LAB 29, INDEX OF REFRACTION

Name _____ Period_____

The index of refraction of a substance is defined as the ratio of the speed of light in a vacuum to its speed in that substance. We measure the index of refraction by permitting light to travel from air into another medium.

Wiltebrord Snell provided a simple, direct method of measuring the index of refraction by defining it in terms of functions of the angle of incidence and the angle of refraction. The mathematical relationship, known as Snell's law, is

$$n = \frac{\sin i}{\sin r}$$

where **n** is the index of refraction, **i** the angle of incidence, and **r** the angle of refraction.

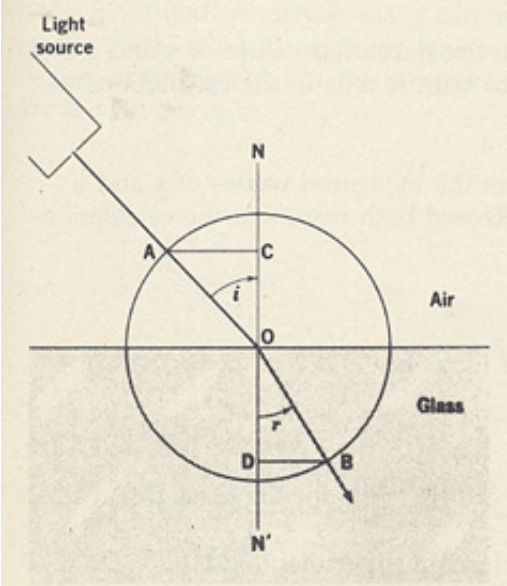

Figure 29-1

$$\sin i = \frac{AC}{AO} \text{ and } \sin r = \frac{DB}{OB}$$

Since AO and OB are radii of the same circle, they are equal. Therefore,

$$n = \frac{\sin i}{\sin r} = \frac{AC}{DB}$$

OBJECTIVE:

After completing this experiment, you should be able to determine the index of refraction of a refractive material by means of refracted light rays.

PROCEDURE:

1. Index of refraction of a plastic block:

Place the plastic block on the center of a sheet of paper and outline it with a pen. Place a point at the lower left-hand corner of the block, and label it point F, as in Figure 29-2.

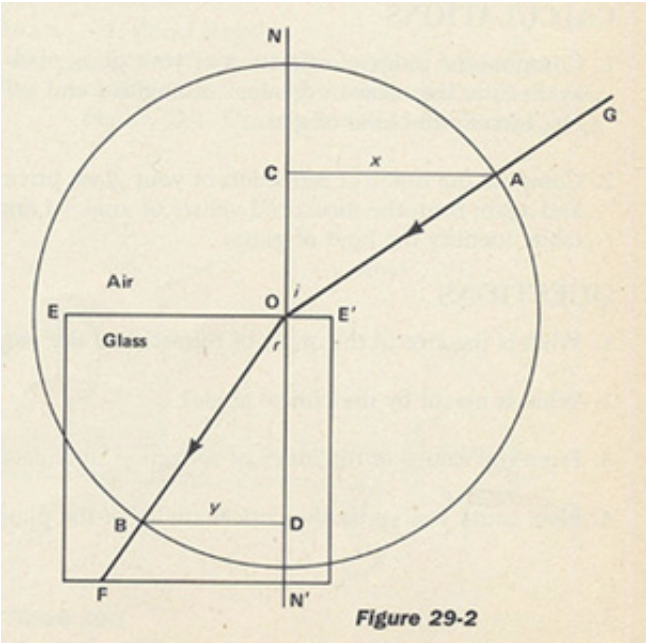

Figure 29-2

Put a point at the upper right-hand corner of the block, and label parts as shown in the diagram 29-2

At a point not less than 7 cm from pen 0, place a third pen G so that pens F, 0, and G are perfectly aligned as seen through the block. Keep the sighting eye near the level of the table top while positioning pen G.

Draw a line from G to O and from O to F. Draw the circle and draw a line from point B to point D, and a line from Point C to point A. Find x and y, and record it in the data table.

Avoid aligning the three pen points as seen above the plastic block.

SUGGESTION: Try locating the best final position of point **G** by holding it upright on the paper the appropriate distance beyond point **O** and approximately aligned with points **F** and **O** as viewed above the block.

Looking through the block along the sight line of pens **F** and **O**, slowly move pen **G** in a clockwise arc until it is observed to pass across the **FO** sight line.

Determine the final alignment point for pen **G** by moving it slowly back and forth across the **FO** sight line. Remove the block and join the points **F**, **0**, and **G** to represent the path of the light ray traveling from point **G** through air to point **O** and through the block to point **F**.

Label the incident ray and refracted ray.

From **O** construct the normal **NO** and **ON'** to the line **EE'**. Using as large a radius as possible (see Figure 29-2), describe a circle with point **O** as the center that intersects **OF**, **ON'**, **OG**, and **ON**.

From the point of intersection of the circle with the incident ray **OG**, draw a line **x** perpendicular to **ON**.

Measure the length of **x** to the nearest 0.01 cm and record it in the data table. From the point of intersection of the circle with the refracted ray **OF**, draw a line **y** perpendicular to the normal **ON'**. Measure the length of **y** to the nearest 0.01 cm and record its value.

Using a protractor, measure the angles of incidence **i**, and refraction **r** to the nearest 0.5^{o}. Record in the data table.

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2. Index of refraction of water:

Arrange the container of water on a separate sheet of paper and, using information gained in the previous trial, construct the diagram and label the angle of incidence **i** and the angle of refraction **r**. Also label the constructed perpendiculars **x** and **y**. Measure the lengths of **x** and **y** and the angles **i** and **r** to the same precision as in Part 1. Record all results in the data table.

DATA AND CALCULATIONS TABLES

DATA TABLE

TRIAL	x (cm)	y (cm)	∠i (°)	∠r (°)
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CALCULATIONS TABLE

Index of refraction $\frac{x}{y}$	Index of refraction $\frac{\sin i}{\sin r}$

CALCULATIONS:

1. Compute the index of refraction of the plastic block from the measured values of **x** and **y** and again from the measured values of angles **i** and **r**: Record both results in the calculations table.

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2. Compute the index of refraction of water from the measured values of **x** and **y** and again from the measured values of angles **i**. and **r**. Record both results in the calculations table.

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QUESTIONS:

1. What is the size of the angle of refraction if the angle of incidence is 0^o?

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2. Define the ***critical angle***.

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CRITIQUE: