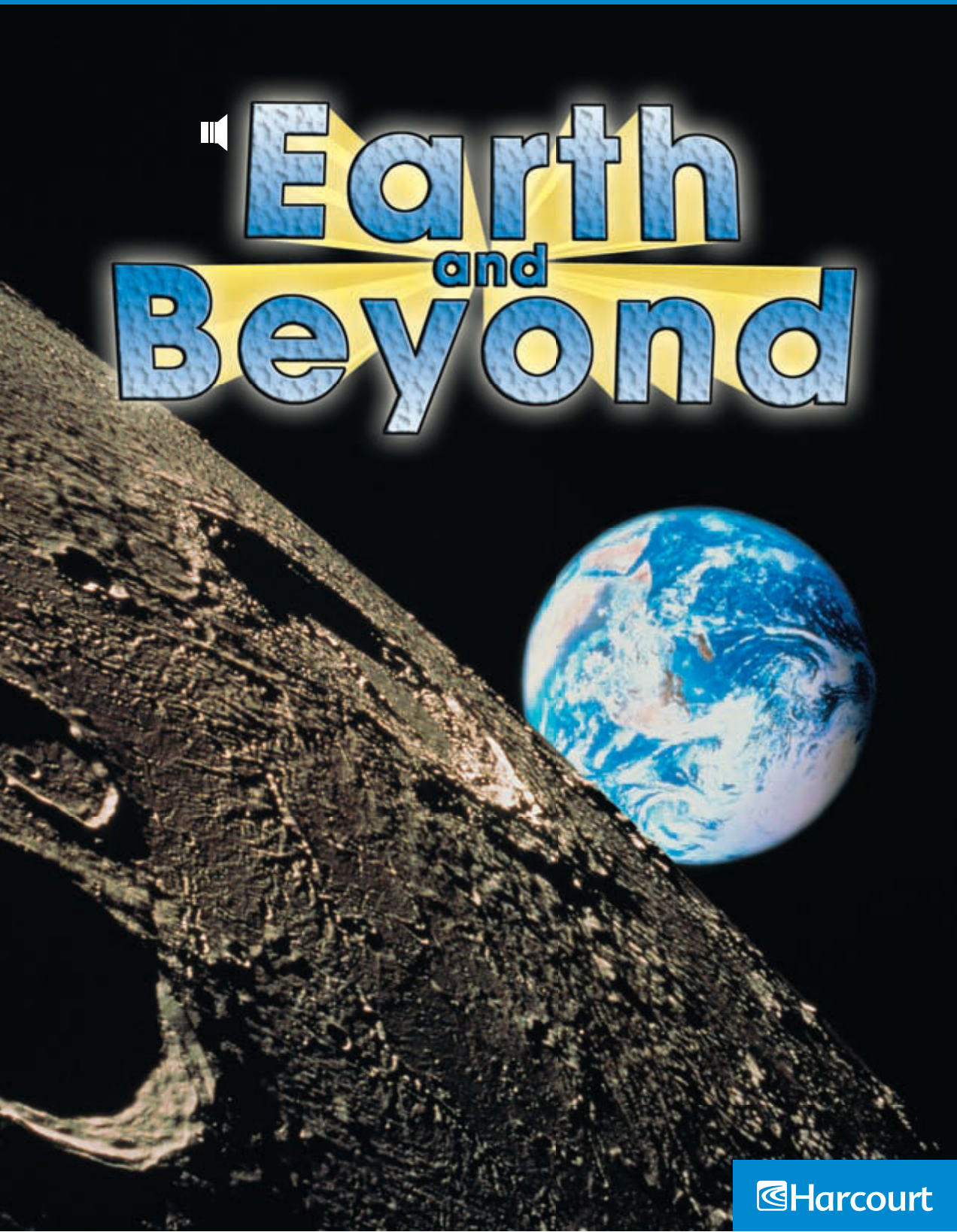
Earth and Beyond



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How Earth Moves in Space

Have you ever watched night turn into day? The dark sky slowly brightens as the sun seems to rise over the horizon. Perhaps you also have seen day turn into night. Different colors paint the sky as the sun sinks lower in the sky. Both sunrises and sunsets are familiar sights. They are part of the cycle of day and night. Each day, the sun appears to rise in the east, reach its highest point around noon, and set in the west.

Earth's rotation causes you to see a sunrise and sunset each day.

A long time ago, people thought that Earth stood still while the sun traveled around it each day. Today we know that the cycle of day and night occurs because Earth **rotates**, or spins on its axis. Earth's **axis** is an imaginary line that passes through its center and its North and South Poles. As Earth rotates there is daylight where Earth faces the sun and darkness where Earth is turned away from the sun. It takes 24 hours for Earth to make one complete rotation. One rotation is one day.

Rotation is only one way Earth moves. Earth also revolves, or travels in a path around the sun. The path Earth takes as it revolves is its **orbit.** It takes about 365 days for Earth to make one complete revolution around the sun. One revolution is one year.

Focus Skill **MAIN IDEA AND DETAILS** **Describe two ways Earth moves in space.**

When a place on Earth faces the sun, it is day in that place. When that place faces away from the sun, it is night.

The Seasons

Just as you have observed the cycle of day and night, you probably have observed the cycle of Earth's seasons. Most places on Earth experience seasonal changes throughout the year. During the summer, there are more hours of daylight and the temperature is higher. During the winter, there are fewer hours of daylight and the temperature is lower. Have you ever wondered what causes the seasons?

Fast Fact

Did you know that the seasons at the North and South Poles are very different from seasons everywhere else? In the summer, the North Pole gets six months of daylight and no darkness. In winter, the North Pole gets six months of darkness with no daylight.

Earth's seasonal changes are a result of the tilt of Earth's axis as it revolves around the sun. Earth's axis is tilted about $23\frac{1}{3}°$. For half of the year, part of Earth tilts toward the sun. The sun's rays strike this half more directly. On that part of Earth, it is summer. The sun's rays strike the half of Earth tilted away from the sun at an angle. It is winter on that part of Earth.

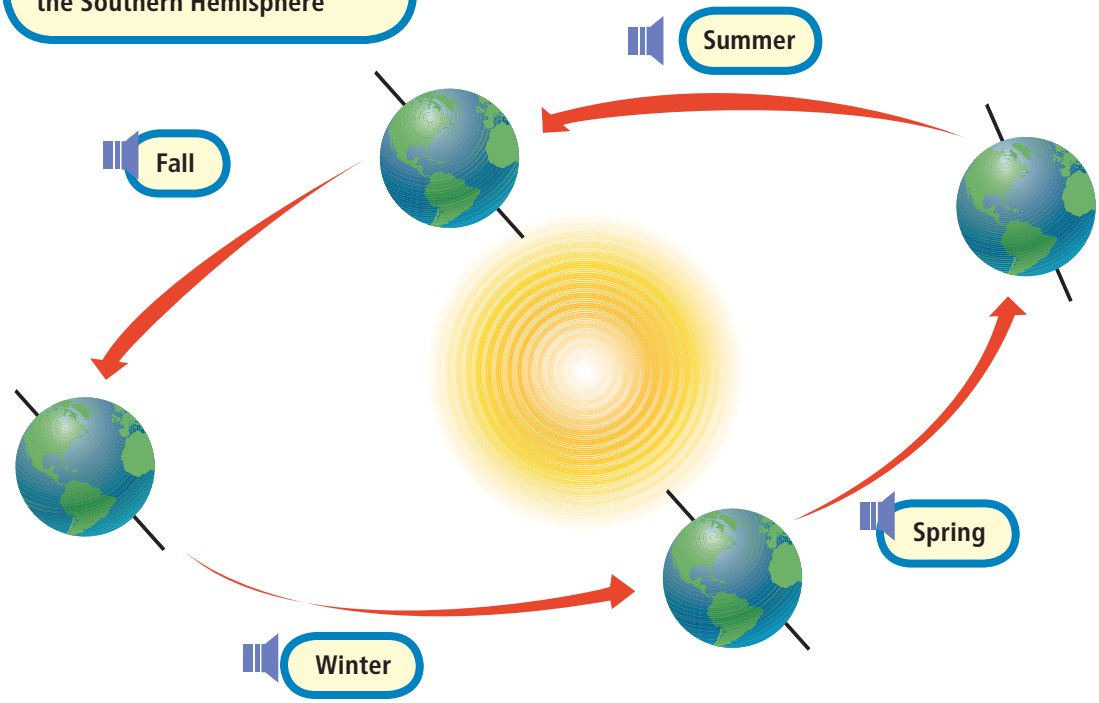
Earth is divided into Northern and Southern Hemispheres by the equator. The **equator** is an imaginary line going all the way around Earth. It is the same distance from both the North and South Poles. When the Northern Hemisphere is tilted toward the sun, the Southern Hemisphere is tilted away. When it is summer in the Northern Hemisphere, it is winter in the Southern Hemisphere.

Focus Skill **MAIN IDEA AND DETAILS** **How does the tilt of Earth's axis as it revolves around the sun cause seasonal changes on Earth?**

Seasonal changes on Earth occur because of how Earth is tilted as it orbits the Sun. Earth's tilt also determines the number of hours of daylight and darkness.

June 21 or 21
Earth's axis is tilted more toward the sun in the Northern Hemisphere. Summer begins in the Northern Hemisphere. Winter begins in Southern Hemisphere.

September 22 or 23
Earth's axis is not tilted toward or away from the sun.
Fall begins in the Northern Hemisphere. Spring begins in the Southern Hemisphere



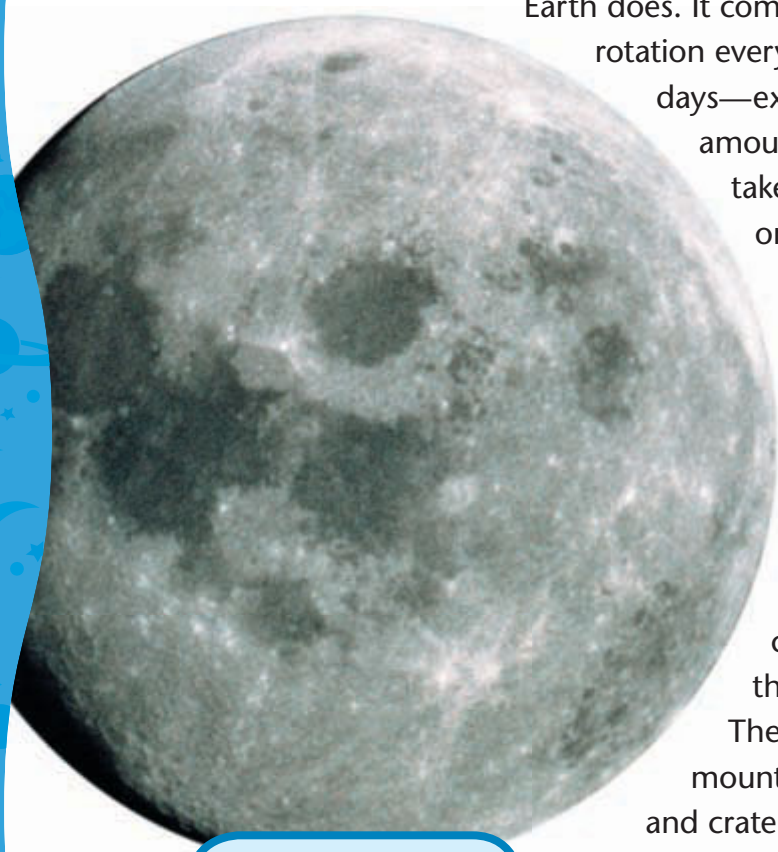
December 21 or 22
Earth's axis is tilted more toward the sun in the Southern Hemisphere. Winter begins in the Northern Hemisphere. Summer begins in the Southern Hemisphere.

March 20 or 21
Earth's axis is not tilted toward the or away from the sun. Spring begins in the Northern Hemisphere. Fall begins in the Southern Hemisphere.

Comparing Earth and the Moon

The moon is the brightest object in the night sky and Earth's closest neighbor in space. A **moon** is any natural body that revolves around a planet. The moon travels around Earth as Earth moves around the sun. It takes 29 $\frac{1}{2}$ days for the moon to complete its orbit around Earth. Like Earth, the moon rotates as it revolves. The moon, however, rotates much more slowly than Earth does. It completes one rotation every 29 $\frac{1}{2}$ Earth days—exactly the same amount of time it takes to complete one revolution.

If you take a good look at a full moon, you may notice its rocky surface. In most places the moon's surface is covered with a thick layer of dust. The moon also has mountains, valleys, and craters. A **crater** is a low, bowl-shaped area on the surface of a planet or a moon.



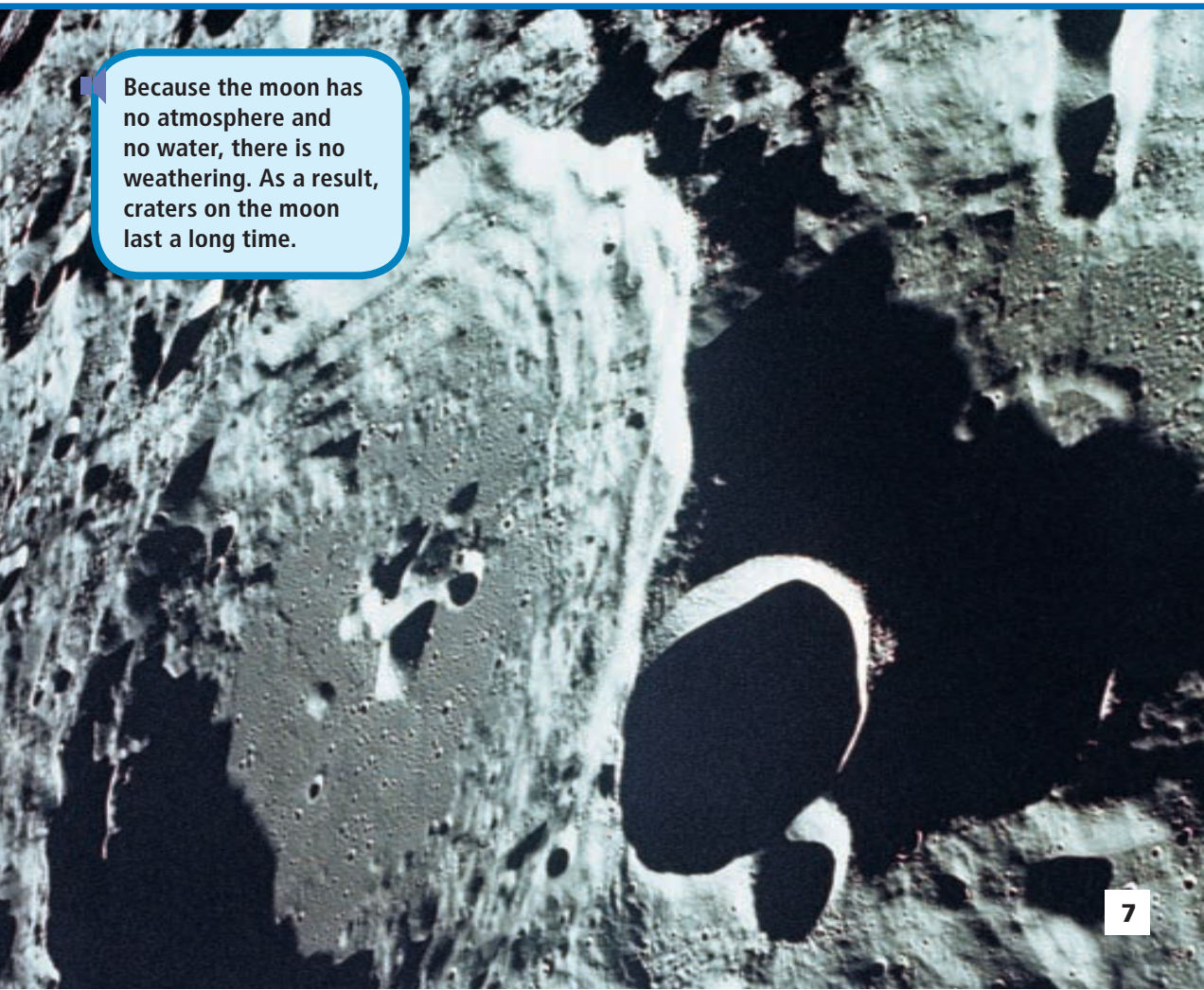
The moon does not give off any light of its own. It appears to shine because it reflects the light of the sun.

Earth's rocky surface also has mountains, valleys, and some craters. In most ways, however, Earth and the moon are quite different. The moon is much smaller than Earth. Its diameter is about one-fourth the size of Earth's diameter. The moon's gravity is only about one-sixth that of Earth and temperature changes on the moon are much more extreme than on Earth. And, unlike Earth, the moon has no atmosphere, no water, and no life.

Fast Fact

Temperatures on the moon can range from more than 100°C (212°F) during the day to -155°C (-247°F) at night!

Focus Skill **COMPARE AND CONTRAST** **In what ways are Earth and the moon alike? In what ways are they different?**



Because the moon has no atmosphere and no water, there is no weathering. As a result, craters on the moon last a long time.

The Moon's Changing Shape

What did the moon look like the last time you saw it? Although the moon is always in the night sky, it doesn't always look the same. In fact, sometimes you can't see the moon at all.

The moon is a sphere. However, the shape it appears in the night sky depends on its position, and the position of Earth and the sun. As the moon orbits Earth, its position in the sky changes. Your changing view of the moon as it changes its position is called the phases of the moon. A **moon phase** is one of the shapes the moon seems to have as it orbits Earth. The moon passes through all of its different phases once about every 29 $\frac{1}{2}$ days.

During the cycle of moon phases, the lighted portion of the moon that you can see gradually changes. The main phases are new moon, crescent, quarter, gibbous, and full moon. When Earth is between the sun and the moon, you see a full moon in the night sky. When the moon is between the Earth and the sun, you can't see the moon at all. When the moon is waxing, more and more of it is visible from one night to the next. When the moon is waning, less and less of it is visible.

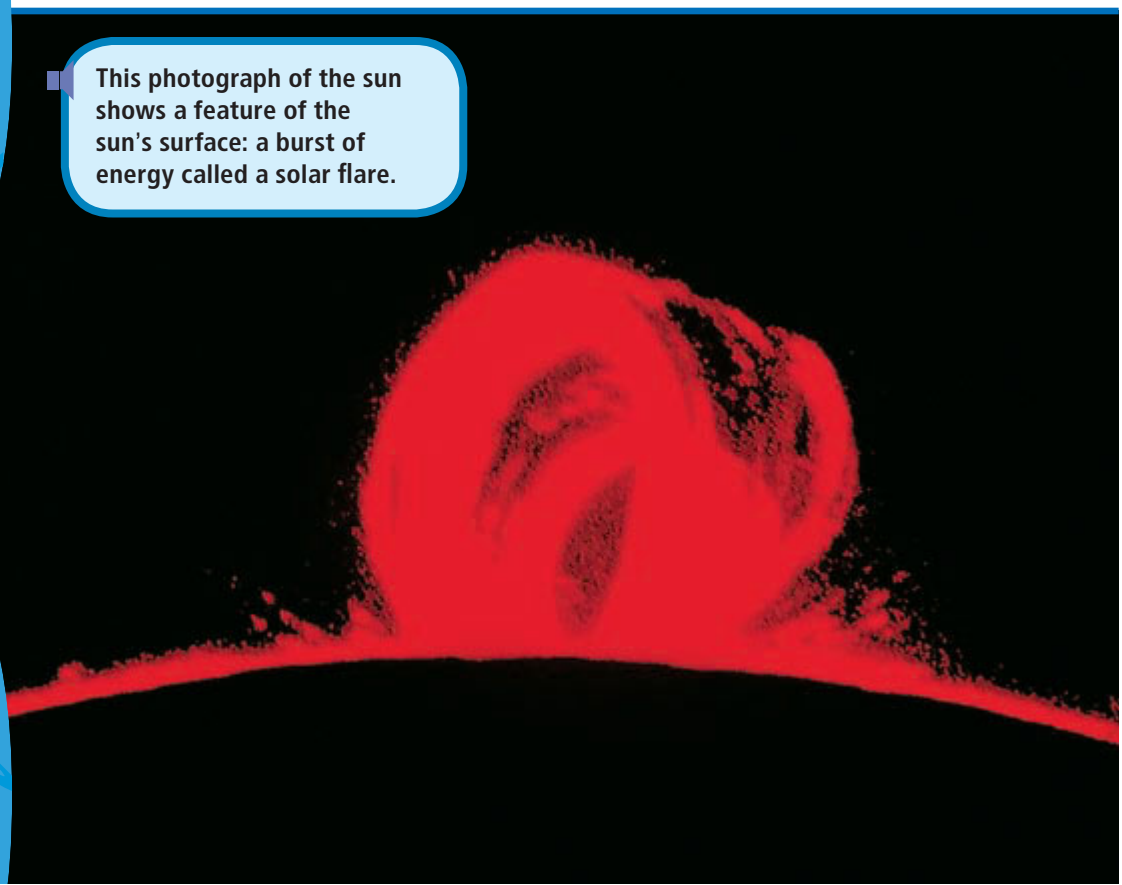
Focus Skill **COMPARE AND CONTRAST** **How does the apparent shape of the moon during the crescent phase compare with its actual shape?**

During the new moon phase you cannot see the moon. You gradually see more and more of the moon in the night sky until the full moon. Then you see less and less, until the new moon occurs again.

The Sun and Other Stars

Can you imagine life without the sun? The sun is a **star**, a huge ball of very hot gases in space. Light and heat from the sun are Earth's main sources of energy. Plants use this energy from the sun to store energy in food. Animals eat plants to use that food energy. The energy stored in fuels such as coal, oil, and gas also comes from the sun. These fuels formed from plants and animals that died long ago. When we burn these fuels, we are using stored energy that originally came from the sun.

Although the sun's energy is very important to life on Earth, it is just one of billions of stars in space. And although it is millions of times larger than Earth, it is only average in size when compared to other stars. It only appears much larger and brighter than other stars because it is so much closer to Earth.



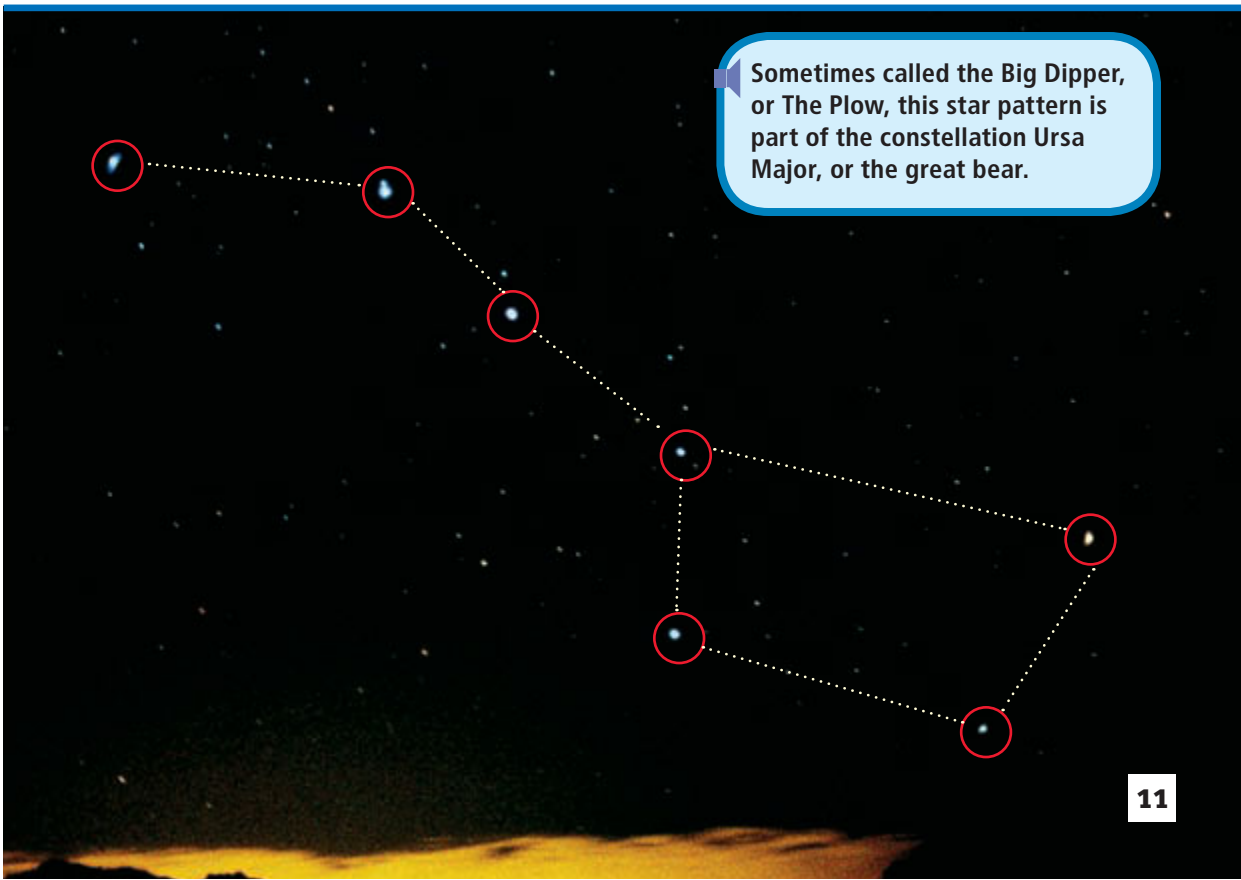
This photograph of the sun shows a feature of the sun's surface: a burst of energy called a solar flare.

Can you locate the North Star in the night sky? Before the invention of modern navigation equipment, travelers such as sailors often relied on their knowledge of the night sky to find their way. Learning the locations of stars is made easier by grouping the stars into constellations. A **constellation** is a pattern of stars named after a mythological or religious figure, object, or animal. The set of constellations that appears in the night sky depends on the time of year and your location on Earth.

MAIN IDEA AND DETAILS **Why is the sun important to life on Earth?**

Fast Fact

Solar flares and other bursts of energy from the sun can have direct effects on Earth's atmosphere and interfere with radio signals and other forms of communication. In 1998, about 80% of pagers in the United States became useless when a communication satellite failed—in part due to bad "space weather"!



Sometimes called the Big Dipper, or The Plow, this star pattern is part of the constellation Ursa Major, or the great bear.

The Solar System

The sun is the center of our solar system. A **solar system** is a star and all the planets and other objects that revolve around that star. Our solar system is made up of eight planets, including Earth. A **planet** is a body that revolves around a star. Scientists divide the planets into two groups: the inner planets and the outer planets. The two groups are separated by the asteroid belt. The asteroid belt is a ring-shaped area where many small, rocky bodies, or asteroids, are located.

The inner planets are the four planets closest to the sun: Mercury, Venus, Earth, and Mars. They are all relatively small and made up of solid, rocky material. The outer planets are the four planets farthest from the sun: Jupiter, Saturn, Uranus, and Neptune. They are all quite large and composed mostly of the gases hydrogen and helium.

Focus Skill **MAIN IDEA AND DETAILS** **What bodies make up our solar system?**

Planets of the Solar System		
Planet	Diameter	Distance from Sun
Mercury	4,900 km (3,000 mi)	58,000,000 km (36,000,000 mi)
Venus	12,100 km (7,500 mi)	108,000,000 km (67,000,000 mi)
Earth	12,700 km (7,900 mi)	150,000,000 km (93,000,000 mi)
Mars	6,800 km (4,200 mi)	228,000,000 km (142,000,000 mi)
(Asteroid belt – located between Mars and Jupiter)		
Jupiter	143,000 km (88,900 mi)	778,000,000 km (483,000,000 mi)
Saturn	120,000 km (74,600 mi)	1,427,000,000 km (887,000,000 mi)
Uranus	51,000 km (31,700 mi)	2,869,000,000 km (1,783,000,000 mi)
Neptune	49,000 km (30,400 mi)	4,505,000,000 km (2,799,000,000 mi)

The planets beyond the asteroid belt are the larger planets. All but two of the planets in our solar system have at least one moon that circles around that planet. Some have many moons.

Beyond the Solar System

What exists beyond our solar system? When you look at the sky on a clear, dark night, you can see millions of stars. On some nights, you may be able to see a bright ribbon of stars overhead. You are looking at the center of Earth's galaxy. A **galaxy** is gas, dust, and a group of stars. Earth's galaxy, the Milky Way Galaxy, has more than 100 billion stars. It is one of the biggest galaxies in the universe. The **universe** is everything that exists—all the stars, the planets, dust, gases, and energy. Scientists estimate that the universe contains more than 100 billion galaxies.

Focus Skill **MAIN IDEA AND DETAILS** **Explain the relationship between galaxies and the universe.**

barred spiral galaxy

elliptical galaxy

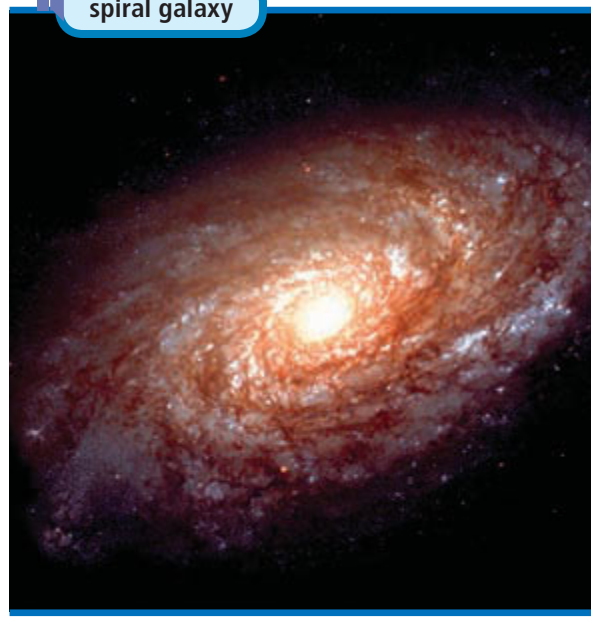
Summary

The motion of Earth and other bodies in space make daily, monthly, and yearly cycles that affect the way you live. Earth's movements in space cause day and night as well as the seasons. The phases of the moon are caused by the changing positions of Earth, the moon, and the sun as Earth and the moon rotate and revolve. In addition to Earth, the sun, and the moon, there are other bodies in space such as other stars and moons, planets, and asteroids. Together with gas, dust, and energy, these bodies make up the universe—everything that exists.

Scientists classify galaxies by shape. There are four basic types: spiral, barred spiral, elliptical, and irregular. The Milky Way Galaxy is a spiral galaxy.

irregular galaxy

spiral galaxy



Glossary

axis (AK•sis) An imaginary line that passes through Earth's center and its North and South Poles (2, 4, 5, 13)

constellation (kahn•stuh•LAY•shuhn) A pattern of stars, named after a mythological or religious figure, an object, or an animal (11)

crater (KRAYT•er) A bowl-shaped, low area on the surface of a planet or moon (6, 7)

equator (ee•KWAYT•er) An imaginary line around Earth equally distant from the North and South Poles (4)

galaxy (GAL•uhk•see) A grouping of gas, dust, and many stars, plus any objects that orbit those stars (14, 15)

moon (MOON) Any natural body that revolves around a planet (6, 7, 8, 9, 12, 13, 15)

moon phase (MOON FAYZ) One of the shapes the moon seems to have as it orbits Earth (8, 9)

orbit (AWR•bit) The path one body takes in space as it revolves around another body (2, 4, 5, 6, 8, 13)

planet (PLAN•it) A body that revolves around a star (6, 12, 13, 15)

revolve (rih•VAHLV) To travel in a closed path (2, 4, 5, 6, 12, 15)

rotate (ROH•tayt) To spin on an axis (2, 6, 13, 15)

solar system (SOH•ler SIS•tuhm) A star and all the planets and other objects that revolve around it (12, 13, 14)

star (STAR) A huge ball of very hot gases in space (10, 11, 12, 14, 15)

universe (YOO•nuh•vers) Everything that exists, including such things as stars, planets, gas, dust, and energy (14, 15)

Think and Write

1. How does Earth's orbit affect the number of hours of daylight and darkness throughout the year?
2. **MAIN IDEA AND DETAILS** Why does the moon appear to change shape?
3. **COMPARE AND CONTRAST** Choose one inner planet and one outer planet. Contrast the characteristics of each.
4. **Narrative Writing** Suppose you are a scientist doing research in Antarctica (the South Pole) during the summer months. Write a brief journal entry describing your observations of the cycle of day and night.

Hands-On Activity

Next stop, the planet Mars! Work with a partner to make a travel brochure for one member of the solar system. Use the information you learned from the reader to describe its characteristics and place in the solar system. Illustrate your brochure.

School-Home Connection

Explain to a family member what you have learned about the phases of the moon. Ask your family member to observe the moon with you several nights in a row. Discuss your observations together.

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