

Teacher Guide: Seasons in 3D



Learning Objectives

Students will ...

- Observe the tilt of Earth's axis at different times of the year.
- Compare the Sun's apparent path across the sky in winter and summer.
- Explain the cause of the seasons.
- Discover why the seasons don't occur at the same time in the Northern and Southern Hemispheres.
- Analyze the change in solar intensity and daylight hours over the course of a year.
- Explain why summer is hotter than winter.



Vocabulary

axis, equinox, latitude, Northern Hemisphere, revolve, rotate, solar energy, solar intensity, Southern Hemisphere, summer solstice, winter solstice



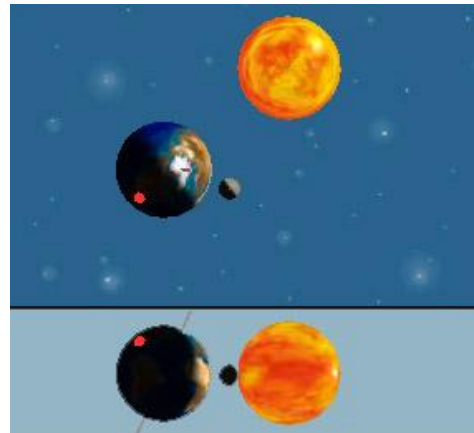
Lesson Overview

Most places in the United States experience distinct seasons. Cool spring showers are followed by hot summer days. Then, fall arrives with gusting winds, only to be replaced by winter's bitter cold. What causes this pattern of changing weather? Students can find the answer to this question using the *Seasons in 3D* Gizmo™.

This Gizmo can be used independently or as a follow-up to the *Seasons: Why Do We Have Them?* and the *Seasons: Earth, Moon, and Sun* Gizmos.

The Student Exploration sheet contains two activities:

- Activity A – Students relate the position of Earth's axis at different times of the year to Earth's seasons.
- Activity B – Students determine why summer is hotter than winter.



Suggested Lesson Sequence

1. Pre-Gizmo activities

(🧠 variable)

You may want to have students explore the *Seasons: Why Do We Have Them?* and/or the *Seasons: Earth, Moon, and Sun* Gizmos before assigning the *Seasons in 3D* Gizmo.

In addition, discuss with students some of the differences between the seasons. Ask students to describe how the following factors vary from season to season: the weather, the length of the day, the types of clothes they wear, the types of sports they play, the types of food they eat, etc. Allow students to hypothesize what causes the seasons. Some students may think that Earth is closer to the Sun during the summer. Point out that, in fact, the opposite is true: Earth's distance to the Sun is shortest in January.

2. **Prior to using the Gizmo** (🧠 10 – 15 minutes)
Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations. Demonstrate how to take a screenshot and paste the image into a blank document.
3. **Gizmo activities** (🧠 15 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.
4. **Discussion questions** (🧠 15 – 30 minutes)
As students are working or just after they are done, discuss the following questions:
 - How does the amount of solar energy striking the Northern Hemisphere change over the course of the year? What causes these changes?
 - Why are days longer in the summer and shorter in the winter?
 - Why is solar intensity greater in the summer than in the winter?
 - Why does the Sun rise higher in the sky during the summer than in the winter?
 - What causes the seasons? Do you think Earth would have seasons if its axis wasn't tilted?
5. **Follow-up activities** (🧠 variable)
Have students complete the *Seasons Around the World* Student Exploration sheet to find out how seasons vary by latitude and how changing the tilt of Earth's axis would affect the seasons.

In addition, bring a piece of cardboard, flashlight, and marker to class. Turn off the lights and have a volunteer hold the flashlight directly perpendicular to the cardboard. Use the marker to draw an outline around the circle of light made on the cardboard by the flashlight. Then, slant the cardboard at an angle to the flashlight. This will cause the circle of light to spread out into an oval. Use the marker to draw a dashed line around this oval. Turn the classroom's lights back on and have students compare the two shapes on the cardboard.

Have students discuss how the flashlight's light spread out and decreased in intensity when the light struck a slanted surface. Students should relate their observations to how they think solar rays would fall on Earth's surface when its axis is tilted towards or away from the Sun.



Scientific Background

Other than areas near the equator, most places on Earth have four distinct seasons. This phenomenon is related to the fact that Earth is tilted on its axis at an angle of approximately 23.5° . Because Earth's axis is tilted, the angle of solar rays striking a particular location on Earth's surface changes as Earth revolves around the Sun. In addition, Earth's tilted axis causes the total area of the Northern and Southern Hemispheres lit by sunlight to vary depending on Earth's location in its orbit.

On the June solstice, the northern end of Earth's axis is pointed toward the Sun. Thus, solar rays are most direct in the Northern Hemisphere and least direct in the Southern Hemisphere. Furthermore, more than half of the Northern Hemisphere is lit by sunlight, while less than half of the Southern Hemisphere is lit. This causes the length of the day to be longer in the Northern Hemisphere than the Southern Hemisphere. The combination of direct sunlight and long days causes higher temperatures in the Northern Hemisphere, where summer is beginning. In the Southern Hemisphere, June marks the beginning of winter. The opposite occurs around the December solstice, which marks the beginning of winter in the Northern Hemisphere and the beginning of summer in the Southern Hemisphere.

The equinoxes occur between the solstices. On the equinox, the top of Earth's axis is neither pointed towards nor away from the Sun. Because of this, both the Northern and Southern Hemisphere receive equally direct solar rays and equal amounts of sunlight. This causes the length of the day to equal the length of the night and temperatures to be intermediate.



Biology Connection: Photoperiods

Often, you can tell what season it is in a picture of a landscape simply by looking at the plants. The spring flowers may be blooming, the summer crops may be ripe, leaves may be changing color for fall, or bare branches may indicate winter has set in. Year after year, all these changes take place with predictable regularity. What allows plants to time their seasonal changes so precisely?

In the early 1900s, most botanists thought plants were simply responding to weather changes. However, experiments with tobacco plants in the 1920s indicated that something else was happening. By altering the amount of light a tobacco plant was exposed to (or its *photoperiod*) the plant could be forced to bloom or go dormant. Further research showed that many other plants also respond to photoperiods. For example, plants known as short-day plants respond to short periods of light followed by long periods of dark (winter daylight conditions). One example of a short-day plant is the poinsettia, which blooms in December. Long-day plants, on the other hand, respond to long periods of light followed by short periods of dark (summer daylight conditions). Spinach is an example of a long-day plant.

Plant responses to daylight length are regulated by the pigment *phytochrome*. When this pigment absorbs red light, it initiates the release of a series of hormones that regulate plant responses. The amount of light absorbed determines which hormones end up being released by the plant cell, thus governing how the plant will change in response to its environment.



Selected Web Resources

Reason Earth has seasons: <http://www.morehead.unc.edu/Shows/EMS/seasons.htm>,
<http://www.astronomynotes.com/nakedeye/s10.htm>

Game: http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level2/javascript/song.html

Photoperiods: <http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/P/Photoperiodism.html>

Related Gizmos:

Seasons: *Why Do We Have Them?* <http://www.explorellearning.com/gizmo/id?407>

Seasons: *Earth, Moon, and Sun*: <http://www.explorellearning.com/gizmo/id?468>

Seasons *Around the World*: <http://www.explorellearning.com/gizmo/id?465>

Summer and Winter: <http://www.explorellearning.com/gizmo/id?656>