

## 20.2

## KEY CONCEPT

# The Moon is Earth's natural satellite.

## Sunshine State STANDARDS

**SC.C.2.3.7:** The student knows that gravity is a universal force that every mass exerts on every other mass.

**SC.E.1.3.1:** The student understands the vast size of our Solar System and the relationship of the planets and their satellites.

**SC.E.1.3.2:** The student knows that available data from various satellite probes show the similarities and differences among planets and their moons in the Solar System.

## VOCABULARY

mare p. 717

The Moon's diameter is about 1/4 Earth's diameter, and the Moon is about 30 Earth diameters away.

## BEFORE, you learned

- Earth turns as it orbits the Sun
- The day side of Earth is the part in sunlight
- The Moon is the closest body to Earth

## NOW, you will learn

- How the Moon moves
- What the Moon's dark-colored and light-colored features are
- About the inside structure of the Moon

### EXPLORE The Moon's Motion

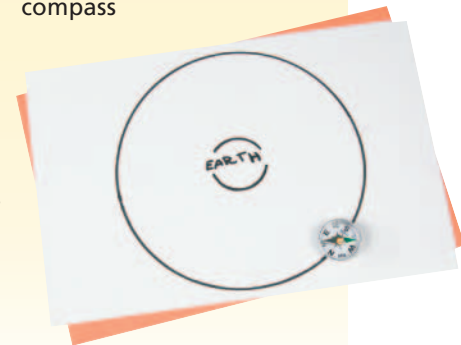
#### How much does the Moon turn?

#### PROCEDURE

- 1 Draw a circle to represent the Moon's orbit with Earth at the center. The compass represents the Moon.
- 2 Move the compass around the circle. Keep the side of the compass marked *E* always facing Earth.
- 3 Observe the positions of the *E* and the compass needle at several positions on the circle.

#### MATERIALS

- paper
- magnetic compass



#### WHAT DO YOU THINK?

What does the model tell you about the Moon's motion?

## The Moon rotates as it orbits Earth.

When you look at the disk of the Moon, you may notice darker and lighter areas. Perhaps you have imagined them as features of a face or some other pattern. People around the world have told stories about the animals, people, and objects they have imagined while looking at the light and dark areas of the Moon. As you will read in this chapter, these areas tell a story to scientists as well.

The pull of gravity keeps the Moon, Earth's natural satellite, in orbit around Earth. Even though the Moon is Earth's closest neighbor in space, it is far away compared to the sizes of Earth and the Moon.



Earth



Moon



The distance between Earth and the Moon is roughly 380,000 kilometers (240,000 mi)—about a hundred times the distance between New York and Los Angeles. If a jet airliner could travel in space, it would take about 20 days to cover a distance that huge. Astronauts, whose spaceships traveled much faster than jets, needed about 3 days to reach the Moon.

You always see the same pattern of dark-colored and light-colored features on the Moon. Only this one side of the Moon can be seen from Earth. The reason is that the Moon, like many other moons in the solar system, always keeps one side turned toward its planet. This means that the Moon turns once on its own axis each time it orbits Earth.

**CHECK YOUR READING**

Why do you see only one side of the Moon?

**Moon**

The side of the Moon that constantly faces Earth has large, dark areas called maria.

**Mass** 1% of Earth's mass

**Diameter** 27% of Earth's diameter

**Average distance from Earth** 380,000 km

**Orbits in** 27.3 Earth days

**Rotates in** 27.3 Earth days

## The Moon's craters show its history.

The half of the Moon's surface that constantly faces Earth is called the near side. The half that faces away from Earth is called the far side. Much of the Moon's surface is light-colored. Within the light-colored areas are many small, round features. There are also dark-colored features, some of which cover large areas. Much of the near side of the Moon is covered with these dark-colored features. In contrast, the far side is mostly light-colored with just a few of the darker features.

Just as on Earth, features on the Moon are given names to make it easier to discuss them. The names of the larger surface features on the Moon are in the Latin language, because centuries ago scientists from many different countries used Latin to communicate with one another. Early astronomers thought that the dark areas might be bodies of water, so they used the Latin word for "sea." Today, a dark area on the Moon is still called a lunar **mare** (MAH-ray). The plural form is *maria* (MAH-ree-uh).

The maria are not bodies of water, however. All of the features that can be seen on the Moon are different types of solid or broken rock. The Moon has no air, no oceans, no clouds, and no life.

**READING TIP**

*Lunar* means "having to do with the Moon." The word comes from *luna*, the Latin word for the Moon.

## Craters and Maria

The light-colored areas of the Moon are higher—at greater altitudes—than the maria, so they are called the lunar highlands. The ground of the lunar highlands is rocky, and some places are covered with a powder made of finely broken rock.

The highlands have many round features, called impact craters, that formed when small objects from space hit the Moon's surface. Long ago, such collisions happened more often than they do today. Many impact craters marked the surfaces of the Moon, Earth, and other bodies in space. On Earth, however, most craters have been worn away by water and wind. On the dry, airless Moon, impact craters from a long time ago are still visible.

Long ago, some of the largest craters filled with molten rock, or lava, that came from beneath the Moon's surface. The lava filled the lowest areas and then cooled, forming the large, flat plains called maria. Smaller impacts have continued to occur, so the dark plains of the maria do contain some craters. Most of the large maria are on the near side of the Moon. However, the widest and deepest basin on the Moon is on the far side, near the Moon's south pole.



**CHECK YOUR READING**

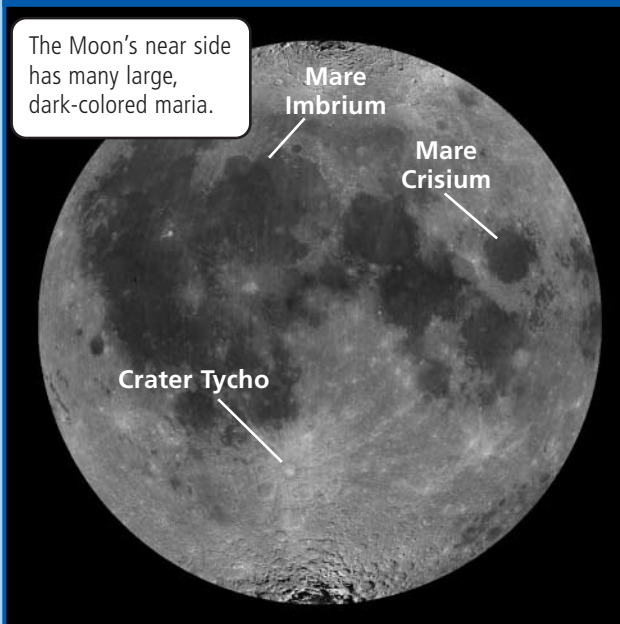
How did the maria form? List the steps.

### Lunar Map

Light-colored highlands and dark maria form a familiar pattern on the near side of the Moon and a very different pattern on the far side.

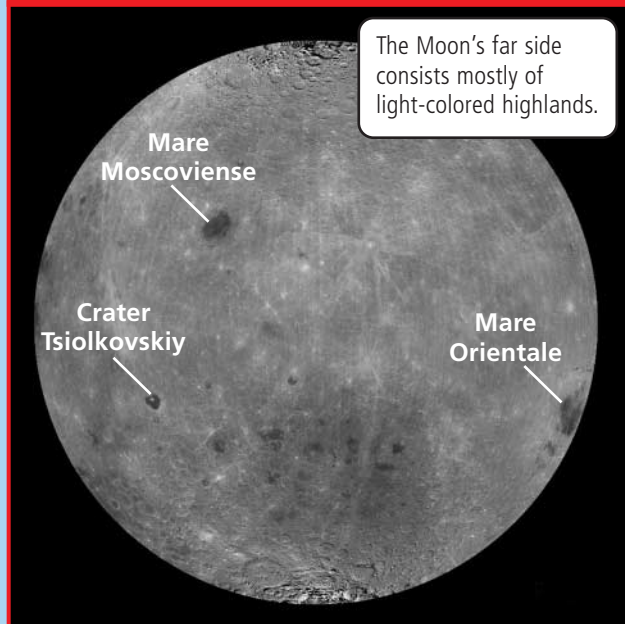
#### Near Side

The Moon's near side has many large, dark-colored maria.



#### Far Side

The Moon's far side consists mostly of light-colored highlands.



## INVESTIGATE Moon Features

### How did the Moon's features form?

In this model, you will use a paper towel to represent the Moon's surface and gelatin to represent molten rock from inside the Moon.

#### PROCEDURE

- 1 Pour about 1 cm of partly cooled liquid gelatin into the cup.
- 2 Hold the paper towel by bringing its corners together. Push the towel into the cup until the center of the towel touches the bottom of the cup. Open the towel slightly.
- 3 Place the cup in the bowl of ice, and allow the gelatin time to solidify.

#### WHAT DO YOU THINK?

- What part of the towel did the gelatin affect?
- When you look down into the cup, what can the smooth areas tell you about heights?

**CHALLENGE** Early astronomers thought there might be oceans on the Moon. How does your model lava resemble an ocean?

#### SKILL FOCUS

Inferring

#### MATERIALS

- liquid gelatin
- clear plastic cup
- paper towel
- bowl of ice

#### TIME

20 minutes



## Moon Rocks

Moon rocks have different ages. Some of the surface rock of the Moon is about 4.5 billion years old—as old as the Moon itself. This very old rock is found in the lunar highlands. The rock in the maria is younger because it formed from lava that solidified later, 3.8–3.1 billion years ago. These two main types of rock and their broken pieces cover most of the Moon's surface. Astronauts explored the Moon and brought back samples of as many different types of material as they could.

Impacts from space objects leave craters, and they also break the surface material into smaller pieces. This breaking of material is called weathering, even though it is not caused by wind and water. Weathered material on the Moon forms a type of dry, lifeless soil. The lunar soil is more than 15 meters (50 ft) deep in some places. Impacts can also toss lunar soil into different places, compact it into new rocks, or melt it and turn it into a glassy type of rock.

The dark-colored rock that formed from lava is called basalt (buh-SAWLT). Lunar basalt is similar to the rock deep beneath Earth's oceans. The basalt of the lunar maria covers large areas but is often only a few hundred meters in depth. However, the basalt can be several kilometers deep at the center of a mare, a depth similar to that of Earth's oceans.

Almost 400 kg (weighing more than 800 lb) of Moon rocks and soil were collected and brought back to Earth by astronauts.



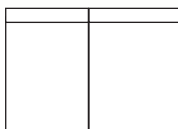
basalt

highland rock

## The Moon has layers.

### COMBINATION NOTES

Remember to take notes and make diagrams when you read about new ideas and terms.

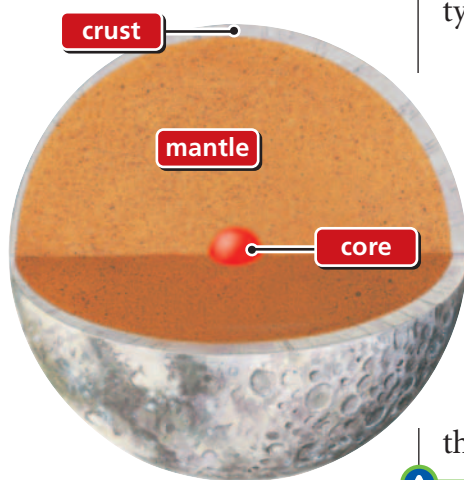


Scientists on Earth have analyzed the lunar rocks and soil to determine their ages and materials. These results told scientists a story about how the Moon changed over time. During an early stage of the Moon's history, impacts happened often and left craters of many different sizes. That stage ended about 3.8 billion years ago, and impacts have happened much less often since then. The highland rocks and soil come from the original surface and impacts. Shortly after the impacts slowed, lava flooded the low-lying areas and formed the maria. Then the flooding stopped. During the last 3 billion years, the Moon has gained new impact craters from time to time but has remained mostly unchanged.

### Structure

Scientists have used information from lunar rocks and other measurements to figure out what is inside the Moon. Beneath its thin coating of crushed rock, the Moon has three layers—a crust, a mantle, and a core. As on Earth, the crust is the outermost layer. It averages about 70 kilometers (about 40 mi) thick and contains the least dense type of rock.

The Moon's interior resembles Earth's interior in several ways.



Beneath the crust is a thick mantle that makes up most of the Moon's volume. The mantle is made of dense types of rock that include the elements iron and magnesium. The basalt on the lunar surface contains these same elements, so scientists infer that the material of the basalt came from the mantle.

In the middle of the Moon is a small core, approximately 700 kilometers (400 mi) across. Although dense, it makes up only a tiny fraction of the Moon's mass. Scientists have less information about the core than the mantle because material from the core did not reach the Moon's surface. The core seems to consist of iron and other metals.



What are your own questions about the Moon?

### Formation

Scientists develop models to help them understand their observations, such as the observed similarities and differences between Earth and the Moon. The two objects have similar structures and are made of similar materials. However, the materials are in different proportions. The Moon has more materials like Earth's crust and mantle and less material like Earth's core.

Scientists have used these facts to develop models of how the Moon formed. A widely accepted model of the Moon's origin involves a giant collision. In this model, an early version of Earth was hit by a

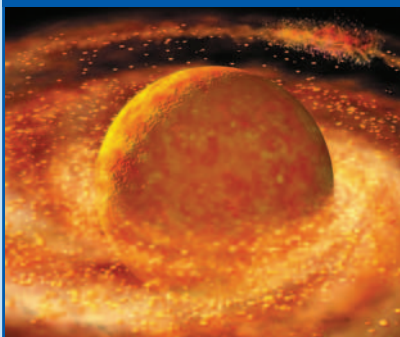
## Formation of the Moon

### Collision



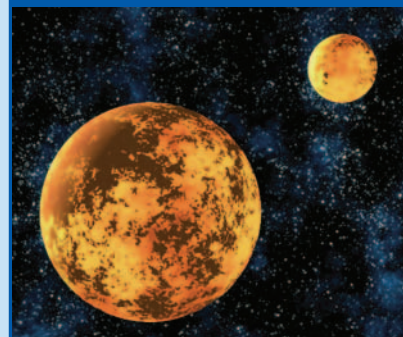
An early version of Earth is struck by a slightly smaller space body.

### Re-Forming



The many pieces pull each other into orbits. Most of the material forms a new version of Earth.

### Earth and Moon



The Moon forms from material that orbits the new version of Earth.

smaller space body. Much of the material from both bodies, especially the cores, combined to form a new version of Earth. The energy of the collision also threw material out, away from Earth. Bits of material from the crusts and mantles of both bodies went into orbit around the new Earth. Much of this orbiting material clumped together and became the Moon. Computer simulations of these events show that the Moon may have formed quickly—perhaps within just one year.

Evidence from fossils and rocks on Earth show that, whether the Moon formed from a giant collision or in some other way, it was once much closer to Earth than it is today. The Moon has been moving slowly away from Earth. It now moves 3.8 centimeters (1.5 in.) farther from Earth each year. However, this change is so slow that you will not notice any difference in your lifetime.

## 20.2 Review

### KEY CONCEPTS

1. How many times does the Moon rotate on its axis during one trip around Earth?
2. What are the dark spots and the light areas on the Moon called?
3. Describe the Moon's layers.

### CRITICAL THINKING

4. **Compare and Contrast** How are the Moon's dark-colored areas different from its light-colored areas?
5. **Draw Conclusions** How have the Moon rocks that astronauts brought back to Earth helped scientists understand the history of the Moon?

### CHALLENGE

6. **Analyze** Scientists use indirect methods to learn about the cores of Earth and the Moon. Imagine you have several Styrofoam balls, some with steel balls hidden inside. Without breaking a ball open, how might you tell whether it contains a steel ball?