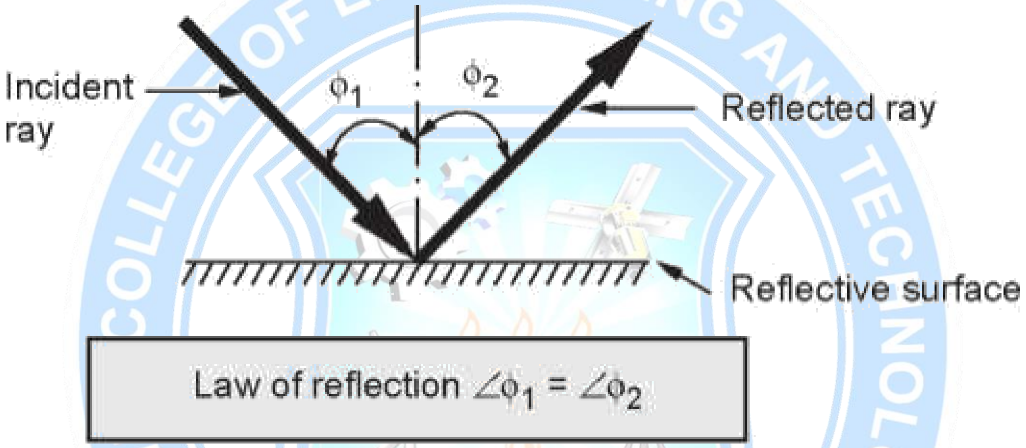
1.3 Basic Optical laws and Definitions

Before studying how the light actually propagates through the fiber, laws governing the nature of light must be studied. These are called as **laws of optics (Ray theory).**

Reflection

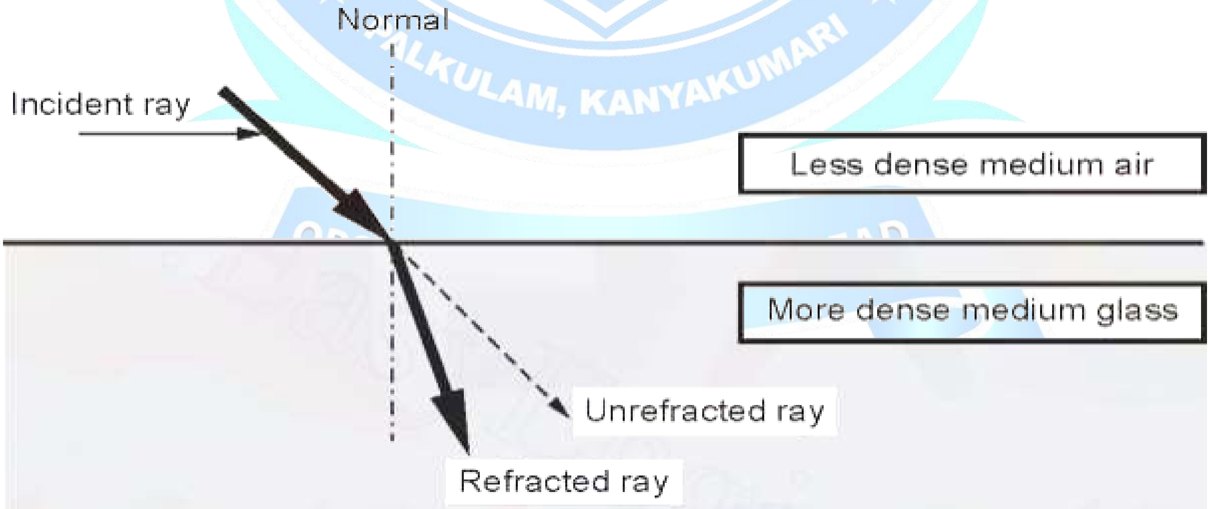
- The law of reflection states that, when a light ray is incident upon a reflective surface at some incident angle φ_1 from imaginary perpendicular normal, the ray will be reflected from the surface at some angle φ_2 from normal which is equal to the angle of incidence



Law of Reflection

Angle of incidence (φ_1) = Angle of reflection (φ_2)

Refraction



- Refraction occurs when light ray passes from one medium to another i.e. the light ray changes its direction at interface.
- Refraction occurs whenever density of medium changes.
- The refraction observed at air and water interface , air and glass interface

Refractive Index

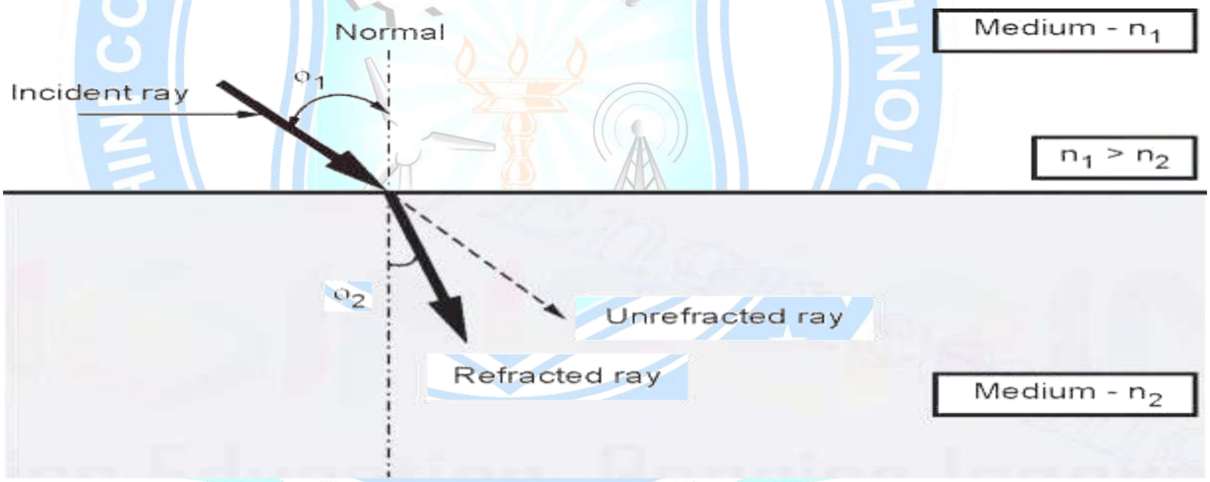
- The amount of refraction or bending that occurs at the interface of two materials of different densities is usually expressed as refractive index of two materials.
- Refractive index is also known as **index of refraction** and is denoted by n
- the refractive index is expressed as the ratio of the velocity of light in free space to the velocity of light of the dielectric material (substance).

$$\text{Refractive Index n} = \frac{\textit{Speed of light in Air}}{\textit{Speed of light in Medium}} = \frac{c}{v}$$

- The refractive index for vacuum and air is 1.0 for water it is 1.3 and for glass refractive index is 1.5.

Snell's Law

Snell's law states how light ray reacts when it meets the interface of two media having different indexes of refraction.



- φ_1 and φ_2 be the angles of incidence and angle of refraction respectively. Then according to Snell's law, a relationship exists between the refractive index of both materials given by
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$$n_1 \sin \emptyset_1 = n_2 \sin \emptyset_2 \qquad \frac{n_1}{n_2} = \frac{\sin \varphi_2}{\sin \varphi_2}$$

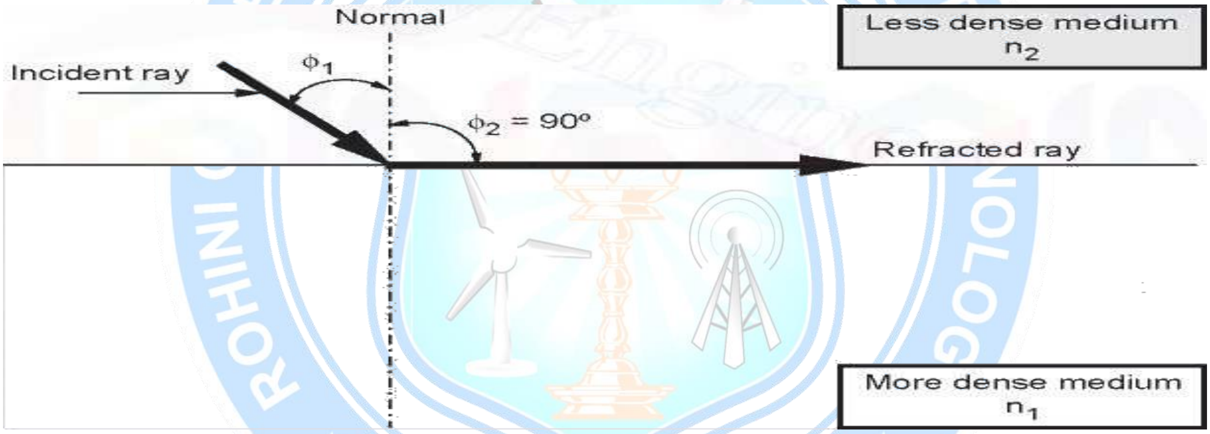
• The refracted wave will be towards the normal when $n_1 < n_2$ and will away from it when $n_1 > n_2$.

- This equation shows that the ratio of refractive index of two mediums is inversely proportional to the refractive and incident angles.
- As refractive index $n_1 = \frac{c}{v1}$ and $n_2 = \frac{c}{v2}$ substituting these values

$$\frac{v_1}{v_2} = \frac{\sin\varphi_2}{\sin\varphi_2}$$

Critical Angle

- When the angle of incidence (φ_1) is progressively increased, there will be progressive increase of refractive angle (φ_2). At some condition (φ_1) the refractive angle (φ_2) becomes 90^o to the normal. When this happens the refracted light ray travels along the interface. The angle of incidence (φ_1) at the point at which the refractive angle (φ_2) becomes 90° is called the **critical angle.** It is denoted by φ_c.
- The **critical angle** is defined as the minimum angle of incidence (φ_1) at which the ray strikes the interface of two media and causes an angle of refraction (φ_2) equal to 90°.



- The actual value of critical angle is dependent upon combination of materials present on each side of boundary.
- Hence at critical angle $\varphi_1 = \varphi_c$ and $\varphi_2 = 90^o$
- Uing Snell Law

$$n_1 \sin\emptyset_1 = n_2 \sin\emptyset_2 \qquad \sin\varphi_c = \frac{n_2}{n_1}$$

$$\varphi_c = sin^{-1}\left(\frac{n_2}{n_1}\right)$$