Lens Lab in a Bag

In this take home lab you will investigate some of the basic properties of lenses. In Part I of the lab you will be introduced to two types of lenses; in Part II, you will be making some measurements. Equipment for both parts of the lab (two lenses, a cloth measuring tape, a candle, and file card) may be found in the bag.

Part I: A Lens Exploration

1. Examine and describe the shape of the two lenses when they are viewed from the side. You may use a sketch if you wish.

2. How do the lenses differ in terms of their thickness at their outer edges versus their thickness at their centers?

3. The lens that bulges out at the center is called a convex lens. The lens whose center “caves in” is referred to as concave lens. Can you focus light on a screen with either of the lenses? If so, which?

4. May either of the lenses (perhaps both?) be used to project a clear image of an object, for example a light bulb, on a screen? If so, describe the nature of the image. That is, is it magnified or reduced, right side up (RSU) or upside down (USD), real or virtual?

5. What do you see when you look at an object directly through each of the two lenses? Vary the distance between your eye, lens, and object as you explore. Describe the nature of the various images in as much detail as possible.

6. Which, if either, of the lenses could be used as a magnifying glass? Which of the two lenses might be used as a field-of-view expanding “fish eye” lens?

7. One of the lenses is capable of forming inverted images. How does this happen? You may wish to use a diagram to illustrate your answer.

8. Why do you suppose one of the lenses only forms reduced, RSU images that appear to be behind the lens? A ray diagram may be useful.

9. Suppose you drop a glass convex lens and it breaks. Is it possible to form a complete image of a scene with only a portion of the lens? Try it by covering a part of your lens. Can you explain what you observe?

10. Complete the following statement: Reflection is the basis of image formation by mirrors. _________________ is the basis of image formation by lenses.

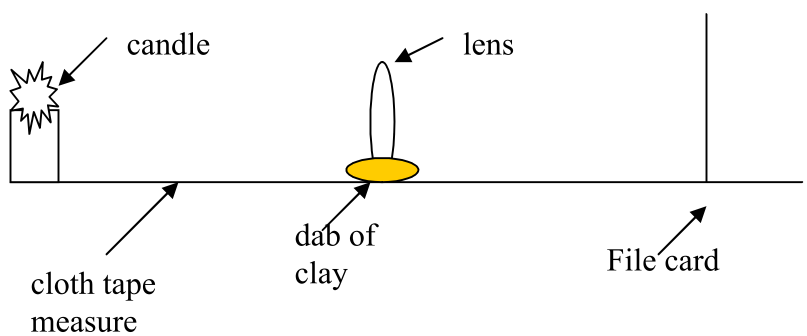
11. Where do you look for real images formed by a concave mirror? On the same side of the mirror as the object or on the opposite side?

Where do convex lenses form real images? On the same or opposite sides of the lens?

12. Based on your observations in this exploration and previous knowledge of curved mirrors, which type of lens has properties similar to a concave mirror? To a convex mirror?

Part II. The Convex Lens

You discovered a relationship between object position, image position, and focal length for concave mirrors. Does such a relationship exist for convex lenses? Hmm….. Let's find out! You will need a convex lens, candle, cloth tape measure, a file card, and perhaps a bit of clay arranged as shown in the diagram below.



1. Before setting up the apparatus in the diagram, measure the focal length of your lens by forming a sharp image of a distant object on the file card. When this is achieved, the distance between the card and the lens is the focal length. Note: As with the concave mirror, the focal length is the image distance only when the object is essentially at infinity.

focal length = _____________

2. Using some type of adhesive tape, attach the stretched out measuring tape on a table. Make certain that the metric side of the tape is facing up. Find the center of the tape and place your lens there. A piece of modeling clay may be used to keep the lens upright.

3. Using the lighted candle as an object, find the location of the image produced when the candle is at object positions equal to 2.5f, 2f, 1.5f, f, and 0.5f. As you do so, fill out the table below. **Attention**: all measurements are to be made with respect to the lens. Make sure that you measure the actual object and image distances, not the numbers written on the tape. (Note: some of these distances may not work for the lens you were given. You may wish to invent your own object distances.)

object distance d_o	image distance d_i	focal length f	orientation (RSU or USD)	Magnification (enlarged, reduced, same size)	$1/d_o$	$1/d_i$	1/f	$1/d_o + 1/di = 1/f$

Questions pertaining to the lab:

1. What mathematical relationship exists between d_o, d_i, and f? Assuming you know d_o and f, what will this relationship, known as the *thin lens equation*, enable you to do?

2. As an object is moved toward a converging lens, what changes occur in the size, position, and orientation of the image? Is the image real for all object distances? If not, where does the transition from real to virtual image occur?

3. Using the thin lens equation, calculate the image positions for the object distances equal to one and less than one focal length. What is going on here?

4. According to the thin lens equation, where is the image located when an object is placed at a large distance (>30 m) from a converging lens?

5. Where should an object be located with respect to a converging lens so that the object and image distance are equal?