

Name: _____
 Date: _____
 Section C D F



Refraction I: Snell's Law

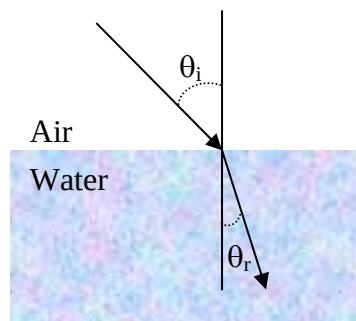
1. Light passes from air ($n_{\text{air}} = 1$) into water ($n_{\text{water}} = 1.33$) at an angle of incidence of 43.0° .

- a. Determine the angle of refraction in the water.

$$n_i \sin \theta_i = n_r \sin \theta_r$$

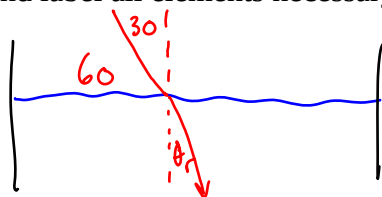
$$(1) (\sin 43) = (1.33) \sin \theta_r$$

$$\theta_r = 30.85^\circ$$



2. A ray of light enters the top of a glass of water at an angle of 60° with the water.

- a. Draw a diagram, and label all elements necessary.



- b. What is the angle between the refracted ray and the vertical?

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$(1.0) \sin 30 = (1.33) \sin \theta_r$$

$$\theta_r = 22.1^\circ$$

3. The angles of incidence and refraction for light going from air into a material with a higher index of refraction are 56.0° and 36.0° , respectively. What is the index of refraction of this material?

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$(1.0) (\sin 56) = n_r (\sin 36)$$

$$n_r = 1.41$$

4. A narrow ray of yellow light from glowing sodium ($\lambda = 589 \text{ nm}$) traveling in air strikes a smooth surface of water at an angle of $\theta_i = 39.0^\circ$. Determine the angle of refraction, θ_r .

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$(1.0) (\sin 39) = (1.33) \sin \theta_r$$

$$\theta_r = 28.24^\circ$$

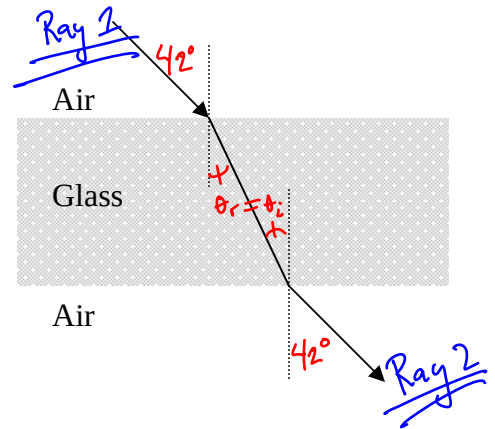
5. Every time a beam of light passes through a window, refraction occurs. If the beam of light strikes a window pane ($n_{\text{glass}} = 1.5$) at an angle of 42° with the vertical:

- a. Calculate the angle of refraction as the light enters the block of glass.

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$(1.0) \sin 42 = (1.5) \sin \theta_r$$

$$\theta_r = 26.5^\circ$$



- b. As the ray is passing through the window pane, and into the house, the light ray refracts again. If the ray of light is passing from glass ($n_{\text{glass}} = 1.5$) into the house ($n_{\text{air}} = 1.00$), find:

- i. Incident angle $\theta_i = 26.5^\circ$

- ii. Refracted angle

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$(1.5) (\sin 26.5) = (1.0) \sin \theta_r$$

$$\theta_r = 42^\circ$$

- c. What do you notice about 5.a and 5.b.ii?

Angle entering glass is equal to angle leaving glass.
Ray 1 // Ray 2

6. The light ray shown in the figure below makes an angle of 20.0° with the normal line at the boundary of linseed oil ($n_{\text{oil}} = 1.48$) and water ($n_{\text{water}} = 1.33$).

- a. Find θ_1

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$(1.0) \sin \theta_1 = (1.48) (\sin 20^\circ)$$

$$\theta_1 = 30.41^\circ$$

- b. Find θ_2

$$n_i \sin \theta_i = n_r \sin \theta_r$$

$$(1.48) (\sin 20) = (1.33) \sin \theta_2$$

$$\theta_2 = 22.37^\circ$$

