

Physics:

Sundial Science



MAIN IDEA

Discover how the sun and its shadow is used to tell time by creating a sundial – an instrument that tracks the position of the sun to indicate time of day.

SCIENCE BACKGROUND

For centuries humans, have utilized the power of the sun as a light source, to grow food, and to tell time. Ancient civilizations used the sun to understand basic astronomy. By tracking the height of the sun in the sky, these civilizations developed calendars for the year and were able to identify harvesting and planting seasons (fall and spring equinoxes) all by tracking the movement of the sun. This also helped certain civilizations find the Equator, an imaginary circle around the Earth that divides it into two halves, the northern and southern hemisphere. By tracking the sun's apparent position through the creation of sundials, these ancient civilizations were able to divide the day into morning and afternoon. A sundial is a device used to track time by marking a shadow on its surface as the sun moves.

Light travels as a wave, similar to waves in the ocean. Shadows occur when this light wave is blocked by an object, creating a dark silhouette of that object on nearby surfaces as light continues to travel all around the object. Based on where the light source is, and the object that is blocking it, the shadow will look different. This is why for a sundial, the shadow will change throughout the day and even more noticeably throughout the year for the same time of day. A sundial's latitude also plays an important role in how the shadow will look. The latitude is the angular distance a location is north or south of the Equator, from 0° (Equator) to 90° (north or south pole). Think of shadows on a wall. If you change the position of the light source, such as a flashlight, you can observe how the shadows change. This can mimic the movement of the sun in the sky based on time of day and throughout the year!

The Earth takes 23 hours, 56 minutes, and 4.09 seconds to rotate from west to east, with daylight hours varying based on time of year and latitude. A classic sundial will have 12 markings similar to a clock, and thus the shadow of the sun will pass over each marking up to two times a day. Some shadows will only occur once a day as the sun is not visible during nighttime, meaning that there is no light to block and there would not be a shadow.



MATERIALS

Compass or Compass App
Smartphone App

Marker

Paper plate

Pencil or Stick

Ruler

Tape

ACTIVITY PROCEDURE

Note: This activity is ideal on a sunny, cloudless day. It is recommended that you begin prior to noon and continue through the afternoon.

Step 1: Use a ruler to help you to locate the center of the plate. Mark the center with a pencil.

Step 2: With adult supervision, poke a hole directly through the center of the plate.

Step 3: With the raised side of the plate facing up, place the pencil through the plate so it is standing up.

Step 4: Use tape to attach the pencil to the plate on both sides so it is sturdy.

Step 5: Next, draw an arrow on the edge of the plate pointing outwards towards the edge, label this with a “N” for north.

Step 6: Take your sundial, marker and compass outside and locate a sunny area. Try to find an area that will remain sunny for the majority of the day.

Step 7: Using the compass (or Compass App on a smartphone), determine which direction is North (N). Place your sundial on the ground with the north arrow facing North.

Step 8: Observe where the shadow is created by the pencil on the plate. Use your marker to trace the pencil’s shadow on the plate. Write the exact time next to the shadow on your plate.

Step 9: Secure your plate on the ground and return throughout the day to follow the pencil’s shadow noting the exact time for each shadow line traced. You can do this until you have all 12 times noted or pick your favorite times of day and just record those.

- ✔ Compare your traced lines. Is the shadow moving?
- ✔ Does the sundial remind you of anything?

Your sundial will be unique to your location, creating a fun way for you to literally watch the time pass.



EDUCATIONAL STANDARDS

Kindergarten

Big Idea 5 – Earth in Space and Time

SC.K.E.5.2 – Recognize the repeating pattern of day and night.

SC.K.E.5.3 – Recognize that the sun can only be seen in the daytime.

Grade 1

Big Idea 5 – Earth in Space and Time

SC.1.E.5.4 – Identify the beneficial and harmful properties of the sun.

Grade 2

Big Idea 7 – Earth Systems and Patterns

SC.2.E.7.1 – Compare and describe changing patterns in nature that repeat themselves, such as weather conditions including temperature and precipitation, day to day and season to season.

Grade 4

Big Idea 5 – Earth in Space in Time

SC.4.E.5.3 - Recognize that the Earth revolves around the Sun in a year and rotates on its axis in a 24-hour day.

ADDITIONAL RESOURCES

A Walk Through Time – Early Clocks, NIST

nist.gov/pml/time-and-frequency-division/popular-links/walk-through-time/walk-through-time-early-clocks

Shadow Season, PBS Blog

pbs.org/wnet/nature/blog/shadow-season/

Changing Shadows, NASA

sunearthday.nasa.gov/2007/materials/changing_shadows.pdf

