RAFT IDEAS

Topics: Optics, Anatomy, Vision and Structure, and Function of the Eye

Materials List

- ✓ Black paper/plastic
- ✓ White paper
- ✓ Bulk CD container (100 - best), clear, with reversible post
- ✓ CD
- ✓ Stickers &/or tape
- ✓ Paperclip, smooth
- ✓ Translucent plastic
- ✓ Convex lens with a ~10 cm (4½" to 5") focal length with a straw handle, or equivalent
- ✓ White paper disc, with a hole ½ the diameter of the lens
- ✓ Scissors
- ✓ Colored markers

This activity can be used to teach Next Generation Science Standards:

- Light and vision (Grade 4, Physical Science 4-2)
- Senses (Grade 4, Life Science 1-2)
- Body structures (Grade 4, Life Science 1-1)
- Waves are reflected, absorbed, transmitted (Middle School, Physical Science 4-2)

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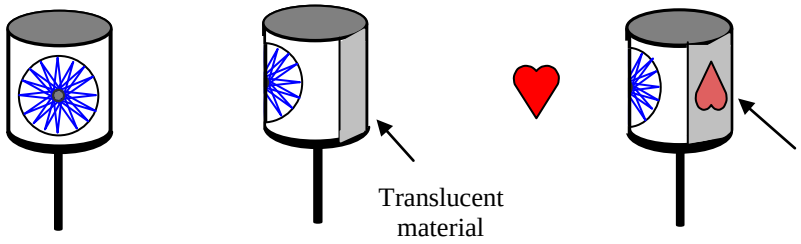
Eye See It!

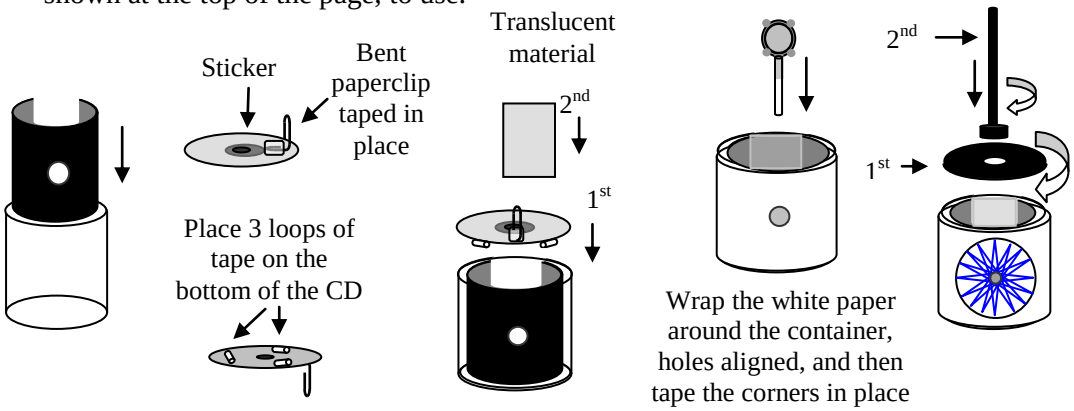
Construct a "working" model of the human eye



Use a bulk CD container to model parts of the eye and their functions.

Assembly

1. Cut one 15 cm x 28 cm (6" x 11") section each of black and white paper.
2. Cut or punch a 3 cm (1⅛") diameter hole in the center of each section.
3. Insert the black section into the inverted CD container. Move the black section until any label(s) on the outside of the container cannot be seen from the inside.
4. Cover a CD's hole and clear center section with a light-blocking sticker or tape.
5. Bend a paperclip's narrower loop up to a 90º angle. Tape the narrow loop to the CD's label side so that the bend is about 1.5 cm (½") from the CD's outer edge.
6. On the other side of the CD place 3 loops of tape evenly spaced around the CD.
7. Put the CD, paperclip up, into the inverted lid of the CD container such that the paperclip is directly below the circular opening in the black section of paper.
8. Insert a 15 cm x 12 cm (6" x 5") section of translucent plastic into the CD container, narrow end down, between the container's side and the black paper. Move the translucent plastic until the sides overlap the black section. Push the overlaps against the container's side and tape the top ends to the container. The circular opening in the black material must remain directly above the paperclip.
9. Insert the lens's straw handle over the upright paperclip loop. Adjust (trim straw, bend paperclip, and/or twist lens) until the lens is centered in the opening,
10. Point the lens at a bright, distant view. If the displayed image is not in focus then move the lens closer, or farther away, by bending the paperclip a little.
11. Wrap the white paper around the bulk container, centering the opening over the lens. Tape the corners of the white paper to the bottom and sides of the container.
12. Color the white disk by making lines that radiate from the center opening to the outer edges. Match up the disk and white paper holes and tape the disk in place.
13. Unscrew the post from the CD container's base. Twist the container's base and lid together. Screw the center post onto the base from the **outside**, as shown at the bottom right. The post provides a convenient handle. Invert the container, as shown at the top of the page, to use.



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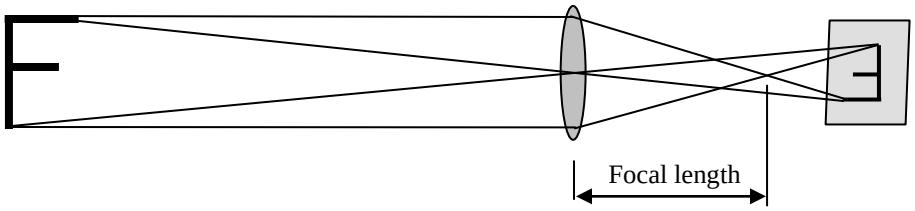
To Do and Notice

1. In a darkened room point the lens at a window with a sunlit view that includes, if possible, the sky, trees, and/or buildings. What is the orientation of the image seen on the translucent material?
2. Point the lens at moving cars or people. In which direction do they seem to be moving?
3. Cover the opening over the lens with a partly closed fist, making a smaller opening for light to pass through. How does the image change on the translucent material?
4. Cover the translucent material with a blocking light material. What color is the opening in front of the lens?

Science Behind the Activity

The **cornea**, the clear front part of the eye covering the lens, does most of the focusing (bending of the light rays) for the eye. While the bulk CD container's cover models the clear and protective features of the cornea, the cover cannot model the cornea's ability to bend and focus light rays.

A convex lens, as found in the eye, will form an inverted image at distances beyond the focal length. The eye's flexible **lens** can flatten by muscles, attached at the sides, pulling on the lens, changing the lens's focal length. Images of objects near or far can be brought into focus by this changeable lens. The rigid plastic lens of the model can focus an image but cannot model the lens's ability to change shape to bring close objects into focus.



The white and black papers model the **sclera**, the protective white outer surface of the eye which blocks light from entering the eyeball. The colored disk models the **iris.** The real iris can vary the size of the center opening called the **pupil,** modeled by combining the disk's opening with a partially closed fist. The iris creates a larger pupil for letting in more light during low light conditions. The iris constricts the opening, making a smaller pupil, to let in less light when the view is brightly lit. The pupil looks black because almost no light is reflected back out from inside the eye. An almost black opening can be created when the translucent material is covered with a light blocking cover, modeling the enclosed eyeball which is surrounded by the light blocking (opaque) sclera. The image focused by the cornea and lens falls on the **retina**, which is modeled by the translucent material. The inverted image is transmitted to the brain along the **optic nerve** and perceived as a non-inverted image. The handle of the eye model could be considered a rough approximation of the optic nerve, but the real optic nerve is attached to the back of the eye.

The light receptors in the retina of humans and other mammals are facing the back of the eyeball rather than pointing toward the source of the light! The optic nerves from the light receptors cover the surface of the retina and light has to first pass through the nerves. The nerves form into a bundle that has to go through the surface of the retina in order to reach the brain. This passage through the retina creates a blind spot in each eye where there are no light receptors. The images from two eyes are combined such that we are not aware of any blind spot. The brain fills in and adds meaning to what is seen by the eye, creating the basis for many optical illusions.

Taking it Further

Near and far sightedness can be modeled by first removing the base of the bulk CD container. Pressing the "sides" together slightly will make the "eyeball" longer, modeling nearsightedness. Pressing the "front" and "back" together will make the "eyeball" shorter, modeling farsightedness. See the RAFT idea sheet ***Modeling Near and Farsightedness.***

Web Resources (Visit www.raft.net/raft-idea?isid=140 for more resources!)

- Extensive teacher/student eye information and activities - http://staff.washington.edu/chudler/bigeye.html
- Label eye diagram with links for its parts - http://www.yorku.ca/eye/eye1.htm
- Near and farsightedness - http://www.nlm.nih.gov/medlineplus/ency/imagepages/19511.htm

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