



P.O. Box 219 • Batavia, IL 60510
(800) 452-1261 • Fax (866) 452-1436
www.flinnsci.com • E-mail: flinn@flinnsci.com
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Earth's Orbit and Seasons

Earth Science Demonstration Kit

Introduction

What causes the seasons here on Earth? How does the revolution of the Earth around the Sun influence the changing of the seasons? In this demonstration a model of the Earth will be assembled to answer these questions.

Concepts

- Seasons
- Earth motions
- Orbits
- Ellipse

Safety Precautions

Although the materials used in this activity are considered relatively nonhazardous, please follow all laboratory safety guidelines.

Materials

Block of wood, with hole*	String, 70 cm*
Lamp, without shade	Styrofoam® ball, 4-inch diameter*
Marker or pencil (dependent upon surface)	Surface for demonstration (piece of plywood, foam board, or cardboard at least 28" × 28")
Pushpins, 5*	Wire, 8 inches*
Ruler	

**Materials included in kit.*

Preparation

Part A . Earth's Orbit Layout

1. Obtain a large piece of cardboard or plywood, pushpins and a 70-cm string.
2. On the demonstration surface, mark two points (foci) on the chosen surface 40 cm apart. Fasten each end of the 70-cm piece of string to each of the foci (using pushpins). If necessary, tape the pushpins to the board to keep them from moving. See Diagram 1 on page 2.
3. Using the fastened string as a guide, carefully, without stretching the string or pulling it loose from the surface, use a pencil or marker to draw the top half of the ellipse. Then relocate the pencil or marker below the foci and draw the bottom half of the ellipse. See Diagram 1. This will be the Earth's orbit.

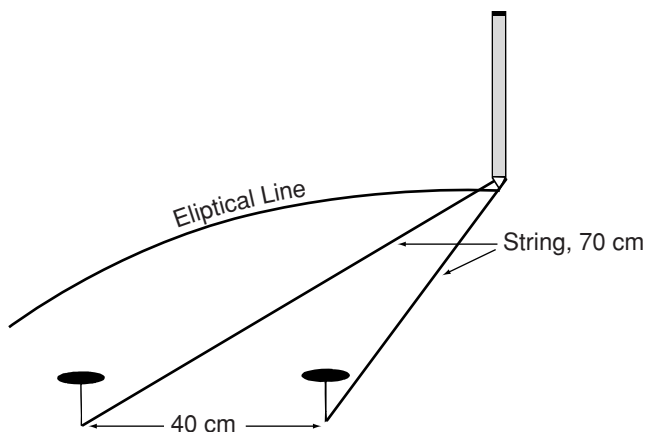


Diagram 1. Drawing Ellipse

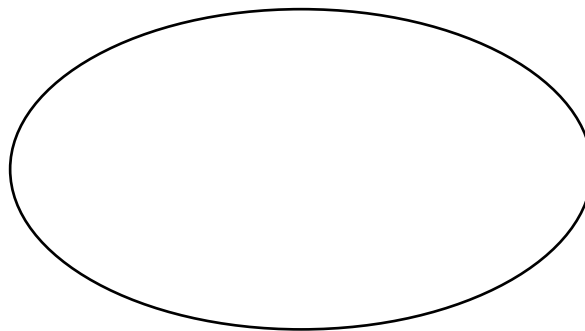


Diagram 2. Completed Ellipse

Part B. Earth Model Assembly

4. Place the wire into the hole in the center of the block of wood. The wire will be at a 23.5 degree angle, which is the tilt of the Earth.
5. Draw an equator on the Earth (Styrofoam ball) to make it easier to see the correct angle of the Earth's axis. Use a marker and label one side of the Earth model "N" for the Northern hemisphere and the other "S" for the Southern hemisphere.
6. Carefully push the wire through the center of the Styrofoam ball, creating an axis, so that the Northern and Southern hemispheres are positioned correctly.

Procedure

Part I. Seasons

1. Place the lamp (with the bulb exposed) slightly to the right of the middle of the drawn Earth orbit to represent the Sun. Darken the room if possible.
2. Label the Earth orbit Spring, Summer, Fall and Winter accordingly (see Diagram 3).
3. Place the assembled Earth model on the Earth orbit line drawn on the surface (see Diagram 3 for the correct tilt position). Trace the orbit of the Earth completely around by sliding the block on the line. Keep the Earth model at the same tilt throughout the demonstration. Do not rotate the Earth as you slide it along the orbit.
4. Stop after completing every 90 degrees of the orbit and show the relative position and angle of the Earth and Sun (see Diagram 3).
5. Note that the Earth is slightly closer to the Sun in the winter. However, the temperature in the Northern hemisphere is cooler in winter due to the fact that the Northern hemisphere is tilted "away" from the Sun and thus receives less light intensity overall. Even though the Earth is slightly further away in summer, the Northern hemisphere is facing the Sun more directly, resulting in more direct radiation and resultant warming.

Part II. Night and Day

6. Place three pushpins into the Earth model: one pushpin on the Equator, one in the Northern hemisphere and one in the Southern hemisphere.
7. Repeat steps 1–4, but now rotate the Earth slowly a full 360° at each "season" position. Do this by only rotating the globe around the wire. Do not rotate the wooden block.
8. Demonstrate and have the students observe how long each pushpin is in daylight and darkness at each position.

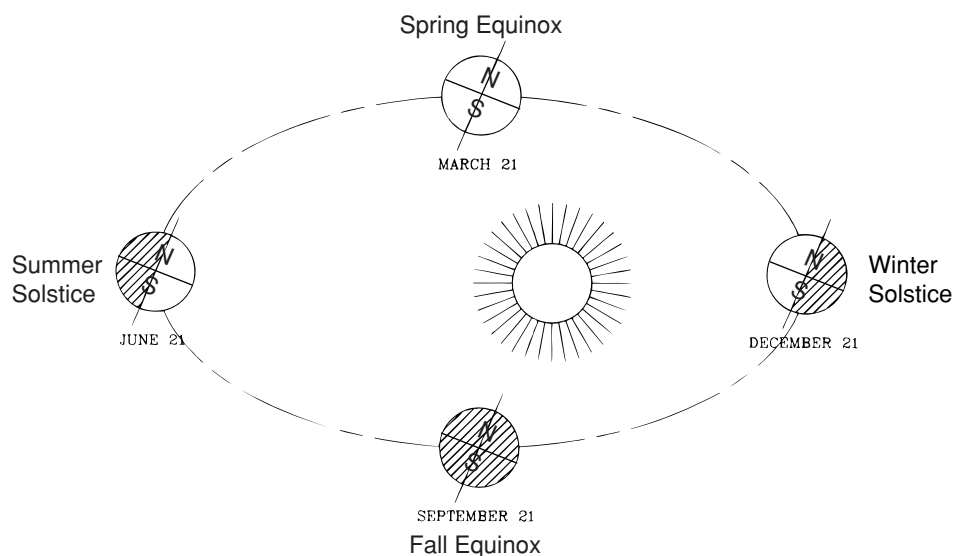


Diagram 3. Seasons

Disposal

All materials may be saved for future use.

Tips

- The angle is what makes the demonstration work. Students may need to see this activity twice. Repeat the demonstration as needed.
- The topics of Equinoxes and Solstices may also be introduced after demonstrating and discussing the Earth's orbit and seasons.
- As an interesting side note to this demonstration: the Earth is actually traveling 67,000 miles per hour through space in order to complete one orbit (one year) around the Sun.

Discussion

As seen in Part I of the demonstration, the Earth travels on an elliptical orbit. The Earth's distance from the Sun varies because of this ellipse. The Earth is actually further away from the Sun during the summer (152 million km) than it is in the winter (147 million km). Knowing this reinforces the fact that it is not the distance from the Sun that determines the seasons on Earth, but it is the Earth's tilt (23.5°) and the angle at which the Sun's rays hit the surface of the Earth. The hemisphere that is tilted toward the Sun receives the greatest amount of radiant energy. For example, the Northern hemisphere in the summer. The hemisphere tilted away from the Sun (i.e., Northern hemisphere in the winter) receives less intense radiant energy.

As seen in Part II of the demonstration, day length is also affected by the Earth's tilt. In the Northern hemisphere, the days are considerably shorter during the winter than the summer due to the tilt of the Earth and the low amount of radiant energy at this time. The opposite is true in the Southern hemisphere, the days are longer in the winter and shorter in the summer.

The Sun is directly above the Earth's equator during an equinox. At this time, the amount of daylight (12 hours) is exactly the same as the amount of darkness (12 hours). In the Northern hemisphere, the spring equinox occurs on March 21 or 22 and the fall equinox occurs on September 22 or 23.

A solstice occurs when the Sun is the greatest distance North or South of the equator as possible. During the summer solstice (June 21 or 22 in the Northern hemisphere), there are more daylight hours than any other time of the year. The opposite is true during the winter solstice (December 21 or 22 in the Northern hemisphere) when there are more hours of darkness than any other day of the year.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12

Evidence, models, and explanation

Form and function

Content Standards: Grades 5–8

Content Standard D: Earth and Space Science, Earth in the solar system

Content Standards: Grades 9–12

Content Standard D: Earth and Space Science, energy in the Earth system, geochemical cycles

References

Feather, R. M., S. L. Snyder, D. T. Hessler, *Merrill Earth Science*. Glencoe, IL. 1993. pp 580–581.

Gross, G. R., M. A. Holzer, E. A. Colangelo, *A Demo A Day—A Year of Earth Science Demonstrations*. Flinn Scientific, Inc: Batavia, IL. 2001. pp 40–44.

The Earth's Orbit and Seasons—*Earth Science Demonstration Kit* is available from Flinn Scientific, Inc.

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AP6150	Earth's Orbit and Seasons—Earth Science Demonstration Kit

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