

Modeling the Seasons

Students model the seasons with their own earth globes.

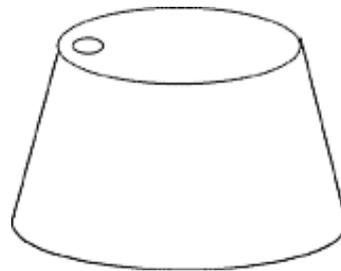
Materials

For the whole group, you'll need:

- a 150–200 watt light bulb (not frosted) or a flashlight
- a lamp or socket for the bulb
- an extension cord
- a room that can be made dark

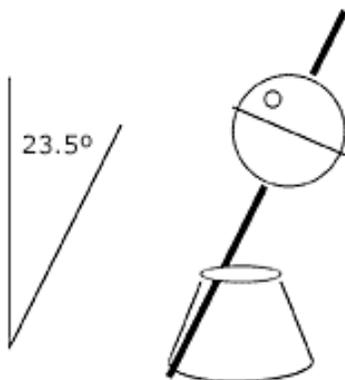
For each student or pair of students, you'll need:

- a Styrofoam ball
- a large straw
- a rubber band
- a flexible plastic cup (5.5 oz)
- scissors
- tape
- a thumbtack or sticky dot
- a protractor
- a ruler with centimeters



Making a Model of the Earth

Push the straw through the center of the Styrofoam ball. This represents the axis about which the earth rotates. One end is north and the other end is south. Place a rubber band around the center of the ball (the earth's equator). Looking at a globe or a map, find your approximate latitude, and place the tack or dot there. (For example, San Francisco is at 37.75° north, so placing the tack not quite halfway between the equator and the North Pole is an acceptable approximation.) Use the scissors to make a hole in the bottom of the plastic cup, near the side, as shown above. It should be just large enough to accommodate the diameter of the straw.



Take an 8-cm piece of tape and stick a 2-cm piece to the center of the 8-cm piece (sticky sides together). Place the straw into the hole in the cup, and use the modified tape to hold the straw against the side of the cup, yet still allowing the straw to rotate in the hole.

Your model should look something like the picture on the left. Use a protractor to check the angle of the earth's tilt. It should be 23.5° degrees.

Setting up the Room

Use one bright lamp for the whole group or flashlights for small groups. Designate some visual reference as Polaris, the North Star. All straws should point to Polaris throughout the activity.

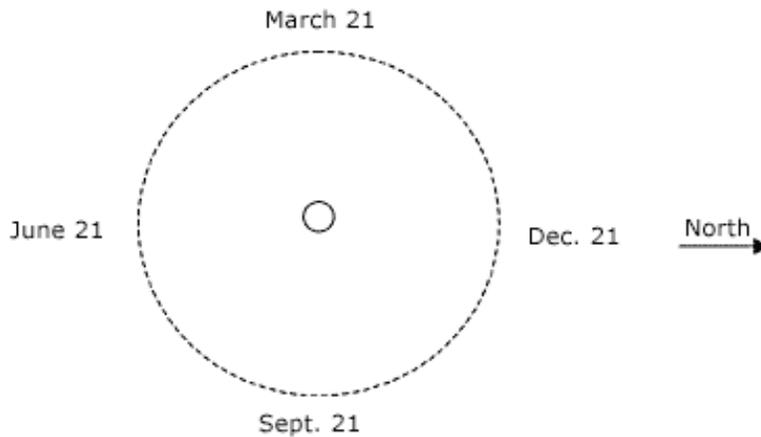
Set up the light in the center of the group or flashlights in the center of each small group. Before darkening the room, make sure all earth models are oriented correctly toward polaris. Darken the room.

To Do and Notice: Model a “Day” on Earth

Each student should turn the straw so that the earth spins counterclockwise (when viewed from the north) for one rotation. They should notice that the dot is in light (day) for about half of the rotation and is in shadow (night) for about half of the rotation.

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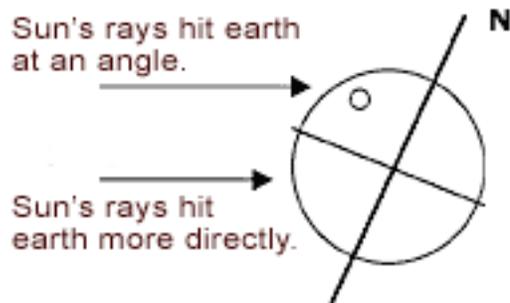
Divide the class into four groups. Have each group move to one of the four seasonal positions around the lamp (or one student at each position around a flashlight if using small groups): December 21, March 21, June 21, and September 21. It should look like this if seen from above:



Have each group model a day at each position. At each position, they should notice:

- For what fraction of the day is the dot in the light? More than half? Less than half? About half?
- For what fraction of the day is the North Pole in the light?
- How is the light from the sun striking the dot? Is it direct or at an angle?

For example, on December 21:
Angle at or above equator, direct below equator



Modeling a Year

After students have been to each of the four dates: December 21, March 21, June 21, and September 21, they'll have modeled a year: one earth revolution around the sun.

What's Going On?

Many people think the seasons are caused by variations in our distance from the sun. While the earth's orbit is slightly elliptical, it's very close to circular, and the variation in distance between the earth and sun is not enough to account for our seasons. The seasons are caused by the tilt of the earth. The earth holds its rotation axis (tilt) fixed in space as it moves around the sun. In the summer, the Northern Hemisphere tilts toward the sun. It's warmer because (1) there are more hours of daylight, providing us with more heat energy, and (2) the midday sun shines more directly head on, increasing the amount of solar energy the earth receives. In the winter, when the Northern Hemisphere tilts away from the sun, the sun's rays strike the earth at a lower angle, and the energy from the sunlight is spread out over a larger area, which reduces its effectiveness at heating the ground. Combined with shorter daylight hours, the temperatures are cooler in winter. The seasons in the Northern and Southern Hemispheres are opposite.

Teacher Tips

for Modeling the Seasons

Grade Level

5-8

National Standards Addressed

Grades 5-8:

Earth and Space Science: Earth in the Solar System

Science as Inquiry: Design & Conduct Investigation, Analyze & Interpret Data, Develop Explanations, Think Critically

Key Concepts

Seasons, rotation of the earth, earth's axis, day and night, earth's orbit around the sun.

Background Science

Seasons of the year

<http://www-istp.gsfc.nasa.gov/stargaze/Sseason.htm>

What causes the seasons?

<http://www.crh.noaa.gov/fsd/astro/season.htm>

Earth's seasons (narrated animation)

<http://kids.msfc.nasa.gov/earth/seasons/EarthSeasons.asp>

BBC Science and Nature: The Seasons

<http://www.bbc.co.uk/science/space/solarsystem/earth/solsticescience.shtml>

Ideas for Discussion

- The sun dagger petroglyph (see link below) was a way for the Chacoans to know when the seasons were changing. Why would this be important for them?

Sun dagger petroglyph:

<http://www.exploratorium.edu/chaco/HTML/sundagger.html>

- How do you know when the seasons are changing? Do you use signs that the Chacoans may have used? What modern signs tell you that the seasons are changing?
- How does the change of the seasons affect you?

Related Media

- Our Seasons has a description of how sunlight is affected by the earth's tilt and orbit: <http://www.exploratorium.edu/chaco/HTML/seasons.html>
- See an animation showing how the sun moves across the horizon throughout the year (requires the Flash Plugin): <http://www.exploratorium.edu/chaco/HTML/TT-seasons.html>

- See an animation showing how the area of the globe that is in sunlight changes throughout the year (requires the Flash Plugin):
<http://www.exploratorium.edu/chaco/HTML/seasons.html>
- What Time Is It on Mars?
A Webcast exploring time and seasons on the Red Planet (requires Real Player):
<http://www.exploratorium.edu/mars/mars-040107.ram>

Going Further

- Revisit the year stations. Notice the angle at which the sun strikes your dot during the summer versus during the winter. In which season are you the most likely to get sunburned? Why?
- Imagine you're living on the equator. How would you describe the change of seasons?
- Now imagine that you're at the North Pole in the summer. What path does the sun take across the sky?

Check for Understanding

- What special aspect of the sun's position or movement do we mark with the solstices and the equinoxes?
- What would seasons on the earth be like if the axis weren't tilted?