CONTENT SUMMARY:

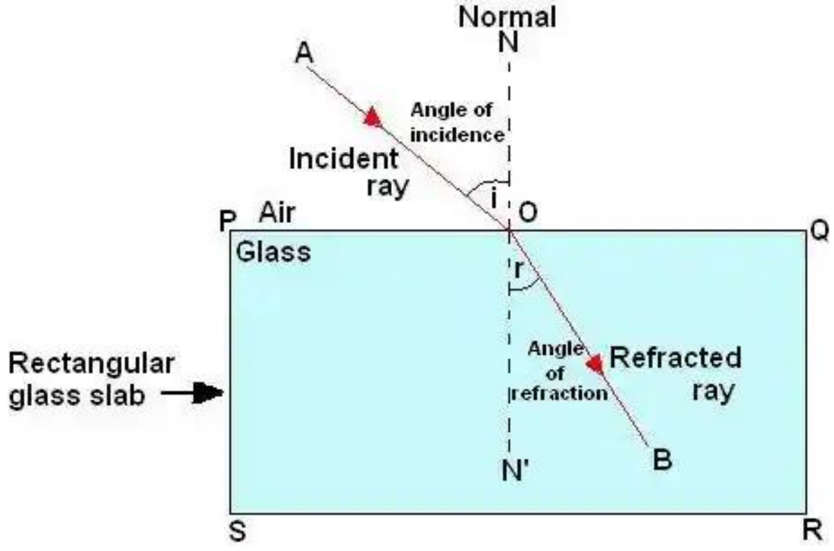
Refraction:

Refraction of light: is the change in the direction of the light as light passes through different media of varying densities. Since light is an example of wave, and as light travels into denser medium, light becomes refracted towards the normal. While light is refracted away from the normal, if it enters a less dense medium. *

Laws of refraction:

There are two laws, which are:

a. The incident ray, normal (N), and the refracted ray are on the same plane
b. The ratio of the sine of the angle of incident to refracted angle, is a constant called refractive index. And this is referred to as the Snell's law.



Demonstrating an experiment on refraction:

1. Apparatus / Materials: Beaker, water, an HB pencil, a length ruler or metre rule
2. Method: Measure the depth of the beaker with a rule, and fill the beaker with water to ¾ full. And then insert a full length HB pencil. Make sure the pencil inserted is a straight pencil.
3. Observation: After the pencil is inserted, the pencil seems no longer straight from the point of entry into the water.

Exercise:

State the reason for what you have observed

State at least a precaution we have took in the demonstration

Write out your conclusion of this demonstration

Refractive index*:

Theory, refractive index, n = sin i / sin r

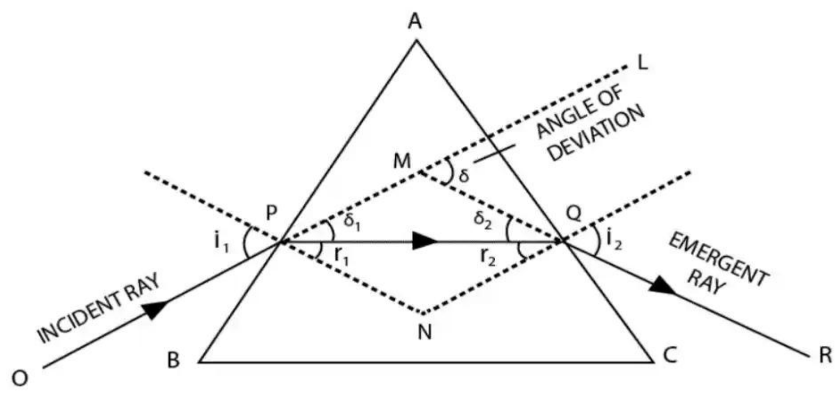
Light moving from air medium to glass medium, refractive index, $_an_g$ = sin i/ sin r

Refractive index, $_an_g = 1 / {_gn_a}$

Refractive index, n = (sin i) / (sin r)

Refractive index, n = true depth / apparent depth

Refractive index, n = speed in the first medium / speed in the next medium



Refractive index of a triangular glass prism, can be expressed as: n = {sin ½ (A + D_{min})} / (sin ½ A)

A = 2r, D_{min} = 2i – 2r*

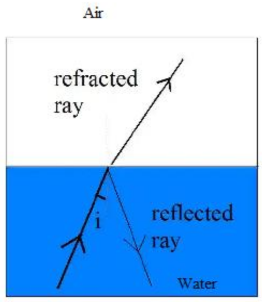
Critical Angle and Total Internal Reflection:*

Critical angle can be defined as the minimum angle that may cause total internal reflection.

Critical angle is the angle of incident at which the refracted angle becomes 90^o, such that further increase in incident angle will bring about total internal reflection. Critical angle occurs with light in a denser medium travelling to a less dense medium, thereby it becomes refracted away from normal.

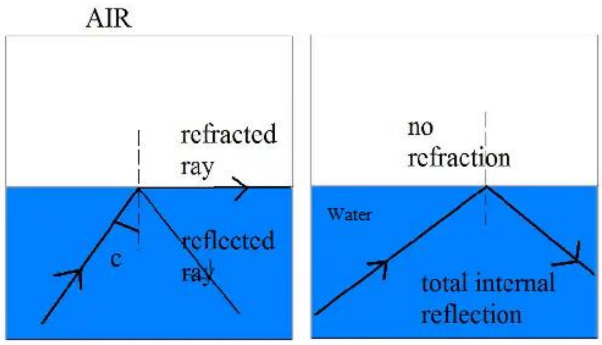
Refractive index, n = (sin i/ sin 90°) = (sin c / sin 90°), where c = critical angle.

Total internal reflection is the phenomenon that occurs to wave or light passing from a denser medium to a less dense medium, with an angle of incident greater than critical angle. In this phenomenon, light is reflected back along the same medium.



Importance of total internal reflection

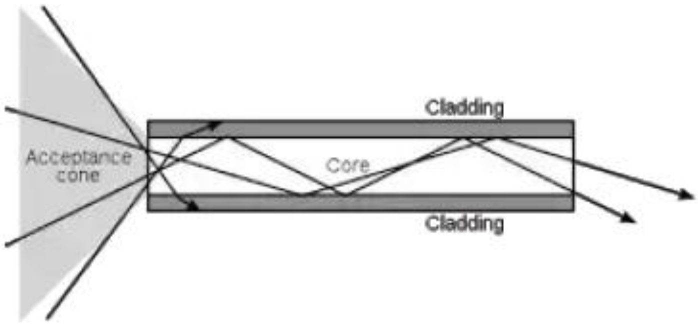
1. It is used in the construction of special periscope
2. It is applicable in optic fibres for communication or transfer of data in the nature of light.



3. It can be used to detect a denser medium
4. It can be used to determine the refractive index of a medium

Optic fibre:
This is used to demonstrate the phenomenon of total internal reflection.

Optical fibre consists of a core (thin glass centre) which is surrounded by a cladding layer with a lower refractive index than that of the core to reflect the light back to the core. The optical fibre is surrounded at the outer layer by the buffer coating which is a plastic coating that protects the fibre from damage and moisture.



There are two main types of optical fibres: mono-mode and multimode. Mode means a form of bandwidth or frequency,

Single (mono) Mode Optic Fibre:
Single mode optic fibre shall receive and transmit a light wave not more than one bandwidth.

The core size of single mode fibre is small (typically around 5 to 10 micrometer), hence only the straight through transmission path is possible (one mode).

Lower signal loss and higher bandwidth as compared to multimode fibres due to low fibre dispersion

Multimode Optic Fibre:
Multimode optic fibre shall receive and transmit light waves which can be more than one bandwidth.

Multimode optical fibre has a much larger core diameter which allows for a larger number of modes.

Modal dispersion (intermodal dispersion) may arrive at the fibre end at slightly different transit times, and this may have the effect of changing the shape of the pulses of light that represent the signal, and causes the light pulse to spread.

When light is launched into the optic fibre with more ease, if the core of the optic fibre is larger in size, then it makes it easier to make more fibre connections, and because of this: light emitting diodes becomes (cheaper, less complex and last longer). Else, laser diodes become applicable, especially in single mode fibre.

Multimode fibres consist of step index fibre and graded index fibre.

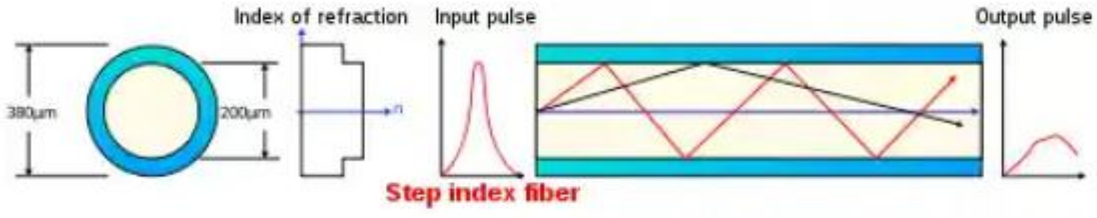
Step index fibre:

Step index fibres have an uniform core with one index of refraction, and the refractive index changes abruptly to a cladding with a smaller index of refraction.

Three different light waves travel down the fibre. One mode travels straight down the center of the core. A second mode travels at a steep angle and bounces back and forth by total internal reflection.

The third mode exceeds the critical angle and refracts into the cladding. The second mode travels a longer distance than the first mode. Since the rays travel different paths, the different modes to arrive at separate times.

This disparity between arrival times of the different light rays is known as dispersion, and the result is a muddied signal at the receiving end. The output pulse is spread out in time compared to the input pulse.



Graded index fibre (continuous-index):
In graded index fibre, the refractive index gradually decreases farther away from the core, hence making the boundary between cladding and core indistinct.

The higher index of refraction in the centre of the core slows the speed of some light rays, allowing all the light rays to reach the receiving end at approximately the same time, reducing dispersion and increasing bandwidth.