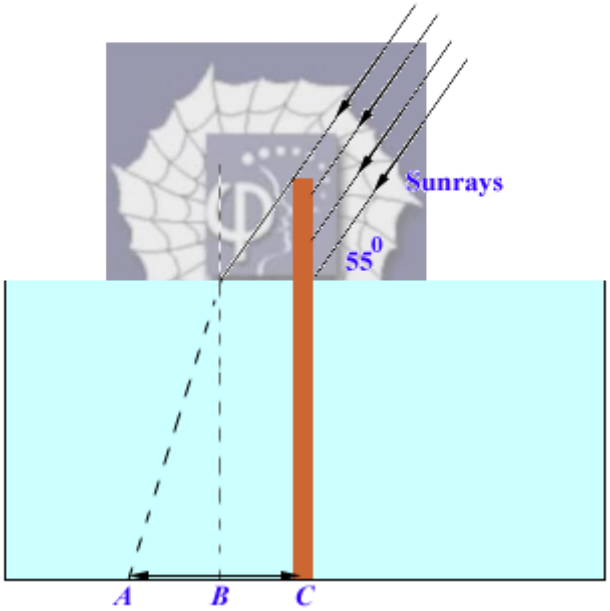
589.

Problem 34.65P (HRW)

As shown in the figure, a 2.00 m *long vertical pole extends from the bottom of a swimming pool to a point* 50.0 cm *above the water. Sunlight is incident at* 55.0^0 *above the horizon. We have to find the length of the shadow of the pole on the level bottom of the pool.*



Solution:

The length of the pole above the water is

$l_1 = 50.0$ cm,

and the length of the pole inside the water is

$l_2 = 150$ cm.

The sunrays are incident at an angle 55.0^0 above the horizon.

From the diagram shown above we note that the shadow of the pole on the level bottom of the pool will be given by the line *AC*.

We note that the angle of incidence of the sunrays with the normal to the surface of water is 35^0. Therefore, the angle of refraction of the sunrays inside the water can be determined using the Snell's law.

Index of refraction of water is

$n = 1.33.$

Therefore,

$$\sin\theta_r = \frac{\sin\theta_i}{n} = \frac{\sin 35^0}{1.33} = 0.431$$

and

$$\theta_r = \sin^{-1}(0.431) = 25.54^0 \ .$$

Therefore, length *AB* will be

$$AB = 150 \times \tan\left(25.54^0\right) \text{ cm} = 71.69 \text{ cm}.$$

From geometry we note that the length BC will be

$$BC = 50 \times \tan 35^0 \text{ cm} = 35.0 \text{ cm}.$$

Therefore, the length of the shadow of the pole on the bottom level of the pool will be

$$AC = AB + BC = \left(71.69 + 35.0\right)\ \text{cm} = 106.7\ \text{cm}.$$