Activity 6

The Earth-Sun Orientation

Resources

Chapter 4

Purpose

A plot of the Sun's path across the sky illustrates many of the complex apparent motions of the Sun and Earth, which leads to understanding of seasons.

Materials

a clear plastic hemisphere from 150 mm to 450 mm in diameter. Clear salad bowls, plastic covers for bird feeders, etc. can be found at hardware stores.

a water soluble marker or grease pencil

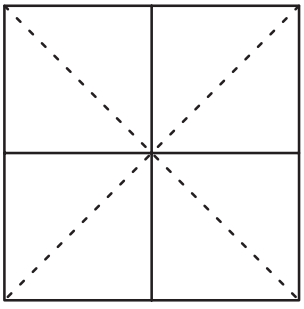
a square sheet of cardboard large enough to act a a base for the dome.

tape

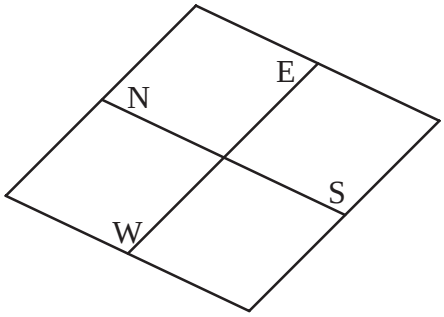
a magnetic directional compass

Procedure

1. Mark the center of the cardboard by finding the intersection of the lines from diagonal corners or midpoint lines from the sides and draw the lines connecting the midpoints of opposite sides.



2. Mark one line with North-South and the other East-West as shown:



3. Tape the dome in place over the center of the cardboard so it won't move.
4. Use the compass to mark a N–S line on the ground outside. A chalk line on the side walk, a driveway, or parking lot in the open sun will last for several days of observations. However, the compass needle may be attracted to iron material used to reinforce the concrete, etc. A technique known as the "Minimum shadow method" is easiest to use when a compass can't be used, but takes several hours to establish an orientation line.
5. Set the cardboard unit on the line so that the edge pointing N–S is on the N–S line on the ground.
6. Plot the position of the sun as described in the following steps.
7. Hold the tip of your marker close to the dome but don't touch it.
8. Carefully move the marker until the shadow of the tip falls right on the center mark of the cardboard.
9. Touch the marker to the dome when the shadow of the dot would fall right on the center mark. If it is not right, make a new dot and erase the old.
10. Repeat the steps 8, 9, 10 every 10 min for as long as possible (at least 30 min = 4 dots). It would be really good if this could be done every half-hour from sunrise to sunset.
11. After collecting as many dots as possible on one day, remove the dome from the cardboard and connect the dots on the inside of the dome. Label the line with the date and the time.

Long term extensions:

1. Wait one week or one month and repeat the data collection. Do this for several weeks or months. How do you account for the differences in the plots?
2. Make a plot of only one time each day, say 12 noon. Do this for as many days as possible—a plot for an entire year would be quite a feat! Try to predict what the plot will be if an entire year of data points could be collected.

Questions

1. Predict where the plotted points would be during different seasons and explain why.
2. Predict where the plotted points would be if you lived at

   a) the North Pole

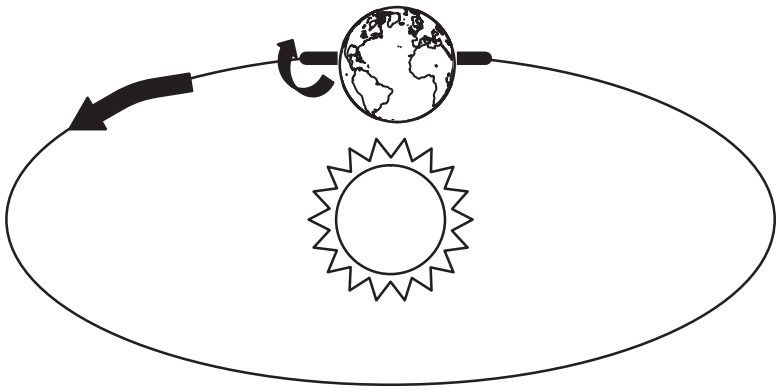
   b) on the equator

   c) in the southern hemisphere.
3. How would the predicted points in #2 change for different seasons?
4. Predict where the plotted points would hit your "horizon" at the edges of the dome for various days of the year such as the first day of winter,

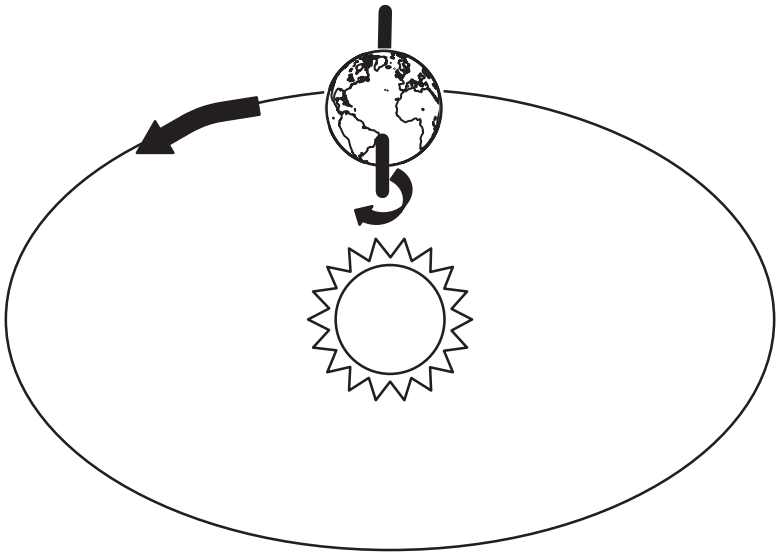
spring, summer and fall, or better yet, at the days of equinox and the solstice.

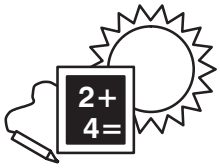
5. Use your plots and predictions to explain the importance of how Earth and Sun are lined up in space.
6. What would the seasons be like if Earth had no tilt to its axis of rotation?
7. What would the seasons be like if Earth's axis were

   a) parallel to the orbital path



   b) always pointed at the sun?

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