

**SCIENCE**  
**Physical Science**  
**Grade 4**  
**Light and Shadows**

**Overview**

The learner will investigate shadows and their properties, then work in groups to create a testable question about shadows, create a procedure to test the testable question, perform the test, and compare their findings with that of the scientific world.

**Lesson Duration**

The opening activities 1-3 will take one day to complete. The body of the lesson may be completed in one class period, or extended depending upon the length of the period.

**Benchmarks**

**PS-E-B3** describing an object's motion by tracing and measuring its position over time

**PS-E-C2** investigating and describing how light travels and what happens when light strikes an object (reflection, refraction, and absorption)

**SI-E-A2** planning and/or designing and conducting a scientific investigation

**SI-E-A3** communicating that observations are made with one's senses

**SI-E-A4** employing equipment and tools to gather data and extend the sensory observations;

**SI-E-A5** using data, including numbers and graphs, to explain observations and experiments

**SI-E-A6** communicating observations and experiments in oral and written formats

**SI-E-A7** utilize safety procedures during experiments

**SI-E-B1** categorizing questions into what is known, what is not known, and what questions need to be explained

**SI-E-B2** using appropriate experiments depending on the questions to be explored

**SI-E-B3** choosing appropriate equipment and tools to conduct an experiment

**SI-E-B4** developing explanations by using observations and experiments

**SI-E-B5** presenting the results of experiments

**SI-E-B6** reviewing and asking questions about the results of investigations

- *Note-* Depending upon the nature of the independent explorations, all *science as inquiry* benchmarks may or may not be completely addressed.

### **Teacher Preparation**

- The teacher will need to gather all materials listed.
- Teacher content is expressed in the boxes in the body of the lesson and the “essential concepts” sheet attached.

### **Materials/Equipment**

#### *Activity 1*

For each pair of students

- Chalk
- Observation recording sheet

#### *Activity 2*

For each group

- Flashlights
- White Paper
- Pencils

#### *Activity 3*

- Different colored paper (black, red, blue, etc.)
- Blocks of different sizes
- Markers
- Clear plastic bottles
- Mirrors
- Wax paper
- Water
- Various other objects to make shadows

#### *Independent group explorations*

- Different kinds of light sources (different types of flashlights, light bulbs, sunlamps, etc.)
- Various objects to make shadows
- Measuring tapes or metersticks
- Different colored plastic wrap
- Poster or chart paper

## **Set or Opener** Exploration

*Activity 1* - \*Must be done in the beginning of the day.

1. Students will go outside to a cement slab or parking lot and make observations about shadows. In pairs, they will draw each other's shadows with chalk. Observations will be recorded on the data collection sheet. (*Observation Record Sheet* is attached)

*Students should be able to determine that the shadow is cast because their bodies are stopping the light from the sun from hitting the cement.*

2. Ask the students if they think that their shadows will look the same later in the day. Allow time for answers.
3. At three-hour intervals, have students go outside and draw their shadows again next to the first drawing.
4. At the end of the day, conduct a whole class discussion of students' findings, and record information on the board or overhead.

*Students should recognize that the shadow length changed through the course of the day. They should also notice that the shadow "moved" to the other side of their body.*

## **Body**

*Activity 2*

1. Students will work in groups of 4.
  - Give each group a flashlight, a pencil, and a white piece of paper.
  - Allow the students time (5-10 minutes) to "play" and investigate shadows they can produce.
  - After 5-10 minutes, have each group report to the class orally by asking them what discoveries they have made about shadows.
2. After groups share their observations add them to previous data record from activity one.

*Activity 3*

1. Give the students different colored paper, different types of lights, measuring tapes or meter sticks, and a variety of objects to manipulate.

*(Be sure to include at least one translucent object, such as wax paper, one transparent object, such as a clear plastic bottle, and one mirror. A clear plastic cup of water should also be available for each group.)*

2. Allow time for students to investigate shadows using the new objects, and record observations.
3. Ask the students, "What questions do you have about shadows that you would like to investigate?" The teacher will record these questions on the board or overhead.
4. Explain to the students that there are two types of questions, testable and non-testable. Testable questions are those that we can investigate by designing and conducting an experiment.
5. Have the students look at the list of questions that the student proposed in number three and divide them into testable and non-testable.

*Experimentation - Independent Group Activity:*

- Allow each group to choose a question to investigate.

*Make sure that the questions address a variety of areas: exploring the effect of the size of the light source, the distance of the object from the light source, the size of the object, the position or angle at which the light source hits the object, etc.*

- Each group will design an experiment using the scientific method that will provide an answer to the question.

*Remind students that the test needs to be fair. They should make sure that there are not any variables that could skew their findings. Allow the students to decide how they will record their data.*

- Students design and implement their test. Groups will record data. The recorder should make sure to record the question they are investigating, their hypothesis, the procedure they will follow, and their findings.
- Students will record their data in some type of table, chart, or graph.

## Closure

- Working in the same groups that completed the independent investigation, students move to the library or Internet for further research on how shadows are used in the world that they live in. In addition, they will to determine if their findings hold true with the findings of the scientific world.
- Students can create a poster or chart paper with all portions of their investigation included. This can also be done in a multimedia format using a word processing document or slideshow.
- Groups share their presentations with their peers.

## **Activity sheets** (attached)

*Essential Concepts* – This sheet can be used for teacher information or to reinforce concept comprehension following students' investigations.

Observation Record Sheet for Activity One

Design Your Investigation sheet for Activity Three

## **Reference links**

1. [http://www.arts.ufl.edu/art/rt\\_room/@rtrageous/shadows.html](http://www.arts.ufl.edu/art/rt_room/@rtrageous/shadows.html)
2. <http://www.exploratorium.edu/snacks/shadows/index.html>
3. <http://www.ocps.k12.fl.us/framework/sc/resource/lessons/43.html>
4. <http://www.sci.mus.mn.us/sln/fo/opaque/opaque.html>
5. [http://www.exploratorium.edu/learning\\_studio/lightsource/menu.html](http://www.exploratorium.edu/learning_studio/lightsource/menu.html)
6. <http://www.madsci.org/cgi-bin/search>
7. <http://www3.ns.sympatico.ca/onstage/puppets/activity/index.html>
8. <http://www.hunkinsexperiments.com/>
9. [http://www.exploratorium.edu/light\\_walk/index.html](http://www.exploratorium.edu/light_walk/index.html)

## **Assessment**

1. Bill noticed that his shadow in the morning appears different than in the afternoon. **List** two ways that the shadow is different and **explain** the reasons for those differences. 4 pts

2. In order for a shadow to occur, which of the following is **not** necessary?

- a. light source
- b. surface
- c. object
- d. the sun

3. Which of the following variables will not change to affect the shadow of an object?

- a. distance from the sun
- b. angle of the sun's rays hitting the object
- c. size of the sun
- d. size of the object

## **Answer Key: Assessment, page 84**

1. Possible answers may include:

### **List:**

The shadow is longer in the morning than at noon.  
The shadow is longer in the afternoon than at noon.  
The shadow moves from one side of his body to the other.  
The shadow is darker around noon.  
There appears to be no shadow at noon.

### **Explain:**

When the sun rises in the eastern sky in the morning, the shadow is longer because of the indirect angle at which it hits the object.  
When the sun is directly overhead at noon, the direct rays of the sun are blocked, and no shadow is visible.  
When the sun sets in the western sky in the afternoon, the shadow is longer again because of the indirect angle at which it hits the object.  
The shadow moves from one side of Bill's body to the other as the sun moves across the sky.

2. d
3. c

**Activity Sheets**  
**And**  
**Resources**

# Essential Concepts

The height of a tilted light source (in other words, the angle between the light source and the ground) and the size of the object it is illuminating determine the length of the shadow that the object casts. The object blocks the light coming from the source so that nothing behind the object gets any direct light. The length of the shadow is a result of how high above or below the top of the object the light source is. Imagine if the light source were directly above the top of the object.

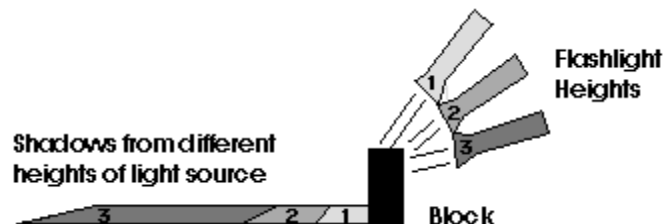
Would there be a shadow?

*No; not one that would be visible around the object.*

Twist the light source a little down from the top, and a shadow appears behind the object, but is very short. This is because as the light source moves down, the shadow is being created by the small area of the object blocking the light. Imagine straight lines coming down from the light and hitting the object. The higher the light, the less light lines get blocked by the object and hence the less shadow. Thus, the lower the light source is aimed at the object, the more the object blocks the lines, or rays, of light.

The key to understanding shadows is to realize that the light source and object must be lined up in order to make a shadow appear. In fact, if the object is placed anywhere along that line, it will produce a shadow of the same length behind the object. It is only when you change the orientation of the light source that the shadow changes.

That makes sense in one order: light hits an object and casts a shadow. But experiencing the connection of these fundamentals in a different arrangement is good for rooting our experiences more firmly—in other words, trying to predict where to place an object to cast a shadow at a specific location: essentially trying to locate the path of the light.



## Shadows

## Observation Recording Sheet



### Activity 1:

Record your observations about shadows in the space provided below.

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### Activity 2:

After exploring in your group, what new observations can you add to your previous list?

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**Name**

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**Design your investigation**

What is the purpose of your investigation (problem)?

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What do you think will happen (hypothesis)?

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What will you need to conduct this investigation (materials)?

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How will you conduct your investigation (procedure)?

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What are your results (data)?

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What have you learned (conclusions)?

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