



**Classroom Activity | Grades K–2**

# Light and Shadow

## GUIDING QUESTIONS

- How is a shadow created and how can it be changed?

## LEARNING OBJECTIVES

Students will be able to:

- identify and sort objects as reflective, transparent, or opaque.
- describe how the distance between an object and its light source affects the size of a shadow.
- recognize the sun as a source of light.

## OVERVIEW

The purpose of this lesson is to provide students with a foundational understanding of light by enabling them to explore how light interacts with different objects and to discover relationships between light and shadow. Students begin the lesson by discussing how light travels and observing and sorting objects that are transparent, reflective, and opaque. Then, students collect and examine data on how changing the distance between an object and a light source affects the size of a shadow. Finally, students connect their learning to home by searching for examples of transparent, reflective, and opaque objects around their homes and by investigating how the appearance of a shadow changes throughout the day.

## NEXT GENERATION SCIENCE STANDARDS

- ESS1.A: The Universe and Its Stars
  - Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1-ESS1-1)
- ESS1.B: Earth and the Solar System
  - Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2)



- ETS1.A: Defining and Delimiting an Engineering Problem
  - A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-2-ETS1-1)(secondary to KPS2-2)
  - Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary to K-ESS3-2)
  - Before beginning to design a solution, it is important to clearly understand the problem.
- ETS1.B: Developing Possible Solutions
  - Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-1)(secondary to K-ESS3-3)(secondary to 2-LS2-2)
- ETS1.C: Optimizing the Design Solution
  - Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-1)(secondary to 2-ESS2-1)

## LESSON TIME FRAME

Two 45-minute lessons

## BACKGROUND INFORMATION

An understanding of light helps students in many fields of science. Astronomers understand that the cycle of day and night is caused by the earth rotating on its axis with different sides facing toward or away from the sun. Biologists know that certain plants grow better in the sunlight or in the shade. Engineers continue to develop technologies that involve light energy such as projectors, photovoltaic tape for solar energy panels, as well as technologies such as window films designed to reduce the effects of sunlight and save on energy costs.

Light travels in straight lines. When light reaches an object, it can travel through the object if the object is transparent. It can be reflected from a shiny object or light can be absorbed if the object is opaque. Shadows are produced when light hits an opaque object which prevents the light beams from passing through. When an object blocks the light's path, then darkness appears on the other side. This darkness is called a shadow.

The sun is a source of light that when it hits an object, it causes shadows. As the Earth rotates each day, the sun appears to change position in the sky and changing angles of sunlight affect the appearance of shadows. For instance, on a sunny day, you can stand a stick in the ground and watch its shadow move and change shape. When the sun gets low in the sky, the stick's shadow gets longer.



## MATERIALS

### Teacher Materials/Prep

- Scotch™ Blue Painter's Tape
- Scotch® Reflective Tape
- Scotch® Transparent Tape
- White bulletin board paper
- Masking or colored tape
- Flashlight for demonstrations
- Print/cut Stoplight Exit tickets for students (1 per student)
- Print Student Capture Sheet: Shadow Investigation (1 per student)
- Print Home Connection Resource: Light and Shadow (1 per student)

### Student Materials

- Pencil
- Science journal or paper

### Materials per Student Group

- Objects for sorting in Session 1 (transparent, opaque, and reflective)
- Chair
- Flashlight
- Cardboard tree cut-out
- Marker
- Scissors

## CLASSROOM ACTIVITY

### Day 1

**Teacher Note:** To prepare for Session 1, you will need to make sure that the weather and sunlight are adequate for observing shadows outside.

1. Show students three different kinds of tape—Scotch® Transparent Tape, Scotch® Reflective Tape, and Scotch™ Blue Painter's Tape. Discuss how the tapes are alike and different including some different purposes for which they are used. Ask: Which tape would be best for wrapping a gift with pretty wrapping paper? Why? (A: Scotch® Transparent Tape will enable you to see through to the paper.) Which tape would enable you to see a bicycle rider at night? Why? (A: Scotch® Reflective Tape enables a bicycle to be seen when the headlights of a car shine on it.) Which tape would be best for taping areas that you would not want painted? Why? (A: Scotch™ Blue Painter's Tape can be easily seen when placed on the wall and can be easily removed.)



2. Introduce the science vocabulary *transparent*, *reflective*, and *opaque*. Explain that light travels in a straight line. Light travels through transparent objects, bounces off reflective surfaces, and is absorbed by opaque objects.
3. Divide students into small groups of three. Provide student groups with a flashlight and a variety of transparent, reflective and opaque objects to observe and sort.
4. Discuss how the sun is a very big and important source of light to the earth. Provide students with the opportunity to go outside and observe what happens when the sun (a light source) shines on them (an opaque object). Students should observe and discuss how their bodies can be used to create shadows.
5. Discuss how shadows are created. Light travels in straight lines. Shadows are produced when light hits an opaque object which prevents light beams from passing through and hitting the ground on the other side.
6. Bring closure to Session 1 by allowing students to select an object of their choice to describe as transparent, reflective, or opaque. Students should use what they know about light to explain their thinking.

## Day 2

**Teacher Note:** To prepare for the activity in Session 2, you will need to prepare the room ahead of time. Place a piece of white bulletin board paper on the wall. Put down a line of Scotch™ Blue Painter’s Tape about 1.5 meters from the wall. This will be the distance where students place their flashlights. (Check to make sure that the shadow created at this point is not too large for the bulletin board paper. If so, move the painter’s tape forward). Place masking or colored tape at different distances from the wall—one marking for each group of students. Prepare a simple cardboard tree cut out for each group (about 20 centimeters tall).

1. Remind students of the shadows they observed outside during “Day 1.” Tell students that in this session they will have the chance to learn more about light and shadow. Direct student attention to a light source and wall space set up for making shadows. Model how to use your hands or other objects to make figures that resemble animals or other objects.
2. Provide students with a brief opportunity to explore making their own shadow figures.
3. Discuss the concept of a shadow puppet show. Puppeteers use shadow figures and dialogue to tell a story. Show students a cardboard cut-out of a tree and provide them with the following problem solving investigation. A student wants to present a shadow puppet show about a tree that grows larger over time. The student has only one cut-out of the tree. Complete the following investigation to find out how you can help the student solve this problem.
4. As a class, discuss what is the question that needs investigation? (How can the size of a shadow be changed?)



5. Divide students into small groups. Distribute Student Resource Page: Shadow Investigation to students. Explain how each group will receive the same size cut-out of a tree. (Confirm this for students by placing the cut outs on top of each other prior to distribution.)
6. Direct student attention to the large piece of bulletin board paper you have posted on the wall as well as the distance from the wall where all of the groups are to place their light source. Mark this distance with a line of Scotch™ Blue Painter's Tape so that each group can see that the light source is the same distance from the wall. Control for the height of the light source by putting the flashlights on chairs of the same height. One member of the group will have the job of keeping the light source steady on the chair.
7. Show students markings on the floor that have been placed in front of the light source at different distances. Discuss how one member of the group is to stand near the line and hold the tree cut-out directly in front of the beam of light so that a shadow appears on the bulletin board paper. A different member of the group will have the job of tracing the shadow onto the bulletin board paper. Finally, after the shadow has been traced, all members of the group should work together to measure the distance from the tape to the light source and make sure that this distance is written inside of the shadow tracing.
8. After each group has traced its shadow and measured the distance of the object to the light source, allow students to cut around the shadow outline. The result should be that groups have different-sized trees.
9. Regroup as a class to compare and discuss the results. Work together as a class to place the shadow outlines in order from smallest to largest. If students are not sure about the size/area, they can place the shadow cutouts directly on top of each other to compare. Posting the distance and the cut-outs as a class on a horizontal chart should enable students to conclude that the closer the cut-out was to the light source the larger the shadow that was created.
10. Remind students about the problem stated previously. What can the student do to make the shadow of the tree larger or smaller for the shadow puppet show? (The student should just move the tree closer to the light source to make it look like it is getting bigger.) How does the distance of an object from a light source affect the size of the object? Allow students to respond to this question in a science journal. Students should use what they learned from the investigation to explain their thinking. (Sample Response: The closer the object to the light source, the larger the shadow.)

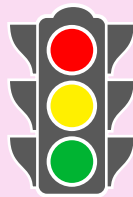
**Teacher Note:** As an optional extension to this lesson, allow students to apply their understanding of shadows to create their own shadow puppet shows!



## REFLECTION

Distribute one Stoplight Exit Ticket to each student. Students will complete the Stoplight Exit Ticket to show their understanding of the lesson. On their Stoplight Exit Ticket handout, students will color in the section of the stoplight that explains their understanding of the lesson.

Refer back to the Guiding Question for the lesson: How is a shadow created and how can it be changed? Tell the students they should keep this question in mind while filling out their exit ticket.



### Stoplight Exit Ticket

- **Red:** I do not understand today's lesson.
- **Yellow:** I almost understand today's lesson.
- **Green:** I get it! I understand today's lesson.

## HOME CONNECTION

Send home the Home Connection Resource: Light and Shadow with the students. Students can complete the following investigations at home with their parents.

- On a sunny day, go outside and observe the shadows created by different objects. Select an object and trace the object's shadow. Do not move the object. Return to the same object three hours later and trace its shadow. Observe and discuss how the appearance of the shadow has changed.
- Locate objects around the home that are transparent, reflective, or opaque. Discuss how these physical properties help the object function.

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Shadow Puppet Problem:

A student wants to do a shadow puppet show about a tree that grows larger over time. The student has only one cutout of the tree. Complete the investigation to find out how you can help the student solve this problem.

### How can the size of a shadow be changed?

Step 1:

- Decide on group jobs.

Flashlight Holder \_\_\_\_\_ Object/Tree Holder \_\_\_\_\_ Shadow Tracer \_\_\_\_\_

Step 2:

- Put the light on the chair that is on the Scotch™ Blue Painter's Tape.
- Hold the tree over the tape located between the wall and the light.
- Shine the light on the tree and trace the shadow.

Step 3:

- Measure the distance from the tree to the light source using centimeters.
- Write this measurement inside the shadow tracing.

Step 4: When the teacher tells you to, cut out the shadow.

Step 5: Meet as a class to discuss the results of each group.

What did you learn that can help you to solve the Shadow Puppet Problem?

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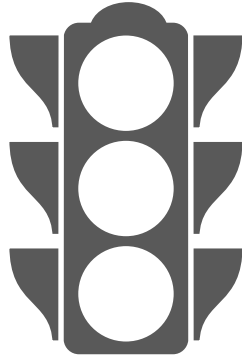
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# STOPLIGHT EXIT TICKET



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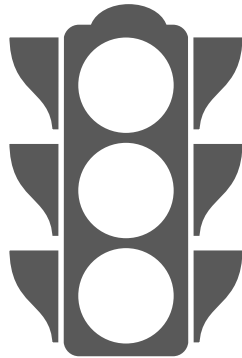
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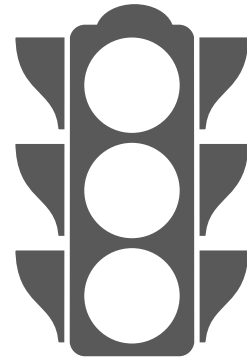
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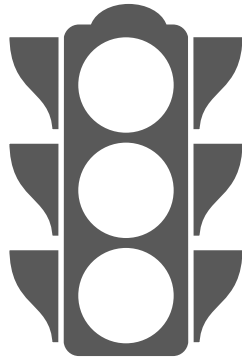
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## HOME CONNECTION RESOURCE: LIGHT AND SHADOW

Dear Parent/Guardian,

Your child has been learning about light and how light can travel through, bounce off of, or be absorbed by objects. Today your child completed an investigation to discover how changing the distance of an object to a light source can change the size of a shadow. Complete the following tasks together with your child to help reinforce and apply his/her understanding of science concepts:

- On a sunny day, go outside and observe the shadows created by different objects. Select an object and trace the object's shadow. Do not move the object. Return to the same object three hours later and trace its shadow. Observe and discuss how the appearance of the shadow has changed.
- Locate objects around the home that are transparent (light travels through), reflective (light bounces off), or opaque (light is absorbed). Discuss together how these physical properties help the object in its function.

For more detailed directions, please see the *Light and Shadow Family Activity*, and more activities found at: <https://www.youngscientistlab.com/parents/family-activities>.

We hope you continue learning together with us about the power of science.

See you in science class!

