Shadows and the Rotation of the Earth (Teacher Guide)

Objective:
Students learn that the relative motion of the Sun in the sky (due to the rotation of the Earth) changes the direction and length of shadows throughout the day.

In this activity, only the daily change in shadows is considered without the complication of how they change seasonally. This activity will also help to teach/practice the use of a 24-hour clock (also commonly known as military time) that is frequently used for recording scientific data. Additionally, the activity also introduces compass directions and how these are used to record scientific data.

Part 1. Observation of shadows during a day

Objective: Collect shadow data and portray in graphical form to reveal the pattern of change in the length and direction of shadows during the day.

Materials

- Flat outdoor surface
- Compass
- Compass rose printed on tabloid paper
- Straw
- Putty
- Data sheet

Mount the printed compass rose on a flat surface such as on a sheet of cardboard or foam core. In the center of the compass rose, put a piece of putty and insert the straw so that it is vertical. Use the compass to find North and orient the board so that the compass rose correctly shows the cardinal directions. You may want to stabilize the board so that it is not moved by the wind by setting a book on it. Over a period of a day, draw the shadow directly on the printed sheet to record the length and position of the shadow of the rod approximately each hour. The time for each shadow can also be recorded directly on the sheet. This activity may be run over multiple class periods during the day to collect data at different times. In addition, the data can be collected one day and analyzed on the next day.

Students may portray the data graphically in different ways:

1. Draw the shadows on a diagram indicating compass directions. Students can also indicate the relative length of shadows on the diagram by establishing a scale.
2. Plot a histogram (bar chart) of the length of the shadow during the day.
3. Plot an x-y plot showing length of the shadow as a function of the time of day.

Is there a pattern to the change in direction of the shadow during the day?

[Answer: The shadow moves from pointing to the west during the morning to pointing to the east in the afternoon.]

Is there a pattern to the change in the length of the shadow during the day?

[Answer: Shadows are longer in the morning and shorten as noon approaches. Then the shadow becomes longer throughout the afternoon.]

Part 2: Modeling shadows

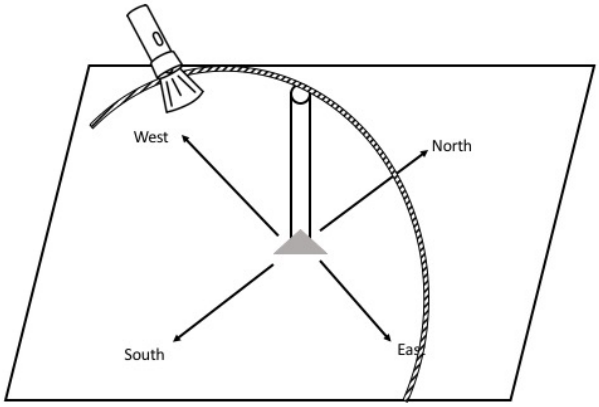
Objective: Create a classroom model to explain the pattern of shadows observed in Part 1.

Materials

- Modeling clay
- Short "test" pencils
- Compass
- Large sheets of paper
- Flashlights

Instructions

- Students should put a small piece of modeling clay in the middle of the sheet of paper and insert a short pencil into the clay to model the meter stick in Part 1.
- Students can use a compass to determine the cardinal directions and draw them on the sheet of paper.
- Student will use a flashlight to represent the Sun and move the light in an arc to duplicate the patterns of shadows observed in Part 1.



In this model, students should understand that the pencil represents the straw in Part 1 and that the flashlight represents the Sun.

Notes:
The compass on a smart phone can be used in the activity.
A strong single LED flashlight can be used. Flashlights with multiple LED's result in multiple shadows and don't work as well. The flashlight on a smart phone can be used.