Chapter 1: Index of Refraction of Glass

Overview:

In this experiment we will examine the refraction of light through glass lenses ("geometrical optics"). We will determine the index of refraction of the glass, and use this to compute the speed of light in glass.

Suggested Reading Assignment:

The section on refraction of light in the chapter about "Electromagnetic Waves", and the sections on lenses in the chapter about "Images"

E.g., Section 34-7, and Sections 35-5 through 35-8 of Halliday, Resnick, and Walker, 6th edition.

Pre-lab Questions:

1. How are focal length f, image distance d_i, and object distance d_o related? When is each negative? Contrast f for concave lenses with convex lenses. Which is converging? How does a "virtual image" differ from a "real image"?
2. What is the Lensmaker's equation? When is either radius of curvature negative?
3. For a typical ray diagram, there are an infinite number of rays that *could* be drawn, but we typically only draw three of them. Describe these three rays.
4. There are three possible configurations for both types of lens, depending on where the object is placed relative to the focal point (i.e., in front of, at, or behind the focal point). Draw a ray diagram to scale for each of the six cases. Note that "to scale" means "proportionally correct", rather than "life size". Choose numeric values for the focal length, object height, and object distance for each case and determine:
   a) whether the image is real or virtual,
   b) the magnification of the image, and
   c) whether the image is upright or inverted.

   Compare the measurements of your scale drawings with the computed predictions of the thin lens equation. How can the magnification m be determined from d_o and d_i?
5. An object of height h = 6cm is located at x_{o1} = 5cm. A lens (f_1 = +10cm) is located at x_{L1} = 30cm. A second lens (f_2 = –15cm) is located at x_{L2} = 40cm. The image of the first lens is the object for the second. Find: d_{o1}, d_{i1}, x_{i1}, x_{o2}, d_{o2}, d_{i2}, x_{i2}, m_1, m_2, and m_{total}. Draw a ray diagram to scale for this problem.
6. What is the smallest possible value for the index of refraction? What is the index of refraction for air? For water? For an ordinary glass?
7. What is the value for the speed of light in vacuum? What is the relationship between the speed of light and the index of refraction? When can the speed of light *in the medium* be exceeded (see "Cerenkov Effect")? In this case, how does the speed of the particle compare to the speed of light in vacuum?