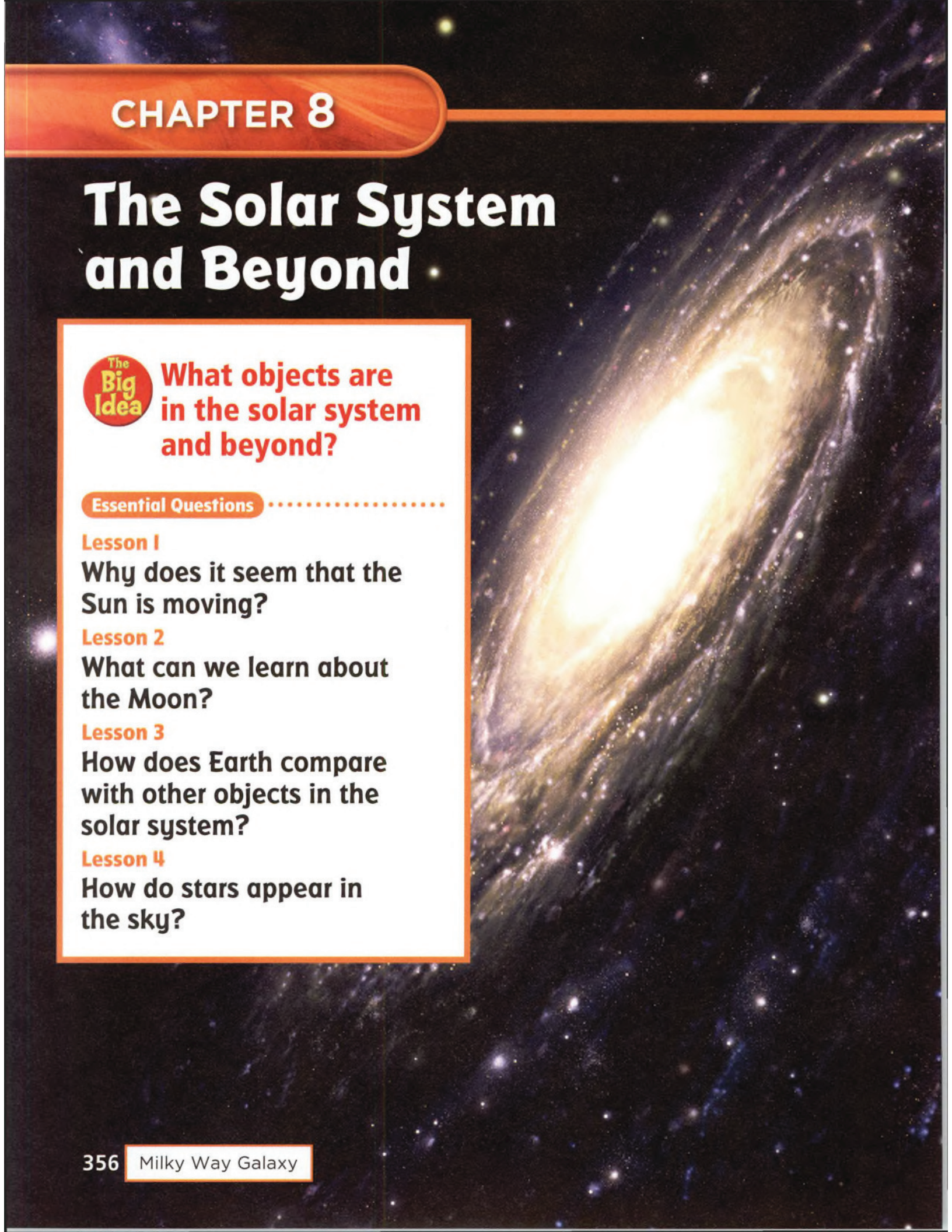
CHAPTER 8

The Solar System and Beyond



The Big Idea: What objects are in the solar system and beyond?

Essential Questions

Lesson 1
Why does it seem that the Sun is moving?

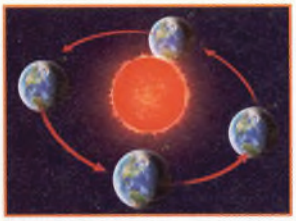
Lesson 2
What can we learn about the Moon?

Lesson 3
How does Earth compare with other objects in the solar system?

Lesson 4
How do stars appear in the sky?

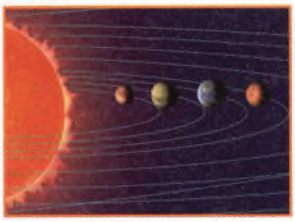
Big Idea Vocabulary

rotation the complete spin of an object around its axis (p. 360)



revolution one complete trip around an object in a circular or nearly circular path (p. 362)

phase an apparent change in the Moon's shape (p. 373)



solar system the Sun and all the objects that travel around it (p. 380)

comet a chunk of ice, rock, and dust that moves around the Sun (p. 388)

constellation a group of stars that appear to form a pattern in the night sky (p. 396)

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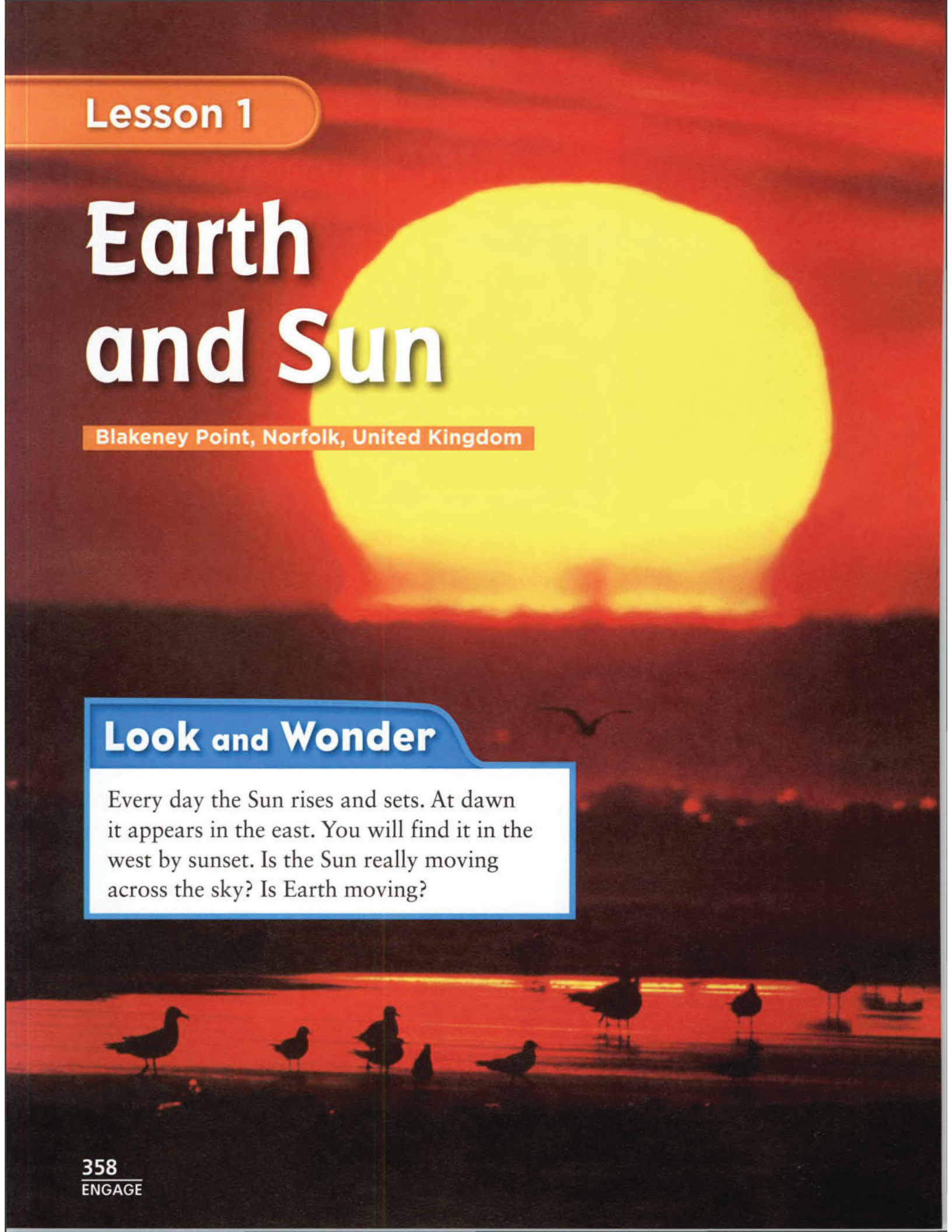


Lesson 1

Earth and Sun

Blakeney Point, Norfolk, United Kingdom

Look and Wonder

Every day the Sun rises and sets. At dawn it appears in the east. You will find it in the west by sunset. Is the Sun really moving across the sky? Is Earth moving?

Explore

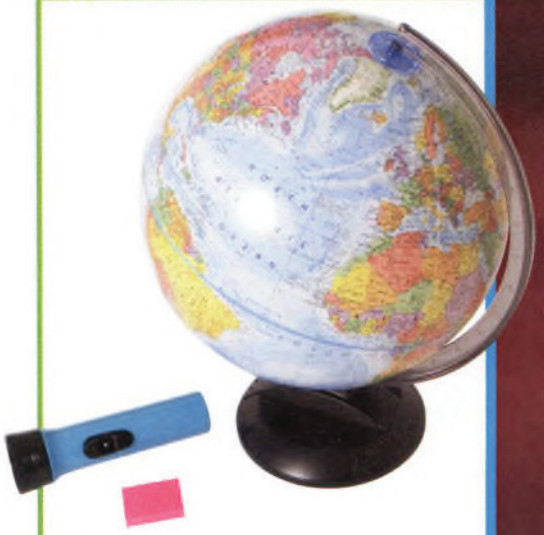
Inquiry Activity

What causes day and night?

Purpose

Explore why Earth has both day and night.

Materials



- self-stick notes
- globe
- flashlight

Procedure

1. Write *I live here* on a self-stick note. Place the note over your home on the globe.
2. **Make a Model** Darken the room. Shine the flashlight on the self-stick note. The flashlight models the Sun.
3. **Observe** What part of the globe is lit? What part is dark? Record your observations.
4. **Form a Hypothesis** What do you think causes Earth's cycle of day and night? Write a hypothesis that you can test.
5. Make two plans to test your hypothesis. You can move the flashlight, the globe, or both. Carry out your plans to test your idea.

Draw Conclusions

6. **Communicate** Describe how you modeled day and night. How did your tests differ?
7. Do you think one of your models is correct? Which one? Why?
8. How much of Earth is lit during the day? How much is lit at night?

Explore More

The Sun rose at a certain time this morning. It will set at a certain time tonight. Does the Sun rise and set at the same time everywhere on Earth? Use your model to support your answer.

Read and Learn

Essential Question

Why does it seem that the Sun is moving?

Vocabulary

rotation, p. 360

axis, p. 360

revolution, p. 362

orbit, p. 362

Reading Skill

Cause and Effect

Cause →	Effect
→	
→	
→	
→	

Technology

e-Glossary, e-Review, and animations online at www.macmillanmh.com

What causes day and night?

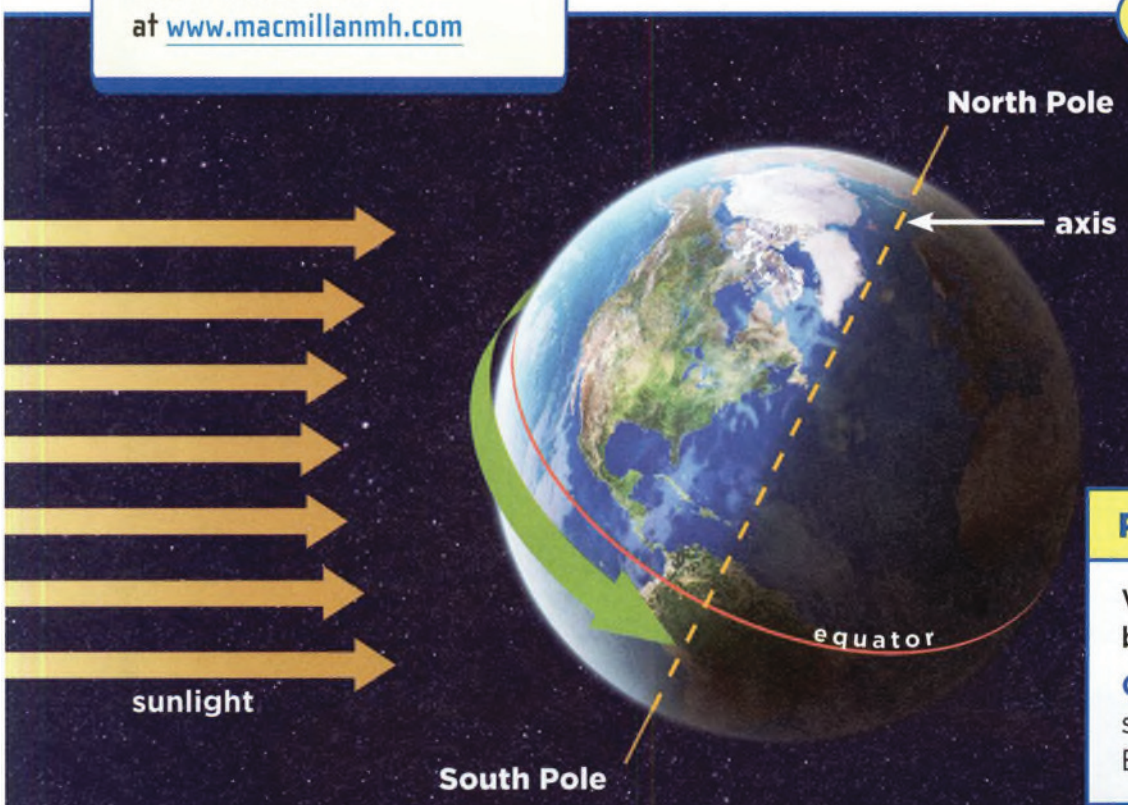
How can it be afternoon where you live and nighttime in Asia? The answer is that you and Asia are on opposite sides of Earth. When your side of Earth faces the Sun, Asia is facing away from the Sun.

Earth Rotates

As Earth moves around the Sun, it also spins. **Rotation** (roh•TAY•shun) is the act of spinning. The diagram shows how Earth rotates.

The dotted line between the North Pole and the South Pole is Earth's axis (AK•sus). An **axis** is a real or imaginary line that an object spins around. Every day, Earth completes one rotation. One rotation takes 24 hours. We divide each hour into 60 minutes. Every minute has 60 seconds.

Earth's Rotation



Read a Diagram

Where on Earth will it be night next?

Clue: The green arrow shows the direction of Earth's rotation.

▲ When the Sun is high in the sky, this antelope has a shorter shadow.

▲ When the Sun is low in the sky, the antelope has a longer shadow.

Apparent Motion

As Earth rotates, you see different parts of space. During the day, the side of Earth where you live faces the Sun. As that part turns away from the Sun, it becomes night. The rotation of Earth changes day into night and night into day again.

Apparent motion is the way something appears, or seems, to move. The Sun appears to rise in the east. It seems to set in the west. Apparent motion is not real motion.

Earth's rotation causes the apparent motion of many objects in space. Stars only seem to move. The Moon and planets do not always move in the same direction as their apparent motion.

Shadows

Have you ever made a shadow puppet? A shadow forms when light is blocked. The light strikes an object but cannot pass through.

You cast a shadow when your body blocks the sunlight. Your shadow always points away from the Sun. As the position of the Sun changes, your shadow changes too. Early in the morning, your shadow is long. It shrinks until midday. Then it grows longer again until sunset.

Quick Check

Cause and Effect What causes Earth's cycle of day and night?

Critical Thinking How might you use the Sun to estimate the time of day?

FACT The Sun is not always at its highest point in the sky at noon.

What causes seasons?

Not only does Earth rotate around its axis, it also revolves (rih•VAHLVZ) around the Sun. **Revolution** is when one object travels around another.

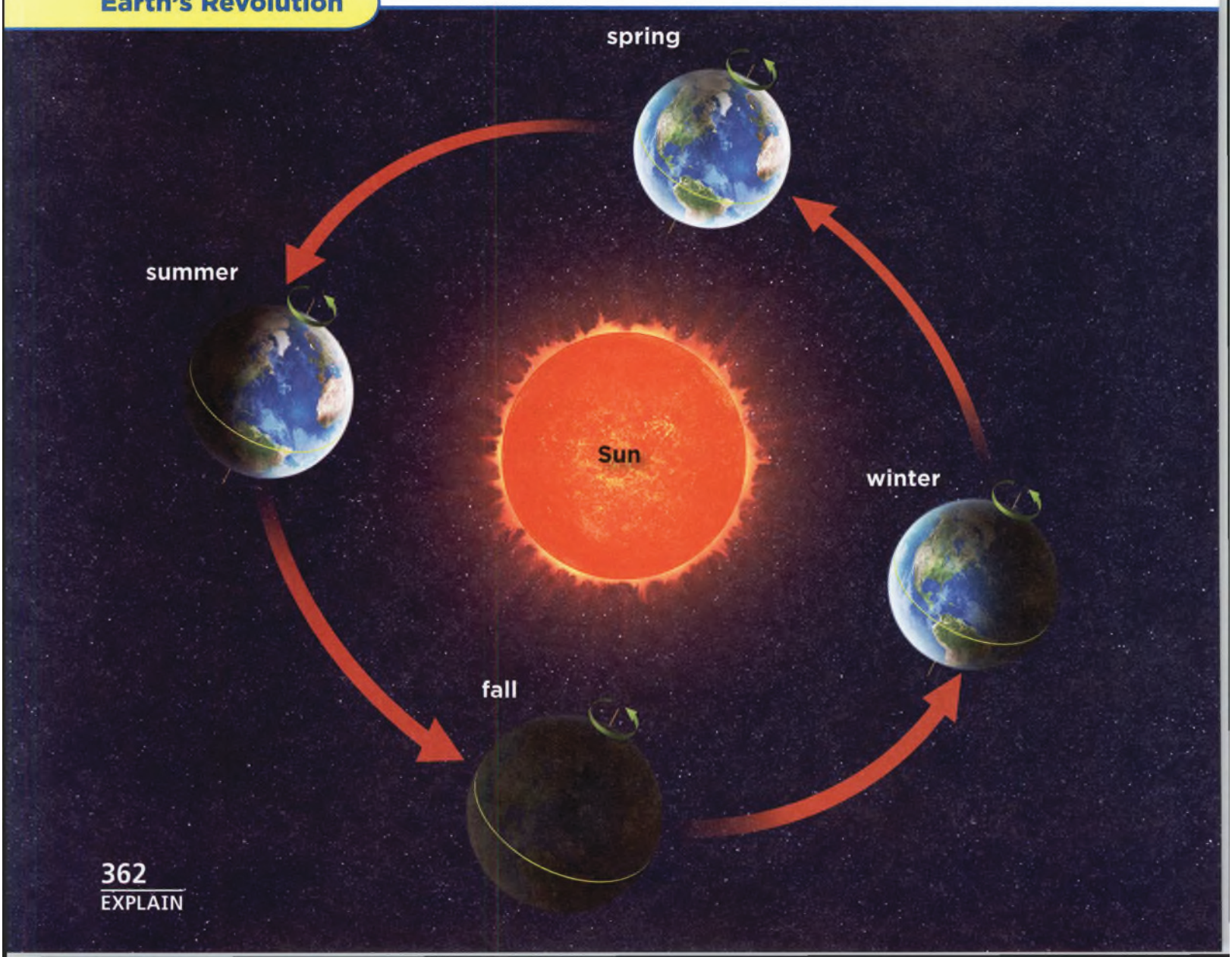
The path a revolving object takes is its **orbit**. Earth's orbit is shaped like an *ellipse* (ih•LIPS), or flattened circle. Earth's orbit around the Sun takes 365 $\frac{1}{4}$ days, or one year.

Earth's Tilted Axis

Earth's axis is not straight up and down. It is tilted at an angle of 23.5°. The tilt points in the same direction throughout Earth's orbit.

Earth's tilt causes sunlight to strike Earth at different angles. At any given time, each *hemisphere* (HE•muh•sfeer), or half, of Earth gets more or less sunlight. The seasons result from both Earth's tilted axis and its revolution around the Sun.

Earth's Revolution



The Four Seasons

How does Earth's tilt cause summer, fall, spring, and winter? In June, the North Pole tilts toward the Sun. Sunlight hits the Northern Hemisphere at steep angles. The light is more intense. It is summer.

In December, the North Pole tilts away from the Sun. Sunlight strikes the Northern Hemisphere at low angles. It is winter in the northern part of the world. In the Southern Hemisphere, however, it is summer.

Quick Lab

Sun and Seasons

1. Hold the bottom of a flashlight 5 centimeters above a piece of graph paper. Trace the circle of light on the graph paper. Label the circle *A*.
2. Tilt the flashlight as shown. Keep it the same distance above the paper. Trace the circle of light. Label it *B*.
3. **Use Numbers** Count the squares on the graph paper that fall inside or mostly inside each circle.
4. Did tilting the flashlight change the number of squares? How?
5. **Infer** How do your results help explain the seasons?

summer
June 21–Sept. 22

fall
Sept. 22–Dec. 21

winter
Dec. 21–March 20

spring
March 20–June 21

Read a Diagram

Describe how sunlight changes in the Northern Hemisphere in one year.

Clue: Follow the red arrows. Look for the shadow.

LOG ON *Science in Motion* Watch how Earth revolves around the Sun at www.macmillanmh.com

Quick Check

Cause and Effect What causes the seasons?

Critical Thinking What would happen to the seasons if Earth's axis were not tilted?

How does the Sun's apparent path change over the seasons?

The diagram shows the apparent path of the Sun during the day. Each yellow circle represents the Sun's position at noon. How does that position change from winter to summer? The Sun rises much higher in the sky during a summer day. It also rises earlier and sets later.

At the Equator

The diagram does not apply to all parts of the world. Near the equator, the Sun's apparent path changes much less during the year. Temperatures there change little from season to season. All year long, sunlight strikes at similar angles.

At the Poles

Near the poles, the Sun's apparent path is very different between seasons. In northern Alaska, for instance, summer nights are very short. During winter, the Sun hardly appears.

Making Predictions

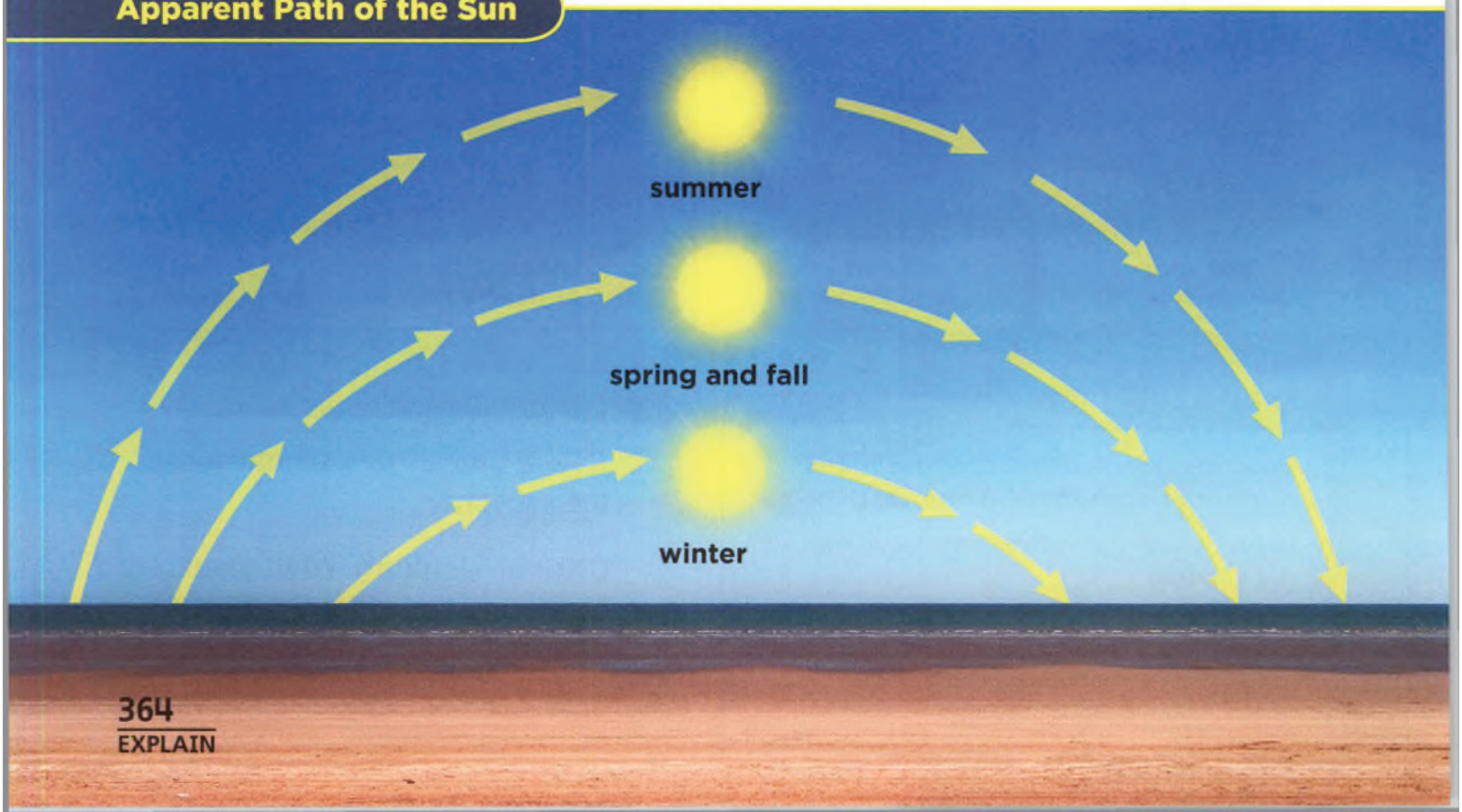
The Sun's apparent path changes in the same pattern every year. Scientists use these patterns to make predictions. They can predict the exact times the Sun will rise and set.

Quick Check

Cause and Effect How does the Sun's apparent path change over the year?

Critical Thinking Why are the differences so large near the poles?

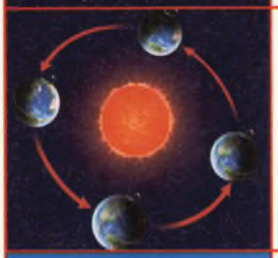
Apparent Path of the Sun



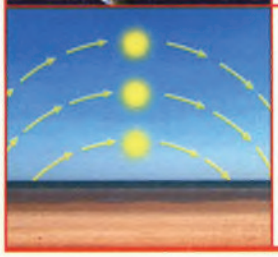
Lesson Review

Visual Summary

Earth's rotation causes day and night. Shadows change with the Sun's apparent motion across the sky.



The tilt of Earth's axis and **Earth's revolution** around the Sun cause seasons to change during the year.



The Sun's apparent path depends on the tilt of **Earth's axis.** The path is different near the equator and poles.

Make a FOLDABLES Study Guide

Make a three-tab book. Use it to summarize what you learned about the Sun and Earth.

Think, Talk, and Write

1. **Vocabulary** Earth's _____ is the path it takes during its revolution.

2. **Cause and Effect** List the different effects caused by Earth's motion.

Cause → Effect
→
→
→
→

3. **Critical Thinking** How would Earth be different if its axis were not tilted?

4. **Test Prep** **When does the Sun rise highest in the sky in the Northern Hemisphere?**

   A March
   B June
   C September
   D December

5. **Test Prep** **Which process takes Earth 24 hours to complete?**

   A rotation
   B revolution
   C shadows
   D seasons

6. **Essential Question** Why does it seem that the Sun is moving?

Math Link

Use Multiplication
A tree is 9 meters tall. In the morning, the tree casts a shadow 3 times its height. How long is the tree's shadow in the morning?

Social Studies Link

Learn about Seasons in Other Places
Find your state on a globe. Where on Earth is the cycle of day and night the opposite from where you live? Where is the cycle of seasons the opposite?

LOG ON e-Review Summaries and quizzes online at www.macmillanmh.com

Writing in Science

Without the Sun

It is the year 3528. Planet Mungo is in conflict with Earth. Mungo's scientists have built a huge device that blocks the Sun's light from reaching Earth.

It happened 14 days ago. First, the sky darkened. Then, the air cooled. It became very still. Rain began to fall. It has been raining for 13 days.

The High Global Commission met. "We must resolve our conflict with Mungo," said the commission chief. "Without the Sun, plants cannot make food. The plants are dying. With no plants, all the animals will die!"

"If this continues," argued the vice chief, "water won't evaporate. We'll face floods and freezing."

"Get up, Lisa," shouted Mom.

Lisa opened her eyes. "Mom, I just had the weirdest dream." She looked out the window and smiled in the sunlight.

Fictional Story

A good fictional story

- **has an interesting beginning, middle, and end;**
- **describes a setting, telling when and where a story happens.**

Write About It

Fictional Story Write your own story about what would happen if sunlight could not reach Earth.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

Light Speed!

Light travels about 10 trillion kilometers in one year. Light travels about 18 million km in one minute. The Sun is about 150 million km away from Earth.

Using this information, you can figure how many minutes it takes for sunlight to reach Earth. Divide 150 million by 18 million to get the answer.

Instead of using long division to get an exact answer, you can make an estimate. Use numbers that are close to the ones in the problem but are easier to divide.

Solve It

Mars is about 230 million km away from the Sun. Estimate the number of minutes it takes for the Sun's light to reach Mars.

Estimate Quotients

- You can use compatible numbers to estimate 150 ÷ 18. What numbers close to these are easier to divide?
- 18 is close to 20. 150 is between 140 and 160. What is 140 divided by 20?

Think: 14 ÷ 2 = 7
So: 140 ÷ 20 = 7

What is 160 divided by 20?

Think: 16 ÷ 2 = 8
So: 160 ÷ 20 = 8

It takes 7 to 8 minutes for the Sun's light to reach Earth.

Lesson 2

Earth and Moon

moonrise, Tijerflue Mountain, Switzerland

Look and Wonder

When the Moon is full, you can see shadowy places on its surface. Those shadows are large holes, or craters. How did the Moon get those features? Why are the craters different sizes?

Explore

Inquiry Activity

What affects the size of craters on the Moon?

Form a Hypothesis

When rocks moving through space hit the Moon, they make holes called craters. Does a bigger rock make a larger crater? Write a hypothesis.

Test Your Hypothesis

1. **Make a Model** Place a large dish or tray on a sheet of newspaper. Cover the inside of the dish with wax paper. Pour in a layer of flour about 3 cm thick. This models the surface of the Moon. Do not touch it.
2. Press the clay into three balls. One ball should have a diameter of about 1 cm. The second should be about 3 cm. The third, 5 cm. These are your model space rocks.
3. **Measure** Drop a model rock onto the flour from a height of 25 cm. Measure the width of the hole it makes. Repeat three times. Record your data in a chart.
4. **Experiment** Repeat step 3 with the other models. Record these results in your chart.

Draw Conclusions

5. **Interpret Data** How does the size of the rock affect the size of the hole that it makes?
6. **Infer** How does this activity explain the Moon's appearance?

Explore More

What variable besides rock size affects the size of craters? Form a hypothesis. Make a plan to test it. Decide which variables will stay the same and which variable will change. Try it!

Materials

- large dish or tray
- newspaper
- wax paper
- flour
- metric ruler
- modeling clay

Step 2

Step 3

Read and Learn

Essential Question

What can we learn about the Moon?

Vocabulary

crater, p. 371

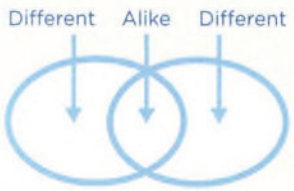
phase, p. 373

lunar eclipse, p. 374

solar eclipse, p. 374

Reading Skill

Compare and Contrast



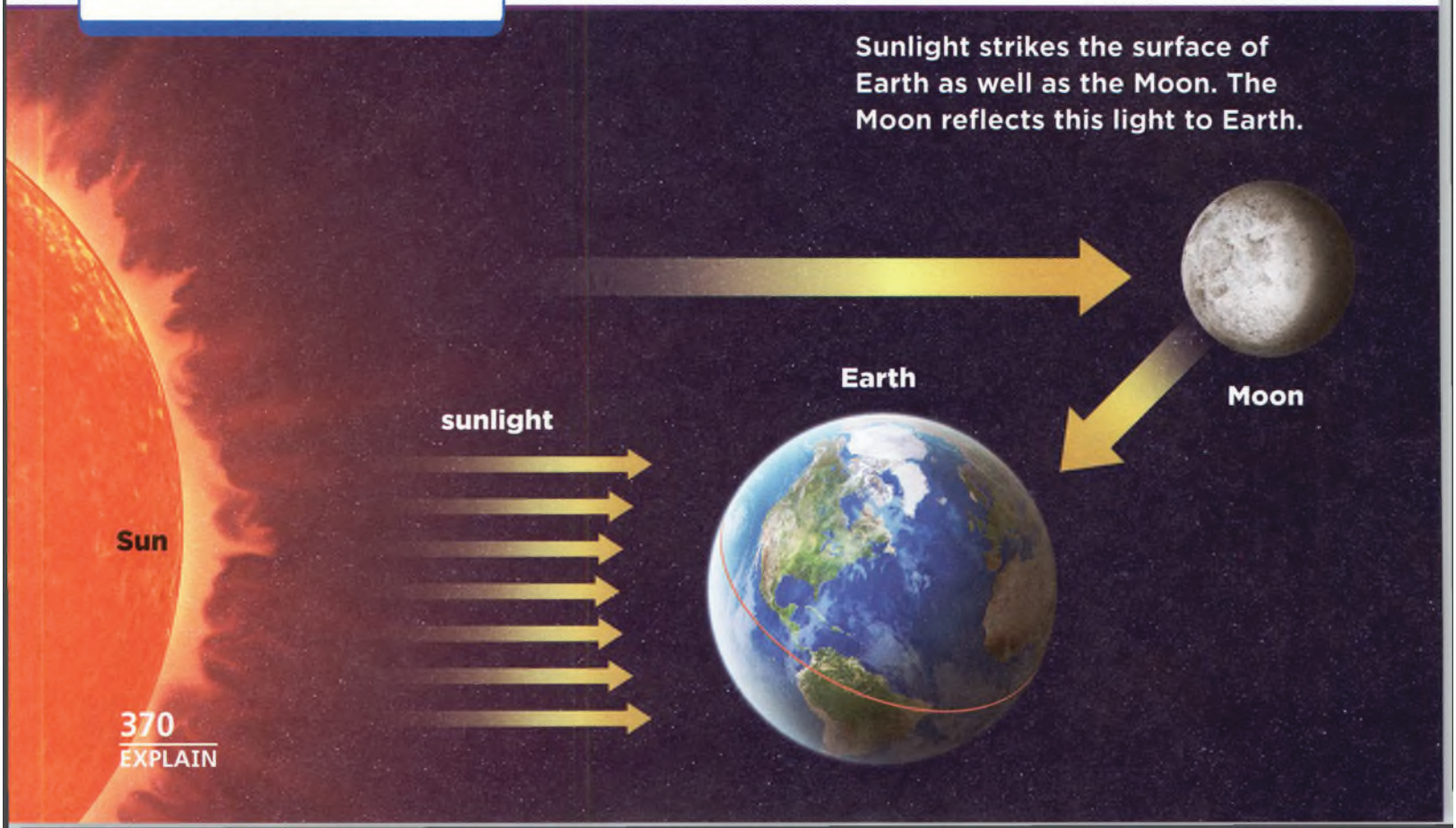
Technology

e-Glossary and e-Review online at www.macmillanmh.com

What is the Moon like?

On many nights, the Moon appears to be the largest, brightest object in the sky. Unlike stars, however, the Moon does not make its own light. Why does the Moon shine? It reflects the light of the Sun. Moonlight is reflected sunlight!

▲ The Moon reflects light from the Sun.



The Moon and Earth

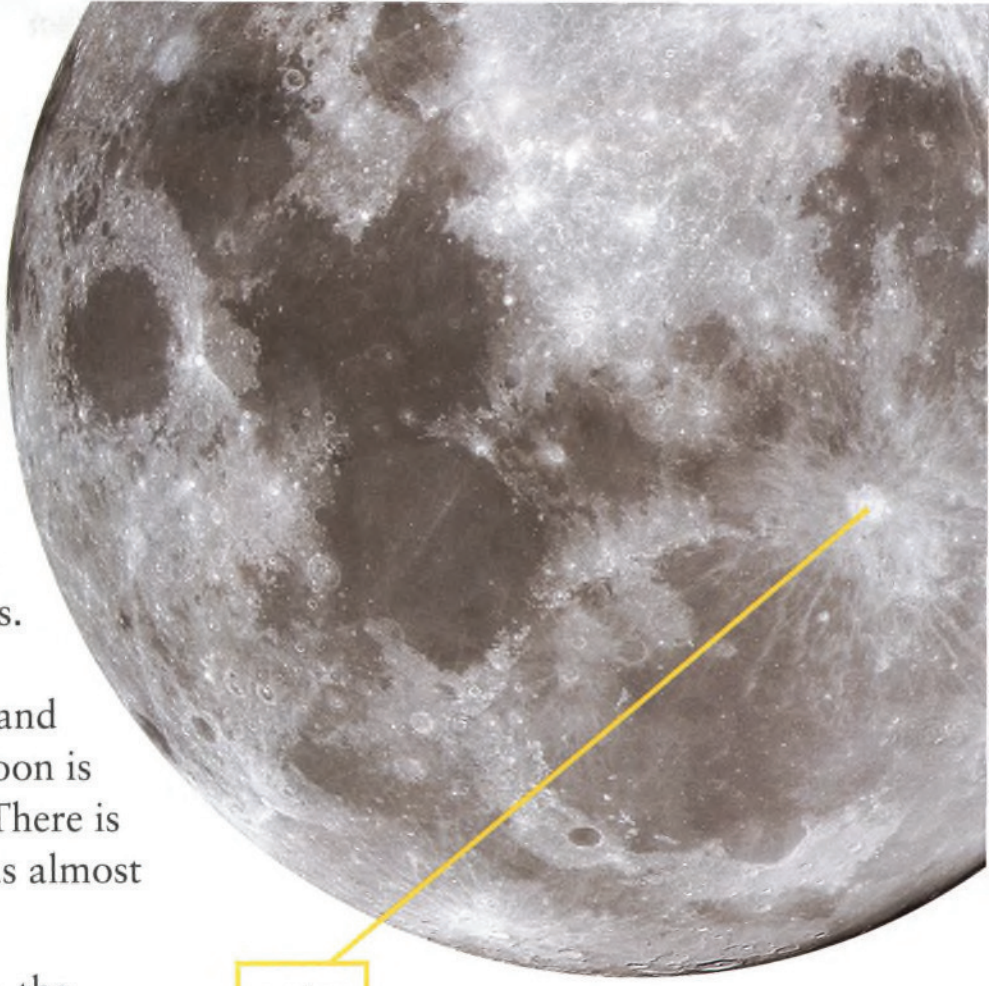
The Moon is Earth's closest neighbor in space. It is about 384,000 km (240,000 miles) from Earth. This is almost 400 times closer to Earth than the Sun.

Rocks on the Moon are similar to some Earth rocks. However, there are many differences between Earth and the Moon. For one, the Moon is much smaller than Earth. There is no air or atmosphere. It has almost no water either.

Because of these factors, the Moon has an extreme range of temperatures. In the daytime, it is hot enough to boil water. The nights are colder than any place on Earth. No wonder the Moon does not support life!

Surface Features

The Moon has a few tall mountains. It also has flat plains. But most of its surface is covered with craters (KRAY•turz). A **crater** is a hollow area or pit in the ground. Large rocks called *meteoroids* (MEE•tee•uh•roydz) made many of the Moon's craters. Meteoroids travel through space. They often crash into other space objects.



Craters and Earth's Atmosphere

If meteoroids are always crashing into things, why isn't Earth covered in craters? Earth's atmosphere keeps them away. When meteoroids enter Earth's atmosphere, they become very hot. Most of them burn up before they hit Earth's surface.

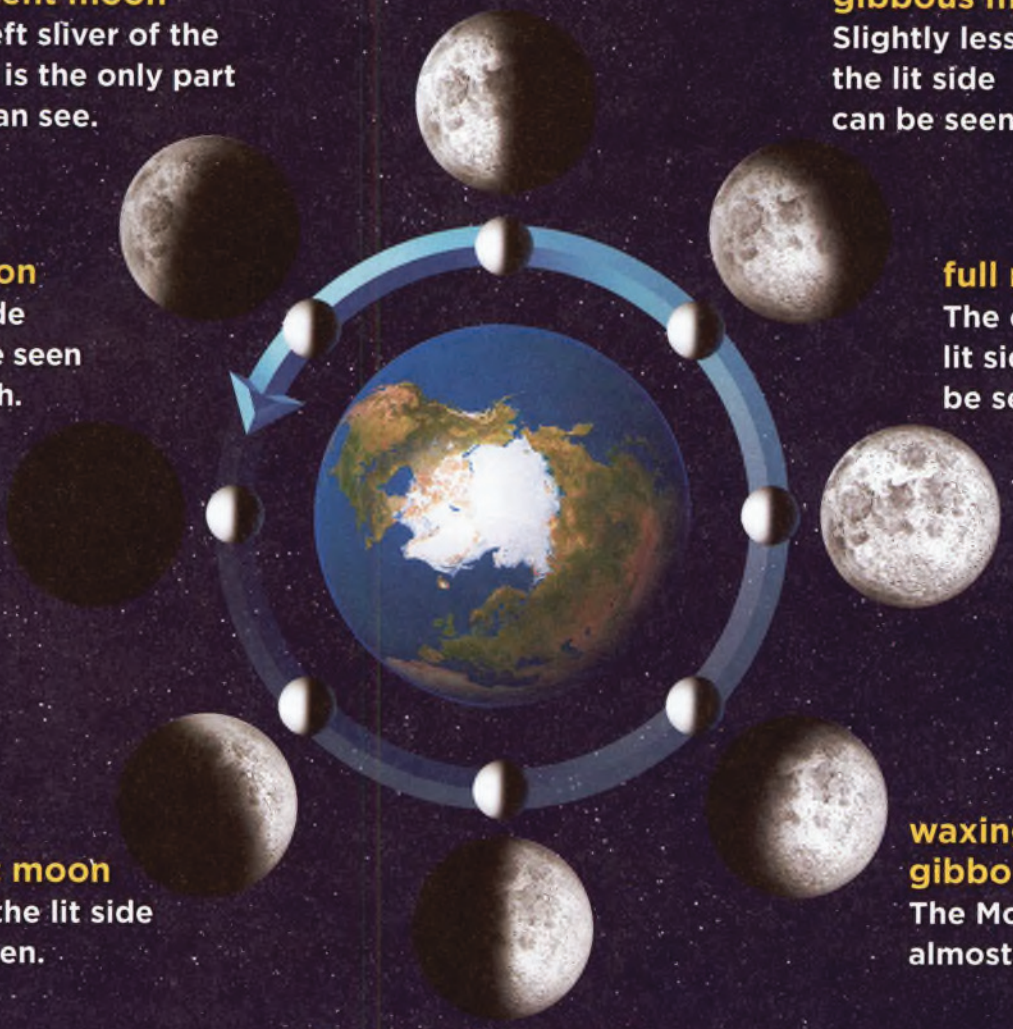
Quick Check

Compare and Contrast How are Earth and the Moon alike? How are they different?

Critical Thinking Why do people who go to the Moon need to wear space suits?

FACT The Moon does not make its own light.

Phases of the Moon



third quarter moon
The Moon is three quarters of the way around Earth.

waning crescent moon
The left sliver of the Moon is the only part you can see.

waning gibbous moon
Slightly less of the lit side can be seen.

new moon
The lit side cannot be seen from Earth.

full moon
The entire lit side can be seen.

waxing crescent moon
Some of the lit side can be seen.

waxing gibbous moon
The Moon is almost full.

first quarter moon
The Moon is a quarter of the way around Earth.

Read a Diagram

You cannot see the Sun in this diagram, but you can infer its position. Where is the Sun?

Clue: Observe the small Moons along the blue circle.

What are the phases of the Moon?

Like the Sun, the Moon seems to rise and set. The Sun does not move around Earth, but the Moon does!

As Earth revolves around the Sun, the Moon revolves around Earth. It completes one orbit around Earth in just over 29 days. This is almost as long as an average month. In fact, some of the earliest calendars were based on the Moon's motion.

Apparent Shapes

As the Moon orbits Earth, its appearance seems to change. The apparent shapes of the Moon in the sky are called **phases** (FAYZ•ez). During one complete orbit, the Moon cycles through all of its phases. At the same time, the Moon completes about one rotation.

All this time, the Sun is shining. It lights one half of the Moon at a time. The other half is dark. During the Moon's orbits, we see different fractions of its lit half.

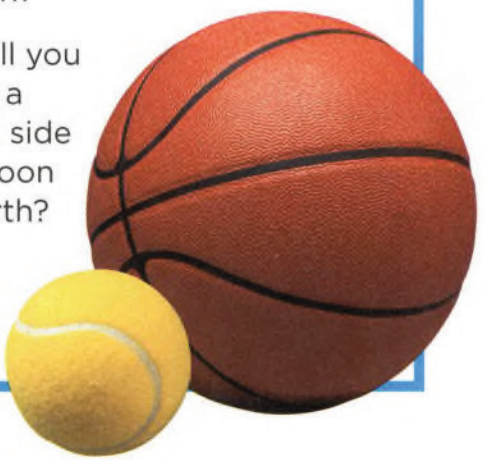
The Moon's Gravity

The Moon has gravity. It pulls slightly on Earth. On the side of Earth that faces the Moon, the water or land bulges slightly outward. The Moon pulls more than the Sun because it is closer to Earth.

Quick Lab

Moon and Earth

1. Use a sticker to mark a spot on a small ball.
2. **Make a Model** Move the small ball in a revolution around a larger ball. Meanwhile, rotate the small ball in the same direction. Your rotation and revolution should finish at the same time.
3. How does this model the Moon and Earth?
4. **Infer** Will you ever see a different side of the Moon from Earth? Explain.



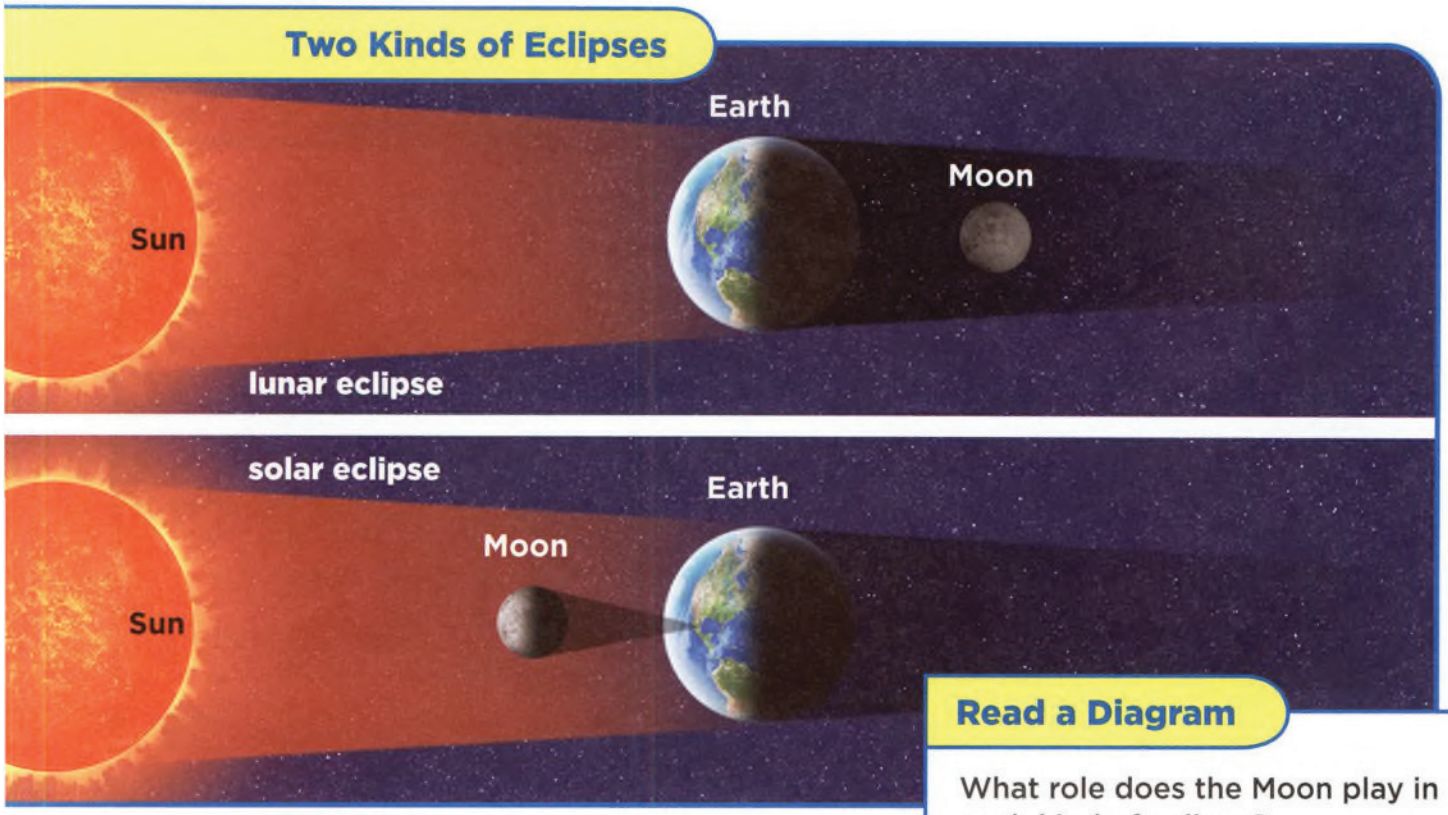
Earth's Tides

The Moon's gravity causes tides. *Tides* are the daily rise and fall of the ocean's surface. Most coasts on Earth have high tides and low tides.

Quick Check

Compare and Contrast How is the Moon's first quarter phase like its third quarter phase?

Critical Thinking How much time passes between a full moon and a new moon?



Read a Diagram

What role does the Moon play in each kind of eclipse?

Clue: Observe the shadows.

What is an eclipse?

An *eclipse* (ih•KLIPS) occurs when a shadow is cast by Earth or the Moon. The diagram shows the two basic kinds.

Lunar Eclipses

In a **lunar eclipse**, Earth casts a shadow on the Moon. This happens when Earth is directly between the Sun and the Moon. The Moon passes through Earth's shadow.

Solar Eclipses

In a **solar eclipse**, the Moon casts a shadow on Earth. Solar eclipses happen only during the new moon. A *partial solar eclipse* is when part of the Sun is blocked. A *total solar eclipse* blocks all of the Sun.

Eclipse Safety

Only a lunar eclipse is safe to observe. Looking at a solar eclipse will damage your eyes or cause blindness. Sunglasses do not help. For this reason, you should never look directly at the Sun during an eclipse. Scientists use special tools to observe solar eclipses safely.

Quick Check

Compare and Contrast How is a lunar eclipse like a solar eclipse? How is it different?

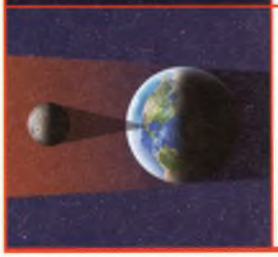
Critical Thinking Why is it safe to observe a lunar eclipse?

Lesson Review

Visual Summary

The Moon is Earth's nearest neighbor in space. It reflects the Sun's light. **Craters** cover its surface.

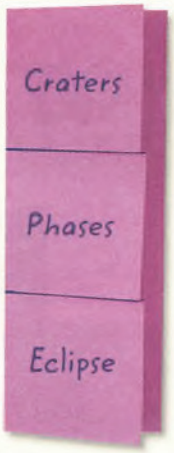
The Moon revolves around Earth about once every 29 days. As the Moon revolves, we see its different **phases.**



An **eclipse** occurs when a shadow is cast by Earth or the Moon. A solar eclipse is not safe to view.

Make a FOLDABLES® Study Guide

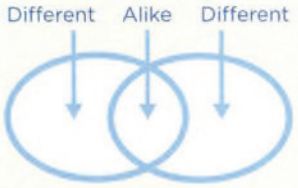
Make a three-tab book. Use it to summarize what you read about Earth and Moon.



Think, Talk, and Write

1. **Vocabulary** During a(n) _____, the Moon's shadow is cast onto Earth.

2. **Compare and Contrast** Fill in the Venn diagram to show how Earth and the Moon are alike and different.



3. **Critical Thinking** You see a full moon in the night sky. Is there a new moon someplace else on Earth? Explain.

4. **Test Prep** **What causes many of the craters on the Moon?**
   - **A** meteoroids striking the Moon
   - **B** earthquakes on the Moon
   - **C** landslides on the Moon
   - **D** flooding on the Moon

5. **Essential Question** What can we learn about the Moon?

Math Link

Diameter and Radius
The diameter of a circle is its width at the widest point. The radius of a circle is one half of its diameter. A picture of the full moon has a radius of 6 cm. What is its diameter?

Social Studies Link

Learn about the Apollo Program
Research and report on NASA's Apollo program. Why was it important to Americans in the 1960s and 1970s? Try to interview an adult who remembers the events.

Focus on Skills

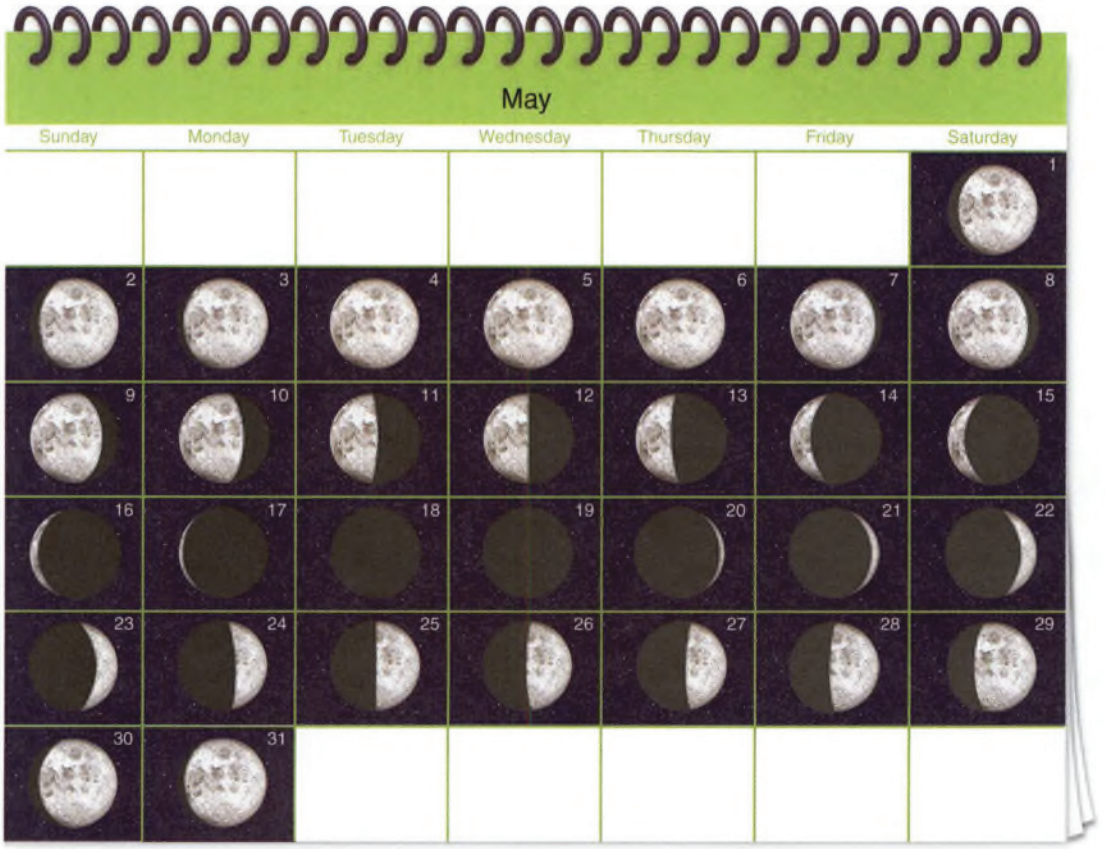
Inquiry Skill: Interpret Data

During any month, you can see different phases of the Moon. The changing positions of Earth and the Moon cause these phases. Scientists can predict when the Moon will be in any of its phases. To do so, they collect and **interpret data** about the Moon.

▶ Learn It

When you **interpret data,** you use information that has been gathered to answer questions or solve problems. Interpreting data from a written report can be difficult. It is better to organize your data into a table, chart, or graph. These tools help you see and understand your data at a glance. They help others understand your data too.

A calendar is a type of table. The one below shows data about moon phases during the month of May. Each drawing shows the phase that was observed on that day. The pattern in the calendar helps you predict other moon phases.



▶ Try It

Interpret data in the moon phase calendar on the opposite page. Answer the following questions.

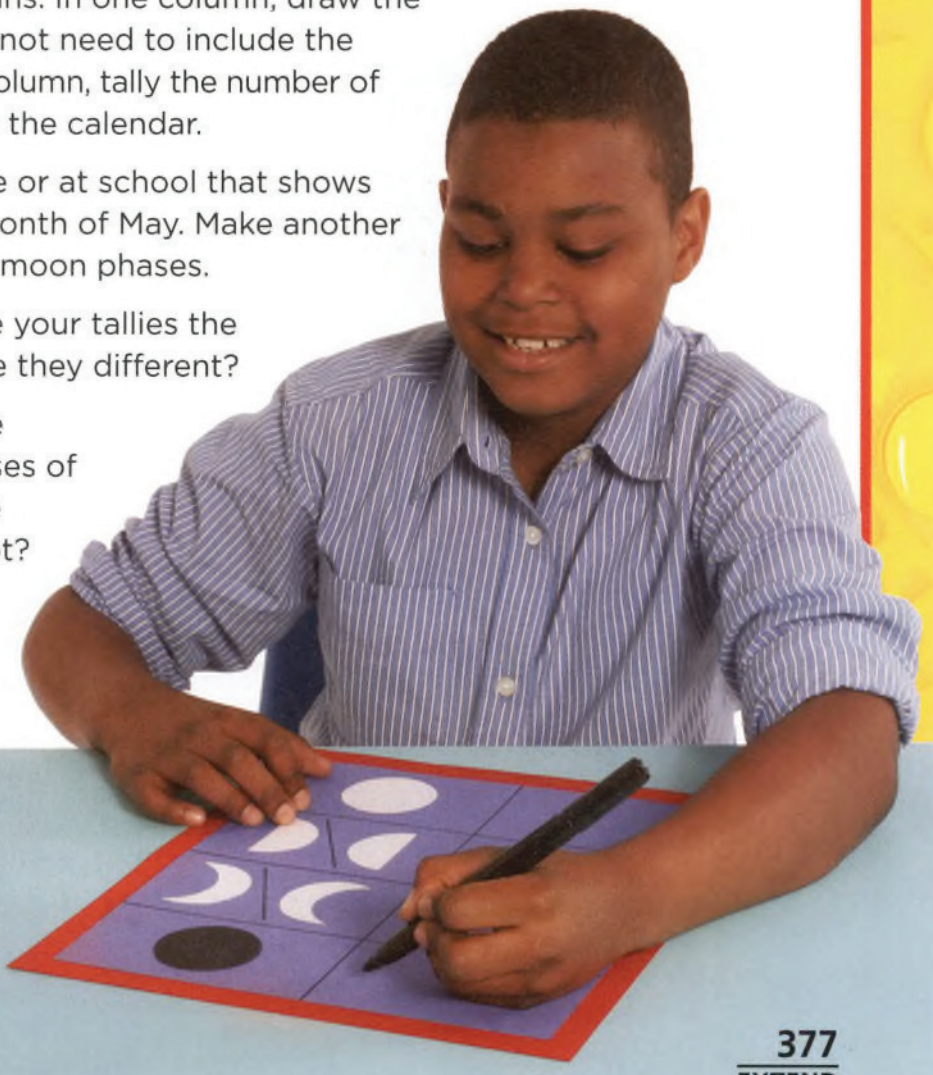
Materials **moon phase calendar**

1. On which day or days was there a new moon?
2. On which day or days was there a first quarter moon?
3. On which day or days was there a gibbous moon?
4. Is there a pattern of moon phases in this calendar? Describe it.

▶ Apply It

Interpret data by turning the information into a table like the one shown here.

1. Make a table with two columns. In one column, draw the phases of the Moon. You do not need to include the gibbous phase. In the other column, tally the number of times each phase appears in the calendar.
2. Find a new calendar at home or at school that shows moon phases. Look at the month of May. Make another table that shows the tally of moon phases.
3. Compare the two tables. Are your tallies the same in both cases? How are they different?
4. Look at the two moon phase calendars. Do the same phases of the Moon occur on the same days in May? Why or why not?



Lesson 3

The Solar System

Look and Wonder

Is this a photograph taken from space? Look at the distances between the three objects. Are they really so close together in space?

Explore

Inquiry Activity

How do sizes of objects in the solar system compare?

Purpose

Explore how Earth's size compares to the Moon's size and the sizes of other objects in the solar system.

Procedure

Be Careful! Handle scissors carefully.

1. **Use Numbers** Study the table. Compare the diameters of the different objects.
2. **Measure** Cut a paper circle with a diameter of 16 cm. This circle models Earth. Measure and cut circles to model the other objects in the table. Label each object. For at least one of the models, you will need to tape two or more sheets of construction paper together.
3. **Classify** Arrange the objects in a way that lets you compare their sizes.

Draw Conclusions

4. **Communicate** How do the sizes of the different objects compare?
5. **Infer** Why does the Moon appear larger than Mars in Earth's night sky? Why does the Sun seem larger and brighter than other stars?

Explore More

Research the sizes of other objects in the solar system. Make large and small circles to represent them. Find out how these objects are arranged in the solar system. Then arrange your models to represent those locations.

Materials

- scissors
- construction paper
- metric ruler
- marker

Comparing Diameters

Object	Size in Earth Diameters
Earth	1
Moon	$\frac{1}{4}$
Mars	$\frac{1}{2}$
Uranus	4

Read and Learn

Essential Question

How does Earth compare with other objects in the solar system?

Vocabulary

solar system, p. 380

planet, p. 380

gravity, p. 381

telescope, p. 382

comet, p. 388

asteroid, p. 388

meteor, p. 388

meteorite, p. 388

Reading Skill

Main Idea and Details

Main Idea	Details

Technology

e-Glossary and e-Review online at www.macmillanmh.com

What is the solar system?

You probably know that human-made satellites (SA•tuh•lites) orbit Earth. Did you know that the Moon is a satellite? A *satellite* is any object that moves in orbit around another body.

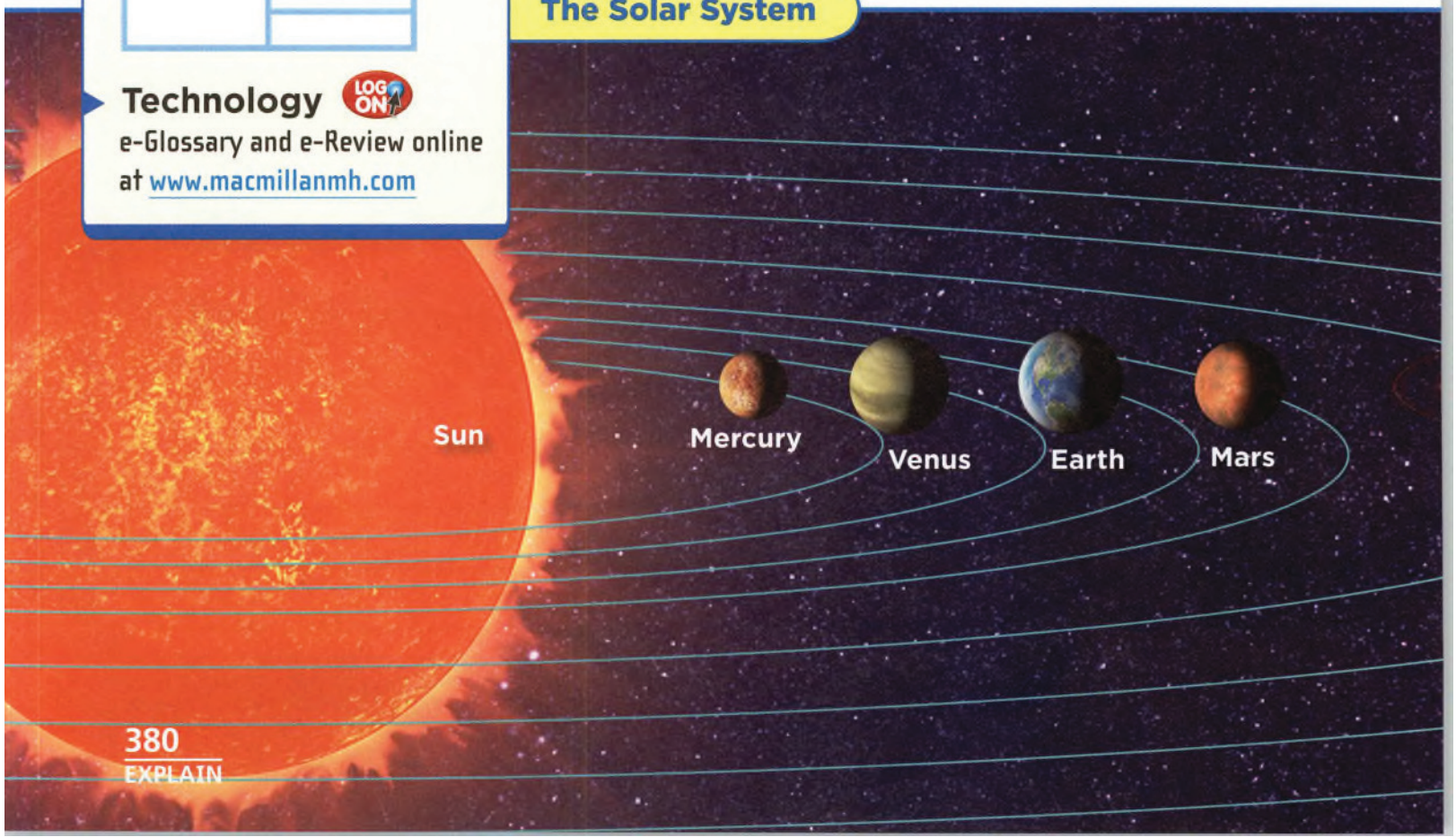
The Sun has many satellites. The Sun and all the objects in orbit around it make up our **solar system**. The solar system is millions of kilometers wide. At its center is the Sun.

Planets

On a clear night, you might see a planet or two in the sky. **Planets** are round objects in space that are satellites of the Sun. Scientists have identified eight planets in our solar system.

Planets are smaller and cooler than stars. Like the Moon, planets cannot make their own light. They reflect the light of the Sun.

The Solar System

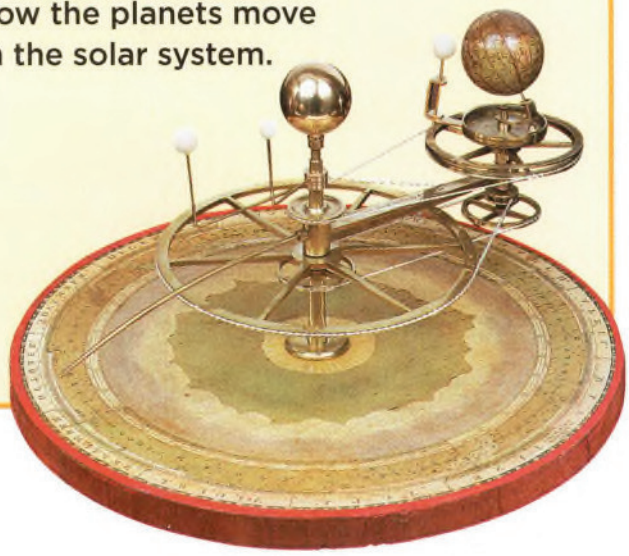


Orbiting the Sun

In the 1500s, a Polish scientist named Nicolaus Copernicus studied the planets. He found that they orbit the Sun. One hundred years later, a German scientist named Johannes Kepler showed that those orbits are ellipses (ih•LIPS•eez). An *ellipse* is a slightly flattened circle, or oval.

The English scientist Sir Isaac Newton lived in the late 1600s. He described how the planets stay in their orbits. Newton said it was a balance between gravity and inertia (ih•NUR•shuh). **Gravity** is a force of attraction between all objects. It pulls planets toward the Sun. *Inertia* is the tendency of a moving object to keep moving in a straight line.

This instrument models how the planets move in the solar system.



Quick Check

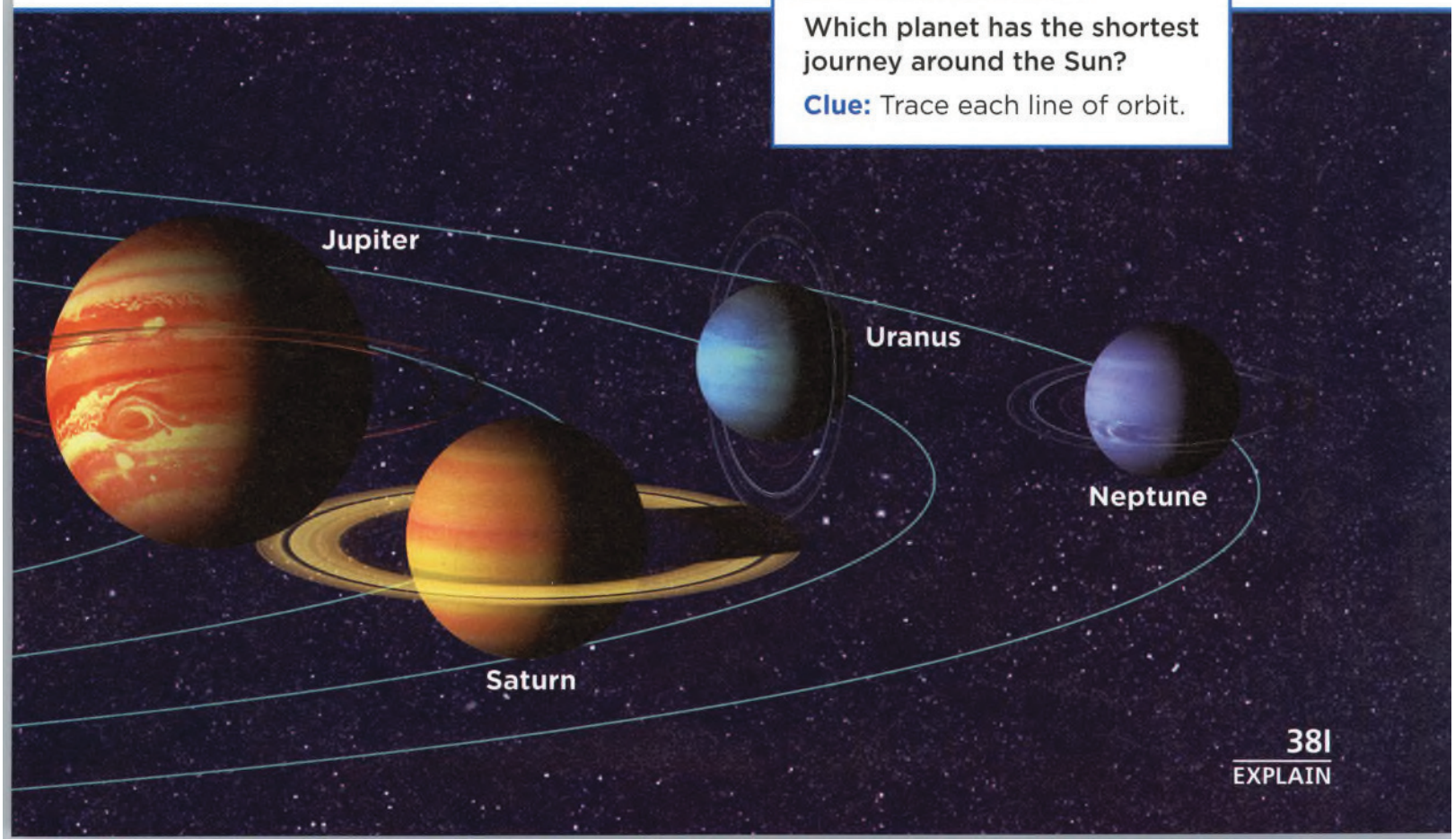
Main Idea and Details How do planets move in the solar system?

Critical Thinking Why is Earth's Moon a satellite?

Read a Diagram

Which planet has the shortest journey around the Sun?

Clue: Trace each line of orbit.



How do we learn about the solar system?

While Kepler studied the planets using math, an Italian scientist was also at work. His name was Galileo Galilei. He arranged curved pieces of glass, or *lenses,* inside a tube. The lenses helped him peer into space.

Telescopes

Do you know what Galileo used to look into space? It was a telescope. **Telescopes** make faraway objects seem closer. Galileo found objects in space that no one had seen before. He was able to show that Copernicus's model of the solar system was correct. Some of today's telescopes work much like larger versions of the ones Galileo made. Others used curved mirrors.

Clouds and city lights make it hard to see through telescopes. For this reason, many telescopes are located in clear, deserted areas or on mountaintops. One of the best places for telescopes is in space.

Astronauts

Many countries have programs to explore space. The United States has *NASA*—the National Aeronautic (ayr•uh•NAW•tik) and Space Administration. In the 1960s, NASA launched rockets that took people into space. Those people were the first *astronauts* (AS•truh•nawts).

New and Old Telescopes

radio telescopes

Galileo's telescope

Read a Photo

How has technology that is used for learning about space changed since Galileo's time?

Clue: Compare the telescopes in the photographs.

Shuttles and Space Stations

Space shuttles help astronauts conduct experiments and launch satellites. Many countries, including the United States, also use the International Space Station. Unlike shuttles, the space station remains in space for a long time.

Probes

Space probes are safer and less expensive than sending astronauts to space. A *probe* is an unmanned spacecraft that leaves Earth's orbit. NASA has launched probes to planets, moons, and other objects. The probes send pictures and other data from space to Earth.

In 2004 a space probe landed on Mars. Two robot explorers, called Mars rovers, studied the surface and recorded data. The names of these rovers are *Spirit* and *Opportunity*.

Because the solar system is so large, some probes need many years to reach their target. In 2006, NASA launched a probe. It will reach the edge of the solar system in 2015.

Quick Check

Main Idea and Details How do scientists learn about space?

Critical Thinking Why is NASA exploring planets with space probes instead of astronauts?

▲ The *Cassini* spacecraft is exploring the planet Saturn and its moons.

This illustration shows a Mars rover on the surface of Mars.

Quick Lab

Model the Solar System

1. As a class, discuss how to best model the solar system.
2. Have each class member pick an object to model.
3. **Make a Model** Carry out the plan in an open space. Observe the model in motion.
4. What did the class model show about the solar system? How could the model be improved?

What are the rocky planets?

The four planets closest to the Sun are called the *rocky planets*. They have much in common. Each is made up mostly of rock. They also seem to have solid cores made of iron. There are also important differences between these planets.

Mercury

Mercury is the closest planet to the Sun. That makes it very hot. It has almost no water and very little air. The surface has many craters like Earth's Moon. It is also the smallest rocky planet. At its equator, it is less than half the size of Earth. Mercury does not have a moon.

Mercury

Distance to the Sun: 58 million km
Diameter: 4,880 km
Rotation Time: 59 Earth days
Revolution Time: 88 Earth days
Fast Fact: Mercury's surface is covered with craters.

Venus

Distance to the Sun: 108 million km
Diameter: 12,100 km
Rotation Time: 243 Earth days
Revolution Time: 225 Earth days
Fast Fact: Temperatures on Venus can reach 500°C.

Venus

Venus is the second closest planet to the Sun. It has a thick atmosphere made mostly of carbon dioxide. The atmosphere does not allow heat to easily escape. This makes Venus the hottest planet. There are many volcanoes on Venus. Its surface is covered in lava flows. Venus also does not have a moon.

Earth

Earth is unique in our solar system. It has oxygen and liquid water. Earth's atmosphere keeps temperatures from getting too hot or too cold. These conditions are just right for life. Earth is the only planet known to support life.

Mars

Of all the planets, Mars is the most like Earth. It has two small moons and a thin atmosphere. Mars has volcanoes, but they are no longer active. The surface has many features that show evidence of erosion by floods and rivers. Today, Mars is much colder than Earth. Its water is frozen in ice caps near both poles. In addition to probes, NASA hopes to send astronauts to Mars.

Quick Check

Main Idea and Details Name and describe the rocky planets.

Critical Thinking Why would Earth's living things be unable to live on the other rocky planets?

Earth

Distance to the Sun: 150 million km
Diameter: 12,756 km
Rotation Time: 1 Earth day
Revolution Time: 365 Earth days
Fast Fact: Earth's atmosphere makes it suitable for life.

Mars

Distance to the Sun: 228 million km
Diameter: 6,794 km
Rotation Time: About 1 Earth day
Revolution Time: 687 Earth days
Fast Fact: Iron oxide, or rust, gives Mars its reddish color.

What are the other planets?

The four planets beyond Mars are called *gas giants*. Can you guess why? They are huge in size and made mostly of gases. The nearest, Jupiter, is five times farther from the Sun than Earth is.

The gas giants do not have solid surfaces. They are mostly made up of hydrogen and helium. Scientists think that they might have some rock and ice at their core.

Each has a ring system, although most are difficult to see. Each also has many moons. Some are like the rocky planets and have atmospheres.

Jupiter

Jupiter is the largest planet in the solar system. Scientists have seen at least 63 moons in orbit around it. This planet's atmosphere is divided into bands. Each band has winds blowing in opposite directions. One band has a large red spot that is the size of Earth. It is a giant storm that has been raging for over 300 years!

Saturn

Saturn is the second-largest planet. It is famous for its large rings. The rings are made of pieces of ice and rock. Most of these pieces are less than a couple of meters in diameter. Saturn has at least 34 moons. The largest is named Titan.

Jupiter

Distance to the Sun: 778 million km
Diameter: 143,000 km
Rotation Time: 10 Earth hours
Revolution Time: 4,333 Earth days
Fast Fact: Jupiter's four largest moons were first observed by Galileo in 1610.

Saturn

Distance to the Sun: 1 billion, 429 million km
Diameter: 120,536 km
Rotation Time: 10 Earth hours
Revolution Time: 10,759 Earth days
Fast Fact: Winds on Saturn can blow at 500 meters per second.

Uranus

Have you ever heard of a "sideways" planet? The axis of Uranus is tilted so much that it rotates on its side! This means that one pole faces the Sun during parts of Uranus's orbit. The unusual color of this planet is caused by gases in its upper atmosphere. Uranus has at least 27 moons.

Neptune

Neptune is the farthest gas giant from the Sun. Winds on Neptune can blow at speeds of 2,000 km (1,200 mi) per hour! Scientists have observed 13 moons orbiting Neptune. Triton is the largest moon. It is known to have volcanoes.

Dwarf Planets

Scientists have been discovering smaller and smaller planets in the solar system. These are called *dwarf planets*. Most are round and made of rock and ice. Their orbits cross the orbits of other objects.

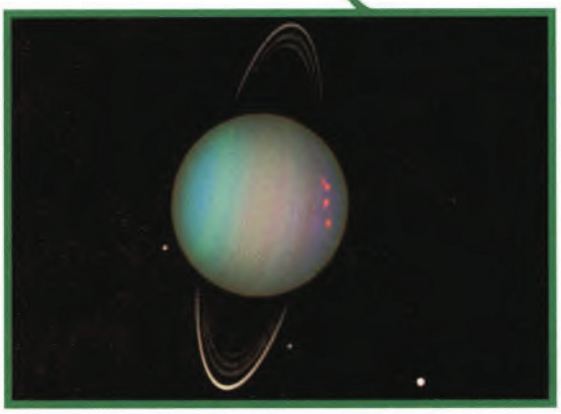
Pluto is the best known dwarf planet. For 76 years, it was considered the ninth planet. Scientists changed Pluto's classification in 2006.

Quick Check

Main Idea and Details Name and describe the gas giants.

Critical Thinking Could humans live on the gas giants? Explain.

Uranus



Distance to the Sun: 2 billion, 871 million km
Diameter: 51,118 km
Rotation Time: 17 Earth hours
Revolution Time: 30,684 Earth days
Fast Fact: The axis of Uranus is tilted toward the Sun.

Neptune

Distance to the Sun: 4 billion, 504 million km
Diameter: 49,528 km
Rotation Time: 16 Earth hours
Revolution Time: 60,190 Earth days
Fast Fact: Neptune takes 165 Earth years to orbit the Sun.

Comet Hale-Bopp last approached the Sun in the 1990s.

What else is in our solar system?

Not all objects in the solar system are planets or moons. Smaller objects also revolve around the Sun.

Comets

A **comet** is mostly ice mixed with rocks and dust. It moves in a long, narrow orbit. When a comet nears the Sun, it heats up very quickly. This forms a tail of gas and dust pointing away from the Sun.

Asteroids

Asteroids (AS•tuh•roydz) are large chunks of rock or metal in space. The solar system has thousands of asteroids. Most of them lie in a belt between Mars and Jupiter.

Meteoroids

When comets or asteroids collide, pieces of rock or metal break off. These smaller pieces are meteoroids. There are millions of them in space!

If a meteoroid enters Earth's atmosphere, it is called a **meteor**. Small meteors burn up in the atmosphere, leaving streaks of light across the sky. We call them shooting stars, but they are not stars at all. If a meteor reaches Earth's surface, it is called a **meteorite**.

Quick Check

Main Idea and Details Describe the smaller solar system objects.

Critical Thinking How do planets compare to asteroids and comets?

FACT Comets have a tail only when they are near the Sun.

Lesson Review

Visual Summary

The solar system is made up of planets, moons, and other objects that orbit the Sun in space.

The planets are round objects in space that are satellites of the Sun. They include gas giants and dwarf planets.

Smaller objects in the solar system include comets, asteroids, meteoroids, and meteors.

Make a FOLDABLES® Study Guide

Make a three-tab book. Use it to summarize what you learned about the solar system.

Think, Talk, and Write

1. **Vocabulary** The large rocks that are found in a belt between Mars and Jupiter are called _____.

2. **Main Idea and Details** Extend and fill in the graphic organizer to show the parts of the solar system.

Main Idea	Details

3. **Critical Thinking** Why might it be better for some experiments to be done in space or someplace away from Earth? Give an example of a variable that such an experiment might test.

4. **Test Prep** **Which is the largest planet in the solar system?**
   - **A** Mars
   - **B** Jupiter
   - **C** Saturn
   - **D** Earth

5. **Essential Question** How does Earth compare with other objects in the solar system?

Writing Link

Write a Report
Research how the planets received their names. Present what you learn in a written report.

Social Studies Link

Learn about a NASA Probe
In early 2006, NASA launched a probe to Pluto. Research the progress of this probe. What do scientists hope to learn from it?

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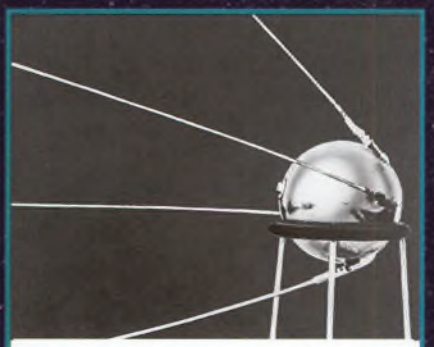
TO THE MOON!

How have scientists explored our solar system? For thousands of years, people used their unaided eyes. Then about 400 years ago, scientists developed telescopes. In recent history, spacecraft have landed robots and people on the Moon. What we learn about the Moon may help us understand and explore other objects in the solar system.



1957 *Sputnik I* is the first spacecraft to travel into space.

1959 *Luna 1* is the first spacecraft to approach the Moon closely. *Luna 2* lands on the Moon. *Luna 3* sends pictures of the Moon to Earth. This is the first time anyone can see what the far side of the Moon looks like.

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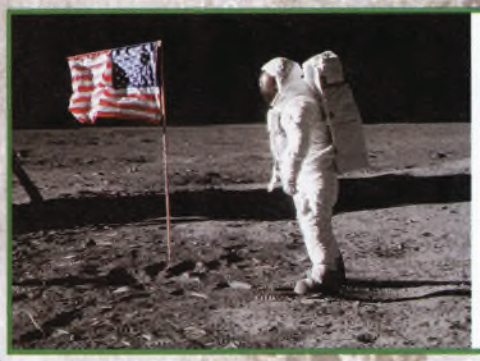
NASA plans to send expeditions back to the Moon to learn more about it and what it takes to live in its extreme environment.

1972 *Apollo 17* is the last manned mission to the Moon. The crew spends 75 hours there. Astronauts Gene Cernan and Harrison Schmitt drive a lunar roving vehicle around the surface of the Moon to collect samples.



1969 *Apollo 11* mission is the first to land a person on the Moon. Neil Armstrong and Buzz Aldrin are the first astronauts to walk on the Moon and collect samples.

Main Idea and Details

- The main idea tells what the article is mostly about.
- Details, facts, and examples support the main idea.

Write About It

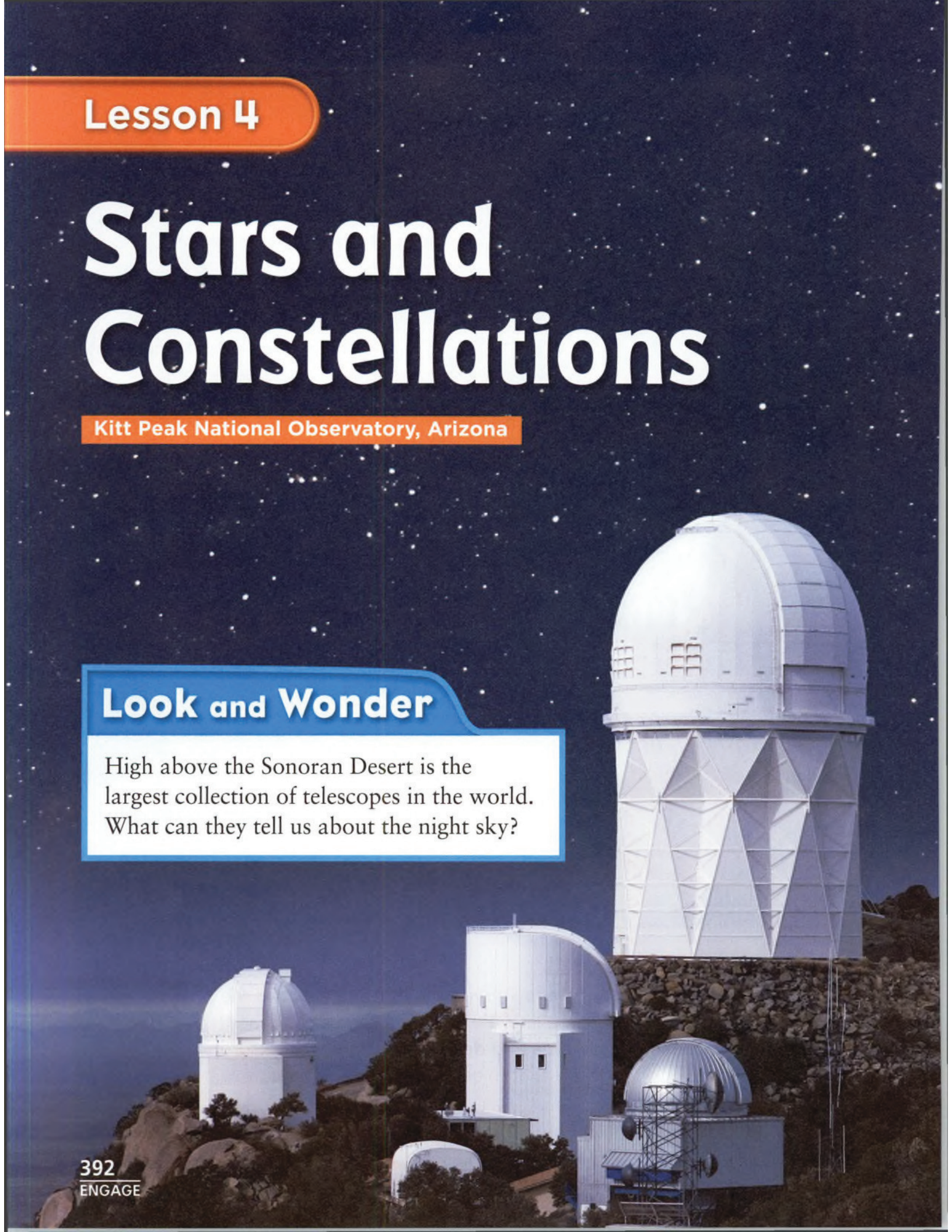
Main Idea and Details Reread the introduction and the captions on the time line. Then write a paragraph that explains the main idea and details of this article. Be sure to include facts and examples in your paragraph.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

Lesson 4

Stars and Constellations

Kitt Peak National Observatory, Arizona



Look and Wonder

High above the Sonoran Desert is the largest collection of telescopes in the world. What can they tell us about the night sky?

Explore

Inquiry Activity

Why do some stars seem brighter than others?

Form a Hypothesis

How does distance affect the apparent brightness of stars? Write a hypothesis.

Test Your Hypothesis

1. Tape one end of a cardboard tube to the flashlight as shown.
2. **Measure** Hold the other end of the tube 10 cm above the center of the graph paper. Turn the flashlight on. Have a partner trace the circle of light on the paper. Label the circle *10 cm*.
3. Repeat step 2 at a distance of 20 cm. Repeat at 40 cm and at 80 cm. Label the circle each time. You might need to place the paper on the floor for the last tests.

Draw Conclusions

4. **Use Numbers** Count the number of squares filling each labeled circle on the graph paper.
5. **Interpret Data** How did the light change as the light moved farther from the paper?
6. **Infer** Why do you think some stars in the night sky seem brighter than others?

Explore More

Does the source of a light affect the apparent brightness? Form a hypothesis. Design a test to compare different sources of light. Predict how the number of lighted squares might change. Try it!

Materials

- masking tape
- cardboard tube
- flashlight
- graph paper
- meterstick

Read and Learn

Essential Question

How do stars appear in the sky?

Vocabulary

star, p. 394

constellation, p. 396

Reading Skill

Fact and Opinion

Fact	Opinion

Technology

e-Glossary and e-Review online at www.macmillanmh.com

What are stars?

For thousands of years, people have observed stars shining brightly in the night sky. A **star** is a sphere of hot gases that gives off light and heat.

The only star you can see in the daytime is the Sun. The Sun might look different from other stars, but it is rather ordinary.

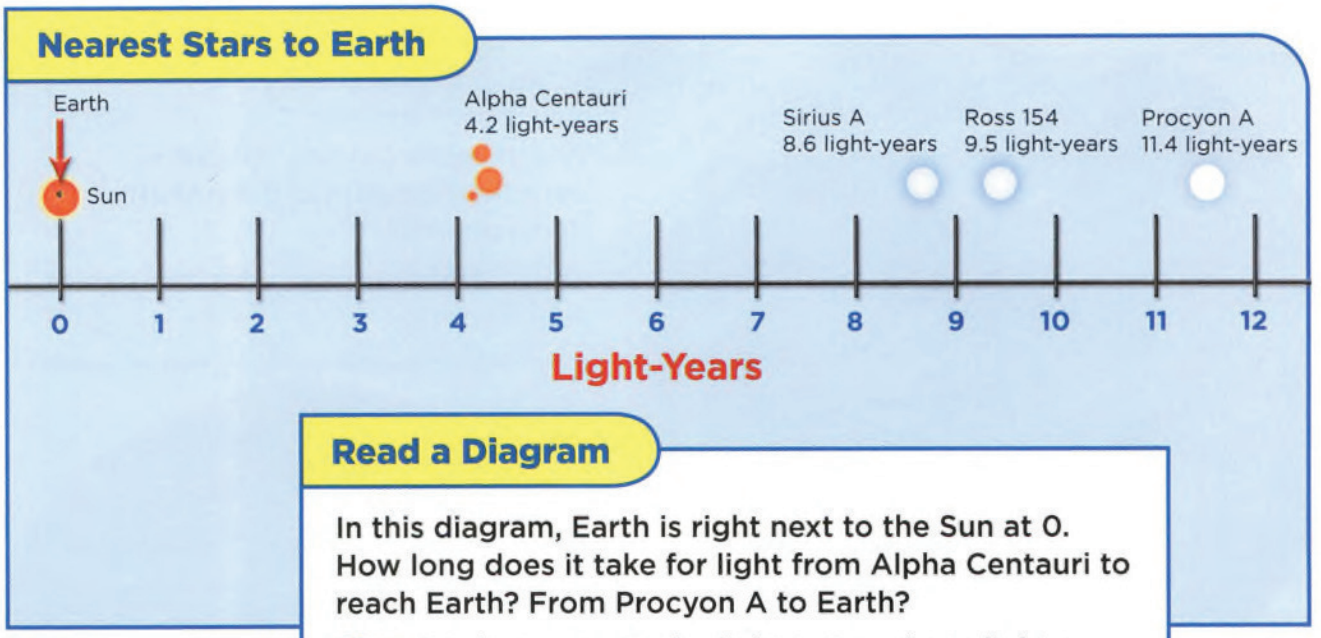
Compared to other stars, the Sun has an average size. Its surface temperature is average too. Why does the Sun look bigger and brighter than any other star? The Sun is the closest star to Earth. Other stars are much farther away.

Colors and Temperature

Have you ever noticed different colors of stars? The colors are due to temperature. The Sun's temperature makes it look yellow. Cooler stars are red or orange. Warmer stars are white or blue.

A star glows for a very long time. Our Sun is about five billion years old. Scientists think it will glow for five billion more years!

The Andromeda Galaxy is wider than our own Milky Way Galaxy. ▼



Read a Diagram

In this diagram, Earth is right next to the Sun at 0. How long does it take for light from Alpha Centauri to reach Earth? From Procyon A to Earth?

Clue: It takes one year for light to travel one light-year.

Light-Years

When you observe the night sky, one star might seem brighter than another. Does that star give off more energy? Maybe not. It might simply be closer to Earth than others.

The Sun is about 150 million km from Earth. It takes about 8 minutes for its light to reach Earth. Most stars are much farther away. They are so far that scientists measure their distance in light-years. One *light-year* is the distance light travels in one year. That is nearly ten trillion km!

When you see a distant star, you are seeing what it looked like millions of years ago. A star you see today might have stopped glowing long ago. However, its light is still making its way to Earth.

Galaxies

Throughout the universe, stars are found in large groups called *galaxies* (GA•luk•seez). Our Sun is near the edge of a galaxy with billions of other stars. You know this galaxy as the Milky Way.

Our galaxy's nearest neighbor is the Andromeda (an•DRAH•muh•duh) Galaxy. It is shaped like a spiral. The universe might have many more galaxies, each with billions of stars. These are yet to be discovered.

Quick Check

Fact and Opinion *Temperature determines a star's color.* Is this a fact or an opinion? Explain.

Critical Thinking How far away are stars? Use your own words to describe the distance.

Northern Hemisphere

Read a Diagram

Which constellations appear in both the Northern and Southern Hemispheres?

Clue: Compare the shapes and names in both circles.

Southern Hemisphere

What are constellations?

There are billions of stars. How could you make sense of them all? One way is to group them into constellations (kahn•stuh•LAY•shunz). A **constellation** is a group of stars that make a pattern or picture in the sky.

Our constellations make sense only to an observer on Earth. Stars that seem close together are actually far apart. If you could move to a different part of the universe, those patterns would change.

Constellations also depend on the position of the observer on Earth. The night sky looks different in the Northern Hemisphere than it does in the Southern Hemisphere. Still, a few constellations appear in both.

Patterns of Stars

As Earth travels in its orbit around the Sun, we see different constellations. The constellations appear to move across the sky throughout the year. In fact, they always remain in the same patterns.

People named constellations after the pictures they saw in the sky. *Draco* is the Latin word for "dragon." The Draco constellation looks like a dragon to some people.

This ancient tool helped people tell time by the stars.

Marking Time and Seasons

Once there were no clocks to tell time. There were no satellites to help you find your position. Instead, people used constellations.

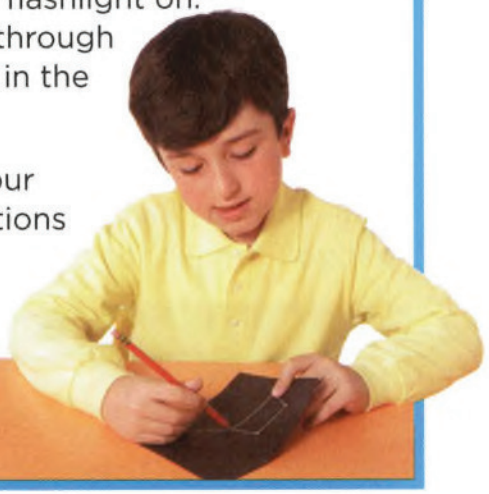
Farmers studied constellations to mark the seasons. The stars' positions helped them decide when to plant or harvest crops. Sailors used constellations to steer their ships at night. They knew which stars on the Big Dipper point to the North Star. The North Star is always in the northern sky.

Today scientists group the stars into 88 constellations. You can study constellations too. Star charts help you know where to look. Telescopes help you see each star. You can visit a local observatory to learn more.

Quick Lab

Modeling Constellations

1. **Be Careful!** Handle scissors with care. Remove one end of a cardboard shoe box. Cut a piece of black construction paper the same size as the cardboard piece.
2. **Make a Model** Choose one of the constellations. Draw it on the black paper. Use a pencil to punch out one hole for each star.
3. Cut a circle from the other end of the shoe box. Make it just big enough to fit a flashlight. Tape the paper from step 2 over the opposite end of the box.
4. **Observe** Dim the lights. Turn the flashlight on. Shine it through the hole in the box.
5. Share your observations with the class.



Quick Check

Fact and Opinion *Draco is the best constellation.* Is this statement a fact or an opinion? Explain your answer.

Critical Thinking Why does a constellation appear to move across the sky every night?

What is the Sun like?

Like Earth, the Sun is made of layers. It has a core and three other layers. The layers are not distinct because the Sun is made of gas.

Unlike Earth, the Sun releases light into space. After all, the Sun is a star. The center, or core, of the Sun is the source of all its energy.

Light and Heat

Some of the Sun's energy is light that we can see. Much of the energy is released as heat. Earth receives just a fraction of the Sun's total energy. Yet that is enough to provide energy for nearly all living things. Producers turn the Sun's energy into food. Consumers take in the Sun's energy when they eat food.

Power for the Water Cycle

The Sun's heat makes water evaporate. Evaporation is part of the water cycle that includes condensation and precipitation. The Sun also drives winds, ocean currents, storms, and other weather.

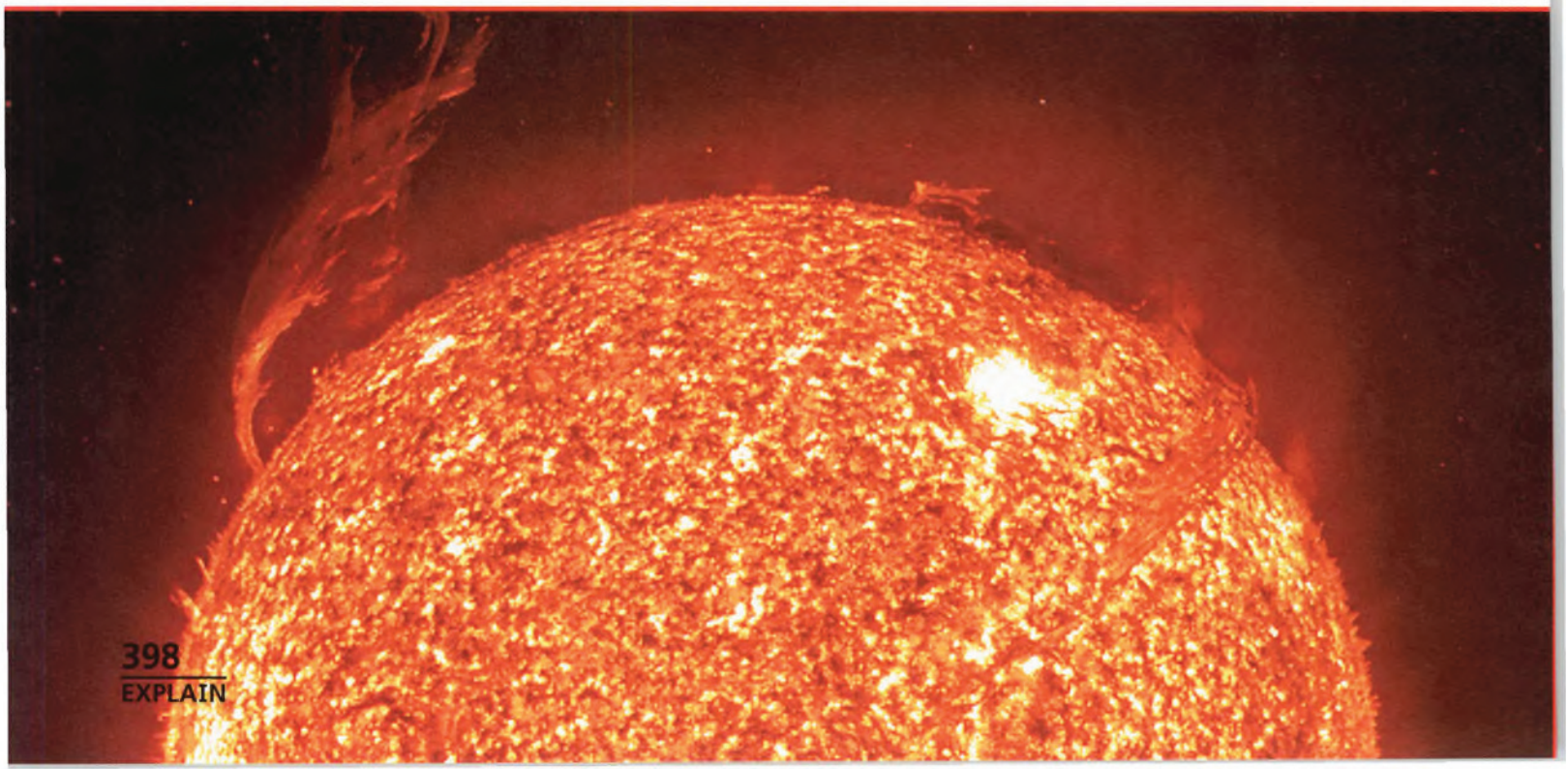
Sun Safety

Never look directly at the Sun. The energy the Sun releases could damage your eyes forever. Always wear sunscreen when you are outside. Even on a cloudy day, the Sun's energy can cause a sunburn.

Quick Check

Fact and Opinion Is the Sun's energy good or bad for Earth? Support your answer with facts.

Critical Thinking How is the Sun like Earth? How is it different?



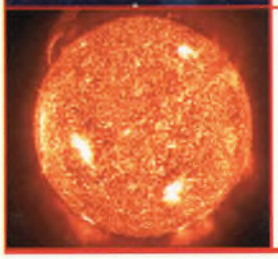
Here you see parts of the Sun that you cannot see from Earth.

Lesson Review

Visual Summary

Stars are spheres of hot gases that give off light and heat. Most stars are light-years away from Earth.

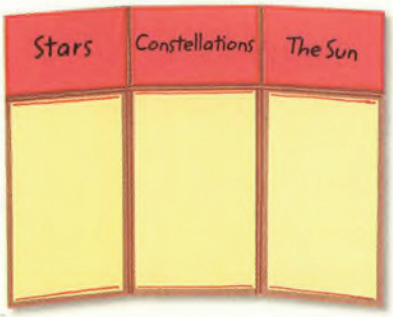
Stars can be grouped into **constellations.** Constellations help people tell time and position on Earth.



The Sun is the closest star to Earth. It provides energy for life, the water cycle, winds, currents, and weather.

Make a FOLDABLES Study Guide

Make a trifold book. Use it to summarize what you read about stars and constellations.



Think, Talk, and Write

1. **Vocabulary** What is a constellation?

2. **Fact and Opinion** Are constellations useful to people today? State your opinion. Support your opinion with at least one fact.

Fact	Opinion

3. **Critical Thinking** Why do some constellations appear only during certain seasons?

4. **Test Prep** **How far away is the Sun from Earth?**
   - **A** 8 million km
   - **B** 150 million km
   - **C** 1 light-year
   - **D** 71 million light-years

5. **Test Prep** **Compared to other stars in the universe, the Sun is**
   - **A** much larger and hotter.
   - **B** much smaller and colder.
   - **C** much older and more massive.
   - **D** about average.

6. **Essential Question** How do stars appear in the sky?

Writing Link

Write a Report
Write about a story, movie, or poem in which people travel among the stars. Discuss whether you think such travel is possible.

Math Link

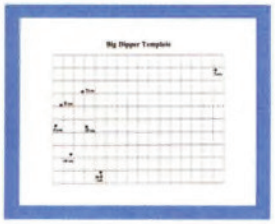
Compare and Order Numbers
Write the following as numbers—four million, five trillion, two billion, eight thousand. Order them from smallest to largest.

Be a Scientist

Materials

aluminum foil

clear tape



Big Dipper template

piece of cardboard

precut pieces of string

Structured Inquiry

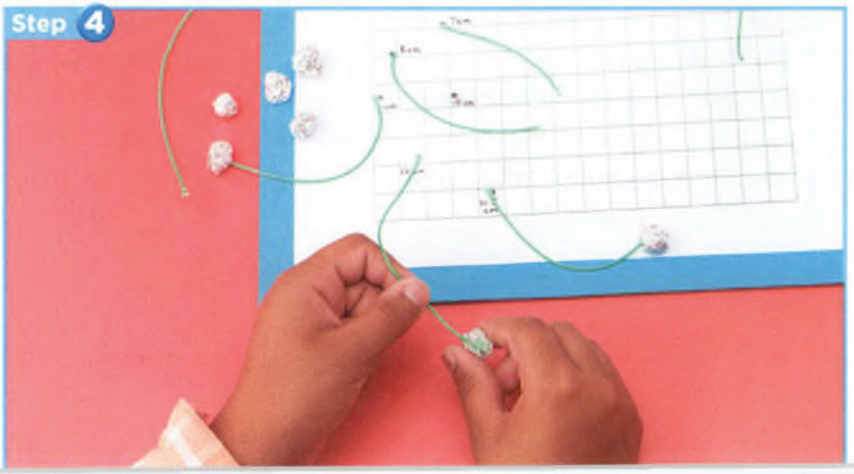
Why do some distant stars appear to be close together?

Form a Hypothesis

Stars that are light-years apart can seem very close together. Does your viewing position affect how you see stars in the sky? Write your answer in the form "If I view a constellation from different positions, then I will observe..."

Test Your Hypothesis

1. **Make a Model** Make seven small balls of aluminum foil. These will model the stars in the Big Dipper.
2. Tape the Big Dipper template to the cardboard.
3. **Measure** Tape each length of string to the dot on the template marked with that length.
4. Open each foil ball partway. Insert the loose end of each string into a foil ball. Squeeze each ball tightly so that its string will stay in.
5. **Observe** Hold the cardboard up so the stars hang below it. Keep it one arm's length away. Observe the stars.
6. Rotate your model one turn to the left. Repeat step 5. Continue turning and observing until you have viewed the model from all four sides.



Draw Conclusions

7. What did your group of stars look like in step 5?
8. What changes did you observe each time you turned the model?
9. **Infer** When viewed from Earth, the stars in a constellation may seem close together. In space, those stars may be light-years apart. What can you infer about the stars in the Big Dipper?

Guided Inquiry

How does distance from Earth affect a star's apparent brightness?

Form a Hypothesis

How does a star's distance from Earth affect how bright it appears? Write a hypothesis.

Test Your Hypothesis

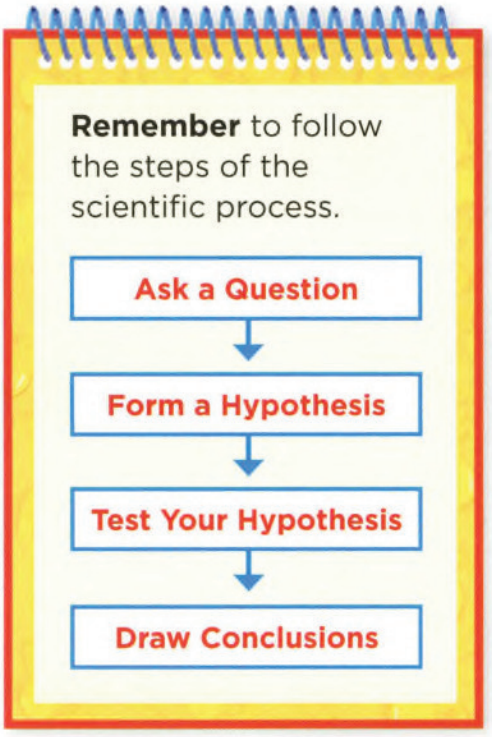
Make a plan to model how the distance from Earth affects the apparent brightness of a star. Write out the materials you need and the steps you will follow. Record your results and observations.

Draw Conclusions

Did your results support your hypothesis? Why or why not? Explain how you set up the experiment to test for only one variable.

Open Inquiry

What else can you learn about stars? For example, which constellations can you see during different seasons? Design an investigation to answer your question. Use reference materials to plan your activity. Write your procedure so that another group can complete the same activity by following your instructions.

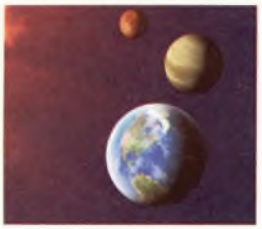


CHAPTER 8 Review

Visual Summary

Lesson 1 Earth's movement in space causes day, night, and the seasons.

Lesson 2 As the Moon revolves around Earth, we observe its different phases.

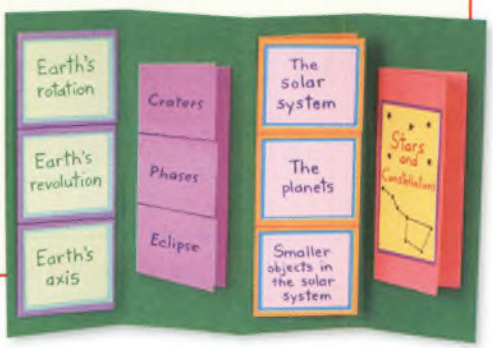


Lesson 3 The Sun is at the center of the solar system. Planets, moons, and other objects orbit around the Sun.

Lesson 4 Stars are spheres of hot gases that give off light and heat.

Make a FOLDABLES® Study Guide

Tape your lesson study guides to a piece of paper as shown. Use your study guide to review what you have learned in this chapter.



Vocabulary

DOK 1

Fill each blank with the best term from the list.

comet, p. 388
crater, p. 371
gravity, p. 381
lunar eclipse, p. 374
meteor, p. 388
phase, p. 373
planet, p. 380
revolution, p. 362
rotation, p. 360
star, p. 394

1. Every 24 hours, Earth completes one _____.
2. Each year, Earth completes one _____ around the Sun.
3. Earth casts a shadow on the Moon during a _____.
4. A chunk of ice, rocks, and dust that orbits the Sun is a _____.
5. If a meteorite enters Earth's atmosphere, it is called a _____.
6. A glowing sphere of gases that gives off heat and light energy is a _____.
7. A large, round object that orbits the Sun is called a _____.
8. When a meteor strikes the Moon, a _____ can form.
9. A full moon is a _____ of the Moon.
10. The attraction force between all objects is called _____.

LOG ON e-Glossary Words and definitions online at www.macmillanmh.com

Skills and Concepts

DOK 2–3

Answer each of the following.

11. **Cause and Effect** What causes a solar eclipse?

12. **Interpret Data** Make a table showing how long it takes each planet to complete one rotation and one revolution. Does the planet with the shortest revolution also have the shortest rotation?

13. **Critical Thinking** Some people refer to comets as "dirty snowballs." Why do they use this term?

14. **Fictional Narrative** Suppose you moved to a new home near the South Pole. Write a story about the change of seasons there. Describe how those seasons differ from the ones where you live now.

15. **Infer** Explain why Mars will most likely be the easiest planet for people to visit someday.

16. **Critical Thinking** Explain why your shadow is longer in the morning than at midday.

17. **True or False** *People see the same stars all year long.* Is this statement true or false? Explain.

18. **Critical Thinking** Where on Earth does the Sun never set during the summer and never rise during the winter? Explain why.

19. We see the Sun rise and set because

A Earth revolves around the Sun.

B Earth rotates on its axis.

C the Sun revolves around Earth.

D the Moon revolves around Earth.

The Big Idea

20. What objects are in the solar system and beyond?

Performance Assessment

DOK 2

Star Research

1. Choose and research a constellation. Explain what you find interesting about it.

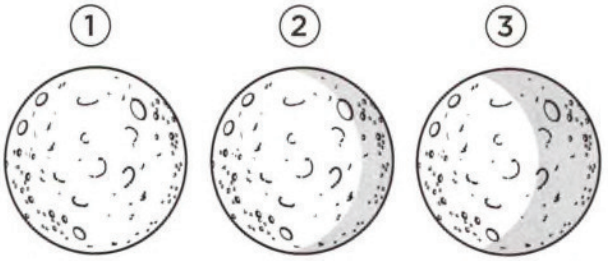
2. Illustrate your constellation. Include labels for all of its stars.

3. Make a chart with details about your constellation. Include facts such as when it is visible in the sky and how it got its name. Also include the distance from Earth to the nearest star in the constellation.

4. Present your illustration and chart to the class.

Test Preparation

1 Lorraine observed the Moon every other night for one week. Look at what she saw.



Which phase will she see next?

A

B

C

D

DOK 2

2 How is the Moon different from Earth?

A The Moon has no atmosphere.

B The Moon has no mountains.

C The Moon has different kinds of rock.

D The Moon has different kinds of living things.

DOK 1

3 How is the Sun different from all other stars?

A It is hotter than other stars.

B It is closer to Earth than other stars.

C It is bigger than other stars.

D It is brighter than other stars.

DOK 1

4 Your shadow is short when you go outside. What time of day is it?

A early morning

B late afternoon

C after sunset

D near noon

DOK 1

5 Meteoroids that strike Earth's surface are called

A comets.

B asteroids.

C meteors.

D meteorites.

DOK 1

6 **A group of stars that form a pattern in the sky is called**

A a constellation.

B an eclipse.

C a galaxy.

D a phase.

DOK 1

7 **What causes Earth's changing seasons?**

A Earth's rotation around the Sun

B the Sun's rotation around Earth

C Earth's tilted axis and revolution around the Sun

D Earth's rotation and the Moon's revolution around Earth

DOK 2

8 **Which tool would best show the details of Saturn?**

A telescope

B binoculars

C microscope

D rover

DOK 1

9 **What do stars have in common with Jupiter, Saturn, Uranus, and Neptune?**

A They give off their own light.

B They are beyond our solar system.

C They orbit around the Sun.

D They are made up of gases.

DOK 2

10 **Which of these is a dwarf planet?**

A Neptune

B the Sun

C Earth

D Pluto

DOK 1

Use the illustration below to answer questions 11–12.

11 **What will the Moon look like in about two weeks?**

DOK 1

12 **What causes the phases of the Moon?**

DOK 2

Check Your Understanding

Question	Review	Question	Review
1	pp. 372–373	7	pp. 362–363
2	pp. 370–371	8	pp. 382–383
3	pp. 394–398	9	pp. 386–387, 394–395
4	pp. 360–361	10	pp. 384–387
5	p. 388	11	pp. 372–373
6	pp. 396–397	12	pp. 372–373

Careers in Science

Planetarium Technician

Would you like to make star shows that are educational and fun? Think about being a planetarium technician. A planetarium is a place where people can watch representations of the solar system. These are usually light shows that are projected onto the ceiling and narrated.

As a planetarium technician, you would operate the audio and light equipment for the shows. You might work with teachers to help plan the programs. You would also get to see and hear the results of your work!

▲ A planetarium technician helps plan exciting star shows.

Air Traffic Controller

People depend on air traffic controllers to keep them safe during air travel. Some air traffic controllers direct planes on the runways. Others direct traffic between airports. All controllers make sure that airplanes keep a safe distance apart.

What does it take to become an air traffic controller? First, you need to be good at math. You should also have good speaking and computer skills. After college, you would train at the Federal Aviation Administration (FAA) Academy. Most graduates of this program have a lifelong career with the FAA.

▲ An air traffic controller keeps flight travel safe.

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