Physics 1 Lab: Images of Converging Lenses

Introduction: Concave mirrors and convex lenses cause incident rays of light parallel to the principal axis to converge on a point called the principal focus. These mirrors and lenses may form different types and sizes of images, depending on the distance of the object from the mirror or lens. The mathematical relationship between the focal length (f) of the mirror or lens and the distance of the object (d_o) and image (d_i) from the mirror or lens can be expressed in the equation: $1/f = 1/d_i + 1/d_o$ or, using the x^{-1} key on the calculator, $f = [(d_i)^{-1} + (d_o)^{-1}]^{-1}$ In this lab we will examine the relationship between the object, the image, and a converging lens.
Purpose: The purpose of this lab is to investigate images formed by converging light created by converging lenses and to verify the optics equation.
Materials: Converging lens, lens holders, metric ruler, dynamics track (used as optics bench), image screen
Procedure:

- Record the focal length of the converging (convex) lens.
- Measure the height of the object (the opening on the light source where the light comes out) and record.
- Set up a dynamics track with the light source, lens holder with lens and image screen.
- Image #1: Place the light source (light bulb in a box) at a convenient point close to one end of the track. Record its position using the scale on the dynamics track. Place the lens so that its distance to the light source is greater than twice the focal length of the lens. Move the image screen until a sharp image is formed. Record the type of image, and the locations of the lens and image. Measure the height of the image and record.
- Image #2: Leave the light source at its original location. Move the lens to exactly twice the focal length from the light source. Move the image screen until a sharp image is formed. Record the image type, location of the lens and image screen and image height.
- Image #3: Move the lens to a distance slightly less than two focal lengths from the light source (but greater than one focal length). Locate the image point by moving the screen until a sharp image forms. Record image type, locations and image height. If the lens to light source distance is only slightly larger than the focal length of the lens, the image will form very far away and too dim to see.
- Image #4: Move the lens to a distance less than one focal length from the light source. Try to find a sharply focused image on the screen. If a sharp image does not form on the screen, look through the lens towards the light source and record your observations of height and location. In this case, it is difficult to measure the image location. Estimate the position by comparing the image position to the object position by looking through the lens and then off to the side of the lens. Estimate the height of the image by standing a ruler off to the side. Record the image type.
- Replace the lens with the converging mirror. Adjust the mirror holder so that the mirror is set at an angle to the incoming light and the reflection is off to the side of the track. Move the mirror through the same positions you used with the lens (using the focal length of the mirror.) Hold the image screen in your hand and verify that the same images can be formed using the mirror as you saw with the lens.
- Restore your work area to its original condition.

Data:

Lens focal length _____ Object Height _____

Data Table

Image #	Source location (cm)	Lens location (cm)	Image location (cm)	Image height (cm)	Image type
1.					
2.					
3.					
4.					

Calculations Table

Image	Object distance	Image distance	$[(d_i)^{-1} + (d_o)^{-1}]^{-1}$	Percent error	d_o/ d_i	h_o/h_i
1.						
2.						
3.						
4.						

- Calculate object distance and image distance for each image and record.
- For each images 1 - 3, calculate $[(d_i)^{-1} + (d_o)^{-1}]^{-1}$ and compare to the focal length of the lens by finding the percent error.
- For the same 3 images, find the ratios d_o/ d_i and h_o/h and compare. What do you conclude?

- Discuss two possible sources of error. "Human error" is not acceptable.