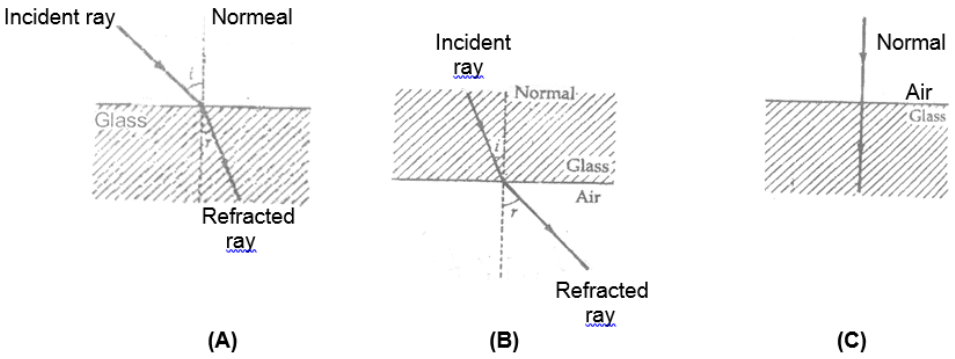
LIGHT - REFLECTION AND REFRACTION

INTRODUCTION OF REFRACTION OF LIGHT

REFRACTION OF LIGHT:

When light travels in the same homogeneous medium it travels along a straight path. However, when it passes from on transparent medium to another, the direction of its path changes at the interface of the two media. This is called refraction of light.

The phenomenon of the change in the path of the light as it passes from one transparent medium to another is called refraction of light. The path along which the light travels in the first medium is called incident ray and that in the second medium is called refracted ray. The angles which the incident ray and the refracted ray make with the normal at the surface of separation are called angle of incidence (i) and angle of refraction (r) respectively.



Showing different cases of refraction

It is observed that :

(i) When a ray of light passes from an optically rarer medium to a denser medium it bends towards the normal $(\angle r < \angle i)$, as shown in figure (A).

(ii) When a ray of light passes from an optically denser to a rarer medium it bends away from the normal $(\angle r > \angle i)$ as shown in figure (B).

(iii) A ray of light traveling along the normal passes undeflected, as shown is figure (C). Her $\angle i = \angle r = 0^0$.

(a) Cause of Refraction :

We come across many media like air, glass, water etc. A medium is a transparent material through which light is transmitted. Every transparent medium has a property known as optical density. The optical density of a transparent medium is closely related to the speed of light in the medium. If the optical density of a transparent medium is low, then speed of light in that medium is high. Such a medium is known as optically rarer medium. Thus, optically rarer medium is that medium through which light travels fast. In other words, a medium is which speed of light is more is known as optically rarer medium.

On the other hand, if the optical density of transparent medium is high, then the speed of light in that medium is low. Such a medium is known as optically denser medium. Thus, optically denser medium is that medium through which light travels slow. In other words, a medium is which speed of light is less is known as optically denser medium.

Speed of light in air is more than the speed of light in water, so air is optically rarer medium as compared to the water. In other words, water is optically denser medium as compared to air. Similarly, speed of light in water is more that the speed of light is glass, so water is optically rarer medium as compared to the glass. if other words, glass is optically denser medium as compared to water.

When light goes from air (optically rarer medium) to glass (optically denser medium) such that the light in air makes an angle with the normal to the interface separating air and glass,

then it bends from its original direction of propagation. Similarly, if light goes from glass to air, again it bends from its original direction of propagation. The phenomena of bending of light from its path is known as refraction. We have seen that the speed of light is different media is different, so we can say that refraction of light takes place because the speed of light is different is different media. Thus, **the cause of refraction** can be summarised as follows :

NOTE :

(i) Refraction is the deviation of light when it crosses the boundary between two different media (of different optical densities) and there is a change in both wavelength and speed of light.

(ii) The frequency of the refracted ray remains unchanged.

(iii) The intensity of the refracted ray is less than that of the incident ray. It is because there is partial reflection and absorption of light at the interface.

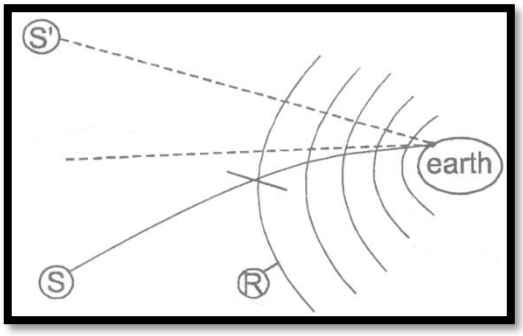
(b) Effects of refraction of Light :

(i) If a straight stick is partially put in water, it appears to be inclined.

(ii) If we see a water tank its bottom appears to e raises. It also appears to be concave shaped although it is flat.

(iii) The sun is visible a few minutes earlier than it actually rises above horizon, because as we go up form earth, the density of air layer decrease, then rays from sun keep on bending towards normal till it enters the eye.

$\therefore$ Sun appears to be at S'. For the same reason it keeps on appearing two minutes after sun-set. Hence the day i.e. the time between the sunrise & sunset is four minutes longer. The day therefore gets longer 4 minutes.



Atmosphere

Twinkling of stars :

On a clear night, you might have observed the twinkling of a star, which is due to an atmospheric refraction of star light. The density of the atmosphere, as we know goes on decreasing as the distance above the sea level increase. For the snake of simplicity, air can be supposed to be made up of a very large number of layers show density decrease with the distance above the surface of the earth. Therefore, the light from a heavenly body, such as a star, goes on gradually bending towards normal as it travels through the earth's atmosphere. As the object is always seen in the direction of the light reaching the observer's eye, the star appears higher up in the sky than its actual position. Further, the densities of the various lavers go on varying due to the convection current set up in air by temperature differences. Thus, the refractive index of layer of air at a particular level goes on changing.

Due to these variations in the refractive indices of the various layers of air, the light from a star passing through the atmospheric air changes its path from time to time and therefore, the amount of light reaching the eye is not always the same. This increase of decrease in the intensity of light reaching the eye results in the change in apparent position or twinkling of the star.

(c) Laws of Refraction :

There are two laws of refraction.

(i) The incident ray, the refracted ray and the normal at the point of incidence lie in the same plane.

(ii) $\frac{\sin i}{\sin r}$ = constant called refractive index denoted by $'\mu'$

The above law is called snell's law (willibrod snell). Eg. $\frac{\sin i}{\sin r} = {}_1\mu_2$

Here ${}_1\mu 2$ is called refractive index of 2nd medium w.r.t 1st medium.

{Laws of refraction are valid for both types of surfaces i.e. for plane as well as spherical reacting surfaces}