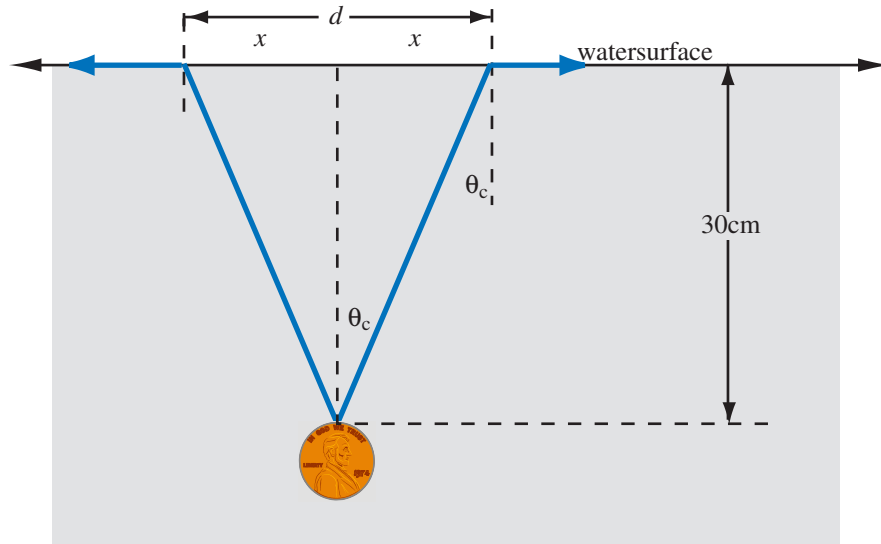


**8.24** A penny lies at the bottom of a water fountain at a depth of 30 cm. Determine the diameter of a piece of paper which, if placed to float on the surface of the water directly above the penny, would totally obscure the penny from view. Treat the penny as a point and assume that  $n = 1.33$  for water.

**Solution:**



**Figure P8.24** Light cone bounded by total internal reflection.

$$\theta_c = \sin^{-1} \left[ \frac{1}{1.33} \right] = 48.75^\circ,$$

$$d = 2x = 2[(30 \text{ cm}) \tan \theta_c] = (60 \text{ cm}) \times \tan 48.75^\circ = 68.42 \text{ cm}.$$