

Making a Sundial



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Purpose

Investigate the movement of the sun through the day and determine the time of local solar noon.

Overview

Students construct a sundial and use it to observe the movement of the sun through the sky over the course of a day by marking changes in the position of a shadow once each hour. Students determine the approximate time of solar noon at their school as indicated by the time of the shortest shadow. Students revisit the site on a subsequent day to estimate the time of day using their sundial.

Student Outcomes

Students will gain an understanding of the daily movement of the sun across the sky and experience conducting a set of simple, quantitative observations.

Science Concepts

Earth and Space Science

The diurnal and seasonal motion of the sun across the sky can be observed and described.

Geography

The physical characteristics of a location depends on its latitude and relation to incident solar radiation.

Scientific Inquiry Abilities

- Identify answerable questions.
- Design and conduct scientific investigations.
- Construct a scientific instrument.
- Develop explanations and predictions using evidence.
- Communicate results and explanations.

Time

Hourly measurements lasting 5 minutes during one sunny school day; 15 minutes to revisit the sundial on subsequent days; time for classroom discussion

Level

Primary and Middle

Materials and Tools

- Wooden dowel or similar pole at least 50 cm long
- Shadow markers (flags, rocks, sticks, nails, etc.)
- Meter stick

Preparation

None

Prerequisites

None

Background

Students may have noticed that when they arrive at school in the morning the sun is shining on one side of the school and when they leave in the afternoon it is shining on the other side. This occurs because the sun appears to travel across the sky each day.

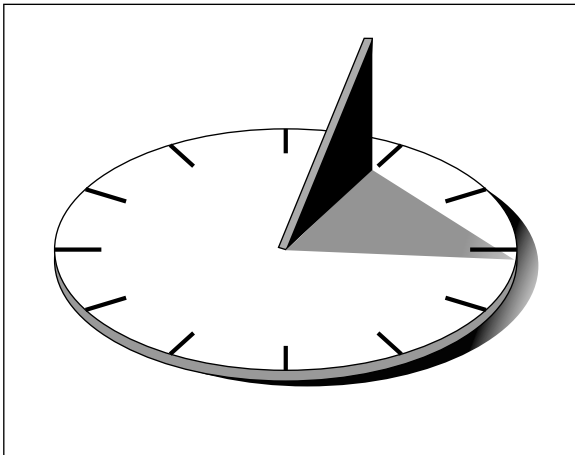
Before the invention of clocks, people used this motion of the sun to determine the time by making sundials. Sundials are simply stationary vertical objects, such as a pole, placed on a flat surface.

The pole is known as a *gnomon* (NO-mon) and the flat surface as a *dial*. As the sun travels through the sky, the length and position of the shadow cast on the *dial* by the *gnomon* change. The shadow is longest at sunrise and sunset and is shortest at local solar noon.

In this activity students will make a sundial by marking the position of the shadow cast by a *gnomon* every hour for one school day. They will return to their dial on a subsequent day to see if they can predict the time of day from the sundial they made.



Figure AT-SU-1



What To Do and How To Do It

1. Select a day that will be sunny for at least seven hours starting when school begins.
2. Take the students outside to a relatively flat spot on school grounds that will be out of the shadow of buildings and trees until the end of the school day. Place the pole in the ground making certain that it is perpendicular to the ground using a plumb bob (a piece of string with a weight on it) or a level. Measure and record the height from the ground to the top of the pole.

3. Have the students put a #1 on the first object (rock, flag, etc.) they will use to mark the position of the shadows. Ask the students to place the marker on the ground at the end of the shadow and to record the time from their watches.
4. The students should measure and record the distance from the base of the gnomon to the end of the shadow in the table provided. (Optional: have the students measure the angle as well using a compass.)
5. Have a few students visit the gnomon at least once an hour for the remainder of the school day. The students should measure the length of the shadow (and the optional angle), place a new numbered marker at the end of the shadow and record the time of day.
6. Ask the students to use the table to determine which marker is closest to the pole. This is the time of the shortest shadow and is the observation closest to solar noon. If you have the time, you could have the students take more frequent measurements around the time of this observation on the following day to get a better estimate of solar noon.

Figure AT-SU-2:

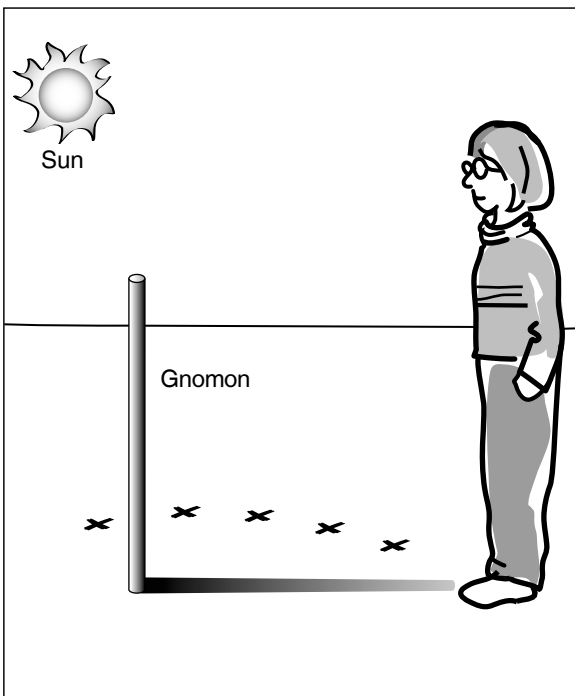
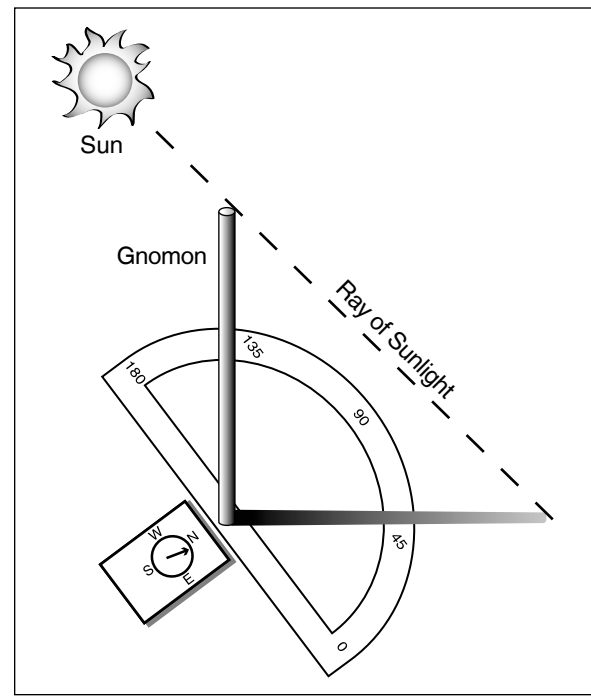


Figure AT-SU-3:



7. Visit the sundial on another day in the same week. The students should bring their completed tables. Have the students look at the shadow being cast by the pole and estimate from their tables what the time on their watches will be. Ask each student to write down his or her estimate. Have the students look at their watches to find out how close their estimates were.

Questions

1. What is the path of the sun as it moves across the sky?
2. Does the path of the sun across the sky and the pattern of the shadows from the gnomon on the dial change during the year? (The answer could form the basis

for a hypothesis that the students could test experimentally.)

Adaptations for Older Students

Older students can observe the changing angle of the sun above the horizon. By measuring the height of the gnomon and the distance from the top of the pole to the end of the shadow (the hypotenuse of the triangle), students can determine the angle of the sun using simple geometry for similar triangles. Have the students add a column to the table and fill in the solar elevation angle for each time they placed a marker. When is the solar elevation the greatest? the smallest? Could they have predicted this from the length of the shadows?

Date _____

Description of Sundial Site _____

Weather Conditions _____

Height of the gnomon (pole) _____

Marker #	Time	Length of shadow cast by the gnomon	Optional: Compass angle of the shadow

Estimated time of solar noon _____