

Me and My Shadow, or How do Shadows Behave?

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Contents

Process objectives	page 2
Content objectives	page 2
Background information	page 2
Pa. Science and Technology Standards addressed	page 2
Pre-test	page 3
Pre-lab activity	page 3
Procedure	page 3
Post lab	page 4
KWL Chart	page 4
Four Question Strategy Guide	page 5
Experimental Design Diagram	page 6
KWL Chart	page 6
Pre-test/post-test (Happy Face graphic)	page 7
Assessment rubric: Four Question Strategy	page 8
Assessment Rubric for Experimental Design	page 9
Extension Activity	page 9
Resources	page 10

Lesson Title: Me and My Shadow, or How do Shadows Behave?

Process Objectives:

- Students will design an experiment with one independent variable.
- Students will make observations about the size and shapes of shadows.
- Students will design a model for making shadows, using a light source, shadow disks, and screen.
- Students will reason about how the size and position of a shadow is affected by the time of day.

Content Objectives:

- Students will inquire into the nature of shadows.
- Students will explain how light travels from a source in straight lines and cannot pass through opaque objects.

PA Science and Technology Standards

3.2.7 B Apply process knowledge to make and interpret observations.

- Design controlled experiments, recognize variables, and manipulate variables.

3.2.7 C Identify and use the elements of scientific inquiry to solve problems.

3.4.7 C. Identify and explain the principles of force and motion.

Background Information:

Shadows are cast on a surface when an opaque object intercepts rays from a source of light. The opaque objects reflect or absorb the light. Shadows are basically an area of partial darkness.

The sun produces light rays which strike the earth in a nearly parallel direction. As the earth rotates and revolves, the angle of the light rays changes, producing shadows of different lengths and directions at different times of day.

In this exploration, shadows will be circular if the shadow disks are held perpendicular to the light source. Changing the angle of the disk will change the shape of the shadow. The opaque disks will produce the best shadows.

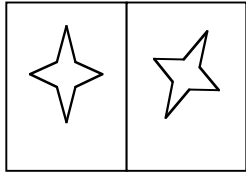
Relevance of the Lesson: This is a beginning lesson in a unit on the nature of light. By learning about shadows we conversely learn about the nature of light and how it travels from its source, the sun. Please refer to the Important Ideas developed for this unit further on in this document.

Pre-Test:

1. Students will complete the first two columns of the KWL activity. This is an individual assessment of their knowledge of shadows.
2. Complete the pre-test assessment on identifying the direction of the light source and time of day for the happy face graphics. (attached)

Pre-Lab Activity (Anticipatory Set or Motivation):

1. In small groups, students will complete a double shadow activity. First, draw and cut out a 4 point star. Use it as a pattern to cut two 4 point stars on a piece of stiff paper like oaktag. Fold the paper in half lengthwise. Position the stars at the same height on each half of the paper. The points in one star should be up and down, while the points of the other star should be placed on a diagonal. Next, cut out the stars. Now shine a light through the paper at various distances until you have projected an 8 point star on a wall or screen behind your shadow template. You have created a double shadow!



2. Students draw their shadows on the sidewalk with chalk at different times of the day, noting differences in size, shape, and position.

Procedure:

1. The following materials will be set out for groups of four to six students:
cereal box with white paper taped to it (screen)
flashlight, with its lighted end covered with foil. A pencil-sized hole is poked in the middle.
shadow disks of various sizes and shapes
construction paper of different colors
2. The Four Question strategy will be followed, allowing students to design an investigation about shadows. Before students begin their experiment, they must complete the Four Question strategy sheet, and complete an Experimental Design Diagram, which includes an hypothesis, a title, and identification of the independent variable, dependent variables, and controls.
3. Students should bring their Experimental Design Diagrams to the teacher before proceeding with their experiment.

Post-Lab Experience

1. Each group presents their experimental design, results, and conclusions to the class.
2. Class discussion will produce a list of further questions to explore through inquiry or research.
3. At this point the teacher should make certain that the concepts are correctly understood and that the appropriate science vocabulary is presented.

Worksheets:

KWL The KWL Chart is used at the beginning of the lesson to assess the students' beginning background knowledge. The third column "What I Learned" may be used as an informal post-assessment. It could also be used part of the way through the lesson to gauge student progress.

What I Know	What I Want to Learn	What I Learned

The Four Question Strategy Guide is used within the lesson as an organizer, but a final, complete copy will also serve as an assessment tool.

Four Question Strategy Guide
Me and My Shadow, or How do Shadows Behave?

Question #1: What materials are readily available for conducting an experiment on shadows?

Cereal boxes Assorted colors of construction paper Pencils
Flashlights Aluminum foil circles Shadow disks

Question #2: How do shadows act?

Question #3: How can I change the set of shadow materials to affect the action?

Question #4: How can I measure or describe the response of the shadow to the change?

The Experimental Design Diagram is used within the lesson as an organizer, but a final, complete copy will also serve as an assessment tool.

Experimental Design Diagram

Title of Experiment: _____

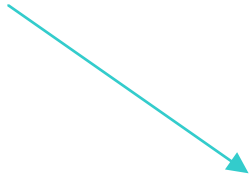
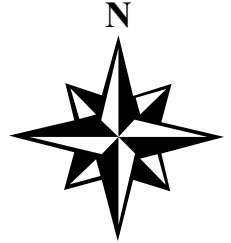
Hypothesis: _____

Independent Variable:				
# of Trials				
Dependent Variable: _____				
Controls: _____				
Conclusions:				

New Questions: _____				

Me and My Shadow
Pre-Test and Post-test Assessment

Directions: 1. Use arrows to show the direction of the light source in each picture.
2. Indicate the time of day---morning, noon, or evening.



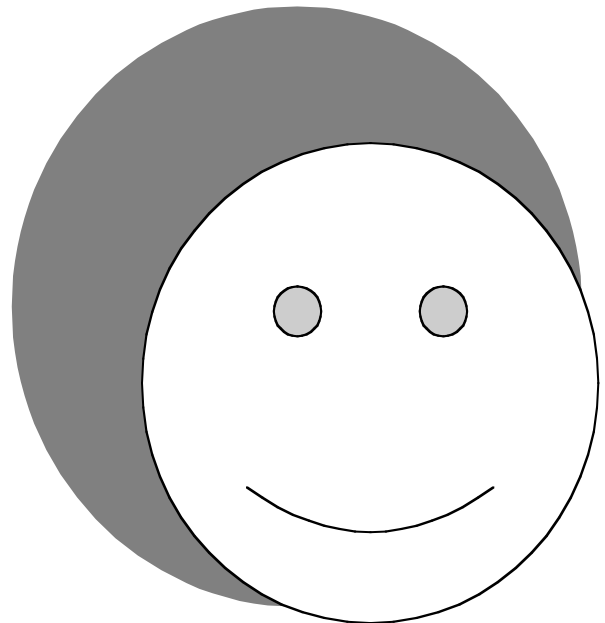
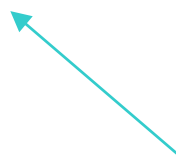
(afternoon)



(late afternoon)



(morning)



(late Morning)

Assessment Rubrics:

Four Question Strategy

Assessment Rubric			
Four Question Strategy			
Me and My Shadow, or How do Shadows Behave?			
Name: _____			
Class Period: _____			
Date: _____			
	Scoring Guide:		
	Q1 is given; 33% credit for each Q2-4		
	(33)	(25)	(20)
	Excellent	Good	Poor
Q #1: What materials are readily available?			
Q #2: How do shadows act?			
Q #3: How did I change the materials?			
Q #4: How did I measure or describe the response of the shadow to the change?			
Consider: Was the approach realistic?			

**Assessment Rubric
Experimental Design Diagram:**

**Assessment Rubric
Experimental Design Diagram
Me and My Shadow, or How do Shadows Behave?**

Name: _____

Class Period: _____

Date: _____

Requirements/ Criteria	Excellent (10)	Good (8)	Poor (6)
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- | | | | |
|--|--|--|--|
| <p>1. Title
Clearly sets the topic</p> <p>2. Hypothesis
Attempts to explain things in terms of a relevant idea from previous experience.</p> <p>3. Identify the Independent Variable</p> <p>4. Identify the Dependent Variables</p> <p>5. List the Control(s)</p> <p>6. Repeated Trials
3 = excellent 2 = good 1 = poor</p> <p>7. Conclusions
Do your conclusions relate to your original questions?</p> <p>8. New Questions
Do your new questions arise from your completed investigation?</p> <p>9. Creativity/Complexity</p> | | | |
|--|--|--|--|

Web Resources:

Web Address	Identification	Description
www.nsf.gov	National Science Foundation	Inquiry Based Foundation Workshops
www.sln.org	Science Learning Network	links to science museums
www.exploratorium.edu	Exploratorium	Many Science inquiry based activities are found here, including “light walk.”
www.unt.edu	Electronic Journal of Science Education	Science education articles
www.mursuky.edu	Kentucky Academy of Technology Education	templates to inquiry lesson plans
www.miamisci.org	Miami Museum of Science	“Atoms Family” Dracula Library on light topics
www.ericse.org	Abstracts about hands- on Science Teaching	
www.learners.org	frequently asked questions about inquiry	

Additional Resources:

Seeing in a New Light NASA

Space Based Astronomy NASA

Light, Color and Their Uses NASA Project LASER

TOPS Learning System Activities

“Color and Light” Adventures in Science Series Educational Insights 1990

Students and Research. Cothron, Julia H., Giese, Ronald N., Rezba, Richard J. Kendall/Hunt Publishing Company, third edition, 2000.