Investigating Lenses & Geometric Optics

Broad Scientific Objectives

- Take experimental properties of a system to determine other properties
- Verify theoretical results from other scientists
- Leverage this theory to determine properties that are not directly observable

Specific Objectives & Experimental Setup

For this lab, you will use the definition of the focal length from recitation in an attempt to experimentally find the focal lengths of 4 lenses. Then, confirm the thin lens equation for the lenses whose focal lengths you have found. Finally, you will design and execute an experiment to determine the focal lengths of any unknown lenses from the first two parts.

For the materials, at each lab station, there is an optics track with four (4) lenses of unknown focal length.

- Optics track with a meter measuring tape on it,
- Four (unknown) lenses, and
- Light source with an object built-in.

Please take care to handle the lenses by the black frame and *do not put your fingers on the lenses*.

In this lab, we have several goals, and are bringing everything full circle from experimental determination, matching to theory, as well as utilizing that theoretical result to calculate other unknown quantities.

Experimentally Determining Focal Lengths

Earlier in this course, we defined the focal length as the distance from the center of a thin lens to the focus, the point at which parallel incoming rays would converge. Devise a method to measure (approximately) the focal length of the lenses at your station. Feel free to confer with your classmates (even outside your group). **Don't forget to account for uncertainties in this measurement.**

Confirming the Thin-Lens Equation

Not all incoming light is parallel. If the light isn't parallel, where will the image be formed? For a thin lens, physicists have predicted that the relationship between the focal length f, object distance d_o, and image distance d_i is given by

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}.$$

Does this equation hold true within experimental uncertainty? Why or why not? Note that the left hand side is something that you have measured, and as a theoretical prediction, the right hand side should agree.

Determining Unmeasured Focal Lengths

If you have any unknown focal lengths in your system, devise a way to calculate the focal length indirectly using the optics bench. How did you determine the initial focal lengths of the lenses? Why do you think the unknown lens' focal length can't be found the same way? Using the first two tasks, design and execute an experiment to determine the last focal length.

Biological Significance

For our purposes, the basic physics is not all that we are concerned with. We saw in Phys 233 that just like how we use calculus to abstract a real-world problem into a mathematical context, we can abstract from a biological or chemical situation into a "basic picture" of a physics problem. Working back the other direction, for both devices, detail possible biological and/or chemical systems wherein the physics from today is relevant. What system are you modeling? From the data you've gathered and analysis you've performed, what is the implication in the system that you believe is modeled by this?