

Lesson 2

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- How does the water cycle show interactions of Earth systems?
- How does weather show interactions of Earth systems?
- How does the rock cycle show interactions of Earth systems?

Vocabulary

water cycle p. 87

evaporation p. 88

transpiration p. 88

condensation p. 89


precipitation p. 89

weather p. 90

climate p. 91

rock cycle p. 92

uplift p. 92

 Multilingual eGlossary

 Video **BrainPOP®**

Interactions of Earth Systems

All Systems Go?

A storm is moving from over the ocean toward land. Waves are crashing against the shore. All Earth systems are affected by the storm. How does water in clouds enter the atmosphere? How are Earth systems interacting in this storm?



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Chapter 3

ENGAGE

How do some Earth systems interact?



Earth's systems constantly interact with each other. In this activity, you'll model some common interactions.

- 1 Read and complete a lab safety form.
- 2 Place a **plastic container** on a sheet of **newspaper**. In one end of the container, mold about 5 cups of **soil** into a landform of your choice.
- 3 Hold a **hair dryer** about 20 cm from the model landform. Using the hair dryer set on low, blow air across the model landscape for 1 min. Be careful not to blow the soil out of the container. Record your observations in your Science Journal.
- 4 Using a **spray bottle**, spray water onto your landform. Record your observations.



Think About This

1. How did you use the materials in this activity to model Earth's systems?
2. How could you improve your model? What changes would you make?
3. **Key Concept** Describe how Earth systems interacted in your model.

The Water Cycle

You read that the amount of water on Earth does not change. The water that you drink has been on Earth for a long time. Millions of years ago, a dinosaur might have swallowed the same water that you are drinking today. Or, that water might have raged down a river, flooding an ancient city. How does water move from place to place as time passes?

The **water cycle** is the continuous movement of water on, above, and below Earth's surface. The Sun provides the energy that drives the water cycle and moves water from place to place. As this occurs, liquid water can change state to a gas or a solid and then back again to a liquid. The change of state requires either an input or an output of thermal energy. **Figure 10** illustrates how energy is absorbed during evaporation and released during condensation.

Because the water cycle is continuous, there is no beginning or end. You will start your investigation of the water cycle in the hydrosphere's largest reservoir, the world ocean.

Reading Check What is the source of energy for the water cycle?

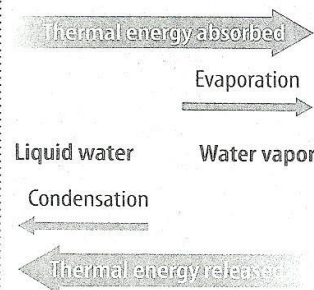


Figure 10 When water changes state from a gas to a liquid, thermal energy is released. Thermal energy is absorbed when liquid water changes into water vapor.

Review

Personal Tutor




Evaporation

When the Sun shines on an ocean, water near the surface absorbs energy and becomes warmer. As a molecule of water absorbs energy, it begins to vibrate faster. When it has enough energy, it breaks away from the other water molecules in the ocean. It rises into the atmosphere as a molecule of gas called water vapor. **Evaporation** is the process by which a liquid, such as water, changes into a gas. Water vapor, like other gases in the atmosphere, is invisible.

Transpiration and Respiration


Oceans hold most of Earth's water, so they are major sources of water vapor. But, water also evaporates from rivers, lakes, puddles, and even soil. These sources, along with oceans, account for 90 percent of the water that enters the atmosphere. Most of the remaining 10 percent is produced by transpiration. **Transpiration** is the process by which plants release water vapor through their leaves.

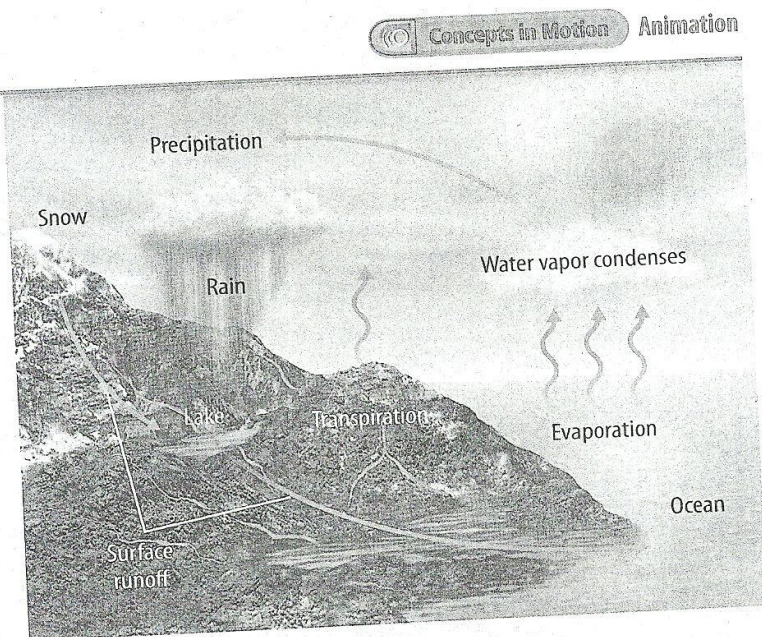
Some water vapor also comes from organisms through cellular respiration. Cellular respiration takes place in many cells. Water and carbon dioxide are produced during cellular respiration. When animals breathe, they release carbon dioxide and water vapor from their lungs into the atmosphere. The blue arrows in Figure 11 show how water vapor enters the atmosphere.

 **Reading Check** How are transpiration and respiration similar? How are they different?

Water Cycle

Figure 11 In the water cycle, water moves through the hydrosphere, the atmosphere, the geosphere, and the biosphere.

 **Visual Check**
Through which processes does water vapor enter the atmosphere?



 Concepts in Motion Animation

Condensation


Recall that the temperatures of the troposphere decrease with increasing altitude. So, as water vapor rises through the troposphere, it becomes cooler. Eventually it loses so much thermal energy that it returns to the liquid state. *The process by which a gas changes to a liquid is **condensation**.* Tiny droplets of liquid water join to form larger drops. When millions of water droplets come together, a cloud forms.

Precipitation

Eventually, drops of water in the clouds become so large and heavy that they fall to Earth's surface. *Moisture that falls from clouds to Earth's surface is **precipitation**.* Rain and snow are forms of precipitation.

More than 75 percent of precipitation falls into the ocean, and the rest falls onto land. Some of this water evaporates and goes back into the atmosphere. Some flows into lakes or rivers, and the rest seeps into soil and rocks.

In the water cycle, water continually moves between the hydrosphere, the atmosphere, the biosphere, and the geosphere. As water flows across the land, it interacts with soil and rocks in the geosphere. You will learn more about these interactions when you read about the rock cycle.


 **Key Concept Check** How do Earth systems interact in the water cycle?

WORD ORIGIN

precipitation
from Latin *praecipitationem*,
means "act or fact of falling
headlong"

MiniLab

20 min


How do plants contribute to the water cycle? 

You have learned how water moves through Earth systems. How does the biosphere contribute to the water cycle?

1. Read and complete a lab safety form.
2. Choose a **potted plant**.
3. Carefully slide the plant into a **self-sealing plastic bag**. Close the bag tightly.
4. Place your bag on a sunny windowsill and leave it undisturbed overnight.
5. Observe the plant and the bag. Record your observations in your Science Journal.



Analyze and Conclude

1. **Recognize** Where did the moisture in the bag come from?
2. **Identify** What process of the water cycle did you model?
3.  **Key Concept** How does your model show interactions among Earth systems?



Math Skills

Use a Formula

The amount of water vapor in air is called vapor density. Relative humidity (RH) compares the actual vapor density in air to the amount of water vapor the air could contain at that temperature. For example, at 15°C, air can contain a maximum of 12.8 g/m^3 of water vapor. If the air contains 10.0 g/m^3 of water vapor, what is the RH?

1. Use the formula:

$$\text{RH} = \left(\frac{\text{actual vapor density}}{\text{maximum vapor density}} \right) \times 100$$

2. Work out the equation.

$$\text{RH} = \left(\frac{10.0 \text{ g/m}^3}{12.8 \text{ g/m}^3} \right) \times 100$$

$$\text{RH} = 0.781 \times 100 = 78.1\%$$

Practice

At 0°C, air can contain 4.85 g/m^3 of water vapor. Assume the actual water vapor content is 0.970 g/m^3 . What is the RH?

Review

- Math Practice
- Personal Tutor

Changes in the Atmosphere

The atmosphere is continually changing. These changes take place mainly within the troposphere, which contains most of the gases in the atmosphere. Some changes occur within hours or days. Others can take decades or even centuries.

Weather

When you wake up in the morning and get ready for school, you might look outside to check the weather. **Weather** is the state of the atmosphere at a certain time and place. In most places, the weather changes to some degree every day. How do scientists describe weather and its changes?

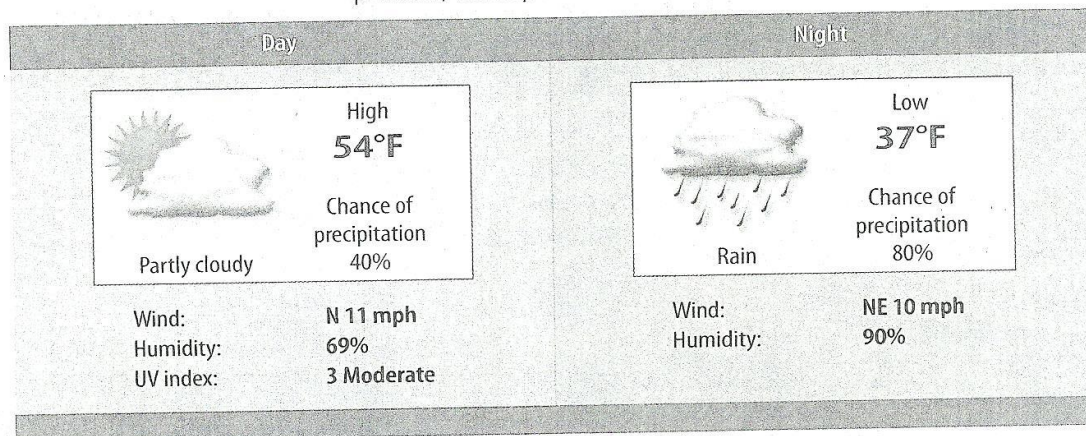
Describing Weather Scientists use several factors to describe weather, as shown in Figure 12. Air temperature is a measure of the average amount of energy produced by the motion of air molecules. Air pressure is the force exerted by air molecules in all directions. Wind is the movement of air caused by differences in air pressure. Humidity is the amount of water vapor in a given volume of air. High humidity makes it more likely that clouds will form and precipitation will fall.

Interactions Weather is influenced by conditions in the atmosphere, the geosphere, and the hydrosphere. For example, air masses take on the characteristics of the area over which they form. So, an air mass that forms over a cool ocean will bring cool, moist air. In addition to these interactions, the hydrosphere provides much of the water for cloud formation and precipitation. Warm tropical waters provide the thermal energy that produces hurricanes.



Key Concept Check How does weather show interactions of Earth systems?

Figure 12 Scientists describe weather using air temperature and pressure, wind speed and direction, and humidity.



Climate

The weather in the area where you live might change each day, but weather patterns can remain nearly the same from season to season. For example, the weather might differ each day in the summer. But overall, summer is warm. These weather patterns are called climate. **Climate** is the average weather pattern for a region over a long period of time. Earth has many climates. Climates differ in part because of interactions between the atmosphere and other Earth systems.


 **Reading Check** How does weather differ from climate?

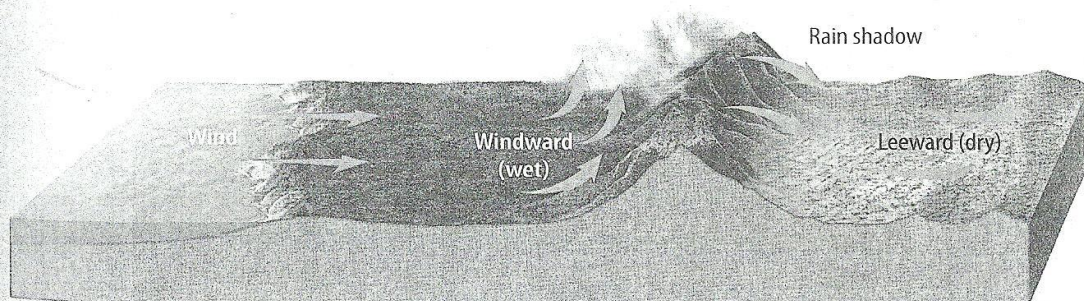
Mountains Recall that air temperature decreases with altitude. So the climate near the top of a mountain often is cooler than the climate near the mountain's base. Mountains also can affect the amount of precipitation an area receives—a phenomenon known as the rain-shadow effect. As shown in **Figure 13**, warm, wet air rises and cools as it moves up the windward side of a mountain. Clouds form and precipitation falls, giving this side of the mountain a wet climate. The air, now dry, continues to move over the mountain's peak and down the leeward side of the mountain. This side of the mountain often has a dry climate.

Ocean Currents As wind blows over an ocean, it creates surface currents in the water. Surface currents are like rivers in an ocean—the water flows in a predictable pattern. These currents transport thermal energy in water from place to place. For example, the Gulf Stream carries warm waters from tropical regions to northern Europe, making the climate of northern Europe warmer than it would be without these warm water currents.

Rain-Shadow Effect

Figure 13 Moist air on the windward side of mountains cools as it rises. Rain falls on this side of the mountain, resulting in a wet climate. This leaves little precipitation for the leeward side of the mountain, resulting in a dry climate.

 **Visual Check** How can mountains affect the amount of precipitation an area receives?



SCIENCE USE V. COMMON USE

pressure

Science Use the force exerted over an area

Common Use the burden of physical or mental distress



Weathering and Erosion

Rocks on Earth's surface are exposed to the atmosphere, the hydrosphere, and the biosphere. Glaciers, wind, and rain, along with the activities of some organisms, break down rocks into sediment. This **process** is called weathering. In Figure 14, weathering is shown in the mountains, where uplift has exposed rocks. Weathering of rocks into sediments is often accompanied by erosion. Erosion occurs when the sediments are carried by agents of erosion—water, wind, or glaciers—to new locations.

Deposition

Eventually, agents of erosion lose their energy and slow down or stop. When this occurs, eroded sediments are deposited, or laid down, in new places. Deposition forms layers of sediment. Over time, more and more layers are deposited.


Compaction and Cementation

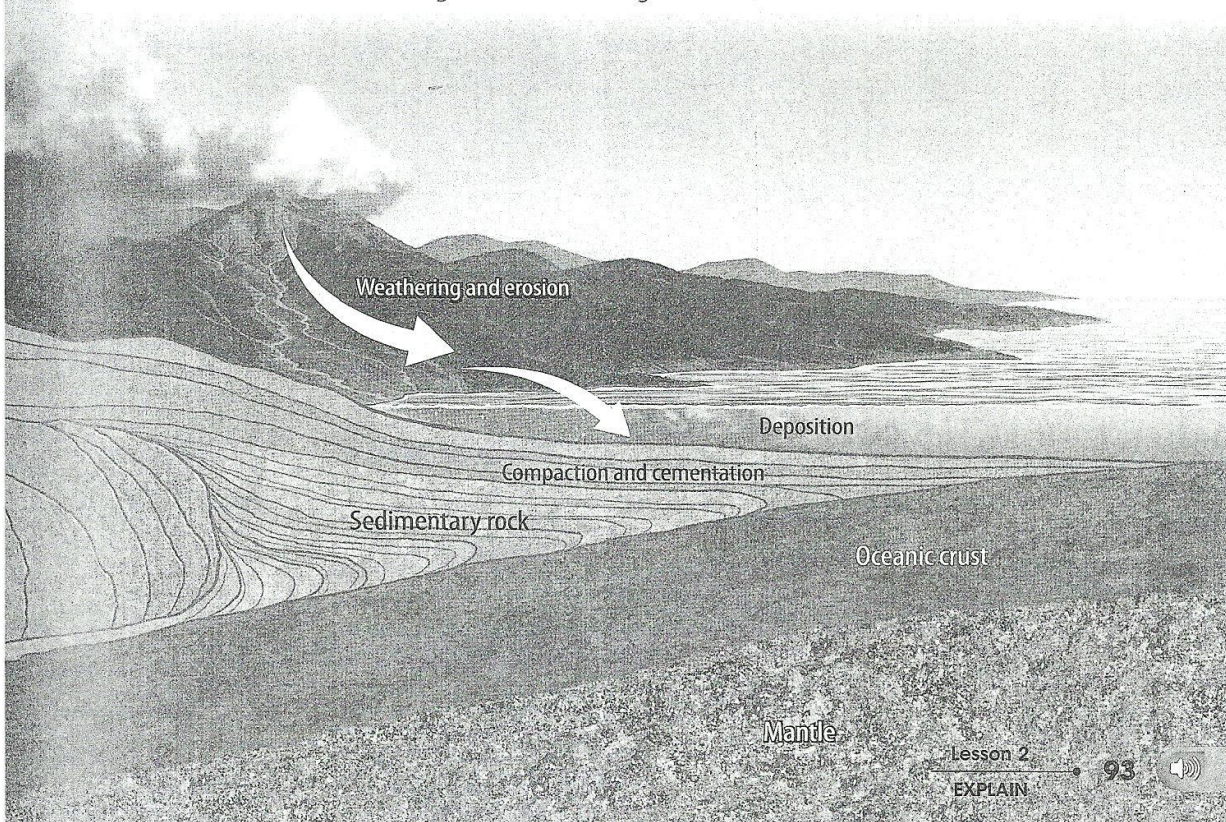
As more layers of sediment are deposited, their weight pushes down on underlying layers. The deeper layers are compacted. Minerals dissolved in surrounding water crystallize between grains of sediment and cement the sediments together. Compaction and cementation produce sedimentary rocks.

ACADEMIC VOCABULARY

process

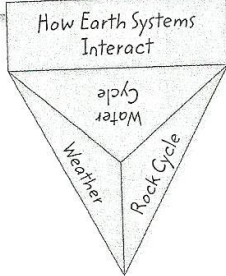
(noun) a natural phenomenon marked by gradual changes that lead toward a particular result

 **Visual Check** How do weathering and erosion change rocks?



FOLDABLES®

Make a pyramid book, and label it as shown. Use it to organize your notes on Earth-system interactions including the water cycle, the rock cycle, and weather.



High Temperatures and Pressure

Metamorphic rocks form when rocks are subjected to high temperatures and pressure. This usually occurs far beneath Earth's surface. Igneous, sedimentary, and even metamorphic rocks can become new metamorphic rocks. Then, uplift can bring the rocks to the surface. There, the rocks are broken down and continue moving through the rock cycle.

Most interactions between the geosphere, the hydrosphere, and the atmosphere occur on Earth's surface. The atmosphere and hydrosphere alter rocks in the geosphere, and the geosphere in turn alters the other Earth systems. For example, energy from the Sun reaches Earth. The energy is reflected by Earth's surface and heats the atmosphere.

These are just a few examples of different interactions among Earth's systems. You have read about four different Earth systems in this chapter. But as Figure 15 shows, the systems interact and function together as one unified system—planet Earth.


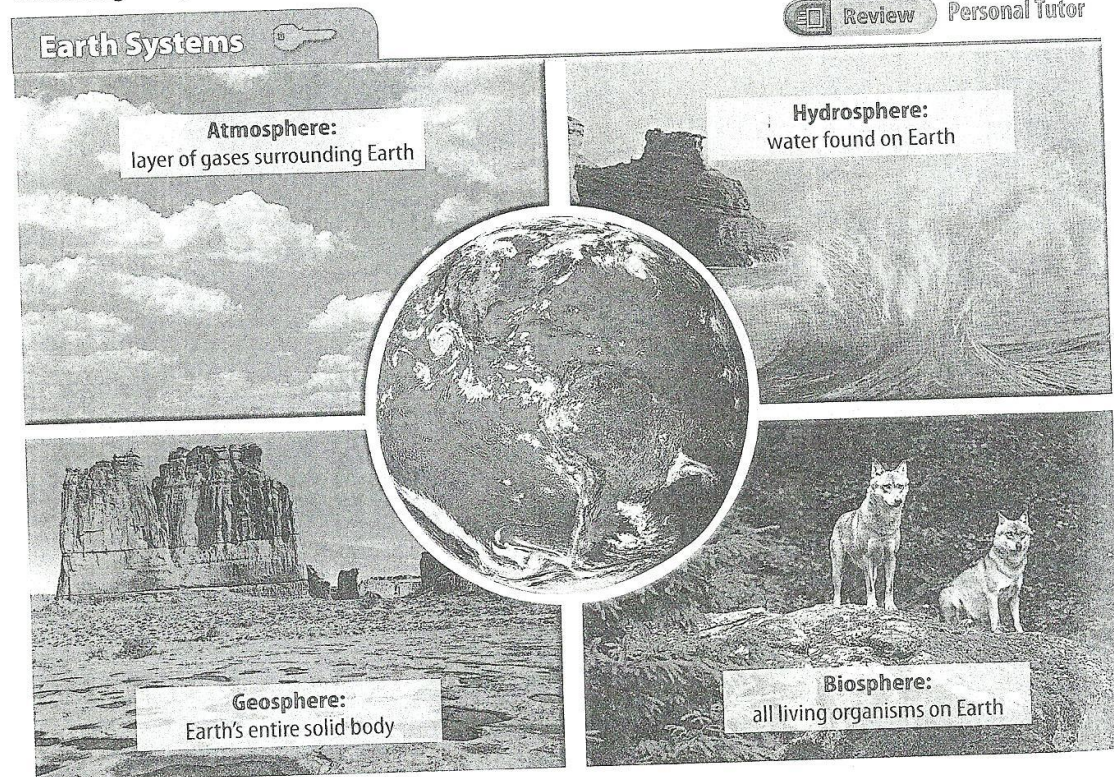
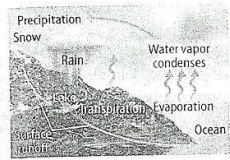
 **Key Concept Check** How do Earth systems interact in the rock cycle?

Figure 15 Earth is a unified system made of four interacting subsystems.

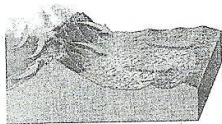


Lesson 2 Review

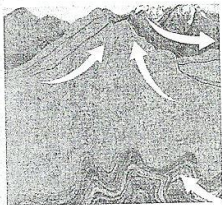
Visual Summary



In the water cycle, water continually moves through the hydrosphere, the atmosphere, the geosphere, and the biosphere.



Weather and climate are influenced by interactions between the atmosphere and the other Earth systems.



In the rock cycle, rocks continually change from one form to another.

FOLDABLES

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

4. The water cycle begins in the ocean.
5. Earth's air contains solids, liquids, and gases.
6. Rocks are made of minerals.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

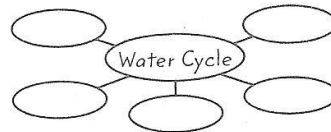
- 1 **Distinguish** between weather and climate.
- 2 **Define** the *water cycle* in your own words.
- 3 The process that changes liquid water to water vapor is _____.

Understand Key Concepts

- 4 Which is an example of an interaction between the atmosphere and the geosphere?
 - A. breathing
 - B. ocean currents
 - C. storms
 - D. weathering
- 5 **Outline** Make an outline about the rock cycle. Include information about processes, rock types, and interactions with Earth systems.
- 6 **Compare** how the hydrosphere affects weather and how it affects climate.

Interpret Graphics

- 7 **Organize Information** Copy and fill in the graphic organizer below. Identify the processes of the water cycle.



Critical Thinking

- 8 **Design** a model that shows an interaction between two Earth systems.
- 9 **Assess** Some gasoline was spilled in a driveway. Could the pollutant pose a problem for the hydrosphere? Why or why not?

Math Skills

Review

Math Practice

- 10 Air at 20°C has a vapor density of 8.65 g/m³. The maximum amount of vapor density at that temperature is 17.3 g/m³. What is the relative humidity?