Seasoned to the Tilt

Ask A Biologist activity for classroom and home

By Daniel S. Brehony and Abel Torres

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This is a companion PDF for this online article:

Seasoned to the Tilt
askabiologist.asu.edu/experiments/seasoned-tilt

About the Authors

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Experiment Overview

Have you ever thought about your favorite season, and why it looks and feels the way it does? Depending on where you live, you may experience seasons that are temperature-based (with cold, warm, and hot months of the year), or climate-based seasons such as dry and wet. This activity will help you see and understand why Earth has seasons, and the two things that work together to make seasonal changes happen. You will be making your own model "Earth" out of clay and using this in front of a battery-powered tap light bulb to see how much light shines on the Earth during certain seasons. You will revolve your Earth model around in a counter-clockwise circle to observe and record how much light shines on each of your hemispheres during each season. Through this activity, you will see how parts of the Earth other than your own experience seasons, with different amounts of sunlight intensity. Ask yourself how the tilt of our Earth's axis, along with the yearly revolution Earth makes around the Sun, might affect the seasons where you live.

What you need

- 1 package of non-drying modeling clay
- 1 toothpick
- 1 anywhere tap light (can be purchased in any major retail chain store's electrical or hardware section)
- 1 roll masking tape
- 1 Protractor
- 1 30 cm (12") ruler
- 1 meter stick
- 1 paper blotter (to kep table areas clean- may be folded paper towel or a small sheet of construction paper- should measure no more then 4" [10 cm] square)
- 1 pencil (per person)
- 1 Science notebook (per person)

The same tree in four different seasons. Image from Cherubino via Wikimedia Commons.

Before you begin

Be sure that the batteries in your tap light work; this is essential to your success with this activity!

Be sure to work with your clay on the paper blotter- this will protect your desk from getting the oils in the clay on it and making a mess.

Have your Science notebook and a sharp pencil ready to record what you see. By revolving your clay sphere around the tap light, you will be observing the effect of how intensely sunlight falls on the Earth at different times of the year.

Your Science notebook can be used to record observations of how the light will fall on your sphere, and it is a good idea to sketch the amount of light you see on the sphere as you revolve it around the tap light to give you an understanding of different seasons.

Read Switching of Seasons to make sure you're familiar with the different kinds of seasons and get a first look at why seasons occur in some areas of the world.

Experiment Overview *(continued)*

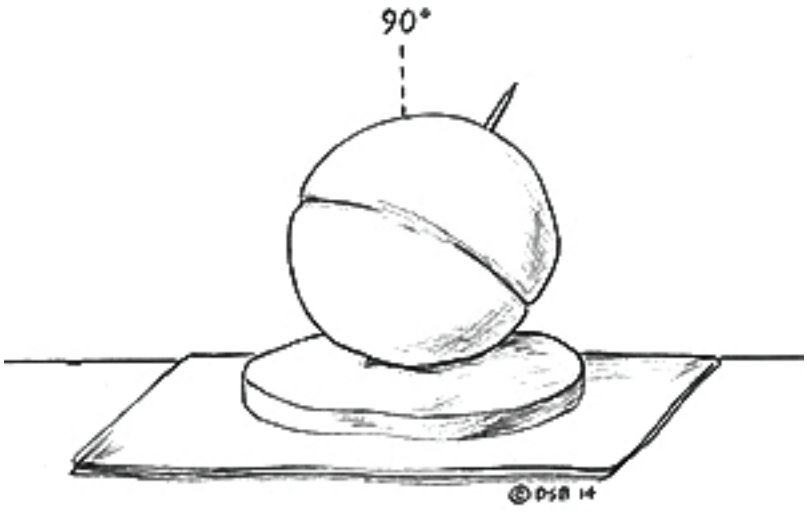
Procedure

1. You are going to make two things out of the clay: a sphere and a base to set the sphere on. First, break off a chunk of modeling clay and make a small sphere which measures around 2 inches in diameter. Using a smaller chunk of clay, make a thin, flat clay base wide enough and thick enough so that the sphere will rest securely on it. Be sure to use the paper blotter when making these so that you keep your desk clean.

2. Push a toothpick directly into the top center of the sphere (North Pole) and continue pushing gently until the toothpick comes out the bottom of the sphere (South Pole). Make sure that each end of the toothpick shows through the sphere at the North and South poles. The toothpick now represents the Earth's axis.

3. Holding the toothpick straight up and down at a 90-degree angle (double check this angle using the protractor), etch a line around the center of the sphere with the pencil- this will represent the equator.

4. Place the clay base in the center of the paper blotter. Place the protractor on the paper blotter behind the clay base- have a partner hold the protractor to keep it steady. Position the sphere representing the Earth onto the clay base. With the protractor behind, have a team member visually determine where the 66.5-degree mark is located on the protractor, then position the sphere so that the toothpick is directly in line with the 66.5-degree mark on the protractor. When the toothpick is in line with the 66.5-degree mark, this represents the 23.5-degree tilt of Earth on its axis. (Please see illustration on Figure 1.)

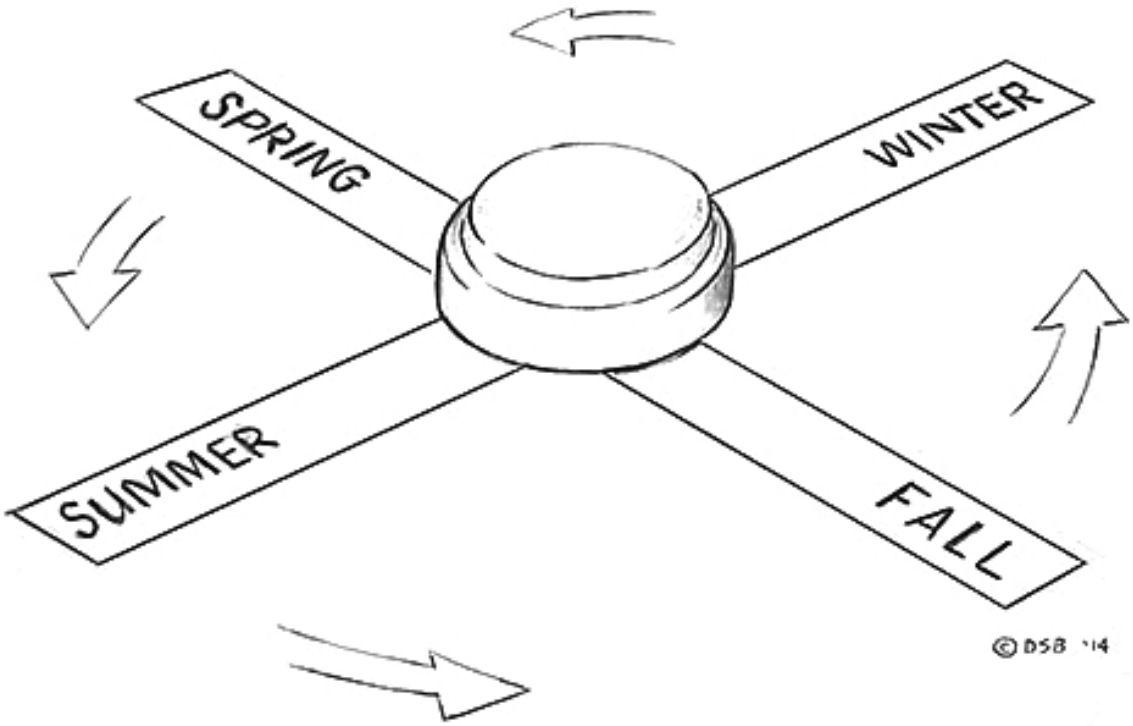


5. Now, construct the "Sun" area by first peeling off a 40 cm strip of masking tape. Use the meter stick to measure accurately. Place this strip down carefully on a desk or table. Next, peel off another 40 cm strip of masking tape and place this over the first strip on the desk or table, using the ruler to make sure the arms are equal (each arm should be about 20 cm long). Make sure the second piece of tape crosses the first piece at a 90° angle to the original strip (use a protractor to measure accurately). You should now have the shape of a cross.

6. Next, label the four arms of the cross at each end. With the tape cross directly in front of you, start with the arm of the cross at the bottom, and label it "summer." Then, label the top arm of the cross directly opposite summer with "winter." Label the arm of cross to the left with "spring", and the arm of the cross to the right with "fall". You should now have the name of one season on each arm of the cross.

Experiment Overview *(continued)*

7. Place one (1) tap light in the center of the cross made with the tape strips. Turn the tap light on by pressing it gently at the top. The light should give off a steady glow. Now, ready the room by turning off the lights. (Please see illustration of Steps 6 and 7 on Figure 2.)



8. Set your sphere and clay base in front of the tap light at the bottom arm of the cross labeled "summer"; the sphere should stay resting on the base, because it is already at its proper 23.5-degree tilt. The sphere and the base should point at the tap light so that the northern hemisphere is facing the tap light- use the toothpick as a guide to help you get this aligned correctly. Observe which hemisphere gets the most direct light, and record and sketch what you see in your Science notebook.

9. Now, for the "revolution" part of this activity: Slowly revolve the sphere in a counter-clockwise fashion around the tap light; be sure to keep the sphere's angle (as shown by the toothpick) at the same original position when revolving it. When you revolve to the strip labeled "fall", what do you see? On which hemisphere does the light shine, or does the light appear to shine equally on the northern and southern hemispheres? Observe, record, and sketch what you see in your Science notebook.

10. Continue to move your sphere to "winter" and "spring" positions. Observe how the light falls on each hemisphere from each angle, and record in your Science notebook.

Teaching Tips

The concepts of Earth's revolution and tilt can be difficult ones for learners of all ages. This hands-on activity is designed to take some of the confusion away.

Students should already have prerequisite knowledge that Earth revolves, or orbits, around the Sun, our nearest star. Students should already know about the equator, which divides the Earth into northern and southern hemispheres, and about the poles and the axis, upon which Earth rotates, or turns, approximately every 24 hours.

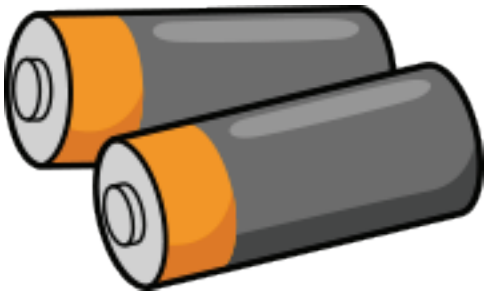
Tips for Classroom Implementation

Time required

Approximately 60 minutes

Classroom set-up

This activity requires a larger table surface area than a standard student desk- it is recommended that desks be grouped together to create a larger surface area. If your classroom has tables, this activity is ideal if the two tables are placed together.



Check that the batteries and light work before starting the activity.

Tips

- After purchasing the tap lights, be sure that the batteries inside each are in good working order!
- Before beginning the guided practice of this lesson, be sure to keep all materials ready to pass to each table. The instructor can put each group's materials in tubs or big bags near each table. Therefore, one student per team can get all the materials needed for the experiment. The teacher will save time during transition to guided practice.
- Modeling is vital for this experiment to help students accurately locate the proper tilt angle and set the sphere down on the base. If your classroom has a document camera system, modeling the construction of the sphere and base, and placement of the toothpick can be done under a document camera in real time.
- Also, teachers can have written step-by-step directions of the experiment available (if needed).
- During the experiment, teachers can also scaffold their students' thinking by asking questions about the seasons and the amount of sunlight that is present at each season.

    1. Are there any differences you see between the tilts of the Northern and Southern hemispheres as to how much light they get when they face the Sun (taplight) at different seasons?
    2. What season would it be in the Northern or Southern Hemisphere if each were tilted more in the direction of the Sun (tap light)?
    3. How do the seasons labeled "spring" and "fall" contrast with the seasons labeled "winter" and "summer"? (This will link students to an understanding of revolution.)

Teaching Tips *(continued)*

Extensions

- Students can explore the possibilities of what would happen if the Earth had no tilt at all, or they can mimic the extreme tilt of Uranus. What kind of seasons would these scenarios create?
- Challenge students with the fact that the Earth is technically physically closer to the Sun during the Northern Hemisphere's winter season, and farther away physically in the summer. If so, then why are summers in the Northern Hemisphere warmer and why are summer days longer?
- Engage students with the fact that the Earth revolves around the Sun in a roughly circular fashion, not elliptically as many perceive it.
- Question students about regions of the Earth near the equator. Based on their experiences with the model Earth in the activity, what might the climate be like near the equator? Is the amount of sunlight intensity at the equator changing, or is it fairly constant? Does land near the equator experience temperature-based seasons?

Objectives

Students will develop a basic understanding that the tilt of the Earth, along with its orbit (revolution) around the Sun contributes to the cause of seasons by doing a hands-on experiment, writing observations, and answering questions in their Science notebooks.

Arizona Science Standards

Strand 1: Inquiry Process

Concept 1: Observations, Questions, and Hypotheses
Formulate predictions, questions, or hypotheses based on observations. Locate appropriate resources.

PO 1. Formulate a relevant question through observations that can be tested by an investigation.

(See M05-S2C1-01)

PO 2. Formulate predictions in the realm of science based on observed cause and effect relationships.

Concept 2: Scientific Testing (Investigating and Modeling)
Design and conduct controlled investigations.

PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.

PO 3. Conduct simple investigations (e.g., related to forces and motion, Earth processes) based on student-developed questions in life, physical, and Earth and space sciences.

PO 4. Measure using appropriate tools (e.g., ruler, scale, balance) and units of measure (i.e., metric, U.S. customary).

PO 5. Record data in an organized and appropriate format (e.g., t-chart, table, list, written log).

Arizona Science Standards *(continued)*

Concept 3: Analysis and Conclusions
Analyze and interpret data to explain correlations and results; formulate new questions.

PO 1. Analyze data obtained in a scientific investigation to identify trends and form conclusions.

PO 2. Analyze whether the data is consistent with the proposed explanation that motivated the investigation.

PO 3. Evaluate the reasonableness of the outcome of an investigation.

PO 4. Develop new investigations and predictions based on questions that arise from the findings of an investigation.

PO 5. Identify possible relationships between variables in simple investigations (e.g., time and distance; incline and mass of object).

Concept 4: Communication
Communicate results of investigations.

PO 1. Communicate verbally or in writing the results of an inquiry.

Strand 6: Earth and Space Science

Concept 2: Earth's Processes and Systems
Understand the processes acting on the Earth and their interaction with the Earth systems.

PO 3. Distinguish between revolution and rotation.

Common Core Standards

Comprehension and Collaboration:

CCSS.ELA-Literacy.SL.5.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

CCSS.ELA-Literacy.SL.5.1c Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

CCSS.ELA-Literacy.SL.5.1d Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

Presentation of Knowledge and Ideas:

CCSS.ELA-Literacy.SL.5.4 Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

Next Generation Standards

ESS1.B Earth and the Solar System

The orbits of the Earth around the Sun, and of the Moon around Earth, together with the rotation of Earth about an axis between its north and south poles, cause observable patterns.