

Make a Sundial



Grades: 3-5

Subjects: Science, Social Studies, Math

Time: 60 minute session plus additional outdoor observation sessions during the day

***Standards:** Students will...

Technology Standard 3: Understand the relationship among science, technology, society and the individual.

Benchmark # 8: Know that people have invented and used tools throughout history to solve problems and improve ways of doing things.

Technology Standard 4: Understand the nature of technological design.

Benchmark # 6: Use appropriate tools, techniques and quantitative measurements to implement proposed solutions.

Science Standard 12: Understand the nature of scientific inquiry.

Benchmark # 3: Plan and conduct simple investigations.

Benchmark # 4: Use appropriate tools and simple equipment to gather scientific data and extend the senses.

Geography Standard 7: Know the physical processes that shape the patterns on Earth's surface.

Benchmark # 3: Know how Earth's position relative to the Sun affects events and conditions on Earth (e.g., how the elliptical orbit of the Earth around the Sun results in solar time varying from clock time).

History Standard 7: Understand selected attributes and historical developments of societies in Africa, Asia and Europe.

Benchmark # 5: Knows significant historical achievements of various cultures of the world (e.g., the development of scientific instrument, such as the sundial).

Mathematics Standard 5: Understand and apply the basic and advanced properties of the concepts of geometry.

Benchmark # 6: Understand characteristics of lines (e.g., parallel, perpendicular, intersecting) and angles.

Objectives: Students will be able to...

- Explain how energy from the Sun has been used over time to improve the way people do things (e.g., sundials to tell time, solar cookers/stills to prepare food and water for consumption, solar power to generate electricity).
- Describe how a sundial works and how it can be used to tell the time.
- Differentiate between solar time and clock time, and explain why they vary.
- Make observations, record and interpret data.

Materials:

- Nine inch paper plates- white
- Plastic drinking straws
- Pencils (multiple colors)
- Sidewalk chalk (2 colors)
- Compasses (a couple of compasses can be shared by the class)
- Scissors
- "Make a Sundial Chart" provided below
- A copy of "Anno's Sundial" by Mitsumasa Anno

Overview: The Sun releases heat and light that reaches us here on Earth and provides us with an abundance of energy. This solar energy is what makes life on Earth possible. It is a renewable resource, available in inexhaustible amounts, and it has many applications. One of the first applications was to use sunlight to tell time.

No one knows who invented the first sundial, but one thing is clear, ancient man recognized the heat and light from the Sun could help him survive and thrive. A sundial is one example of how the energy of the Sun was first used. It is perhaps the oldest scientific instrument found to date. Archeological evidence indicates the earliest sundial is of Egyptian origin and places its appearance around 1,500 BC. Similar evidence suggests that the Greek civilization further developed the Egyptian's design and improved its accuracy, while the Romans made great public displays of the sundials they brought back from Egypt. Though much of the sundial technology was lost during the "Dark Ages" it was rediscovered in the Middle East during the "Middle Ages" and brought back to the Europe.

A sundial in a very practical sense is an instrument for telling time in an exact location, although many are beautifully crafted and used as ornamentation as well. A sundial has a pointer, called a gnomon that casts a shadow on the surface surrounding it when struck by sunlight. This shadow moves in a predictable path throughout the day. This path can be divided into equal segments, marking the hours to indicate the time. However, because the Earth follows an elliptical orbit around the sun and is tilted on its axis, the shadow's path changes causing the shadow to move at different speeds and locations during different times of the year. As a result a sundial keeps what is known as solar time, which varies somewhat from clock time kept by mechanical timepieces.

Kid's Speak: The Sun is a source of energy and gives off both heat and light. Sunlight can help us tell time. The time of day can be found from the position and length of a shadow that is created by sunlight. A shadow is cast when energy from the Sun, in the form of sunlight, strikes a pointer called a gnomon. This part of the sundial casts a shadow onto a flat base that is divided into equal segments. Where the shadow falls indicates the time of day. At noon, when the sun is directly overhead and highest in the sky no shadow can be seen.

Eco-Fact: The largest sundial on Earth was built in India in 1724. Its base covers almost one acre of land and its gnomon exceeds 100 feet in height.

Procedures:**Before Making the Sundial:**

- Read the book, "Anno's Sundial" by Mitsumasa Anno. Discuss the concepts of solar time and how it was one of the first applications of solar energy.
- Tell students they are going to work with solar energy by making their own sundials. Provide a brief history of the sundial and compare it to other applications of solar energy used today.
- Distribute the materials and the worksheet that has been provided.

Making the Sundial:

1. Have students fold their paper plate over so one half is completely covering the other. Have them pinch the center, making a small crease. Open the plate. Turn the plate so the crease facing them is vertical.

Now fold the plate once again so the vertical crease is divided in two horizontally. Pinch the center. When the plate is reopened there should be two intersecting crease lines. The point of intersection is the center of the plate. Have students make four marks, equidistant from one another, around the perimeter of their plates using the crease lines as guides. Three of the marks should be in one color and the fourth in a different color. The four marks represent the times of day: 12, 3, 6, and 9.

2. Have students pinch one end of the straw in half. Make a half-inch cut up from the bottom on each fold line. Press the cut ends together and make another half-inch cut in the middle of the two pieces. This will give the students four flaps at the end of the straw. Next have students bend back the cut pieces and tape them to the center of their plates lining them up with the crease marks and making the straw perpendicular to the plate. Measure and cut the straw to a two-inch height. The plate now represents the base of the sundial and the straw represents a gnomon.

After Making the Sundial:

Note: For the best results conduct this lesson when there is a good chance of fair weather several days in a row. This will assure the chalk markings from Day 1 are not washed away prior to the second day of observations.

1. Take students outside as early in the morning as possible. Select a sunny area of pavement where the students can test their sundials. Have students place their sundials down and with chalk make four lines that extend the lines on their plates. The line that is a different color should be marked on the pavement as well. If you do not have two colors of chalk the students can make a circle at the end the line that represents the colored line on the paper plate. The point is that the lines all match up in the same place each time the students go out to measure, so that they take an accurate reading.

2. Ask students to trace the shadow their gnomon casts onto their sundial base. Then have students mark the time of day on their worksheets and on the sundial. Have students measure and record the length of the shadow and use the compass to find the direction in which it points, North, South, East or West.

3. Ask students to pick up their sundials, and put their name on the spot where it was placed so they are sure they are using the same location on the next three observations.

4. Repeat step 4 late morning, early afternoon and just before school dismissal.

5. On the next sunny day, repeat steps 4 and 6 using a different color pencil to mark the shadows on the sundial. Make sure you take the students out at the same times of day.

After Using the Sundial:

- Compare and discuss the results of their observations. If the observations were made at the same time on both days why were the shadows not in the exact position? What did the students notice about the length of the shadows? What conclusions can they draw?

Adaptations: Have students trace each other's shadows at different times during the day and compare lengths and positions. In this case the student that is casting the shadow becomes the gnomon.

Extensions:

- To learn more about solar time compared to clock time visit, www.sundials.co.uk/equation.htm
- Read "Tools of Timekeeping: A Kid's Guide to the History and Science of Telling Time" by Linda Formichelli.

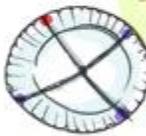
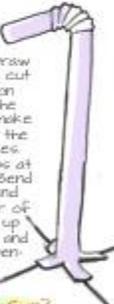
GEF Community: Join the GEF Community online. It only takes a minute. Share pictures of your sundial activity with other GEF Community students.

Make a Sundial

You will need:

- 9" white paper plates
- Plastic drinking straws
- Pencils
- Sidewalk chalk (2 colors)
- Compasses
- Scissors



1. Fold the paper plate over so one half is completely covering the other. Pinch the center, making a small crease. Open the plate. 
2. Turn the plate so the crease facing you is vertical. Now fold the plate once again so the vertical crease is divided in two horizontally. Pinch the center. When the plate is re-opened there should be two intersecting crease lines. 
3. The point of intersection is the center of the plate. Make four marks, equidistant from one another, around the perimeter of the plates using the crease lines as guides. Three of the marks should be in one color and the fourth in a different color. The four marks represent the times of day 0, 3, 6, and 9. 
4. Pinch one end of the straw in half. Make a half-inch cut up from the bottom on each fold line. Press the cut ends together and make another half-inch cut in the middle of the two pieces. This gives you four "pegs" at the end of the straw. Bend back the cut pieces and tape them to the center of their plates lining them up with the crease marks and making the straw perpendicular to the plate. 

Time of Day	Length of Shadow	Where is the Sun?

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