LAB 9 REFRACTION-THE BENDING OF LIGHT by R.E. Tremblay

Purpose: To determine the index of refraction of glass, plastic and water.

Materials: Common pins, glass block, plastic block, small semi-circular water container, cardboard, protractor and ruler.

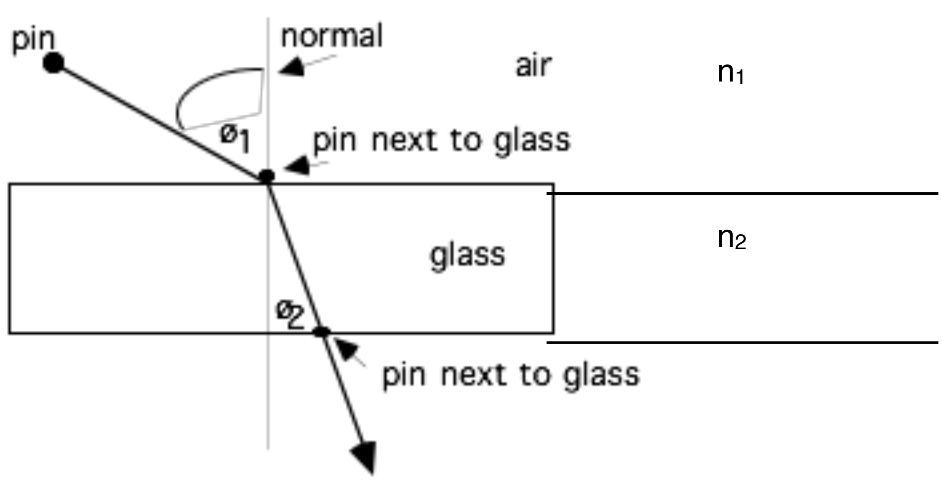
Discussion: The index of refraction of a medium is defined as: $n \equiv \frac{c}{v}$ where c is the speed of light in a vacuum. It is the fastest possible speed. v is the speed of light in the medium that it is traveling in. The index of refraction of a medium is usually between 1.00 and 2.42. When light moves from one medium to another, it often changes direction. If the two mediums have a different index of refraction and the light is at an angle from the perpendicular, light will change direction. This is called refraction. The angle of incidence, θ_1, and the angle of refraction, θ_2, by convention, are measured between the normal and the light ray. The **normal** is a line that is perpendicular to the interface between the two media. The angle of refraction, depends on only two things:

1. The angle of incidence (θ_1) and
2. The ratio of the indices of refraction ($\frac{n_2}{n_1}$) of the two media. The larger the ratio, the

more light will bend as it goes from one medium to the other. This relationship is summarized in Snell's law.

Snell's Law : $Sin\theta_1 n_1 = Sin\theta_2 n_2$

Figure 1



Angles θ_1 and θ_2 are always measured from the ray to the normal. The index of refraction of the substance that the light is coming from is labeled n_1. We will use air as our first substance and its index of refraction is 1.003. The value of the index of refraction of the second substance (n_2) is the thing that we are trying to determine.

The angle of refraction (θ_2) is measured from the penetrating ray to the normal. The only time that the light ray does not bend is when the angle of incidence is zero or the media have the same index of refraction.

If we solve Snell's law for n_2 we get: $n_2 = \frac{Sin\theta_1 n_1}{Sin\theta_2}$

We will use this fact to help us determine n_2, the index of refraction of the second medium.

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Name:________________________

Lab 9 preparation: Please complete the following exercise before coming to lab. Hand this page in, before the beginning of the lab.

1. What is the purpose of this lab?

2. What is the <u>definition</u> of index of refraction?

3. Draw and label Figure 1.

4. Write Snell's Law:

5. Solve Snell's Law for index of refraction.

6. Why can't the index of refraction of a medium be less than 1.000?

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Procedure:

1) Place the glass block on a piece of paper and trace its outline.

2) Draw a normal as in the diagram on the previous page.

3) Place a pin in the paper where the block and normal meet.

4) Place a second pin to the left of the normal and about 1 inch above the block.

5) Now look through the block from the other side and stick a pin in the paper(**next to the glass)**, that lines up with the other two pins when viewed through the glass.

6) Measure the angle of incidence and the angle of refraction with the protractor and go back to step 4 until you have seven different values for θ_1 and θ_2 .

7) Repeat this process for the plastic block and for the water.

8) Make a graph of $Sin\theta_1 n_1$ versus $Sin\theta_2$ for the glass, plastic and water. Draw a straight line through the data points of each medium. Put them all on the same piece of graph paper.

9) Take the slope of each graph. The slope will equal the index of refraction, n_2 of the material. Do you know why? For 1 point extra credit, attach a separate sheet explaining why the slope of the graph equals the index of refraction of the medium, n_2.

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LAB 9 Name________________ sect.___

Data sheet

Glass	θ_1	$Sin\theta_1$	θ_2	$Sin\theta_2$
1)				
2)				
3)				
4)				
5)				
6)				
7)				

slope__________

Plastic	θ_1	$Sin\theta_1$	θ_2	$Sin\theta_2$
1)				
2)				
3)				
4)				
5)				
6)				
7)				

slope__________

Water	θ_1	$Sin\theta_1$	θ_2	$Sin\theta_2$
1)				
2)				
3)				
4)				
5)				
6)				
7)				

slope__________