Equatorial Sundial

National Science Education Standards

- Content Standard in 5-8 Earth and Space Science (Earth in the solar system)
- Content Standard in 5-8 Science as Inquiry (Abilities necessary to do scientific inquiry)

Egyptian Stonehenge

Summer arrives in the northern hemisphere today, as the Sun appears farthest north for the entire year.

In centuries long past, skywatchers around the world watched for the solstice at special observatories — circles of stones. The most famous is Stonehenge in England, but circles of much smaller stones were found in the Americas, too.

The oldest of these stone observatories may have been built in southern Egypt, at a site called Nabta. It was used 6,000 years ago, and perhaps even earlier — at least a thousand years before Stonehenge.

Anthropologist Fred Wendorf of Southern Methodist University discovered the site in 1973. Last year, studies by Wendorf and Colorado astronomer J. McKim Malville confirmed that Nabta had an astronomical function.

Among other artifacts, the site contains a 12-foot-wide "calendar circle" of small stones. Two pairs of stones stand across the circle from each other. If you look through the spaces between each pair, you'll see the point where the Sun rose on the summer solstice thousands of years ago. This alignment was important to the people who lived at Nabta because monsoons brought a few inches of rain to the region soon after the solstice.

Over the centuries, though, the rains dried up and Nabta was abandoned. But the people of Nabta may have left a legacy. Their culture may have stimulated the formation of Egypt's Old Kingdom — the civilization that built the great pyramids.

This is the transcript of a StarDate radio episode that aired June 22, 2003. Script by Damond Benningfield, ©1998, 2003.

One of astronomy's first tools to measure the flow of time, a sundial is simply a stick that casts a shadow on a face marked with units of time. As Earth spins, the shadow sweeps across the face. There are many types of sundials; an equatorial sundial is easy to make and teaches fundamental astronomical concepts. The face of the sundial represents the plane of Earth's equator, and the stick represents Earth's spin axis.

Preparation

First, find your latitude and longitude and an outdoor observing site in a clear (no shadows) area. Determine north (from a map, or by finding the North Star at night and marking its location). Assemble the equipment as described below. Use a flashlight to demonstrate how to position and read the sundial indoors before going outside.

Materials and Construction

Each student team needs a copy of page 19 and a drinking straw.

Have the students cut out the Dial Face Template. Fold and glue the template, making sure the dial faces are lined up. Cut a cross in the center hole where the straw will be snuggly inserted. Mark the straw using the latitude strip as a guide. First mark the bottom of the straw at one end, then mark a line corresponding to your latitude. Place the straw in the template hole at the line marking your latitude. The south face of the template should aim toward the bottom of the straw. Make sure the stick and template are perpendicular. The straw should fit snugly; tape it in place if necessary.

Experiment

On a sunny day, take the sundial outside. Set it on a flat horizontal surface with the bottom of the straw and the folded edge of the template both resting on the ground. Aim the straw with the top pointing due north. (If done correctly, the straw will point at the celestial north pole, where we see the North Star at night.) Record the time on the sundial at least four times in one day, with measurements at least an hour apart. Each time, also record the "clock" time for your date and location. Try this experiment during different months.

Analysis

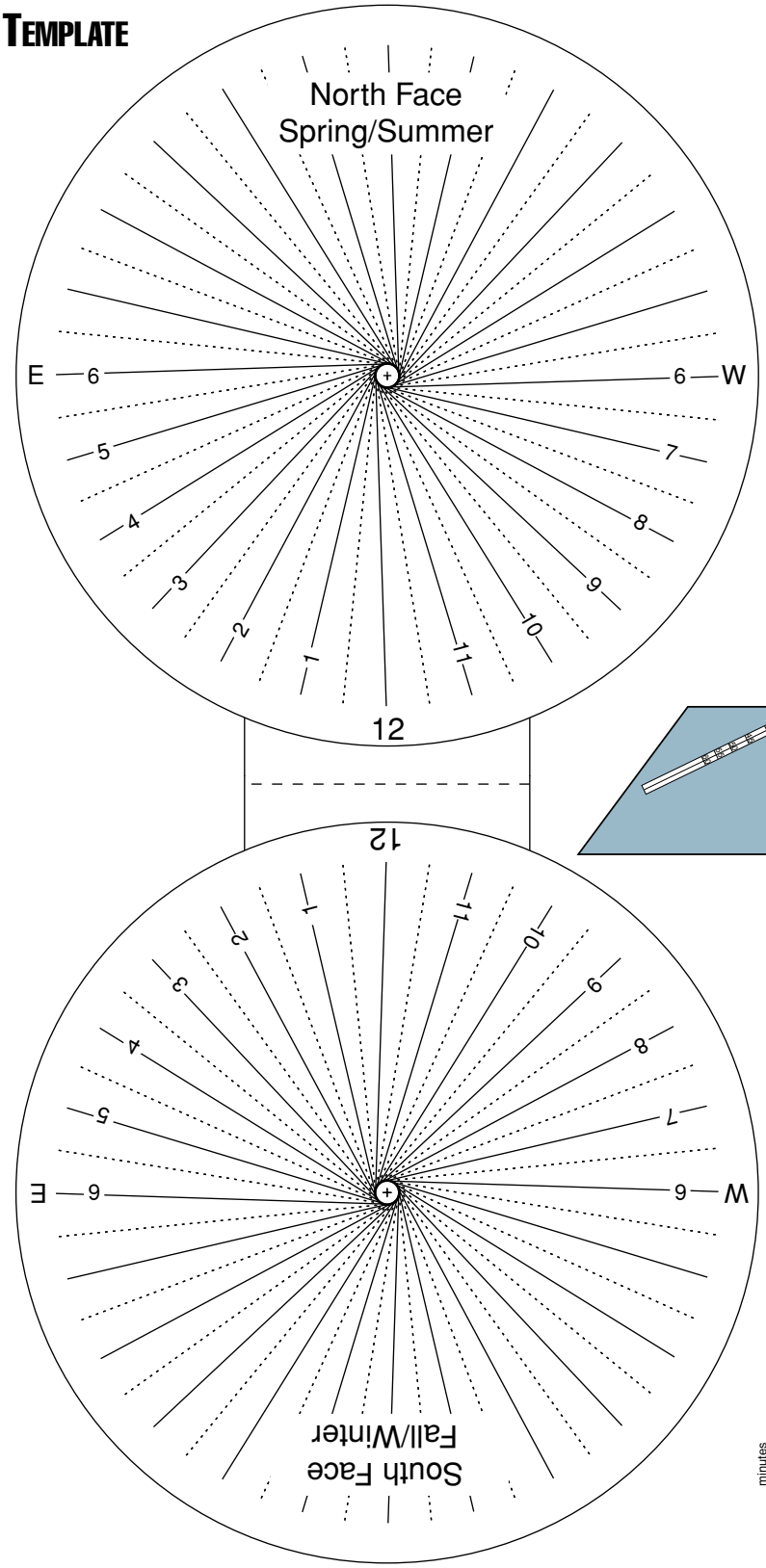
1. If the sundial time did not match clock time, explain why.
2. Why does this sundial have front and back dial faces?

Answers

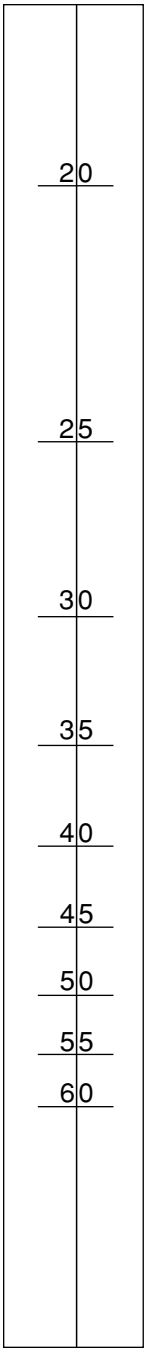
1. For each degree east or west of the center of your time zone (your longitude difference from the center of the time zone), there is a correction of four minutes. Also, the Sun's location in the sky changes with the seasons, and a correction of up to about 15 minutes for the "equation of time" must be made. Read the correction from the graph on page 19. Daylight Saving Time changes results by one hour.

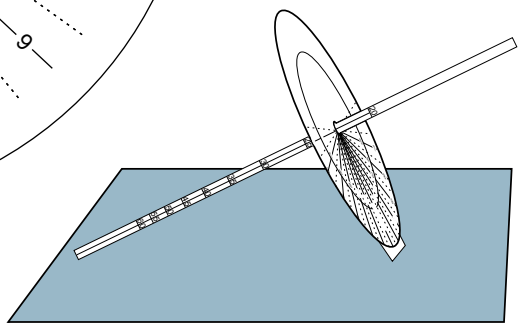
2. The shadow of the straw is cast on the north face from March 21 to September 21, and the south face from September 21 to March 21. The plane of the template is aligned with the celestial equator. The Sun is north of the celestial equator during the first period (spring and summer) and south of the celestial equator during the second (fall and winter).

Dial Face Template

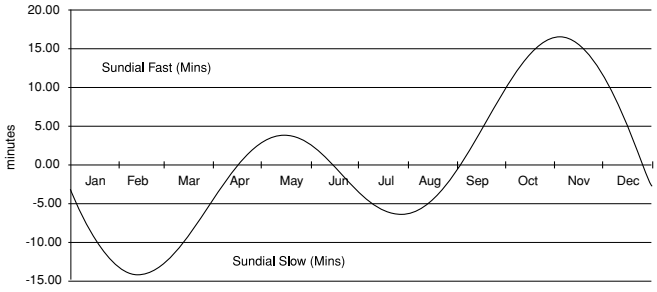


Latitude Strip





Finished Sundial



Correction for the "Equation of Time"

Equatorial Sundial

Subjects: Observing the Sky

Grade Levels: 6-12

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Texas Essential Knowledge and Skills

Science:

§112.18-grade 6 (b)-4(A) use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, and other equipment as needed to teach the curriculum.

§112.19-20- grade 7-8 (b)-3(C) identify advantages and limitations of models such as size, scale, properties, and materials.

§112.20-grade 8 (b)-7(A) model and illustrate how the tilted Earth rotates on its axis, causing day and night, and revolves around the Sun causing changes in seasons.

Astronomy, grade 9-12:

§112.33(c)-8(A) recognize that seasons are caused by the tilt of Earth's axis.

§112.33(c)-8(B) explain how latitudinal position affects the length of day and night throughout the year.

§112.33(c)-8(C) recognize that the angle of incidence of sunlight determines the concentration of solar energy received on Earth at a particular location.

§112.33(c)-8(D) examine the relationship of the seasons to equinoxes, solstices, the tropics, and the equator.