PHSX 222L **Refraction and Snell's Law** **Name:**_____

Object: To measure the index of refraction for (a) water, (b) a liquid organic compound, (c) a plexiglass or glass block, and (d) a glass prism.

Theory: When a light ray crosses the interface between two transparent media it bends, or changes direction, according to a relationship known as Snell's Law (Decartes' Law in France).

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \tag{1}$$

where n is the index of refraction and θ is the angle from the normal. Snell's Law can be derived from Fermat's principle of least time. (The index of refraction is actually a function of the frequency of the light, which gives rise to the phenomenon of dispersion.)

Procedure:

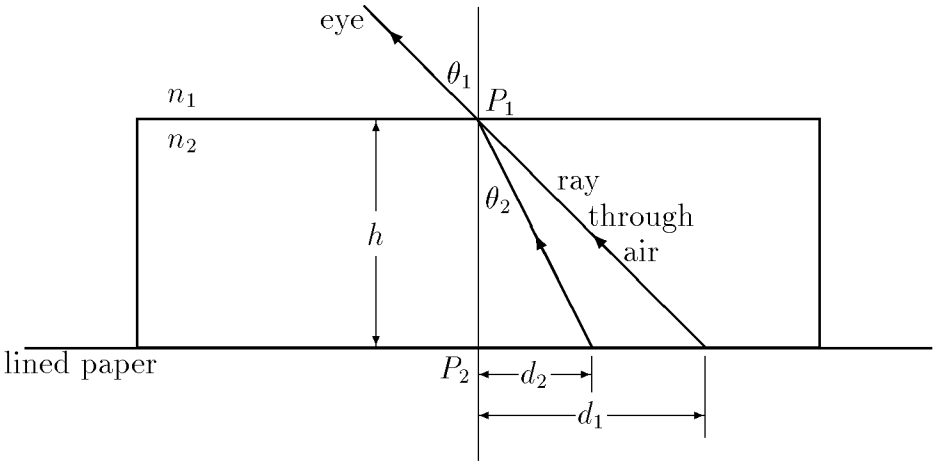
For the liquids:

1. The index of refraction for the two liquids will be measured by placing them in a tank, attached to which is a scale for measuring the incident angle and the refracted angle. This is done by filling the tank half-way and lining up the sights through the liquid and then again above the liquid in the air.

2. Draw a diagram of the apparatus and illustrate the angles measured and used in Snell's Law. It may seem that θ_1 and θ_2 are reversed until you think this through very carefully.

For the plexiglass or glass block:

1. The index of refraction for a slab of plexiglass will be measured by placing it on a sheet of lined paper or a flat ruler and observing the images of the lines produced by refraction and measuring the apparent displacement of this image. First nondestructively (with a non-permanent marker or pen) make a mark on the top of the block at point P_1 and line it up vertically with a line on the paper at P_2. Then move your eye to the position labeled eye and look simultaneously through the block at another line on the paper and through the air right next to the block. d_2 is the actual distance from the second line to P_2, and d_1 is where the line *appeared* to be.



2. Verify that the mathematical derivation of n_2 is given by

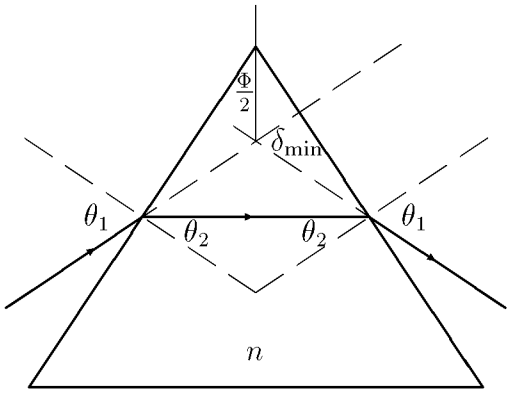
$$n_2 = n_1 \frac{\sin(\arctan \frac{d_1}{h})}{\sin(\arctan \frac{d_2}{h})}. \tag{2}$$

For the glass prism:

1. Use the method of minimum deviation on an equilateral prism. Adjust both the rotating platform and the telescope of the spectrometer until a minimum deviation is achieved. Minimum deviation occurs when θ_1 on the left face is equal to θ_1 on the right face (the ray inside the prism will then be parallel to the base). Equation 3 for n is only valid at minimum deviation.

2. Measure n for a couple of different wavelengths of light. As shown in Example 35.7 in Serway,

$$n = \frac{\sin(\frac{\Phi + \delta_{\text{min}}}{2})}{\sin(\Phi/2)}. \tag{3}$$



Conclusions:

1. Compare the indices of refration as measured above with the standard handbook values.

2. Discuss sources of error in each case. What clever things did you do to reduce your error and to determine its size?