REFRACTION AND REFRACTIVE INDEX

We cover (i) Refraction, (ii) Laws of Refraction and (iii) Refractive Index.

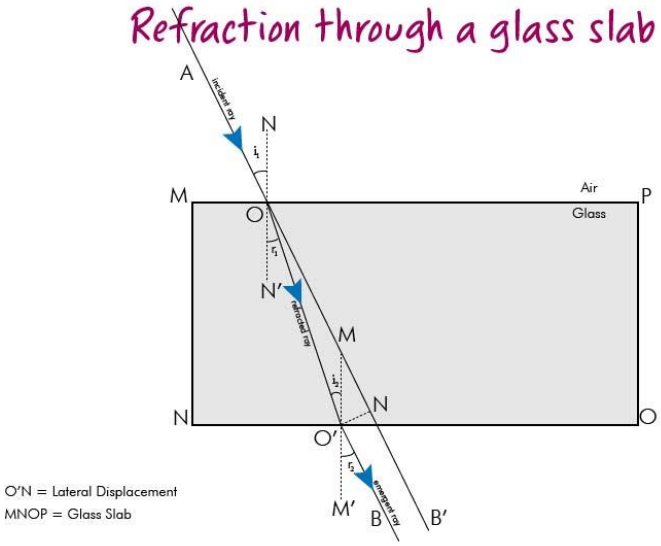
Refraction

1. Light travels from air (medium 1) to glass (medium 2). As the **density of glass** is more than that of air, the **speed of light decreases at the intersection of the two medium**. Therefore, light gets deflected and travels obliquely when it enters from air to glass. This **defection of light at the interface of two mediums gives rise to the optical phenomena called Refraction**. Refraction can happen also when light enters from glass to air. Therefore, for refraction to occur: -

   (i) Light must travel from one medium to another medium
   (ii) One medium is denser than the second medium

2. An easy example of refraction is a pencil dipped in glass of water looks bent when seen from the side.

3. For better understanding we take up refraction through a **rectangular Glass Slab:**



   (i) The ray of light which enter the glass slab is called the **incident ray**. The ray of light inside the glass slab is called a **refracted ray**. Ray of light which comes out of the other end of the glass slab is called **emergent ray**.

   (ii) You may have noticed that when **light moves from air** (rarer/lighter medium) **to glass** (denser/heavier medium) light **bends towards the normal**. When **light travels from glass to air** (denser to rarer medium), it **bends away from the normal**.

   (iii) The **emergent ray is parallel to the incident ray** when extended. The distance parallel distance between emergent ray and incident ray is called **LATERAL DISPLACEMENT** of light. More is the thickness or width of the rectangular (length x width) glass slap, more is the lateral displacement.

   (iv) For a glass slab the angle of incidence of light at air-glass interface is equal to the angle of emergence of light at the glass-air interface.

   (v) Refraction is due to change in the speed of light as it enters from one transparent medium to another.

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4. The **laws of refraction** of light state that: -

   (i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.

   (ii) The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media.

   This law is also known as **Snell's law** of refraction. If i is the angle of incidence and r is the angle of refraction, then,

$$\frac{\sin \angle i}{\sin \angle r} = \text{constant}$$

This constant value is called the **refractive index** for the pair of medium.

Refractive Index

1. The value of the refractive index for a given pair of media depends upon the speed of light in the two media. Therefore, refractive index is the relative speed of propagation of light in different media.

2. Light propagates with different speeds in different media. Light travels the fastest in vacuum with the highest speed of 3×10^8 m s^{-1}. The speed of light in air is little less than in vacuum. For glass or water, the speed of light reduces drastically., as given below.

3. Let v_1 be the speed of light in medium 1 and v_2 be the speed of light in medium 2. The refractive index of medium 2 with respect to medium 1 is given by the ratio of the speed of light in medium 1 and the speed of light in medium 2. This is usually represented by the symbol n_{21}. This can be expressed in an equation form as:

$$n_{21} = \frac{\text{Speed of light in medium 1}}{\text{Speed of light in medium 2}}$$

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

4. If the medium 1 is vacuum, then refractive index is called the absolute refractive index of the medium. It is simply represented as n_2. The absolute refractive index of a medium is simply called its refractive index.

5. Refractive Index of water $= \frac{\text{Speed of light in vacuum/air}}{\text{Speed of light in water}} =$ Refractive Index of Water wrt Air

6. Remember $n_{21} = \frac{1}{n_{12}}$

7. **Refractive Index** is a ratio of two speeds, therefore it **has no UNITS**. It's simply a number.