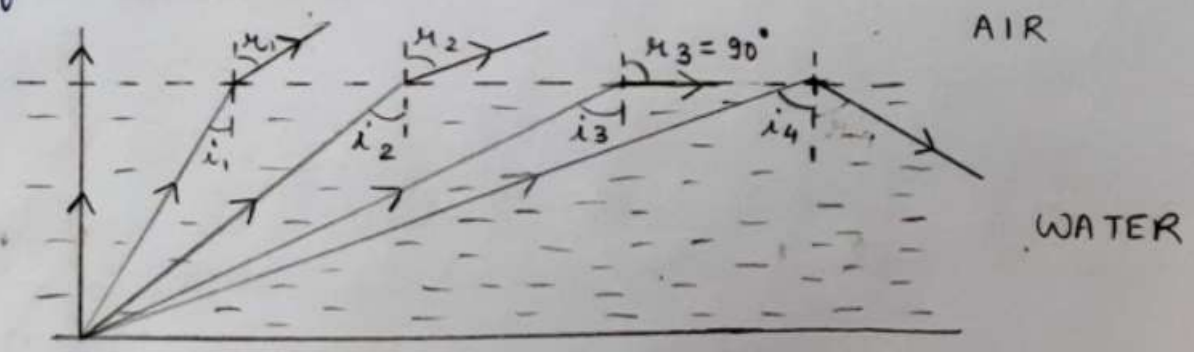
Total Internal Reflection –

When light travels from denser to rarer medium above a certain angle of incidence it will reflect back into the same medium.



$$_wμ_a = \frac{\sin i}{\sin r}$$

when $i = i_c$ then $r = 90°$

$$_wμ_a = \frac{\sin i_c}{\sin 90°}$$

$$_wμ_a = \frac{\sin i_c}{1}$$

$$_aμ_w = \frac{1}{_wμ_a} = \frac{1}{\sin i_c} \Rightarrow \boxed{μ = \frac{1}{\sin i_c}}$$

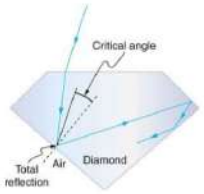
Conditions for Total Internal Reflection of Light:

- The ray of light should travel through an optically denser medium into an optically rarer medium.
- The angle of incidence should be equal or greater than the critical angle (i_C) for the two mediums.

Applications of Total Internal Reflection of Light:

- The phenomenon of total internal reflection of light is used in many optical instruments like telescopes, microscopes, binoculars, spectroscopes, periscopes etc.
- The brilliance of a diamond is due to total internal reflection.
- Optical fibre works on the principle of total internal reflection.
- This phenomenon is used in many optical instruments like telescopes, microscopes, binoculars, spectroscopes, periscopes etc.
- The phenomenon of mirage can be explained on the basis of total internal reflection.

Sparkling Brilliance of Diamond:

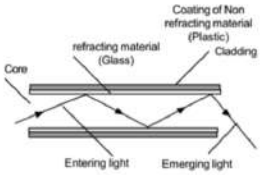


Total internal reflection of the light phenomenon is also used in polishing of diamonds, to create a sparkling brilliance effect. Sparkling brilliance of diamond can be explained as follows

For diamond and air interface the difference between the refractive index of a diamond ($\mu = 2.8$) and the refractive index of air ($\mu = 1$) is very large. The critical angle for a diamond in diamond and air interface is very small (24.4°).

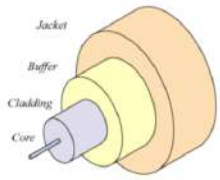
By polishing the diamond with specific cuts it is adjusted that most of the light rays approaching surface are incident with the angle of incidence more than the critical angle. Hence they suffer multiple total internal reflections and ultimately come out of diamond from the top. This gives the diamond a sparkling brilliance.

Optical Fibre:



When light enters the core of glass fibre from one end with such that the angle of incidence is greater than critical angle then, it suffers total internal reflection of light many times and emerges out as the divergent beam from another end. This is known as the principle of the optical fibre.

Each fibre is made up of a material of high refractive index. Its outer side is covered by a layer of material of low refractive index, which provides a suitable boundary. Due to this, the transmission of light from one fibre to others is avoided.



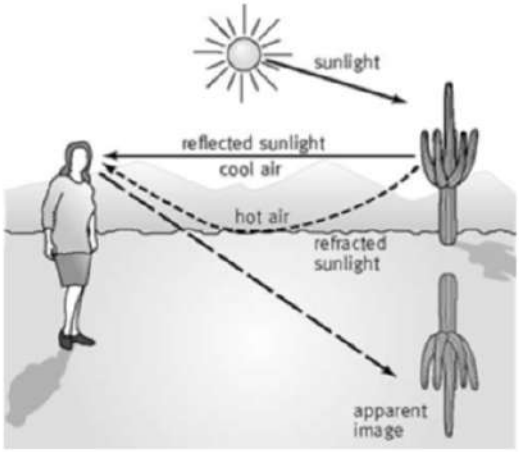
The glass is not flexible and hence breaks easily. Hence the optical fibres are grouped together in a single cable, which is flexible and unbreakable.

Applications of optical fibre:

- It is used in optical communication.
- It is used in endoscopy.

Mirage:

A mirage is an optical phenomenon that creates the illusion of water and results from the refraction of light through a non-uniform medium. Mirages are most commonly observed on sunny days when driving down a roadway. As you drive down the roadway, there appears to be a puddle of water on the road several metres (maybe one-hundred metres) in front of the vehicle. Of course, when you arrive at the perceived location of the puddle, you recognize that the puddle is not there. The appearance of the water is simply an illusion.



Explanation of mirage can be given on the basis of total internal reflection of the light phenomenon. Mirages occur on sunny days. The role of the sun is to heat the roadway to high temperatures. This heated roadway, in turn, heats the surrounding air, keeping the air just above the roadway at higher temperatures than that day's average air temperature. Hot air tends to be less optically dense than cooler air. As such, a non-uniform medium has been created by the heating of the roadway and the air just above it.

While light will travel in a straight line through a uniform medium, it will refract when travelling through a non-uniform medium. If a driver looks down at the roadway at a very low angle (that is, at a position nearly one hundred yards away), light from objects above the roadway will follow a curved path to the driver's eye as shown in the diagram. Now, the observer receives two rays from the object, one direct and other curved. Thus the illusion of water takes place.