NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 35 MINS

The Reason for the Seasons

Students use polystyrene foam balls and light bulbs to investigate the sun's intensity on the surface of the Earth.

GRADES

2 - 5

SUBJECTS

Earth Science, Astronomy, Experiential Learning, Mathematics

CONTENTS

1 Image

OVERVIEW

Students use polystyrene foam balls and light bulbs to investigate the sun's intensity on the surface of the Earth.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/the-reason-for-the-seasons/

Program

WILDEST WEATHER IN THE SOLAR SYSTEM

DIRECTIONS

1. Activate prior knowledge about seasons and sunlight.
Explain to students that the Earth orbits an ideal distance from the sun, and this affects the weather we experience here on Earth. Ask: *What are the different seasons?* Write the

sequence of the seasons on the board for students' reference: winter, spring, summer, autumn. Ask: *What is the weather like during the different seasons? What is the same or different about the seasons?* Prompt students to include similarities and differences in weather, temperature, and length of daylight. Write their ideas on the board. Then explain to students that the answer to that question is different for those who live in a different hemisphere, or half of the Earth. Ask: *What do you think causes the difference in seasons? What do you think causes the difference in what time it gets dark outside?*

2. Build background about what causes seasons.

Use a globe and gesture to introduce the vocabulary terms *tilt* and *axis*, the imaginary line between the North and South Poles. Then explain the following to students: The Earth rotates on an axis that is tilted. In other words, our planet never stands upright—it is always leaning to the side. The direction of this lean does not change significantly over the course of a year, but it does shift gradually over millennia. As the Earth travels along its orbit, it sometimes leans toward the sun and sometimes away from the sun. Display the diagram "Seasons" for students, and point to the parts of the diagram as you explain the following: If you live in the Northern Hemisphere, you live on the part of the Earth that is north of the Equator. When the Northern Hemisphere is tilted toward the sun, you experience summer. When the Northern Hemisphere is tilted away from the sun, you experience winter. Ask: *How would this change if you lived in the Southern Hemisphere?* (The opposite would happen. When the Earth's axis is tilted toward the sun for the Northern Hemisphere, the people in the Northern Hemisphere experience summer, while at the same time, the Southern Hemisphere is tilted away from the sun and the people there experience winter. When the Northern Hemisphere experiences winter, the Southern Hemisphere experiences summer.)

3. Introduce the hands-on activity.

Divide students into small groups of three. Provide each group with one polystyrene foam ball, one marker, one flashlight, and two pushpins. Have groups choose who will hold the foam ball that represents the Earth and who will hold the flashlight that represents the sun. Ask the student holding the Earth to draw a circle around its middle to represent the Equator, and dots on the North Pole and South Pole. Have the third group member place a pushpin, representing a person, midway between the Equator and the North Pole, and another between the Equator and South Pole. Make sure students place both pushpins on the same side of their Earth. Tell students that the Earth moves around the sun in an elliptical orbit and

is tilted on its axis. Explain that as Earth orbits the sun, it rotates on its axis, and the axis is always pointed in the same direction. Have the students representing the Earth and sun in each group stand approximately 5-7 feet apart. Dim or turn off the lights.

4. Use guided inquiry to have students investigate direct and indirect sunlight.
First, have the student acting as the sun keep the flashlight pointed straight at the representation of Earth while the student holding Earth walks in a circle around the sun. The Earth should stop when the pushpin representing a person in the Northern Hemisphere can "see" the sun. Ask the student holding Earth to tilt the Earth so that the sun, without moving the flashlight, is shining directly overhead of the pushpin/person in the north. Ask: *Is the sun more direct for the person at the top or the person at the bottom of the Earth?* (top) *Do you think it is warmer for the person at the top or the person at the bottom of the Earth?* (top) *Why do you think so?* Address any student misconceptions. One common student misconception is that this is due to the Northern Hemisphere being closer to the sun. Note that there is no significant difference in the distance of the sun to the Northern and Southern Hemispheres. The difference is due to direct and indirect solar radiation. The hemisphere that is pointed toward the sun receives more direct solar radiation, thus it is warmer. Now ask the student holding Earth to orbit the sun, making sure to hold the tilt in the same direction until the tilt of the Earth is positioned so that the sun is directly overhead of the pushpin/person in the Southern Hemisphere. Ask: *Is the sun more direct, or bright, for the person in the Northern Hemisphere or the Southern Hemisphere?* (Southern Hemisphere) *Which person do you think feels warmer temperatures?* (the person in the Southern Hemisphere) *Why?* (due to direct solar radiation)

5. Use guided inquiry to help students investigate the role of axis and tilt in the sun-Earth relationship.
While the sun is still shining directly overhead of the pushpin/person in the Southern Hemisphere, have students locate where in the classroom, such as a wall or ceiling, the North Pole points to. Tape a black circle to the wall at that location to help students keep the axis pointed in one direction. Next, ask the Earth to resume orbiting the sun, while keeping the North Pole pointed at the black circle. Remind students to keep the sun stationary and pointed at Earth. Have the rest of the group help to make sure the Earth’s tilt doesn't change. Explain to students that the Earth's tilt does not change significantly over the course of a year, but does shift gradually over millennia. Have students stop the Earth after one-half of an orbit so that it is opposite of where it started. Then ask one group member to make it daytime for the “top” and “bottom” people. It should be night for them if the Earth has

orbited correctly, so the student will have to spin the Earth. Finally, ask groups to move the Earth half an orbit around the sun again, making sure to keep the North Pole pointed at the black circle. Make sure the sun does not move. Also, ensure as the Earth orbits the sun, the axis does not change orientation and continues pointing to the black circle. Have a group member make it daytime for the "top" and "bottom" people. Ask:

- *Does the sun shine more directly on the person on the top half of the Earth, or the person on the bottom half?* (bottom half, or Southern Hemisphere)
- *Which person feels warmer temperatures?* (the person in the Southern Hemisphere)
- *Which person is experiencing summer?* (the person in the Southern Hemisphere) Winter? (the person in the Northern Hemisphere) How do you know? (The person in the Southern Hemisphere is receiving more direct sunlight, so it is warmer there and is the summer season.)
- *Is the sun brighter or more concentrated for the person in summer or the person in winter?* (the person in summer)

6. Have students make a math connection.

Ask for a volunteer from one of the groups to come to the front of the classroom with their "sun" (flashlight). Have the rest of the students sit on the floor in a small area near the center of the classroom but facing the sun. Ask students to imagine that the floor is the Northern Hemisphere of the Earth. In the winter, the North Pole of the Earth is pointing away from the sun, so the sun appears farther south in the sky to us. Have the student hold the sun closer to the floor. Have the rest of the class place their hands close to the floor and point toward the sun. Ask: *Do your finger and the floor form a large or small angle?* (small angle) Tell students they are forming an acute angle. Then have the student holding the sun hold it up as high as he or she can. Have the rest of the class keep their hands close to the floor and again point to the sun. Ask: *Is the angle you have formed with your finger and floor larger or smaller?* (larger) Tell students they are forming an obtuse angle. Ask: *What season does this represent?* (summer)

7. Have a whole-class discussion about how the sun affects Earth's seasons.

Point out to students that the seasons are opposite for people on the top (north) of the Earth and on the bottom (south) of the Earth. Ask:

- *When it is winter on the top (north) of the Earth, what season is it on the bottom (south) of the Earth?* (summer)

- *When it is winter on the bottom (south) of the Earth, what season is it on the top (north) of the Earth?* (summer)
- *How can we use angles to help others to understand seasons?* (In the summer, the angle of the sun is more directly over us, and larger, providing more direct solar radiation and making it warmer. In the winter, the angle of the sun is smaller and we receive less direct solar radiation, so it is colder.)

TipGoing Green

To make this activity more "green," use round fruit instead of polystyrene foam balls.

Modification

For advanced students, introduce the concepts of the winter solstice, summer solstice, autumnal equinox, and vernal equinox. Have them make connections between the hands-on activity and these special days that correspond to different points in the Earth's orbit.

Modification

In Step 4, address any student misconceptions about direct versus indirect sunlight. Dim the lights. Adjust a small flashlight to its most concentrated beam and shine the light on dark paper or a wall. Explain that this is similar to concentrated, direct sunlight during summer months. Then adjust the flashlight to the wide beam and describe it as dispersed, or indirect sunlight during winter months.

Informal Assessment

Ask students to orally explain how the interaction between the sun and Earth affects seasons here on Earth, and what happens with the sun's rays during the different seasons. Encourage them to use vocabulary terms *axis, tilt, direct sunlight,* and *indirect sunlight* in their responses.

Extending the Learning

Explain to students that every planet in our solar system has seasons. But the seasons that occur on other planets are extremely different from the traditional spring, summer, autumn, and winter that we experience on Earth. Remind students that the two reasons seasons occur are the tilt of a planet's axis and its orbit around the sun. Ask: *A planet's axis might have a smaller or larger tilt than Earth's. Which would cause more extreme seasons—a smaller or larger*

tilt? (larger) *A planet's orbit might be closer to or farther away from the sun than Earth. Which would cause more extreme seasons—being closer or farther away?* (closer) Have students explain their answers using evidence from the hands-on activity. Then have them read a list from NASA about the length of seasons on other planets in our solar system.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Astronomy

- Experiential Learning
- Mathematics

Learning Objectives

Students will:

- explain the relationship between the sun and Earth
- describe how the tilt and position of the Earth affects the seasons
- explain differences in direct and indirect sunlight

Teaching Approach

- Learning-for-use

Teaching Methods

- Cooperative learning
- Demonstrations
- Discussions
- Hands-on learning
- Inquiry
- Multimedia instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding

National Standards, Principles, and Practices

NCTM PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

• **Geometry (3-5) Standard 4:**
Use visualization, spatial reasoning, and geometric modeling to solve problems

NATIONAL SCIENCE EDUCATION STANDARDS

• **(K-4) Standard B-2:**
Position and motion of objects
• **(K-4) Standard D-3:**
Changes in earth and sky

ISTE STANDARDS FOR STUDENTS (ISTE STANDARDS*S)

• **Standard 2:**
Communication and Collaboration
• **Standard 4:**
Critical Thinking, Problem Solving, and Decision Making

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Black construction paper
- Flashlights
- Globe
- Markers
- Polystyrene foam balls or round fruit
- Push pins
- Rulers
- Scissors
- Toothpicks
- Transparent tape

REQUIRED TECHNOLOGY

- Internet Access: Optional
- Tech Setup: 1 computer per classroom, Projector, Speakers
- Plug-Ins: Flash

PHYSICAL SPACE

- Classroom
- Home

SETUP

Before starting this activity, cut a large, black circle out of black construction paper.

GROUPING

- Large-group instruction
- Small-group instruction

BACKGROUND & VOCABULARY

Background Information

One common misconception that students have about seasons is that seasons are due to how close or far the Earth is to the sun. The changing position of the Earth's tilt is the reason for the differences in temperature and length of daylight that distinguish the seasons. When the

Northern Hemisphere of the Earth is leaning toward the sun, it receives direct sunlight. The warmth of direct rays causes spring and then summer in that part of the globe. When the Northern Hemisphere of the Earth is leaning away from the sun, it receives more indirect sunlight. The cooling effects of more indirect sunlight cause autumn and winter. Because of the Earth's approximately 23.5º tilt, the seasons in the Northern and Southern Hemispheres are reversed, about six months apart from each other.

Prior Knowledge

["the Earth orbits the sun and rotates on its own axis"]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
acute angle	*noun*	angle measuring between 0 and 90 degrees.
angle	*noun*	slanting space between two lines that ultimately meet in a point.
autumnal equinox	*noun*	autumn day, usually around September 22, when day and night are of generally equal length.
axis	*noun*	an invisible line around which an object spins.
Equator	*noun*	imaginary line around the Earth, another planet, or star running east-west, 0 degrees latitude.
hemisphere	*noun*	half of a sphere, or ball-shaped object.
Northern Hemisphere	*noun*	half of the Earth between the North Pole and the Equator.
North Pole	*noun*	fixed point that, along with the South Pole, forms the axis on which the Earth spins.
obtuse angle	*noun*	angle measuring more than 90 degrees, but less than 180 degrees.
orbit	*noun*	path of one object around a more massive object.
season	*noun*	period of the year distinguished by special climatic conditions.
solar radiation	*noun*	light and heat from the sun.

Term	Part of Speech	Definition
Southern Hemisphere	*noun*	half of the Earth between the South Pole and the Equator.
South Pole	*noun*	fixed point that, along with the North Pole, forms the axis on which the Earth spins.
summer solstice	*noun*	day of the year with the most hours of sunlight, June 20 or 21 in the Northern Hemisphere and December 21 or 22 in the Southern Hemisphere.
temperature	*noun*	degree of hotness or coldness measured by a thermometer with a numerical scale.
tilt	*verb*	to lean or slant.
vernal equinox	*noun*	day, usually around March 21, when day and night are of generally equal length. Also called the spring equinox.
winter solstice	*noun*	(December 22 in the Northern Hemisphere, June 22 in the Southern Hemisphere) longest night of the year and the beginning of winter.

For Further Exploration

Websites

- NASA: Educator Features—Planetary Seasons
- National Geographic Science: Space
- NASA: Solar System Exploration—Kids
- Nat Geo Movies: Wildest Weather in the Solar System

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