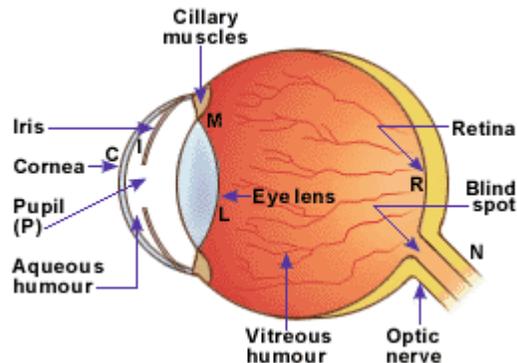


Modeling the Eye then Taking a Picture

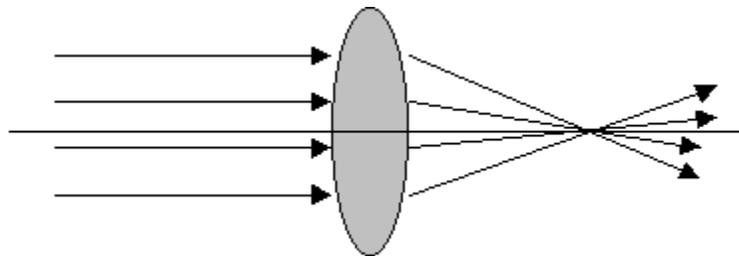


Summary

When light rays enter a piece of glass, they refract, or bend, because the speed at which they are traveling changes. If the glass is shaped certain ways, the image that results from the light's passage can appear larger, smaller, closer, or farther away than the original object. Magnifying glasses, eyeglasses, cameras, and microscopes are a few of the instruments that use lenses. The human eye is another example.



A convex lens (pictured below) is one that is thicker at the middle than the ends and converges light so it meets at a single point.



A convex, or converging, lens is thicker in the middle than on the ends. Parallel light rays will meet at a point beyond the lens.

Because our eyes are convex lenses, our eyes turn an image upside down on the retina. In order for us to perceive this image, our brains must make sense of this and turn it "right-side up".

The retina is the back part of the eye that contains the cells that respond to light. These specialized cells are called photoreceptors. There are 2 types of photoreceptors in the retina: **rods and cones**. The cones in our eyes allow us to see colors. These cones are sensitive to one of three different colors (green, red or blue). Signals from the cones are sent to the brain that then translates these messages into the perception of color.

All visible objects either emit light or reflect light. The way that we "see" things is by the light that is reflected off of them into our eyes. For example, if you are wearing a blue shirt, and are out in the sunlight, your shirt absorbs all colors of the rainbow except for blue. The particular color of blue that your shirt is then is reflected in all directions from the shirt. If you happen to be looking down at your shirt, blue is also reflected to your eyes that allows you to "perceive" or "see" that you are wearing a blue shirt.

Cameras have become a standard item in many households since the development of the Polaroid Land Camera in the 1940s. Film is cheap and easy to make, but the cameras and lenses have become expensive and complicated. However, the principles behind cameras are still simple. The most basic type of camera is the pinhole camera, which can be made from a cigar box, aluminum foil, and sheet film. In this activity, we'll learn how to make a simple pinhole camera (we call it a pinhole scope) and why it works.

Materials

- Magnifying glass
- White Surface

Activity

How Our Eyes Work

The brain must make sense of this and turn it "right-side up." To model what a convex lens does to an image, get a magnifying glass. Find a white wall or tape a white piece of paper to a wall that faces a window. Hold the magnifying glass close (3 in; 10 cm) to the white wall or paper. You should see an inverted image of whatever is outside of the window. This is what is projected onto your retina.

Taking an Image of What We See: A Camera

Procedure

Materials

- Cardboard tube from a roll of paper towels
- Cardboard tube from a roll of aluminum foil or plastic wrap (smaller diameter than the tube from the paper towels)
- Make sure one of the cardboard tubes has a smaller diameter than the other.
- A 2"x 2" piece of aluminum foil
- Clear tape (the type that is semi-transparent, not the clear, glossy kind)
- 1 rubber band
- A small pin, needle, or thumbtack

Directions

- On one end of the **smaller** tube place several strips of the magic tape across the hole so that the hole is **completely covered** by the tape with some overlap between the strips



- On one end of the **larger** tube place the aluminum foil over the hole so that it **completely covers** the hole and use tape or a rubber band around the tube to hold the foil in place



- With your pin or needle, poke a small hole in the center of the aluminum foil.



- Slide the two tubes together so that the magic tape and the aluminum foil are on the same side. If you slide the little tube inside the bigger one, the clear tape should be next to the foil.



Activity

- Find a bare light bulb or a bright light source (fluorescent lights do not work as well) that you can view with your new Pinhole Scope
- Stand about 5-10 feet from the light and look at the light source through your Viewer. Slide the tubes back and forth until you see an image of the light in focus before your eyes.
- You've just made a simple camera! To see multiple images of the light, poke several holes into the aluminum foil and point the Viewer at the light source.
- Rotate your image viewer while looking at the light. What do you notice about the images? Do they rotate with the image viewer?

When you made your pinhole viewer with the cardboard tubes and tape, you punched a small hole (or several) in the aluminum foil with a pin. We looked into the viewer and could see an image of a bright light source on the tape. How did this happen? How could the light from the source get through the tiny pinhole to create a complete image of the source?

You can confirm this by just walking around your computer and looking at it: you can see it from every angle. Only a tiny fraction of the light from the object gets into our eyes at one time, however. Even then, we are usually focusing on **one part** of the object and not the whole thing at once (unless it's far away).

Imagine a building that you can see in the distance. You may focus our eyes on the top or the building but your eyes can still see the entire image. The same is happening with the pinhole and the light source. But why is the image upside down on the screen? Here is where we have to think about the path of light.

Aim your pinhole viewer at a building or another object and notice that the image on the tape screen is upside down. Imagine a ray of light from the top branch of the tree traveling toward the pinhole. Since the pinhole is so small, only this ray and a few others from the top branch can pass through the hole. The light rays travel in a straight path from the object to the screen. Notice in the image above that the rays from the top of the object and the bottom of the object have to cross at the pinhole in order to pass through it. This is what causes the image of the object to be upside down. Our pinhole is acting as a converging lens!

What do you think would happen if we enlarge our pinhole? Does the image become more or less clear? Does it get brighter or dimmer? Try this by punching a new, larger hole in your pinhole viewer and observing the light source through your viewer.

