PAPER PLATE PLANET POINTER

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Abstract: In this activity, observers determine where and when to look for planets by converting celestial coordinates or elongation tables in *Sky & Telescope* magazine into a paper plate model.

This paper introduces an aid for casual observers who are trying to locate planets in the twilight or night sky. By converting right ascension or elongation tables into a paper plate model, the observer can readily determine which planets are in which direction at any given time. The dial, though crude, functions with acceptable accuracy for one month.

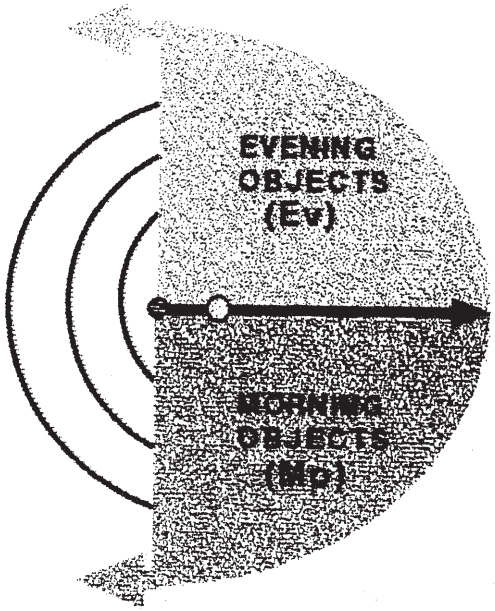
Required materials are a paper plate, a piece of paper, a protractor, a pencil, scissors, and a current issue of *Sky & Telescope* magazine.

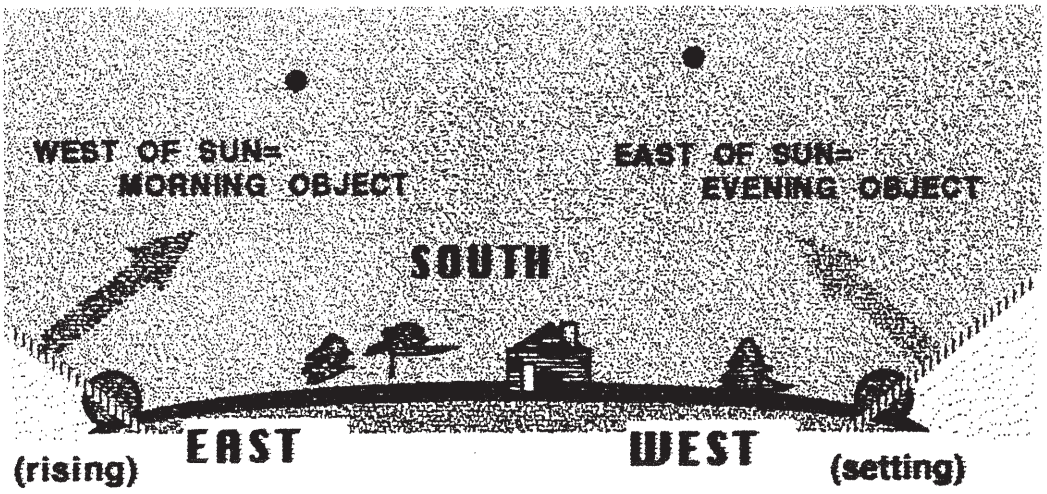
First, students will construct an orrery from elongation tables to show the positions of the planets in orbit around the sun. Then they will combine the orrery with a depiction of their local horizon.

On the piece of plain paper, very lightly draw six concentric circles around a sun to depict the orbits of Mercury through Saturn. Left of the sun, mark a point on the third circle to represent the position of the earth in orbit around the sun.

Draw a line from the earth to the right, to and through the sun and to the edge of the paper. From where the line contacts the earth, the sun is in the noon position. Objects seen below this line (west of the sun for Earthlings) are morning objects, and those seen above this line (east of the sun for Earthlings) are considered evening objects. See Figure 1.

Figure 1

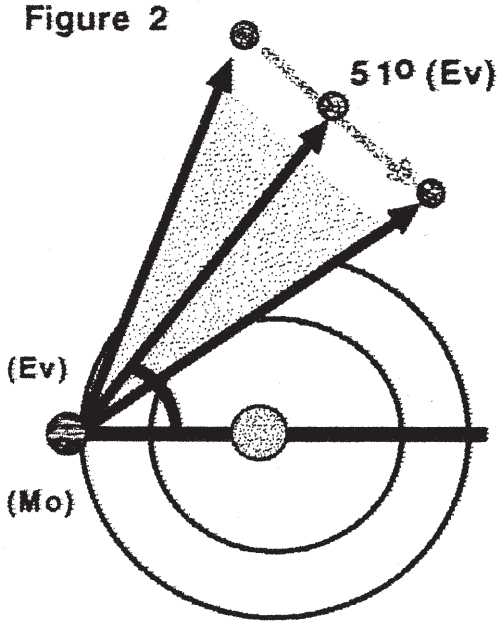




In *Sky & Telescope* magazine's monthly report on the sky, find the chart entitled "The Sun and Planets". The elongation column lists "the angle between a planet and the Sun, in the morning (Mo) or evening (Ev) sky." With the protractor centered on the earth and aligned along the line through the sun, mark the angle and draw a dark line that corresponds to a planet's listed elongation.

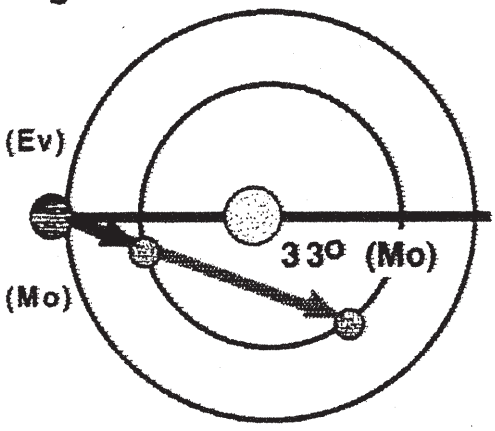
For example, in Novemember 1996 the mid-month elongation for Jupiter is 51^{o} Ev. See Figure 2. Mid-month positions are often accurate enough for the casual observer. You may wish to mark the planet's position throughout the month if it alters much.

Figure 2



For inferior planets, a line drawn out from the earth almost always intersects the orbit at two points, one close to the earth and one far. See Figure 3. Frankly, where the inferior planet is in its orbit is of little interest for the purpose of this paper dial. What is important is the angular direction to that planet. For this reason, the orbits are originally drawn only lightly.

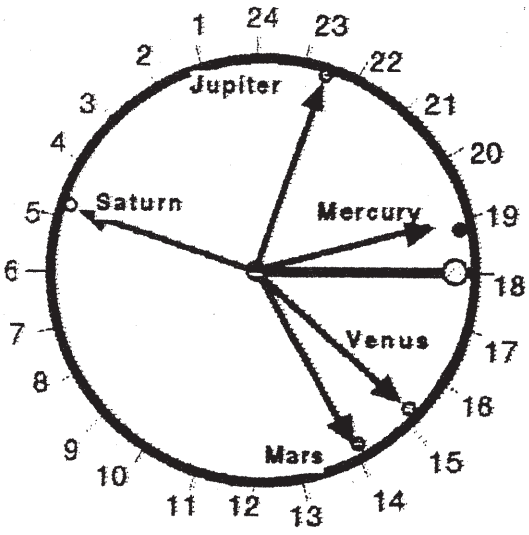
Figure 3



Draw the respective lines from the earth to the remaining visible planets.

As an alternative to converting elongation tables into an orrery, the student can simply plot the direction of the planets relative to the earth using current right ascensions for the planets. See Figure 4. Though the final outcome is the same, the simplified technique does not aid the student in envisioning the planets in orbit around the sun.

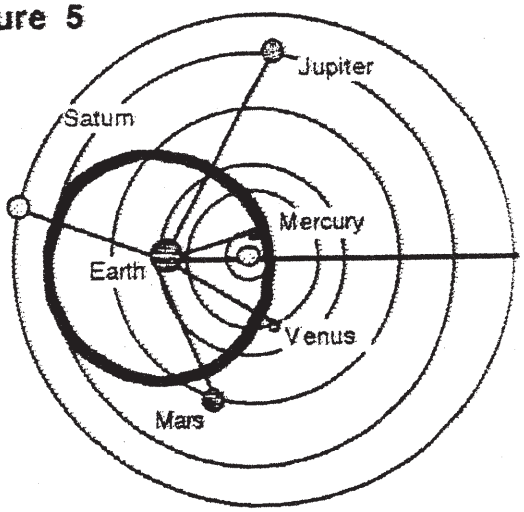
Figure 4



Another alternative is to construct an orrery using Voyager software (not Voyager II). Under the Options menu select Orrery. Set the Field Diameter to 20 A.U. to include all visible planets. After printing the orrery, you may extend arrows from the earth through the sun and each of the planets. A bonus of the Voyager orrery is that the zodiac names are labeled as well, a further aid in finding the planets.

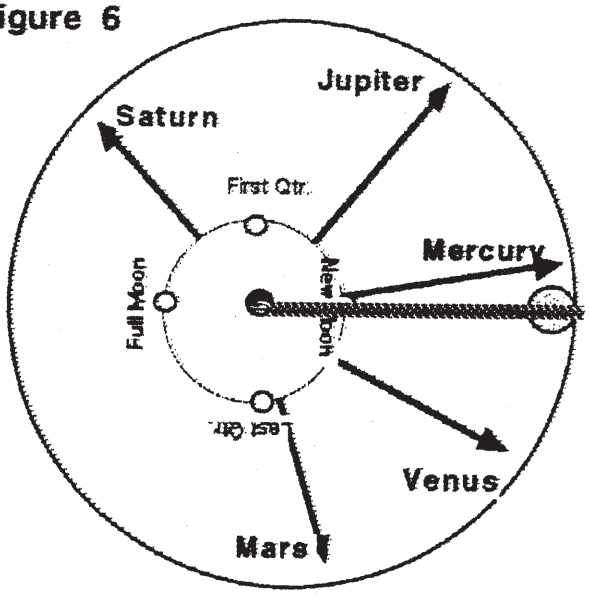
Next, centering on the earth, draw and cut out a circle with a diameter just smaller than the size of the inner flat part of the paper plate. See Figure 5. Extend any short lines and label the planets to which the lines point. And at the edge of the circle in the direction of the sun, draw a prominent figure to represent the sun if it is not already within the cut out circle.

Figure 5



The planetary dial can be complemented by a moon dial with some minor additions. In doing so, observers can figure out which moon phase will occur near each of the planets throughout the month. On the paper disc, draw four tiny circles in orbit around the earth to represent the moon at its four main phases. Label them accordingly. See Figure 6. When you intend to go viewing, determine the moon's phase for that day or night. The dial will then indicate the moon's direction and rising/setting times as well as that of the planets.

Figure 6



Cut a line halfway across the paper, along the line from the sun to the earth, bisecting the sun itself.

In the second part of this activity, a local horizon will be constructed from the paper plate. Draw a horizontal line across the plate, labeling the left edge *East (rising)* and the right edge *West (setting)*. Label the top of the plate *South*. Below the horizon line is the ground, so you may shade it in. If you wish, at the center of the plate you may draw the back side of a stick figure standing on the horizon facing south.

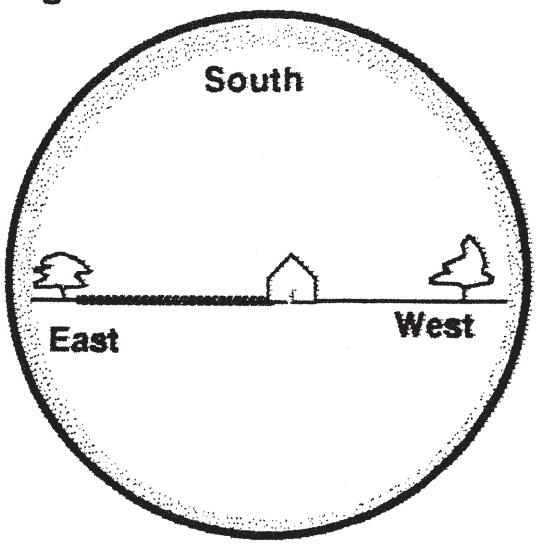
Cut a partial slit across the left half of the plate, from the center along the horizon to just beyond the flat part. Do not cut all the way across the plate into the crinkled edge. See Figure 7.

Lastly, intertwine the paper and the paper plate at their respective centers. That is, slip the bottom half of the disk under the plate, while the top half of the disk remains above the plate.

Your planet-finding dial is now ready for use. Holding the dial upright, face south. To your left is east; to your right is west. In front of you and beyond is south.

The sun's position corresponds to the time, *somewhat* like on a 24-hour clock face. When the sun is at the horizon in the easterly direction, the time is sunrise. When the sun is

Figure 7



at the horizon in the westerly direction, the time is sunset. When the sun is due south the time is noon. And when the sun is opposite the noon position, behind the earth, the time is midnight.

Notice that the east and west positions are not necessarily 6 a.m. and 6 p.m., respectively. Rise and set times vary with the seasons. Check your local paper for current times. The times between the cardinal points then have to be interpolated.

For example, set the dial's sun just below the western horizon. Though the sun and the paper will be above the paper plate, consider the sun set because it is below the horizon line. The lines on the paper dial will indicate the direction in which you will find the planets visible at, say, 8 p.m. in November. As evening planets, Venus and Mercury will often be near the horizon at this time.

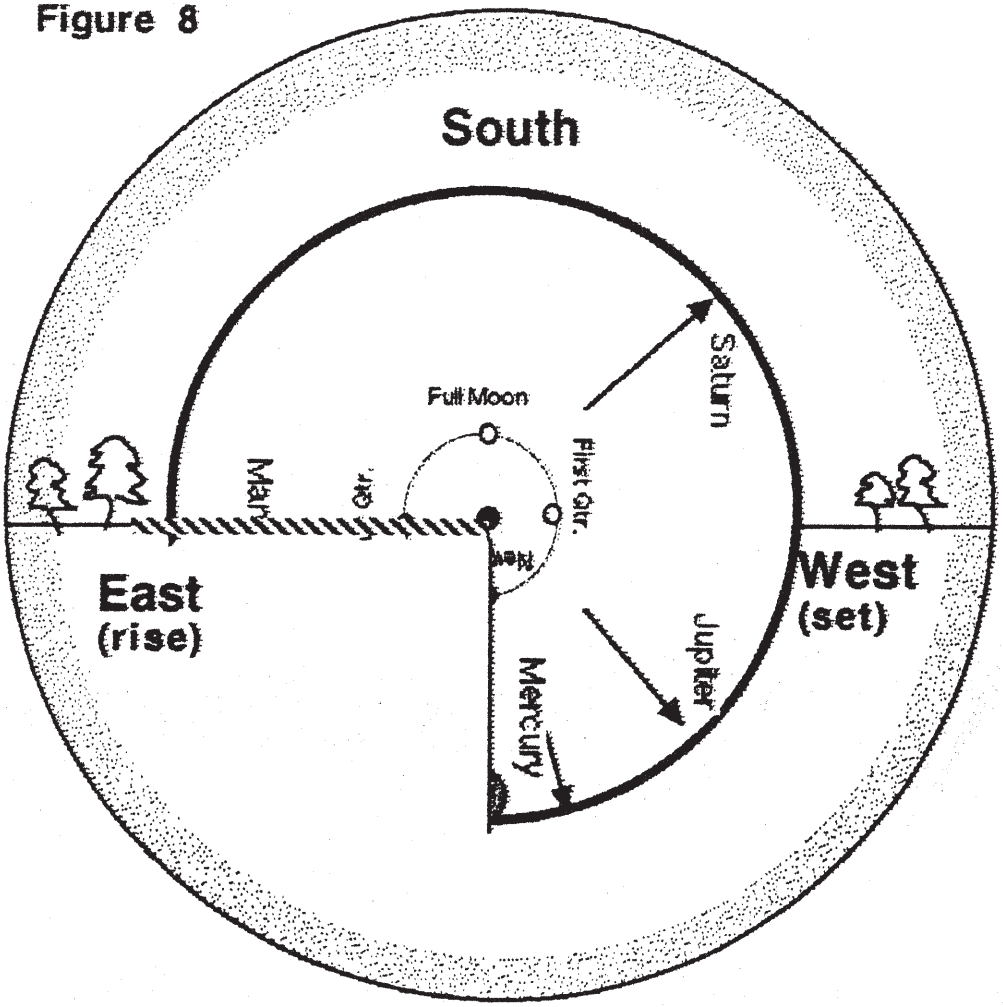
Rotate the paper to the midnight position. See Figure 8. As you do so, you will see planets set and new ones rise through the hours. Continue rotating the dial until just before the sun comes up (and the paper almost falls out of the plate's slit). Here again you will often see the morning planets Mercury and Venus rising.

The dial reflects the mid-month angular separation between the sun and the planets along the ecliptic. Inaccuracies arise when the paper insert is held at an angle unlike the angle of the ecliptic relative to the true horizon. Crude design and assembly constraints prohibit the paper insert from matching the solar plane. The dial also suggests the sun, the planets, and the moon rise due east and set due west. These and other shortcomings of the dial should be addressed.

While there are certainly limitations to this device, it will at least get the viewers looking in the general direction of the planets, if in fact the planets they seek are even above the horizon. That in itself can be valuable information when they are trying to find a planet.

As always, I welcome your comments about this paper plate dial and ways to improve both its presentation and its use.

Figure 8


South
Saturn
Full Moon
First Qtr.
Last Qtr.
East
(rise)
West
(set)
Jupiter
Mercury