

ULTIMATE KCET



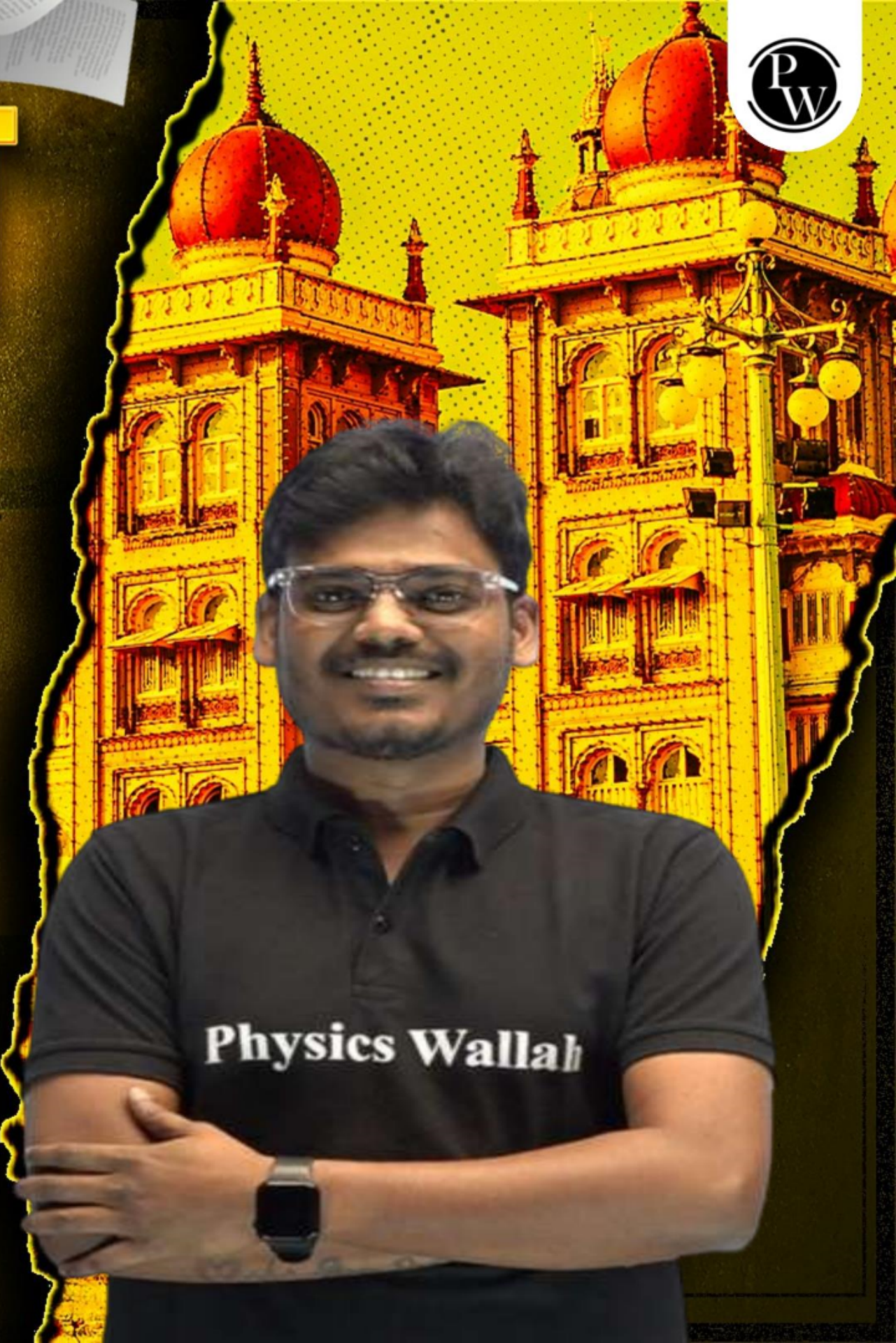
CRASH COURSE 2026

PHYSICS

LECTURE NO-1

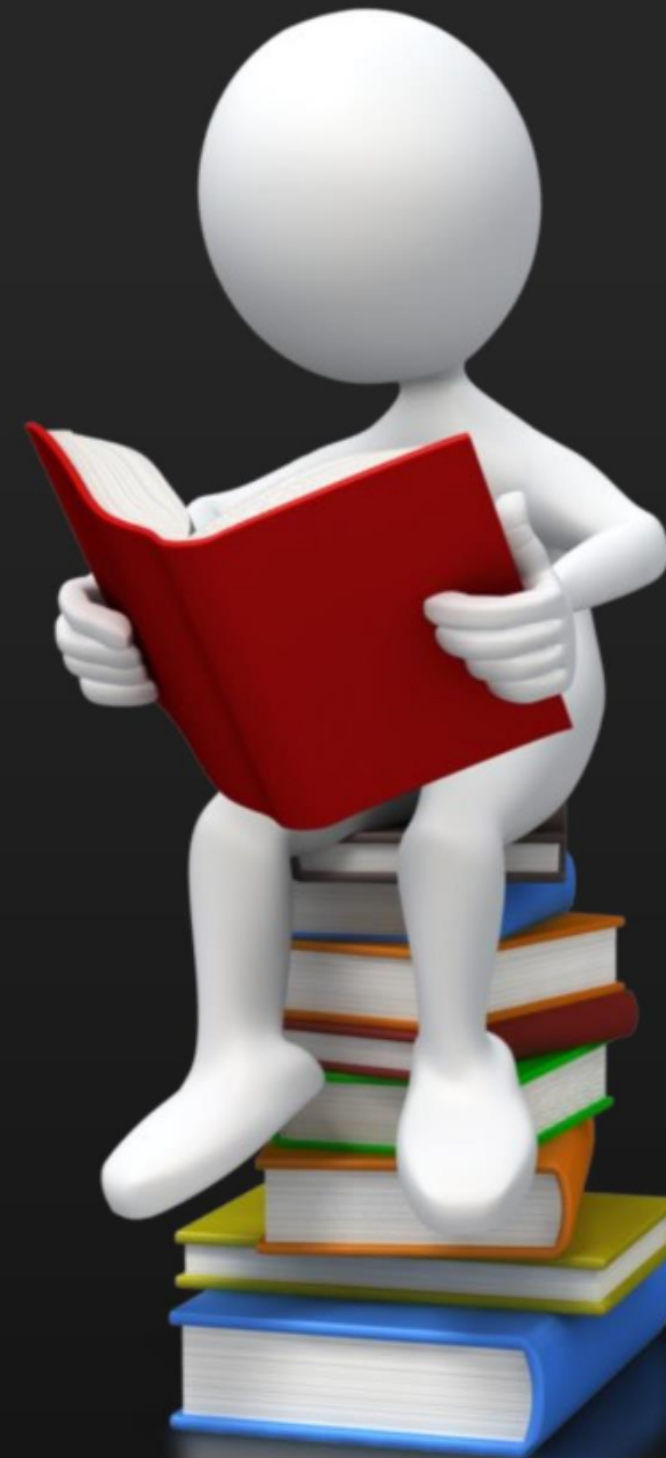
RAY OPTICS AND OPTICAL INSTRUMENTS

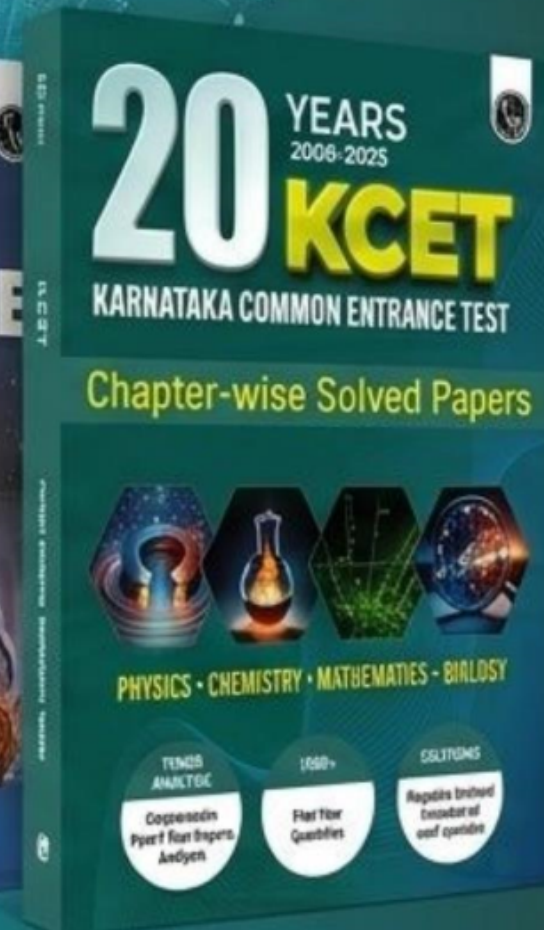
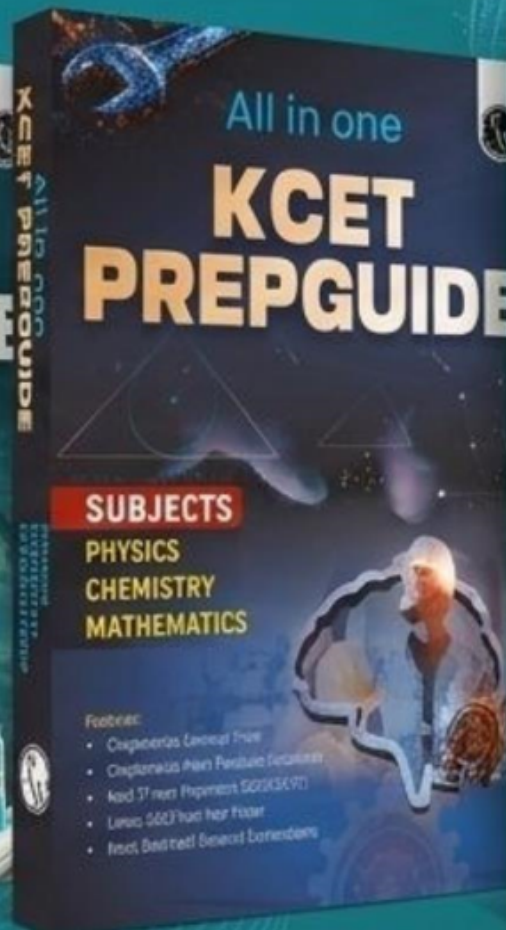
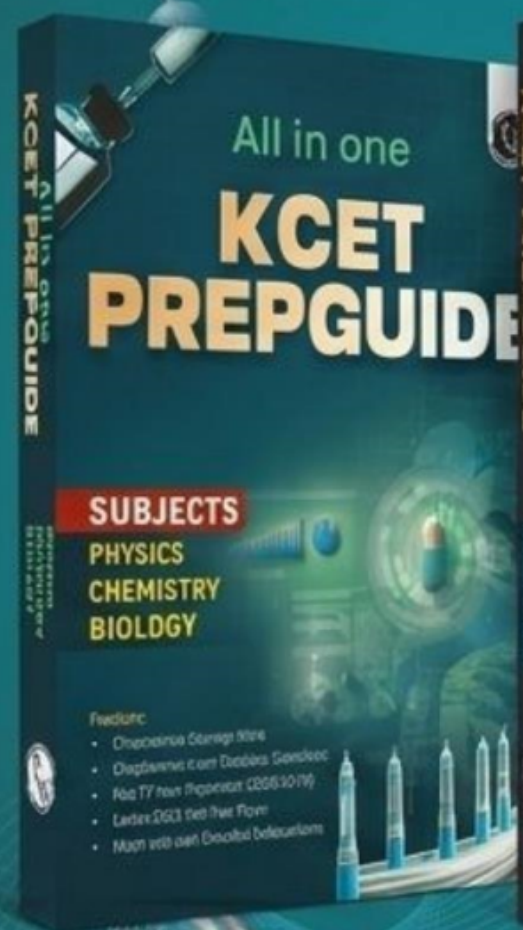
By – AK SIR



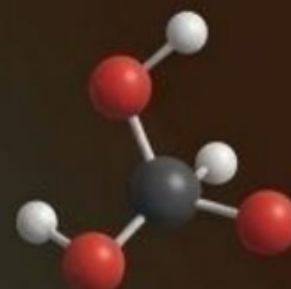
Topics *to be covered*






- 1 LIGHT REFLECTION AND ITS LAWS
- 2 FOCAL LENGTH AND MIRROR FORMULA
- 3 IMAGE FORMATION BY SPHERICAL MIRRORS *
- 4 LIGHT REFRACTION AND ITS LAWS





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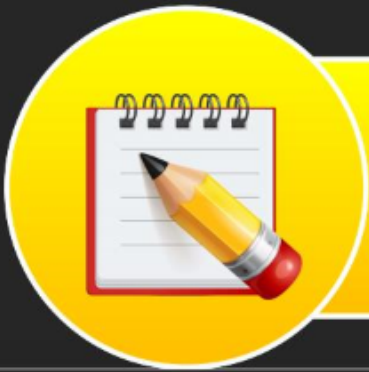
-  **Class-wise Distribution of Questions**
-  **Chapterwise Most Probable Questions**
-  **Latest 2025 Past Year Paper**
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KCET analysis of chapter – Marks weightage

Year	Topic
2025 (4Q)	Angle of incidence in terms of Refractive Index, Cutting of lens (Power of lens), Image formation by Compound microscope and refraction of light through prism
2024(4Q)	Refraction at spherical surface, Speed of light inside prism, Image formation by astronomical telescope and Image distance from convex lens (half shaded)
2023(4Q)	Speed of the image wrt convex lens, Change in focal length of convex lens, Critical angle and Virtual image
2022(5Q)	Refraction through glass slab, Power of lens, Magnification of lens, Angle of deviation and Focal length of convex lens
2021(3Q)	Refractive Index, Power of lens and Size of the image



KCET analysis of chapter – Marks weightage

Year	Topic
2020(3Q)	Angle of minimum deviation, Image distance from lens and speed of the image from lens
2019(2Q)	The average velocity of the image from mirror and Minimum deviation
2018 (3Q)	Image distance-Mirror and Object distance from mirror & Focal length of lens
2017(3Q)	Sign convention, Image distance and Scattering of light
2016(4Q)	Glass slab, Multiple glass slab, object distance from lens and angle of deviation
2015 (4Q)	Focal length of reading glass, Object distance-Mirror, Refractive Index of the medium and Angle of refraction



Optics is the branch of physics in which we study the behaviour and properties of light, including its interactions with matter.

Light is that part of electromagnetic waves which gives sensation to our eyes.

Properties of light

1. Speed of light in vacuum, denoted by $c = 3 \times 10^8 \text{ m/s}$ approximately
2. Light carries energy and momentum.
3. Light is electromagnetic wave (proposed by Maxwell). It consists of varying electric and magnetic field.
4. Light is an electromagnetic wave and transverse in nature. $v = f\lambda$
5. The formula $C = f\lambda$ is applicable to light.



OPTICS

RAY OPTICS

- ↳ Reflection
- ↳ Refraction

WAVE OPTICS

- ↳ Reflection
- ↳ Refraction

- ↳ Interference
- ↳ Diffraction
- ↳ Polarisation.



Laws of Reflection

1ST LAW : The angle of incidence is equal to angle of ~~incidence~~ ^{reflection} at a point of incidence.

$$\angle i = \angle r.$$

2ND LAW : The incident ray, Normal and Reflected Ray at a point of incidence, all lie in the same plane.

Question



In reflection of light, the **angle of reflection** is

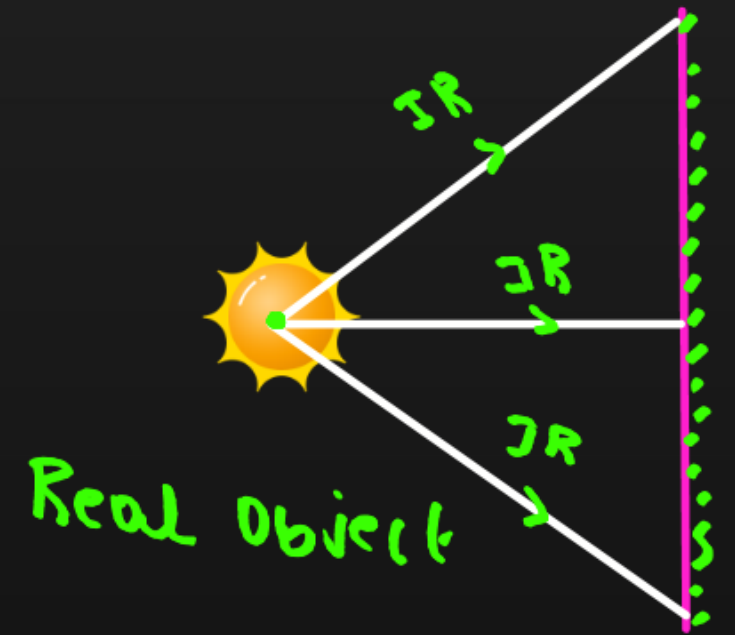
- A** More than incident angle
- B** Less than incident angle
- C** **Equal to angle of incidence** $\angle i = \angle r.$
- D** More or less than incident angle



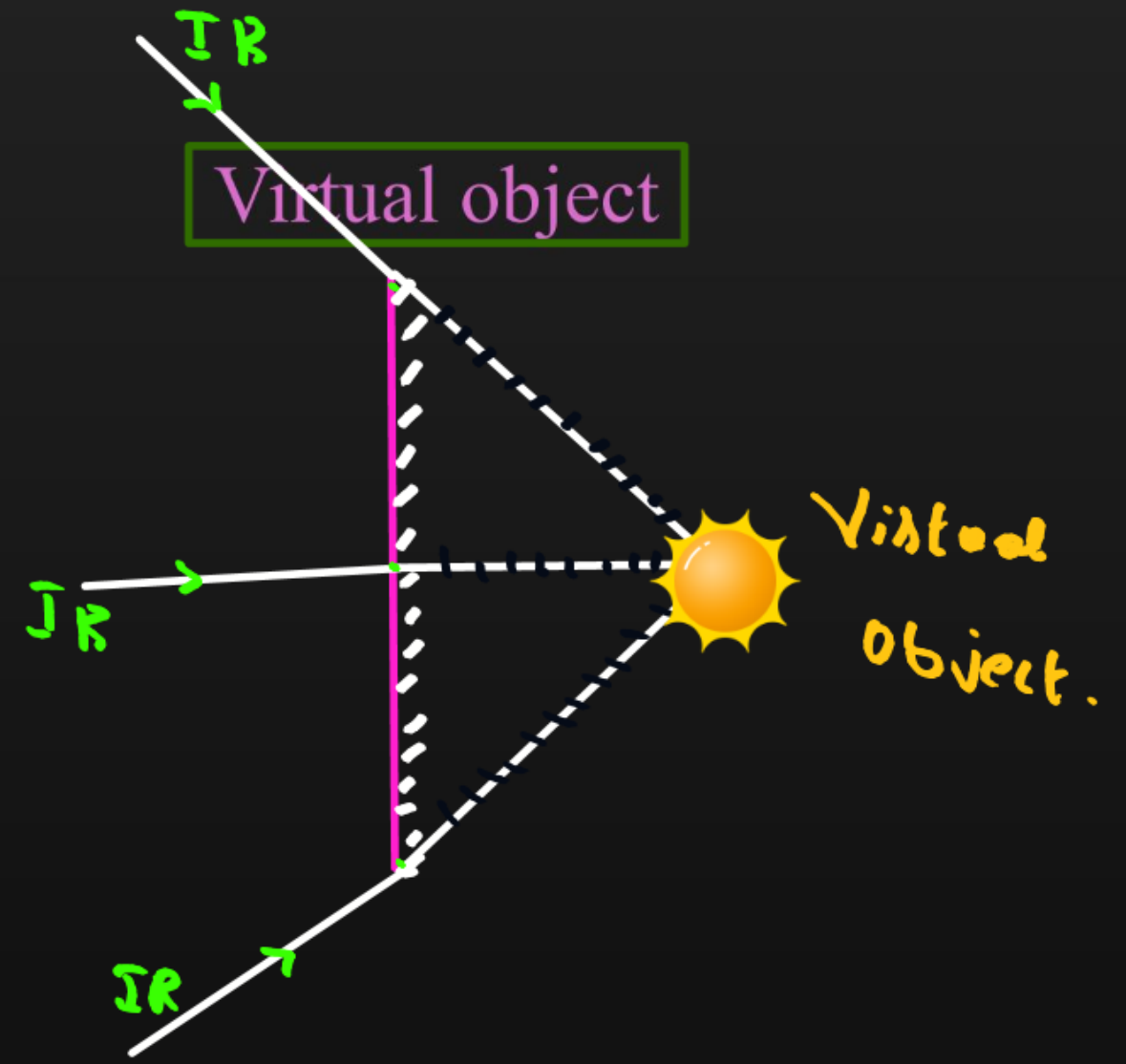
Object and Image

Object : Rays falling on the mirror OR The point of intersection of incident rays.

Real object



Virtual object

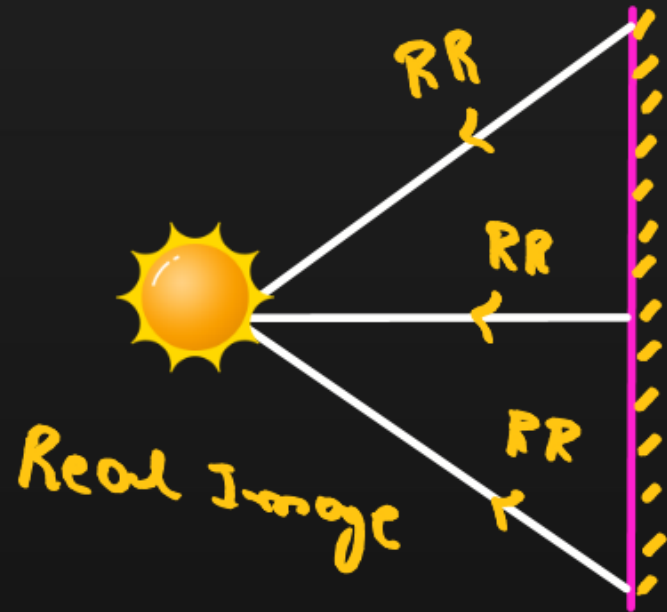




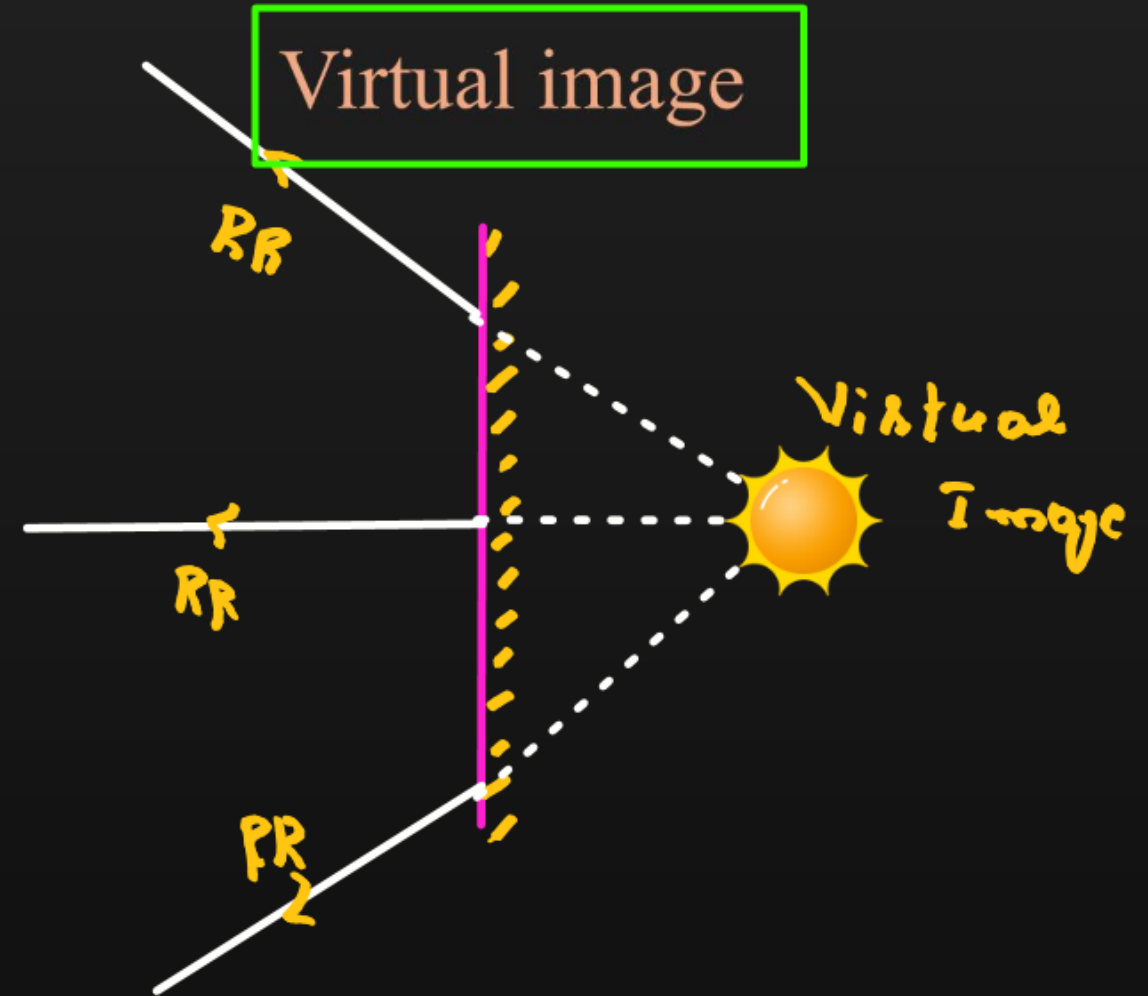
Object and Image

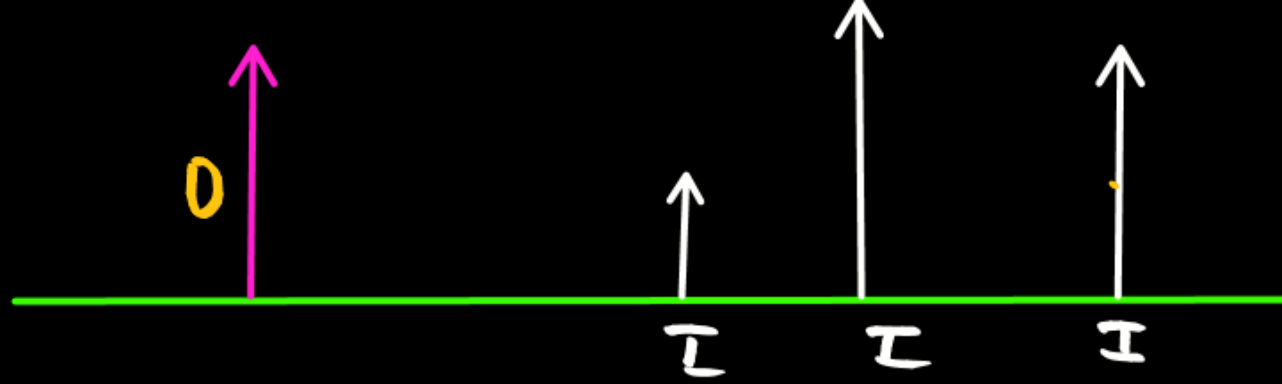
Image : Rays away from the mirror OR The point of intersection of reflected rays.

Real image

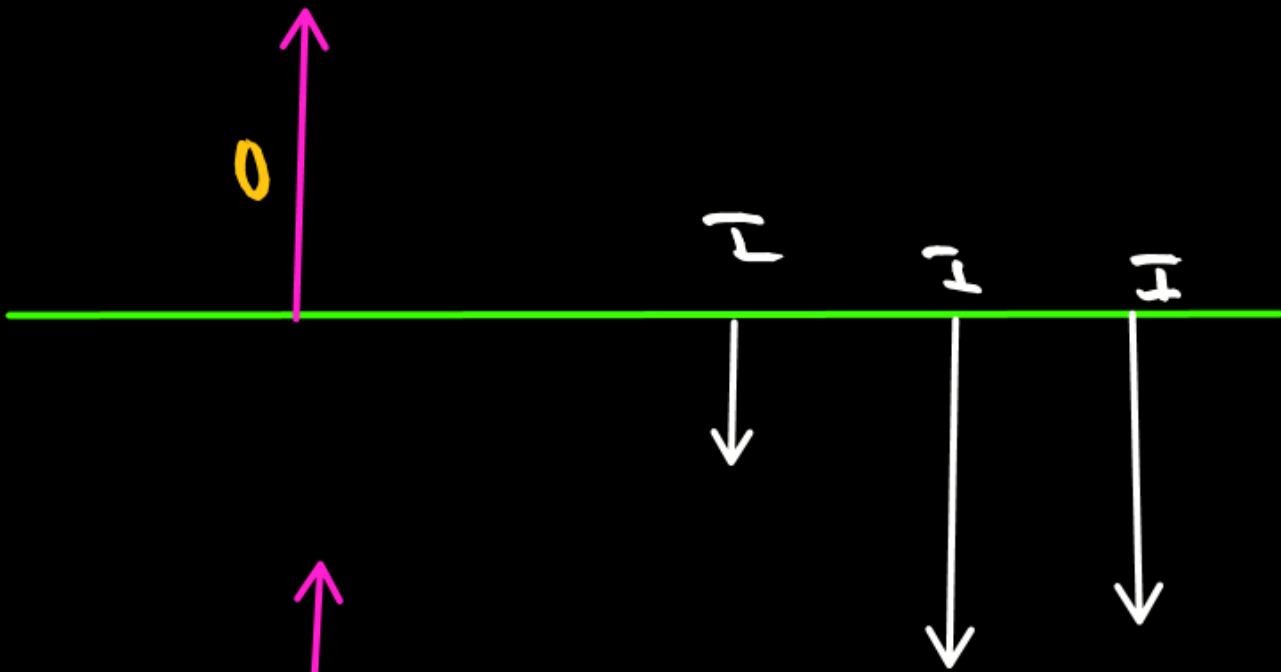


Virtual image

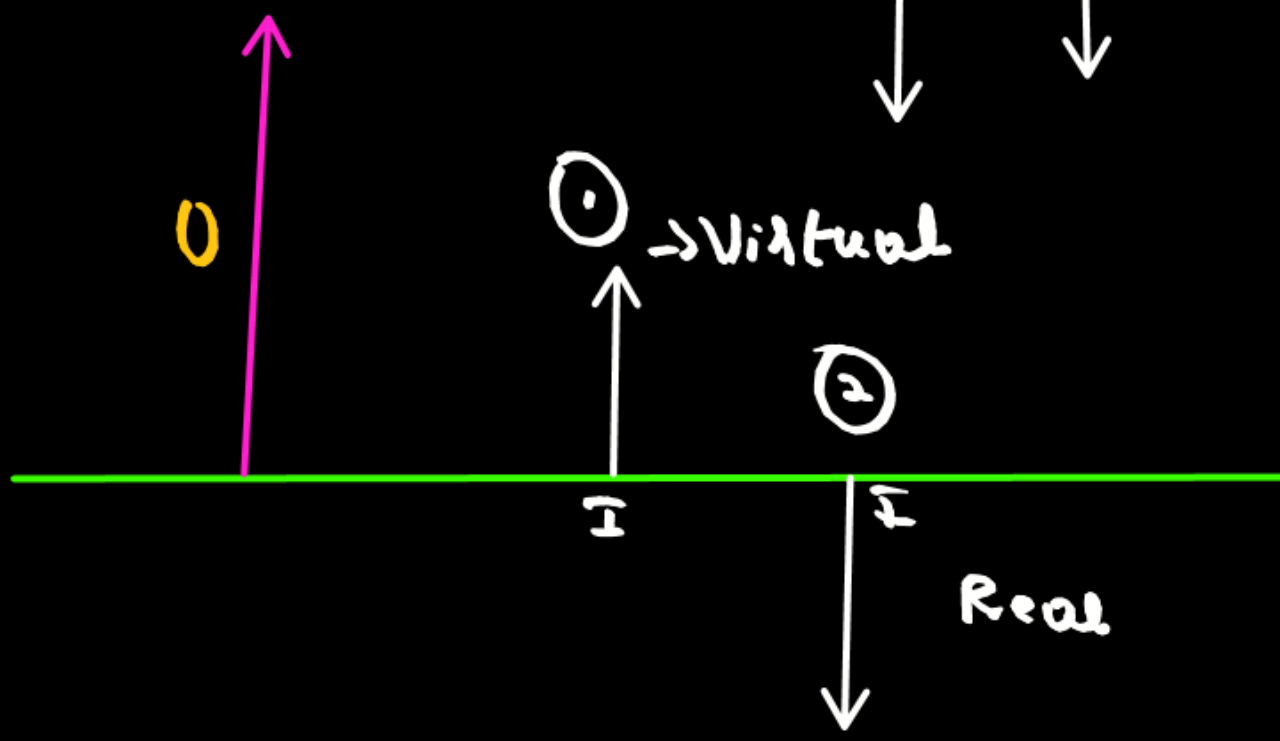




Erected \rightarrow Virtual ✓
 Small \rightarrow Diminished
 Bigger \rightarrow magnified, Enlarged



Inverted \rightarrow Real.
 \rightarrow obtained on screen





Real and virtual image

Reflection
 ↓
 Reflected rays

Refraction
 ↓
 Refracted rays

Real Image	Virtual Image
1. It is formed due to actual intersection of the rays reflected by the mirror.	1. It is formed due to when the rays reflected by the mirror appear to meet if they are produced backwards.
2. It can be obtained on a screen.	2. It cannot be obtained on a screen
3. It is inverted wrt object.	3. It is erect wrt object.



Types of mirror

MIRRORS

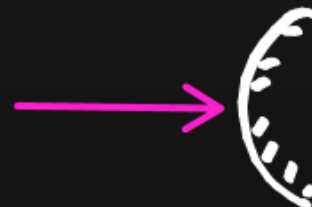
→ Smooth & polished surface

PLANE MIRRORS

SPHERICAL MIRRORS

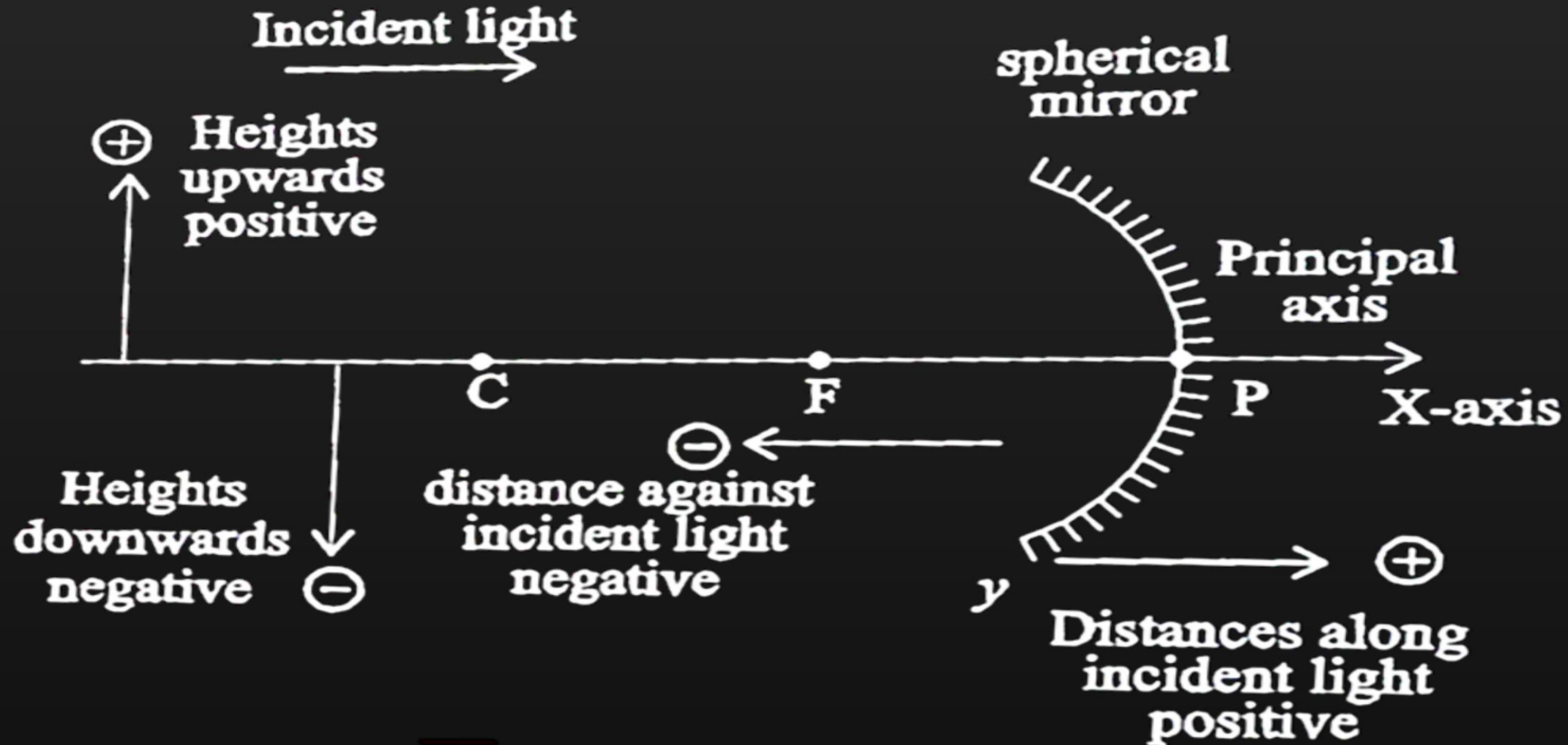
CONCAVE MIRROR

CONVEX MIRROR





Sign convention





Sign convention

According to New Cartesian Sign Convention:

- ✓ 1. The pole of the mirror is chosen as origin of the coordinate system.
- ✓ 2. The object is considered to be placed on the principal axis to the left of the mirror.
- ✓ 3. All the **distance** are measured along the **principal axis** from the pole of the mirror. The distance of an object from the mirror is denoted by 'u', the distance of the image from the pole of the mirror is denoted by 'v' and the focal length of the mirror by 'f'.
 \rightarrow x -axis
- ✓ 4. Distance measured in the direction of the incident ray are taken positive, while distances opposite to the direction of the incident ray are taken negative.

Question



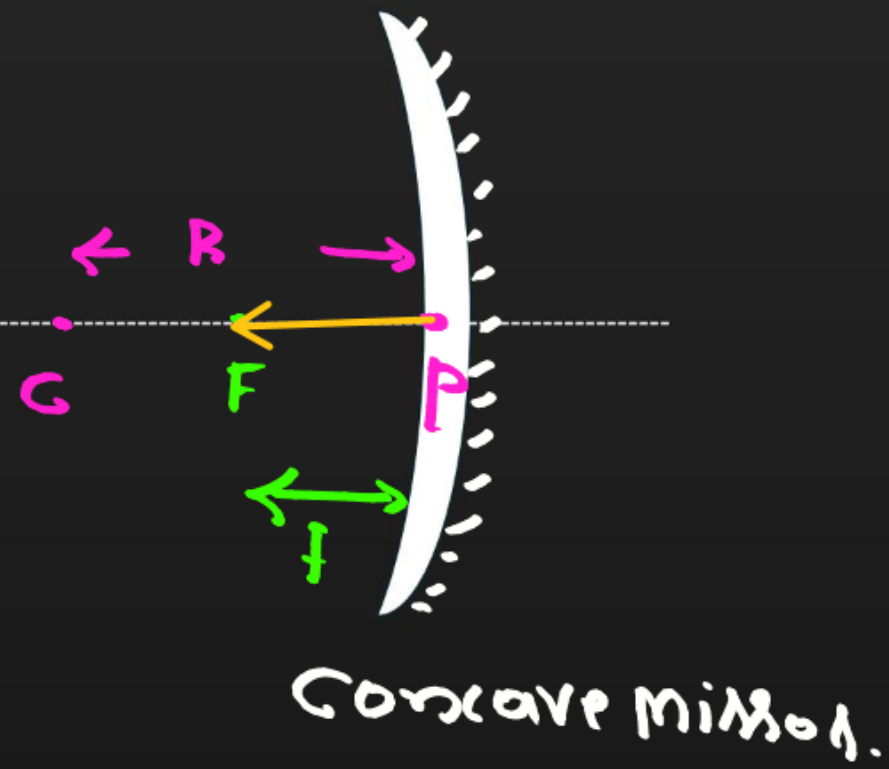
For reflection in spherical mirrors, all distances are measured **from** the

- A** Pole
- B** Principal focus
- C** Centre of curvature
- D** From object



Focal length of spherical mirror

EX: $R = 40\text{cm}$.

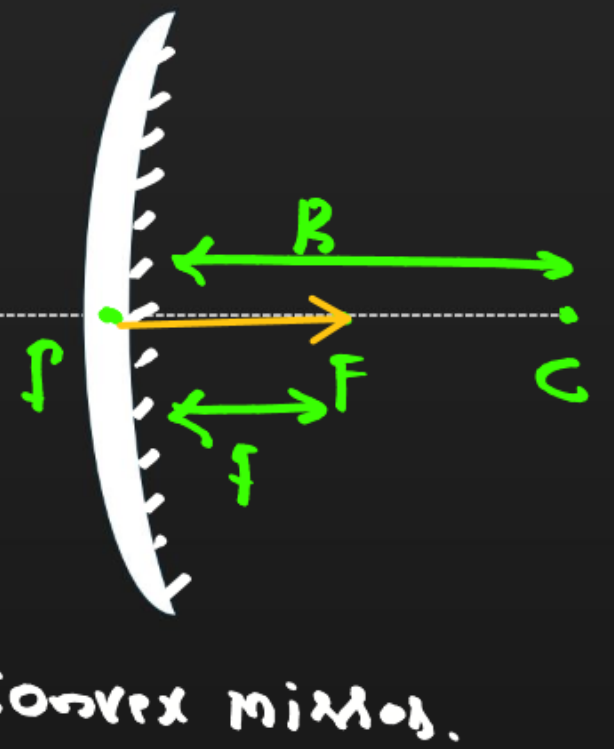


$f = -ve \rightarrow$ concave mirror

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

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

$$\Rightarrow f = \frac{40}{2} = 20\text{cm}$$



$f = +ve \rightarrow$ convex mirror.

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

Question



Focal length of a spherical mirror depends on

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

- A** Object distance ✗
- B** Image distance ✗
- C** Both object and image distances ✗
- D** Radius of curvature

Question



The focal length of a spherical mirror is

- A** Equal to radius of curvature $f = R$
- B** Two times the radius of curvature $f = 2R$
- C** Half of the radius of curvature $f = \frac{R}{2}$
- D** Not depends on radius of curvature



The mirror equation

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

↳ Which gives Relation between f, v, u .

*

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



Magnification

It is the ratio of height of the image to the height of the object.

$$m = \frac{h_I}{h_o} \rightarrow \gamma\text{-axis}$$

It is the ratio of distance of the image to the distance of the object.

$$m = -\frac{v}{u} \rightarrow x\text{-axis}$$

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

$$m = \pm n$$

$m = +ve \Rightarrow$ Virtual Image

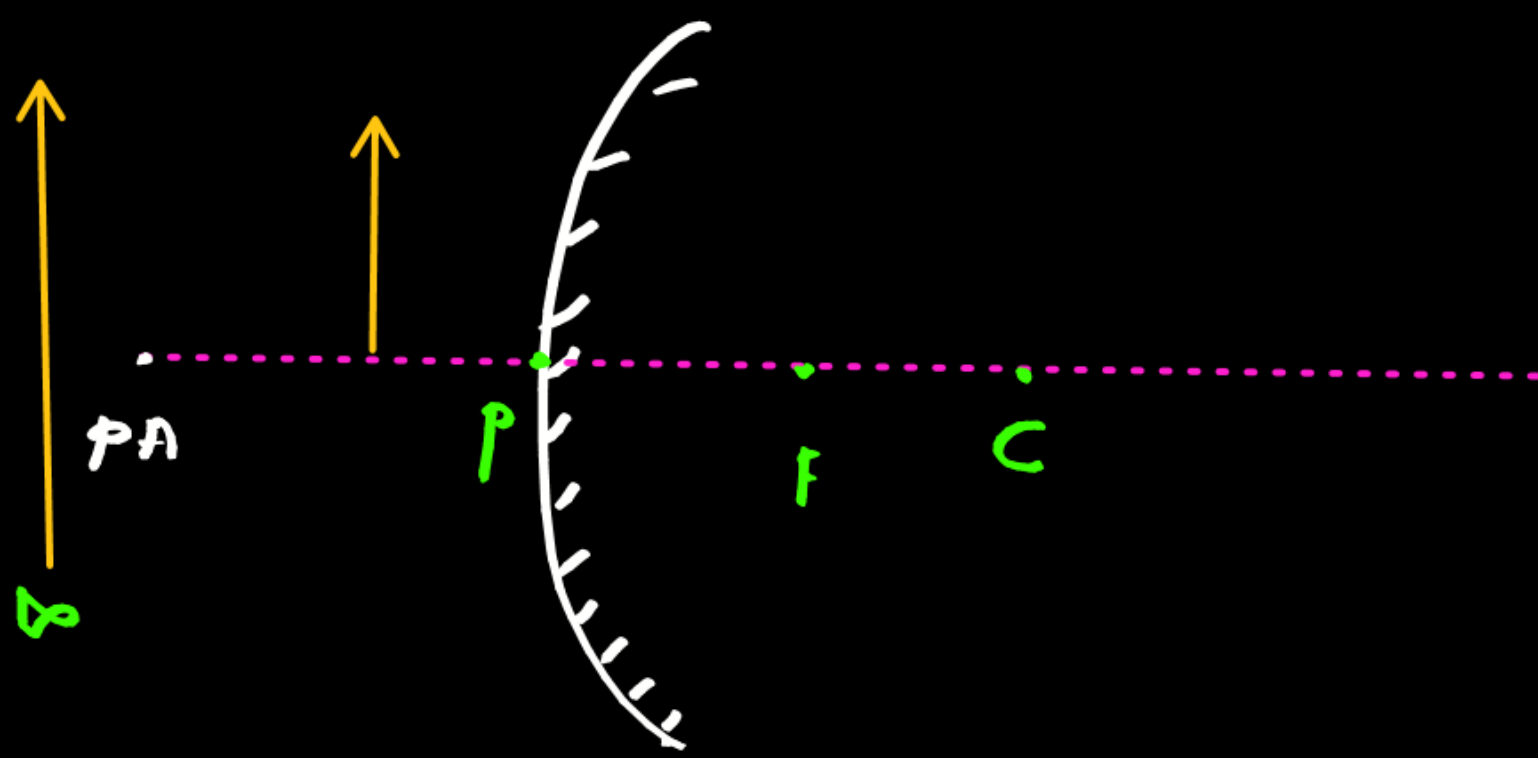
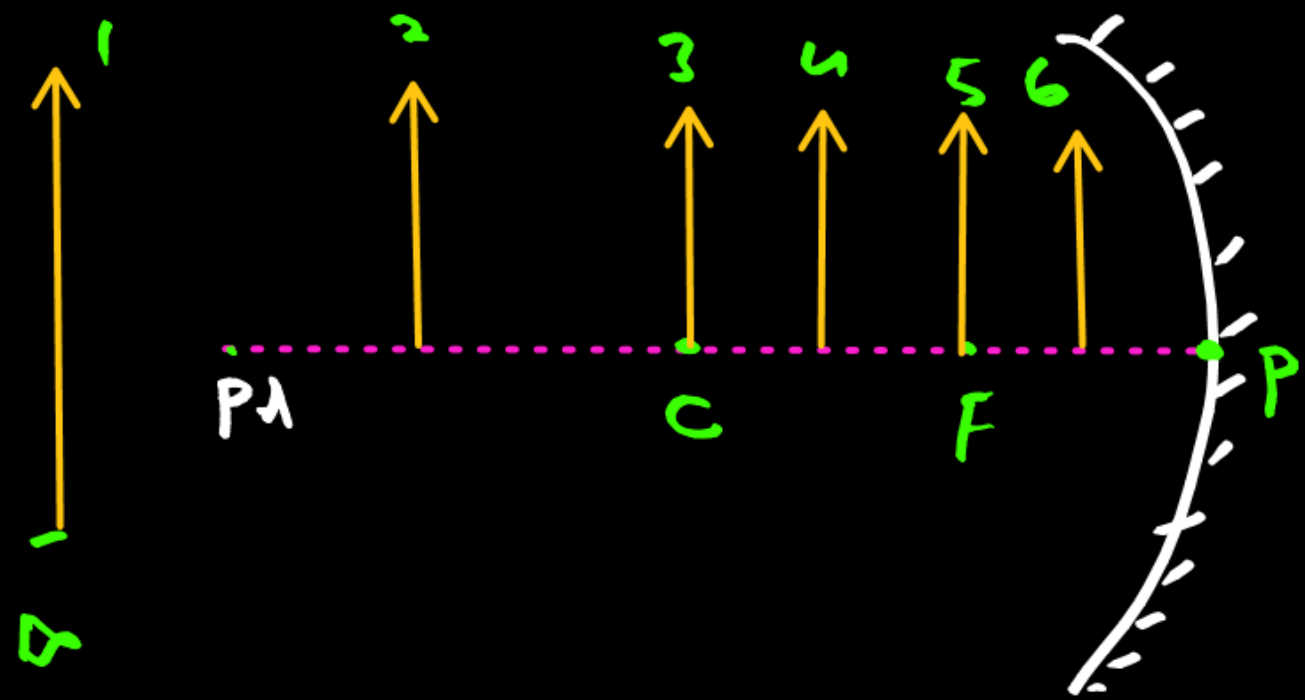
$m = -ve \Rightarrow$ Real Image

n - Size of Image

$n > 1 \rightarrow$ Magnified, Enlarged

$n = 1 \rightarrow$ Size of the image is same as object

$n < 1 \rightarrow$ Diminished.



only for understanding



Image formation by Concave mirror

Position of the object	Position of the image	Size of the image	Nature of the Image
At infinity ✓	At the focus F ✓	Highly diminished, point-sized ✓	Highly diminished, point-sized R+I
Beyond C ✓	Between F and C	Diminished ✓	Real and inverted ✓
At C ✓	At C ✓	Same size ✓	Real and inverted ✓
Between F and C ✓	Beyond C ✓	Enlarged ✓	Real and inverted ✓
At F	At infinity ✓	Highly enlarged ✓	Real and inverted ✓
Between P and F ✓	Behind the mirror ✓	Enlarged ✓	Virtual and erect ✓



Image formation by Convex mirror

Position of the object	Position of the image	Size of the image	Nature of the Image
At infinity ✓	At the focus F, behind the mirror	Highly diminished, point-sized ✓	Virtual and erect ✓
Between infinity and the pole P of the mirror	Between P and F, behind the mirror	Diminished ✓	Virtual and erect ✓

Question



When an object is placed at **infinity** from a spherical mirror, the image is formed at

- A** Infinity
- B** **principal focus**
- C** at centre of curvature
- D** pole

Question



A **convex mirror** is used to form an image of a real object. Then mark the **wrong** statement

- A** The image lies between the poles and focus ✓
- B** The image is diminished in size ✓
- C** The image is erect ✓
- D** **The image is real**



Relation between u, v and f

Case (i): Relation when focal length and object distance is given (f, u)

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

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

Case (ii): Relation when focal length and image distance is given (f, v)

$$* m = \frac{f \cdot v}{f}$$

Question



An object is placed at (i) 10 cm, (ii) 5 cm in front of a concave mirror of radius of curvature 15 cm. Find the position, nature, and magnification of the image in each case.

(i) $u = -10 \text{ cm}$
 $f = \frac{R}{2} = \frac{15}{2} = 7.5$

$f = -7.5 \text{ cm}$

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

$m = \frac{-7.5}{-7.5 - (-10)}$

$m = \frac{-7.5}{2.5} \times \frac{10}{10} = -\frac{75}{25}$

$m = -3$ R+I+M

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

$-3 = +\frac{v}{10}$

$v = -30 \text{ cm}$

Real (R)
 Inverted (I)
 Magnified (M)

Question



An object is placed at a distance of 25 cm from a **concave mirror** of focal length 15 cm. Find the position of image formed.

$$u = -25 \text{ cm}$$

$$f = -15 \text{ cm}$$

$$v = ?$$

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

$$m = \frac{-15}{-15 - (-25)}$$

$$m = \frac{-15}{-15 + 25} = \frac{-15}{10} = \frac{-3}{2}$$

$m = -1.5$ Real + Inverted
magnified

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

$$-\frac{3}{2} = -\frac{v}{-25}$$

$$v = \frac{-3 \times 25}{2} = -\frac{75}{2}$$

$$v = -37.5 \text{ cm}$$

Question



A point 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, by how much distance will the image be displaced?

case (i): $u = -40 \text{ cm}$
 $f = -15 \text{ cm}$

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

$$\frac{1}{v_1} = \frac{1}{-15} - \frac{1}{-40} = \frac{1}{40} - \frac{1}{15} = \frac{3-8}{120}$$

$$\frac{1}{v_1} = -\frac{5}{120} \quad \boxed{v_1 = -24 \text{ cm}}$$

case (ii): $u = -40 + 20$

$$u = -20 \text{ cm}, f = -15 \text{ cm}$$

$$\frac{1}{v_2} = \frac{1}{-15} - \frac{1}{-20} = \frac{1}{20} - \frac{1}{15}$$

$$\frac{1}{v_2} = \frac{3-4}{60} = -\frac{1}{60} \quad \boxed{v_2 = -60 \text{ cm}}$$

$$\begin{aligned} \text{Distance} &= v_2 - v_1 = -60 - (-24) \\ &= -60 + 24 = \boxed{-36 \text{ cm}} \end{aligned}$$

Question



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

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

A convex mirror of focal length 20 cm forms image which is quarter the size of the object. The distance of the object from mirror is

(u)

A 50 cm

B -60 cm

C -40 cm

D -70 cm

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

$$+\frac{1}{4} = \frac{20}{20 - u}$$

$$20 - u = 4 \times 20 = 80$$

$$u = 20 - 80$$

$$u = -60 \text{ cm}$$

Question



An object is placed at a distance of 40 cm in front of a concave mirror of focal length 20 cm . The image produced is

u

$$m = \frac{f}{f - u} = \frac{-20}{-20 - (-40)} = \frac{-20}{20}$$

$$m = -1$$

- A** Real inverted and smaller in size
- B** Real, inverted and of same size
- C** Real and erect
- D** Virtual and inverted

Question



An object is placed at 20 cm in front of a concave mirror produces three-time magnified real image. What is the focal length of the concave mirror?

$$m = -3$$

- A** -15 cm
- B** 6.6 cm
- C** 10 cm
- D** 7.5 cm

$$m = \frac{f}{f - u}$$
$$-3 = \frac{f}{f - (-20)} \Rightarrow -3 = \frac{f}{f + 20}$$
$$-3(f + 20) = f$$
$$-3f - 60 = f$$
$$-4f = 60$$

$$f = -\frac{60}{4} = -15\text{ cm}$$

Question



$h_o = +ve$ Always u

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

- A 0.11 cm
- B 0.5 cm
- C 0.55 cm
- D 0.60 cm

$$\begin{aligned}h_o &= +5 \text{ cm} \\u &= -1 \text{ m} = -100 \text{ cm} \\R &= 20 \text{ cm} \\f &= \frac{R}{2} = \frac{20}{2} \\f &= -10 \text{ cm}\end{aligned}$$

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

$$f = -\frac{1}{9}$$

$$m = \frac{h_I}{h_o} \Rightarrow h_I = m \times h_o$$

$$h_I = -\frac{1}{9} \times 5$$

$$h_I = -\frac{5}{9} \approx -0.55 \text{ cm}$$

Question



Object is placed 15 cm from a concave mirror of focal length 10 cm, then the nature of image formed will be

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

Handwritten notes in pink:
1. $m = \frac{f}{f-u}$ ✓
2. $f < u$

- A** magnified and inverted
- B** magnified and erect
- C** small in size and inverted
- D** small in size and erect

Question



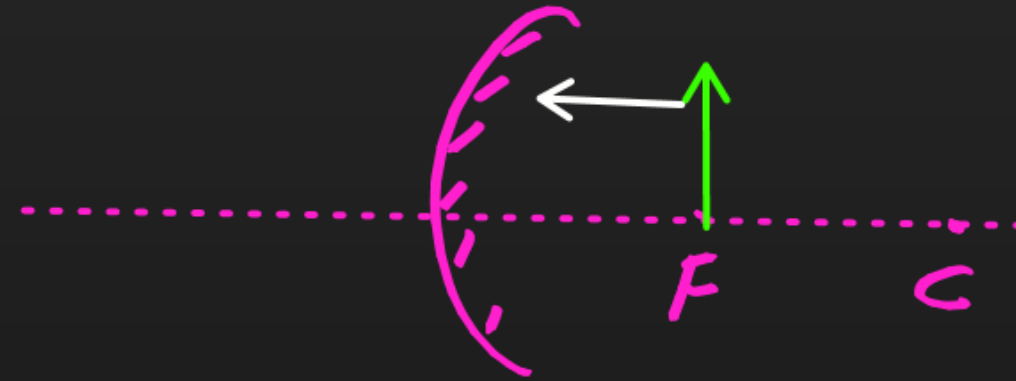
For a point object, which of the following **always** produces **virtual image** in air?

- A** Concave mirror
- B** Plano-convex lens
- C** Convex mirror
- D** Biconvex lens

Question

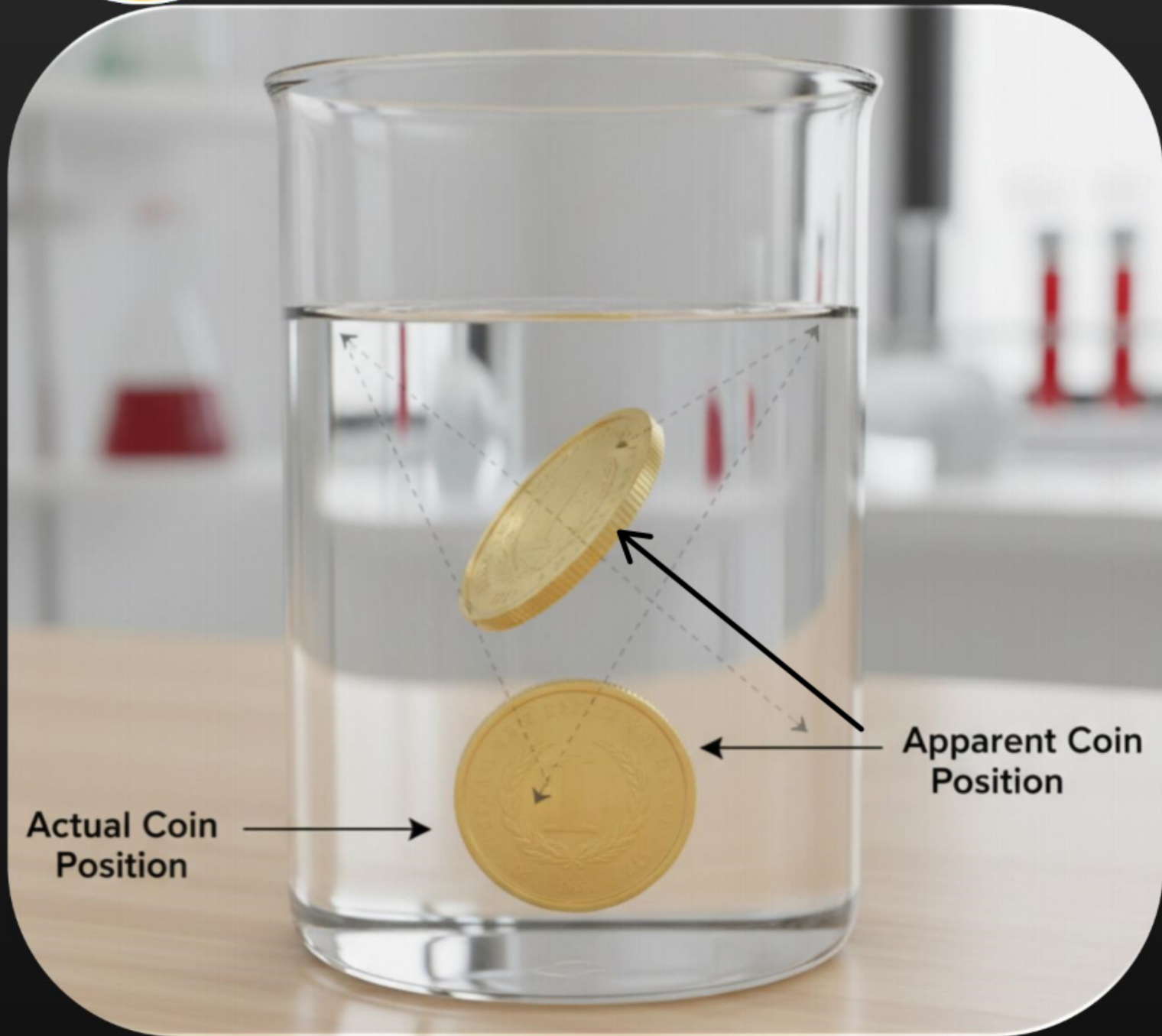
An object is placed at the principal focus of a **convex mirror**. The image will be at

- A** Centre of curvature
- B** Infinity
- C** Principal focus
- D** No image will be formed



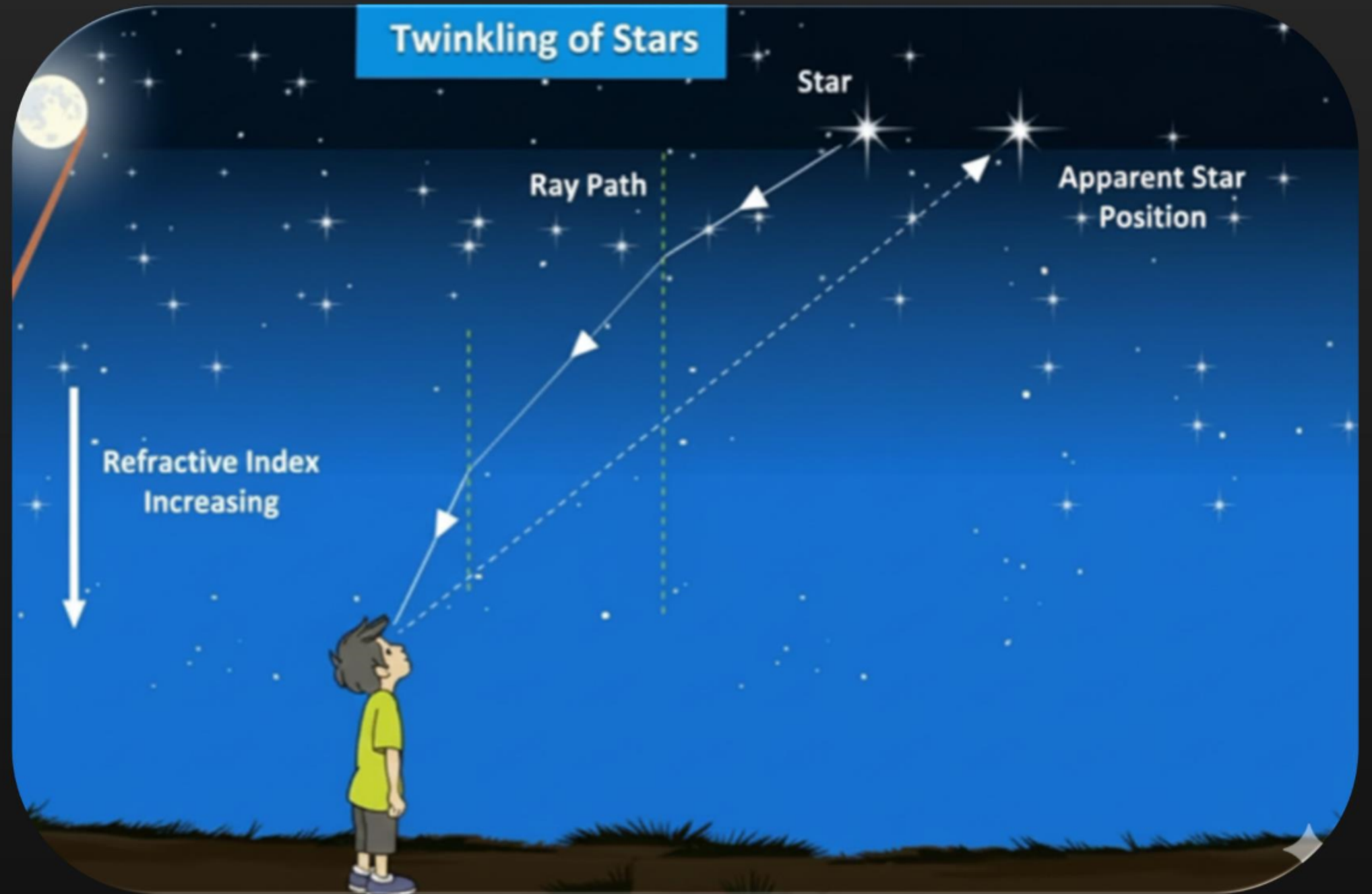


Do you know ?





Do you know ?



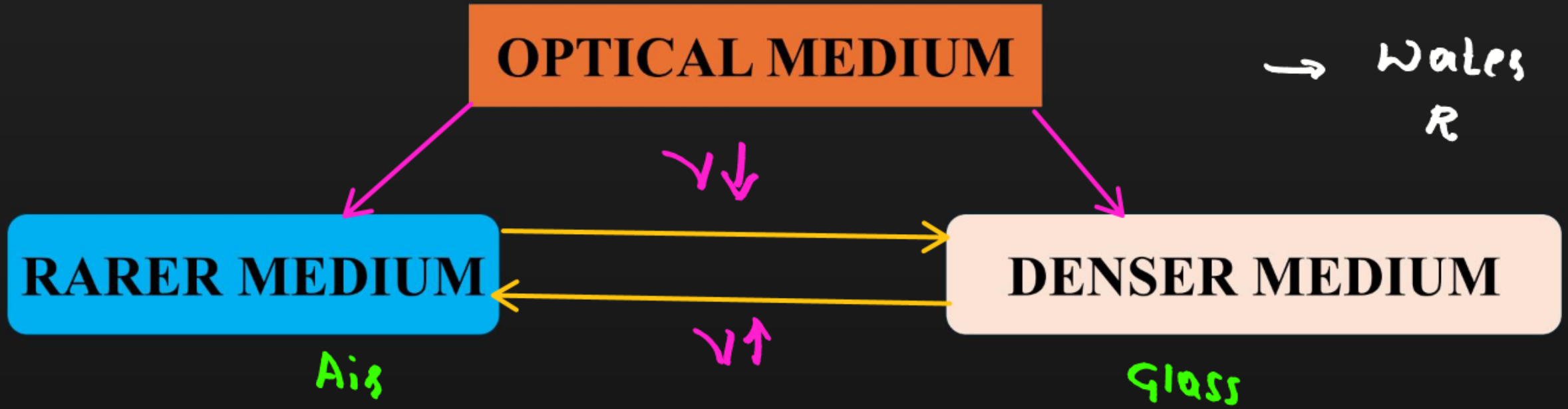


Refraction of light

→ Air R Water D

Refraction of light : The phenomena in which light ray changes its direction when it is travelling from one optical medium to another.

→ Air R Glass D
 → Water R Glass D





Refraction of light

Cause of refraction : When a ray of light passes from one medium to another medium ~~to~~ ~~another medium~~, its direction or path changes because of the **change in speed of light**.

Speed of light :

1. Vacuum or Air - $c = 3 \times 10^8 \text{ m/s}$

2. Water - $v_w = 2.5 \times 10^8 \text{ m/s}$

3. Glass - $v_g = 2.25 \times 10^8 \text{ m/s}$



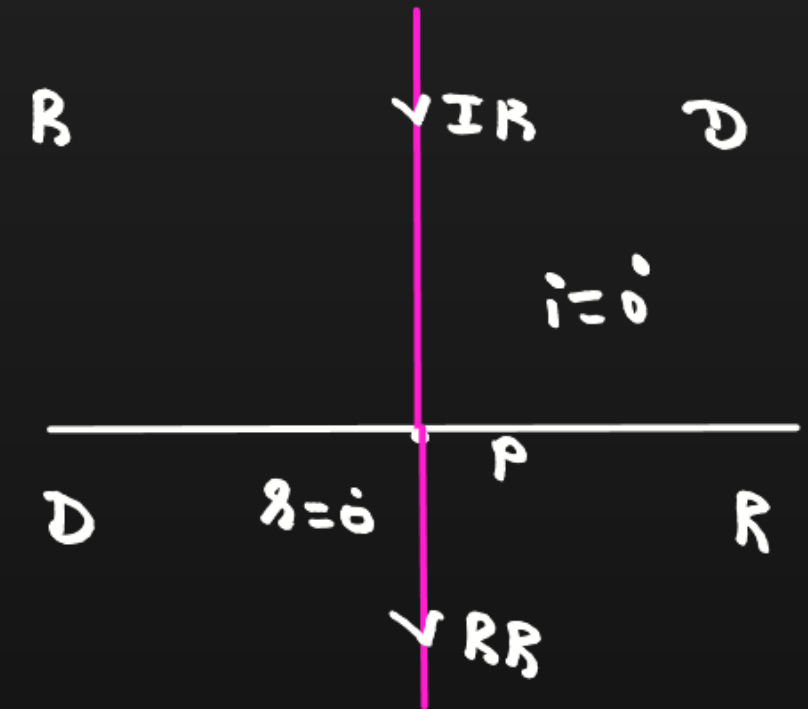
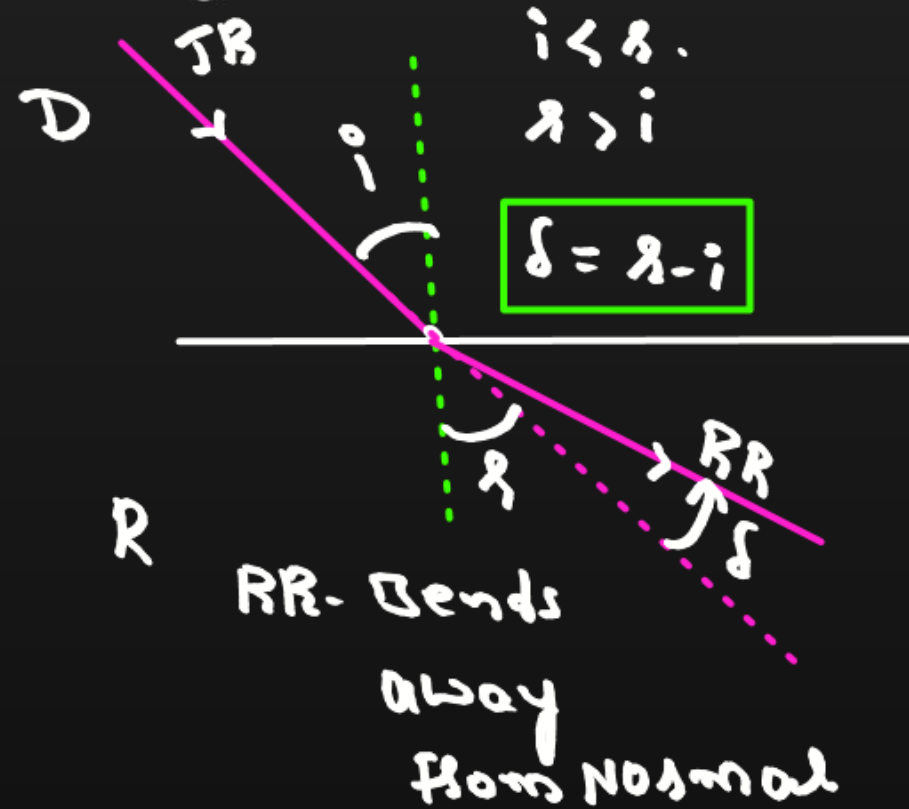
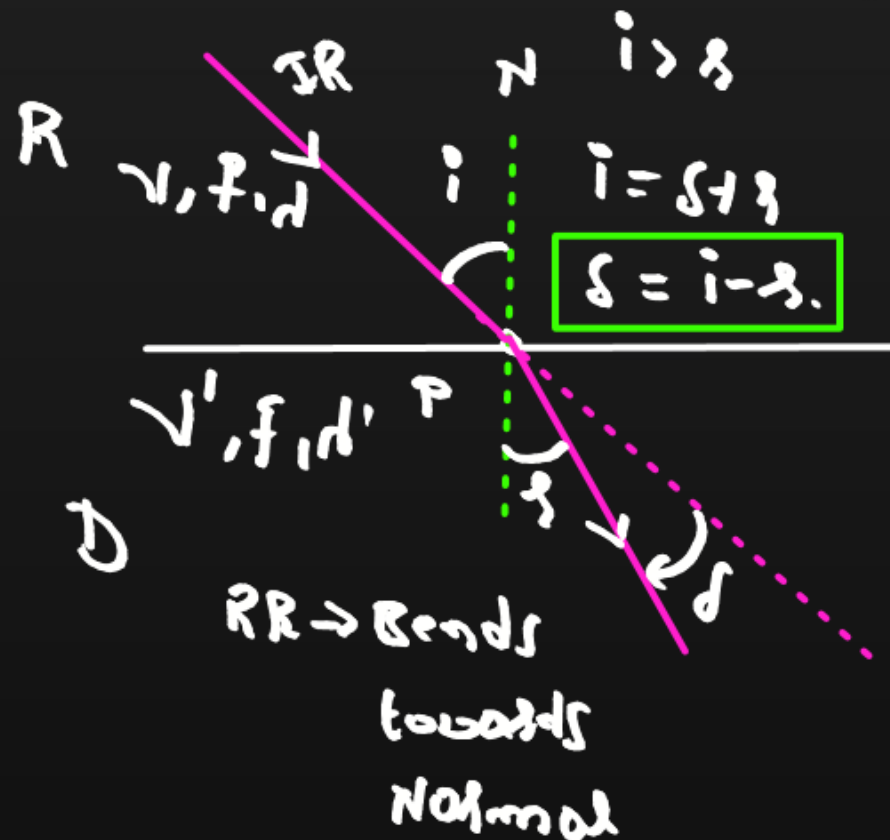
Deviation of light ray

$$v = f\lambda$$

$$c = f\lambda$$

1. Refraction from Rarer to Denser medium: When a ray of light gets refracted from a rarer medium to denser medium, the speed of light decreases.

2. Refraction from Denser to Rarer medium: When a ray of light gets refracted from a denser medium to rarer medium, the speed of light increases.





Effect on speed, frequency and wavelength

1. When a ray of light gets refracted from a rarer medium, the **speed of light** decreases; while if it is refracted from a denser to a rarer medium, the speed of light increases.
2. The **frequency f of light** depends on the source of light, so it does not change on refraction of light.
3. The speed of light V in a medium is related to its **wavelength** in that medium and the frequency as :

$$v = f\lambda \quad \boxed{v \propto \lambda} \quad f = \text{const}$$

$$\boxed{f = \frac{v}{\lambda}} \rightarrow \text{medium}$$

$$c = f\lambda$$

$$\boxed{f = \frac{c}{\lambda}} \rightarrow \text{Air}$$

Question



When a light ray from a rarer medium is refracted into a denser medium, its

$$R \rightarrow D$$
$$v, f, \lambda \rightarrow v', f, \lambda'$$

$$v > v'$$

$$\lambda > \lambda'$$

$$v \downarrow$$

$$\lambda \downarrow$$

- A** Speed increases, wavelength increases ✗
- B** Speed decrease, wavelength increases ✗
- C** Speed increases, wavelength decreases ✗
- D** Speed decreases, wavelength decreases ✓

Question



When light travels from one medium to the other of which the refractive index is different, then which of the following **will change**

$$f = \text{const} \quad \boxed{v \neq d}$$

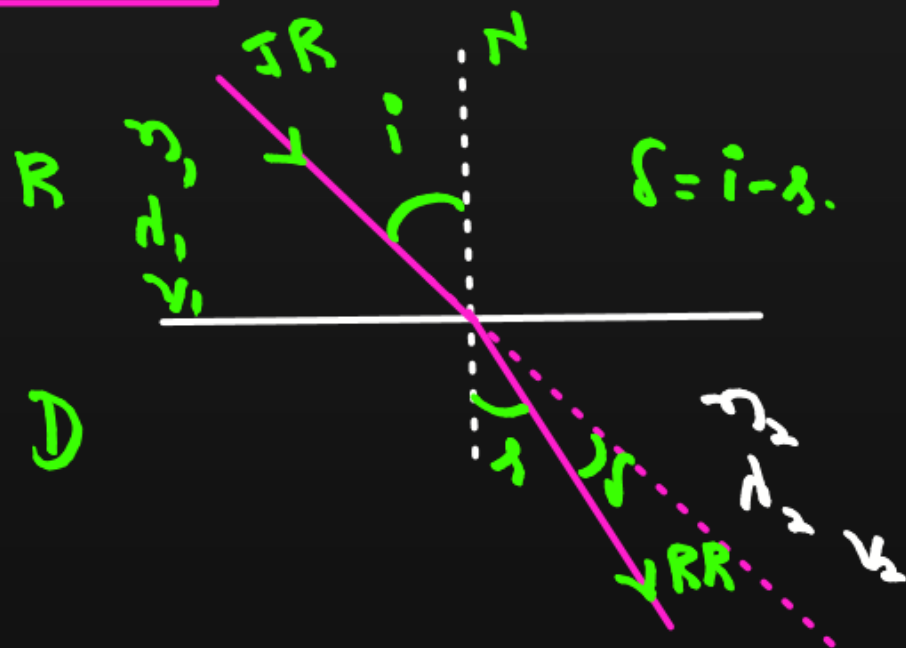
- A** Frequency, wavelength and velocity
- B** Frequency and wavelength
- C** Frequency and velocity
- D** **Wavelength and velocity**



Law of Refraction

1ST LAW: The incident ray, Normal and Refracted Ray at a point of incidence, all lie in the same plane.

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



$$n_1 \sin i = n_2 \sin r$$

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = n_{21} = \mu(RD)$$

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



Refractive Index

REFRACTIVE INDEX

ABSOLUTE REFRACTIVE INDEX

RELATIVE REFRACTIVE INDEX



Refractive Index

Refractive Index: The R.I of the 2nd medium with respect to 1st medium defined as “The ratio of sine of angle of incidence and sine of angle of refraction for a pair of media”

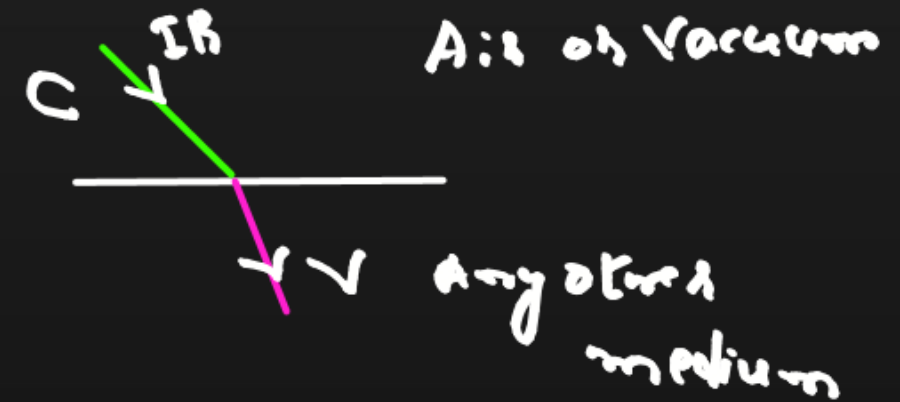
$$\frac{c_2}{c_1} = \mu = \frac{\sin i}{\sin r}$$

Absolute Refractive Index: The ratio of speed of light in air/vacuum to the speed of light in a medium.

$$\begin{aligned} A &\rightarrow c \\ v &\rightarrow v \end{aligned}$$

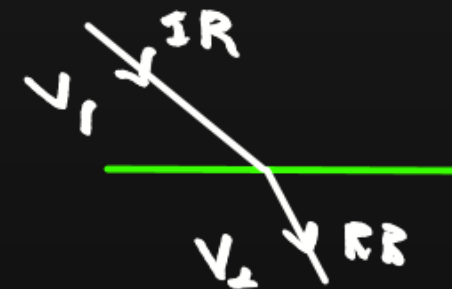
$$\frac{c}{v} = \mu_a$$

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



Relative Refractive Index: The ratio of speed of light in 1st medium to the 2nd medium. *Ex: Water Glass*

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



Question



The speed of light in air is $3 \times 10^8 \text{ m/s}$ and in glass it is $2 \times 10^8 \text{ m/s}$, Find Refractive index of glass.

Air \rightarrow Glass

$$\mu_a = \frac{c}{v_g} = \frac{3 \times 10^8}{2 \times 10^8} = 1.5$$

Question



The speed of light in air is $3 \times 10^8 \text{ m/s}$ and in water it is $2.25 \times 10^8 \text{ m/s}$, Find Refractive index of water.

Air \rightarrow Water.
R D

$$\mu_w = \frac{C}{v_w} = \frac{3 \times 10^8}{2.25 \times 10^8} = 1.33$$

Question



The speed of light in water is $2.25 \times 10^8 \text{ m/s}$ and in glass it is $2 \times 10^8 \text{ m/s}$, Find Refractive index of glass with respect to water.

Water \rightarrow glass
R D

$$\frac{n_g}{n_w} = \mu_g = \frac{v_w}{v_g} = \frac{2.25 \times 10^8}{2 \times 10^8} = 1.125$$

Question



1.6

The speed of light in water is $2.25 \times 10^8 \text{ m/s}$ and in glass it is $2 \times 10^8 \text{ m/s}$, Find Refractive index of water with respect to glass.

Glass \rightarrow Water
D R

$$\frac{v_w}{v_g} = \mu_w = \frac{v_g}{v_w} = \frac{2 \times 10^8}{2.25 \times 10^8} = 0.88$$



Refractive Index

Absolute Refractive Index in terms of Electric permittivity ϵ_0 and Magnetic permeability μ_0 of free space :

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$



Factors affecting the Refractive Index of a medium

1. **Nature of medium** : Less the speed of light in a medium as compared to that in air, more is the refractive index of the medium.

$$R.I \propto \frac{1}{\text{speed}}$$

$$\mu_a < \mu_w < \mu_{\text{glass}}$$

$$c > v_w > v_{\text{glass}}$$

2. **Physical condition such as temperature** : With increase in temperature, The refractive index of the medium decreases, So speed of light in the medium increases.

3. **The colour or wavelength of the light** :

V I B G Y O R
 n_v n_R
 v_v v_R

$$n_R > n_v$$

$$v_R > v_v$$

$$R.I \propto \frac{1}{\text{speed}}$$

$$\mu_R < \mu_v$$

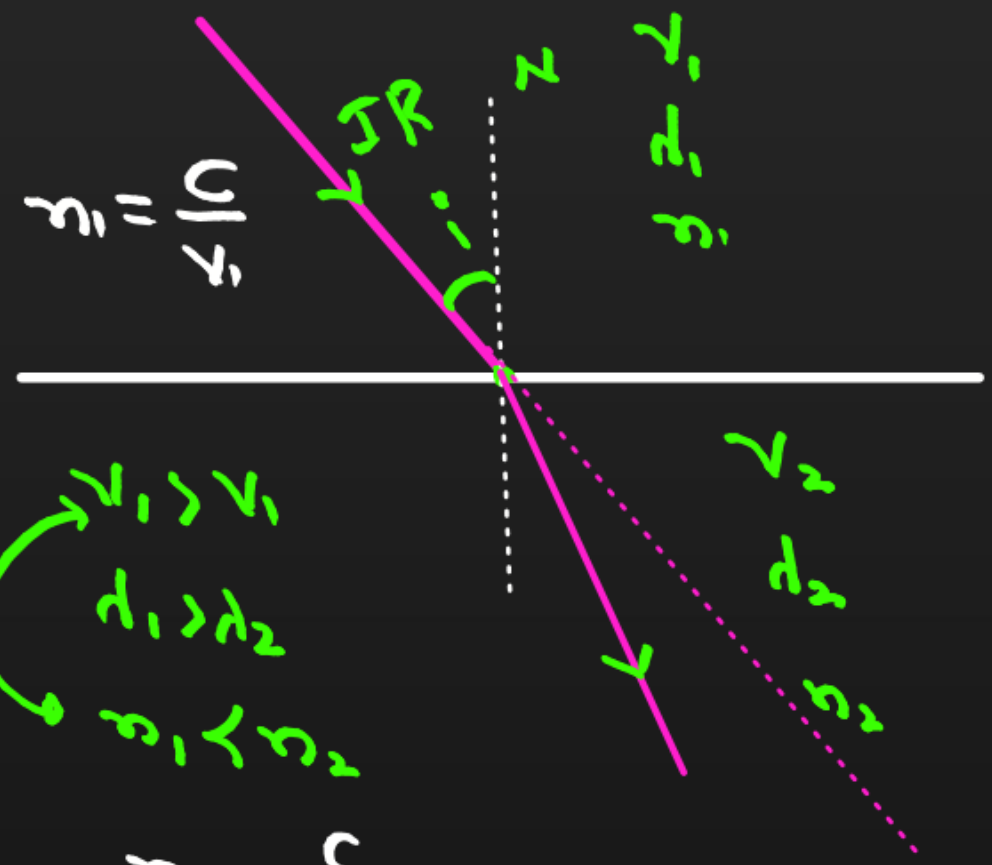
$$\mu_v > \mu_R$$



Factors affecting the Refractive Index of a medium

$n_1 = \frac{c}{v_1}$

B



D

$v_1 > v_2$
 $n_1 < n_2$
 $i < r$
 $c_1 > c_2$
 $f_1 < f_2$
 $\lambda = \lambda$

Snell's Law Law

$n_1 \sin i = n_2 \sin r$

$$\frac{\sin i}{\sin r} = \frac{v_2}{v_1} = \frac{c_1}{c_2} = \frac{f_2}{f_1} = \frac{\lambda_1}{\lambda_2}$$

*

$$\frac{\sin i}{\sin r} = \frac{v_2}{v_1} = \frac{c_1}{c_2} = \frac{\lambda_1}{\lambda_2}$$

v_1, f, λ, n

Question



The refractive index of a certain glass is 1.5 for light whose wavelength in vacuum is 6000 \AA . The wavelength of this light when it passes through glass is

A 4000 \AA

B 6000 \AA

C 9000 \AA

D 15000 \AA

$$\frac{\sin i}{\sin r} = \frac{v_2}{v_1} = \frac{\lambda_1}{\lambda_2}$$

$$\frac{v_2}{v_1} = \frac{\lambda_1}{\lambda_2} \Rightarrow \frac{1.5}{1} = \frac{6000}{\lambda_2}$$

$$\lambda_2 = \frac{6000}{1.5} = 4000 \text{ \AA}$$

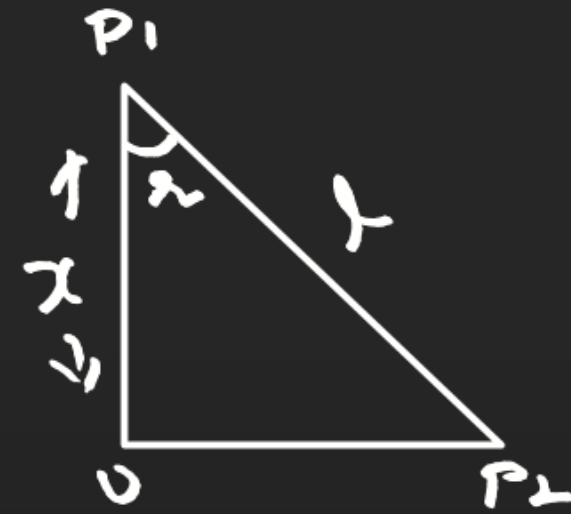
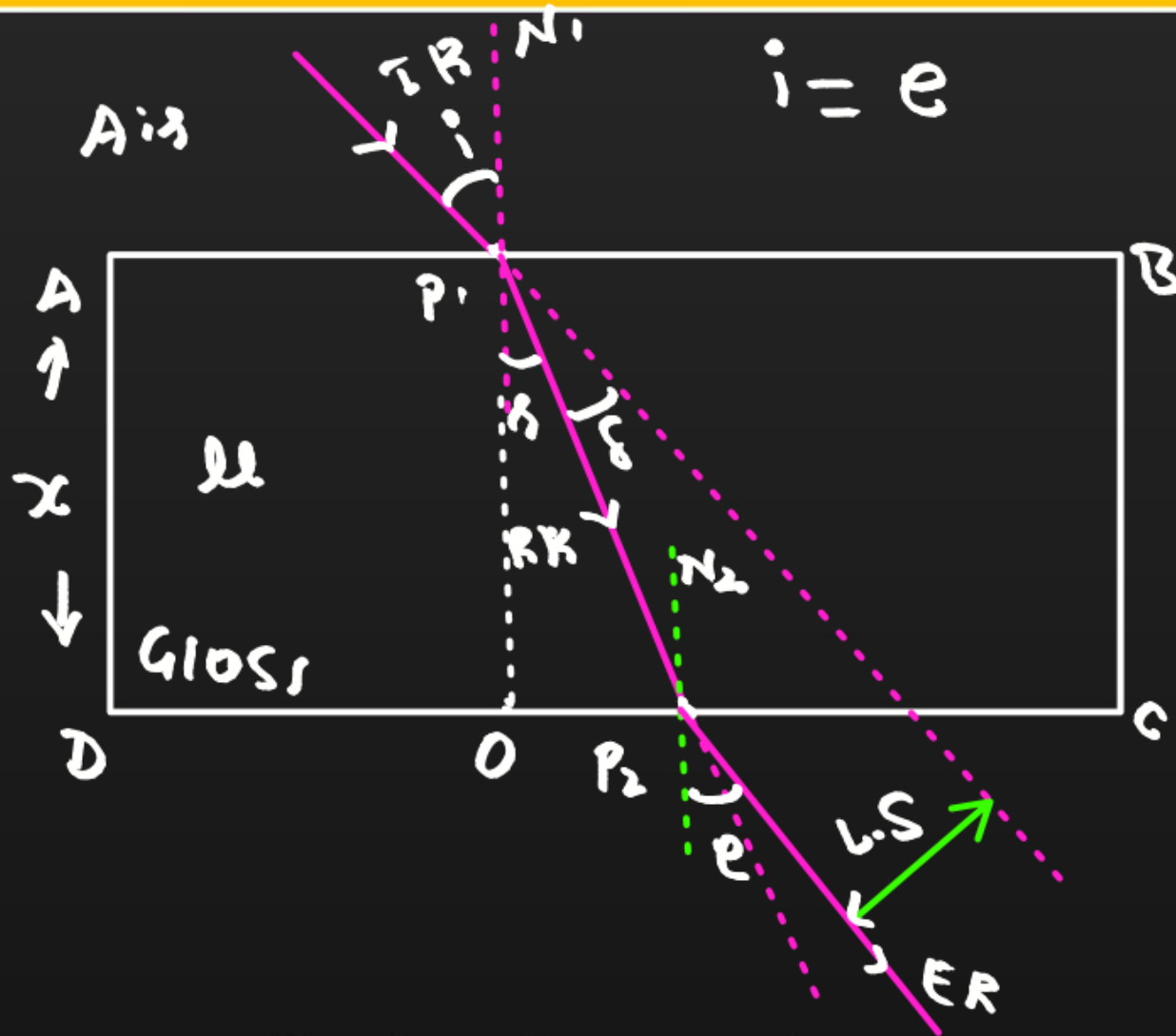
$$\lambda_g = \lambda_2$$

$$\lambda_a = \lambda_1$$

$$\rightarrow n_1 = 1$$



Refraction through a glass slab



$$\cos \theta = \frac{B}{H}, \quad \cos r = \frac{x}{l}$$

$$l = \frac{x}{\cos r}$$

$$l_g = l = \frac{c}{v}$$

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

Lateral shift : The perpendicular distance between emergent ray and direction of incident ray is called lateral shift.



Refraction through a glass slab

Calculation of Lateral Shift:

$$L.S = \frac{x \sin(i-r)}{\cos(r)}$$

(b)

Time taken by light ray to cross the slab is

$$\text{Speed} = \frac{\text{length}}{\text{time}} = \frac{l}{t}$$

∴

$$t = \frac{l}{v}$$

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

$$t = \frac{l}{\frac{c}{\mu}} = \frac{\mu l}{c} = \frac{\mu x}{c \cos r}$$

$$t = \frac{\mu x}{c \cos r}$$

x - thickness of glass slab
 μ - R.I of glass
 $c = 3 \times 10^8 \text{ m/s}$

Question

H.L



A light ray incident on a glass surface of refractive index $\sqrt{2}$ from air at an angle of incidence 45° . Find out:

- (i) Angle of refraction
- (ii) Angle of deviation.

Thank

You