

# USING OPTICS TO STUDY INVERSE RELATIONSHIPS

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## Introduction and Basics

Tonight in class we will investigate how lenses form images and study the mathematical relationships between the nature of the lens. As the accompanying handout shows, converging lenses will bend (refract) light to form an image. Each lens has a characteristic *focal length*; the focal length is the distance from the lens where an image will form of an object that is very far away from the lens. As you move the object closer to lens, the position of the image will also change.

Tonight, we will do investigations with a few lenses and sources, and study the relationship between the distance of the object from the lens and the distance at which the image is formed.

Before we get started, let's go over a few terms and some lab tips for the evening. The distance of the object from the lens is the *object distance*. The distance between the lens and where a sharp image forms is called the *image distance*. Tonight we will be working only with converging lenses; if the image forms on the *opposite* side of the lens from the object, then we regard both the object and image distance as positive numbers. If the image forms on the same side as the object, then we consider the the object distance as a positive number and the image distance as a negative number.

We will be working with some fragile optical equipment tonight, so I want to go over some guidelines to make sure we do not destroy or damage any equipment.

First, never touch the lens surfaces with your fingers. Always hold lenses at the edges. And of course, never drop them.

I will show you tonight how to mount the light sources on the tracks; do not force them as they will break apart if you do so. I will also show you how to mount lenses in the lens holders; tighten the holding screws enough so that the lenses are held in place, but not so tightly that the lenses experience significant stress.

Once you have the light source, lens, and screen mounted on the metal tracks, adjust your focal and image distances by moving the lens and the screen as needed; once the light source is mounted, let it remain in place as it is typically the most difficult to move along the tracks.

## Investigations

First, choose a lens and mount it in the lensholder. Mount this to the track along with a light source and screen. With the light source on, move, maneuver the lens holder and screen so that you form an image on the screen (with the screen on the opposite side of the lens from the object). Record the object and image distances for your lens, which you should refer to as lens 1. Now, slowly move the lens away from the light source by a few cm. Is your image still in focus? Move your screen until an image re-emerges. As the object distance increased, did the image distance increase or decrease?

Now, for several different object distances, record the image distance for lens 1. Is there an object distance for which you cannot get a focused image on the opposite side of the screen. Record the largest object distance at which this occurs.

If time permits, carefully put away lens 1 and mount a second lens (lens 2). Take the same series of data for object and image distance.

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## Data and Graphs

For Wed., March 18 (after spring break) turn in your recorded data for lens 1 (and also lens 2 if you were able to make those observations). Also, make a graph of  $(1/\text{object distance})$  vs.  $(1/\text{image distance})$ . This means that the values of  $(1/\text{object distance})$  are plotted on the vertical axis, and  $(1/\text{image distance})$  are plotted on the horizontal axis. Make a copy of both your data and graphs, as we will discuss them in class on the 18th.

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## Format for Submitting Homework :

Starting with this homework set, the following guidelines must be followed for submitting homework :

1. All homeworks must be stapled in the upper right hand corner (staples, not paperclips, rubber bands, or the corner of the paper folded over).
2. Your name must be written on each sheet you submit.
3. Write only on one side of each sheet.
4. Homeworks need not be typed, but must be legible.

I will deduct 15% from any assignments not adhering to these guidelines.