After a long day of driving you take a late-night swim in a motel swimming pool. When you go to your room, you realize that you have lost your room key in the pool. You borrow a powerful flashlight and walk around the pool, shining the light into it. The light shines on the key, which is lying on the bottom of the pool, when the flashlight is held 1.2 m above the water surface and is directed at the surface a horizontal distance of 1.5 m from the edge. If the water here is 4.0 m deep, how far is the key from the edge of the pool?

Treating the air as medium a and the water as medium b.

The incident angle is $\boldsymbol{q}_a = \arctan\left(\frac{1.5 \text{ m}}{1.2 \text{ m}}\right) = 51^\circ$.

Using Snell's Law you can solve for the angle in the pool as

$$\Rightarrow \boldsymbol{q}_b = \arcsin\left(\frac{n_a}{n_b}\sin\boldsymbol{q}_a\right) = \arcsin\left(\frac{1.00}{1.33}\sin 51^\circ\right) = 36^\circ$$

So the distance along the bottom of the pool from directly below where the light enters to where it hits the bottom is:

$$x = (4.0 \text{ m}) \tan \mathbf{q}_b = (4.0 \text{ m}) \tan 36^\circ = 2.9 \text{ m}.$$

 $\Rightarrow x_{\text{total}} = 1.5 \text{ m} + x = 1.5 \text{ m} + 2.9 \text{ m} = 4.4 \text{ m}.$

