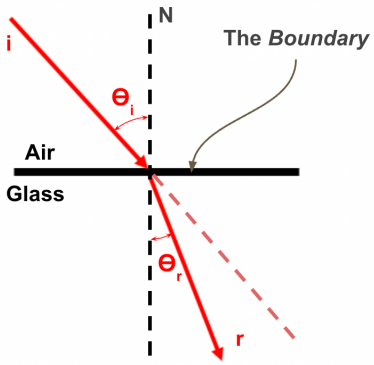
Snell's Law
Lesson Notes

Learning Outcomes

- What variables affect the amount of refraction at a boundary?
- How can one mathematically predict the angle of refraction at a boundary?

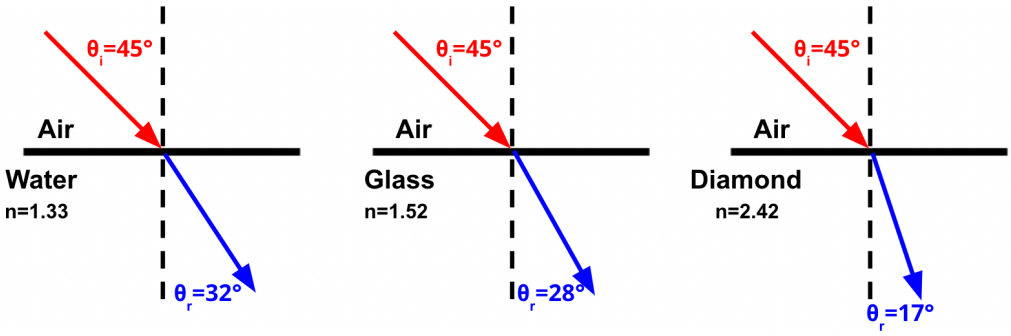
The Angle of Refraction

Refraction = the bending of the path of light at a boundary.
i = incident ray
N = normal line
Θ_i = angle of incidence
r = refracted ray
Θ_r = angle of refraction



The Amount of Refraction

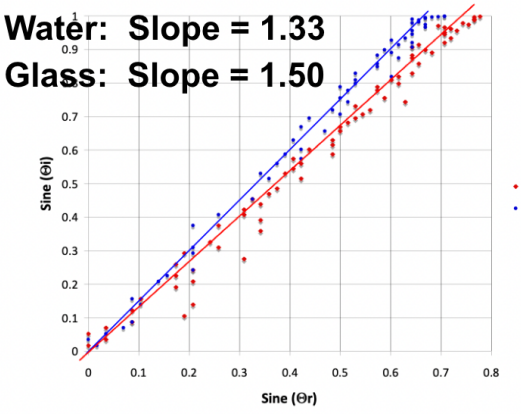
- The amount of refraction (or bending of the light path) depends upon **the materials** and **the angle of incidence**.
- When the angle of incidence (θ_i) is 0°, there is no refraction; the amount of refraction increases with increasing θ_i values.

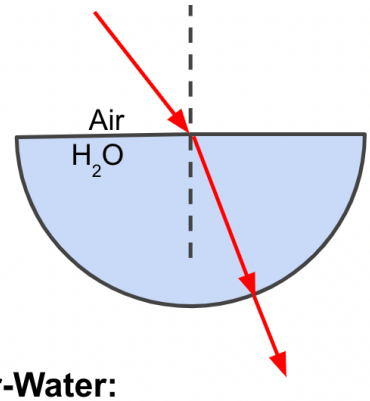


A Lesson from the Laboratory

Light is incident upon the flat surface of a plexiglass tank filled with water. Θ_i and Θ_r values are measured for a variety of angles.

Θ_i (°)	Θ_r (°)
0.00	0.00
5.00	3.8
10.0	7.5
15.0	11.2
20.0	14.9
25.0	18.5
30.0	22.1
35.0	25.5
40.0	28.9
45.0	32.1
50.0	35.2
55.0	38.0
60.0	40.6
65.0	43.0
70.0	45.0
75.0	46.6
80.0	47.8
85.0	48.5



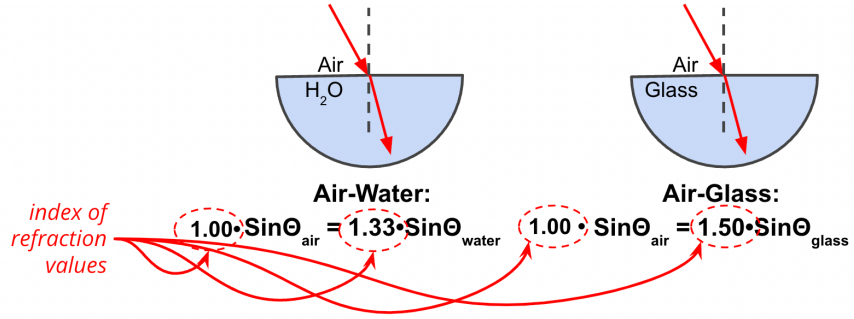


Air-Water:
$\mathbf{Sin\Theta_{air} = 1.33 \cdot Sin\Theta_{water}}$

Air-Glass:
$\mathbf{Sin\Theta_{air} = 1.50 \cdot Sin\Theta_{glass}}$

Snell's Law

One can draw generalizations from the lab data …



… to develop a law of refraction known as **Snell's Law**.

$$n_1 \cdot \sin\Theta_1 = n_2 \cdot \sin\Theta_2$$

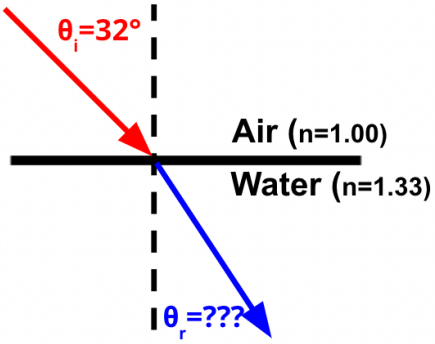
n_1 and n_2 represent index of refraction values

Θ_1 and Θ_2 are the angles of incidence and refraction

Approaching a Snell's Law Problem

The following strategy will be useful for solving Snell's Law problems.

- Acquire and record the numerical values for three unknown quantities:
  $n_{air} = 1.00$ $n_{water} = 1.33$ $\theta_{air} = 32°$
- Identify the unknown value: $\theta_{water} = ???$
- Construct a diagram of the situation.
- Substitute known values into the equation and solve for the unknown.
- Check the reasonability of your answer.



Utilize the above strategy and the instruction provided in the video to solve the following problems. Show your solution.

Snell's Law Example Problem 1

Light in water is incident on a surface with glass at an angle of 39°. The indices of refraction of water and glass are 1.33 and 1.52 respectively. Determine the angle of refraction.

Snell's Law Example Problem 2

A ray of light in glass (n=1.52) approaches the boundary at the angle shown. Calculate the angle of refraction.