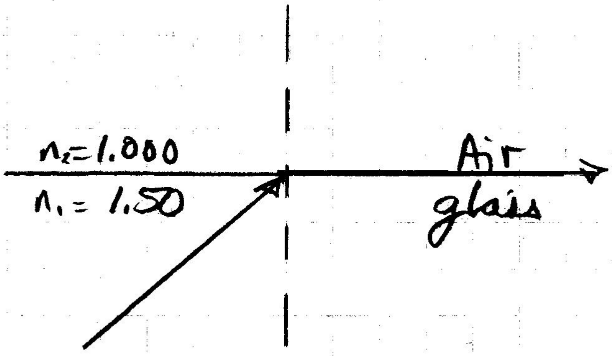
Dr. Bob

1.




$n_2 = 1.000,\ \theta_2 = 90°$
$n_1 = 1.50,\ \theta_1 = \theta_c = ?$

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

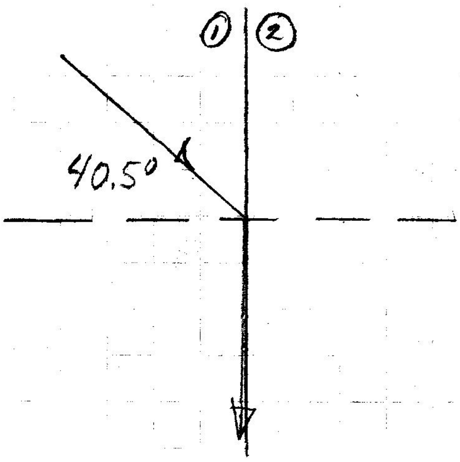
$\sin\theta_1 = \frac{n_2}{n_1} \sin\theta_2$

$$\theta_c = \theta_1 = \sin^{-1}\left(\frac{n_2}{n_1} \sin\theta_2\right) = \sin^{-1}\left(\frac{1.000}{1.50} \sin 90°\right)$$

$$\theta_c = \sin^{-1}\left(\frac{1}{1.50}\right) =$$

$$\boxed{\theta_c = 41.8°}$$

2. $\theta_c = 40.5°$ $n_1 = ?$ $\theta_2 = 90°$ Air
$\theta_1 = \theta_c$ $n_2 = 1.000$




$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$

$\sin\theta_c = \frac{n_2}{n_1}$

$n_1 = \frac{n_2}{\sin\theta_c}$

$= \frac{1.000}{\sin 40.5°}$

$$\boxed{n_1 = 1.54}$$

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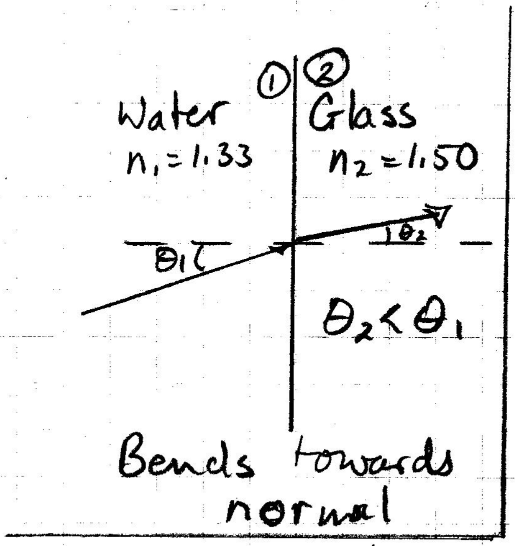
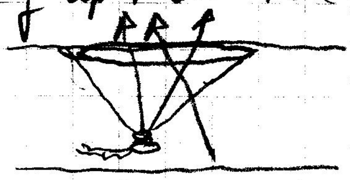
3. No. At the water-glass interface the ray is going from lower (1.33) to higher (1.50) index of refraction. Total internal reflection only occurs when the ray bend away from the normal. This means the ray must travel from a higher to a lower index of refraction this is not the case here since $n_1 < n_2$.




4. Looking up from the bottom of the pool.



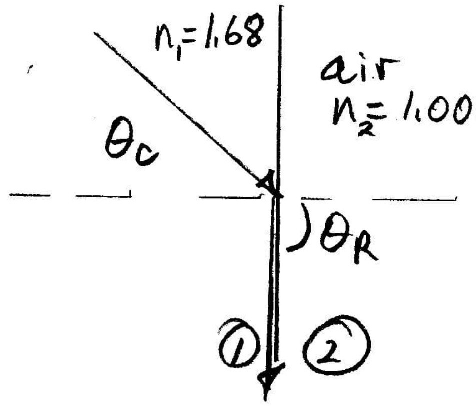
The light from inside the pool leaving the botton of the pool shines upward. For small angles of incidence, this light is refracted as it passes in to the air. In the middle of the circle the light shining from above is brighter so you see the roof or sky above the pool. Outside the circle the light from the bottom of the pool

4. (continued)

is reflected back to your eye. This reflected light is brighter than the refracted light from above. So, you see the bottom of the pool reflected in the surface of the water outside the circle.

5.

a.




$\theta_1 = \theta_c = ?$ $n_1 = 1.68$

$\theta_2 = \theta_R = 90°$ $n_2 = 1.000$

$n_1 \sin\theta_1 = n_2 \sin\theta_2 = n_2 \sin 90°$ (sin 90° = 1)

$n_1 \sin\theta_1 = n_2$

$\sin\theta_1 = \frac{n_2}{n_1}$

$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right) = \sin^{-1}\left(\frac{1.000}{1.68}\right)$

$\boxed{\theta_c = 36.5°}$

b. $n_1 = ?$ $\theta_c = 40°$

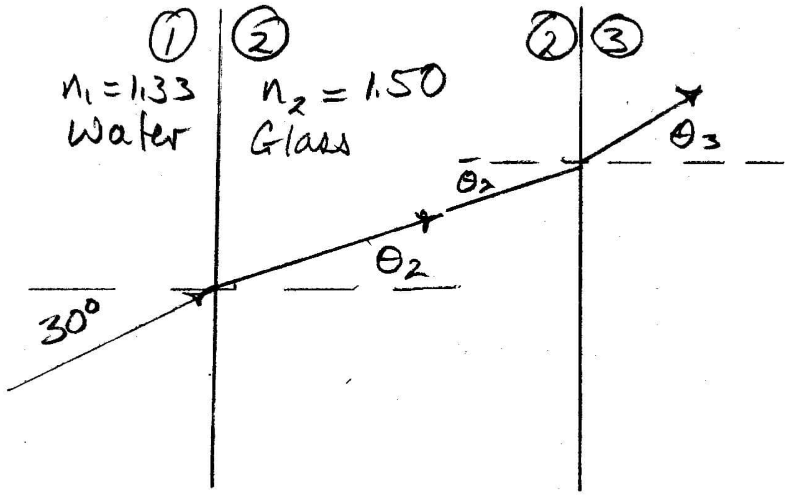
$n_2 = 1.000$

$\sin\theta_c = \frac{n_2}{n_1}$

$n_1 = \frac{n_2}{\sin\theta_c} = \frac{1.000}{\sin 40°}$

$\boxed{n_1 = 1.56}$

6.




a. 1st interface

$n_1 = 1.33 \qquad \theta_1 = 30^\circ$

$n_2 = 1.50 \qquad \theta_2 = ?$

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

$$\sin\theta_2 = \frac{n_1}{n_2} \sin\theta_1$$

$$\theta_2 = \sin^{-1}\left(\frac{n_1}{n_2}\sin\theta_1\right) = \sin^{-1}\left(\frac{1.33}{1.50}\sin 30^\circ\right)$$

$$\theta_2 = 26.32^\circ$$

$$\theta_3 = \sin^{-1}\left(\frac{n_2}{n_3}\sin\theta_2\right) = \sin^{-1}\left(\frac{1.50}{1.000}\sin 26.32^\circ\right)$$

$$\boxed{\theta_3 = 41.7^\circ}$$

b.

$$\theta_2 = \sin^{-1}\left(\frac{1.33}{1.50}\sin 52^\circ\right) = 44.32^\circ$$

$$\theta_3 = \sin^{-1}\left(\frac{1.50}{1.000}\sin 44.32^\circ\right) = \text{error}$$

The light will not emerge. It is totally internally reflected