



What Causes Winter?

LESSON

GRADE LEVEL:

4-7

CATEGORY:

Earth, Ecosystems, and Ecology

TOPIC:

Changes in seasons, earth rotation and revolution around the sun

LENGTH:

- 10 minutes demonstration
- 20 - 30 minutes making models and presenting
- 10 minutes role play

MATERIALS:

- Globe model or Earth ball
- Flashlight or lamp
- Round shaped objects, apples or ball of yarn (something you can easily insert a chopstick or skewer) other items students come up with for making models.
- Paper and protractor to measure axis angles.
- Chopsticks or other items to make axis

SETTING:

- Indoors or Outdoors
- A place that can be dimmed or darkened

GROUP SIZE:

Small groups

SUBJECT AREAS:

Astronomy, math, science

KEYWORDS:

Seasons, summer, fall, winter, spring, orbits, rotate, revolve, equator, sunlight, radiation, heat, earth, moon, northern and southern hemisphere, axis.

Overview

Students observe a model of how the earth rotates on its axis and revolves around the sun and then use their own bodies to create models of the movements.

Objectives

Students will be able to:

- Create models to demonstrate why the northern hemisphere experiences seasonal changes.
- Demonstrate how the sun's radiation strikes the earth differently in winter and summer.
- Explain why we experience different seasons

Making Connections

Seasonal changes are necessary for ecosystems processes: they provide energy for new plant growth in the spring; snow melt for a dry summer; and, drive migration events in the fall. These can be times of great harvest and birth such as in the late fall when bald eagles feast on salmon returning to spawn in freshwater creeks. Winter brings in snow, cold temperatures, and longer nights that are easy to dislike, but are necessary for survival in some ecosystems. Polar bears for example, require winter ice to reach seal hunting grounds; winter's cold kills off overgrown insect infestations; and some trees benefit from cold temperatures to signal the time for seeds to sprout.

Background

Seasonal changes occur because the earth revolves around the sun on a fixed tilted axis (23.5 degrees). The northern and southern hemispheres receive varied amounts of solar radiation as the earth travels depending on which hemisphere is tilted towards the sun during the year long journey around the sun. The earth's orbit around the sun is oval (elliptical) and

therefore it is easy to assume that the earth is simply closer to the sun in the summer and farther away in winter; but this is incorrect: our earth is closer to the sun in the winter! Even though closer, the northern hemisphere's angle away from the sun causes the radiation (heat and light) to be spread out over a greater area during the winter. During the summer, the earth's tilt towards the sun makes up for any further distance because the sun's radiation is concentrated on a smaller area of the earth's surface. At the equator the tilt does not affect the solar radiation received on the surface and therefore seasonal change is very slight, if noticeable at all during the year.

The earth also spins on its axis or rotates. One complete rotation takes twenty-four hours to complete resulting in what we know as a day. At the same time, it is also revolving around the sun in an orbit that takes one year to complete.

For half the year, the north pole (Arctic) tilts away from the sun while the earth continues to rotate on its axis. For these six months, the sun is not visible above the horizon each day, but this does not mean that there is complete darkness as the sun illuminates the sky even when it is below the horizon. There is a period of total darkness that lasts about eleven weeks. During these same six months, the south pole (Antarctic) experiences the opposite with the sun never reaching below the horizon. The situation reverses for the other half of the year between the two poles. The degree to which this is experienced depends on how close you live to the poles. If you are within the arctic circle you may experience these two extremes.

Procedure

Warm-up

1. Using a globe of the Earth and the flashlight, demonstrate and discuss what causes day and night.
2. Use the same globe rotate the earth on its axis while moving the earth around a light source to demonstrate how the earth orbits the sun.
3. Use pictures or draw the movement on the board.
4. For older students you may wish to demonstrate how the sun's rays strike the earth differently in winter, take a flashlight and hold it against a card (or graph paper) that is perpendicular to the light. Allow students to experiment with graph paper and flashlights by tracing the outline of the rays on the card. Count the number of graph squares inside the outline. Now, hold the card at an angle leaning away from the flashlight and trace the outline. Again, count

the number of graph squares inside the outline. Students may wish to use a protractor to angle the paper to 23.5 degrees and try again. This simulates how the tilt of the earth on its axis in winter causes a reduced angle of sun's rays and, therefore, less radiation received per unit area. The same amount of light is coming out of the flashlight both times, but with the angled card, the amount is spread out over a larger area, so less per unit area. See if the level of light seems different to the eye, do the areas farther away from the source seem less bright? Use shading to make the concept clearer.

The Activity

1. In small groups, ask the students to build a model of the sun and earth from loose parts, balls of yarn, apples, round balls, paper, different sized circles, etc.
2. Students should figure out a way to demonstrate sunlight striking the earth with a light source while also moving the earth around the light (sun).
3. Students should also figure out how to demonstrate seasons by showing how light falls differently on the earth model depending on which part of the earth is tilted towards the sun in its orbit. Experiment with the model if there was no tilt. Try again with different axis tilts.
4. Each group presents their model to the rest of the class.
5. Older students may wish to add the moon to their models. Using the models, can they figure why only one side of the moon is visible at one time (it is not because the moon does not rotate on its axis, it does; but the rotation of the moon on its axis is equal to how long it takes to orbit the earth).

Wrap-up

1. Discuss how less sunlight affects the earth's ecosystems in Winter.
2. Use the globe to select a location that is the opposite of where students are now. Find out what temperatures it is and compare it to the chosen location in the southern hemisphere. Discuss how the sun hitting us at an angle might affect our climate? How does that influence the kind of plants and animals live in the area during the winter?

Assessment

- Students role play the movement of the earth and its tilt around the sun's orbit in small groups of two or three. The sun should also rotate and move to simulate radiation shining out from all directions while the earth moves around in its orbit. Add in a third person as a moon to orbit the earth.

Extensions

1. Use pictures from calendars and see if students can match them to the correct seasons.
2. Investigate the location of the sun throughout the day (how high is it in the sky). Demonstrate how shadows change with different heights of light. Measure shadows every week at the same time for a season to see how the sun's light is changing in the sky.
3. Provide students with a map of the world and in small groups, ask them to identify where winter never occurs. See if they can come up with several hypotheses to answer: Why winter does not occur in these areas? How is life (plants and animals) where winter occurs different in places that do not experience winter?
4. Investigate the moon's effect on the earth including producing tides.