PHY 1033C - Lab 9
Index of Refraction

Light in a vacuum travels approximately 300,000,000 m/s. Light in air travels at almost the same speed. However, when light goes from air to glass it slows down. The ratio of the speed of light in a vacuum to that in a substance is called the refractive index and is given the symbol n. We take $n = 1.000$ for air in most cases. In this lab, you will measure the index of refraction, n, of a block of glass and test Snell's law, which relates n to the angle of incidence and the angle of refraction. **Steps marked with an asterisk (*) are steps related to data which must be shared amongst the group, and so should be completed before lab time ends. Read each step completely before performing the step.**

*1. Place the large, solid block of glass in the corner outline on the data sheet. Now stick a pin right up to the top side of the block along the dashed line. This location will be referred to as pin 1. This pin remains in place throughout the experiment and should not be removed until all necessary data is gathered.

*2. Now place one pin at position 2a and a second pin on line 3 which is aligned with pin 2a and the image of pin 1. Put a small circle around pinhole 3a, label its location with an a and remove pins 2a and 3a. The locations of the three pins indicate the path of a ray of light which travels through the block of glass (pin 1 to 2a) and is then refracted when it enters the air (pin 2a to 3a).

*3. For each of the other pin 2 locations (b, c and d), another student from the group should repeat step 2 for their chosen pin 2 location.

*4. Remove the block of glass and all of the pins. Use a ruler to draw the light paths in the glass from pin 1 to pin 2 and the path in the air from pin 2 to pin 3 for each of the four cases. Extend the pin 1 to pin 2 line to the top of the data sheet, this will make it easier to measure θ_g.

*5. Now place a surface normal at each of the four pin 2 locations and measure θ_g (the angle in the glass) and θ_a (the angle in the air) while putting all of the data in a table. Include the sine of each angle that is measured as well in separate columns. Remember that these angles are measured from the normal of the glass/air interface. To summarize, your table should have columns for pin set (a,b,c, or d), θ_g, θ_a, $\sin\theta_g$, and $\sin\theta_a$.

Note: **All students in the group should write their name on the data sheet, and one student should tape the data sheet into their lab book.**

6. To analyze the data, make a graph in your lab book by plotting $\sin\theta_a$ along the vertical axis against $\sin\theta_g$ on the horizontal axis. Make the graph plenty **big** – a size of 20 squares by 20 squares will probably do. Do the points fall nearly on a straight line? If so, then draw in a single straight line which includes all of the points, to the extent that is possible. Find the slope, $\Delta Y/\Delta X$, of this line—this slope is the index of refraction of the glass, denoted n.

7. For a special value of θ_g, the refracted ray just skims the surface of the block of glass. In that case θ_a is 90°, and $\sin\theta_a$ is 1. From your graph, first find the value of $\sin\theta_g$ which corresponds to $\sin\theta_a$ = 1. Then find the corresponding angle, θ_g, by using the arcsine, or inverse sine, function. This is the critical angle for total internal reflection.

8. The expected index of refraction is $n = 1.50$ and the expected critical angle is 45.0°. Determine how close your estimations got to these values by computing the percent error for each.

$$\%\text{error} = \left|\frac{\text{expected} - \text{experimental}}{\text{expected}}\right| \times 100\%$$

As part of your conclusion, explain what feature(s) of your data support(s) Snell's law, which, for our experiment, says

$$n_g \sin\theta_g = n_a \sin\theta_a$$

where the g subscript refers to glass and the a subscript refers to air.