Group Members:

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Lenses and Telescopes

In this lab, you will examine the properties of lenses that allow them to form images. At the end of the activity, you will construct a simple telescope on an optical bench.

Background information

At the beginning of the activity, your instructor will set up a demonstration showing how a lens forms an image. Based on the demonstration, draw a sketch showing the path of light rays through a lens to form an in focus image.

Preliminary Setup:

Steps to get an in focus image with your lens:

- When you come to the lab, you will find an apparatus called an optical bench set up with four movable slides. You will also find two lens holders, a cardboard or glass screen, an "object" arrow and a light. These all fit into the slides. To move the slides, loosen the thumbscrews that lock them into position.
- Set up the optical bench with the lens holder near the middle and the screen on one end. Place the lamp at the opposite end of the optical bench with the "object" arrow immediately next to it.
- Carefully put the largest of the three lenses at your station into the lens holder and tighten the holder around it.
- Start with the viewing screen close to the lens. Then, slowly move the viewing screen away from the lens. As you do so, you will notice that the spot of light on the screen becomes smaller and smaller. At some point it will focus into a clear and sharp image of the source of light.
- Describe the image that you see. Is it upside down or right side up? Is it inverted left to right? Is it larger or smaller?

Description of the image

It's time to make a prediction. If you were to cover the top half of the lens with a card, how would your image change? Explain why you think this will happen. Write your prediction down before doing this observation.
Prediction:

Take the larger lens and form a sharp image of the lamp. Cover up the top half of the lens with a 3X5 card. Describe how the image changes when you do this. How does this observation compare with your prediction? Explain why the image changes as it does?

Part 1: Properties of lenses

Definition of Focal length of a lens:

In general, the distance between the lens and the in focus image depends on how close the object (the lamp) is to the lens. The focal length is defined as the distance between the lens and the in focus image when the object is very far away from the lens. In our case, the object must be at least 5 m away from the lens to get an accurate measurement of the focal length. If it is a clear day you can use the sun as the object. If it is cloudy, use the scaffolding in the atrium of the SSC.

1) Measure the focal length of each of your converging lenses. Use the atrium ceiling or the sun as the objects for measuring the focal length. Explain what the term focal length means and how you measured it.

   Large Lens: _____

   Small Thin Lens: _____

   Small Thick Lens: _____

2) Use the large lens as a magnifier. Observe a small object (like the individual letters of text on the page) by holding the lens in front of your eye then moving it close enough to the object for it to be in focus. Describe what you see.

Part 2. Constructing an Astronomical Telescope.

An astronomical telescope can be made with two converging lenses. The angular magnification is given by the equation

$$Magnification = \frac{\text{focal length of objective } lens}{\text{focal length of eyepiece } lens}$$

- Use the longest focal length converging lens as an objective and build a telescope on the optical bench using the other converging lens as the eyepiece.
- The lenses should be separated by the sum of their focal lengths.
- Focus your telescope on an object across the room.
- Answer the questions on below.

1) Is the image that you see erect (right-side up) or inverted?

2) Follow the light through the system with a 3×5 card. Can you find the image between the two lenses?

3) Is the distance between the two lenses equal to the sum of the focal lengths (i.e.; did you have to move the eyepiece lens to focus the image)? Is it larger, smaller or the same? By how much?

4) Focus on a distant object and try to measure the magnification. Your instructor will show you how to measure the magnification. Now calculate the magnification using the formula at the beginning of this section. How do the two values compare?