Lesson Focus
This lesson develops principles of the effect of sunlight on the Earth’s surface. Students will explore the effects of the location of the sun on shadow formation, and design and build a structure to hide a groundhog’s shadow.

Age Levels
◆ 5-8

Objectives
◆ All children will make observations to determine the effect of sunlight on the Earth’s surface
◆ All children will use tools and materials to design and build a structure that will block the light from the sun.
◆ All children will develop a simple sketch, drawing.
◆ Most children will be able to use their own words to describe the activity and the effects of the sun on the Earth’s surface.

Anticipated Learner Outcomes
Students will be able to:
◆ Design a model/prototype to protect an animal from the sun
◆ Describe the effects of the sun and identify shadows

Alignment to Curriculum Frameworks
See attached curriculum alignment sheet.

Recommended Reading

Optional Extension Ideas
◆ Shadow Puppets: Cut figures from paper and glue to a craft stick to make puppets. Create shadows on the wall using a flashlight. Students can create a story to accompany their puppets and present as a play to the class.
Playground Chalk Drawing: On a playground with chalk, encourage students to create, trace, and label shadows. If the shadow traced is from a permanent object (basketball stand, trash barrel, mailbox), take students out a few hours later to see how the shadows have moved from the chalk lines created earlier.
For Teachers: Teacher Resource

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Students will be able to:
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Activity 1: Shadow Walk

Materials
- clipboard
- paper
- pencils

Procedure
1. Give each student a partner, clipboard, one or two crayons, and piece of paper labeled “shadows”
2. Tell them that they are going on a walk around the block. As they walk, ask them to pay attention to the shadows shape and location.
3. Find some interesting shadows that are close to each other. Have them compare shadows, consider which ones are bigger, or different shapes, and why. Ask students to see whether all shadows are the same size as its object.
4. Have student draw the object, the shadow, and the location of the sun on their paper.
5. Ask questions regarding the different shapes and sizes of shadows that they see.
6. Bring them back to classroom and have them share their work with the class – record observations.
7. Discuss - Where were the shadows? Will they be in the same place after school? Why not? Why were shadows different sizes? What
Activity 2: Shade the Groundhog

**Materials**
- Flashlight
- Stuffed or plastic toy animal (2-3 inches)
- Plastic wrap
- Cotton balls
- Craft Sticks
- Rubber bands
- Straws
- Paperclips
- Paper towel rolls (not paper towels)
- Balloons
- Crayons
- Pipe cleaners
- Clear Tape
- Ruler

**Procedure**

1. Present the challenge to the class and explain that the Groundhog Day legend says that when the groundhog sees his shadow, it means another six weeks of winter.
2. Display the toy animal to students and ask them to write down the dimensions of the toy. Explain that the students will be working in teams to design and build a structure to prevent the groundhog from seeing its shadow. Add that the structure needs to be designed with a door that the toy they see can fit through to enter the shelter.
3. Explain to students that they will have 40 minutes to design and build their structure.
4. Explain that they have limited materials to use, and provide the dimensions of the toy/stuffed animal, but do not allow students to test their design using the actual toy animal…just provide the dimensions.
5. After students look at all the materials available, they should be encouraged to sketch their initial design.
6. Once they all agree on the design for their structure, they can gather materials and begin building.
7. Encourage students to carefully measure their door opening and use a flashlight to test the opacity of their design.
8. Once all groups are done, shut off all the lights, have the students put the groundhog in their structure and test the opacity of the structure using a flashlight.
9. Lead a group discussion touching on questions such as:
   ◆ What materials did each group use? Why?
   ◆ After testing your structure, would you have changed the original design? How? What could have been improved?
   ◆ Which designs of other teams inspired you? Why?
For Students: Student Resource and Design Space

◆ Key Vocabulary
Sun – A ball of gas that gives us heat and light
Shadow – A dark shape made when an object comes between light and surface
Shade – Darkness and coolness caused by shelter
Opaque – A material that does not allow light to pass through it
Solar Power – Energy that comes from the sun
Prototype – A model
Design – A plan to create

◆ Design Space
Use the space below to draw your team plan for the groundhog structure:
For Teachers: 
Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:
- U.S. Next Generation Science Standards (www.nextgenscience.org)
- U.S. Common Core State Standards for Mathematics (www.corestandards.org/Math)
- International Technology Education Association’s Standards for Technological Literacy (http://www.iteea.org/TAAPDFs/xtnd.pdf)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆ Next Generation Science Standards - Grades K-2 (Ages 5-8)
  K-PS3-1 Energy
  ◆ Make observations to determine the effect of sunlight on Earth’s surface/
  K-PS3-2 Energy
  ◆ Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on Earth’s surface.
  K-2-ETS1-1 Engineering Design
  ◆ Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
  K-2-ETS1-2 Engineering Design
  ◆ Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

◆ Next Generation Science Standards - Grades K-2 (Ages 5-8)
  K-2-ETS1-1 Engineering Design
  ◆ Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
  K-2-ETS1-2 Engineering Design
  ◆ Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.