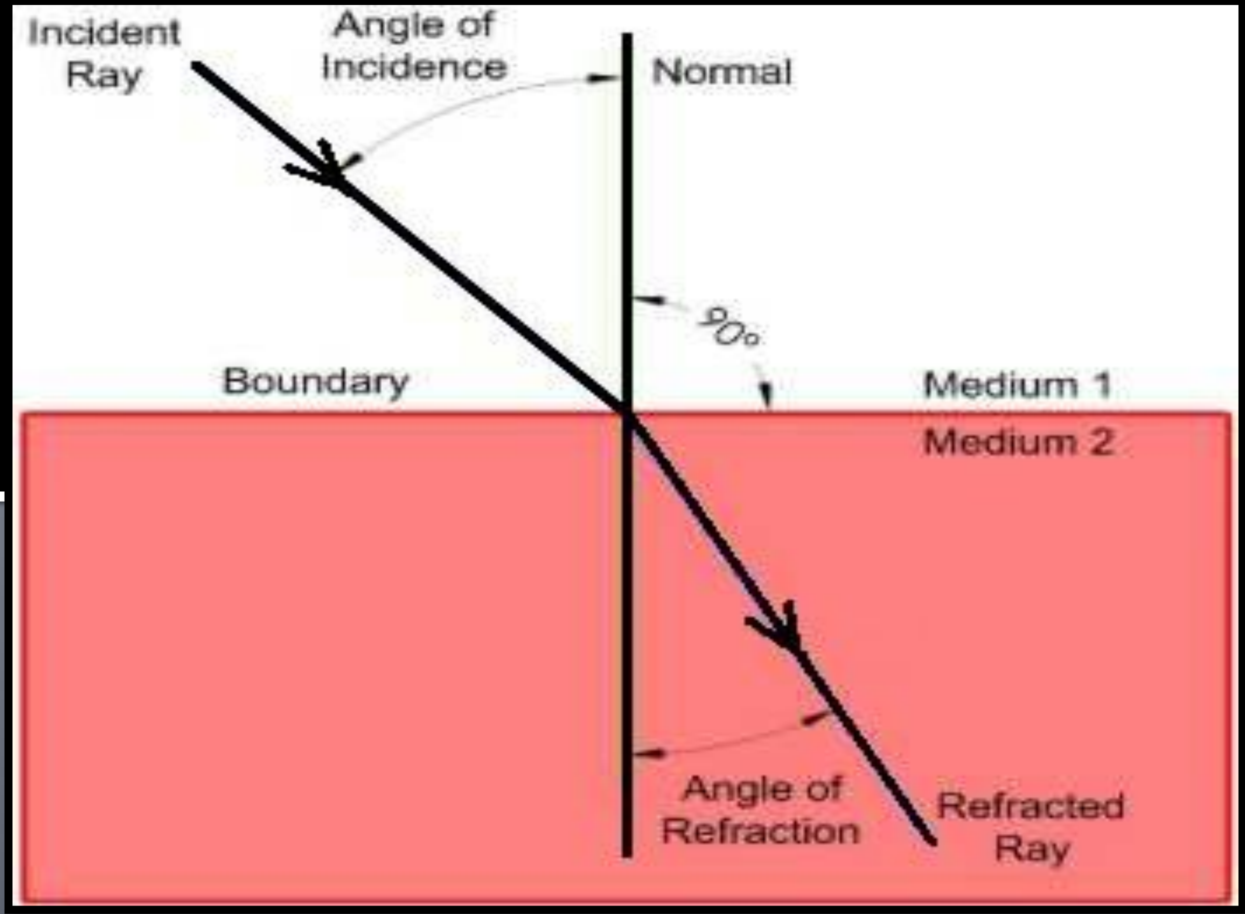
Refraction of light

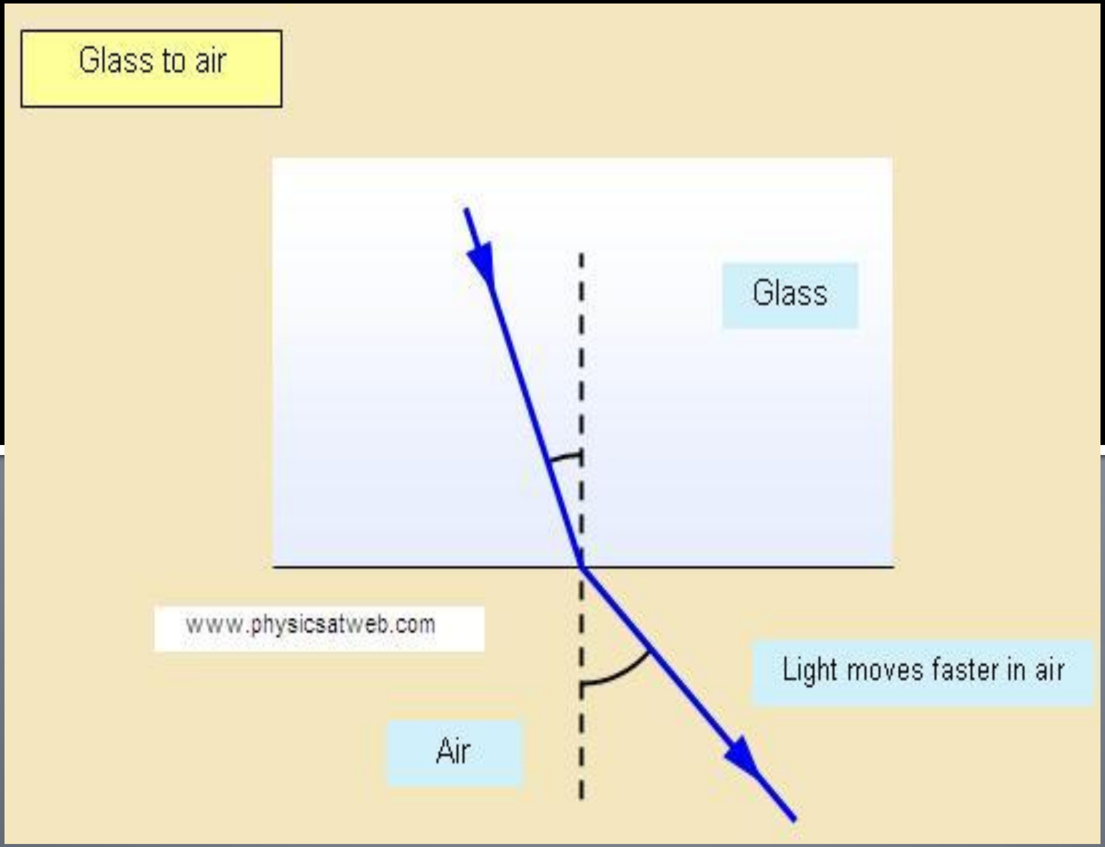
Refraction

- Refraction is the bending of light when it enters from one transparent medium into another.
- It is caused by the different speeds of light in different media.
- The greater the optical density of the medium, the slower the speed of light



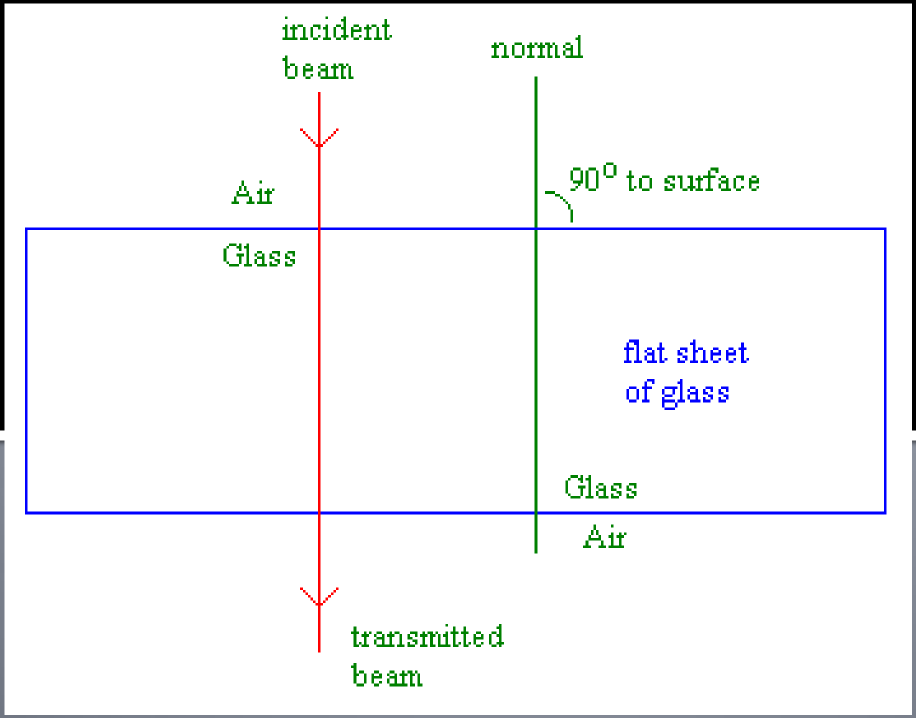
When a ray of light travels from a rarer medium to a denser medium (say, from air to glass), it bends towards the normal i.e angle i › angle e

Refraction from rarer to denser medium



When a ray of light travels from a denser medium to a rarer (say ,from glass to air) it bends away from the normal i.e angle i < angle e

Refraction from denser to rarer medium



The ray of light which is incident normally on the surface separating the two media , passes undeviated .Thus if angle i=o then angle r= o

Refraction at normal incidence

Laws of Refraction

The **incident** ray, the refracted ray and the normal all lie in the same plane.
For two particular media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.

$$n = \frac{\sin i}{\sin r}$$ (Snell's Law)

Refractive Index

When light passes from vacuum (or air) into a given medium (eg. water), the constant ratio of $\frac{\sin i}{\sin r}$ is known as the refractive index, *n*, for that medium.

$$n = \frac{\sin i}{\sin r}$$

Speed and Refractive Index

Speed of light in vacuum = 3 x 10^8 ms^{-1}
Light is found to move slower in optically denser mediums. (eg. glass and water)

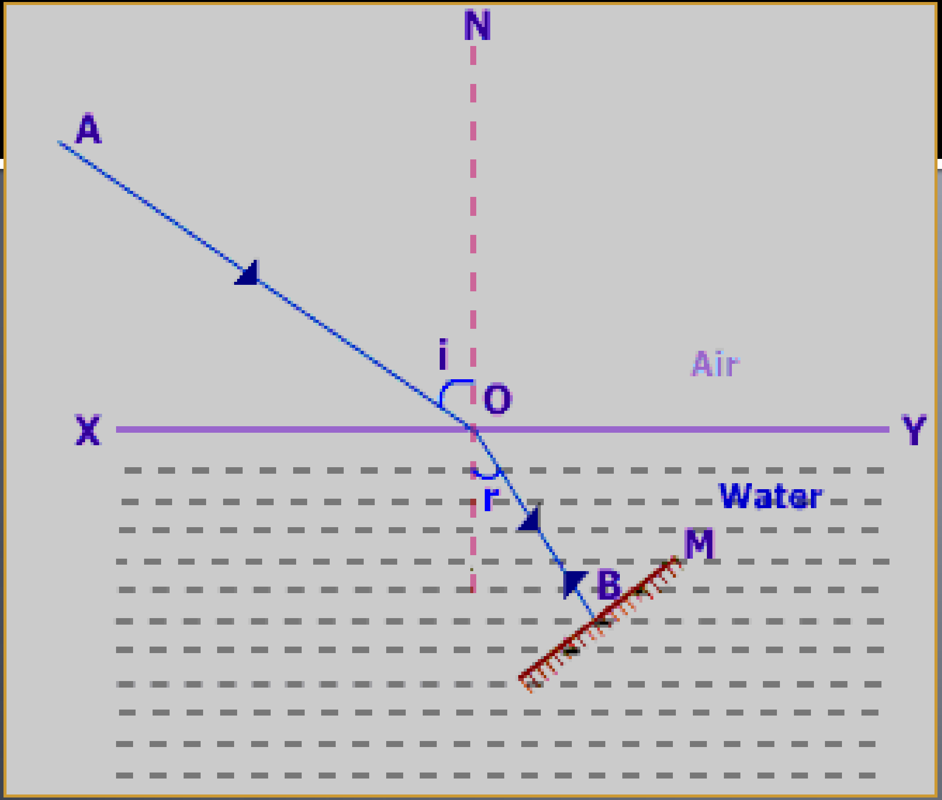
$$n = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$$

$$n = \frac{c}{v}$$

Factors affecting refractive index

- Nature of material- smaller the speed of light in a medium relative to air, higher is the refractive index
- Colour or wavelength of light-refractive index increases with the decrease in wavelength. $\mu_v > \mu_r$
- Temperature- with increase in temperature ,the speed of light in medium increases, so the refractive index of medium decreases

Principle Of Reversibility



The principle of reversibility of light states that the path of a ray of light is reversible.
According to this principle , if a ray of light travels from A to B along a certain path, it will follow exactly the same path, while travelling from B to A

${}^{a}m_{g}$ represents refractive index of glass with respect to air then

$$ {}^{a}\mu_{g} = \frac{\mu_g}{\mu_a} = \frac{\sin i}{\sin r} $$

Similarly if refraction occurs from denser to rarer medium

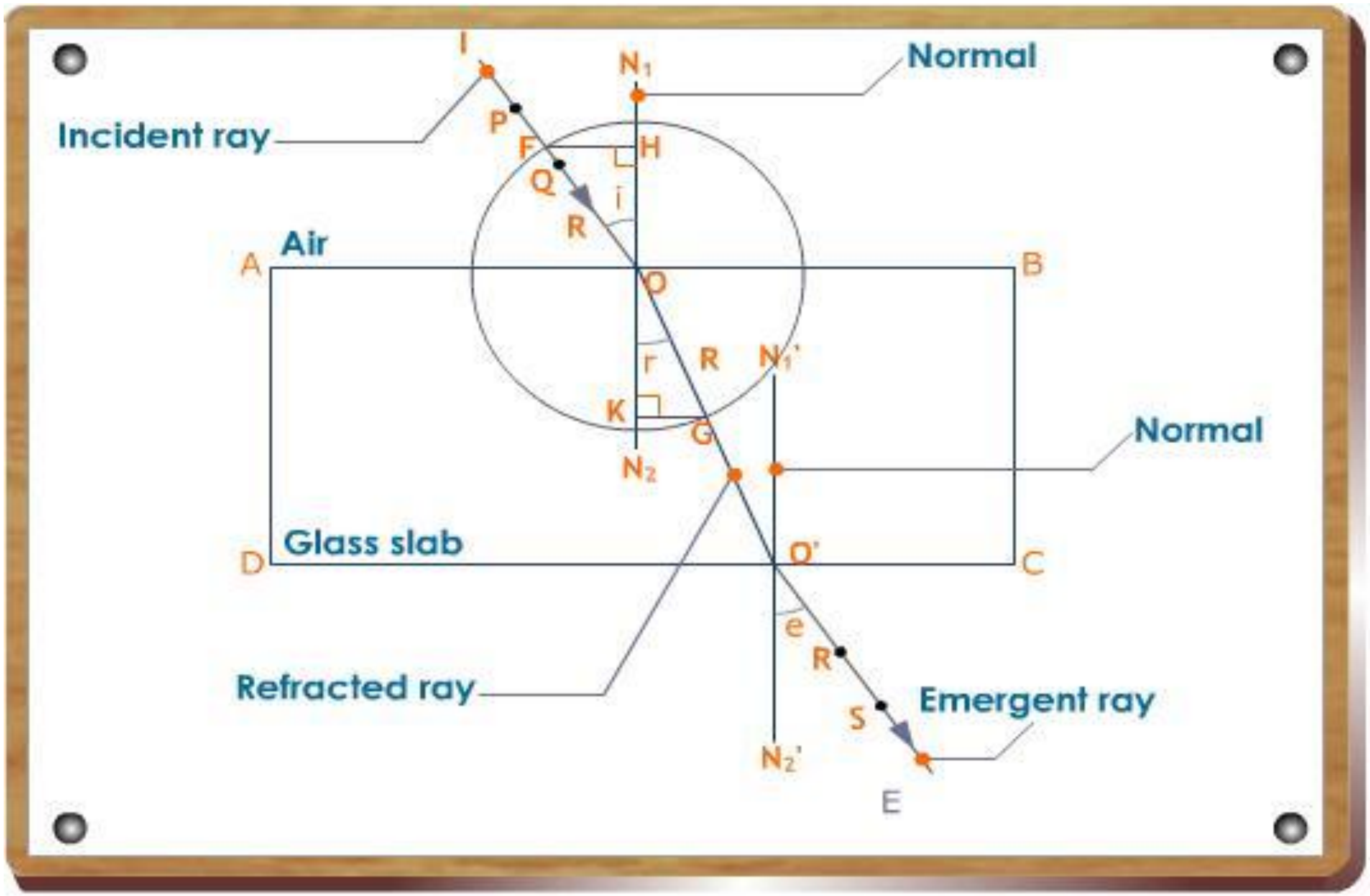
$$ {}^{g}\mu_{a} = \frac{\sin r}{\sin i} $$

Them multiplying the two, $\frac{\sin i}{\sin r} \times \frac{\sin r}{\sin i} = {}^{a}\mu_{g} \times {}^{g}\mu_{a} = 1$

or $$ {}^{a}\mu_{g} = \frac{1}{{}^{g}\mu_{a}} $$

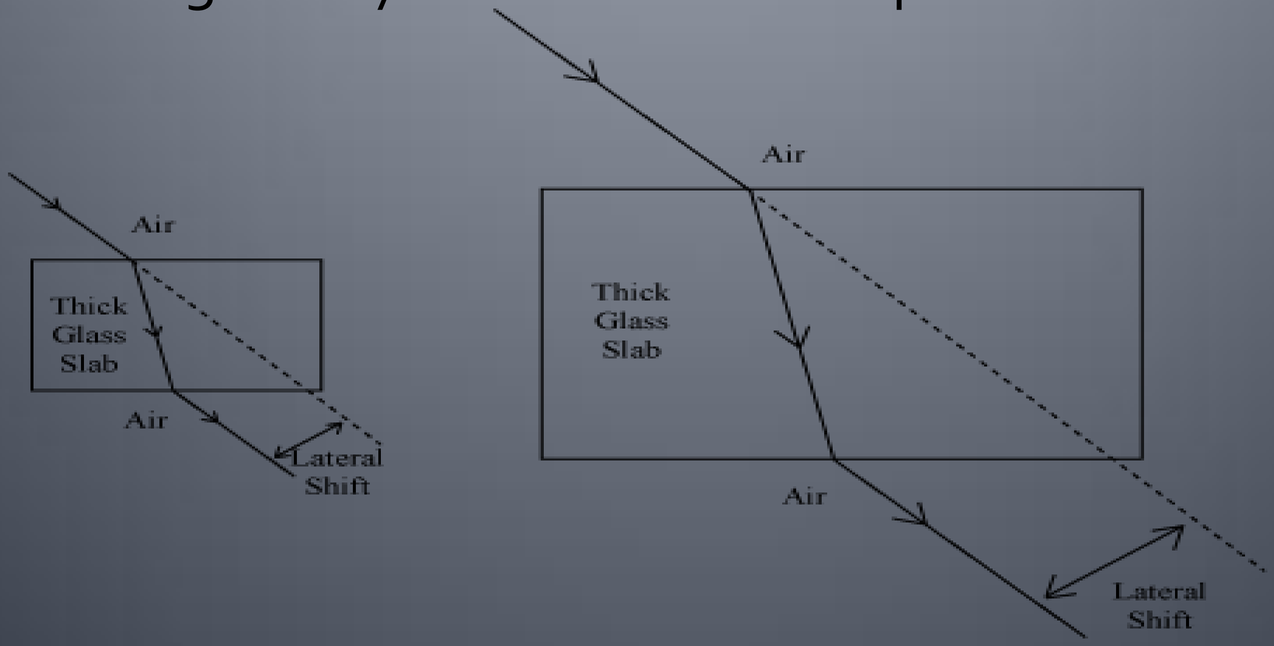
The above expression is an important result of the principle of reversibility of light which states that when a ray of light after suffering a large number of reflections and refractions has its final path reversed, it travels back along the same path in the opposite direction as shown above.

Refraction of light through a glass block



Lateral Displacement

The perpendicular distance between the path of incident ray and emergent ray is called lateral displacement.



Multiple images in a Thick Glass Plane Mirror