NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 1 HR 30 MINS

Seeing is Believing

Students explore the basic concepts and properties of light. Students use clear receptacles, cardboard, and a candle to model how an object can be seen when light enters the eye.

GRADES

3 - 5

SUBJECTS

Biology, Health

CONTENTS

1 Video, 2 PDFs

OVERVIEW

Students explore the basic concepts and properties of light. Students use clear receptacles, cardboard, and a candle to model how an object can be seen when light enters the eye.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/seeing-believing/

Program

DIRECTIONS

1. Activate prior knowledge

Pour water into the clear drinking glass. Place a pencil into the glass of water so that half of it is submerged. Have students walk past the glass, bending over to look at it from the side. When all have seen it, discuss what they observed. Ask:

- *Is the pencil really bent?* (No, it's an optical illusion)
- *What do you think makes the pencil appear to bend under water?* (Adjust the expected answer to the students' ages. The water acts as a prism; the light reflecting off the submerged half of the pencil is refracted, while the half sticking out of the water is not. Clearly explain what it means for light to be refracted.)
- *What are some other odd things you have noticed light doing?* (If necessary, prompt students to think about light making a rainbow effect on the ground when seen through angled glass or prisms; how objects sometimes look larger when viewed through water, and so on.)

Explain that the behavior of light often affects the way we see in odd and interesting ways.

2. Prepare groups for the activity

Watch the clip "How the Human Brain Sees Light" from the film *Mysteries of the Unseen World*. Explain that the class is now going to create a model that will show more clearly how light behaves when it enters their eyeballs.

NOTE: Instructions are written for small group presentations. Adjust accordingly if you prefer to perform this as a large-group demonstration.

Separate students into groups of three to four students each. Assemble each group around a table or counter. Distribute the cardboard pieces as well as the clear, round drinking glasses or glass bowls (whichever you chose to use for the experiment).

3. Guide groups in preparing for the experiment

Explain the procedure, having a different group member perform each of the following tasks.

- Fill each drinking glass with water. OR fill the glass bowl with water.
- Poke a hole into the center of the BLACK cardboard with a sharp pencil. The hole should be small—less than the diameter of the pencil itself—and located so that it can be lined up

with the center of the glass when the cardboard is held up beside it.
- Have one group member hold the black cardboard steady against the glass or bowl.
- Have another group member hold the white cardboard one or two inches away from the glass or bowl on the opposite side. This student should be prepared to move the cardboard during the experiment.

4. Use the candle to complete the model

[Safety tip] An adult must take charge of each candle and the matches.

Guide students in continuing the investigation as follows:

- Turn off the lights and lower window shades to darken the room as much as possible.
- Move from one group to another to conduct the next part of the experiment. (NOTE: If more than one adult is available, this part of the activity will take less time.)
- Instruct groups not to discuss what they see aloud, so all groups can observe the experiment for themselves.
- At each table, light the candle and hold or set it in front of the black cardboard so the light reflects through the hole, through the glass or bowl, and onto the white cardboard on the other side.

NOTE: The student holding the white cardboard may need to move it around until the candle flame is visible there.

- Make sure every student has the chance to see the image of the candle on the white cardboard and make note of its appearance. One member of the group can move a pencil or other non-flammable object over the flame (not touching it), so it is obvious that the top of the flame shows up on the bottom of the image on the white cardboard. (Warn students not to mention what they see aloud.)
- Blow out the candle and move to the next group to repeat the procedure until everyone has observed the results.

5. Discuss what was observed

Use the guided questions listed below or your own discussion starters to debrief the experiment. Tell students that you are going to talk about the parts of the eye that the model represented: the pupil, eyeball, and retina. Remind students that in the video they learned that an object can be seen when light reflected from its surface enters the eye.

Ask and discuss the following questions:

- *What was our light source in this case?* (The candle)
- *What do you think the small hole in the black cardboard represented?* (The **pupil**, a small hole in the front of the eyeball that lets light into the eye)
- *What did the glass (or bowl) filled with water represent?* (The **eyeball**, which is shaped roughly like a sphere)
- *What does the white cardboard represent, and what is its job?* (The **retina**. It receives the image from the light source)
- *What was odd about the image you saw on the model "retina"?* (It was upside down and backwards)
- *Think back to when we looked at the pencil in the glass of water. What do you think caused the image in our model to flip?* (The curvature of the glass or bowl, which imitates the curvature of the eyeball, bends the light in the same way the water bent the image of the pencil. Older students should include understanding of the terms reflection and refraction)
- *According to the video, why don't we "perceive" everything we look at upside down and backwards, then?* (The brain interprets the image and flips it back for us)

6. Wrap up by reviewing parts of the eye and how humans see

Distribute the worksheet "Model of the Naked Eye" and have students complete the work independently. When they have completed the worksheet, lead students in a discussion about their responses on the worksheet and their experiences with the experiment. Collect the worksheets to assess students' understanding.

Tip

Common misconception among older students: Students often confuse the terms *reflect* and *refract*. Make sure they understand that the light REFLECTS off of the candlestick, while the curvature of the eyeball REFRACTS, or bends, the light, flipping the image upside down onto the retina.

Tip

Create and test the model before this activity to decide whether you will use the balloon or bowl and whether you wish to perform a large-group presentation or allow small groups to create the models.

Tip

- English Language Learners tip: Pre-teach the terms *pupil, eyeball,* and *retina*. This will help them identify words, place them in context, and remember them.

Informal Assessment

Ask students to explain the experiment and how the model represents the human eye. Encourage students to include in their explanations the three parts of the eye discussed (pupil, eyeball, and retina), and how those three parts enable an object to be seen by the naked eye and perceived by the brain (using the terms reflection/refraction, or bending of light, depending on students' ages and prior exposure to this topic).

Extending the Learning

Brain Games experts explain how your eyes and brain work together to make sense of the world in this two-minute video from National Geographic called "Seeing with Your Brain."

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Name and describe the function of three parts of the eye: pupil, eyeball, and retina
- Explain how light behaves when passing through a curved surface
- Describe the relationship between light and visibility to human beings

Teaching Approach

- Learning-for-use

Teaching Methods

- Cooperative learning
- Discussions
- Hands-on learning

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding

National Standards, Principles, and Practices

NATIONAL SCIENCE EDUCATION STANDARDS

- **(5-8) Standard A-1:**

Abilities necessary to do scientific inquiry

- **(5-8) Standard B-3:**

Transfer of energy

- **(5-8) Standard E-1:**

Abilities of technological design

- **(5-8) Standard E-2:**

Understandings about science and technology

- **(K-4) Standard A-1:**

Abilities necessary to do scientific inquiry

- **(K-4) Standard B-3:**

Light, heat, electricity, and magnetism

- **(K-4) Standard E-1:**

Abilities of technological design

- **(K-4) Standard E-2:**

Understanding about science and technology

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- For class: Water source (NOTE: If using balloons, make sure the lip fits over the faucet opening) One tall clear drinking glass One candle (for each adult participating in the experiment) Matches
- For each small group: Choose One: one tall, clear, round drinking glass OR one clear glass bowl, 8-10 inches in diameter One sheet of black poster or railroad board (11 X 14) (or any cardboard painted black) One sheet of white poster or railroad board (11 X 14) (or any cardboard painted white)

REQUIRED TECHNOLOGY

- Internet Access: Optional
- Tech Setup: 1 computer per classroom, Projector

PHYSICAL SPACE

- Classroom
- Community center
- Media Center/Library

SETUP

- Arrange tables for small group collaboration OR one table for large group presentation.
- Locate a nearby source for tap water.
- Create and test the model before this activity to decide whether you will use the glass or bowl and whether you wish to perform a large-group presentation or allow small groups to create the models.

GROUPING

- Large-group instruction
- Small-group work

OTHER NOTES

This activity can be completed in one or two class periods.

BACKGROUND & VOCABULARY

Background Information

Without light we cannot see. Light is a form of electromagnetic radiation—fluctuations of both electric and magnetic waves that travel through space. But the human eye is only able to see a small portion of the electromagnetic spectrum, the part known as the visible spectrum. The eye is structured in a way that capitalizes on how this visible light reflects off of objects. The human eye not only can capture reflected light for vision, it also can distinguish about 10 million distinct colors. The eye contains photosensitive (light sensitive) cells that regulate the opening and closing of the pupil—the hole through which light enters the eye—causing them to open wider when the light source dims and to narrow in brighter light.

Prior Knowledge

[]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
eyeball	*noun*	the entire round part of the eye.
light	*noun*	the form of energy that makes it possible to see things; the brightness produced by the sun, by fire, a lamp, etc.
optical illusion	*noun*	image seen by the eyes that is different than what is actually there.
optic nerve	*noun*	either of the second pair of cranial nerves that pass from the retina to the optic chiasma and conduct visual stimuli to the brain.
prism	*noun*	device for distributing light into different colors of the spectrum.
pupil	*noun*	the contractile aperture in the iris of the eye.
reflect	*verb*	to rebound or return light from a surface.
refraction	*noun*	seeming bending of light by liquids, solids, or gases.
visible	*adjective*	able to be seen.

For Further Exploration

Websites

- Cow's Eye Dissection at San Francisco's Exploratorium

FUNDER

This material is based in part upon work supported by the National Science Foundation under Grant No. DRL-0840250. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

MADE POSSIBLE IN PART BY