

47. Consider a ray that grazes the top of the pole, as shown in the diagram below. Here $\theta_1 = 35^\circ$, $\ell_1 = 0.50$ m, and $\ell_2 = 1.50$ m. The length of the shadow is $x + L$. x is given by $x = \ell_1 \tan \theta_1 = (0.50 \text{ m}) \tan 35^\circ = 0.35$ m. According to the law of refraction, $n_2 \sin \theta_2 = n_1 \sin \theta_1$. We take $n_1 = 1$ and $n_2 = 1.33$ (from Table 34-1). Then,

$$\theta_2 = \sin^{-1} \left(\frac{\sin \theta_1}{n_2} \right) = \sin^{-1} \left(\frac{\sin 35.0^\circ}{1.33} \right) = 25.55^\circ .$$

L is given by

$$L = \ell_2 \tan \theta_2 = (1.50 \text{ m}) \tan 25.55^\circ = 0.72 \text{ m} .$$

The length of the shadow is $0.35 \text{ m} + 0.72 \text{ m} = 1.07 \text{ m}$.

