SEASONS AND ECLIPTIC SIMULATOR

Overview:

In this lesson, students access an online simulator to aid in understanding the relationship between seasons and Earth's tilt and the day/night cycle caused by Earth's rotation.

Objectives:

The student will:

- relate seasons to Earth's tilt in relationship to the sun; and
- associate the angle of solar radiation to the amount of heat that reaches a location on Earth's surface.

Targeted Alaska Grade Level Expectations:

Science

[7-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[8] SD3.1 The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by recognizing the relationship between the seasons and Earth's tilt relative to the sun and describing the day/night cycle as caused by the rotation of the Earth every 24 hours.

Math

[8] G-10 The student demonstrates a conceptual understanding of geometric drawings or constructions by drawing, measuring, or constructing geometric figures (polygons, perpendicular bisectors, or perpendicular or parallel lines).

Vocabulary:

axis - Earth's axis is an imaginary line that runs from the North Pole to the South Pole

altitude – the height of a thing above a reference level, usually the Earth's surface; the vertical angle between a celestial object and the horizon, as seen by the observer; altitude and azimuth are the coordinates used to navigate with respect to the stars

ecliptic - the great circle on the celestial sphere that is made by the plane containing Earth's orbit around the sun; the ecliptic traces the sun's apparent path in the sky in one year, as viewed from Earth

tilt - Earth's axis tilts, or leans, from the perpendicular of the ecliptic plane by 23.45°

rotation - the act of spinning on an axis; Earth makes one complete rotation every 24 hours

revolution - the motion of an object around a point. Earth makes one complete revolution around the Sun in about 365 days

latitude - distance measured when traveling north or south on Earth's surface; Latitude is measured in degrees from the equator

radiation - energy in the form of electromagnetic waves, or streams of particles, photons or electrons; The sun emits radiation

perpendicular - crossing at, or forming a right angle

parallel - lines or surfaces that are separated from each other by the same distance everywhere

Whole Picture:

The sun is the primary source of energy for Earth's climate system. The tilt of Earth's axis relative to its orbit around the Sun results in predictable changes in the duration of daylight and the amount of sunlight received at any latitude throughout a year. These changes cause the annual cycle of seasons and associated temperature changes.

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During the summer, the North Pole tilts toward the sun and in the winter, it tilts away. As the sun rises higher in the sky in the summer in the regions around the North Pole, the sun's radiation becomes more direct and increases surface heat. A common misconception is that the North Pole experiences colder weather in the winters because Earth's tilt increases the distance between the pole and the sun. Actually, during summertime in the north, the Earth is farther away from the sun than in the winter. The decreasing amount of direct sunlight impacts the temperature in the Arctic.

Some Elders can still recall those times in winter when darkness prevailed and a source of light was hard to come by. Long hours of darkness led to the telling of stories. But such stories could only be told in late fall and the first half of winter, when the days were still shortening. Telling stories when the days were getting longer was taboo. Each storyteller would end with the phrase, "I thought that winter had just begun, but now I have chewed off part of it."

Source: Make Prayers to the Raven: A Northern View of the Northern Forest by Richard K. Nelson, The University of Chicago Press, 1983

Materials:

- VIDEO: "Seasons and Ecliptic Simulator"
- STUDENT WORKSHEET: "Seasons and Ecliptic Simulator"

Activity Preparation:

Look up the latitude of your community.

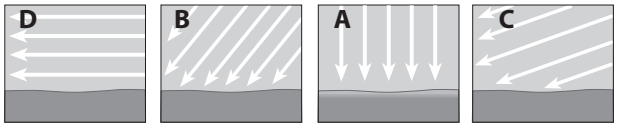
Activity Procedure:

1. Explain that students will learn how Earth's motion and the sun create seasons. Pose the question: Why is the North Pole colder in the winter than in the summer? Write notes of student responses on the board.
2. Distribute STUDENT WORKSHEET: "Seasons and Ecliptic Simulator." Review the information on the sheet and have students complete the activities.
3. Review student work and revisit the question posed at the beginning of the lesson. Check for understanding and dispel any misconceptions expressed.

Extension Idea:

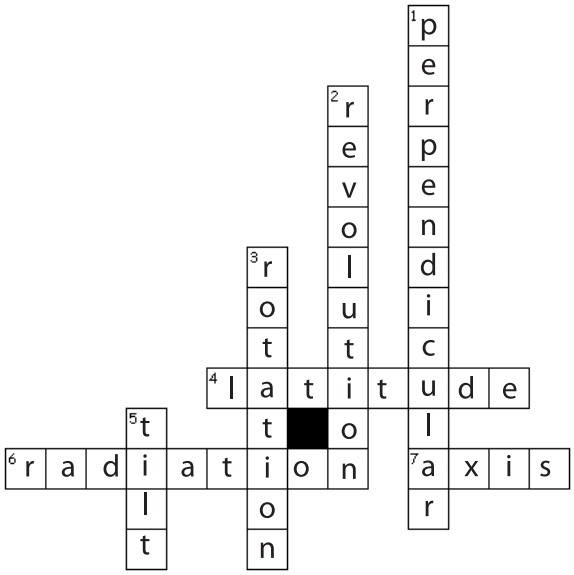
Have students act out the vocabulary words. For example, students stand and spin to show "rotate." Students may pair up to show "revolve" or "revolution."

Answers:

1. Answers will vary.
2. A. perpendicular
3. decrease
4. 

5. C. Barrow, AK; latitude 71.3° N
6. March 21 and September 21
7. Answers will vary.
8. Answers will vary but altitudes should be higher than Alaskan community.

9. Answers will vary.
10. Answers for A, B, and C will vary.
11. True
12. True
13. False
14. A. the tilt of Earth on its axis
15. B. The tilt allows certain latitudes of Earth to be heated at a greater rate while Earth rotates.
16. Crossword Answers:



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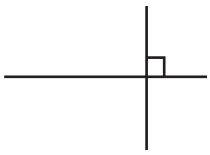
The sun is the main source of energy for Earth's climate system. The sun's radiation provides heat and light. Earth rotates, or spins, causing both day and night. Earth's axis, an imaginary line that runs from the North Pole to the South Pole, is tilted. This makes days longer in the summer in the Northern latitudes and shorter in the winter. Latitude is a measurement of distance from the equator. Earth revolves, or circles, the sun. The combination of Earth's tilt and revolution around the sun create seasons.

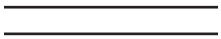
1. What is the latitude of your community? _____

During the summer, the North Pole tilts toward the sun and in the winter, it tilts away. As the sun rises higher in the sky in the summer in the regions around the North Pole, the sun's radiation becomes more direct and heats the surface more. The sun's rays are direct when they are perpendicular to Earth's surface. That means, the rays meet Earth's surface at a right angle (90°).



These lines intersect and form four right angles. They are ***perpendicular lines.***

The sun's rays are not direct when they are parallel to Earth's surface. Parallel lines never intersect, or cross each other.



These lines are ***parallel.***

A common misconception is that the North Pole experiences colder weather in the winters because Earth's orbit increases the distance between the pole and the sun. Actually, during summertime in the north, Earth is farther away from the sun than in the winter. The decreasing amount of direct sunlight impacts the temperature in the Arctic.

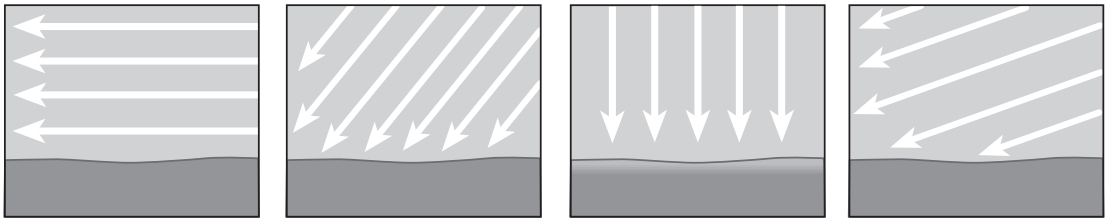
2. The most direct sunlight is _____ to Earth's surface.
   A. perpendicular
   B. parallel

Directions: Watch the VIDEO: "Seasons and Ecliptic Simulator" and manipulate the settings in the different boxes to view the changes of seasons and angles of sunlight received on various locations on Earth, and then answer the questions below.

3. Move the stick figure in the upper right box of the Seasons and Ecliptic Simulator. As the stick figure is dragged towards the poles, does the amount of direct sunlight increase or decrease?

   _____

4. Match each description of the angle of sunlight (solar radiation) to the picture of Earth's surface.
   A. most direct B. less direct C. least direct D. parallel



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5. A location where sunlight may be parallel to Earth at different times of the year is:
   A. Anchorage, AK; latitude 61.2° N
   B. Honolulu, HI; latitude 21.3° N
   C. Barrow, AK; latitude 71.3° N
   D. Seattle, WA; latitude 47.7° N

6. Move the stick figure to the equator. Drag the red arrow on the calendar to answer the following question. During what two months does a person standing at the equator experience the most direct sunlight?

   _____ (month) _____ (month)

7. Drag the stick figure to your latitude. In the lower right box, select "view from side." Use the sun's altitude, the angle of the sun in the sky, to complete the table below.

My Alaskan community: _____ Latitude: _____

Day	Spring Equinox March 21	Summer Solstice June 21	Autumn Equinox September 21	Winter Solstice December 21
Sun's Altitude (°)				

8. Complete the following table using one of the following communities.

Community and Latitude	
Honolulu, HI	21.3°
Seattle, WA	47.7°
Miami, FL	25.8°

Community in a warmer climate: _____ Latitude: _____

Day	Spring Equinox March 21	Summer Solstice June 21	Autumn Equinox September 21	Winter Solstice
Sun's Altitude (°)				

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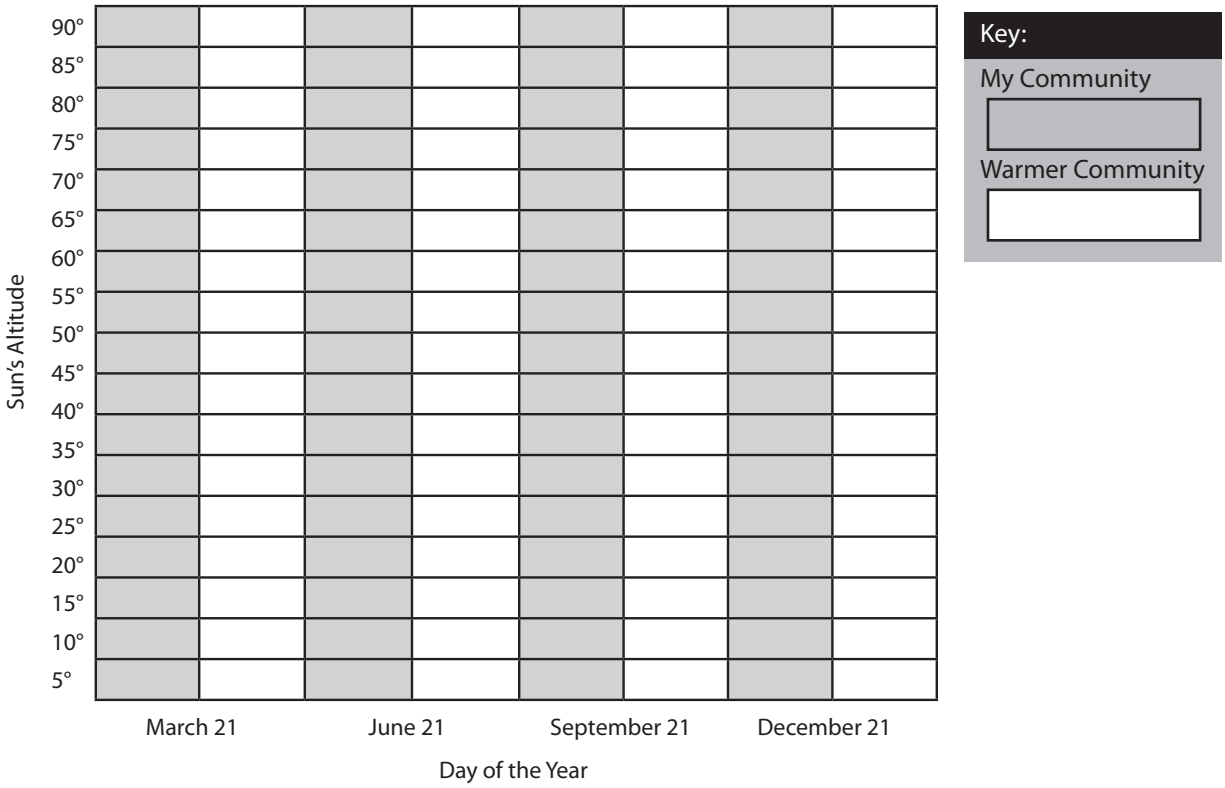
9. Graph the information from the two tables on the previous page in the graph below.



10. Use the graph to answer the following questions.
    A. What is the lowest altitude of the sun for the community in the warmer climate?_____
    B. What is the highest altitude of the sun for your community?_____
    C. What is the difference in altitude?_____

11. True or False: Lower latitudes are warmer because of the direct sunlight.

12. True or False: Warmer climates are most likely to be closer to the equator.

13. True or False: The North Pole is colder in the winter because it is farther away from the sun.

14. Seasons in Alaska are primarily caused by which factor as Earth revolves around the sun?
    A. the tilt of Earth on its axis
    B. the rate of rotation of Earth
    C. the effects of solar flare activity
    D. the relative distance between Earth and the sun

15. How does the tilt of Earth's axis and its rotation affect the weather?
    A. The tilt of Earth allows Earth to absorb all the sun's radiation as it rotates.
    B. The tilt allows certain latitudes of Earth to be heated at a greater rate while Earth rotates.
    C. The tilt of Earth allows Earth to rotate fast enough to allow surface cooling to occur at night.
    D. The tilt allows energy to be evenly distributed throughout the atmosphere while Earth rotates.

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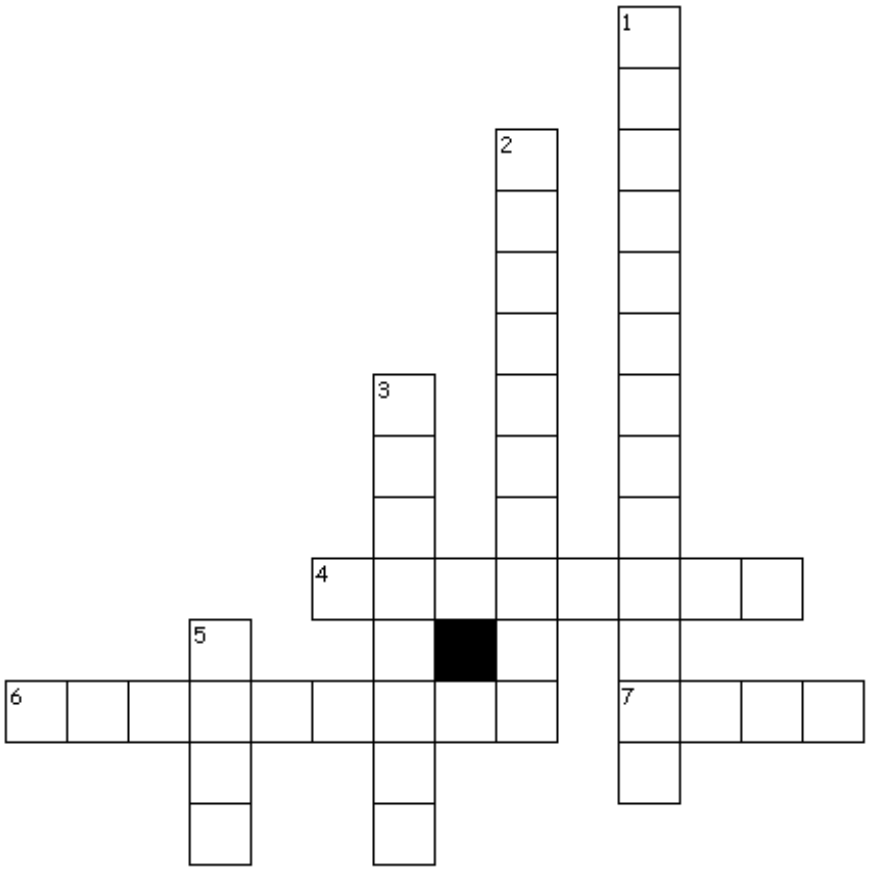
16. Check your understanding. Complete the crossword below.



Across

4. distance measured when traveling north or south on Earth's surface
6. energy in the form of electromagnetic waves, or streams of particles, photons or electrons from the sun
7. an imaginary line that runs from the North Pole to the South Pole

Down

1. The most direct sunlight is _____ to Earth's surface.
2. the motion of an object around a point
3. This motion of the Earth is responsible for our days and nights
5. the lean of Earth's axis