1. Nature of Light

In the seventh century the most prominent advocate of particle theory of light was Isaac Newton. Newton clearly regarded rays of light as streaming of very small particles emitted from a source of light and travelling in straight line (sharp shadows of objects).

Christian Huygens said that light is a wave motion, spreading out from a light source in all directions and propagating through an all pervasive elastic medium called the ether. When two beams og light intersected, they emerged unmodified, just as in the case of two water or sound waves.

Thomas Young performed a decisive experiment that seemed to demand a wave interpretation, it was the double-slit experiment.

In 1821 Augustin Fresnel published results of his experiments and analysis (Fresnel equations).

James Clerk Maxwell synthesized known principles in his set of four Maxwell equations (the speed of an electromagnetic wave).

2. The Refractive Index

The index of refraction, or refractive index, of any optical medium is defined as the ratio between the speed of light in a vacuum and the speed of light in the medium:

$Refractive\ index = \dfrac{Speed\ in\ vacuum}{Speed\ in\ medium}\ , n = \dfrac{c}{v}$	1

For glass: n = 1.520 , For water: n = 1.333 , For air: n = 1.000

Different kinds of glass and plastics have different refractive indices. The most commonly used optical glasses range from 1.52 to 1.72. The *optical density* of any transparent medium is a measure of its refractive index. A medium with a relatively high refractive index is said to have a high optical density, while one with a low index is said to have a low optical density.

3. Laws of Reflection and Refraction

Whenever a ray of light is incident on the boundary separating two different media, part of the ray is reflected back into the first medium and the remainder is refracted (bent in its path) as it enters the second medium (see Fig. 1). The directions taken by these rays can best be described by two well-established laws of nature. According to the simplest of these laws, the angle at which the incident ray strikes the interface MM' is exactly equal to the angle the reflected ray makes with the same interface. Instead of measuring the angle of incidence and the angle of reflection from the interface MM', it is customary to measure both from a common line perpendicular to this surface. This line NN' in the diagram is called the normal. As the angle of incidence ϕ increases, the angle of reflection also increases by exactly the same amount, so that for all angles of incidence

angle of incidence = angle of reflection ------- *

A second and equally important part of this law stipulates that the reflected ray lies in the plane of incidence and on the opposite side of the normal, the plane of incidence being defined as the plane containing the incident ray and the normal. In other words, the incident ray, the normal, and the reflected ray all lie in the same plane, which is perpendicular to the interface separating the two media. The second law is concerned with the incident and refracted rays of light, and states that the sine of the angle of incidence and the sine of the angle of refraction bear a constant ratio one to the other, for all angles of incidence:

$\frac{\sin \emptyset}{\sin \emptyset^{\backslash}} = constant$	2

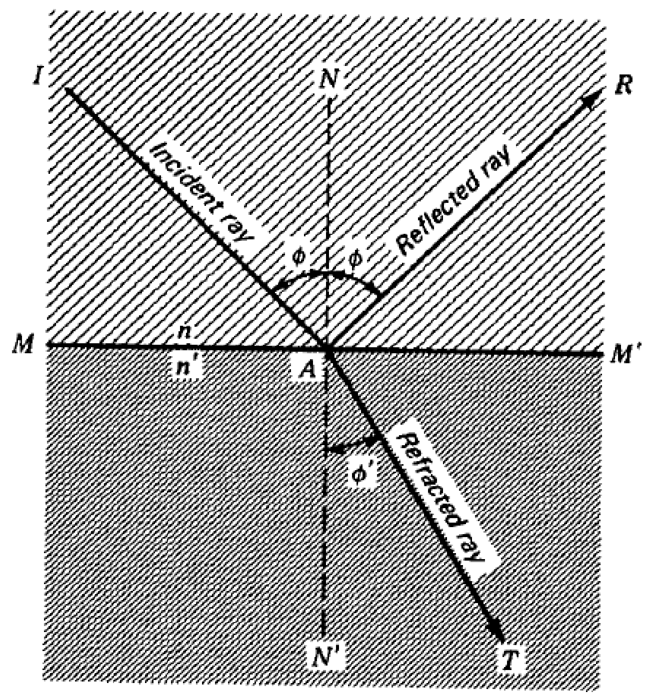

Fig. (1): Reflection and refraction at the boundary separating two media with refractive indices n and n'

Furthermore, the refracted ray also lies in the plane of incidence and on the opposite side of the normal. This relationship, experimentally established by Snell, is known as Snell's law. In addition, the constant is found to have exactly the ratio of the refractive indices of the two media n and n'. Hence, we can write

$n \sin \emptyset = n^{\backslash} \sin \emptyset^{\backslash}$	3

the refractive indices of different optical media are defined

$n = \frac{c}{v}, n^{\backslash} = \frac{c}{v^{\backslash}}$	4

where *c* is the speed of light in a vacuum *(c* = 2.997925 x 10^8 *m/s)* and v and $v^\backslash$ are the speeds of light *in* the two media.

By the substitution of Eqs. (l) in Eq. (3), we obtain,

$\frac{\sin \emptyset}{\sin \emptyset^\backslash} = \frac{v}{v^\backslash}$	5

4. The principle of reversibility

The symmetry of Eqs. (*) and (3) with respect to the symbols used shows that if a reflected or refracted ray is reversed in direction, it will retrace its original path. For any given pair of media with indices n and n' anyone value of ϕ is correlated with a corresponding value of n'. This will be equally true when the ray is reversed and $\phi^\backslash$ becomes the angle of incidence in the medium of n'; the angle of refraction will then be ϕ.