## Reflection and Refraction *warm up*

1. When a beam of light moves from air into water it will bend toward the normal.

2. When a beam of light moves from the water into air, it will bend away from the normal.

3. Should a spear fisherman aim above or below a fish he is trying to stab? Why?
He should aim down, below where he sees the fish. Light is bending to make the fish look farther away from him.

4. Why is the spear fisherman in the lower picture jumping to stab the fish from above?
When he jumps, he can see straight down. Angle of incidence is 0, then angle of refraction is 0. Refraction only occurs when light hits at an angle.
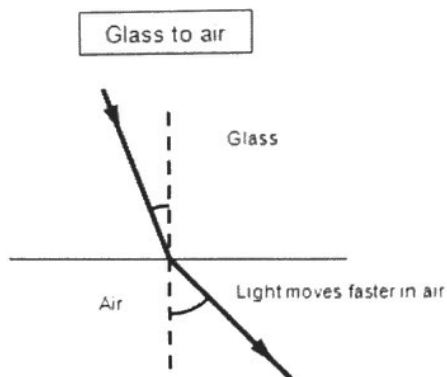
Notes:
The index of refraction is a ratio, a measure, of the speed of light, when it is not in a vacuum.

When the index of refraction is low on the top and higher on the bottom (air to water), the light will bend toward the normal.
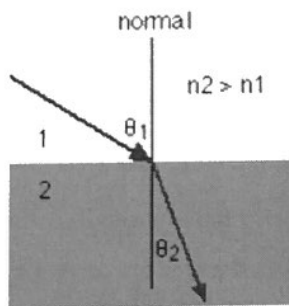
Snell's law : $n_1 \sin\theta_1 = n_2 \sin\theta_2$

When the index of refraction is greater on the top than it is on the bottom (glass to air), the light will bend away from the normal.

Snell's law $\boxed{n_1 \sin\theta_1 = n_2 \sin\theta_2}$ or $\boxed{\dfrac{n_1}{n_2} = \dfrac{\sin\theta_2}{\sin\theta_1}}$

n_1 – index of refraction of first medium

θ_1 - angle of incidence (before it enters next medium)

n_2 – index of refraction of second medium

θ_2 - angle of refraction (after it enters the second medium)

Critical angle- The angle where the light ray crosses the surface line and all the light bounces off of surface and none refracts.

Example of Snell's Law:

① If a beam of light is shined from air into glass($n = 1.5$), at an angle of 80°, at what angle will the light refract?

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

$1 \sin 80 = 1.5 \sin\theta_2$

$\dfrac{.985}{1.5} = \dfrac{1.5 \sin\theta_2}{1.5}$

$.657 = \sin\theta_2$

$\sin^{-1}(.657) = \theta_2$ $\boxed{\theta_2 = 41°}$

② A beam of light is shined from water into another material, the angle of incidence is 60° and angle of refraction is 70°, what is the index of refraction of the second material?

$\dfrac{n_1}{n_2} = \dfrac{\sin\theta_2}{\sin\theta_1}$ $\dfrac{1.33}{n_2} = \dfrac{\sin 70°}{\sin 60°}$

$\dfrac{1.33}{n_2} = 1.08$ $\boxed{n_2 = 1.2}$