Teacher Guide: Seasons: Earth, Moon, and Sun

Learning Objectives

Students will …

- Relate different units of time to astronomical events.
- Track the Sun's apparent path across the sky.
- Explain why sunrise and sunset times vary over the course of the year.
- Describe how latitude affects sunrise and sunset times.

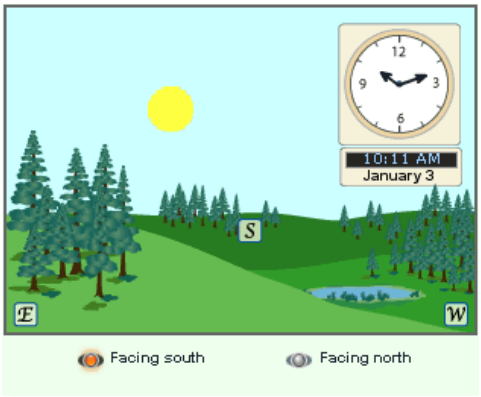
Vocabulary

altitude, axis, azimuth, equinox, horizon, latitude, revolution, rotation, solstice

Lesson Overview

Why are there 24 hours in a day? Why do months last 28 to 31 days? Why are there 365 days in the year? These are all questions that students can explore using the *Seasons: Earth, Moon, and Sun* Gizmo™.

This Gizmo allows students to watch the movements of the Earth, Moon, and Sun in relation to each other. Using the Gizmo, students can view the position of Earth and its axis on any day of the year, analyze how the apparent path of the Sun varies by latitude and time of year, and study how the Sun's position in the sky relates to the orientation of shadows.



Watching the Sun rise

The Student Exploration sheet contains three activities:

- Activity A – Students determine how the passage of a day, month, and year relates to the movements of the Earth, Moon, and Sun.
- Activity B – Students analyze the Sun's apparent path across the sky.
- Activity C – Students explore the factors affecting sunrise and sunset times.

Suggested Lesson Sequence

1. **Pre-Gizmo activity: Tracking the Sun** (15 – 30 minutes)
   At the beginning of class, go outside and pick out an identifiable, readily visible object in the landscape. Examples include a flagpole, a prominent tree, or a building. Have the class use this object as a reference point to describe the position of the Sun. (CAUTION: Tell students that looking directly at the Sun can cause permanent eye damage.)

   Near the end of class, go back outside and have the class describe how the position of the Sun has changed. Use students' observations to start a discussion about how the Sun could be used to tell time. If possible, have the class track the Sun's path over the course of several days or weeks. (More Sun-tracking activities can be found in the **Selected Web Resources** below.)

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:

   - Jupiter is over five times as far away from the Sun as Earth is. Because of this, Jupiter's orbit is much larger than Earth's orbit. How do you think this affects the length of Jupiter's year? [Because Jupiter's orbit is so large, it takes Jupiter much longer to complete one revolution. Thus, Jupiter's year is longer than Earth's year. (In fact, one year on Jupiter is equivalent to almost 12 years on Earth.)]
   - Hundreds of years ago, many people thought the Sun orbited Earth. Why do you think people believed this? [Standing on Earth's surface, it appears that the Sun moves across the sky.]
   - If Earth's axis were straight up and down instead of tilted, how do you think this would affect the lengths of days and nights? [Every day would be an equinox.]
   - In the Northern Hemisphere, the longest day of the year is on or close to June 21. When is the longest day of the year in the Southern Hemisphere? Explain. [The longest day of the year in the Southern Hemisphere is December 21 because this hemisphere is tilted toward the Sun in December and, thus, receives more sunlight than the Northern Hemisphere.]

5. **Follow-up activity: Build a sundial** (30 – 45 minutes)
Have students build their own sundials. A simple way to do this is to draw a circle on a piece of poster board. Draw a line through the center of the circle, and write *noon* at one end of that line. Place a piece of clay at the center of the circle and press the eraser end of a pencil into the clay so the pencil stands straight up.

   Have students take their sundials outside and observe the pencils' shadow moving around the sundials. At each hour, students should mark the position of the shadow. (For instructions on building a more intricate sundial, see the **Selected Web Resources** below.)

   Afterwards, have students discuss their results. Ask students whether they think the sundials they made would be accurate year-round. Then have students consider how they could change their sundials to tell Daylight Saving Time.

   The *Seasons: Earth, Moon, and Sun* Gizmo is the first in a series of three modules that use the same simulation. The next two are *Seasons in 3D* and *Seasons Around the World*. See the **Selected Web Resources** for links to these and other seasons Gizmos.

Scientific Background

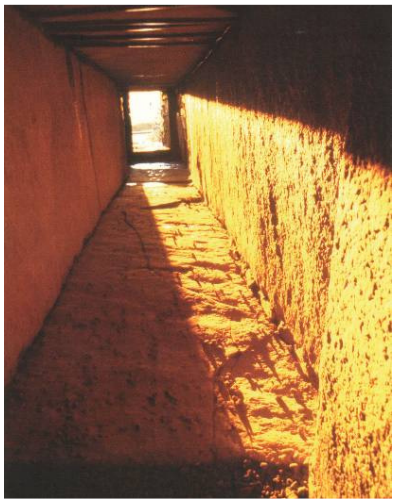
Although you cannot feel it, the planet you live on is hurtling through space at approximately 107,000 kilometers (66,000 miles) per hour. Earth's movements are the basis of our units of time. 24 hours equals one Earth day, or the time it takes Earth to rotate on its axis. 365 days equals one Earth year, or the time it takes Earth to revolve around the Sun.

Careful observation will show you that the Sun's apparent path across the sky is not identical over the course of a year. In the northern hemisphere, the Sun's azimuth seems to move southward in the winter and northward in the summer. The reason for this has to do with the tilt of Earth's axis. In the summer, the top of the axis is tilted towards the Sun. In the Northern Hemisphere, this causes longer daylight hours and the Sun to appear at a higher altitude in the sky. In the winter, the top of the axis is tilted away from the Sun. In the Northern Hemisphere, this causes shorter daylight hours and the Sun to appear at a lower altitude in the sky.

The shortest day of the year at northern latitudes is the winter *solstice,* which usually falls on December 21. That same date is the summer solstice at southern latitudes. Thus, December 21 is the longest day of the year south of the equator.

Historical Connection: Maeshowe

Thousands of years ago, before there were any clocks or calendars, people paid close attention to the movements of the Sun and Moon in order to keep track of time. The solstices and equinoxes were particularly important days because they indicated the beginning and end of animal migratory periods and plant-growing seasons. Some of the oldest structures in the world were built with these dates in mind. For instance, Maeshowe, a 5,000-year-old tomb in the United Kingdom, has a narrow entrance perfectly aligned with the azimuth of the Sun at sunrise on the winter solstice. As the sun comes up, light pours through the entrance passageway into the tomb's chamber. Today, webcams placed inside the tomb are used to broadcast sunrise on the solstice (see the **Selected Web Resources** below).



Selected Web Resources

Tracking the Sun: http://hea-www.harvard.edu/ECT/the_book/Chap1/Chapter1.html
Build a sundial: http://solar.physics.montana.edu/ypop/Classroom/Lessons/Sundials/novice.html
Maeshowe webcams: http://www.maeshowe.co.uk/
Calculate sunrise/sunset times by latitude: http://www.weatherimages.org/latlonsun.html
Observing the night sky worksheet:
http://www.astro.washington.edu/courses/labs/clearinghouse/labs/word_documents/observing_nightsky.doc

Related Gizmos:
Seasons in 3D: http://www.explorelearning.com/gizmo/id?463
Seasons Around the World: http://www.explorelearning.com/gizmo/id?465
Summer and Winter: http://www.explorelearning.com/gizmo/id?656
Seasons: Why Do We Have Them?: http://www.explorelearning.com/gizmo/id?407
Rotation/Revolution of Venus and Earth: http://www.explorelearning.com/gizmo/id?374