Properties of Concave Lenses

Prof. Jordan C. Hanson

December 1, 2023

1 Introduction

In this activity, we will verify the *thin lens equations*:

$$\frac{1}{d_\mathrm{o}} + \frac{1}{d_\mathrm{i}} = \frac{1}{f} \tag{1}$$

$$m = \frac{h_\mathrm{i}}{h_\mathrm{o}} = -\frac{d_\mathrm{i}}{d_\mathrm{o}} \tag{2}$$

In Eq. 1, d_o is the distance between the object and the lens origin, and d_i is the distance to the image. In this lab activity, we will use a concave lens with a focal length f that produces real images. The parameter m is called the magnification, representing the ratio of image height h_i to object height h_o.

We will verify Eq. 1 by varying d_o with respect to the lens origin and measuring d_i. The value of d_i corresponds to the distance from lens origin at which the real image is in focus. The focal length f is a constant in this experiment. Thus, the only measurement required to verify Eq. 1 is d_i. To verify Eq. 2, we will confirm two facts. First, we will confirm that the focused image is inverted and that $d_\mathrm{i} > 0$, which will justify the minus sign in Eq. 2. Second, we will measure m geometrically, and verify that this matches $d_\mathrm{i}/d_\mathrm{o}$.

2 Experimental Setup

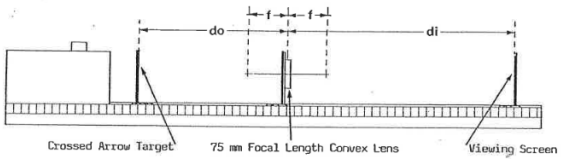

Figure 1: A diagram of the setup.

The procedure depicted in Fig. 1 should produce results that verify Eqs. 1 and 2. Check that you have the following items at your table:

- Optics bench
- Light source
- Magnetic object holder with crossed-arrow target
- Magnetic object holder with concave lens ($f = 75$ mm or $f = 150$ mm)
- Magnetic object holder with viewing screen
- Meter stick

Place the light source as far as possible at one end of the optics bench. Plus the crossed arrow target in front of the light source using the magnetic holder. Using another magnetic holder, place the concave lens more than one focal length away from the target. The designed focal length is written on the lens, and we will verify this constant with our measurements. Finally, place the viewing screen more than one focal length from the lens origin, using a magnetic holder. Plug in the light source, and turn it on. Adjust the primary ray direction with the knob on the top of the light source as necessary. Move the viewing screen forwards and backwards until a focused image forms on it.