



Refraction of Light
Physics – Leaving Cert
Quick Notes

Refraction of Light

Refraction is the bending of light on passing from one medium to another of differing density.

This occurs due to the different densities of the two media.

When light goes from less dense to more dense medium, it bends towards the normal.

When light goes from more dense to less dense medium it bends away from the normal.

Laws of Refraction:

The incident ray, the normal at the point of incidence and the refracted ray are all in the same plane.

$$\frac{\sin i}{\sin r} = n, \quad (n = \text{refractive index of second medium with respect to first medium})$$

The refractive index is a ratio – it has no units.

The refractive index on going from medium A into medium B = 1/refractive index from B into A.

Real and apparent depth:

When you look into a swimming pool it appears less deep than it really is. If you look at writing through a glass block the writing appears to be inside the block. These are both as a result of refraction.

$$n = \frac{\text{real depth}}{\text{apparent depth}}$$

The reason the light bends on entering a medium of different density is that the light slows down when it enters a denser medium. This can also be used as a basis for refractive index calculations

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

Total internal reflection:

As light passes from a more dense to a less dense medium it bends away from the normal. As the angle of incidence increases so does the angle of refraction. Eventually an angle is reached where the light no longer escapes the block, but travels along the surface.

The angle of incidence for which the angle of refraction = 90° is called the critical angle, C .

If the angle of incidence is increased beyond the critical angle then the refracted ray bends back into the block. This is called Total Internal Reflection.

If you consider light travelling from more dense to less dense at the critical angle then

$$n = \frac{\sin i}{\sin r'} = \frac{\sin C}{\sin 90}$$

Looking at the problem the other way round, for light travelling into the more dense medium

$$n = \frac{\sin 90}{\sin C} = \frac{1}{\sin C}$$

Total internal reflection has several applications. It can be used with a prism to turn light through 90° or through 180° . It is also used in optical fibres.

Optical fibres – are thin glass rods which can bend easily and so be used to carry light around corners. The light always hits the inside of the fibre at greater than the critical angle so total internal reflection occurs and the light travels along the fibre.

- Losses can occur if
- (i) the fibre is bent at too steep an angle – the light may not then hit at greater than the critical angle
 - (ii) Two fibres touch – light may then pass from one to another. This is prevented by coating each fibre with a layer of glass of lower refractive index. This ensures total internal reflection always occurs.

Optical fibres are used in internal medicine – to view inaccessible areas of the body without requiring surgery.

They are also used in telecommunications – since electrical signals suffer from interference, and also since light signals travel faster and optical fibres are smaller.