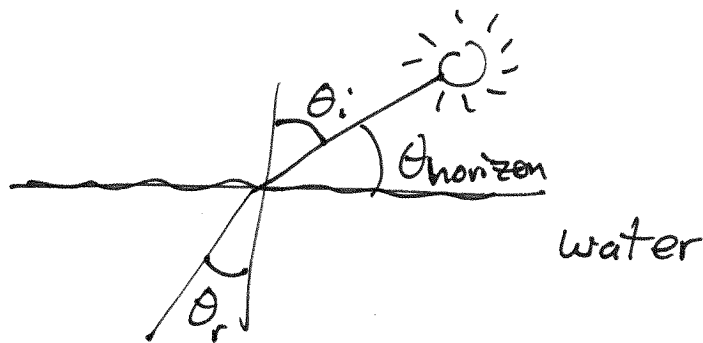


Ch. 1. Prob 42



Find the angle the sun is above the horizon.

The index of refraction of air is $n_{\text{air}} = 1.000$
" " " " water is $n_{\text{H}_2\text{O}} = 1.333$

Using Snell's Law

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$n_{\text{air}} \sin \theta_i = n_{\text{H}_2\text{O}} \sin \theta_r$$

Solving for the incident angle gives

$$\sin \theta_i = \frac{n_{\text{H}_2\text{O}}}{n_{\text{air}}} \sin \theta_r = \frac{1.333}{1.000} \sin(30^\circ)$$

$$\sin \theta_i = 0.6665$$

$$\theta_i = 41.8^\circ$$

For Snell's law all angles are measured relative to the normal of the surface.

To get the angle above the horizon, you need to take the complement of the angle

$$\theta_{\text{horizon}} = 90 - \theta_i = 90 - 41.8^\circ = \boxed{48.2^\circ}$$