NDA-CDS 1 2025

GS

LIVE

PHYSICS

REFRACTION OF LIGHT

CLASS 1

NAVJYOTI SIR

02 Dec 2024 Live Classes Schedule

8:00AM	02 DEC 2024 DAILY CURRENT AFFAIRS	RUBY MA'AM
9:00AM	02 DEC 2024 DAILY DEFENCE UPDATES	DIVYANSHU SIR

NDA 1 2025 LIVE CLASSES

1:00PM	PHYSICS - REFRACTION OF LIGHT - CLASS 1	NAVJYOTI SIR
5:30PM	MATHS - LIMITS & CONTINUITY - CLASS 3	NAVJYOTI SIR

CDS 1 2025 LIVE CLASSES

1:00PM	PHYSICS - REFRACTION OF LIGHT - CLASS 1	NAVJYOTI SIR
7:00PM	MATHS - TRIGONOMETRY - CLASS 4	NAVJYOTI SIR

LIGHT - REFRACTION

SSBCrack EXAMS

WHAT WILL WE STUDY ?

- Refraction And Laws
- Refractive Index
- Lenses – Convex And Concave Lens
- Image Formation By Lenses
- Power
- Total Internal Reflection And Applications
- Refraction In Nature

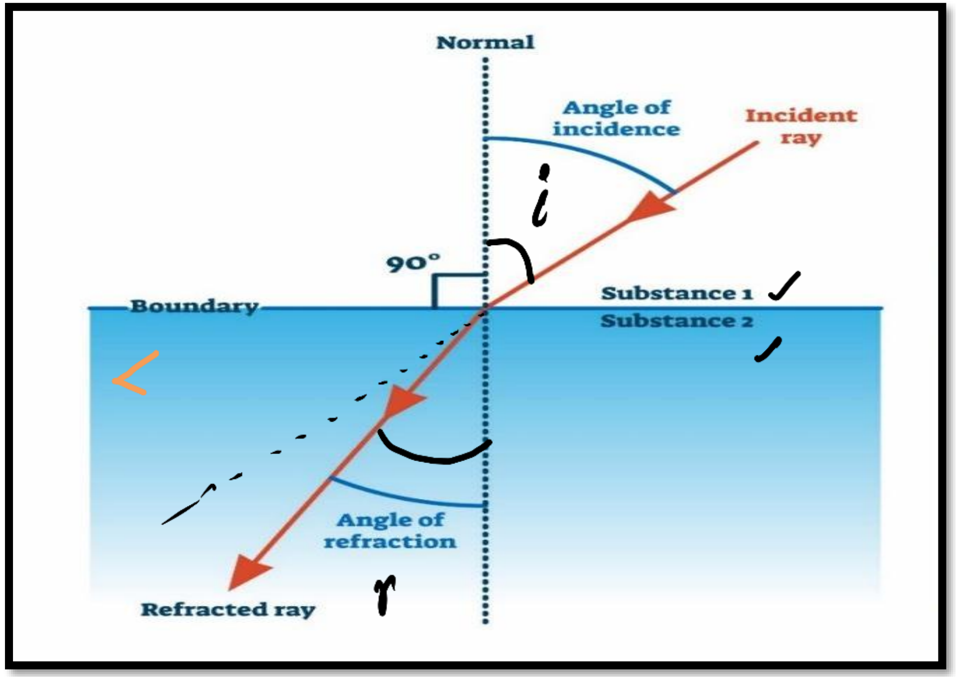
Refraction

- Bending of a light ray due to change in speed of light.
- It happens between two mediums / media.

LAWS OF REFRACTION

1. The Incident Ray, The Refracted Ray And The Normal At The Incident Point All Lie In The Same Plane.

2. Snell's Law : The Ratio Of The Sine Of The Angle Of Incidence To The Sine Of The Angle Of Refraction Is A Constant.

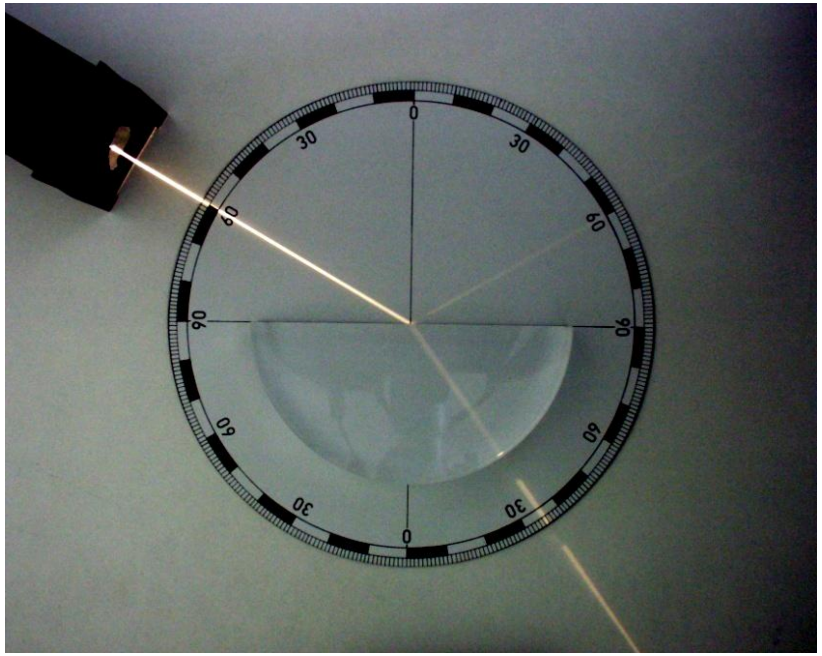


$$\frac{\sin i}{\sin r} = \text{constant} = \mu$$

(μ: refractive index for the two medium)

REFRACTIVE INDEX

- The Ratio Of Speed Of Light In Vacuum (c) To The Speed Of Light In Any Medium (v) Is Called Refractive Index Of The Medium.



2 types

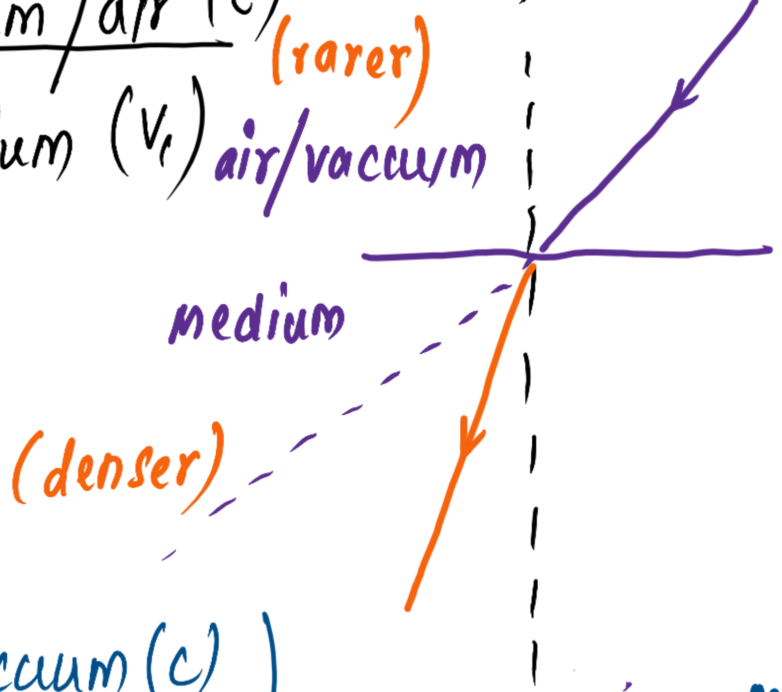
a) absolute refractive index (μ_a / n_a) — w.r.t. air / vacuum

b) relative refractive index (μ_r / n_r) — w.r.t. any other medium

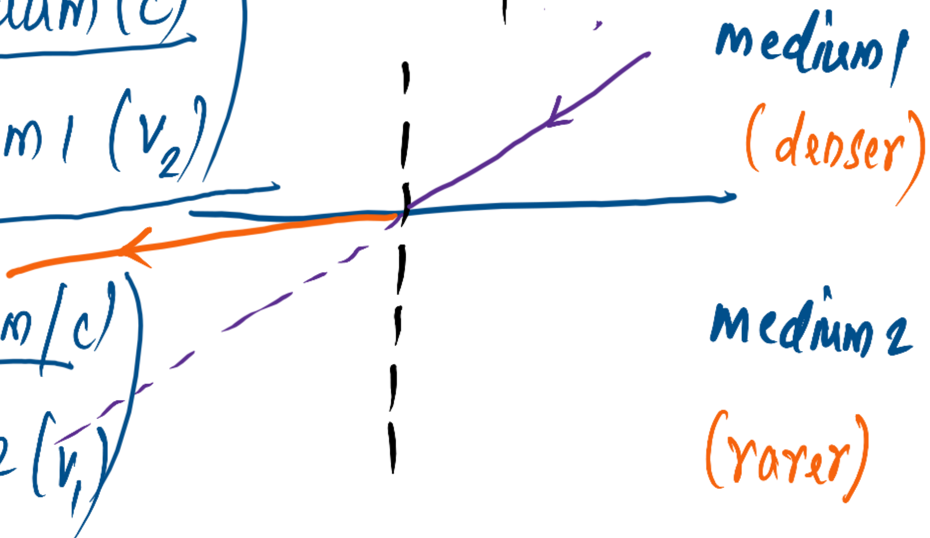
$$\mu_a / n_a = \frac{\text{speed of light in vacuum/air } (c)}{\text{speed of light in medium } (v_1)}$$

↓

Absolute refractive Index



$$\mu_r / n_r = \frac{\mu_{a_2}}{\mu_{a_1}} = \frac{\left(\dfrac{\text{speed of light in air/vacuum } (c)}{\text{speed of light in medium 1 } (v_2)}\right)}{\left(\dfrac{\text{speed of light in air/vacuum } (c)}{\text{speed of light in medium 2 } (v_1)}\right)}$$



Light ray coming from,

Denser → Rarer → Light ray bends away from normal

(towards lower μ)

Rarer → Denser → towards the normal

(towards higher μ)

$$\frac{\mu_2}{\mu_1} = \frac{\frac{c}{v_2}}{\frac{c}{v_1}} = \frac{v_1}{v_2} \Rightarrow \boxed{\frac{\mu_2}{\mu_1} = \frac{v_1}{v_2}}$$

$$\left(\mu_{21} = \frac{v_1}{v_2}\right)$$

* If speed of light is more in a medium, its refractive index will be less.

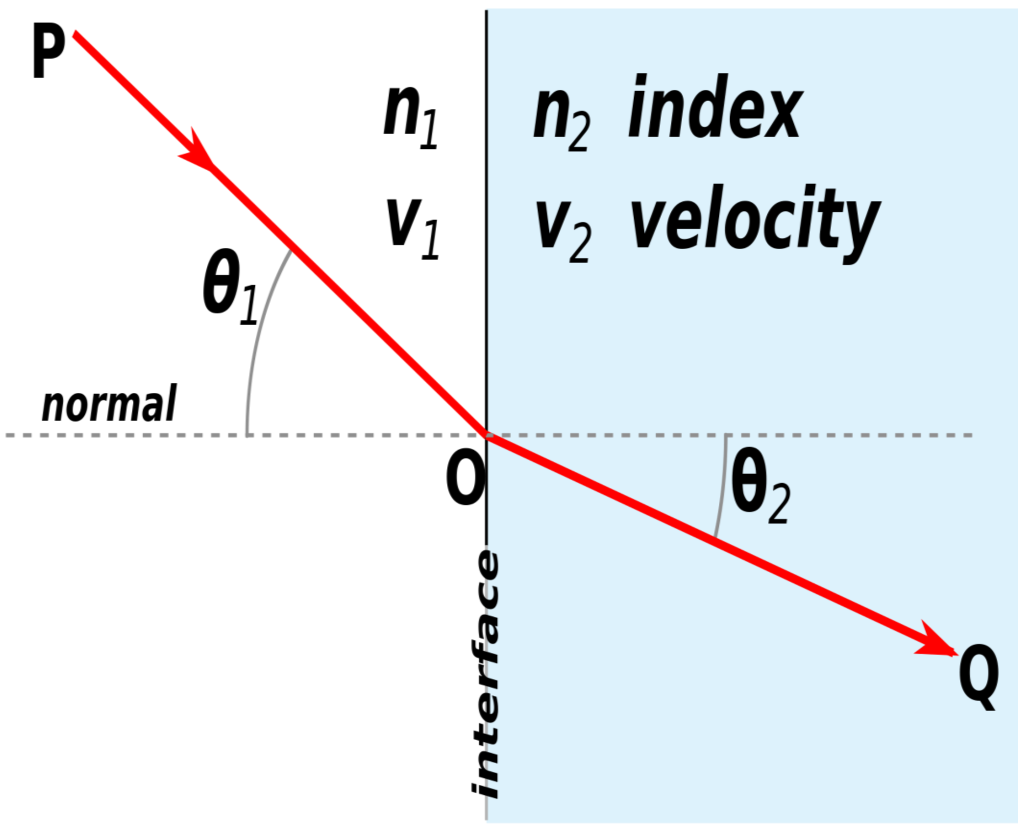
$$\mu_a \propto \frac{1}{v}$$

$$\mu_{diamond} = 2.42$$

$\mu_{air} = 1$; $\mu_{glass} = \frac{3}{2} = 1.5$; $\mu_{water} = \frac{4}{3} \sim 1.33$

SSBCrack EXAMS

Absolute And Relative Refractive Indices



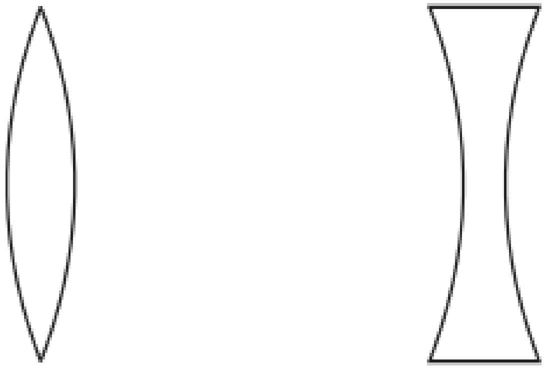
$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

Snell's law

SSBCrack EXAMS

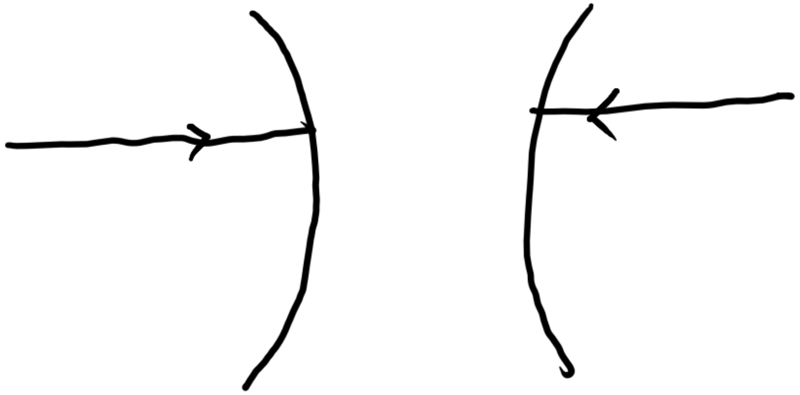
LENS

- A Transparent Material Bound By Two Surfaces, Of Which One Or Both Surfaces Are Spherical, Forms A Lens.



Convex Lens (2 convex mirrors)

Concave Lens (2 concave mirrors)



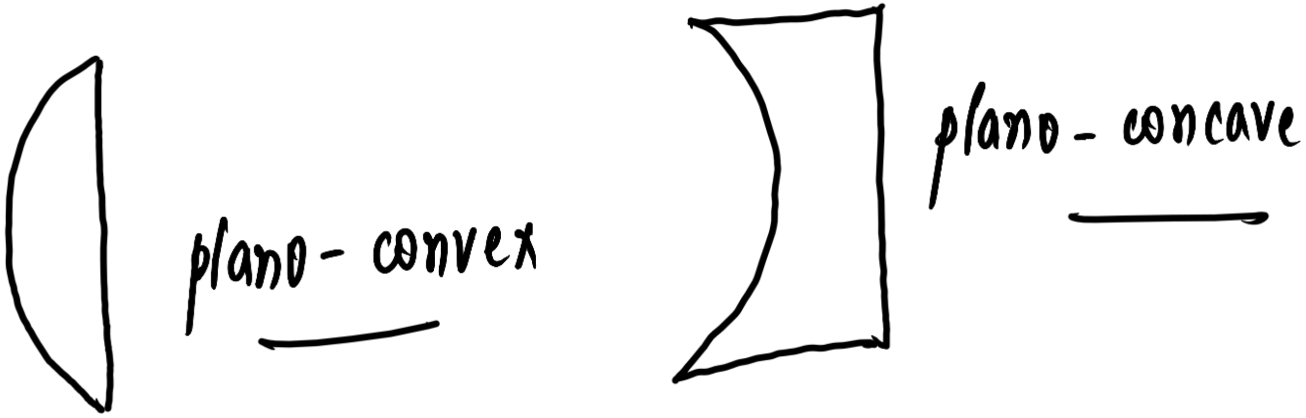
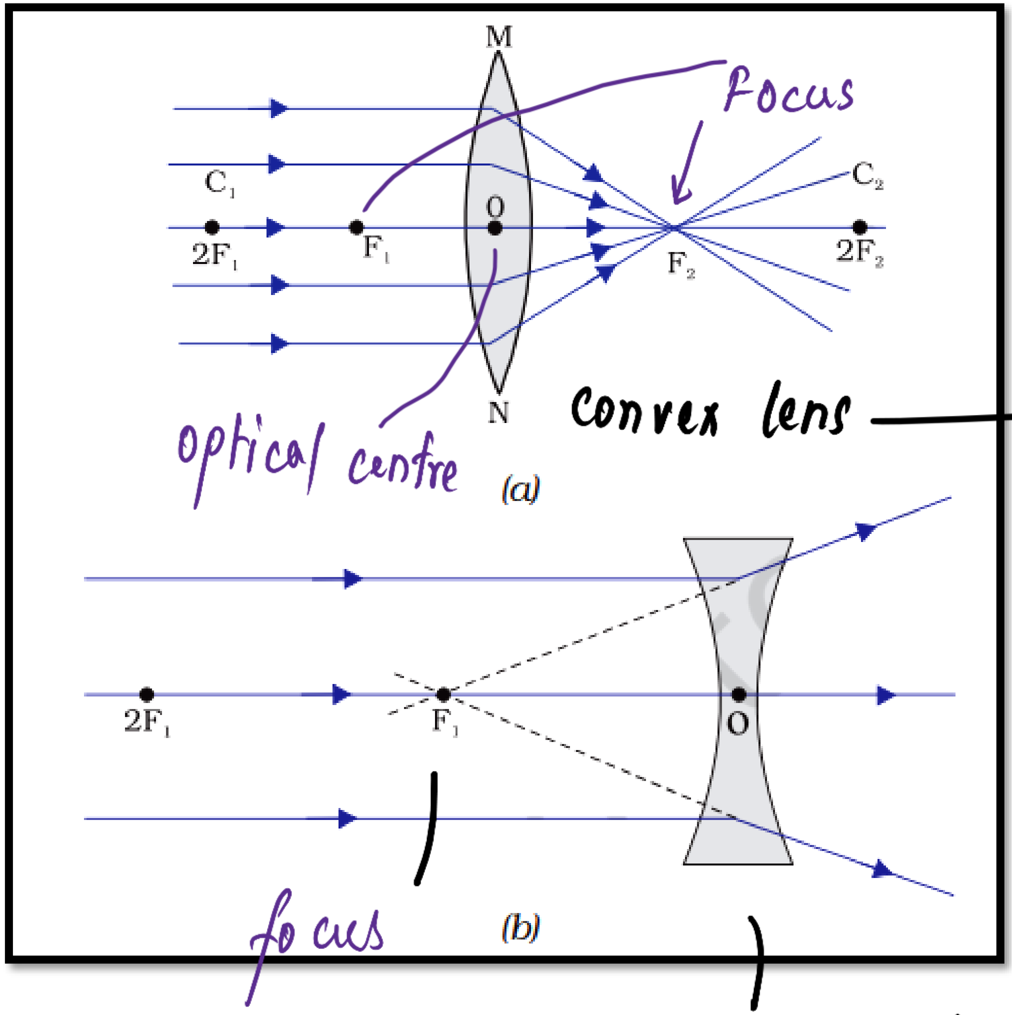


IMAGE FORMED BY CONCAVE AND CONVEX LENS

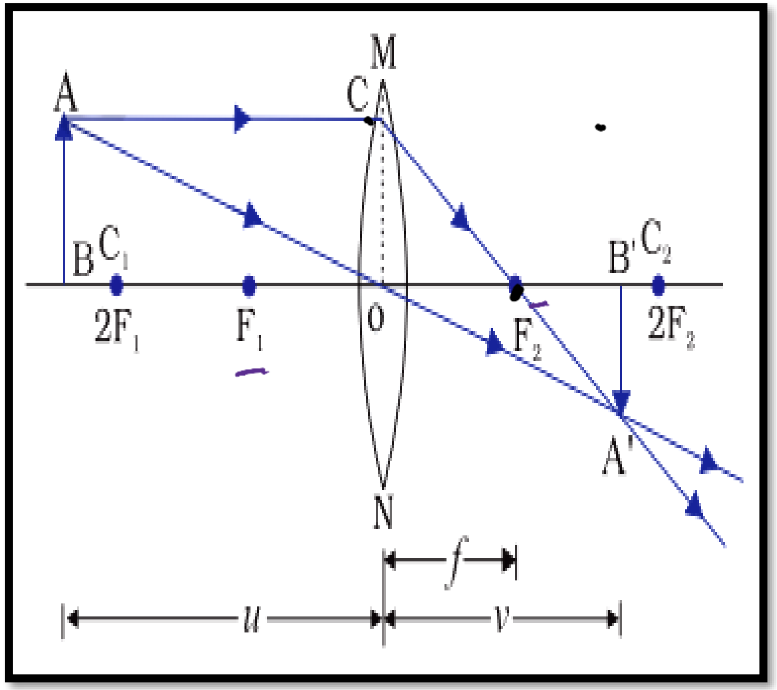


convex lens → acts like concave mirror (converging) (f = +ve)

concave lens → acts like convex mirror (diverging) (f = −ve)

IMAGE FORMED DUE TO DIFFERENT POSITION OF OBJECTS

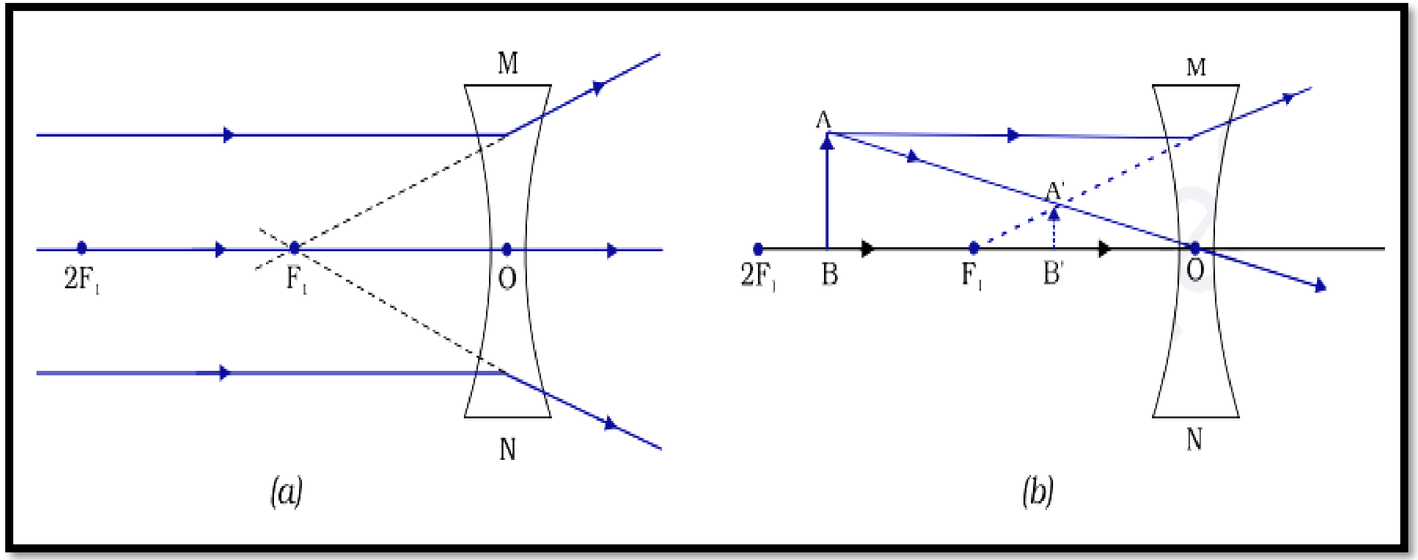
Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_2	Highly-diminished, point-sized	Real and inverted
Beyond $2F_1$ (c)	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At Focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between F_1 and Optical centre O	On the same side of the lens as the object	Enlarged	Virtual and erect ✓



$2F_1 = C_1$ $2F_2 = C_2$

CONCAVE LENS

Position of the Object	Position os the Image	Relative size of the Image	Nature of
At infinity	At focus F_1	Highly-diminished, point, sized	Virtual and erect
Between infinity and Optical centre O of the lens	Between F_1 and Optical centre O	Diminished	Virtual and erect



SSBCrack EXAMS

POWER OF LENS

- The Reciprocal Of Focal Length Of Lens In Metres. Its Unit Is Dioptre(D).

$$\text{Power of a lens, } (P) = \frac{1}{f\,(\text{metre})}$$

If f (in cm),

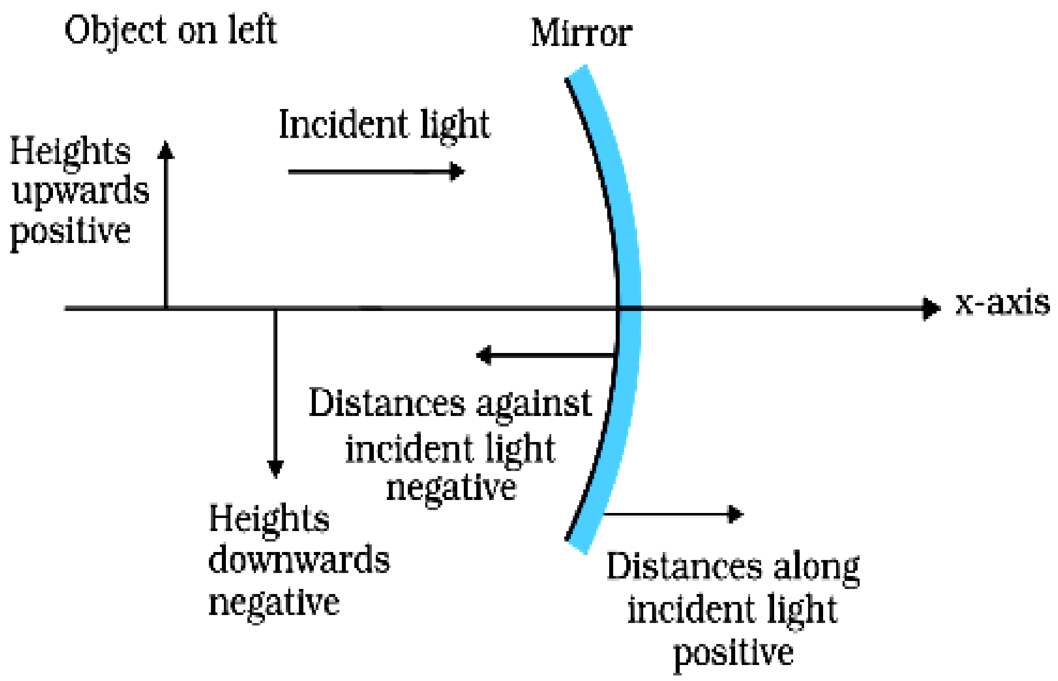
$$P = \frac{1}{\left(\frac{f}{100}\right)m} = \frac{100}{f(\text{in cm})}$$

- For a combination of lenses ,
  - (a) When in contact , $P = P_1 + P_2$
  - (b) When seperated by distance ‘d’ ,

$$P = P_1 + P_2 - dP_1P_2$$

$P = P_1 + P_2 + P_3 + P_4 + \ldots$

SIGN CONVENTION FOR LENS



LENS FORMULA AND MAGNIFICATION

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

- **Magnification ,**

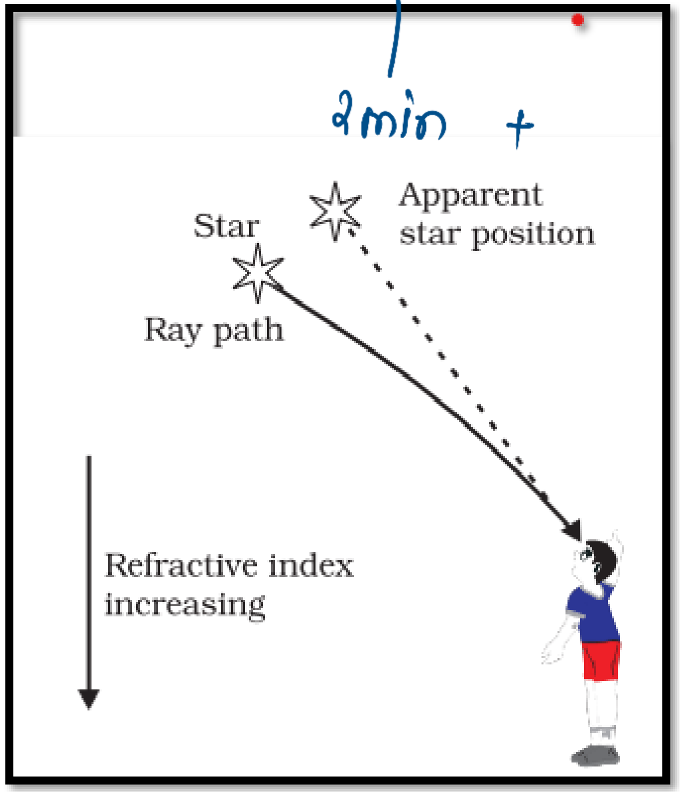
$$m = \frac{h'}{h} = \frac{v}{u}$$

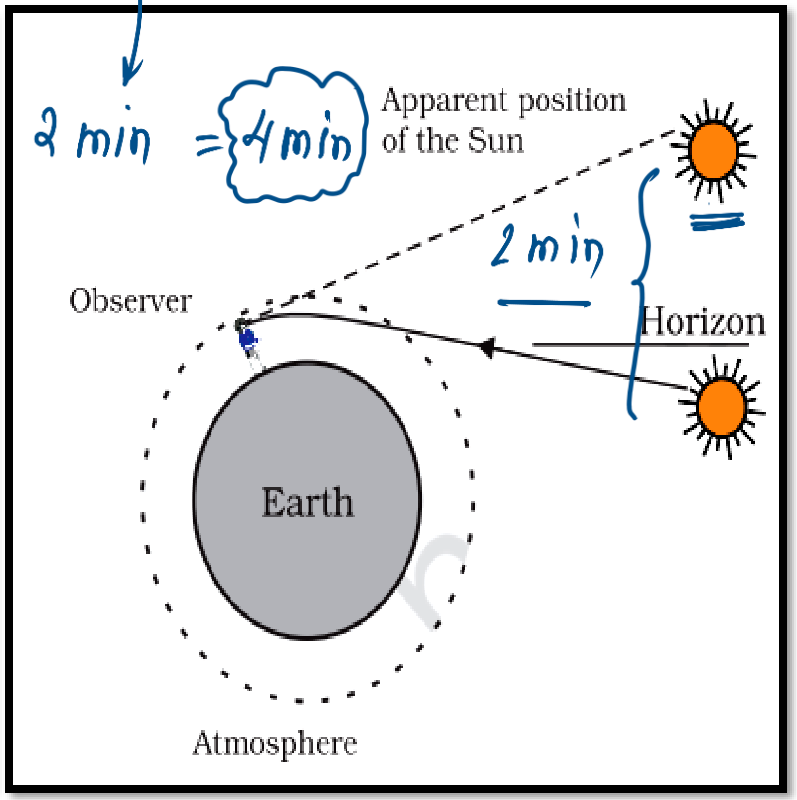
REFRACTION IN NATURE

by Atmosphere

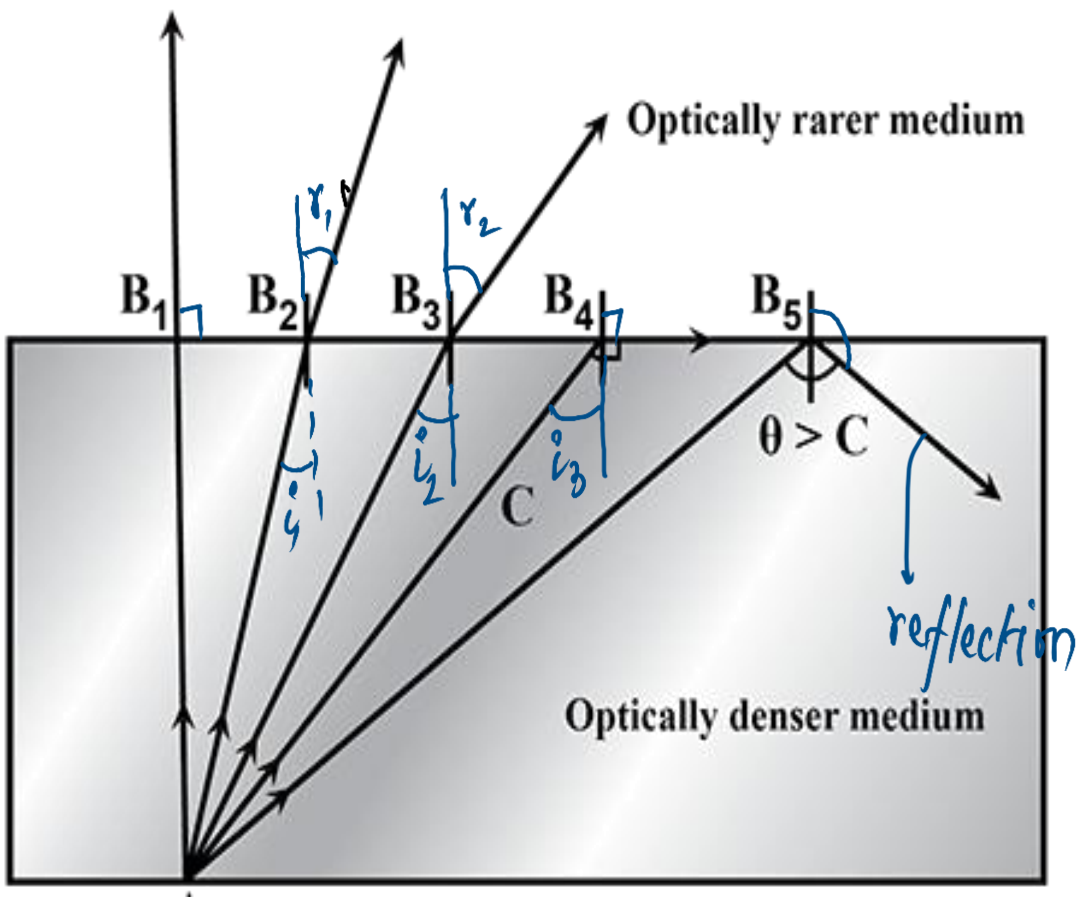
- **Twinkling of Stars.** ✓
- **Advanced Sunrise and Delayed Sunset**

various layers have different refractive index.





TOTAL INTERNAL REFLECTION (TIR)



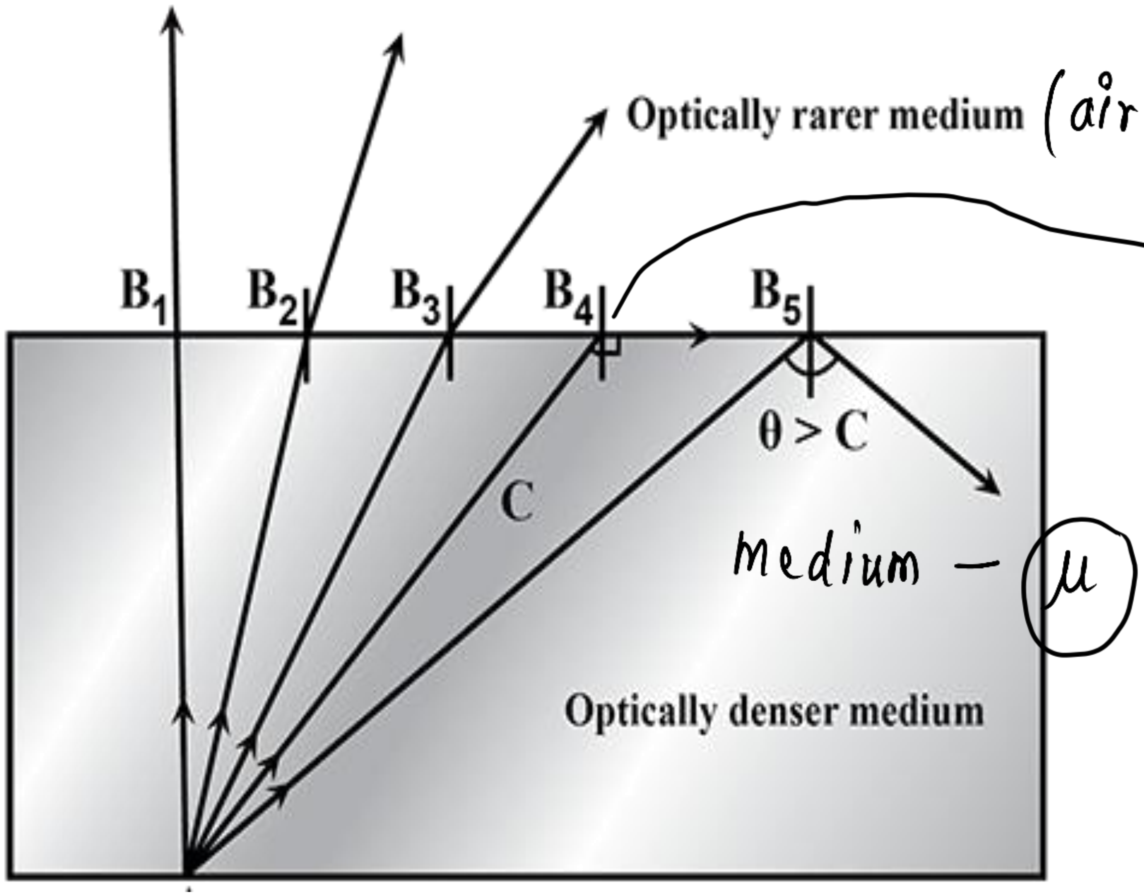
Angle of incidence at which r = 90° is called critical angle (i_3, i_c)

reflection → (TIR)

condition to happen,

($i > i_c$)

When i increases, r also increases,



Applying Snell's law

$\sin i_c \cdot \mu = \sin 90^\circ \cdot 1$

$\mu \cdot \sin i_c = 1$

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

For small θ, $\sin\theta \approx \theta$

$i_c = \frac{1}{\mu}$

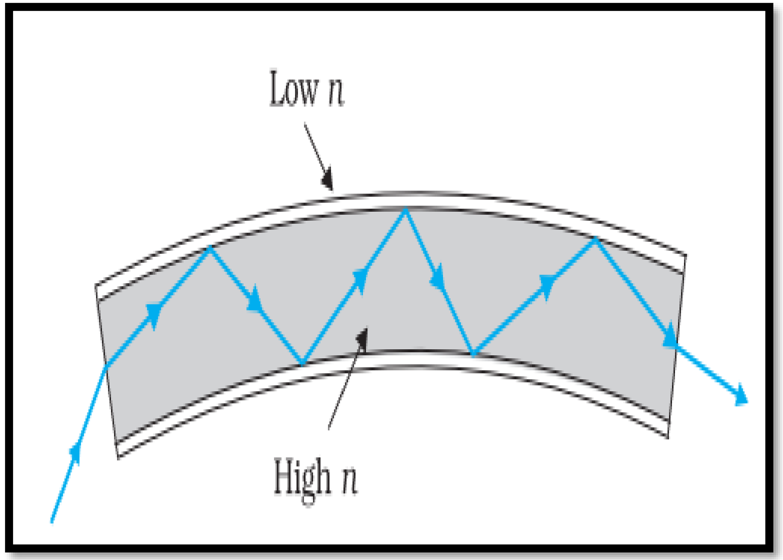
$i_c \propto \frac{1}{\mu}$

Diamond , $\mu = 2.42$

$i_c = 24.2^\circ$

APPLICATIONS OF TIR

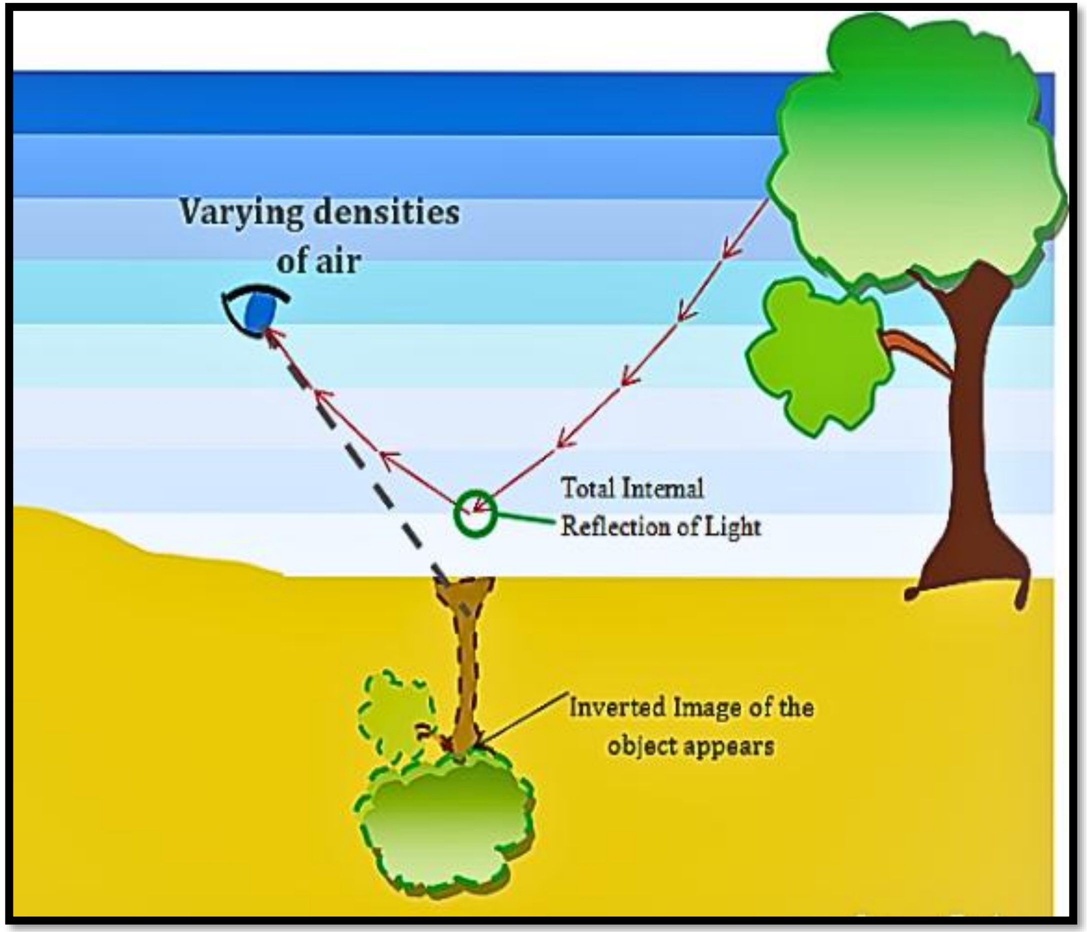
- Optical Fibres



Sparkling of Diamond

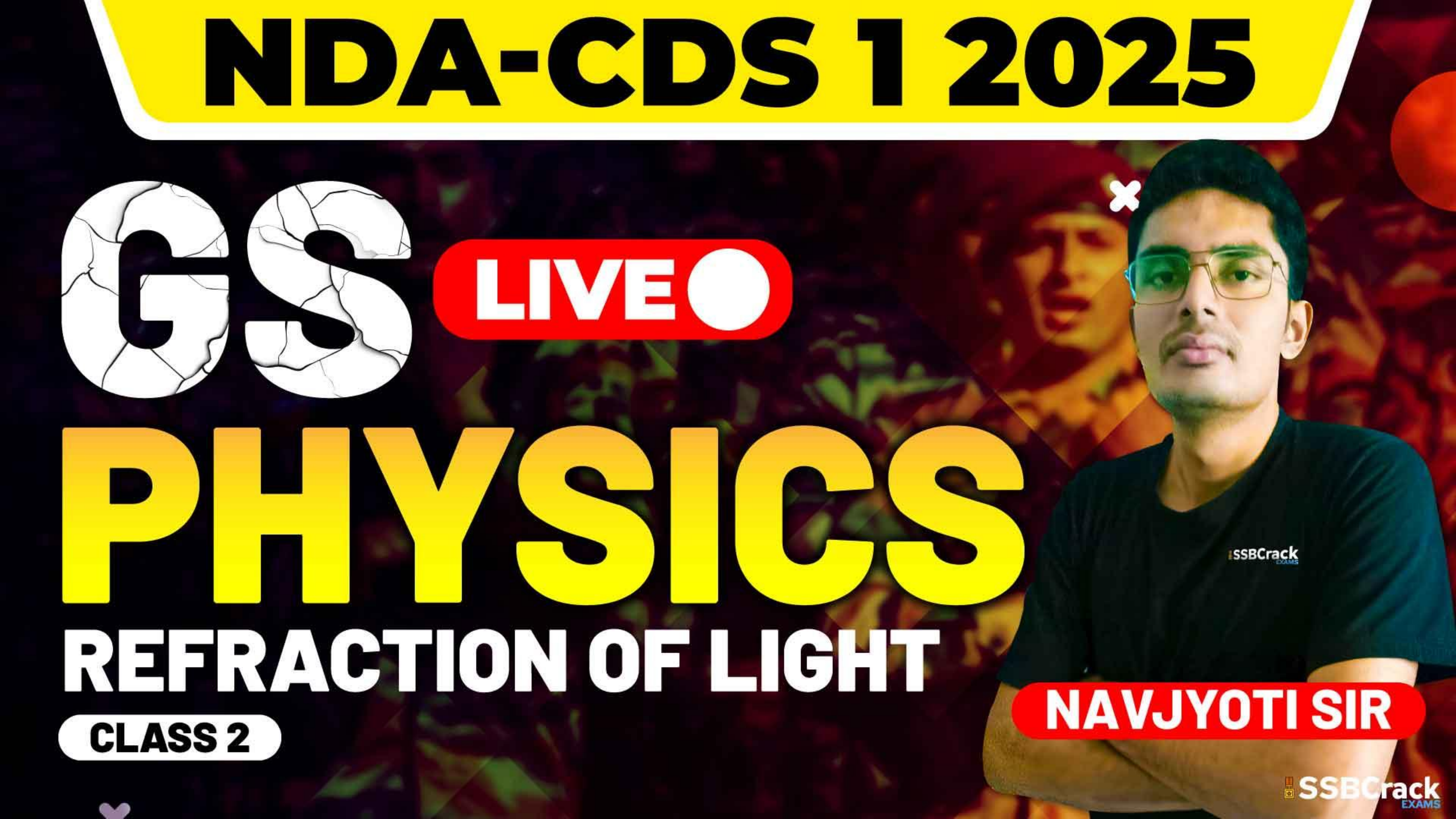
APPLICATIONS OF TIR

- **Mirage** → Atmospheric refraction + TIR



SUMMARY

- Refraction of Light
- Refractive Index and speed of light in media
- Lenses and Image Formation
- Lens Formula
- Atmospheric Refraction
- Total Internal Reflection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