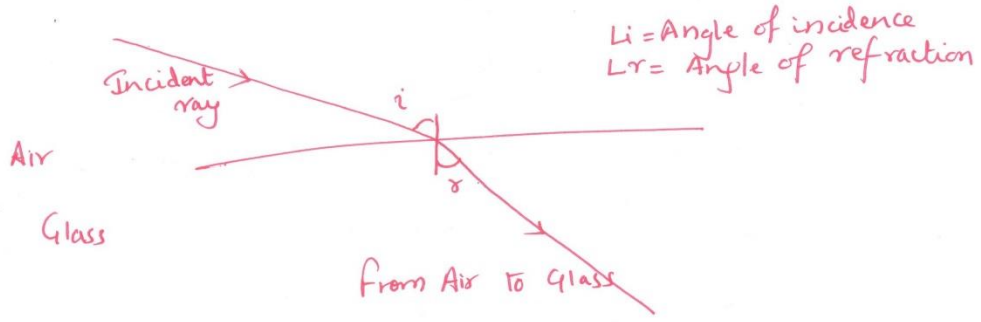
POONAM LATA YADAV

REFRACTION OF LIGHT

The bending of light when it passes obliquely from one transparent medium to another is called

Refraction of light

Refraction is also defined as the change in the direction of light when it passes obliquely from one medium to another.



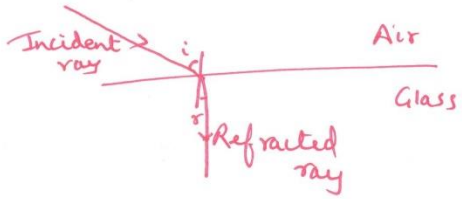
A medium in which the speed of light is more is known as Optically Rarer Medium.

A medium in which the speed of light is less is known as Optically denser medium.

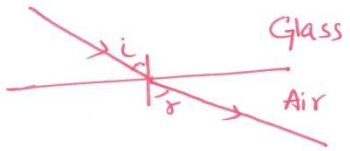
* More the ~~speed~~ difference in the speeds of light in 2 media, greater will be the deviation in path of light in Second medium.

Cases -

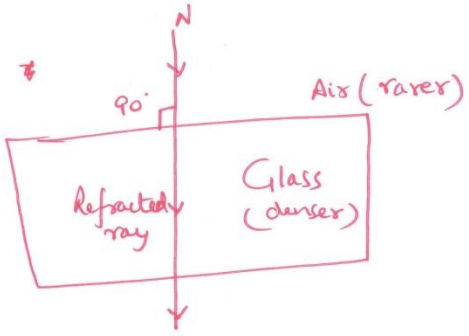
1) When ray of light travels from rarer to a denser medium, it bends towards the normal (at pt. of incidence)



2) When ray of light travels from denser to rarer medium, it bends away from the normal.



3) If incident ray falls normally (or perpendicularly) on the surface of a glass slab, then there is no bending of ray of light and it goes straight.



LAWS OF REFRACTION OF LIGHT -

1) The incident ray, the refracted ray and the normal at the pt. of incidence, all lie in same plane.

2) Ratio of Sine of angle of incidence to sine of angle of refraction is a constant.

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

↓

μ (n) = Refractive index

↓

R.I of second medium wrt the first medium

REFRACTIVE INDEX OF THE MEDIUM -

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

This constant is called Refractive Index (R.I) of medium b with respect to medium a.

It is denoted by μ or n.

$$\frac{\sin i}{\sin r} = {}^{a}n_{b} \text{ or } {}^{a}\mu_{b}$$

(med. b wrt med. a)

eg: 1) If light ray travels from air to glass ⇒ It means, R.I of glass w.r.t air.

$$\frac{\sin i}{\sin r} = {}_{air}\mu_{glass}$$

2) If light passes from vacuum to glass ⇒ R.I of glass wrt vacuum.

$$\frac{\sin i}{\sin r} = {}^{\text{vacuum}}\mu_{\text{glass}}$$

3) glass ⟶ air ⇒ R.I of air wrt glass

$$\frac{\sin i}{\sin r} = {}^{\text{glass}}\mu_{\text{air}}$$

NOTE -
R.I is ratio of 2 similar quantities, hence no units.

In Terms of Speed of light in a medium

Consider light travels from air (med 1) to glass (med 2).

Let V_1 ⇒ Speed of light in air

V_2 ⇒ Speed of light in glass

R.I of glass (med 2) wrt air (med 1) is ratio of Speed of light in med 1 (air) to Speed of light in med 2 (glass).

$$\text{air}\,\mu_{\text{glass}} = \frac{\text{med. 1 Speed}}{\text{med 2 speed}} = \frac{V_1}{V_2}$$

Similarly, R.I of air wrt glass

$$^{glass}\mu_{air} = \frac{v_2}{v_1}$$

ABSOLUTE REFRACTIVE INDEX

Ray of light travels from vacuum (air) to other medium.

R.I of medium = Speed of light in vacuum / Speed of light in medium

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

where, $c = 3 \times 10^8$ m/s

NOTE -

The medium with higher R.I is more optically denser medium.

The medium with lower R.I is ~~less~~ optically rarer medium.

If ray of light travels from med 1 (air) to med 2 (glass) then, RI of med 2 wrt med 1.

$$^{1}\mu_{2} = \frac{\sin i}{\sin r}$$

when light travels from med 2 to med 1 then RI of med 1 wrt med 2

$$^{2}\mu_{1} = \frac{\sin i}{\sin r}$$

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

$$\boxed{^{1}\mu_{2} = \frac{1}{^{2}\mu_{1}}}$$

eg: R.I of dense flint glass is 1.65, and for alcohol, it is 1.36, wrt air. What is RI of dense flint glass wrt alcohol.?

$\longrightarrow$ $^{air}\mu_{flint} = 1.65$

~~$^{air}\mu_{water}$~~ $^{air}\mu_{alcohol} = 1.36$

$$^{alcohol}\mu_{flint\ glass} = {}^{air}\mu_{flint} \times {}^{alcohol}\mu_{air}$$

$$= {}^{air}\mu_{flint} \times \frac{1}{^{air}\mu_{alcohol}}$$

$$= 1.65 \times \frac{1}{1.36} = 1.21$$

Imp

$$\mu_{flint}^{alcohol} = \mu_{flint}^{air} \times \mu_{air}^{alcohol}$$

$$= \mu_{flint}^{air} \times \frac{1}{\mu_{alcohol}^{air}}$$

NUMERICALS -

1. If R.I for light going from air to glass is 1.5, what will be the R.I of light going from glass to air?

[Ans: 0.66]

2. The speed of light in water is 2.25×10^8 m/s and in air is 3×10^8 m/s. Calculate the R.I. of water with respect to air.

[Ans: 1.33]

3. A beam of light passes from air into a substance M. If angle of incidence is 40° and angle of refraction is 30°, Calculate the refractive index of the substance.

[Given $\sin i = \sin 40° = 0.6428$

$\sin r = \sin 30° = 0.500$]

[Ans: 1.28]