Pulse of the Planet: Calculating Sun Angles

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Grade Level	6 and High School
Duration	2 class periods

National Standards	AZ Standards	Arizona Social Science Standards
GEOGRAPHY **Element 3: Physical Systems** 7. The physical processes that shape the patterns of Earth's surface.	**SCIENCE** **Earth and Space Standards** **6.E1U1.6 Investigate and construct an explanation** demonstrating that radiation from the Sun provides energy and is absorbed to warm the Earth's surface and atmosphere. **6.E2U1.10 Use a model** to show how the tilt of Earth's axis causes variations in the length of the day and gives rise to seasons. **Essential HS.E1U1.11** Analyze and interpret data to determine how energy from the Sun affects weather patterns and climate. **MATHEMATICS** **The Number System** 6.NS.3. Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation. 6.NS.5. Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. **Standards for Mathematical Practice** 6.MP.2. Reason abstractly and quantitatively. 6.MP.7. Look for and make use of structure.	**GEOGRAPHY** **The use of geographic representations and tools helps individuals understand their world.** 6.G1.1 Use and construct maps, graphs, and other representations to explain relationships between locations of places and regions. Key concepts include major landforms and water bodies, countries, cities, ecosystems, climate, languages, religion, economic systems, governmental systems, population patterns, disease, trade routes, and settlement patterns HS.G1.1 Use geographic data to explain and analyze relationships between locations of place and regions. Key tools and representations such as maps, remotely sensed and other images, tables, and graphs

Overview

Seasons affect much of our lives, from what we wear to when crops are planted. Students need to learn about why the Earth has seasons. This is a core concept in physical geography and has implications for all parts of learning about Earth and its peoples.

Pulse of the Planet: Calculating Sun Angles

Purpose

In this lesson, students will learn the basic reason behind seasons using math to help explain relationships.

Background Information for Teachers

Question: Why is it summer after the June 22nd solstice? Why isn't it summer a month and a half before and after the solstice?
Answer: It takes a long time for Earth to heat up and cool down. So the 3 months after the time of most sunlight is the time when Earth has already heated up. There is also a "lag effect" after the winter solstice (December 22nd).

Question: Earth is closest to the sun (perihelion) in January, and Earth is farthest from the sun (aphelion) in July. So why is it summer in June and winter in January?
Answer: Earth is 3 million miles closer in January. It is still winter (in the northern hemisphere), because the sun angles are so low and because the day lengths are so short.
Question: Are seasons harsher in the Southern Hemisphere because perihelion (closest) occurs during their summer solstice (longer days, higher sun angles)?
Answer: Yes The sunlight is more intense in their summer and less intense in their winters. Another point to make is that having perihelion occur in winter makes our winters less harsh and our summers less intense.

Materials

- The Seasons on Earth—Note Taking Guide and Answer Key
- Noon Sun Angle Worksheet and Answer Key
- Why do we have seasons? Assessment and Answer Key
- Calculating Sun Angles PowerPoint
- Projection device
- Computer with Internet
- Protractor
- Optional: flashlight and globe
- Wall Map

Objectives

The student will be able to:

1. Explain the relationship between sun angles and seasons

2. Use information on the time of year and specific latitude to calculate the noon sun angle.

Procedures

Students should have had experience in angles and subtraction. Students should know basic features of a globe such as Tropic of Capricorn, North Pole, etc.

SESSION ONE
1. Introduce the lesson by playing "Pulse of the Planet" video that links music to satellite imagery. (2.19 min) https://svs.gsfc.nasa.gov/2395 (There is a separate file that has notes on this video if you want to narrate for the students what is happening as the video plays.) Then ask the students for their explanation of "Why do we have seasons?"
2. Begin the direct instruction. Explain that the basic of idea of seasons is easy to understand. Summer occurs when more sunlight hits that place on Earth. Winter occurs when less sunlight hits that place. Explain that summer occurs when two things happen together: (1) days are longer, so more sunlight hits the Earth at that place; (2) sun angles are higher (45° – 90°), so sunlight is more intense. To reinforce these concepts show the following audio visual presentations:

- Why do we have different seasons? California Academy of Science (3.16 min) https://www.youtube.com/watch?v=WgHmqv_-UbQ
- Why do we have seasons? SciShow (2.28 min) https://www.youtube.com/watch?v=wwdB22opre0
- Sun Angle GSFC773.mpg (1.15 min) https://geoalliance.asu.edu/node/171

After the third presentation, it is sometimes useful to use a flashlight to make the point. If you shine a flashlight directly down on a spot, the light is most intense – as in summer. The angle formed between the light source and the surface is 90°. Then, shine the light at an oblique angle. The angle formed between the light source and the surface is less than 90°. Explain that the light is spread out over a larger area and is much less intense — as in winter.
2. Distribute The Seasons of the Earth—Note Taking Guide. Lead the students through the completion of this worksheet as a review of the important latitude numbers (66,5^{0}N etc., etc.), the names of human features (Arctic Circle, etc.), key vocabulary words to understanding the causes of seasons (axis, etc.), and the dates and names for seasonal changes (March 22, Vernal Equinox, etc.).

SESSION TWO
3. Distribute the Noon Sun Angle Worksheet. Allow students to access their The Seasons of the Earth—Note Taking Guide to complete this assignment.
4. Project the Calculating Sun Angles PowerPoint to reinforce the idea behind seasons and sun angles, and to model the mathematics of the lesson. Have students complete the Noon Sun Angle Worksheet.
5. Have students complete the Why do we have seasons? assessment.

Assessment

Science and Geography
The Seasons of the Earth—Note Taking Guide and the Noon Sun Angle Worksheet can be graded for geography and science. Mastery will be considered 80% or higher.

Why do we have seasons? can be graded as a final assessment for science and geography. A score of 75% or higher will be considered mastery.

Mathematics
The Noon Sun Angle Worksheet can be graded for mathematics. Mastery will be considered 80% or higher.

Extensions

Have students use protractors to draw the angles they calculate on the student worksheet.

Create climographs, so students can see how seasons play out at different places on Earth.

Use this lesson to introduce the need for different clothing styles, house types, vegetation, etc. around the world.

Have students read the NGS Reading Expeditions® book Earth, Sun, Moon by Glen Phelan. ISBN 07922-4573-3.

Sources

For more information:
https://earthsky.org/earth/can-you-explain-why-earth-has-four-seasons

Why do we have different seasons? California Academy of Science (3.16 min)
https://www.youtube.com/watch?v=WgHmqv_-UbQ

Why do we have seasons? SciShow (2.28 min)
https://www.youtube.com/watch?v=wwdB22opre0

Pulse of the Planet NASA Scientific Visualization (2.19 min) Studio https://svs.gsfc.nasa.gov/2395