Experiment 2

Geometrical Optics

1 Introduction

In this experiment, we will continue to explore geometrical optics by studying the optics of simple curved mirrors and lenses.

2 Background *see Hecht, Chap. 5, Pedrotti, Chap. 3 and 18*

When studying the geometrical optics of mirrors or lenses one considers the following three quantities: object distance s_o, image distance s_i, and focal length f. These quantities are related by the equation

$$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f} \tag{1}$$

There is a convention to be followed in the definition of these quantities. For lenses, a converging lens (convex) has $f > 0$ while a diverging lens (concave) has $f < 0$. For mirrors, $f > 0$ for concave mirrors, and $f < 0$ for convex mirrors. Also by convention, we place the object to the left of the lens, with $s_o > 0$. If $s_i > 0$, it is on the right of the lens and is a *real* image. If $s_i < 0$ it is to the left of the lens (same side as object) and is a *virtual* image. One can consider the mirror as a folded over version of the lens: s_o is positive and on the left, but now a $s_i > 0$ is on the left (the opposite of the lens) and $s_i < 0$ is on the right, behind the mirror, and a virtual image.

The focal length of a mirror is simply $f = R/2$, and the focal length of a thin lens is given by

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right), \tag{2}$$

where n is the index of refraction, and R_i are the radii of curvature of the two surfaces.

3 Experiment

You are supplied with a concave mirror, two positive lenses and one negative lens. Your challenge is to find the focal lengths of the optics as accurately as possible.

A first start is to use an object at infinity (or close to it). The windows in the hallway are a good place to start.

You have available the laser as a source of rays to do ray tracing. Think about what happens to the rays as they pass through a lens, or bounce off a mirror.

Using two (or more) optics, build a compound lens device, and measure its properties.