

Lab 27: Lenses

Problem

To make predictions about and study the formation of images with ray diagrams and lenses. Also to study the two common types of eyeglasses

Background

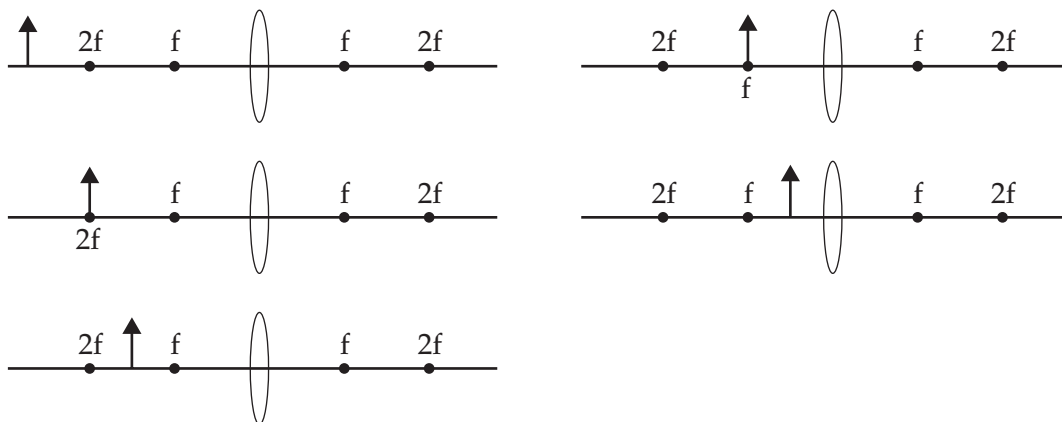
Did you know that the film for the movies in theaters is placed in the projector upside down? Projectors have convex lenses inside which flip the image on the film and magnify it so it can be projected up on a screen a long distance away. That is a type of image that you can see without even looking through the lens. However, there are many images that you can only see by looking through a lens. To see magnified objects with a microscope or magnifying glass, you must look through the lens and carefully adjust the distance of the lens from the object to see the image clearly with your eye. The distance of an object from a lens and from the lens to the image are variables that can be controlled for many different applications, from eyeglasses to cameras to light houses.

Skills Focus

Graphing, observing, applying concepts

Procedure

1. Start *Virtual Physics* and select *Lenses* from the list of assignments. The lab will open in the Optics laboratory.
2. The laboratory will be set up with a candle on an optics table with a convex lens in front of it. An eye will be on the other side of the lens so it can look at the image produced by the candle through the lens. You will observe the image of the candle from various distances to determine how images are changed in a convex lens.
3. **Graphing** Lenses produce very different images of an object depending on where the object is with respect to the lens. Ray diagrams are often used to construct the image that would be viewed through a lens. The following is a set of ray diagrams for a convex lens. Draw the necessary rays to determine where the image will be in each of the cases.



4. Observing Now you will confirm your predictions with the given lens. The focal point of this lens is 20.32 cm, or 8 in. Each of the pin locations, or holes, on the table is 2 inches apart. You will be placing the object at different distances from the lens, and then using the eye as a detector on the far side of the lens to find the location of the image produced by the lens. There is only one point at which an image is truly in focus. Turn off the autofocus feature in the detector screen by unchecking the Auto Focus box. Uncheck the grid box also to allow yourself to see the image better. Move the detector eye until the image is in focus. Record in the table below the distance from the lens to the image. Also record the Height Factor displayed in the bottom of the detector screen. This is the magnifying factor of the image from the original size of the object. Repeat the experiment for each of the different cases that you drew with the ray diagrams.

Data Table 1

Distance of object from lens (cm)	Distance of image from lens (cm)	Inverted? (yes/no)	Image bigger or smaller than object?	Height Factor

5. Did the data you collected and the images you observed match your predictions from the ray diagrams? Explain.

6. You have been using a symmetrical lens that has the same curvature on each side, which creates more predictable images, as you have observed. Now you will test two types of lenses that are used in glasses and are more complicated. Click on the Clipboard on the right side of the table to bring up a list of preset experiments. Select *Experiment 15: Farsighted Eyeglasses: Converging Lens*. The table is set up with a candle, lens and detector as before, but the lens is different because it is the type of lens that is used in glasses for farsighted people, and in reading glasses. Right click on the lens to pop up the control panel. The values for r1 and r2 reported are measures of the curvature of the lens. r1 is the first side of the lens that the light from the candle strikes. A small radius of curvature means that the lens is more curved, or that it would be part of a circle of smaller radius. Which side of the lens is more curved? Draw a picture of what the lens would look like with the different radii of curvature. Which part of the lens is thicker—the middle or the edges?

7. The type of lens used in Step 6 is called a converging lens, because it helps light to converge down to a point. Glasses for farsighted people are used for looking at things that are close, to help the light to focus on the retina farther forward than it would normally. This is necessary because the eye in this case is misshapen enough to cause the light to focus too far behind the retina. If you turn off auto-focus and move the detector around, you can see precisely how the lens is made to focus the light at one specific distance into the eye for a focused image.

8. Repeat Step 6 with *Experiment 14: Nearsighted Eyeglasses: Diverging Lens*. Which side of the lens is more curved in this setup? Sketch the lens and describe which part of the lens is thicker.

9. **Applying Concepts** The type of lens used in Step 6 is called a diverging lens. Explain what this type of lens would do for a nearsighted person.
