



Sun-Earth Day

Celebrate the Connection!

www.sunearthday.nasa.gov

Public Outreach: Make and Take Activities

Solar Clock

About this Activity

Build your own paper sundial and tell the time of day by using the Sun.

Right: A photo of a completed Solar Clock in the sunlight.



Preparation

This activity works best when the handout is printed on thick cardstock. Another option is to have the handouts on regular paper, and have the participant paste it to a manila folder before cutting and assembling.

To Do and Notice

- 1) Read the instructions to familiarize yourself with the process.
- 2) Have the participant begin by cutting off the half sheet where indicated on the handout.
- 3) On the base (the half sheet with "I Tell Only Sunny Hours"), carefully cut a slit up the middle line ("12") only up to the notch about 2/3 of the way up. Do not cut more than that!
- 4) On the gnomon half sheet, have the participant cut off and discard the corners. Then fold the gnomon in the middle along the dotted line so the curved lines are on the outside. Keep it folded and cut along the solid curved line and continue to cut to the edge of the sheet of paper. Do not cut along the dotted lines!
- 5) Fold along the dotted lines in the opposite direction than the original middle fold, like wings of a paper airplane. The "wings" should be flat on the table and the gnomon should rise above them like a shark fin.
- 6) Slide the gnomon into the slit on the base, with the tall, skinny tip of the gnomon pointing towards "12," until they are flush. Flip it over and tape the gnomon securely to the base.

Activity Notes

It is important to keep the gnomon perpendicular to the base, and to make the folds as crisp and neat as possible to create the best shadow for telling the time. It is also helpful to know where north is in your location. When the sundial is complete, orient the tip of the gnomon (or the top of the base) to the north, keeping the base parallel to the ground. Compare with your wristwatch to see how accurate your sundial is! Or better yet, use the sundial throughout the day to tell the time.

This activity is adapted from "From Stargazers to Starships" Educational Exposition. To learn more about sundials, follow the link under "Related Websites" below.

What You'll Need

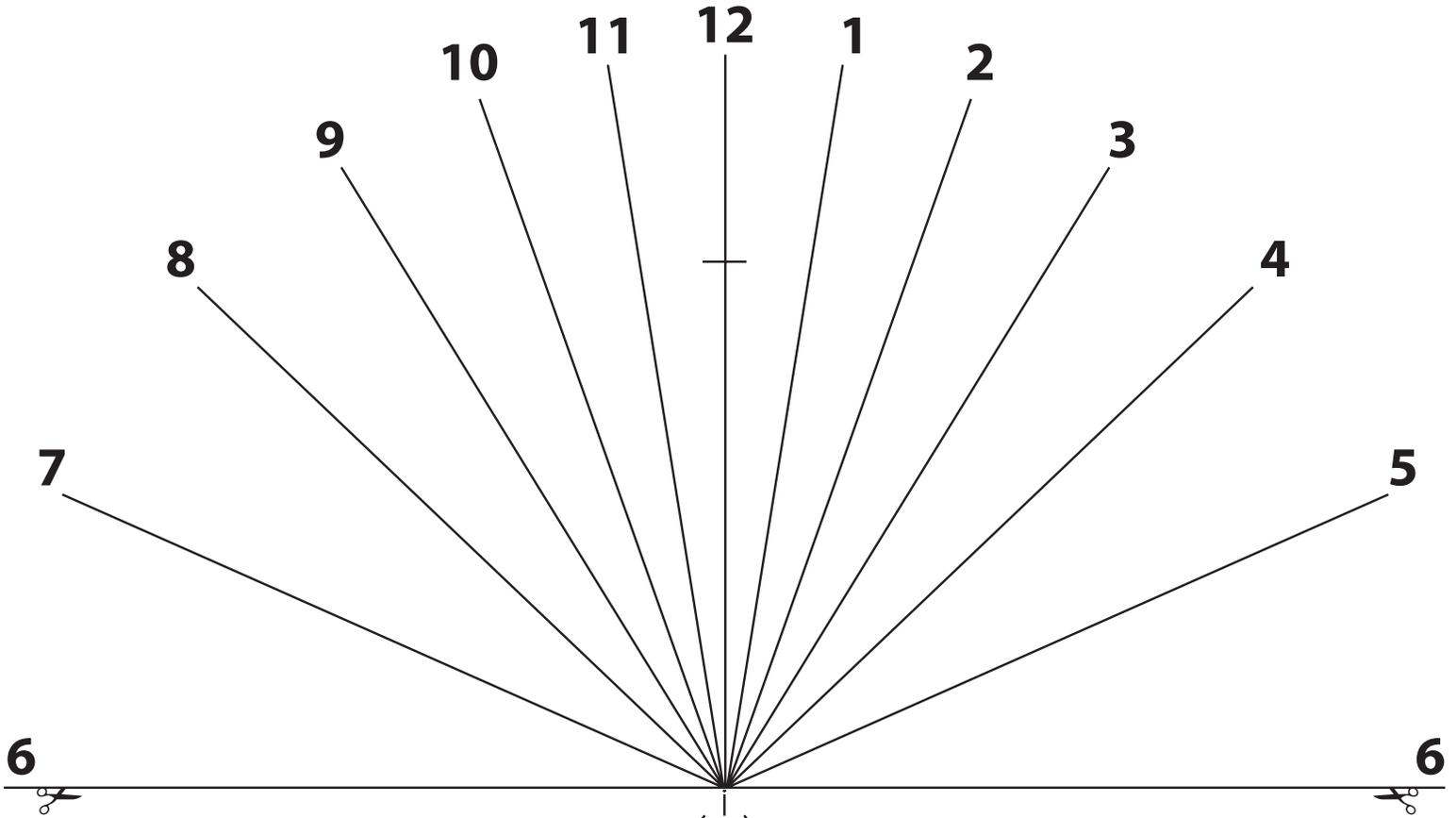
- White or light-colored Cardstock
- Copies of the Solar Clock handout (see next page) printed on cardstock
- Scissors
- Scotch Tape
- (optional) Manila Folders
- (optional) Glue sticks or paste

Related Websites

"From Stargazers to Starships" – More Information on Sundials:

<http://www-spof.gsfc.nasa.gov/stargaze/Sundial.htm>

I Tell Only Sunny Hours



Cut off half sheet

Fold on this line

Fold on this line

After folding along middle, cut double thickness along curved line.

Then fold along broken lines

Cut to bottom of page

Discard

Discard

Instructions (from <http://www-spof.gsfc.nasa.gov/stargaze/Sundial.htm>; more there.)

1. Cut the paper along the marked line: one half will serve as **base**, the other will be used to construct the **gnomon**.
2. In the gnomon part, cut away the two marked corners.
3. **Fold** that part at the broken line at its **middle, to get paper of double thickness**. The two other broken lines (leading to the cut-off corners) should remain visible. The line of the fold is the gnomon.

Note: In stiff paper, straight folds are helped by first scoring the paper: draw the line with a black ballpoint, guided by a ruler and pressed down hard.

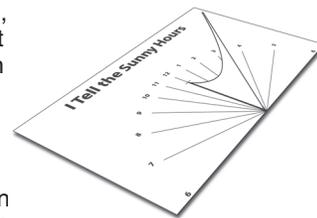
4. With the gnomon sheet folded at its middle, **cut out along the curved line**, cutting a double thickness of paper in one cut. The cut begins near the top of the gnomon-fold and ends on the secondary (broken) line. **Do not cut along the broken line** but connect the cut with the edge ("Cut to bottom of page"). No pieces come off.
5. **Fold** the gnomon sheet at the other two broken lines, in directions **opposite** to the one of the earlier fold. These folds should form 90-degree angles, not produce a double thickness.

If the two pieces on the outer side of the fold are placed flat on the table, the gnomon should rise above them.

6. In cut (4), the fin of the gnomon was separated from two pieces with curved outlines. **Fold** those pieces so that they, too, are flat with the table. One goes above the other, then fit the fin to fit into slots they form near the broken lines.
7. You are almost done. Take the **base** sheet, and note the **apex** where the hour-lines all meet (that is where the bottom corner of the fin will go). Carefully cut the sheet from this point along its middle line, up to the small cross-line marked on it. Do not cut any further!

The outlines of this sundial can also be downloaded from the world-wide web, at the above URL <http://www-spof.gsfc.nasa.gov/stargaze/Sundial.htm>. The site is part of an extensive educational exposition on **astronomy, space, spaceflight, the Sun and Newtonian mechanics**, titled "From Stargazers to Starships." It contains 90 main sections, plus a math course, glossary, timeline, lesson plans and more.

8. **Slide the fin** into the cut you made, all horizontal parts of the first sheet **below** the base sheet; only the fin sticks out. Its bottom corner should be at the apex. **Very important:** the fin must be **exactly perpendicular** to the base (you may have to widen the slot with a second sn otherwise, the sundial's time is wrong).



The sundial is now ready, but you might use tape on the bottom of the base-sheet to hold the two pieces together firmly. For further stability, and to prevent the sundial from being blown away, you may attach its base with thumbtacks, tape or glue) to a section of a wooden board or a piece of plywood.

9. Finally, **orient the fin** to point north. The shadow of the tip of the fin now tells the time.

A sundial should work equally well at any time of the year. Equinox is special because

- (1) The Sun rises exactly in the east and sets exactly in the west, both directions perpendicular to north; north could be defined as the direction of a flagpole's shadow when it is shortest. You may not get students to observe at sunrise but maybe they could do so at sunset. They could in any case use the shadow of a flagpole to determine north.
- (2) The length of the shadow at noon changes most rapidly at equinox. Draw a northward line from the flagpole on the ground, and mark on it the tip of the shadow. If students make 2 marks per week, they probably will see changes.
- (3) The location on the horizon of sunset (and sunrise) changes fastest at equinox.

"From Stargazers to Starships" found at URL <http://www-spof.gsfc.nasa.gov/stargaze/Sintro.htm> was written by Dr. David Stern, a scientist working in space research, at roughly the high school level.

It follows the historical thread of humanity's quest into space, from the early Greek astronomers to NASA and Sputnik, and to ideas still on the drawing boards.