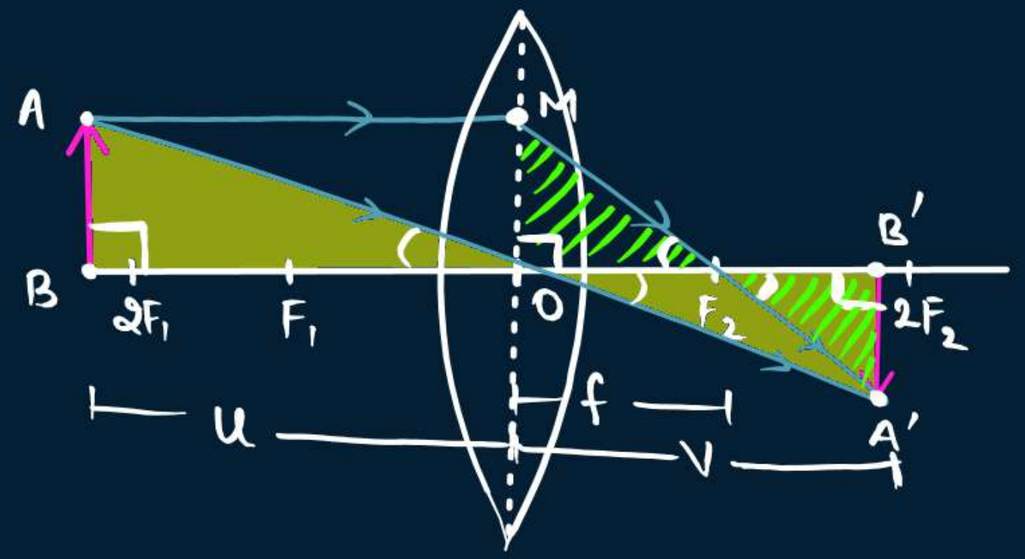
$$\frac{OM}{A'B'} = \frac{OF_2}{B'F_2}$$

$$\frac{AB}{A'B'} = \frac{OF_2}{B'F_2} \quad (OM = AB) \quad \text{----} (2)$$

By equating (1) and (2) ...

$$\frac{OB}{OB'} = \frac{OF_2}{B'F_2}$$

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



focal length $= OF_2 = +f$

object distance $= OB = -u$

image distance $= OB' = +v$

object height $= AB = +h_o$

image height $= A'B' = -h_i$

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

$$-uv + uf = vf$$

divide by 'uvf' both sides

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

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

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

* for $\boxed{m = \frac{v}{u}}$

In ΔAOB and $\Delta A'OB'$

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

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

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

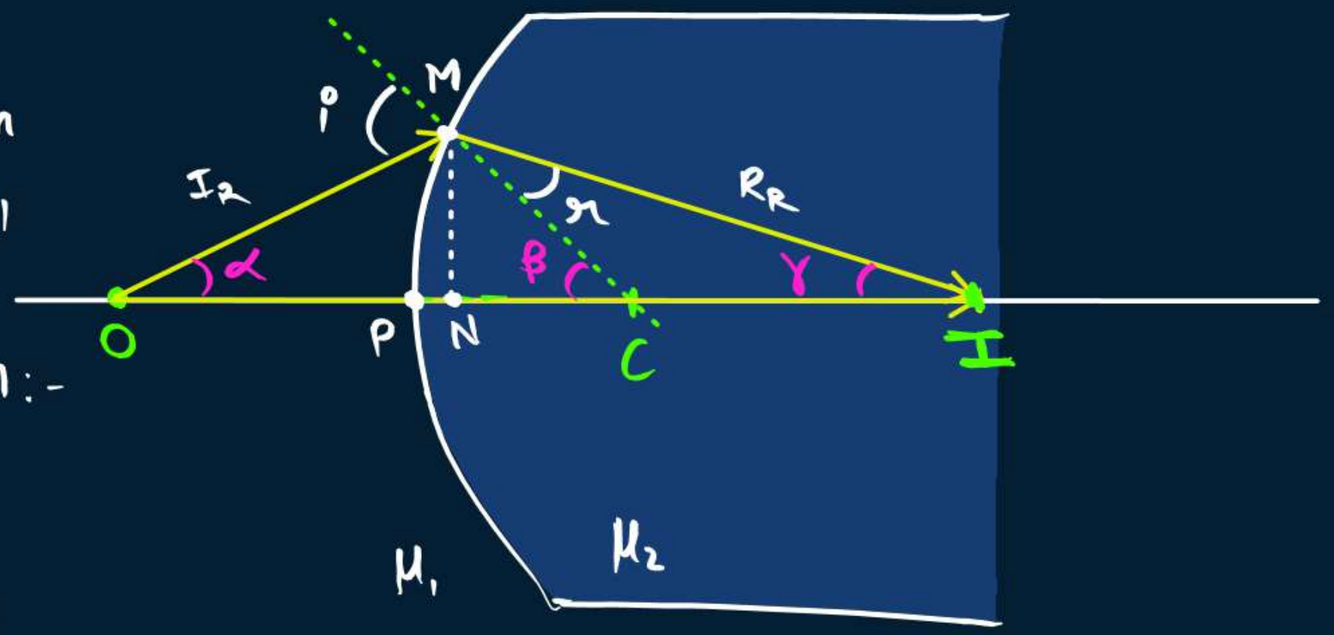
$$\boxed{m = \frac{v}{u}}$$

Refraction through Spherical Surface → Convex

Assumption :-

- Small Angle Approximation

$i, r, \alpha, \beta, \gamma$ are very small



Applying Snell's Law at point M :-

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

$$\mu_1 i = \mu_2 r \quad \text{.... (1)}$$

Y.K.B.

$\sin\theta \approx \theta$

$\tan\theta \approx \theta$

$\cos\theta = 1$

In ΔMNO,

$$\tan\alpha = \frac{MN}{ON}$$

OP → object dist.

IP → img. dist.

CP → Radius of Curvature

Refraction through Spherical Surface → Convex

In ΔMCN,

$$\tan\beta = \frac{MN}{CN}$$

In ΔMIN,

$$\tan\gamma = \frac{MN}{IN}$$

After Small Angle Approx

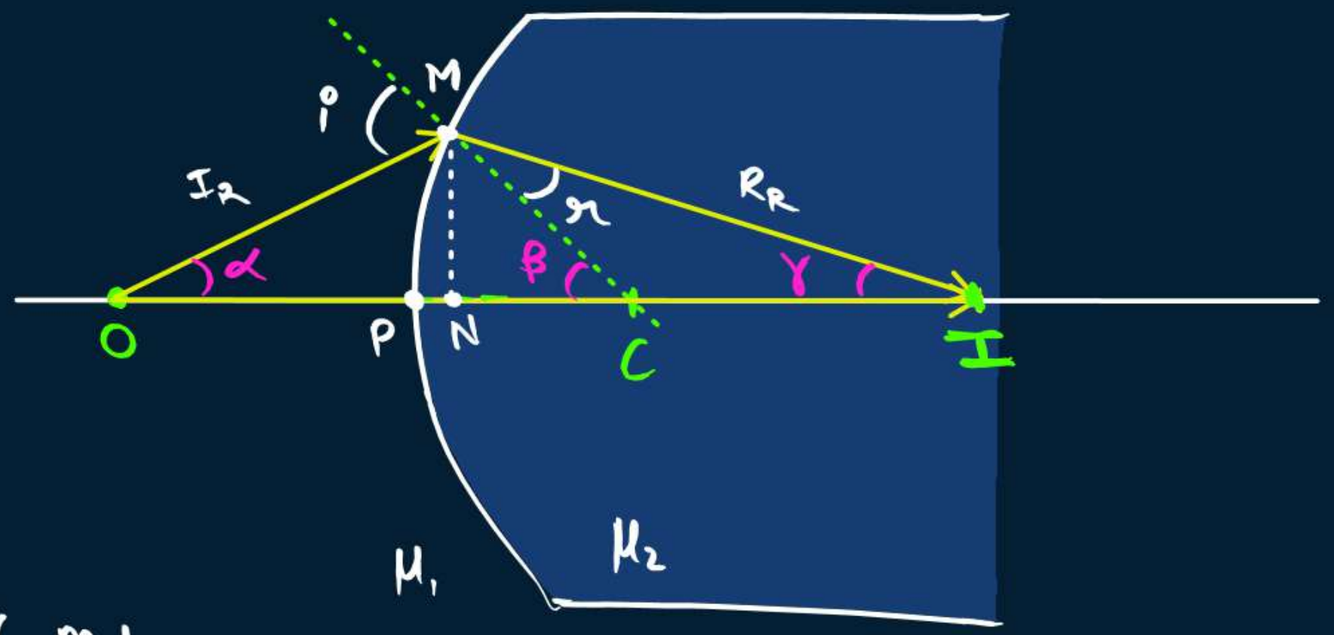
$$\alpha = \frac{MN}{ON}, \quad \beta = \frac{MN}{CN}, \quad \gamma = \frac{MN}{IN}$$

In ΔOMC,

$$i = \alpha + \beta \quad \text{(ext. Angle Prop)}$$

In ΔMCI,

$$\beta = r + \gamma \quad \text{(ext. Angle Prop)}$$



OP → object dist. $= -u$

IP → img. dist. $= +v$

CP → Radius of Curvature $= +R$

Y.K.B.

$\sin\theta \approx \theta$

$\tan\theta \approx \theta$

$\cos\theta = 1$

$$i = \alpha + \beta$$

$$\beta = r + \gamma \Rightarrow r = \beta - \gamma$$

put the value of 'i' and 'r' in eq ①

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

$$\mu_1\left(\frac{MN}{ON} + \frac{MN}{CN}\right) = \mu_2\left(\frac{MN}{CN} - \frac{MN}{IN}\right)$$

Assuming 'N' and 'P' points are very close

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

$$\mu_1\left(\frac{\cancel{MP}^{1}}{OP} + \frac{\cancel{MP}^{1}}{CP}\right) = \mu_2\left(\frac{\cancel{MP}^{1}}{CP} - \frac{\cancel{MP}^{1}}{IP}\right)$$

$$\mu_1\left(\frac{1}{-u} + \frac{1}{+R}\right) = \mu_2\left(\frac{1}{+R} - \frac{1}{+V}\right)$$

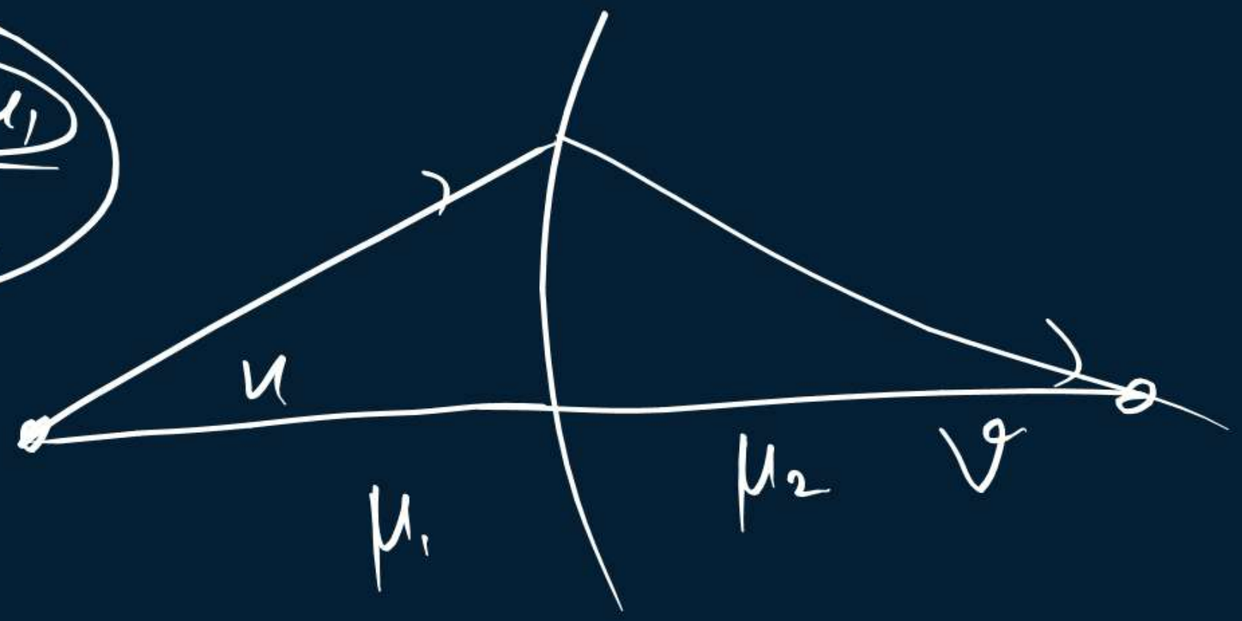
$$-\frac{\mu_1}{u} + \frac{\mu_1}{R} = \frac{\mu_2}{R} - \frac{\mu_2}{V}$$

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

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

RDx Way : Baad Wala – Pehle Waala

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



Homework

- lens formula
- refraction (curved surface)

PARISHRAM

2026

Lecture- 07

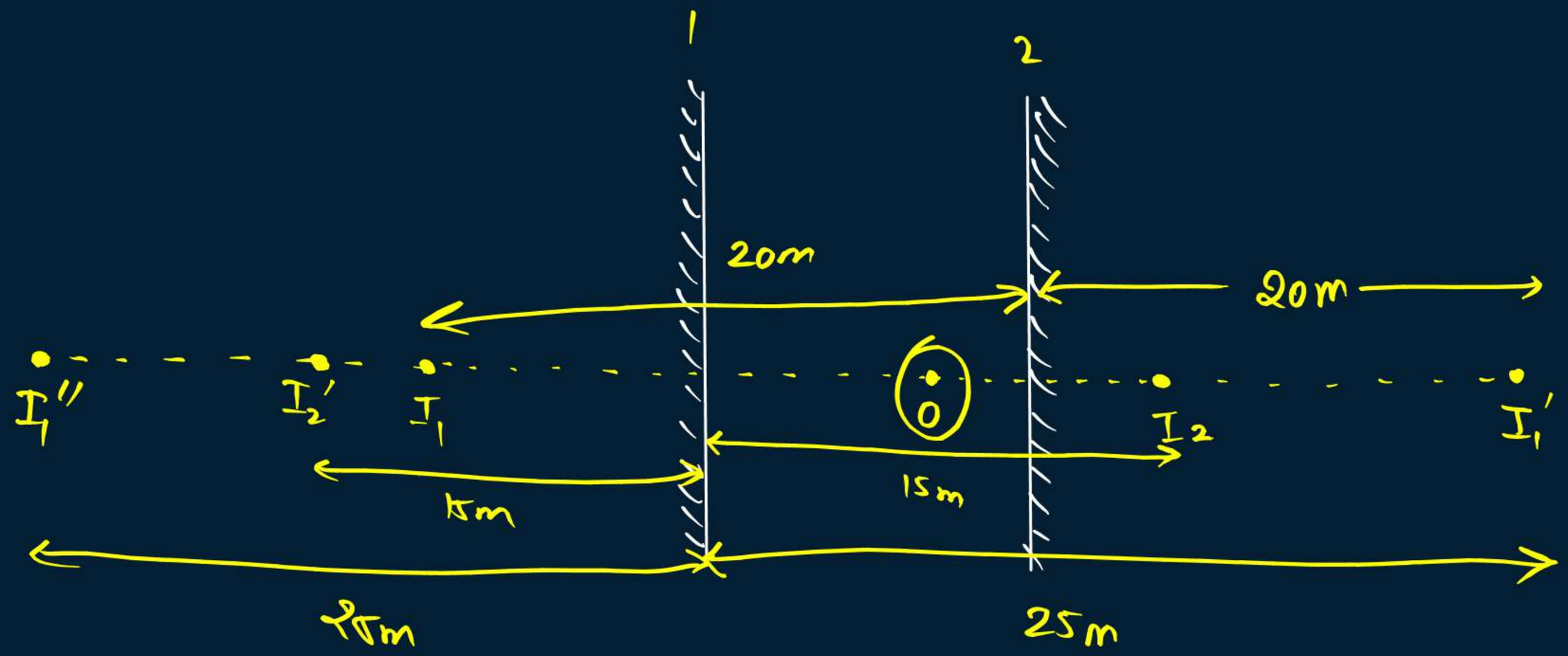
Ray Optics and Optical Instruments

PHYSICS | **Lecture - 7**

BY - RAKSHAK SIR

Topics *to be covered*

1. Lens Maker's Formula ✓
   Refraction Through Lenses
2. Lenses ✓


1
2
20m
20m
I_1''
I_2'
I_1
O
I_2
I_1'
5m
15m
25m
25m

Lens Maker's Formula

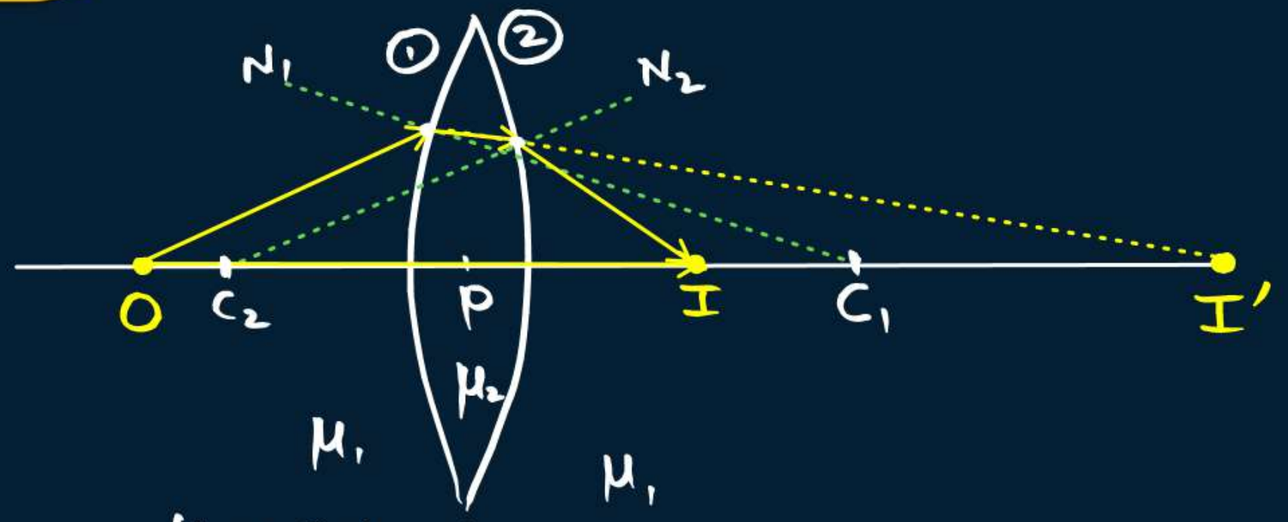
$$\left(\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}\right)$$

The object at position 'O' has the ray refracted by "Surface 1" of the convex lens

$$\frac{\mu_2}{I'P} - \frac{\mu_1}{OP} = \frac{\mu_2 - \mu_1}{C_1P} \quad \text{.....} \quad (1)$$

Now, the ray travels through the lens and gets refracted at "surface 2"

$$\frac{\mu_1}{IP} - \frac{\mu_2}{I'P} = \frac{\mu_1 - \mu_2}{C_2P} \quad \text{.....} \quad (2)$$



μ_1 = refractive index of surrounding
μ_2 = refractive index of lens
OP = Object distance
IP = final image distance = v
I'P = first image distance = Virtual object distance
C_1P = Radius of curvature (Surface 1)
C_2P = Radius of curvature (Surface 2)

Now adding eq ① & ② ...

$$\cancel{\frac{\mu_2}{I'P}} - \frac{\mu_1}{OP} + \frac{\mu_1}{IP} - \cancel{\frac{\mu_2}{I'P}} = \frac{\mu_2 - \mu_1}{C_1P} + \frac{\mu_1 - \mu_2}{C_2P}$$

$$\mu_1\left(\frac{1}{IP} - \frac{1}{OP}\right) = \frac{(\mu_2 - \mu_1)}{C_1P} - \frac{(\mu_2 - \mu_1)}{C_2P}$$

$$\frac{1}{IP} - \frac{1}{OP} = \frac{(\mu_2 - \mu_1)}{\mu_1}\left[\frac{1}{C_1P} - \frac{1}{C_2P}\right]$$

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

$$\boxed{\frac{1}{f} = (\mu_{2,1} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$$

With sign convention

Hi

Use

karna

QUESTION

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

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

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.

(A) 20 cm

(B) 30 cm

(C) 40 cm

(D) 10 cm

Given :-

$R_1 = +15\,cm$

$R_2 = -30\,cm$

$\mu_2 = \mu_g = \frac{3}{2}$

$f = ?$

$\mu_1 = 1$ (Air)

$$\frac{1}{f} = (\mu_{2,1} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

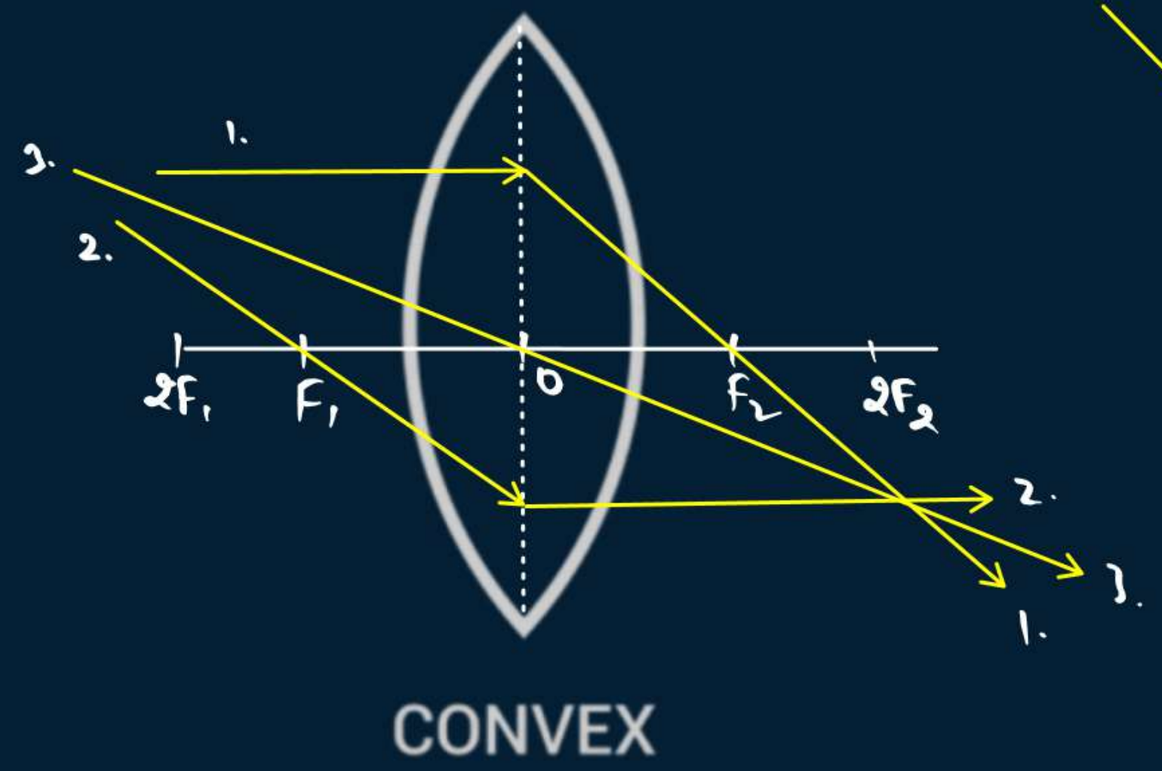
$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

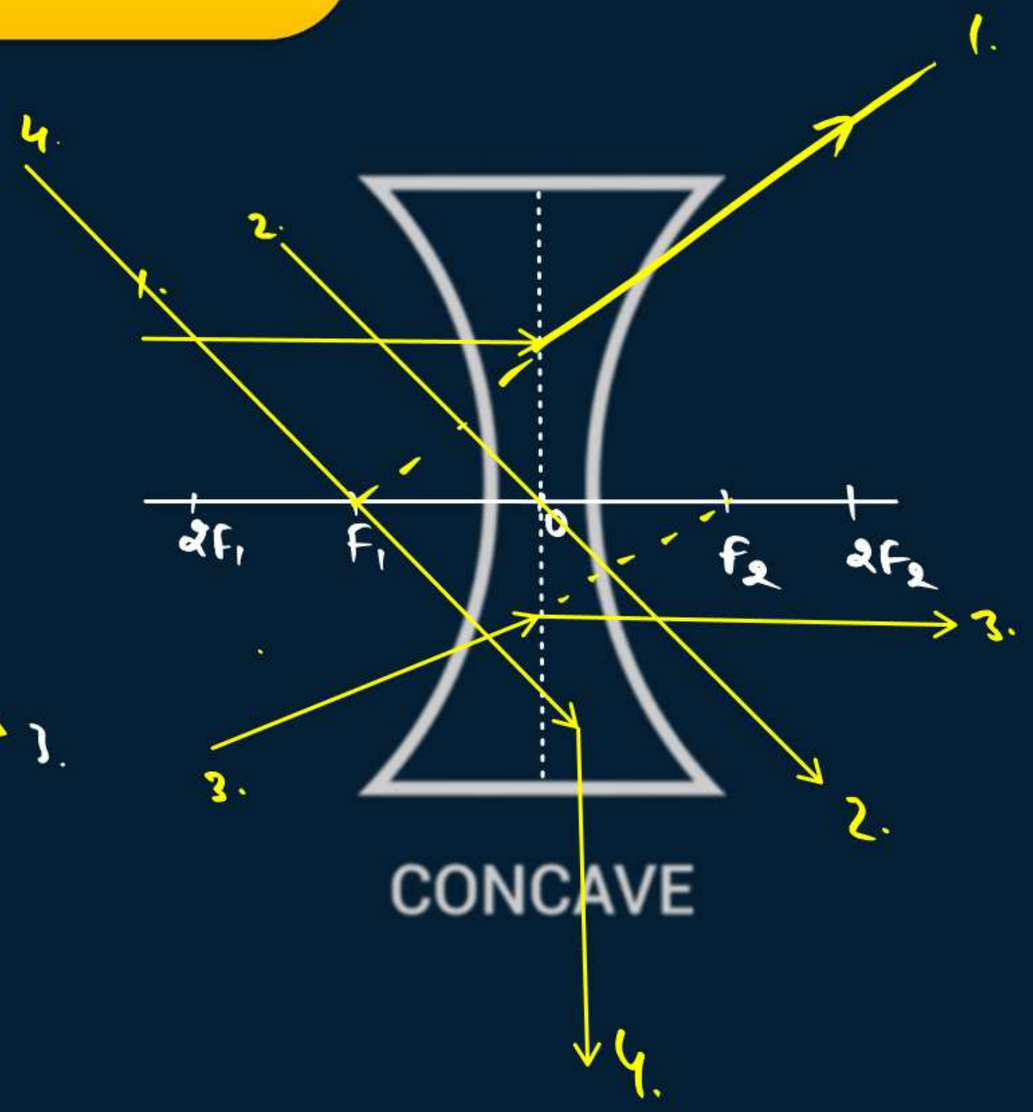
$$\frac{1}{f} = (\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{15} - \frac{1}{-30}\right)$$

$$\frac{1}{f} = \frac{1}{2}\left(\frac{1}{15} + \frac{1}{30}\right) = \frac{1}{2} \times \frac{2+1}{30} = \frac{1}{2} \times \frac{3}{30} = \frac{1}{20}$$

Rules for image formation



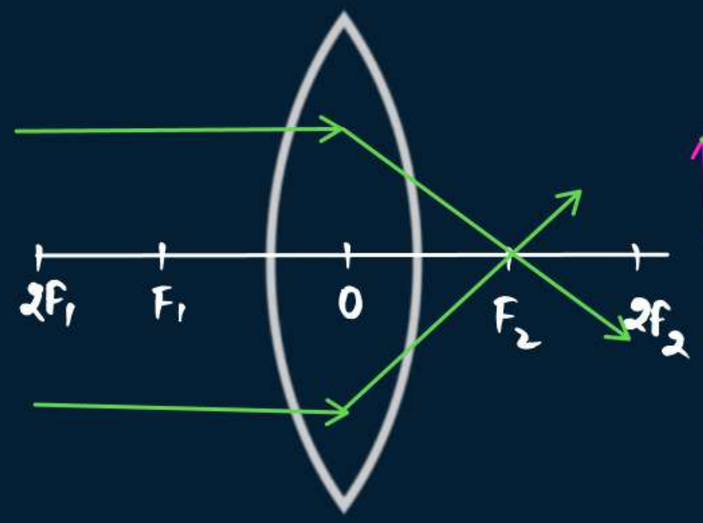


Cases

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

Image formation through convex lens (1)

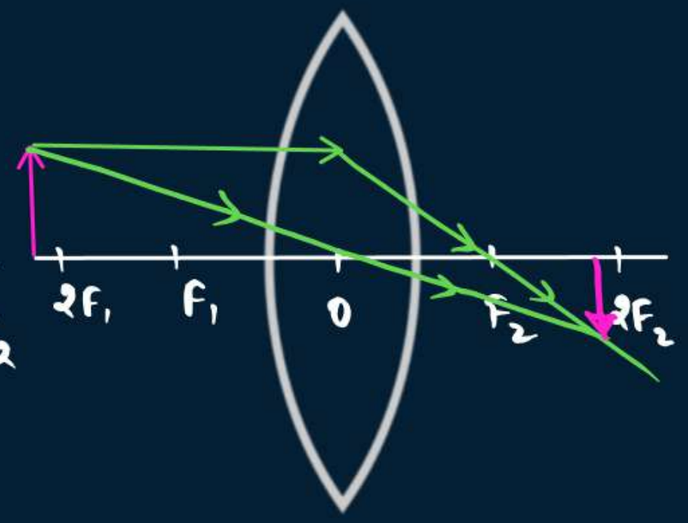
1. Obj at ∞



CONVEX

At F_2, Real, Inverted, highly diminished

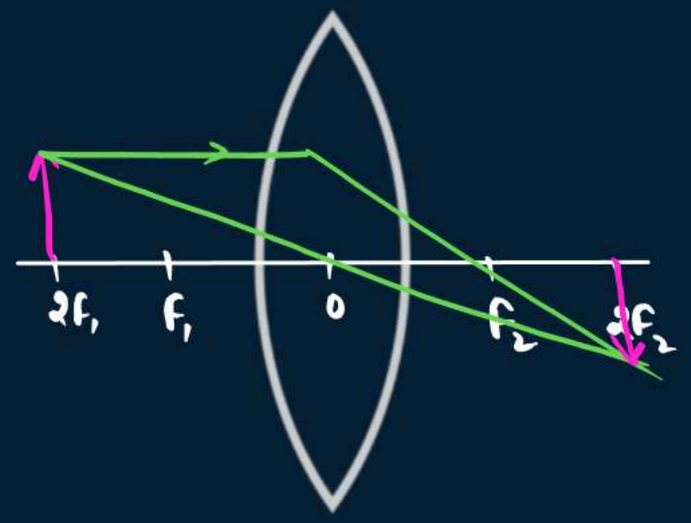
2. Object beyond $2F_1$



CONVEX

B/w F_2 and $2F_2$, Diminished Real, inverted

3. At $2F_1$

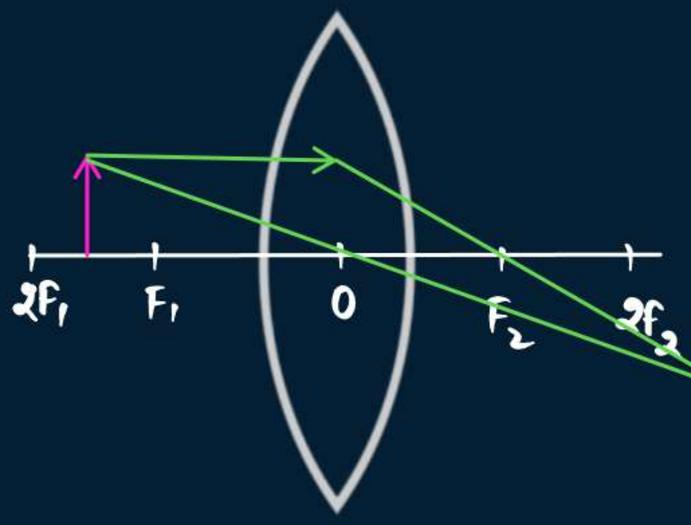


CONVEX

At $2F_2$, Same Size Real, inverted

Image formation through convex lens (2)

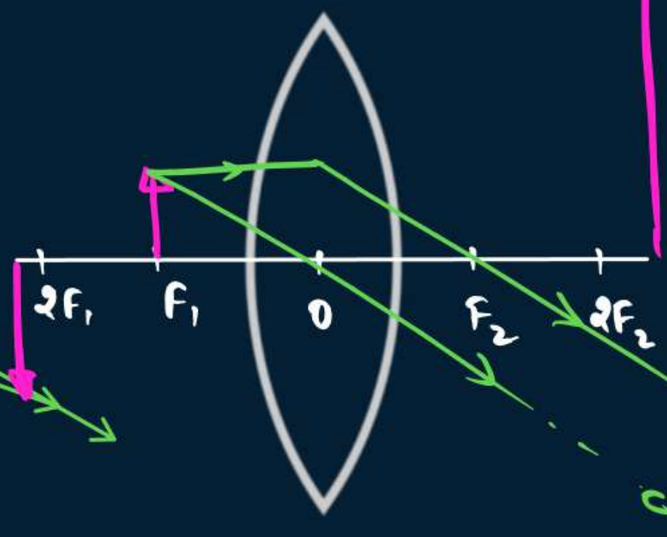
4. B/w F_1 and $2F_1$



CONVEX

Beyond $2F_2$, Enlarged, Real, inverted

5. At F_1

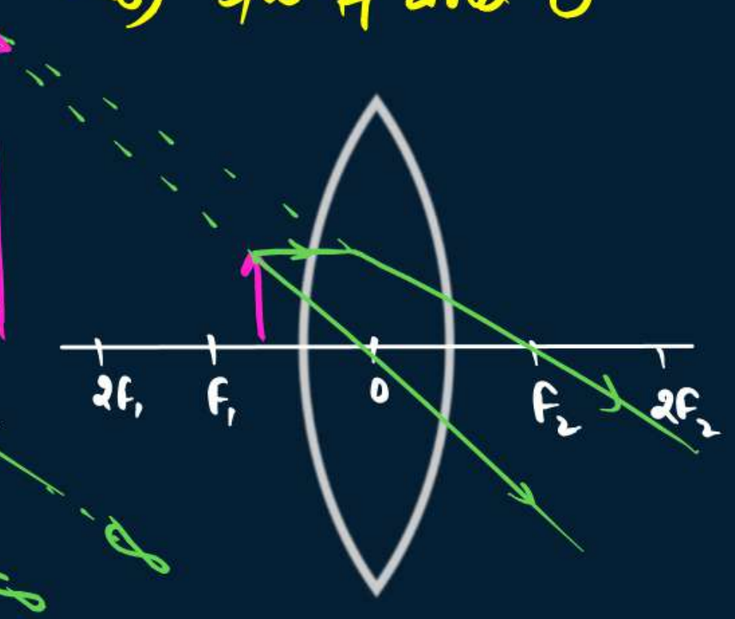


CONVEX

At ∞, R, I, Highly Enlarged

VVIP

6) b/w F_1 and O



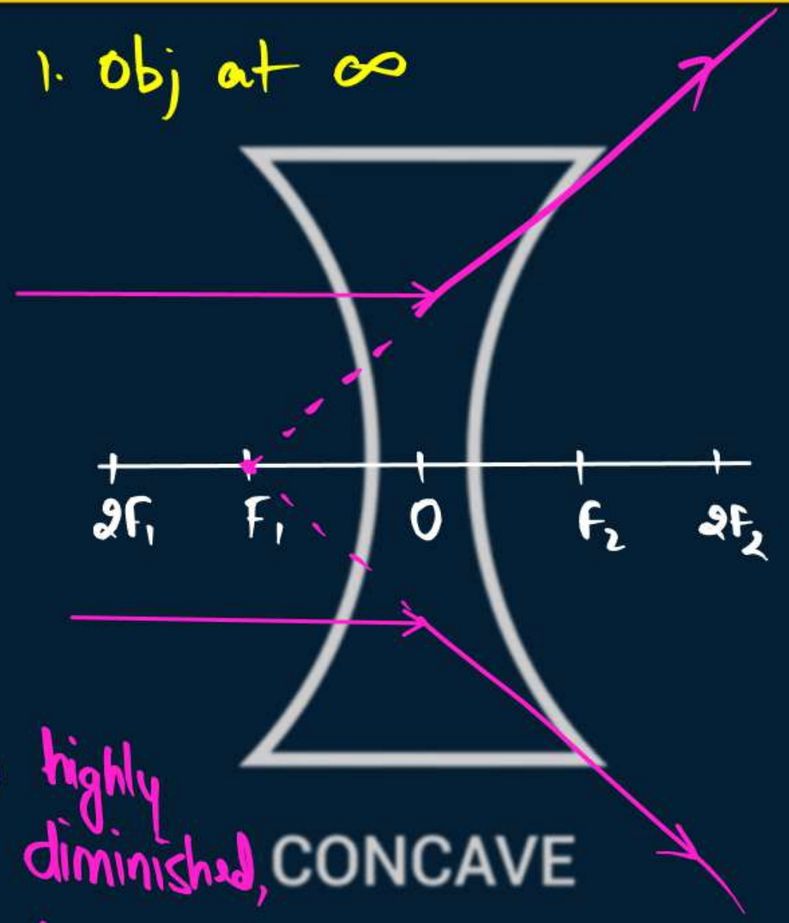
CONVEX

Same side of the lens, Enlarged, Virtual, Erect

Image formation through concave lens

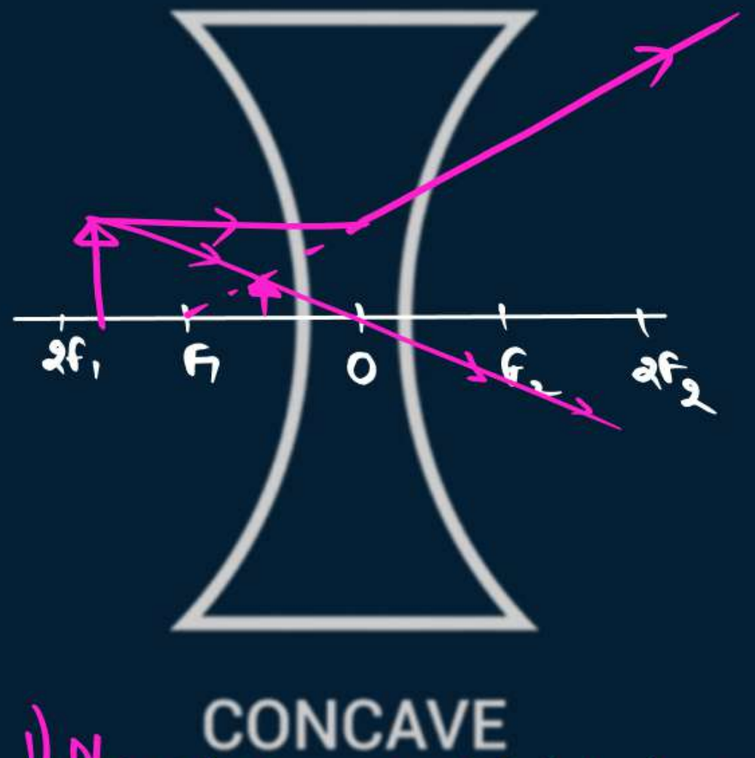
VED

1. obj at ∞



At F_1, highly diminished, V, E

2. obj at finite dist.



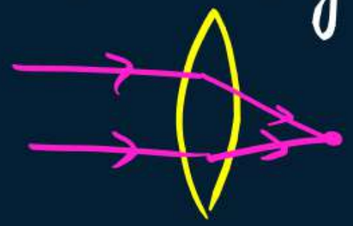
1) B/w O & F_1 2) Diminished 3) V 4) E

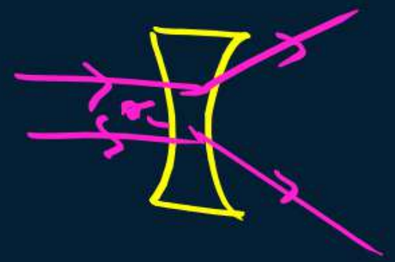
RDx Points

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.

Normally

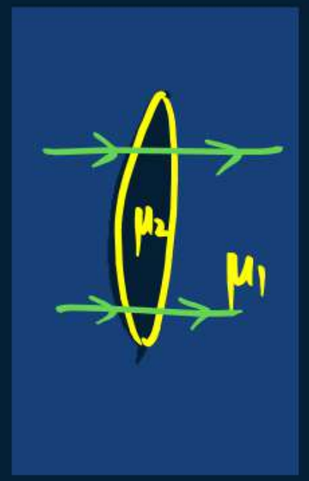
Surrounding -> rarer





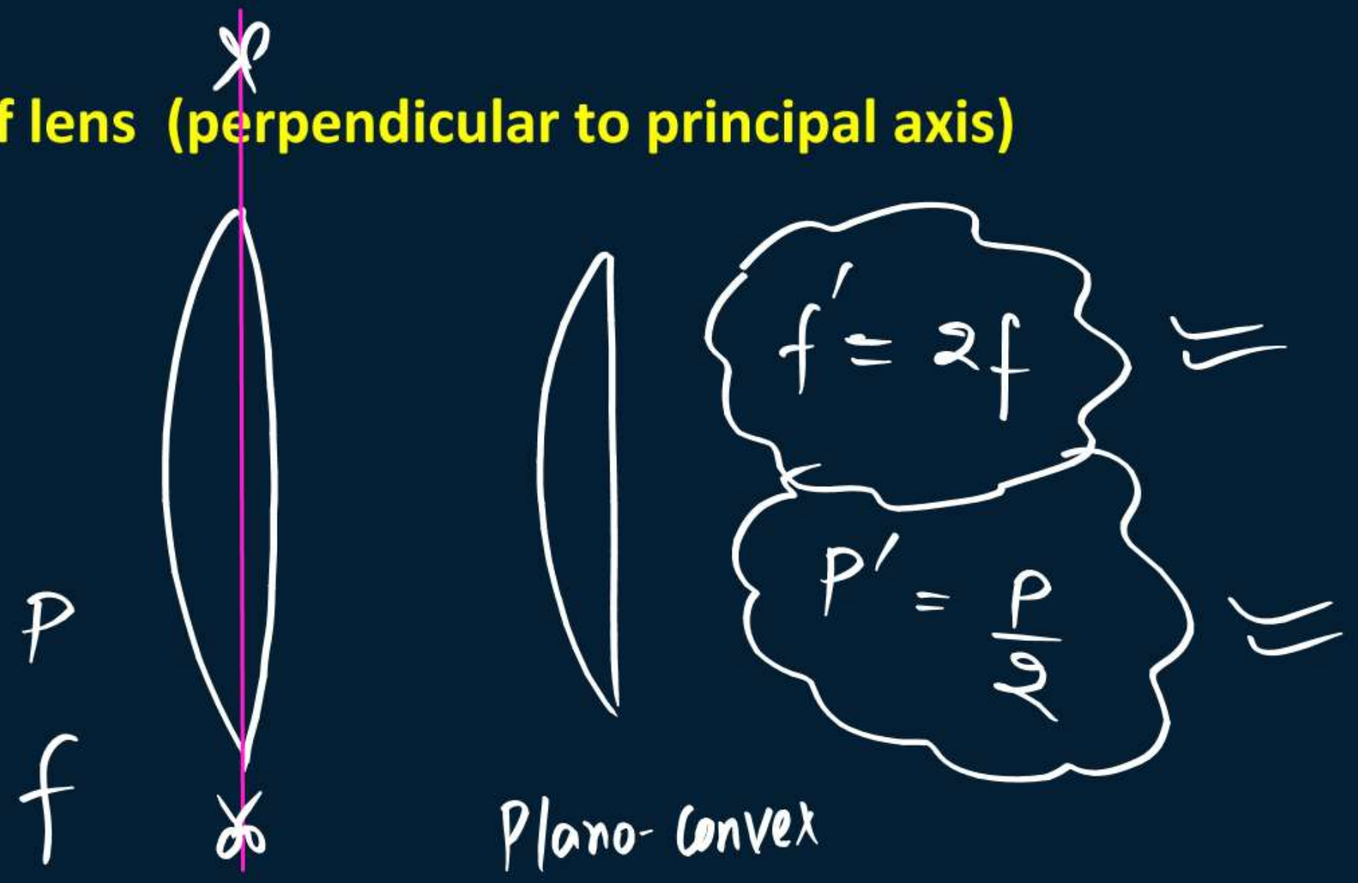
$\mu_1 > \mu_2$

Surrounding denser

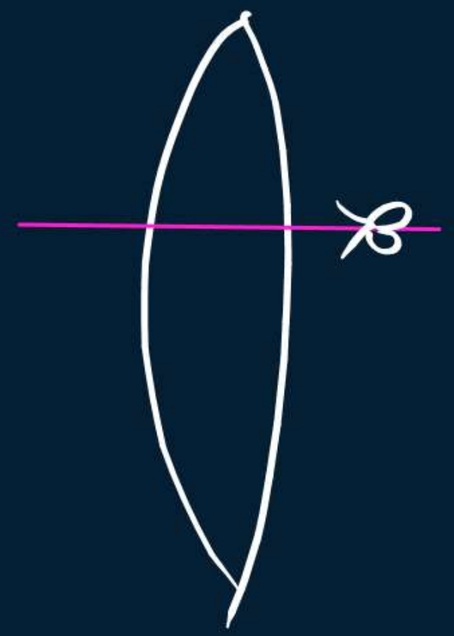


$\mu_1 = \mu_2$

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



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



P, f

P, f → Remain Same

Aperture reduce

Power of a lens

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

Dioptre ← P, f → metre

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

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

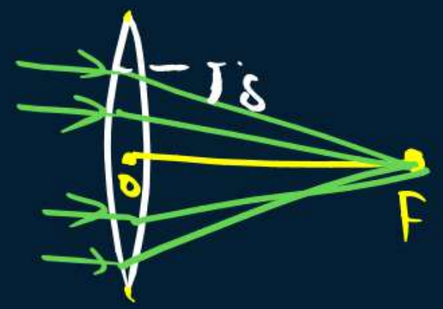
RDx → P, Dioptre → f

RDx Feel

Motta
f↓

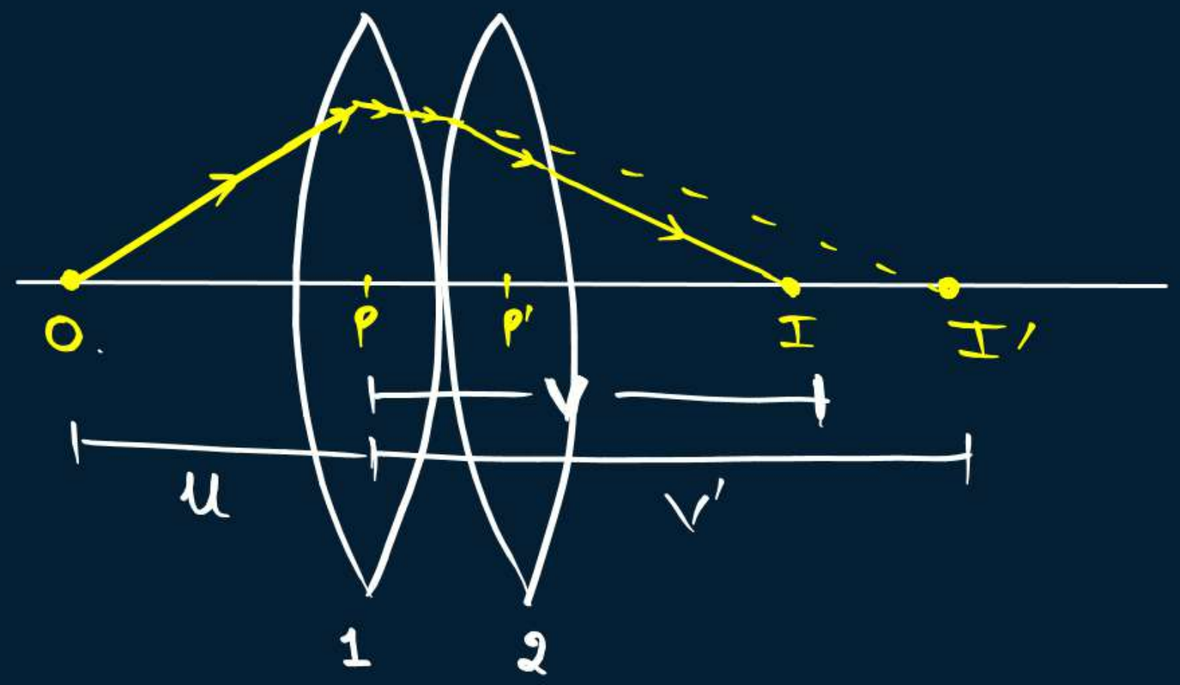
δ↑ Convergence↑
P↑ f↓

Patla
f↑



δ↓ Convergence↓
P↓ f↑

Power of a lenses in contact (Thin lenses)



f_1 = focal length of 1st lens

f_2 = " " " 2nd "

Since the lenses are considered thin, P and P' are very close to each other.

refraction by 1st lens,

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

refraction by 2nd lens,

$$\frac{1}{f_2} = \frac{1}{v} - \frac{1}{v'} \quad \text{---} (2)$$

Adding both ..

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

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

$$\boxed{\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{f_{net}}} \Rightarrow \text{Net focal length}$$

We know that

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

$$\boxed{P_1 + P_2 = P_{net}} \Rightarrow \text{Net Power}$$

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

(A) 50

(B) infinite

(C) zero

(D) 25

$f_1 = 25cm$ $f_2 = -25cm$

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{f_{net}}$$

$$\frac{1}{25} - \frac{1}{25} = \frac{1}{f_{net}}$$

$$0 = \frac{1}{f_{net}}$$

$$P_{net} = \frac{1}{f_{net}}$$

$$f_{net} = \infty$$

$$P_{net} = \frac{1}{\infty} = 0$$

QUESTION

A convex lens of focal length 80 cm and a concave lens of focal length 50 cm are combined together. What will be their resulting power?

(A) +6.5 D

(B) –6.5 D

(C) +7.5 D

(D) –0.75 D

$f_1 = +80\,cm$

$f_2 = -50\,cm$

$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$

$\frac{1}{f_{net}} = \frac{1}{80} - \frac{1}{50}$

$= \frac{1}{10}\left(\frac{1}{8} - \frac{1}{5}\right)$

$= \frac{1}{10}\left(\frac{5-8}{40}\right)$

$\frac{1}{f_{net}} = \frac{-3}{400}$

$f_{net} = -\frac{400}{3}\,cm$

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

$= \frac{100}{-\frac{400}{3}} = -\frac{3}{4}$

$= -0.75\,D$

Homework

→ Derivation x 3

→ Sawal try

PARISHRAM

2026

Lecture - 08

Ray Optics and Optical Instruments

PHYSICS | **Lecture - 8**

BY - RAKSHAK SIR

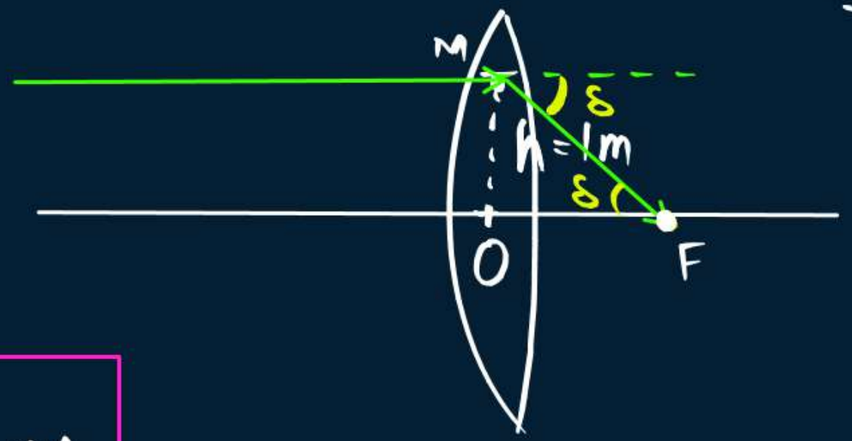
Topics *to be covered*

1. Misc. Topics
2. Optical Instruments

Derivation of Power of a Lens

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

Power of a Lens is defined as the tangent of the angle by which it converges or diverges the parallel beam of light falling on unit distance from optical center



In ΔOFM,

$$\tan\delta = \frac{OM}{OF}$$

$$\tan\delta = \frac{h}{f}$$

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

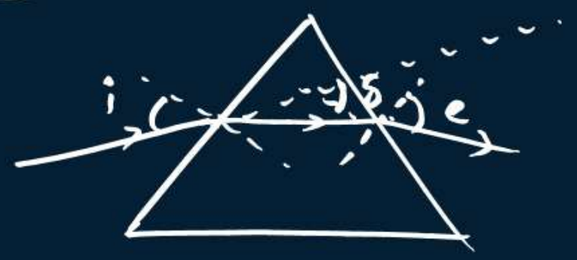
(Small Angle Approx)

Power of the lens $\Longleftrightarrow$ $P = \frac{1}{f}$

Total Magnification of combination of lenses :-

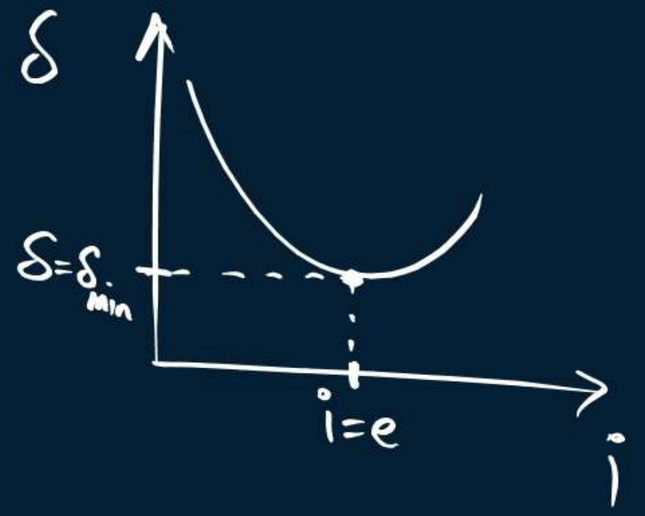
$$m_{total} = m_1 \times m_2 \times m_3$$

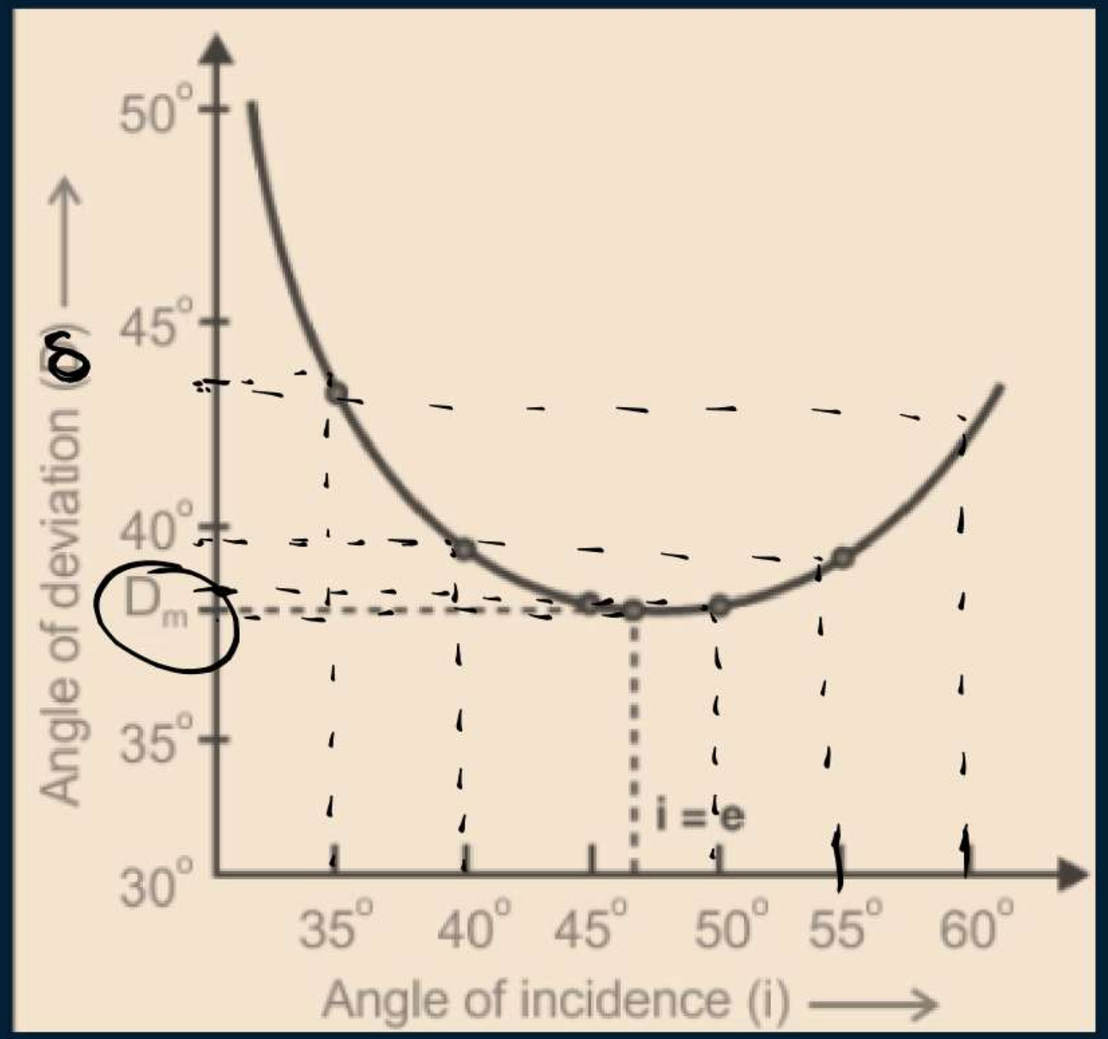
Graph in Prism



When $i = e$

$\delta = \delta_{min}$





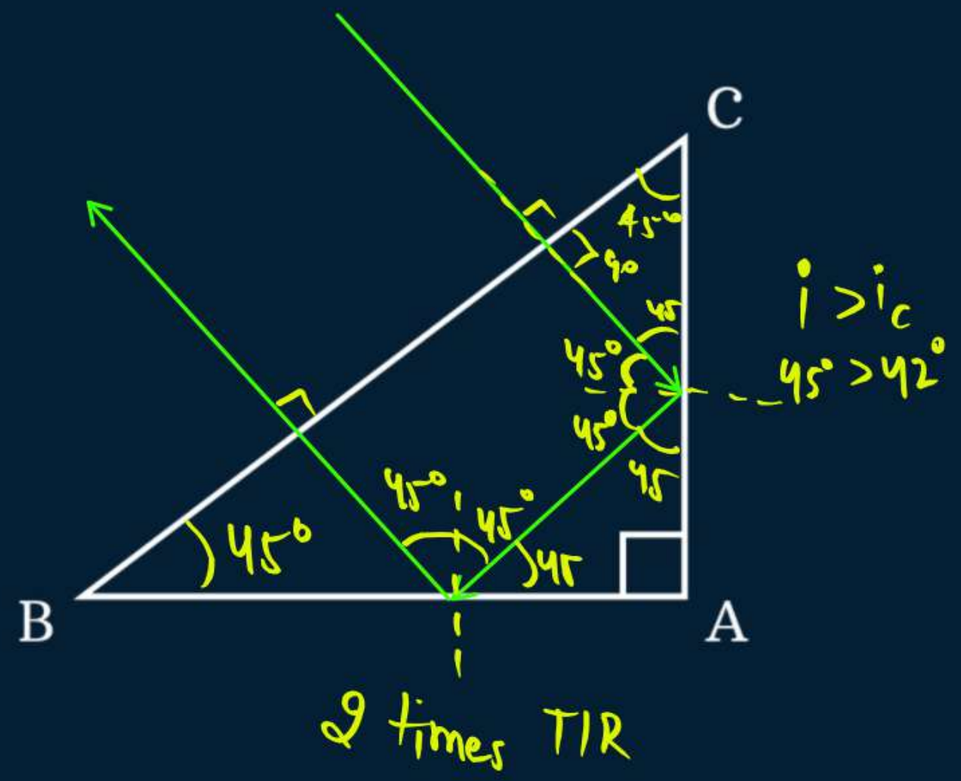
TIR in Prisms

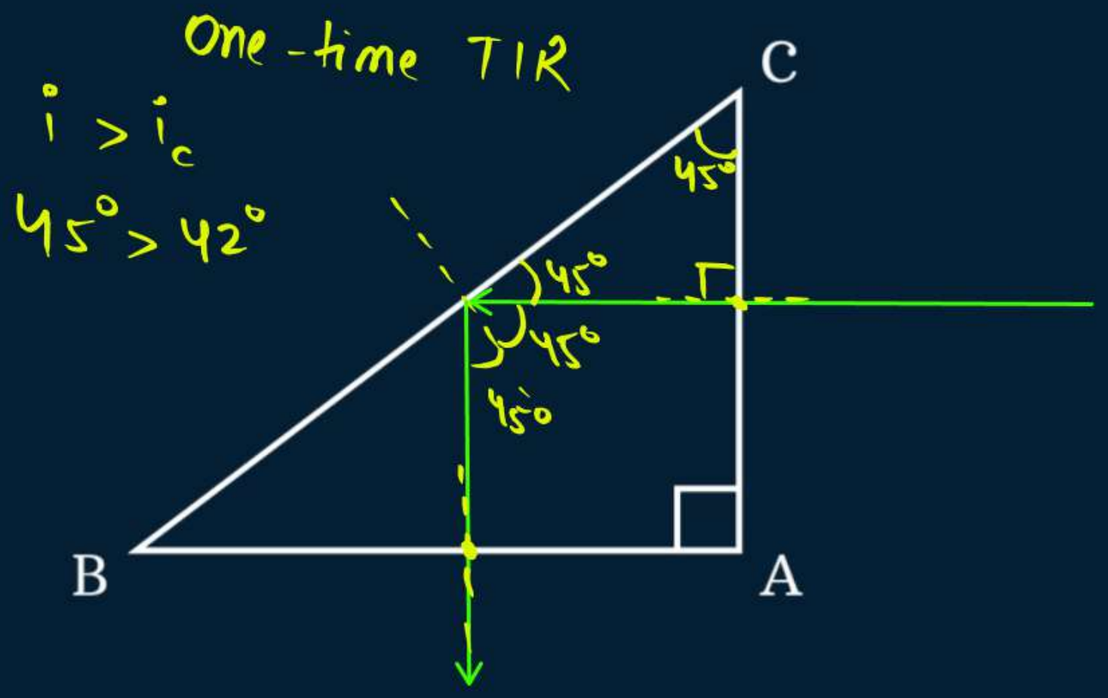
$\boxed{\sin i_c = \mu}$ → $i_c = \sin^{-1}(\mu)$

$i_c = 42^\circ$

$\mu =$

The critical angle in glass, specifically for light traveling from glass to air, is approximately 41.8 degrees





TIR in Prisms

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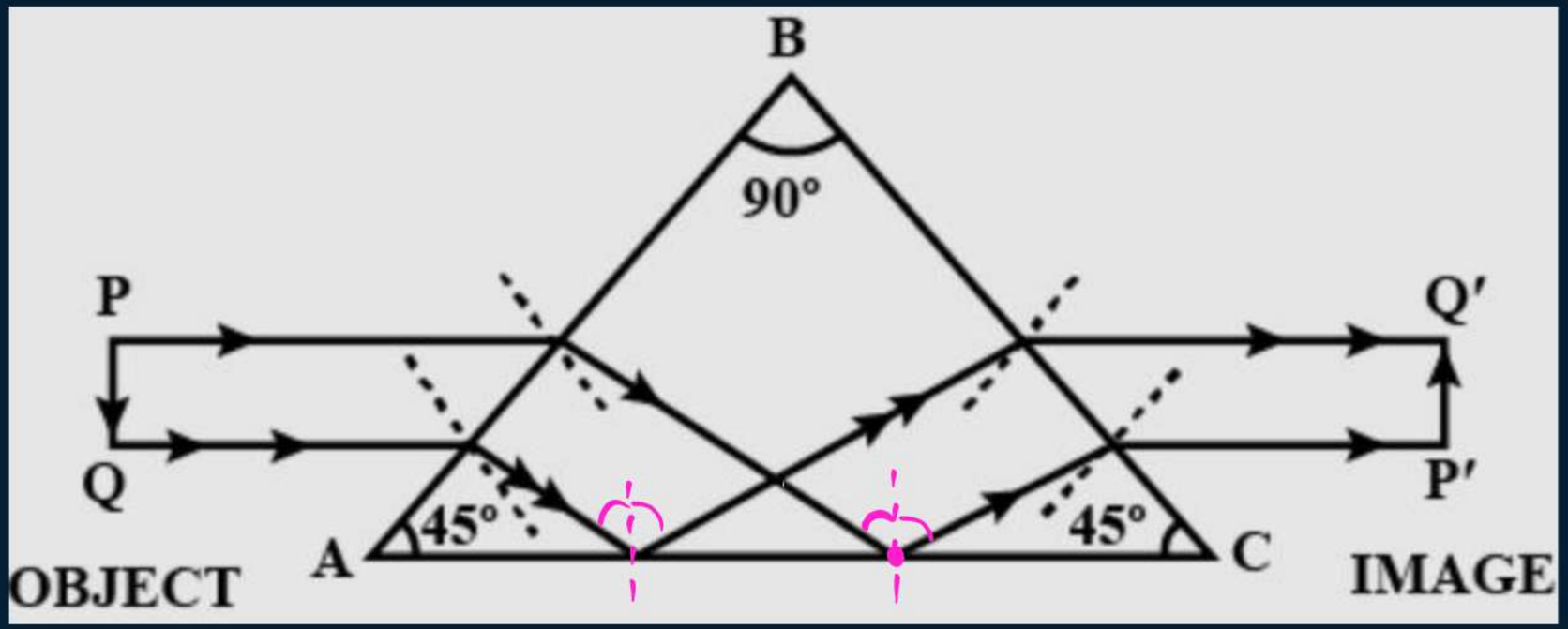


Optical Instruments

1) Simple Microscope (CID Waala Lens)

2) Compound Microscope (Bio Lab)

3) Astronomical Telescope

4) Reflecting type Telescope (Diagram only)

Visual Angle $\Rightarrow$ Angle subtended by an object on the eye

* Magnifying Power (M.P.)

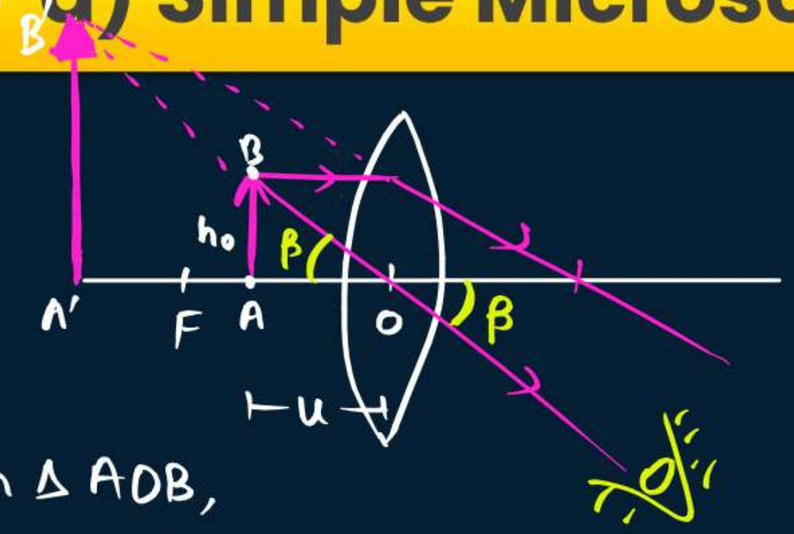
$$M.P. = \frac{\text{Visual Angle subtended by final image (using instrument)}}{\text{Visual Angle subtended on naked eye}} = \frac{\beta}{\alpha}$$

Naked Eye

SI Unit 'x'

$$\boxed{M.P. = \frac{\beta}{\alpha}}$$

a) Simple Microscope



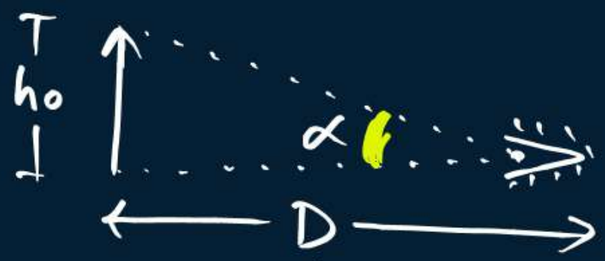
In ΔAOB,

$$\tan\beta = \frac{P}{B} = \frac{h_0}{u}$$

$$\boxed{\beta = \frac{h_0}{u}}$$ (Small Angle Approx.)

$$M.P. = \frac{\beta}{\alpha} = \frac{\frac{h_0}{u}}{\frac{h_0}{D}} = \frac{D}{u}$$

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



Naked eye

↳ Near point = 25cm

L.D.D.V – Least Distance of Distinct Vision

$$\tan\alpha = \frac{P}{B} = \frac{h_0}{D}$$

By small Angle Approx.

$$\boxed{\alpha = \frac{h_0}{D}}$$

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

(Far pt.) 1. Relaxed Eye

$V = \infty$

$u = -u$

Applying lens formula,

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

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

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

$$\boxed{u = f}$$

$$* \boxed{MP = \frac{D}{f}}$$ → Min.^{m} magnification

2. Strained Eye (Near pt.)

$V = -D$

$u = -u$

Applying lens formula,

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

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

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

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

$$M.P. = D\left(\frac{1}{f} + \frac{1}{D}\right)$$

$$\boxed{M.P. = 1 + \frac{D}{f}}$$ → Max.^{m} M.

QUESTION

Maximum magnification produced by simple microscope of focal length $f = 5$ cm is

(A) 5

(B) 7

(C) 6

(D) 9

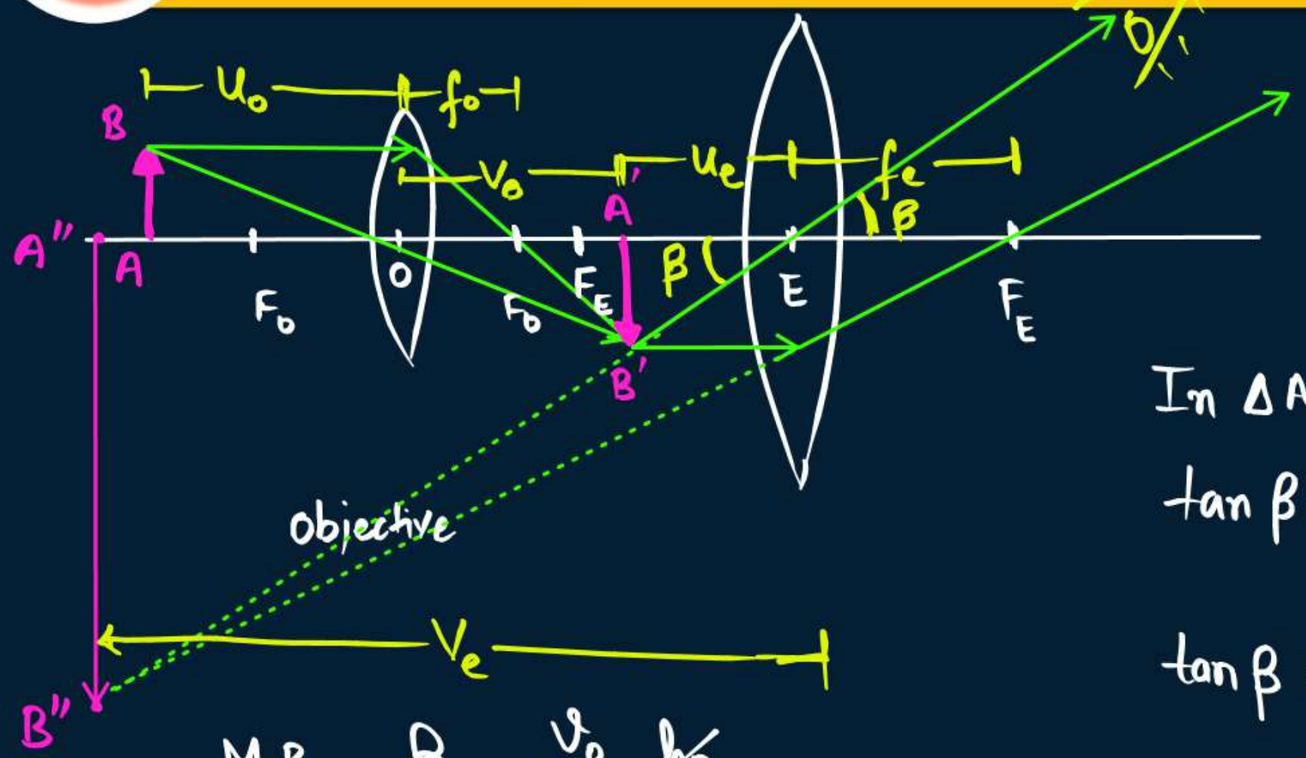
$$M.P. = 1 + \frac{D}{f}$$

$$= 1 + \frac{\cancel{25}\,5}{\cancel{5}}$$

$$= 6$$

Length of the tube ← $L = |V_o| + |u_e|$

b) Compound Microscope



$$M.P. = \frac{\beta}{\alpha} = \frac{\frac{v_o}{u_o}\cdot\frac{h_o}{u_e}}{\frac{h_o}{D}} = \frac{V_o}{u_o}\frac{D}{u_e}$$

$$\boxed{M.P. = \frac{V_o}{u_o}\frac{D}{u_e}}$$

In $\Delta A'B'E$,

$$\tan\beta = \frac{A'B'}{A'E}$$

$$\tan\beta = \frac{h_i}{u_e}$$

$$\boxed{\beta = \frac{V_o}{u_o}\frac{h_o}{u_e}}$$

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

$$\boxed{\alpha = \frac{h_o}{D}}$$

Linear magnification of Obj lens:-

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

$$m_o = \frac{h_i}{h_o} = \frac{V_o}{u_o}$$

$$h_i = \frac{V_o}{u_o} \times h_o$$

$$M.P. = \left(\frac{V_0}{u_0}\right) \times \left(\frac{D}{u_e}\right)$$

$$M.P. = m_0 \times m_e$$

1. Relaxed Eye (Far pt.)

$V = -\infty$

$u = -u_e$

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

$$\frac{1}{f_e} = \frac{1}{-\infty} - \frac{1}{-u_e}$$

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

$$\boxed{u_e = f_e}$$

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

$$\boxed{L = |V_0| + |f_e|}$$

2. Strained Eye (Near pt.)

$V = -D$

$u = -u_e$

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

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

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

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

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

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

$$M.P. = \frac{V_0}{u_0} D \left(\frac{1}{f_e} + \frac{1}{D}\right)$$

$$\boxed{M.P. = \frac{V_0}{u_0}\left(1 + \frac{D}{f_e}\right)}$$

$$\boxed{L = |V_0| + \left|\frac{f_e D}{f_e + D}\right|}$$

Normal Adjustment

object at Focus

$u_o \approx f_o$

$V_o \Rightarrow$ Maximized

$L = V_o + \cancel{u_e}^{\,0}$

$$\boxed{L = V_o}$$

$$M.P. = \frac{V_o}{u_o}\frac{D}{f_e}$$

$$\boxed{M.P. = \frac{L}{f_o}\frac{D}{f_e}}$$

$$M.P. \propto \frac{1}{f_o f_e}$$

QUESTION

M.W.

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.

A. 50, 8.5 cm

B. 30, 8.5 cm

C. 20, 6.5 cm

D. 45, 7.5 cm

Homework

- Notes × 3 Practice
- Lecture repeat!!!
- DPP ×

PARISHRAM

2026

Lecture- 09

Ray Optics and Optical Instruments

PHYSICS | **Lecture - 9**

BY - RAKSHAK SIR

Topics *to be covered*

1. Misc. Topics
2. Optical Instruments (Part - 2)

QUESTION

H.W.

$L = |V_0| + |f_e|$
$= 6 + 2.5 = 8.5\,cm$

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

M.P. = ?

$L = ?$

(A) 50, 8.5 cm

(B) 30, 8.5 cm

(C) 20, 6.5 cm

(D) 45, 7.5 cm

$f_0 = 1\,cm$

$f_e = 2.5\,cm$

$u_0 = -1.2\,cm$

$$\text{M.P.}_{(\text{relaxed})} = \frac{V_0}{u_0} \cdot \frac{D}{f_e}$$

$$\frac{1}{f_0} = \frac{1}{V_0} - \frac{1}{u_0}$$

$$\frac{1}{1} = \frac{1}{V_0} - \frac{1}{-1.2}$$

$$1 - \frac{10}{12} = \frac{1}{V_0}$$

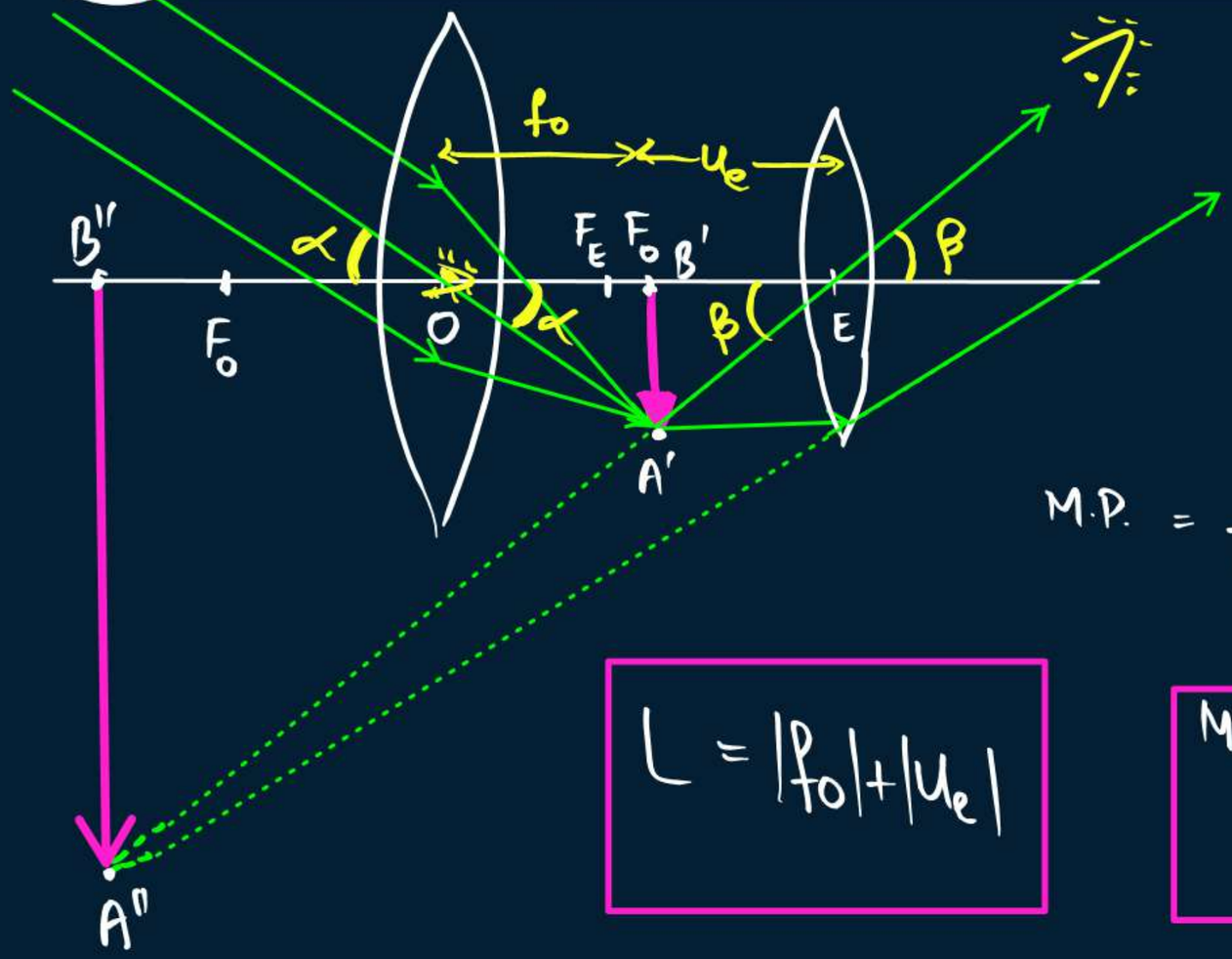
$$\frac{1}{6} = \frac{1}{V_0}$$

$V_0 = 6$

$$\text{M.P.} = \frac{6}{12} \times \frac{25}{2.5} \times 100$$

M.P. = 50

c) Astronomical Telescope



In $\Delta OA'B'$,

$$\tan\alpha = \frac{A'B'}{OB'}$$

$$\boxed{\alpha = \frac{h_i}{f_o}}$$

In $\Delta A'B'E$

$$\tan\beta = \frac{A'B'}{EB'}$$

$$\boxed{\beta = \frac{h_i}{u_e}}$$

$$M.P. = \frac{\beta}{\alpha} = \frac{\frac{\cancel{h_i}}{u_e}}{\frac{\cancel{h_i}}{f_o}}$$

$$\boxed{L = |f_o| + |u_e|}$$

$$\boxed{M.P. = \frac{f_o}{u_e}}$$

$$\boxed{M.P. = \frac{f_o}{u_e}}$$

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

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

1) Relaxed

$$V_e = \infty$$
$$u = -u_e$$

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

$$\frac{1}{f_e} = \frac{1}{V_e} - \frac{1}{-u_e}$$

$$\frac{1}{f_e} = \cancel{\frac{1}{\infty}}^{\,0} + \frac{1}{u_e}$$

$$u_e = f_e$$

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

$$\boxed{L = |f_o| + |f_e|}$$

2) Strained

$$V_e = -D$$
$$u = -u_e$$

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

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

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

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

$$M.P. = f_o\left(\frac{1}{f_e} + \frac{1}{D}\right)$$

$$\boxed{M.P. = \frac{f_o}{f_e} + \frac{f_o}{D}}$$

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

QUESTION

Relaxed eye

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]

(A) 18 cm, 2 cm

(B) 11 cm, 9 cm

(C) 10 cm, 10 cm

(D) 15 cm, 5 cm

$L = 20\,cm$

$f_o + f_e = 20\,cm$

$f_o = 18\,cm$

$f_e = 2\,cm$

$M.P. = 9$

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

QUESTION

$f_o \uparrow$

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

[CBSE AIPMT 2014]

A. microscope will increase but that of telescope decrease

B. microscope and telescope both will increase

C. microscope and telescope both will decrease

D. microscope will decrease but that of telescope will increase

Tele

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

Micro

$M.P. \downarrow \propto \frac{1}{f_o f_e}$

QUESTION

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

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

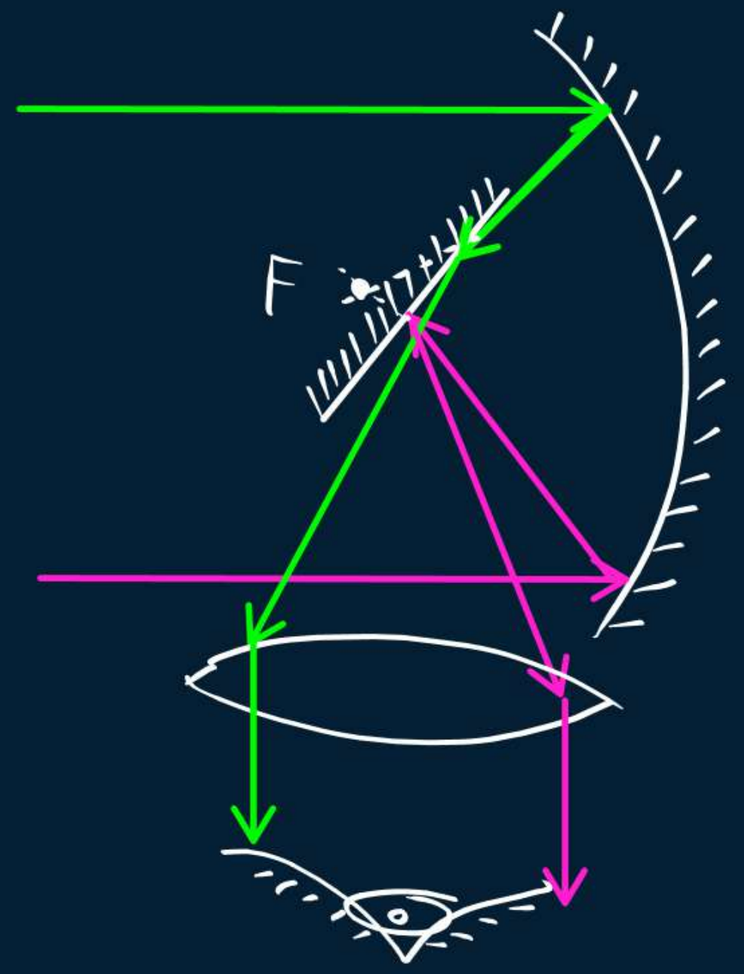
(B) a large area of the objective ensures better light gathering power T

(C) a large aperture provides a better resolution T

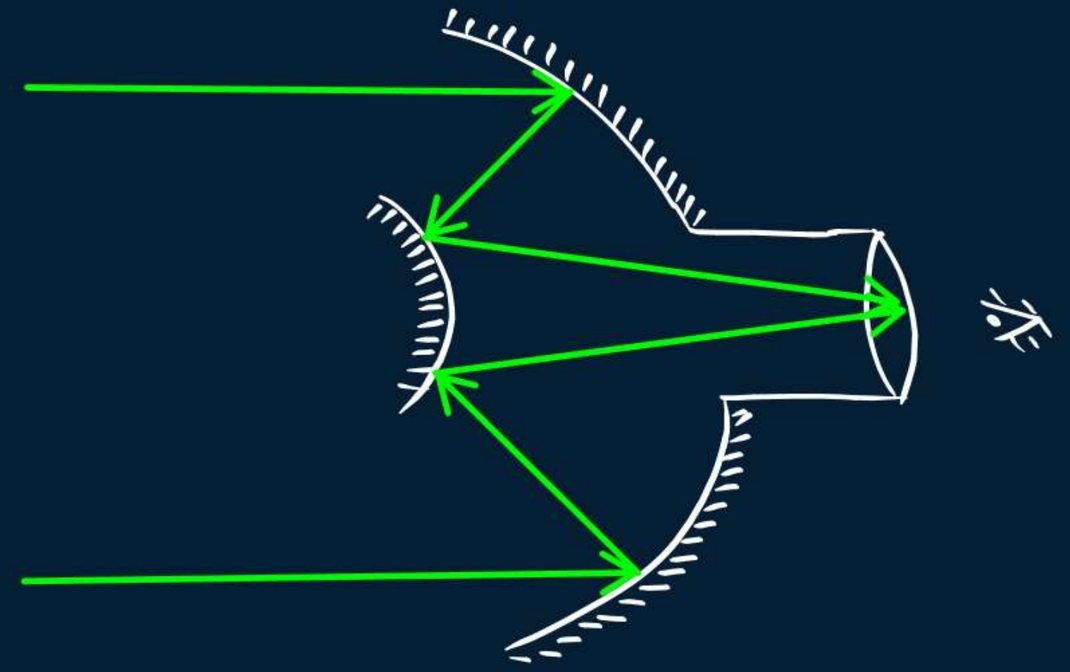
(D) All of the above

* Reflecting Type Telescopes (only diagrams)

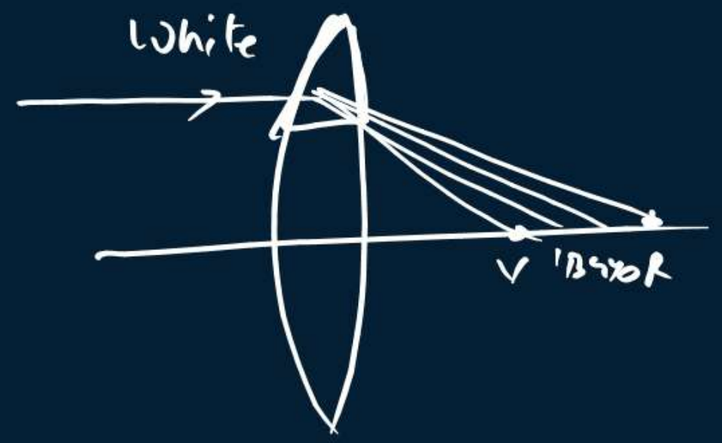
① Newtonian :-



② Cassegrain :-



Why reflecting type telescopes are used :-



Parabolic Mirror ← 1. Spherical Abberation remove

Mirror Use karke ← 2. Chromatic Abberation remove

3. Mirrors can be supported at Back

4. Lenses are heavy, mirrors are light

Homework

→ Notes x 3 Baar

→ Revision

PARISHRAM

2026

Ray Optics and Optical Instruments

PHYSICS | **Lecture - 10**

BY - RAKSHAK SIR

Topics *to be covered*

Short Notes (Formula Sheet)

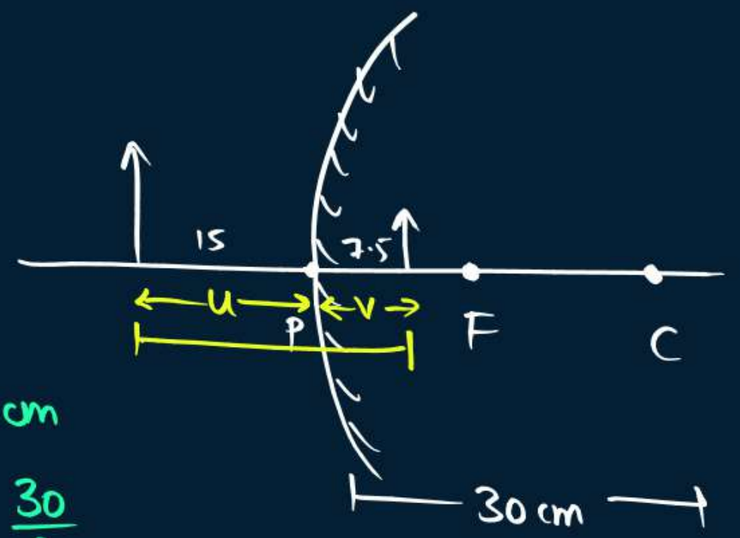
Rough Copy + Pen

A Practice Session

QUESTION

The radius of curvature of a convex mirror is 30 cm. It forms an image of an object which is half the size of the object. Find the separation between the object and the image.

[2024]



$R = +30\,cm$

$f = \frac{R}{2} = \frac{30}{2}$

$\boxed{f = +15\,cm}$

$m = +\frac{1}{2}$

$m = -\frac{v}{u} = \frac{1}{2}$

$\boxed{u = -2v}$

$u = -2 \times 7.5$

$\boxed{u = -15\,cm}$

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

$\frac{1}{15} = \frac{1}{v} - \frac{1}{2v}$

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

$\frac{1}{15} = \frac{1}{v} \times \frac{1}{2}$

$\frac{1}{15} = \frac{1}{2v}$

$\boxed{v = \frac{15}{2} = 7.5\,cm}$

Separation $= |u| + |v|$

$= 15 + 7.5 = 22.5\,cm$

QUESTION

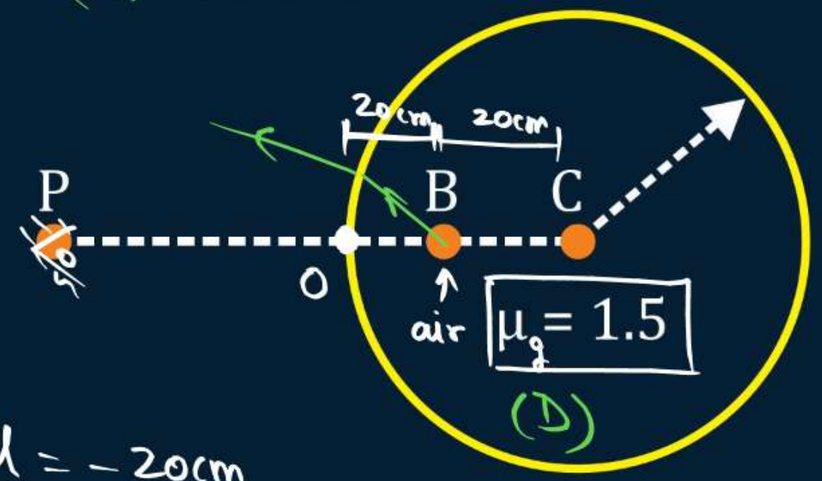
An air bubble is trapped at point B (CB = 20 cm) in a glass sphere of radius 40 cm and retractive index 1.5 as shown in figure. Find the nature and position of the image of the bubble as seen by an observer at point P. **[2024]**

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

$$\frac{\mu_{air}}{V} - \frac{\mu_{glass}}{-20} = \frac{\mu_a - \mu_g}{-40}$$

$$\frac{1}{V} - \frac{1.5}{-20} = \frac{1-1.5}{-40}$$

(R) $\mu_{air} = 1$



$u = -20cm$

$R = -40cm$ $\quad OC = 40cm = R$

QUESTION

Assertion (A) : A convex lens, when immersed in a liquid, disappears.

Reason (R) : The refractive indices of material of the lens and the liquid are equal.

[2024]

A Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

B Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

C Assertion (A) is true, but Reason (R) is false.

D Assertion (A) is false and Reason (R) is also false.

QUESTION

M.P. = −ve

Assertion (A) : The magnifying power of a compound microscope is negative. T

Reason (R) : The final image formed is erect with respect to the object. F

[2024]

A. If both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).

B. If both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of Assertion (A).

C. If Assertion (A) is true but Reason (R) is false.

D. If both Assertion (A) and Reason (R) are false.

QUESTION

The focal lengths of the objective and the eyepiece of a compound microscope are 1 cm and 2 cm respectively. If the tube length of the microscope is 10 cm, the magnification obtained by the microscope for most suitable viewing by relaxed eye is [2024]

(A) 250

(B) 200

(C) 150

(D) 125

$f_o = 1cm$

$f_e = 2cm$

$L = 10cm$

$M.P. = m_o \times m_e$

$M.P. = \frac{L}{f_o} \times \frac{D}{f_e}$

$= \frac{\cancel{10}\,5}{1} \times \frac{25}{\cancel{2}}$

$= 125 \times$

QUESTION

The magnifying power of an astronomical telescope is 24. In normal adjustment. Distance between its two lenses is 150 cm. Find the focal length of the objective lens.

[2024]

$MP = 24$

$L = 150\,cm$

$$\boxed{M.P. = \frac{f_o}{f_e}} = 24 \Rightarrow f_o = 24 f_e$$

$$\boxed{L = f_o + f_e} = 150$$

$$= 24 f_e + f_e = 150$$

$$\cancel{25}^{1} f_e = \cancel{150}^{6}$$

$$f_e = 6\,cm$$

$$f_o = 24 f_e$$

$$= 24 \times 6$$

$$f_o = 144\,cm$$

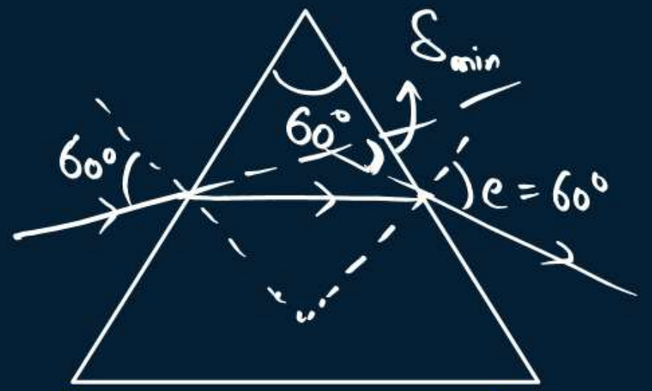
QUESTION

T.I.R.

(i) Explain the working principle of an optical fibre with the help of a diagram. Mention one use of a light pipe.

(ii) A ray of light is incident at an angle of 60° on one face of a prism with the prism angle A = 60°. The ray passes symmetrically through the prism. Find the angle of minimum deviation (δ_m) and refractive index of the material of the prism. If the prism is immersed in water. How will δ_m be affected? Justify your answer. **[2023]**

loss



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

$$60^\circ + 60^\circ = 60^\circ + \delta$$

$$120 - 60 = \delta$$

$$\delta_{min} = 60^\circ$$

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

$$\mu \downarrow \quad \delta_{min} \downarrow$$

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

$$\mu = \frac{\sin\left(\frac{60+60}{2}\right)}{\sin\left(\frac{60}{2}\right)} = \frac{\sin 60^\circ}{\sin 30^\circ} = \frac{\frac{\sqrt{3}}{2}}{\frac{1}{2}} = \sqrt{3}$$

$$\boxed{\mu = 1.732}$$

QUESTION

(i) Draw a ray diagram to show the working of a compound microscope. Obtain the expression for the expression for the total magnification for the final image to be formed at the near point. Strained Eye

(ii) In a compound microscope an object is placed at a distance of 1.5 cm (u_o) from the objective of focal length 1.25 cm (f_o). If the eye-piece has a focal length of 5 cm (f_e) and the final image is formed at the near point. (D) Find the magnifying power of the microscope. **[2023]**

$$\boxed{M.P. = \frac{V_o}{u_o}\left(1+\frac{D}{f_e}\right)}$$

$$= \frac{7.5}{1.5}\left(1+\frac{25}{5}\right)$$

$$= 5(1+5)$$

$$= 5\times 6 = 30\times$$

$$\frac{1}{f_o} = \frac{1}{V_o} - \frac{1}{u_o}$$

$$\frac{1}{1.25} = \frac{1}{V_o} + \frac{1}{1.5}$$

$$\frac{100}{125} - \frac{10}{15} = \frac{1}{V_o}$$

$$\frac{100}{125} - \frac{10}{15} = \frac{1}{V_o}$$

$$\frac{4}{5} - \frac{2}{3} = \frac{1}{V_o}$$

$$\frac{12-10}{15} = \frac{1}{V_o}$$

$$\frac{2}{15} = \frac{1}{V_o}$$

$$V_o = 7.5\ cm$$

QUESTION

(i) Draw a ray diagram for the formation of image of an object by an astronomical telescope, in normal adjustment. Obtain the expression for its magnifying power.

(ii) The magnifying power of an astronomical telescope in normal adjustment is 2.9 and the objective and the eyepiece are separated by a distance of 150 cm. Find the focal lengths of the two lenses. **[2023]**

$M.P. = 2.9$

$L = 150\,cm$

$f_o = ?$

$f_e = ?$

$MP = \frac{f_o}{f_e} = 2.9$

$L = f_o + f_e = 150$

$\Rightarrow 2.9 f_e + f_e = 150$

$3.9 f_e = 150$

$f_e = \frac{\cancel{1500}\ 500}{\cancel{3.9}\ 13}$

$f_e = \frac{500}{13}\ cm$

$f_o = 2.9 f_e$

$= 2.9 \times \frac{500}{13}\ cm$

QUESTION

A number of optical devices and instruments have been designed and developed such as periscope, binoculars, microscopes and telescopes utilising the reflecting and refracting properties of mirrors, lenses and prisms. Most of them are in common use. Our knowledge about the formation of images by the mirrors and lenses is the basic requirement for understanding the working of these devices.

(i) Why the image formed at infinity is often considered most suitable for viewing? Explain. → eye is most relaxed when focussed at ∞.

(ii) In modern microscopes multicomponent lenses are used for both the objective and the eyepiece. Why? → Better Quality of image, to reduce various Abberations.

(iii) Write two points of difference between a compound microscope and an astronomical telescope.

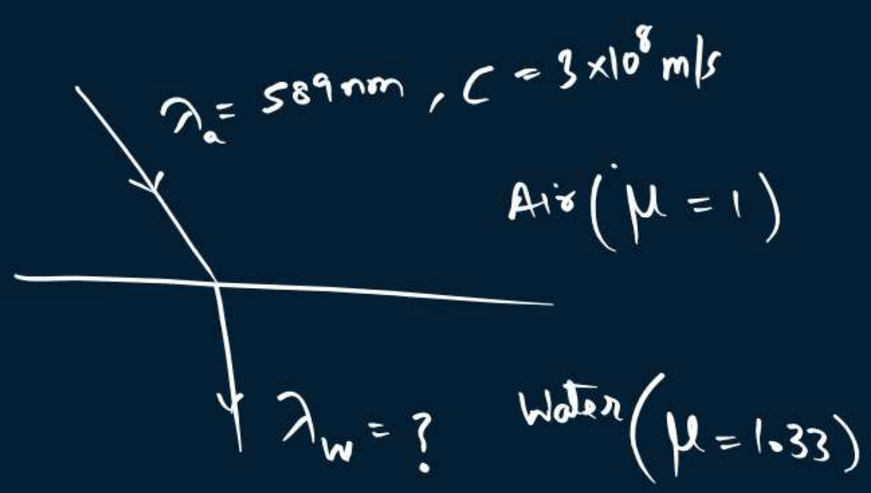
OR

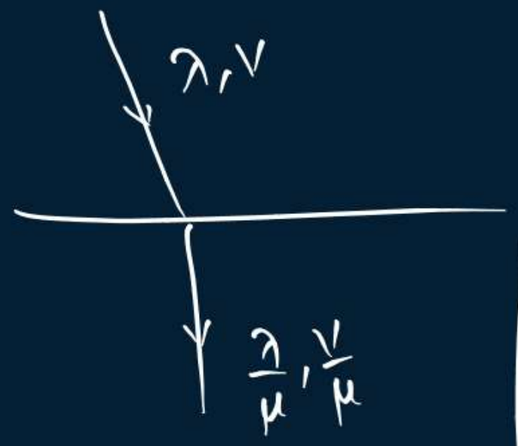
Write two distinct advantages of a reflecting type telescope over a refracting type telescope.

[2022-2023]

QUESTION

Monochromatic light of wavelength 589 nm is incident from air on a water surface. If μ for water is 1.33, find the wavelength, frequency and speed of the refracted light. **[2017]**





$$\lambda_w = \frac{\lambda_a}{\mu}, \quad V_w = \frac{c}{\mu}$$

$$\lambda_w = \frac{589}{1.33}, \quad V_w = \frac{3\times10^8}{1.33}$$

$$= \boxed{}\ nm \qquad \boxed{}\ m/s$$

$$V = \lambda\nu$$

$$V_w = \lambda_w \nu$$

$$\frac{3\times10^8}{1.33} = \frac{589\times10^{-9}}{1.33}\times\nu$$

$$\nu = \frac{\frac{3\times10^8}{\cancel{1.33}}}{\frac{589\times10^{-9}}{\cancel{1.33}}}$$

$$\nu = \frac{3\times10^8}{589\times10^{-9}}$$

$$\nu = \boxed{}\ Hz$$

QUESTION

1) $D \rightarrow R$ 2) $i > i_c$

(a) Write the necessary conditions for the phenomenon of total internal reflection to occur.

(ii) Write the relation between the refractive index and critical angle for a given pair of optical media. [2019]

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

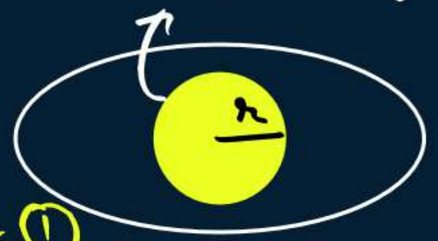
$$i_c = \sin^{-1}\left(\frac{1}{\mu_D}\right)$$

QUESTION

A small bulb (assumed to be a point source) is placed at the bottom of a tank containing water to a depth of 80 cm. Find out the area of the surface of water through which light from the bulb can emerge. Take the value of the refractive index of water to be 4/3.

[2013]

$A = \pi r^2$

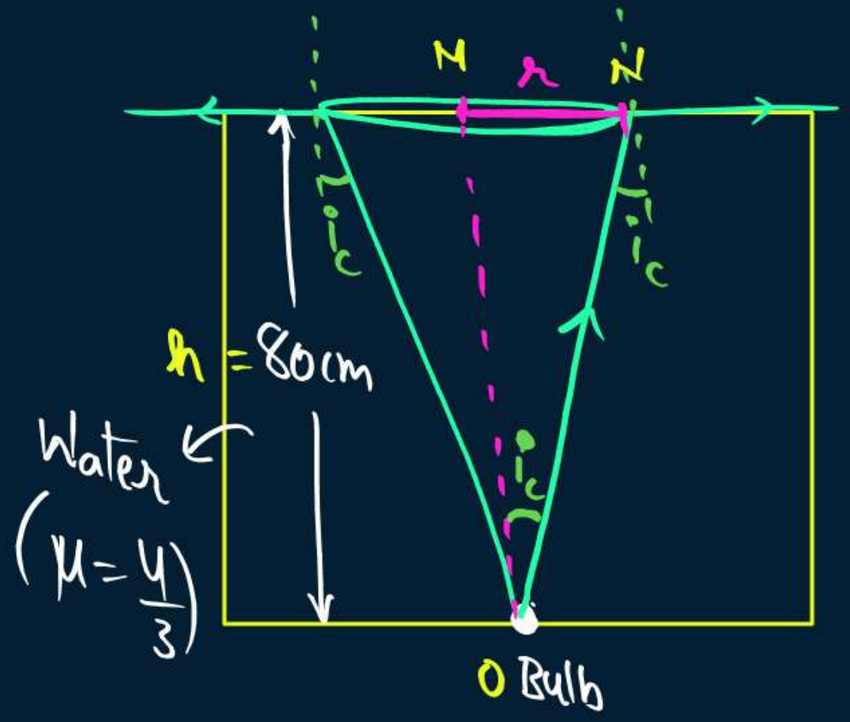


In ΔMNO :-

$$\sin i_c = \frac{P}{H} = \frac{r}{\sqrt{r^2+h^2}} \quad \cdots (I)$$

$$\sin i_c = \frac{1}{\mu_D} \quad \cdots (II)$$

$$\frac{r}{\sqrt{r^2+h^2}} = \frac{1}{\mu_D}$$



$$\frac{r}{\sqrt{r^2+h^2}} = \frac{1}{4/3}$$

$$\frac{r}{\sqrt{r^2+h^2}} = \frac{3}{4}$$

$$\frac{r}{\sqrt{r^2+(80)^2}} = \frac{3}{4}$$

$$\frac{r^2}{r^2+6400} = \frac{9}{16}$$

$$16r^2 = 9r^2 + 9\times 6400$$

$$16r^2 - 9r^2 = 9\times 6400$$

$$7r^2 = 9\times 6400 \longrightarrow r^2 = \frac{9\times 6400}{7}$$

$$A = \pi r^2$$

$$A = \frac{22}{7}\times\frac{9\times 6400}{7}\ cm^2$$

QUESTION

A ray of light falls on a transparent sphere with centre C as shown in the figure. The ray emerges from the sphere parallel to the line AB. Find the angle of refraction at A if refractive index of the material of the sphere is $\sqrt{3}$. **[2014]**

At point A,

Applying Snell's Law :-

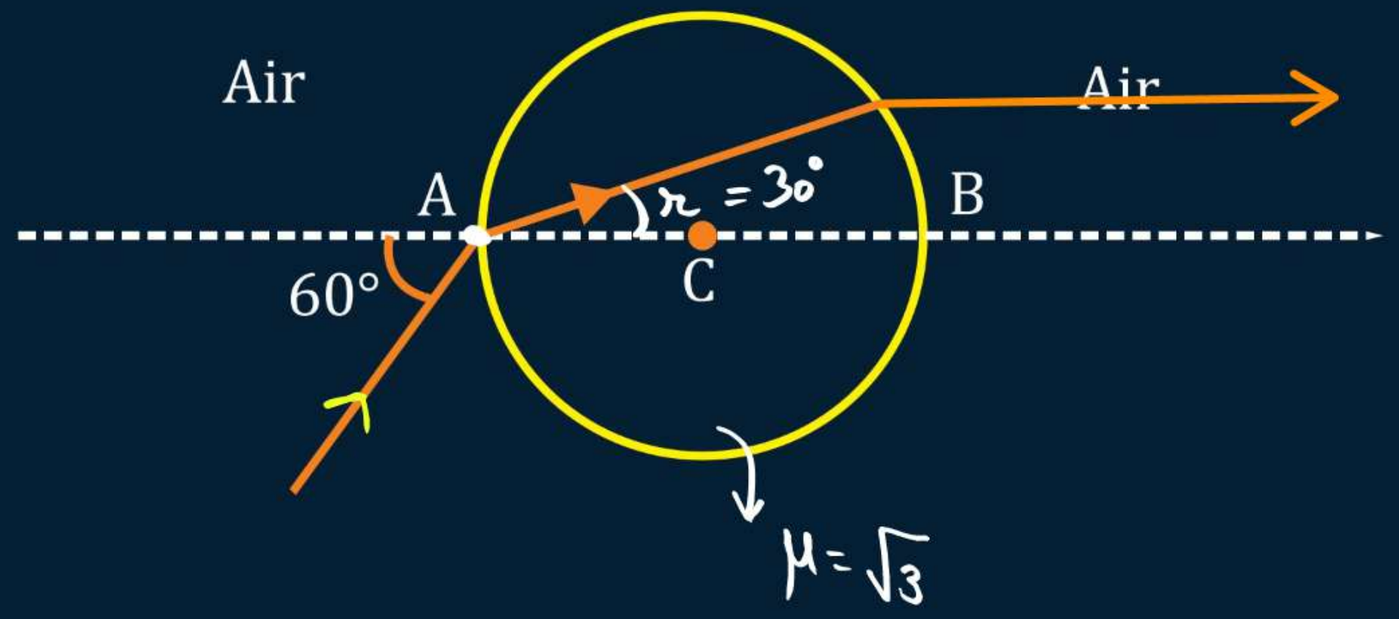
$\mu_1 \sin i = \mu_2 \sin r$

$\mu_a \sin 60^\circ = \mu_g \sin r$

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

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

$r = 30^\circ$



Homework

→ Saare Sawaal retry karne hai

Ch-1 : Notes ✓
: Formula sheet ✓
: Short Notes ✓
: NCERT ≈

} NCERT Ques
Exemplar
PYQ
Sample Paper

⋮

Ch-2