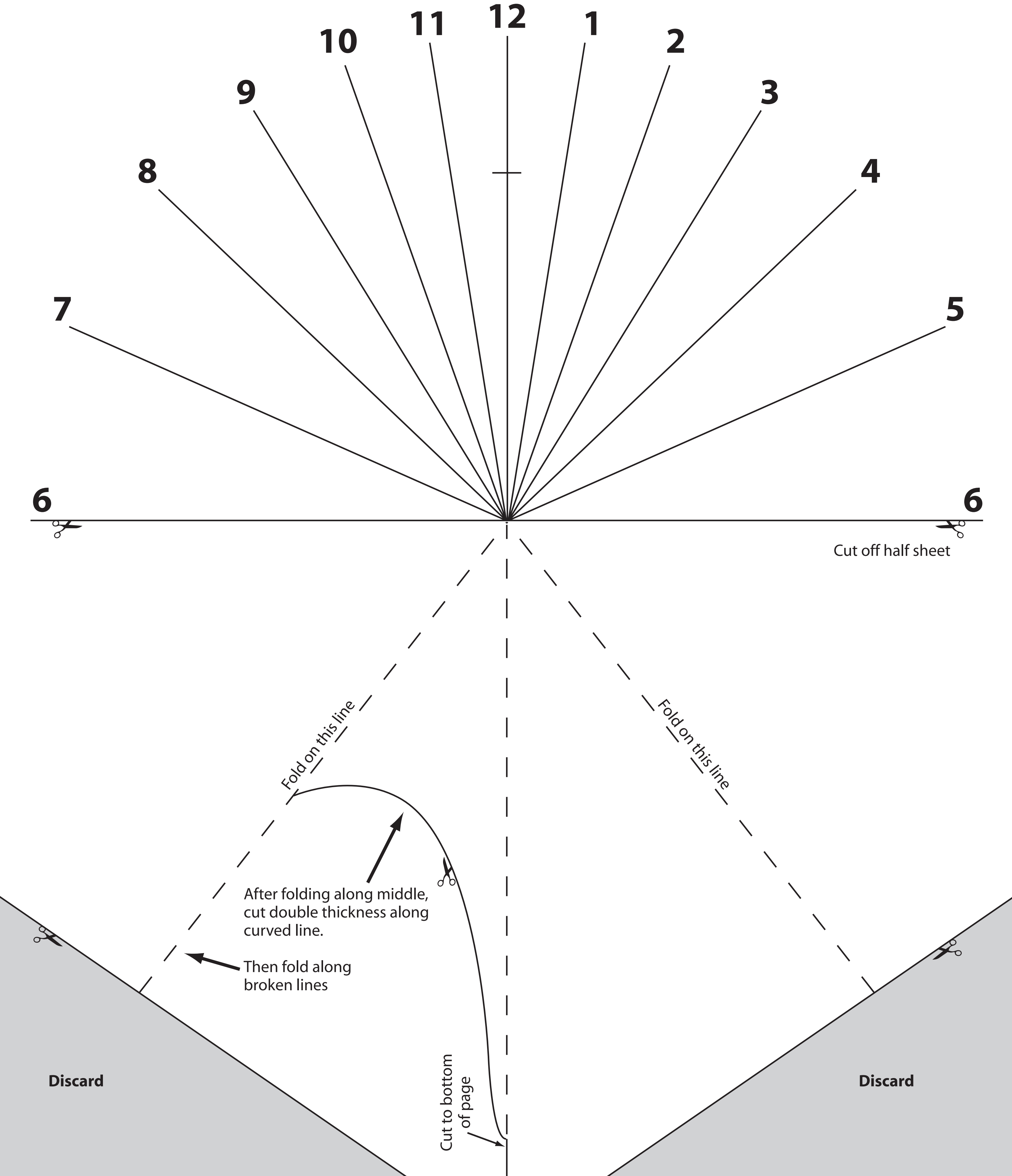
I Tell Only Sunny Hours

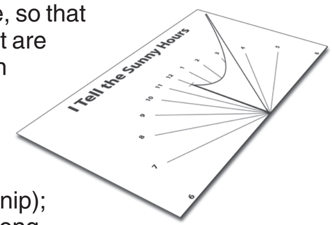


Instructions (from **http://www-spof.gsfc.nasa.gov/stargaze/Sundial.htm**; more there.)

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!
8. **Slide the fin** into the cut you made, so that all horizontal parts of the first sheet are **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 snip); 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.

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.

"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.