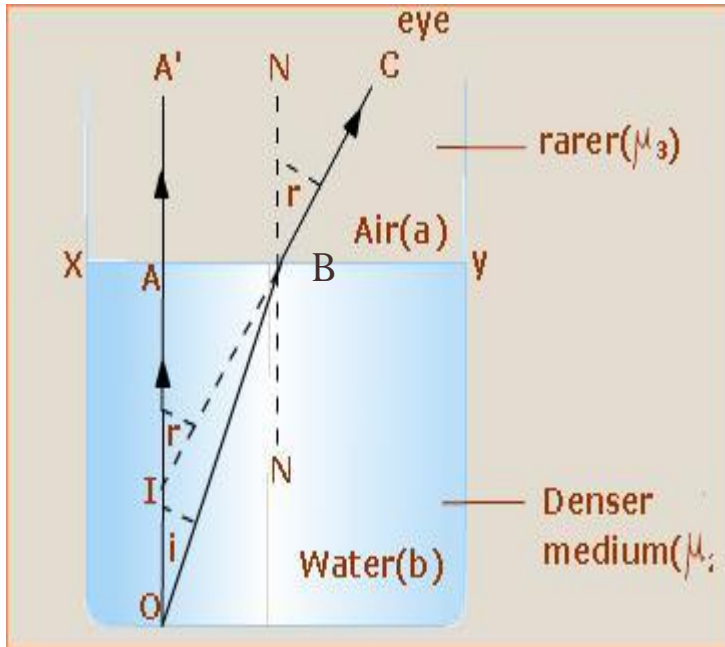


# APPLICATIONS OF REFRACTION OF LIGHT

# Real and Apparent Depth

Consider a ray of light incident on XY, normally along OA, it passes straight along OAA<sup>1</sup>. Consider another ray from O (the object) incident at an angle  $i$  on XY, along OB. This ray gets refracted and passes along BC. On producing this ray BC backwards, it appears to come from the point I and hence AI represents the apparent depth, which is less than the real depth AO.



$$\angle AOB = \angle OBN = i \text{ (alternating angles)}$$

$$\angle AIB = \angle NBC = r \text{ (corresponding angles)}$$

$$\text{In } \Delta \sin i = \frac{AB}{OB}$$

$$\text{In } \Delta \sin r = \frac{AB}{IB}$$

When angles are small, B lies close to A such that  $OB \sim OA$

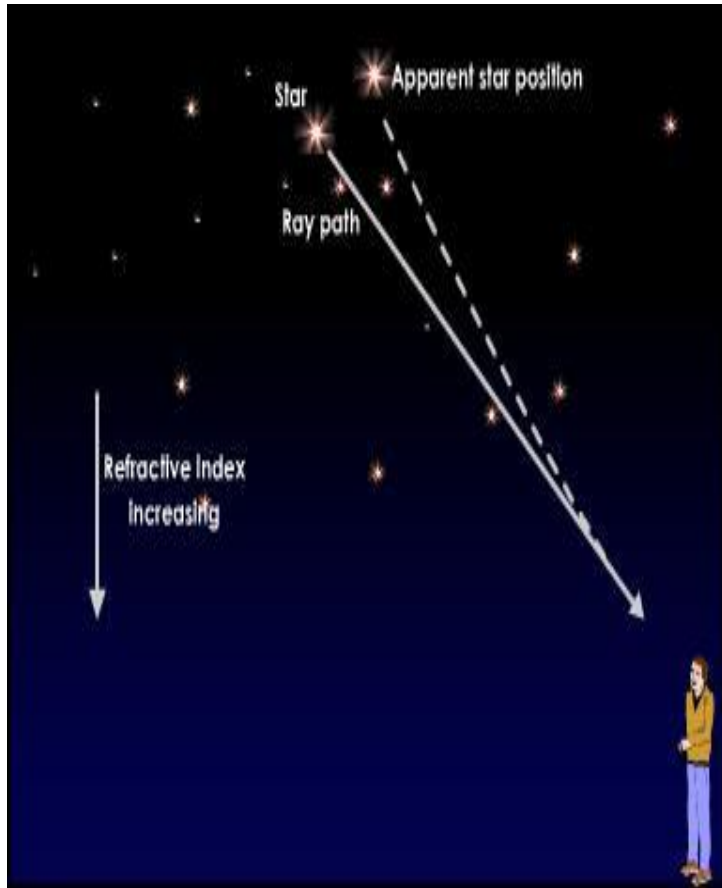
$IB \sim AI$

$$2 \mu_1 = \frac{\sin i}{\sin r} = \frac{AB}{OB} \times \frac{IB}{AB} = \frac{IB}{OB} \approx \frac{AI}{OA}$$

$$\mu_2 = \frac{OA}{AI} = \frac{\text{Real depth}}{\text{Apparent depth}}$$

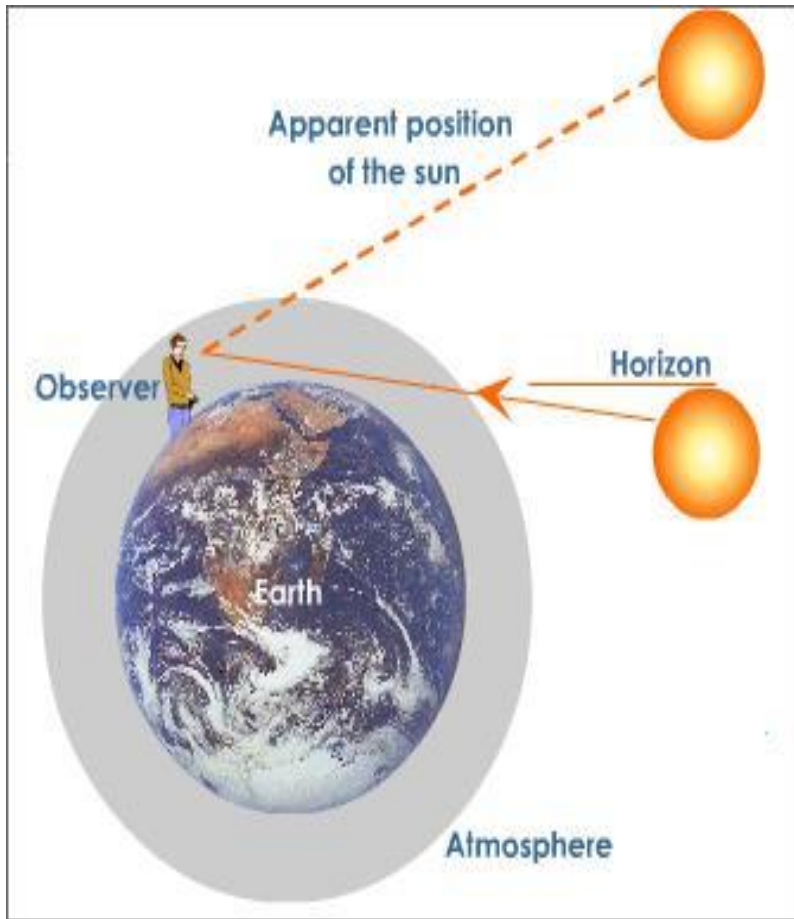
$$\text{Apparent depth} = \frac{\text{Real depth}}{\text{Refractive index}}$$

# Apparent position and twinkling of stars



The atmosphere consists of a number of parallel layers of different densities. Varying temperature and pressure account for the different densities. As the rays enter in layers of increasing densities they are being continuously refracted. In the process, the rays follow a curved path and reach the observer. But due to the wind and convection currents, the density of the layers go on changing. Therefore, after very short intervals of time, the position of the image of the star keeps changing, and produces the twinkling effect.

# Apparent sunrise/sunset



Due to atmospheric refraction, sunrise occurs shortly before the sun crosses above the horizon. Light from the sun is bent, or refracted, as it enters earth's atmosphere. This effect causes the *apparent* sunrise to be earlier than the actual sunrise. Similarly, apparent sunset occurs slightly later than actual sunset. The sunrise and sunset times reported in our calculator have been corrected for the approximate effects of atmospheric refraction. However, it should be noted that due to changes in air pressure, relative humidity, and other quantities, we cannot predict the exact effects of atmospheric refraction on sunrise and sunset time. Also note that this possible error increases with higher (closer to the poles) latitudes.

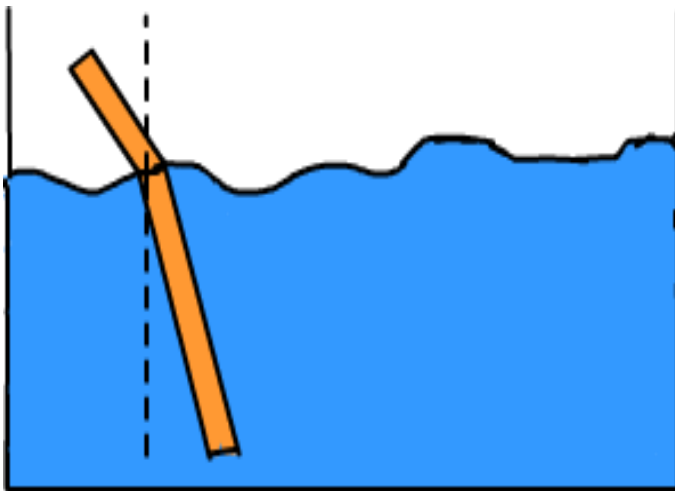
# Spear Fishing



Spear fishermen use a strange trick to catch their prey. They aim at a point slightly *below* where the fish seems to be.

The reason is that light changes direction when it moves from one transparent substance, such as water, to another of different density, such as air. This change of direction is called REFRACTION.

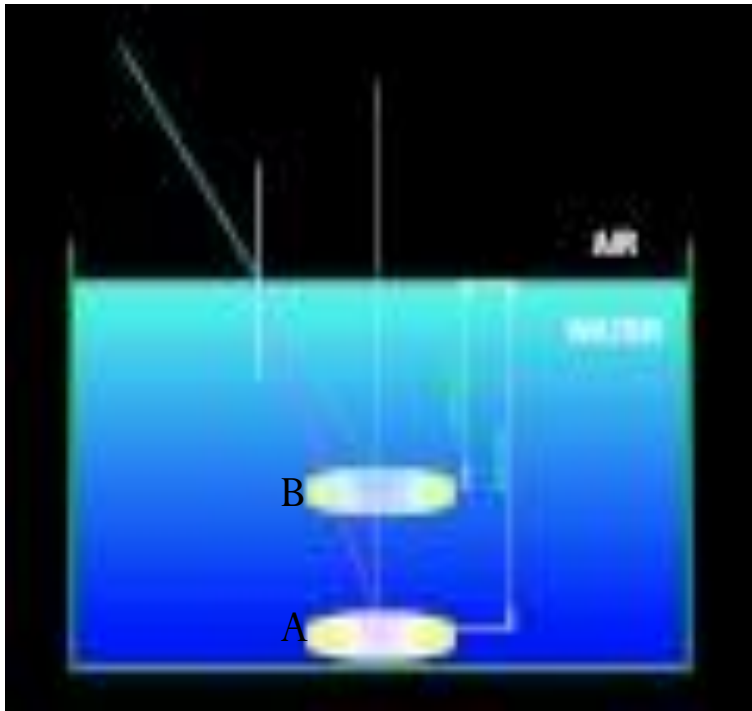
# Bending of stick in water



© Copyright  
[www.physicstutorials.org](http://www.physicstutorials.org)

A stick immersed in water appears bent and short at the surface of water when viewed obliquely from above. This is because the rays of light travel from water to air and bend away from the normal at the surface

# A coin appears raised in water



Place a coin A at the bottom of an empty vessel. The position of the eye is so adjusted that the coin cannot be seen. Now slowly fill the vessel with water and maintain a steady gaze at the coin. The coin gradually begins to appear. Thus, B is the raised, apparent position of the coin A due to refraction of light

# Virtual image observed by Refraction

