Lab 1
Reflection and refraction

The simplest way to set up an optics lab is to buy a complete kit, for example the PASCO Basic Optics System (PASCO, http://www.pasco.com/home.html, catalog number OS-8515C).

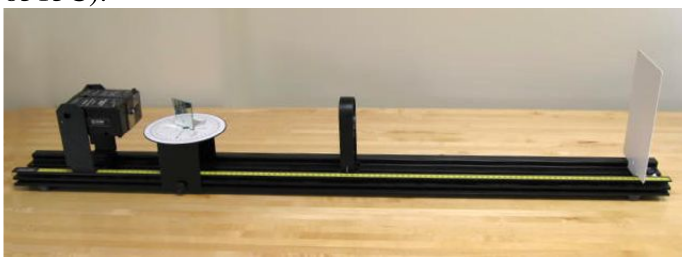

Fig. 1

This comprises a 120 cm long optical bench, a light source, a ray table with goniometer (white disc in Figure 1), a screen, lenses, mirrors, prisms, a D-shaped lens, etc. The lamp is really weak, so the room should be darkened.

The Law of Reflection can immediately be verified, quantitatively, using the ray table and a mirror, as shown in Figure 2.

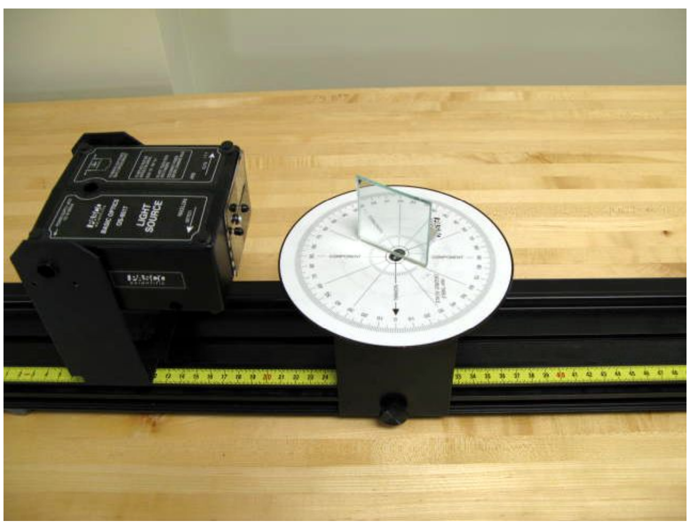

Fig. 2

This experiment is really fun! How tall does a mirror need to be to image your entire body? Most students are surprised to see that the answer does not depend on the distance. One student can apply duct tape or a post-it on top and bottom of the image of another student. Walking towards and away from the mirror does not change the image size.

Figure 3 shows this explicitly.

Fig. 3

The position of the virtual image behind a semi-reflective mirror can be measured accurately. Use two identical objects one in front and one behind the mirror. When the image and the real object (seen through the mirror) seem to coincide, leave them in place, and measure their distance from the mirror. The distances will be identical, as shown in Figure 4.

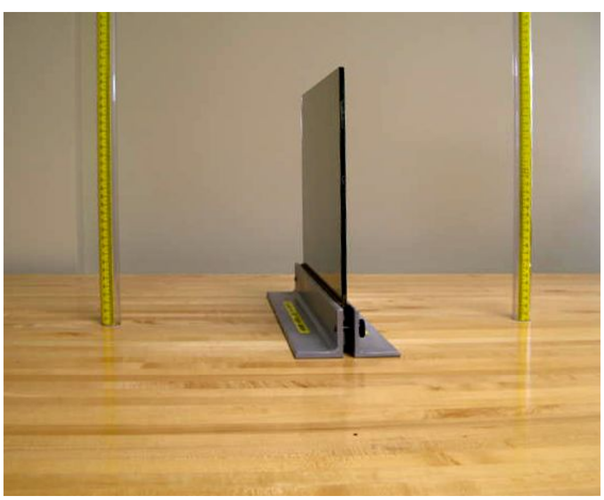

Fig. 4

Snell's Law can immediately be measured quantitatively using the D-shaped lens on the ray table (Figure 5), and reporting many different incidence and refraction angles into a table. Rotating the ray table by 180°, the student can then find that inverting the light path all angles are reproducible. However, there is a limit, and that is the critical angle. The student can accurately determine the critical angle for the acrylic lens.

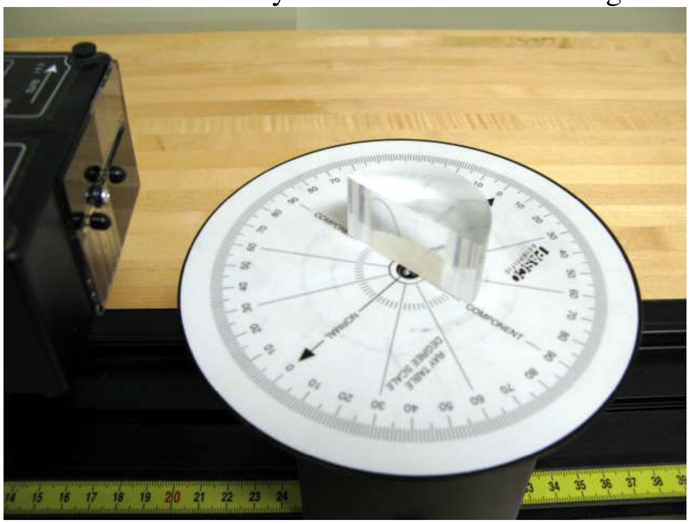

Fig. 5

Dispersion upon refraction is displayed using the same D-shape lens. Let the light ray enter through the curved surface, and rotate the ray table until the refraction angle is almost 90°. The refracted beam shows the colors of the rainbow. They are dim, however, therefore projecting them onto a hand-held piece of white paper, placed very near the refracting flat surface is very helpful. Figure 6 shows how to position the D-shape lens.

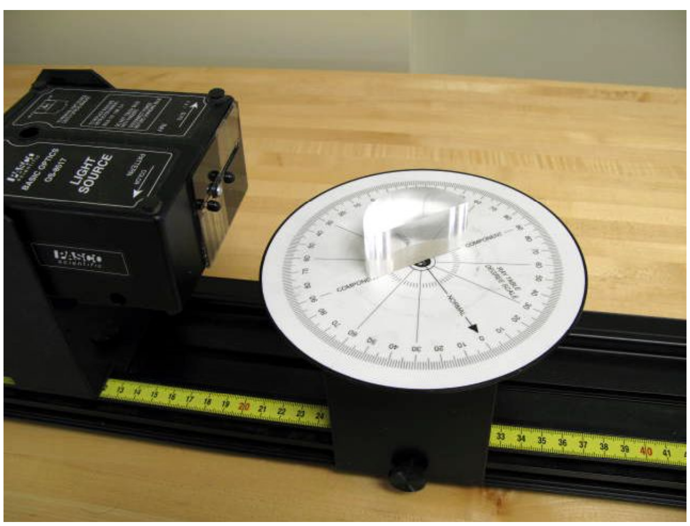

Fig. 6

Polarization by reflection

Look at a table lamp reflected by a glass surface, as shown in Figure 7. Look through a polarizer filter and slowly rotate it. At one particular position of the polarizer, horizontal, you see a much dimmer reflection. Now move your head and the polarizer up and down, and move the position of the lamp closer and farther from the glass pane until you find the angle at which you do not see the reflected light at all. This is the Brewster angle. In Figure 7, on the left, the photograph is taken with the horizontal polarizer at the Brewster angle. The right photograph is taken in the exact same position with the vertical polarizer. This experiment is much more striking in reality when you rotate the polarizer by hand in front of your eye.

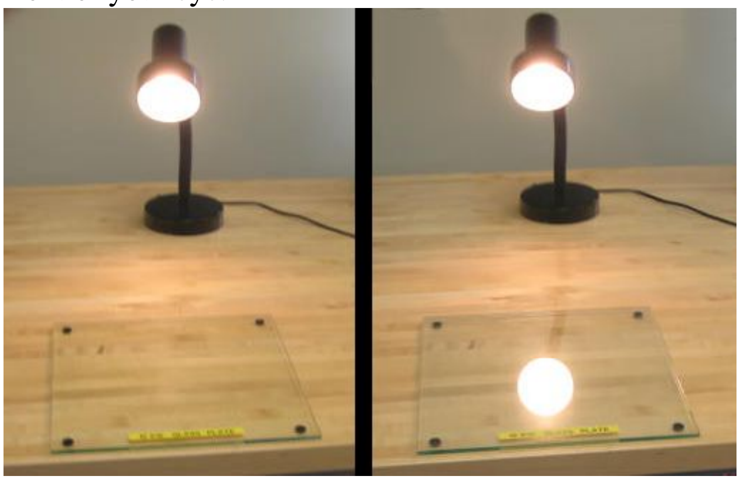

Fig. 7