

FORMATION OF MIRAGE – TOTAL INTERNAL REFLECTION

Refraction from denser medium to rarer medium :

(i) If the light ray travels from denser medium to rarer medium, it bends away from the normal drawn to the interface at point of incidence.

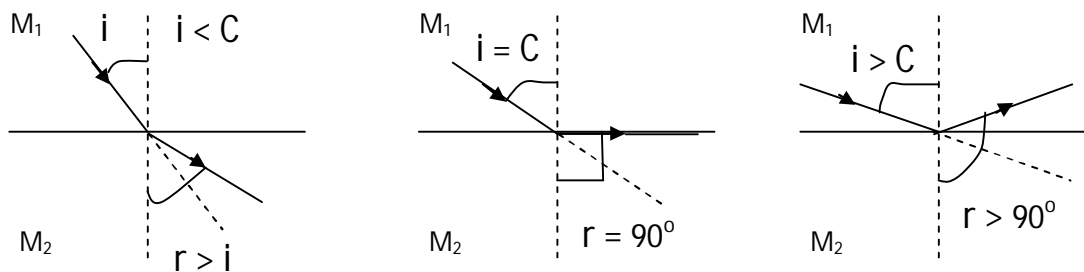
$$\text{If } i < C \rightarrow r < 90^\circ$$

(ii) For which incident angle, the angle of refraction is 90° that incident angle is called critical angle. If the incident angle is critical angle then the refracted ray passes along the interface of the two media.

$$\text{If } i = C \rightarrow r = 90^\circ$$

(iii) If the incident angle is greater than the critical angle then the light ray gets total internal reflection. It means, the light ray gets reflection instead of refraction.

$$\text{If } i > C \rightarrow r > 90^\circ$$



M_1 = Denser medium M_2 = Rarer medium

Mirages : Mirage is an optical illusion where it appears that water has collected on the road at a distant place but when we get there, we don't find any water.

The formation of a mirage is the best example where refractive index of a medium varies throughout the medium.

During a hot summer day, air just above the road surface is very hot and the air at higher altitudes is cool. It means that the temperature decreases with height. As a result, density of air increases with height. We know that refractive index of air increases with density. Thus the refractive index of air increases with height.

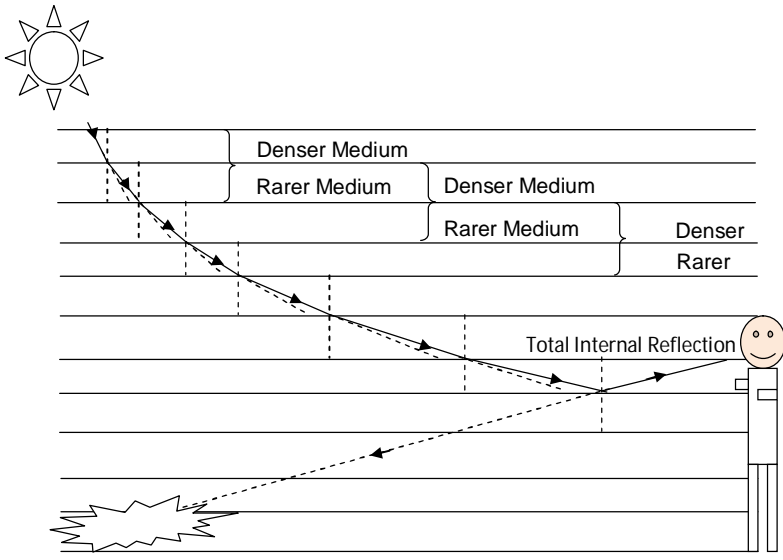
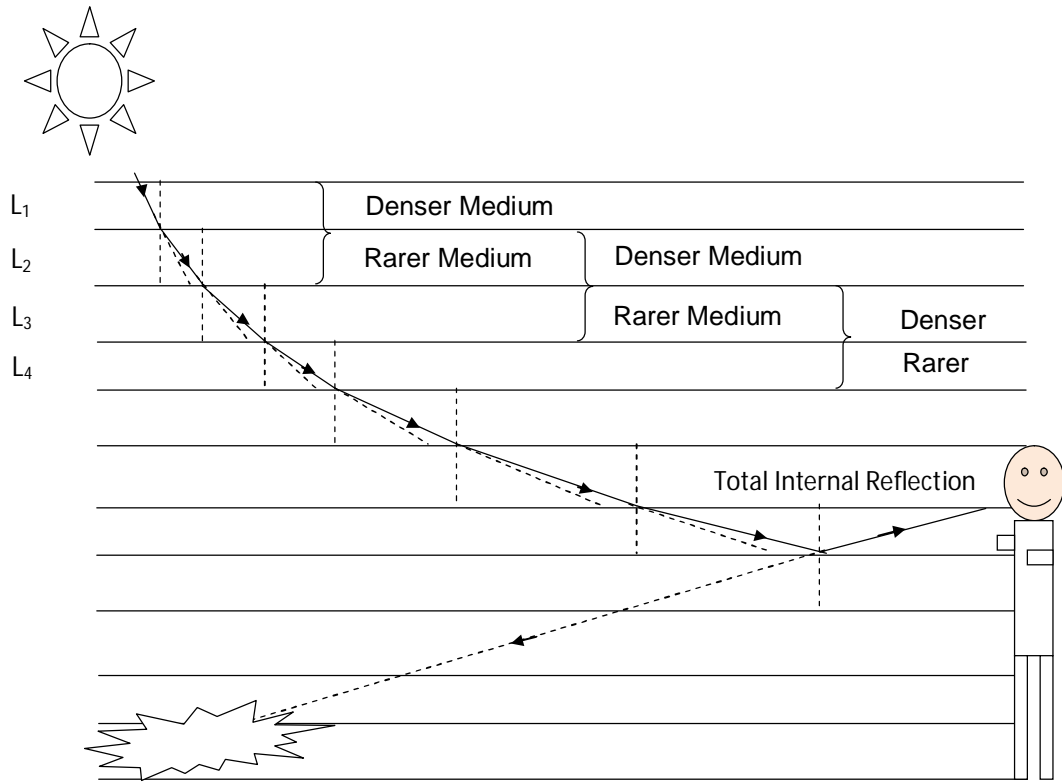
So, the cooler air at the top has greater refractive index than hotter air just above the road. Light travels faster through the thinner hot air than through the denser cool air. The paths of light rays when there is no change in density of air. Refractive index decreases with depth above it.

When the light from a tall object such as tree or from the sky passes through a medium just above the road, whose refractive index decreases towards ground, it suffers, refraction and takes a curved path because of total internal reflection.

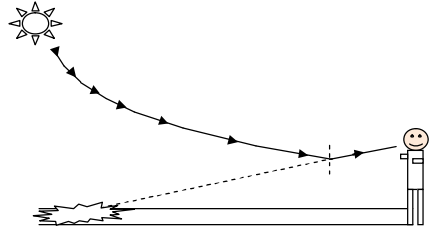
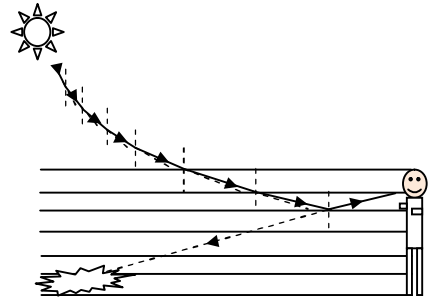
This refracted light reaches the observer in a separate direction. This appears to the observer as if the ray is reflected from the ground.

Hence we feel the illusion of water being present on road, which is the virtual image of the sky (mirage) or an inverted image of tree on the road.

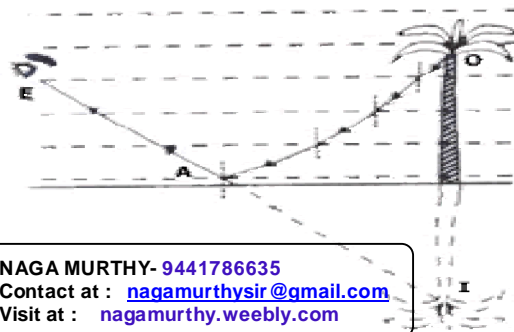
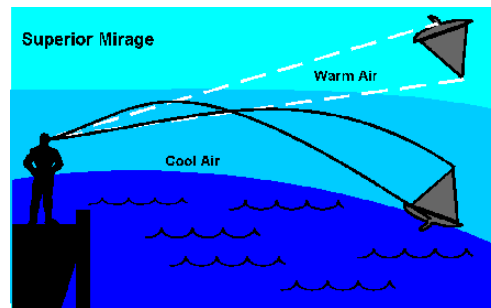
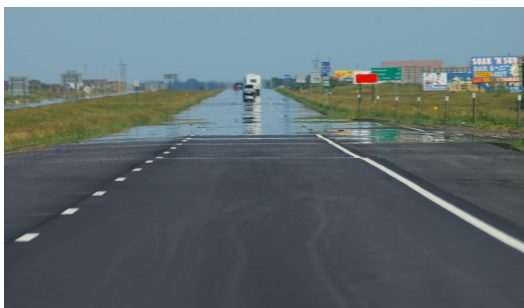
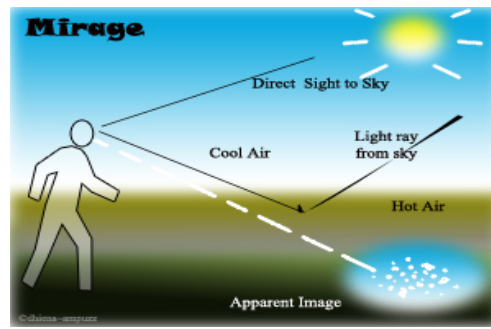
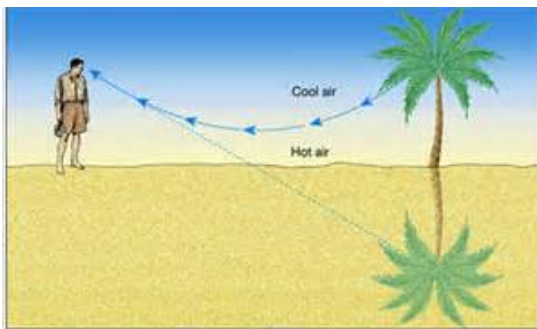
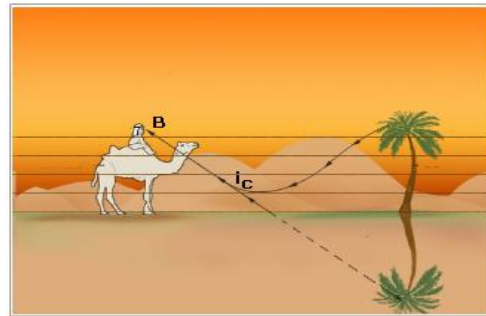
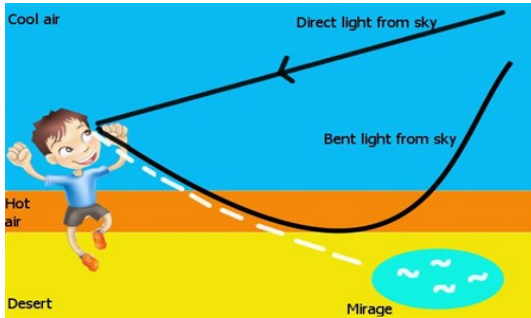
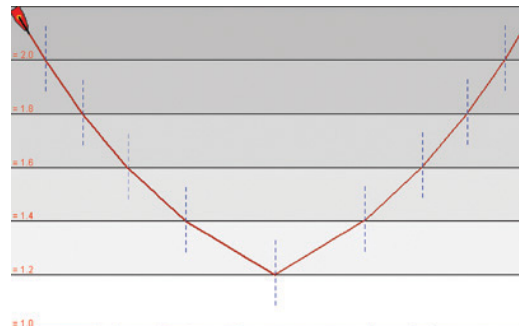
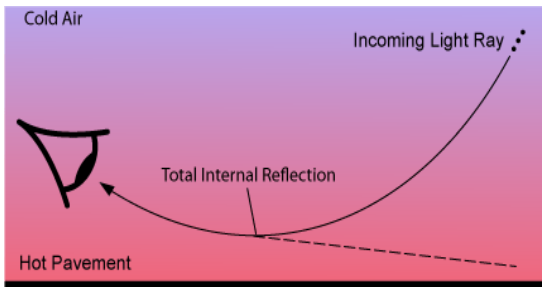
DIAGRAMS FOR FORMATION OF MIRAGE



Imagine there are several layers of air with different refractive indices. L_1 layer is colder than L_2 layer. L_1 acts as denser medium and L_2 acts as rarer medium. So the light rays bends away from the normal while passing through L_1 - L_2 interface. L_2 layer is colder than L_3 layer. L_3 acts as denser medium and L_2 acts as rarer medium. So the light rays bends away from the normal while passing through L_2 - L_3 interface. Similarly the refraction continues at different layers. At a particular layer, it gets Total internal reflection.



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