Name **Section #**

Refraction of Light

To determine the speed of light in glass by investigating how light rays bend when passing through an air-glass boundary. The relationship between i, the angle of incidence and r, the angle of refraction will be explored. A graph will be plotted with the sine of i as the ordinate and the sine of r as the abscissa. The slope of the resulting graph, n_g will be used to determine the speed of the refracted ray.

Theory

When a ray of light passes obliquely from air into glass, the relationship between i and r is given by Snell's law as: $\frac{\sin i}{\sin r} = \frac{n_g}{n_a} = n_g$, where n_g is the index of refraction for glass. (n_a, the index of refraction for air being 1.00.) Once n_g is determined, v_g – the speed at which light travels through glass can be calculated as follows: $v_g = \frac{3.00 \times 10^8 \ \mathrm{m/s}}{n_g}$.

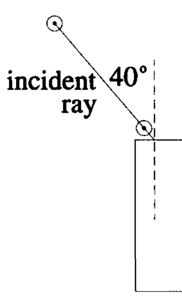


Figure I

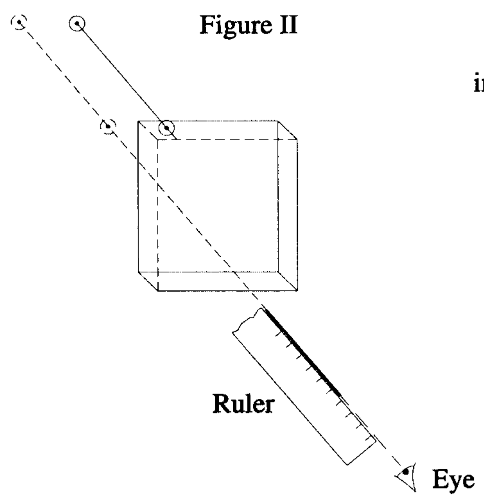


Figure II

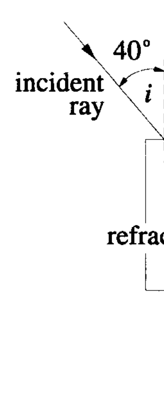


Figure III

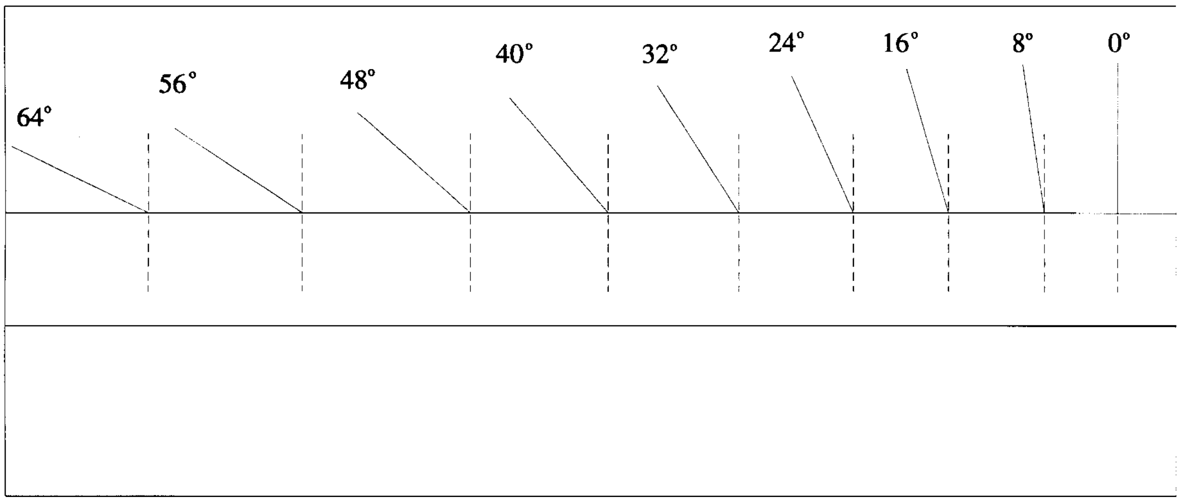
Procedure

Put a glass block in the middle of a sheet of paper and outline its shape. Remove the block and construct a perpendicular near the outline's upper left corner, then draw a line at an angle of 40° to the normal and label it as the "incident ray." Place two vertical pins on this line as shown in Figure I.

Place the glass block on its outline and then try to view the incident ray with its pins through the glass. Use a ruler and aim it in such a way that the line with its pins appear to be an extension of the ruler's edge. When the ruler is correctly aligned, draw a line along its edge. If done properly, this line will be parallel to the incident ray, and both pins will line up and appear as one pin when sighted along the ruler's edge and viewed through the glass. Note that in Figure II, the incident ray appears as if it were shifted to the left and seems to extend from the ruler.

Remove the glass block, extend the line drawn from the ruler to the outline's edge. This line will represent the emergent ray. Draw a third straight line (within the outline) connecting the incident and emergent rays. Label this third line as the "refracted ray." See Figure III. Measure the angle r between the normal and the refracted ray.

Repeat the above procedure for incident rays entering the glass at angles from zero to 64° in increments of 8°. You might want to prepare a data sheet similar to the one illustrated below. In this diagram, the distance between the two parallel lines is equal to the width of the glass block. Move the glass between the lines to obtain the refracted ray for each of the incident rays. Make sure that for every case, the block's sides are carefully aligned with (and touching) each of the parallel lines.



After completing the table below, make a graph plotting $\sin i$ as the ordinate versus $\sin r$ as the abscissa. Draw the straight line that best fits the plotted points. The slope of this line is the ratio of $\sin i$ to $\sin r$ and is therefore equal to n_g , the index of refraction of the glass block.

Angle of incidence i	0°	8°	16°	24°	32°	40°	48°	56°	64°
Angle of refraction r									
$\sin i$									
$\sin r$									

Questions

Record the value of the slope of your graph here. n_g = ______
Calculate the speed of light in the glass block.

Explain why the ray emerging from the glass block come out parallel to the incident ray.

As the angle of incidence increases in equal 8° intervals, does the angle of refraction also increase in equal intervals?

Determine from the relationship $n = \frac{\sin i}{\sin r}$, the highest value that r can have in the glass.

How can the technique of this experiment be used to determine whether any two different colors of light, such as red light and blue light, travel at the same speed in the glass?

Graph of $\sin i$ versus $\sin r$