

Reflect

In ancient Greece, people believed that powerful gods were responsible for all things that happened in nature. The Greeks believed that Helios, the Sun god, drove his fiery chariot from one end of Earth's sky to the other each day. His daily trip caused sunrise in the morning and sunset in the evening. At night, Selene, Helios's sister and the goddess of the Moon, made her own trip across Earth's sky. Today, scientists know that these stories are only myths. Do you know what really causes sunrise, sunset, day, and night?

How often does the day-and-night cycle occur on Earth?

Earth moves through space in several important ways. One type of motion is called rotation. A rotation is a spin around a center. For example, imagine a spinning top.

Earth also spins around a central line called an axis. Earth's axis is an imaginary vertical line that runs through the planet from the North Pole to the South Pole. If you held a globe by putting one finger at the North Pole and another finger at the South Pole, the invisible line that connects your fingers represents the axis. Earth's axis is slightly tilted at an angle of 23.5° . Because of this tilt, different locations on Earth receive different amounts of sunlight at different times. As a result, Earth experiences the different seasons of spring, summer, autumn, and winter.



Like a spinning top (right), a globe (left) spins around a central line called an axis. Earth's axis travels through the planet's center, connecting the North Pole to the South Pole.

As you read this sentence, Earth is rotating around its tilted axis at a rate of 1,000 miles (1,609 kilometers) per hour! Why, then, does it feel like Earth is standing still? In comparison to humans and other things on Earth, the planet is incredibly huge. Because of this difference in size, you cannot feel the speed of Earth's rotation. We know the planet is rotating, though, because we see the effects of it every day.

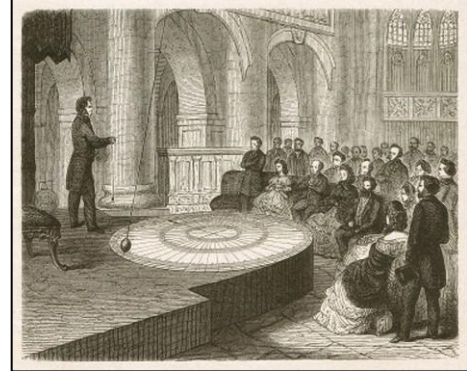
Earth makes one complete rotation on its axis every 23 hours and 56 minutes, which is rounded up to 24 hours. Does this time sound familiar? The 24 hours that Earth takes to make one rotation is equal to one *day*. Suppose you have a big math test in three days. How many rotations will Earth make in that time? If you answered three,

Reflect

you are correct. All planets rotate on an axis, but they do it at different speeds. Venus has a very slow rotation. It takes eight months for Venus to spin one time on its axis. Because a rotation is the same as a day, a day on Venus lasts for eight months. Jupiter, on the other hand, rotates quite fast. One rotation is fewer than 10 hours.

Discover Science: Foucault's Pendulum

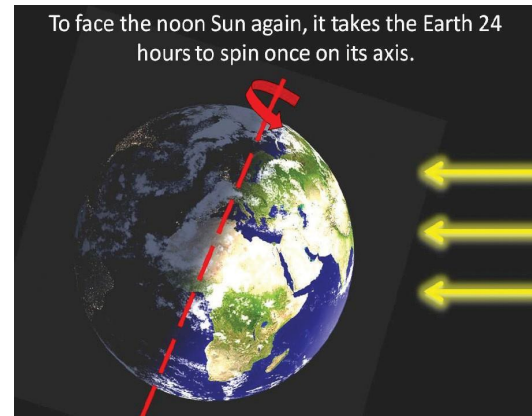
Scientists have thought that Earth is rotating on an axis for centuries. For much of this time, however, they could not prove it using experiments. Finally, in the 19th century, French scientist Jean Foucault found a way to demonstrate Earth's rotation. He hung a long **pendulum** from the ceiling of a tall building in Paris, France. Foucault swung the pendulum from north to south. If Earth did not rotate, the pendulum would continue to swing back and forth in the same direction. But the pendulum didn't swing back and forth! At each swing, it moved slightly to the right, eventually making a huge circle. This meant that Earth must have been moving beneath the pendulum.



pendulum: a weight (hung from a single point) that is allowed to move freely with gravity

Describe the positions of Earth and the Sun when it is daytime. How are they different at night?

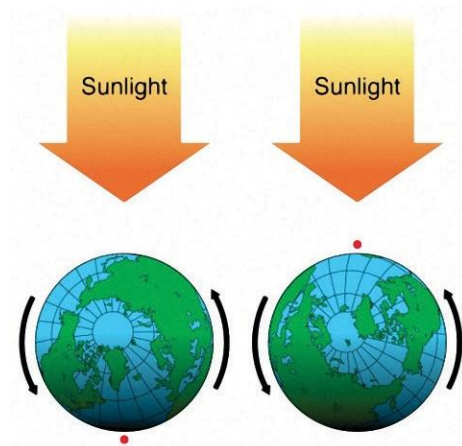
As Earth rotates on its axis, the different locations on Earth change position in relation to the Sun. A city on Earth that faces toward the Sun at noon will rotate to face away from the Sun 12 hours later. The positions of Earth and the Sun over the course of a 24-hour rotation cause sunrise, sunset, day, and night.



At all times, half of Earth faces toward the Sun and half faces away from the Sun. The half that faces toward the Sun is illuminated by the Sun's glow. It is daytime on that half of the planet. At the same time, the half of Earth that faces away from the Sun is in darkness. It is nighttime on that half of the planet. As Earth rotates, the Sun-facing half steadily moves from sunlight into darkness. From our position on Earth, this appears as sunset. Meanwhile, the dark-facing half of Earth steadily moves into the sunlight. We see this as process sunrise.

What Do You Think?

Look at these pictures of Earth. The picture on the left shows a red dot marking Venezuela's location at a certain time of day. The picture on the right marks Venezuela 12 hours later. In which picture would it be daytime in Venezuela?



On Earth it looks like the Sun is moving across the sky. Why is this not true?

Throughout the day, the Sun appears to move from east to west across the sky. In reality, Earth is rotating from west to east. Shadows offer some evidence to support this. You can see the apparent motion of the Sun in the movement of shadows during the day. When the Sun appears to rise above the eastern horizon in the morning, its light casts long shadows that point to the west. As the Sun takes its arc-shaped path across the sky, the shadows change. As the hour approaches noon, the shadows become shorter. When the Sun is directly overhead, very little shadow is observed. As the day continues, the Sun appears to move toward the western horizon. Again, the shadows lengthen but now point toward the east. Before clocks and wristwatches were invented, people used the Sun's apparent motion to tell time. A *sundial* uses shadows to determine the time of day.

Try Now

Work with a partner to make a human sundial.

1. With a partner, choose a flat, paved area that you can mark with chalk or masking tape. Be sure you can get to the area in the morning, at noon, and in the afternoon.
2. In the morning (around 9:00 a.m.), go to your area and face south. (If you do not have a compass, remember: If you face south in the morning, the Sun will be on your left.) Have your partner trace your shadow.
3. Use a ruler to measure the length of your shadow in centimeters.
4. Use a ruler to measure your actual height. Then, find the difference between your shadow length and your height.
5. Repeat Steps 2 through 4 again at noon and in the afternoon (around 3:00 p.m.). Make sure you face the same direction each time.



Try Now

6. Take a look at your data. How did your shadow change from morning to noon to afternoon? How did the Sun's position affect your shadow's position? How do you think your shadow would look at 6:00 a.m.? At 6:00 p.m.? Explain.

Look Out!

Because one rotation takes 24 hours, you might think that each side of Earth spends approximately 12 hours facing the Sun and 12 hours in darkness. This is true of places located on or near the equator. However, as you move toward the North and South Poles, the length of daytime and nighttime varies. The closer a city is to the North or South Pole, the more extreme the difference in daylight hours and nighttime hours is. This is due to the tilt of the axis and Earth's **revolution** around the Sun.

As Earth revolves around the Sun, the North Pole is tilted toward the Sun for part of the year. When this happens, the days are very long and the nights are very short. Eventually, Earth's revolution causes the North Pole to tilt away from the Sun. When this happens, the days are very short and the nights are very long. There is even a time of year when the Sun doesn't rise at the North Pole! This is in the middle of winter when the pole is facing completely away from the Sun.

revolution:
Earth's motion around the Sun; Earth takes one year, or 365 days, to make a single revolution

Of course, when days are long at the North Pole, they are short at the South Pole. And when days are short at the North Pole, they are long at the South Pole.

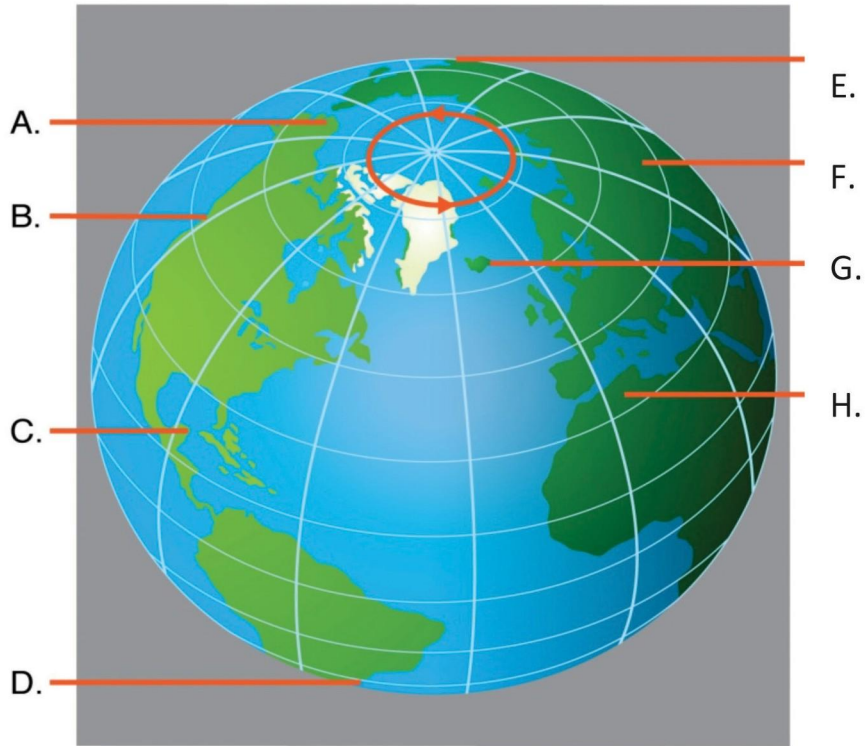
What do you know?

Because of Earth's rotation, cities around the world experience day and night at different times. The following table lists eight cities around the world and the time of day in each location. Each point on the globe (A–H) matches one of these cities. The arrows on top of the globe show the direction of Earth's rotation (from west to east). Use your knowledge of the relationship between Earth's rotation, daytime, and nighttime to determine the location of each city on the globe.

Earth's Rotation

Look Out!

City	Time of Day	City	Time of Day
Algiers	8:00 p.m.	Montevideo	5:00 p.m.
Cancun	2:00 p.m.	Reykjavik	7:00 p.m.
Fairbanks	11:00 a.m.	Ulaan Batar	3:00 a.m. (next day)
Magadan	7:00 a.m. (next day)	Vancouver	12:00 noon



Connecting With Your Child

Experiencing Earth's Rotation

To help your child learn more about Earth's rotation, visit a place where you can watch a sunrise or a sunset. Be sure your location allows your child to see the horizon. Large open areas lacking tall trees or buildings—such as a field, a beach, or atop a building—are the best choices. Have your child write down observations of the Sun, its motion, and the shadows on the land. Discuss these observations with your child and encourage him or her to notice the length and direction of the shadows and how quickly (or slowly) the darkness changes into light. Make sure not to look directly at the Sun during your observations.



Then, have your child explain the scientific reason behind each observation. Encourage your child to draw diagrams or construct

models showing how your position on Earth rotated into the Sun-facing side during your sunrise observations or into darkness during sunset. For any explanations that your child doesn't know, have him or her use the knowledge of Earth's rotation to hypothesize a possible explanation.

Then, ask your child why the Greeks thought the Sun god Helios traveled across the sky each day. How did the observations correlate to the ancient Greek myth? Take your child to a library or conduct an Internet search to find stories about day and night from other ancient cultures. What do the stories have in common? How are they different? Why do you think so many cultures have myths about day and night? Which are the most scientifically accurate?

Here are some questions to discuss with your child:

- How did the shadows change as the sunrise or sunset continued?
- What did the sky look like just before you saw the Sun (sunrise) or just after the Sun disappeared (sunset)? Why did it look like this?
- If we wanted to see sunrise or sunset during the summer, would we have to arrive at this location earlier or later? How about during the winter?