PHYSICS

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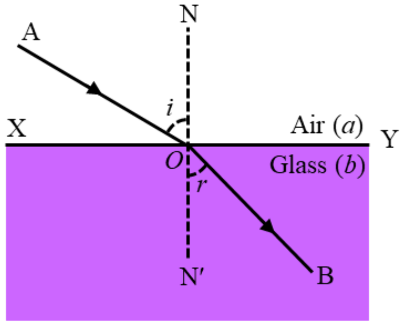
01. Refraction

A homogeneous medium, light travels along a straight path. But when a ray of light travels from one transparent medium into another, it bends while crossing the surface separating the two media.

The phenomenon of change in path of light as it goes from one medium to another is called refraction.



Figure

02. Laws of Refraction

The phenomenon of refraction takes place according to the following two laws:

1. *The incident ray, the normal to the refracting surface at the point ofi ncidence and the refracted ray – 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 constant for the two given media.* This constant is denoted by ${}^{a}\mu_b$ and is called the ***relative refractive index*** of medium *b* (in which refracted ray travels) w.r.t. medium a (in which incident ray travels).

$$\therefore \qquad \frac{\sin i}{\sin r} = {}^{a}\mu_b$$

This law is also called **Snell's law** of refraction.

Problem The refractive index of glass is 1.5. What is the speed of light in glass? Speed of light in vacuum is 3.0×10^8 m s^{-1}.

Solution Here, $\mu = 1.5$; $c = 3.0 \times 10^8$ m s^{-1}.

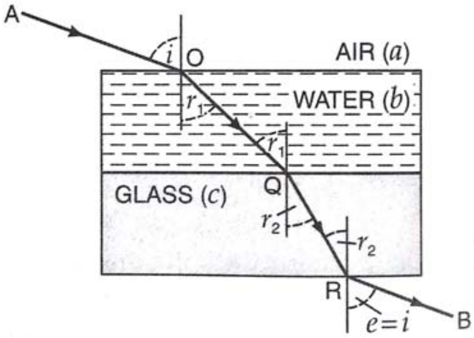
Speed of light in glass,

$$v = \frac{c}{\mu} = \frac{3.0 \times 10^8}{1.5}$$

$$= 2.0 \times 10^8 \text{ m s}^{-1}$$

03. Refraction through Multiple Refracting Media

Consider a compound plate of two media b (water) and c (glass) bounded by parallel faces and placed in the medium a(air) as shown in Figure.



Suppose that a ray of light AO travelling in medium a is incident at point O on the surface separating the two media a and b. It is refracted along OQ in medium b, such that i is the nagle of incidence and r_1, the angle of refraction. Then,

$$^{a}\mu_b = \frac{\sin i}{\sin r_1} \qquad \text{...(i)}$$

Now, the ray of light OQ meets the surface separating the two media b and c at angle of incidence r_1. It is, then, refracted along QR in medium c, such that r_2 is the angle of refraction. Then,

$$^{b}\mu_c = \frac{\sin r_1}{\sin r_2} \qquad \text{...(ii)}$$

Finally, the ray of light QR strikes the surface separating the media c and a at point R, such that r_2 is the angle of incidence. The ray of light, then emerges along path RB in medium a. As the various interfaces are parallel, the angle of emergence will be equal to i. Therefore,

$$^{c}\mu_a = \frac{\sin r_2}{\sin i} \qquad \text{...(iii)}$$

Multiplying the corresponding sides of the equation we (i), (ii) and (iii), we have

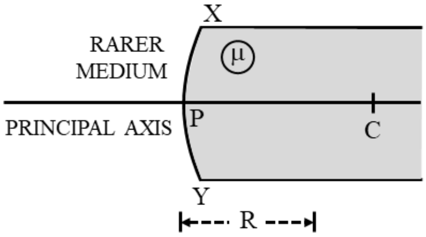
$$^{a}\mu_b \times {}^{b}\mu_c \times {}^{c}\mu_a = \frac{\sin i}{\sin r_1} \times \frac{\sin r_1}{\sin r_2} \times \frac{\sin r_2}{\sin i} = 1$$

or $$^{a}\mu_b \times {}^{b}\mu_c = \frac{1}{^{c}\mu_a} \qquad \left(\because \frac{1}{^{c}\mu_a} = {}^{a}\mu_c\right)$$

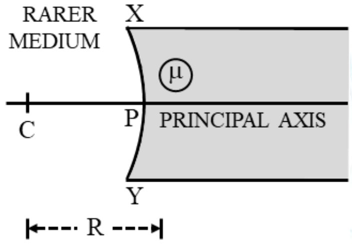
or $$^{a}\mu_c = {}^{a}\mu_b \times {}^{b}\mu_c \qquad \text{...(iv)}$$

04. Spherical Refracting Surface

The portion of a refracting medium, whose curved surface forms the parts of a sphere, is called spherical refracting surface.



Figure



Figure

05. Refraction at Spherical Surface

Use this formula for refraction at spherical surfaces

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

where symbols have their usual meanings.