PHY 157
Geometrical Optics
(Experiment 11)

Names of Group Members: _____

1 Introduction

In this lab you will observe the image formed by a lens and determine the focal length of the lens. A lighted object, mounted on an optical bench, will be used to send light toward an optical surface (a lens). The image formed by the lens will be focused on a screen. The object distance and image distance are easily read from a meter scale on the optical bench. The focal length of the lens will be determined using the data and the lens formula.

2 Apparatus

- Optical bench
- Lens holder
- Level
- Lighted object
- Screens and holder
- Lens (+15 cm)

- cm ruler
- Night light
- Meter stick

Note: The optical bench has four component mounts along its length. Since you will use only three mounts, you can either remove the extra mount or push it to one end of the track. Be sure to mount all components along the *same axis* at the *same height* above the bench. Replace the mounts when you have finished your experimental work. There is not a separate analysis section for this experiment. Work together on this experiment and submit a single report from your group.

3 Procedure 1 - Quick Determination of Focal Length.

The optical bench is not needed for this part of the experiment. Recall that the focal point is defined to be the *image position for an object at infinity.* For most practical purposes, infinity is just a few meters from a mirror or lens. We will turn off the room lights and you can use the doorway for the distant object. By focusing an image of the doorway on the screen, the approximate focal length (distance from screen to optical surface) can be measured quickly, as explained below.

1. Take the +15 cm lens and the screen without the hole to a position across the room from the open doorway. Place the lens in a lens holder and focus the image of the doorway onto the screen.

2. While holding the lens and screen steady with the image focused sharply on the screen, let your partners use a meter stick to make an approximate measurement of the focal length f of the lens. Record the result below.

   f = _____

4 Procedure 2 - Image Formation by a Converging Lens.

1. *Set Up.* Carefully place the lens in the lens holder and mount it at $x = 50$ cm and mount the lighted object at the left end of the bench at approximately $x = 0$ cm. The rays from the lighted object travel to your right toward the lens, are refracted by the lens, and continue to travel to your right. Place the screen just behind the lens and move it until you obtain a sharp image of the lighted object.

2. *Focal Length.* Use the following table to record your data:

Object distance d_o (cm)	Image distance d_i (cm)	Image height h_i (cm)	Exp. Magnification M	Focal length f (cm)

Measure the object height and record it here:

h_o = _____

(a) Move the object to a position which results in an image *smaller* than the object. Record the object distance d_o (distance from the object to the lens), image distance d_i (distance from the image to the lens), and image height h_i in the table. Compute a value for the experimental magnification ($M = h_i / h_o$) and record it in the table.

(b) Move the object to a position which results in an image *larger* than the object, repeat the above measurements, and record the results in the table.

(c) Determine the focal length f of the lens for each case using the formula

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

Record your results in the table above. Do your results agree with the earlier quick determination of the focal length?