Physics 11-04 Meter Stick Optics Lab — *Name:* ______________

Objective:

- Understand images with lenses.

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.

Materials:

- 1 Meter stick
- 1 Optics System such as https://www.arborsci.com/products/introductory-optics-set
  - 1 Lens holder
  - 1 Object
  - 1 Screen
  - 1 Convex Lens
- Light (provide your own from the window or phone flashlight)

Note: Be sure to mount all components along the *same axis* at the *same height* above the bench.

Part 1: Quick Determination of Focal Length

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 or window for the distant object. By focusing an image of the doorway or window on the screen, the approximate focal length (distance from screen to optical surface) can be measured quickly, as explained below.

1. Take the lens and the screen to a position across the room from the window. Place the lens in a lens holder and focus the image of the window 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 = ____________________

Part 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 object at the left end of the bench at approximately x = 0 cm. The rays from the light travel from your object 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.
2. *Focal Length.* Use the following table to record your data:

d_o (cm)	d_i (cm)	h_i (cm)	m	f (cm)

3. *Magnification.* 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 ($m = \frac{h_i}{h_o}$) 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) Move the object to two other positions and record the results in the table.

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

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

Analysis:

1. As the object moved closer to the lens, what happened to the image distance?

2. As the object moved closer to the lens, what happened to the magnification?

3. As the object moved closer to the lens, what happened to the focal length?

4. Find the average focal length.

5. Find the percent difference for the average focal length compared to the focal length found in Part 1.

$$\%diff = \frac{experiment - standard}{standard} \times 100\%$$