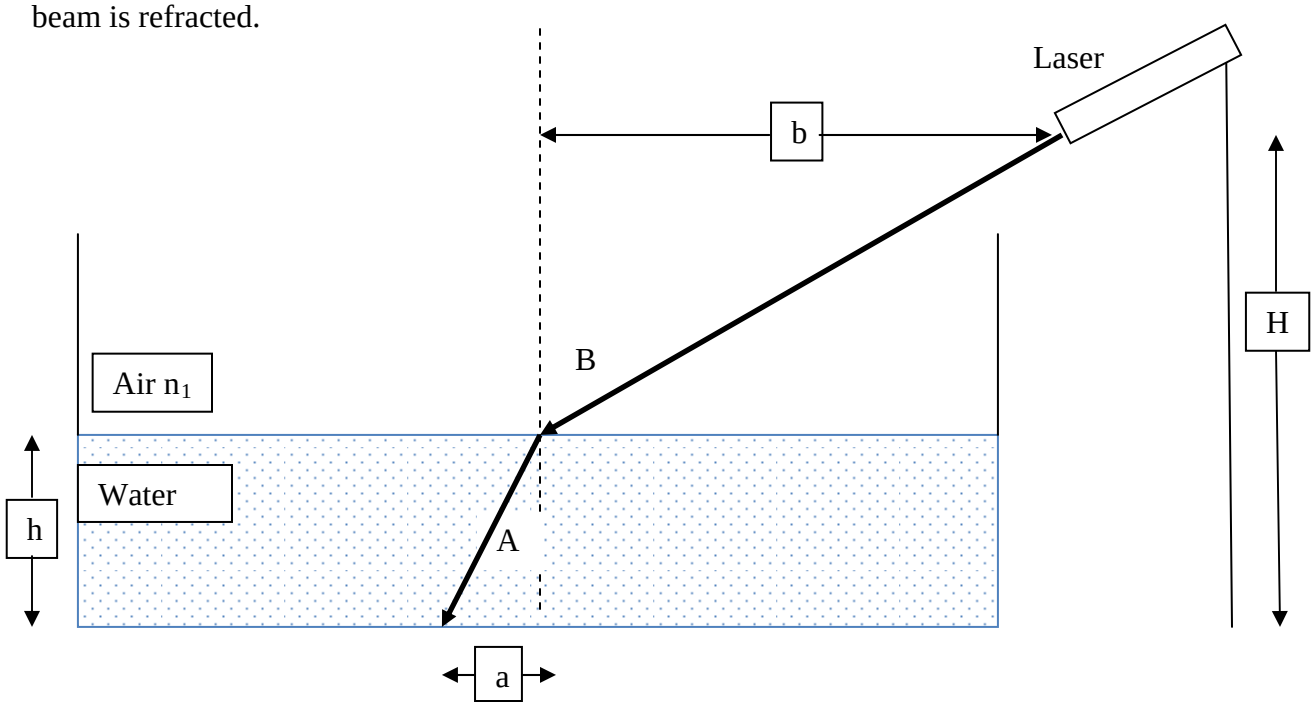
14 April 2009
Lablet 8
Optics-Measuring index of refraction of water

Reading in text
Ch. 18 Refraction of Light, pg. 359-362: Sections to read are *Index of Refraction*
Purpose
To determine the index of refraction for water
Materials
Plexiglass tank
Laser **BE SAFE! DO NOT POINT THE LASER AT SOMEONE'S EYE!**
Stand and clamps
Meter stick or measuring tape
Masking tape
Apparatus
Use the stand to clamp the laser so it is directed into the water in the tank, where the beam is refracted.



Key to above diagram:
A = refracted angle
B = incident angle
a = distance from normal to where beam hits the bottom of tank
b = distance from normal to where beam originates from laser
H = height of laser beam
H = height of water

Theory

When light enters into a medium with a higher index of refraction, the beam bends toward the normal. This is illustrated by Snell's law:

$$n_1 \sin B = n_2 \sin A$$

n_1 is the index of refraction in the original medium, which is air in this case. Air has an index of refraction very close to 1. n_2 is the index of refraction for medium 2, which is the water. In this lab we want to determine n_2. From Snell's law, we can solve for n_2.

$$n_2 = n_1 \times \frac{\sin B}{\sin A}$$

$$n_2 = \frac{\sin B}{\sin A}$$

This is with the substitution n_1 equals 1. That means we can find the index of refraction for water if we know Sin B and Sin A. We can find Sin B and Sin A by using trigonometry.

Remember that:

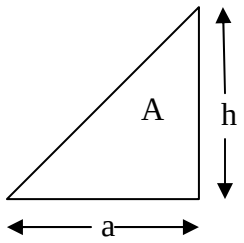
$$\text{Sin (angle)} = \frac{opposite}{hypotenuse}$$

Also we know the Pythagorean Theorem:

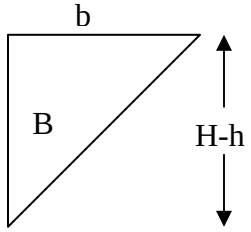
$$\text{Hypotenuse}^2 = \text{Opposite}^2 + \text{Adjacent}^2$$

$$\text{Hypotenuse} = \sqrt{(\text{Opp}^2 + \text{Adj}^2)}$$

There are 2 triangles in the diagram of the tank and laser.



$$\text{Sin A} = \frac{opposite}{hypotenuse} = \frac{a}{hypotenuse} = \frac{a}{\sqrt{a^2 + h^2}}$$



$$\text{Sin B} = \frac{opposite}{hypotenuse} = \frac{b}{hypotenuse} = \frac{b}{\sqrt{b^2 + (H-h)^2}}$$

Procedure

Laser Safety: Do not point the laser in anyone's eye. You can cause them to go blind. This laser is a scientific instrument, NOT a toy. Use it only in the manner described below, or it will be confiscated and you will receive a zero on this lab.

1. Assemble the apparatus as shown.
2. Mark the position of the tank and laser with masking tape so that you can reposition it if it is bumped out of place.
3. Fasten the laser to the stand, and point the laser into the water.
4. Measure the values of a, b, h and H and fill in the data chart. Make sure they are all measured using the same unit (i.e. centimeters).
5. Perform the calculations to fill in the remaining columns in the data chart.
6. Move the laser to a different angle, and repeat steps 4 and 5 for this new trial.
7. Try to finish five different angles.

Data

Trial	**a**	**h**	**Sin A** $\frac{a}{\sqrt{a^2+h^2}}$	**b**	**H**	**H-h**	**Sin B** $\frac{b}{\sqrt{b^2+(H-h)^2}}$	$\mathbf{n_2}$ $\frac{\sin B}{\sin A}$
1								
2								
3								
4								
5								

Calculations
Take an average of the 5 values you obtained for n_2 in the data chart.

Results
What is your result for the index of refraction of water?

Conclusion
The accepted value for the index of refraction of water is 1.33. Is your value similar to this? Why or why not?

How might you improve this experiment to improve your value for the index of refraction of water?

DUE TUESDAY 14 APRIL 2009 Turn in this lab worksheet.