How does light work? Making a Camera Obscura

Did you know our eyes actually see everything upside down and backwards? Learn about light properties, how our eyes see, and how early telescopes and early cameras work by making your own camera obscura.

Time

- 30-40 minutes

Grades

- 4-8

Utah Science Core Standards

- 6.6.2 Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.
- 8.2.5 Develop and use a model to describe the structure of waves and how they are reflected, absorbed, or transmitted through various materials.

Next Generation Science Standards

- 4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
- 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Materials

◊ Cardboard boxes, all sizes will work, one for each student or student group

◊ Tape, one for each cardboard box, dark colors and wide widths will block the light best

◊ Aluminum foil, one roll for the class

◊ Scissors, one for each cardboard box

◊ Pushpins

◊ Optional– heavy rubber bands to secure cell phones to viewer

Do Ahead

GBO Suggestion: You may want to do the How does light work? Angles of Reflection activity before this one.

Before doing the activity teach your students how human eyes work. You can use the videos on the video tab, slideshow on the PowerPoint tab, or interactive on the interactive tab to teach your class these concepts. You may also want to review the properties of light with your students, particularly that light is made of waves that are reflected and refracted all around us before entering our eyes.

Depending on how many cardboard boxes you have available, you can choose to do this activity in groups or individually. All sizes of boxes will work and recycled boxes work perfect!

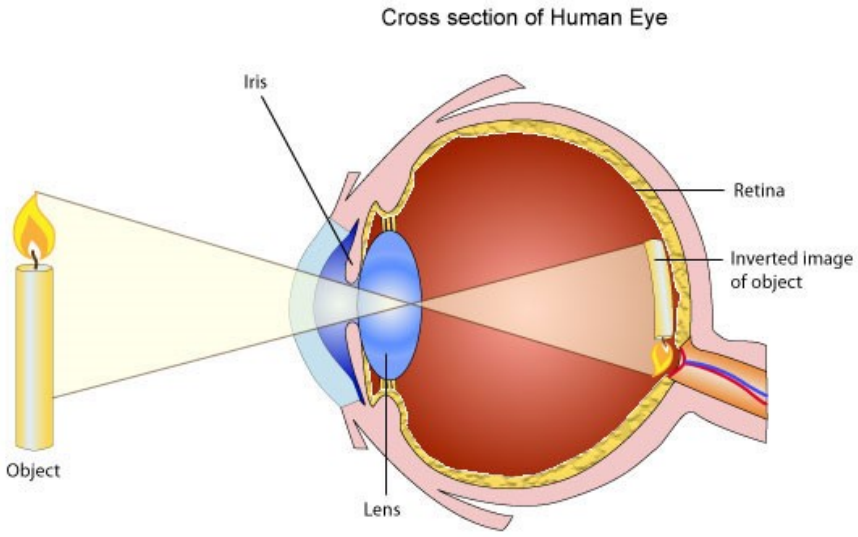
You can also choose to give your students more or less instruction with this activity. With less instruction you make the activity more of an engineering challenge.

Explanation

The human eye (as well as those of other animals including birds, fish reptiles etc.) belongs to a general group of eyes found in nature called "camera-type eyes." Light-waves from the sun, or artificial light, travel and bounces off objects, entering our eyes through the pupil. Depending on the amount of light, the iris changes the size of the pupil to let more or less light in. Then the light then passes though the lens (just like a camera lens) focusing light onto the back surface of the eyes light-sensitive membrane called the retina.

The image formed on the back surface of the eye (and camera obscura) is upside down and backwards. It is our brain that changes the image to upright and corrects the image from right to left. All eyes of all animals work this way. All early telescopes and early cameras worked this way as well.

A camera obscura is a perfect way to demonstrate this phenomena. By blocking out almost all of the light except for a pinhole, we can view the mirror and upside down image our eye encounters before our brain adjusts it. You may choose to discuss aperture and clarity as well. With a small pinhole, we can view a more clear image in the camera obscura because we have less noise in our image. With a larger hole (greater aperture) we get more information (better color) but our image quality decreases. This is why a telescope needs a lens, to focus all of the light entering to a single point and a clear image.



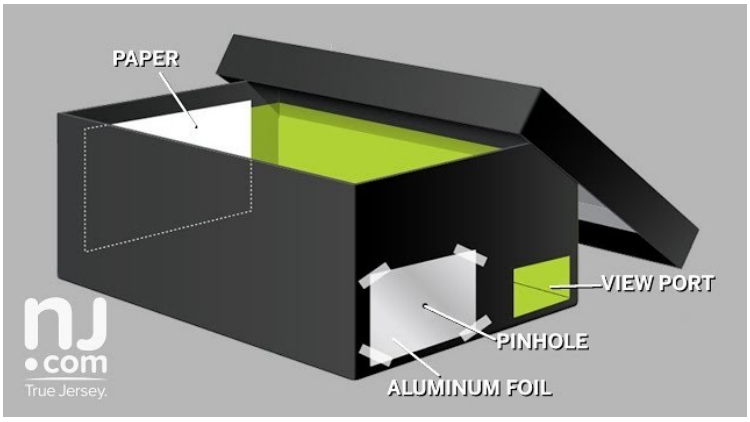
Activity Directions

- Have each student or student group decide how to orient their camera obscura on their cardboard box, select the front and back, top and bottom.
- Open your box and cut a white piece of paper to fit the back of your camera.
- Securely attach your paper to the box, this allows for a clearer image than using the cardboard box alone.
- Make sure the inside of the box is free of extra cardboard that may block light or viewing.
- Close the box and select a place to cut a hole approximately 1 inch by 1 inch in the front center of the box. This will be the place you will be placing your pinhole.
- After cutting the hole, secure aluminum foil over the top with tape, you will be making your pinhole in a future step.
- Cut another hole to be your viewer, **this can be done in one of two places**-

  1. You may put it in the bottom corner of the box on the same side as the lens, but where when held up to view, a person's head will not interfere with the light entering the pinhole lens.

  2. You can put it directly under the pinhole lens near the bottom of the box to use with a cell phone. You can not use this location to view with your eye, because your head would block the incoming light.

  3. Either way, cut just enough area for viewing. You do not want to allow extra light to enter the box through this hole when in use. Once again, make sure the inside of the box is free of extra cardboard that may block light or viewing.
- Tape the box shut and block out all light from the camera except for the viewer hole.
- Now make a small hole in the aluminum foil with your pushpin.
- Test your camera where there is strong light, near a bright window or outside (works best).
- For a cell phone camera, you will want to attach your phone's camera to the viewer, you can use heavy rubber bands, or tape to aid you. It takes a little adjusting to get the camera lens in the right place.
- You may need to adjust your hole a little bigger with the pushpin to see the image.
- Look for objects that move in your camera. Take pictures or videos. Have a friend go in your field of view and jump up and down or watch cars passing by. Take turns with others to see how each camera obscura works a little differently.
- Experiment with making your hole a little bigger, does the quality of the picture decrease? Can you see better color?



You can place your view port directly below the pinhole if you are using a cell phone camera lens rather than your own eye for viewing.

Extension

For teachers who really want to shake things up…. Turn your entire classroom into a Camera Obscura!

Turn you classroom into a Camera Obscura!

- Totally darken your classroom with black plastic or cardboard and tape to cover all the light from your windows and doors.
- Choose a place at the students eye view to put your camera lens. You will want this to be a window with no screen. Can you capture a familiar or fun outdoor scene with your lens?
- Place a small hole in the cardboard or plastic to create the lens.
- You can place 3 or 4 small holes a foot or two apart from each other, each with a different diameter, or aperture.
- Have one sheet of velum available for each lens.
- Students can use the velum to capture the image, moving it forwards and back to focus it. Stand within a foot of the lens to do this. Alert students to study the difference a greater aperture creates in the image.
- Mark a spot on the ground outside which is captured in the classroom camera obscura. Have someone go to this spot and jump up and down, dance or cartwheel. A moving object is fun to see!
- Send us a video of from your classroom Camera Obscura and we'll put it on our website!