Lab 1

(Of course, at this point in your career, your professor does not need to remind you that every measurement must have an associated uncertainty and any number calculated from measured numbers must have this, so we won’t bother to remind you that here or in future labs.)

Please try to avoid getting fingerprints on the glass.

Mount the circular table onto the optical board using a mounting block (on the side of the room) so that it is about half way between the laser and the photodiode (check the heights to make sure it is not blocking the beam). Make sure the scale is facing towards you and that the two zero’s on the scale are aligned. Align the laser and the diode. Make sure the laser is not tilted by placing the glass plate into the slot so it is vertical. Look at the reflection of the laser beam back on the laser case. Make sure the reflection is not above or below the laser, but goes right back into it. We are going to be making beam profiles similar to those we made last week. How should the iris be set to get the best measurements?

We want to put the clear square plastic block into the slot and align it so that so that its sides are perpendicular to the beam direction. To do this, we need to make sure the reflection off the block goes right directly back into the laser opening (why does this mean the block is perpendicular to the laser beam?) Put the block into the slot. To adjust the position, note that on the RHS on the table is the fine adjustment and the LHS is the coarse. Start with the coarse and then perfect the direction afterwards with the fine adjust. If you do not know how to use a vernier scale, please look at: http://www.phys.hawaii.edu/~teb/java/ntnujava/ruler/vernier.html

Rotate the table by 10 degrees. Now scan the photodiode across the beam (think about this! How many measurements will you make during this entire lab? What do you want to measure? Where should you stop and start the scan to do this most accurately?) and measure the distance d. From that, calculate the angle of refraction. Using your measurement, calculate n. Is it what you expect? Take similar measurements for 5 different angles rotating clockwise and another set of 5 angles rotating counter-clockwise. (and of course we don’t need to tell you to save the raw data from each scan to a file on disk so you can retrieve it later.) Make a plot of the sine of the angle of refraction versus the sine of the angle of incidence using these 10 data points, and use this to determine the index of refraction for the block.
**Total Internal Reflection:** If light is propagating from medium with $n_1$ to $n_2$ and $n_1 > n_2$, Snell’s Law no longer has a solution for incidence angles greater than the critical angle, where the angle of refraction is 90 deg. For larger angles, no light is transmitted - it is all totally internally reflected. The critical angle is given by

$$\theta_c = \sin^{-1} \frac{n_2}{n_1}.$$ 

On the side of the room is a metal circular holder for the acrylic semi-circle, that can be mounted on top of the slotted holder on your rotating stand. Place the semicircular optical block onto it so that its outer arc is concentric with the motor shaft/stage axis of rotation. Make sure the laser is aimed directly along the radial direction. Get the screen that is mounted on a post to use to view the refracted light (we will not use the photodiode in this section.) Alignment is the key to this part of the experiment! Be careful and precise! Why use a semi-circle, and not the square block from the previous experiment? What index of refraction does this $\theta_c$ correspond to? Do the same thing rotating in the opposite direction. Do you get the same value of $\theta_c$? Do the results agree within uncertainties?