Weather

Weather Patterns

Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	3. Precipitation often occurs at the boundaries of large air masses.	
	4. There are no safety precautions for severe weather, such as tornadoes and hurricanes.	

Read to Learn

Pressure Systems

Weather is often associated with pressure systems. Air pressure is the weight of the molecules in a large mass of air. Cool air molecules are closer together than warm air molecules. Cool air masses have high pressure, or more weight, than warm air masses do. Warm air masses have low pressure.

A **high-pressure system** *is a large body of circulating air with high pressure at its center and lower pressure outside of the system.* Air moves from high pressure to low pressure. Heavy, high-pressure air inside the system moves away from the center. Air moving from areas of high pressure to areas of low pressure is called wind. The dense air inside the high pressure system sinks and brings clear skies and fair weather.

A **low-pressure system** *is a large body of circulating air with low pressure at its center and higher pressure outside of the system.* Air on the outside of the system will spiral in toward the center. This causes air inside the low-pressure system to rise. The rising air cools and the water vapor condenses. Clouds form, and sometimes precipitation, such as rain or snow, also forms.

Key Concepts

- What are two types of pressure systems?
- What drives weather patterns?
- Why is it useful to understand weather patterns?
- What are some examples of severe weather?

Study Coach

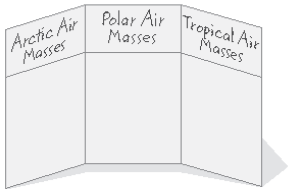
Learning with Graphics Maps, diagrams, charts, and graphs can help you understand what you've read. Trace the details on each graphic with your finger after you read the description.

Key Concept Check

1. Compare and contrast two types of pressure systems.

FOLDABLES®

Make a three-column book from a sheet of paper and record information about types of air masses.



Air Masses

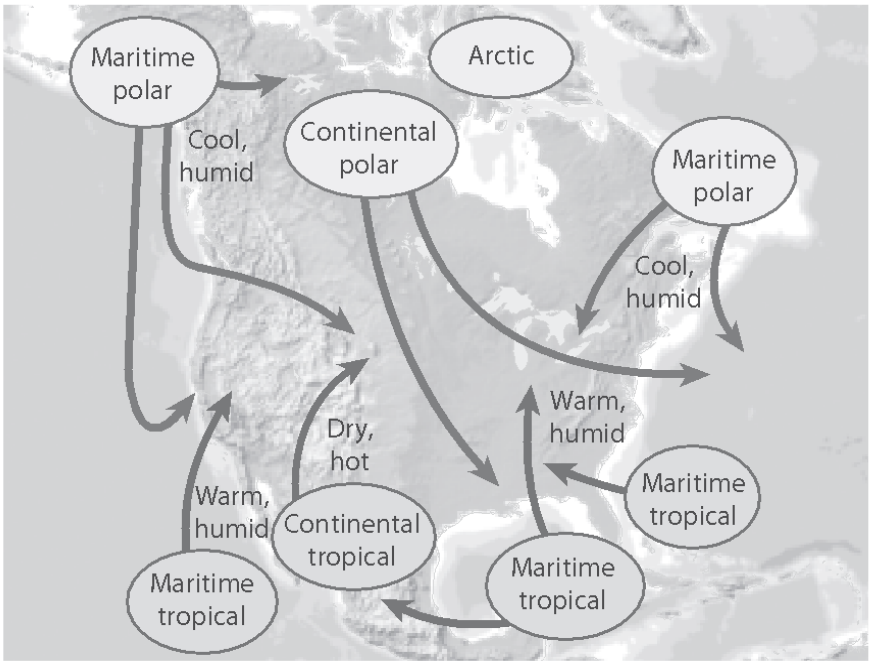
Have you ever noticed that the weather sometimes stays the same for several days in a row? Air masses are responsible for this. **Air masses** *are large bodies of air with distinct temperature and moisture characteristics*. An air mass forms when a large, high-pressure system stays over an area for several days. The air circulating in the high-pressure system comes in contact with Earth. This air takes on the temperature and moisture characteristics of the surface below it.

Air masses, like high- and low-pressure systems, can extend for a thousand kilometers or more. Sometimes one air mass covers most of the United States. Air masses affect weather patterns.

Air Mass Classification

The figure below identifies types of air masses and the regions where they form. The arrows on the map show the general paths that the air masses commonly follow. Air masses are classified by their temperature and moisture characteristics. Air masses that form over land are called continental air masses. Air masses that form over water are called maritime air masses. Air masses that form near the equator are called tropical air masses. Those air masses that form in cold regions are called polar air masses. Air masses that form near the poles are called arctic and antarctic air masses.

Air Mass Classifications



Visual Check

2. Classify Where does continental polar air come from?

Arctic Air Masses Arctic air masses form over Siberia and the Arctic. These air masses contain bitterly cold, dry air. During the winter, an arctic air mass can bring temperatures to −40°C.

Continental Polar Air Masses Land cannot transfer as much moisture to the air as oceans can. Thus, air masses that form over land are drier than air masses that form over oceans. Continental polar air masses are fast moving. They bring cold temperatures in winter and cool temperatures in summer. Polar air masses that affect North America often form over Alaska and Canada.

Maritime Polar Air Masses Air masses that form over the northern Atlantic and Pacific Oceans are maritime polar air masses. These air masses are cold and humid. Maritime polar air masses often bring cloudy, rainy weather.

Continental Tropical Air Masses Air masses forming in the tropics over dry, desert land are continental tropical air masses. These hot and dry air masses bring clear skies and high temperatures. Continental tropical air masses usually form only during summer.

Maritime Tropical Air Masses These air masses form over the Gulf of Mexico, the Caribbean Sea, and the eastern Pacific Ocean. Maritime tropical air masses are moist air masses. They bring hot, humid air to the southeastern United States in summer. In winter, they can bring heavy snowfall.

Air masses can change as they move over the land and ocean. Warm, moist air can lose its moisture and become cool. Cold, dry air can move over water and become moist and warm.

Fronts

In 1918, Norwegian Jacob Bjerknes (BYURK nuhs) and his coworkers developed a new method for forecasting the weather. Bjerknes noticed that specific types of weather occur at the boundaries between different air masses. He used the word *front,* a military term, to describe this boundary.

A military front is the boundary between opposing armies. *A weather* **front** *is the boundary between two air masses.* As wind carries an air mass away from the area where it formed, the air mass will eventually bump into another air mass. Major weather changes often occur at fronts. Changes in temperature, humidity, cloud types, wind, and precipitation are common at fronts.

Math Skills

To convert Fahrenheit (°F) units to Celsius (°C) units, use this equation:

$$°C = \frac{(°F - 32)}{1.8}$$

Example: Covert 76°F to °C.

a. Always perform the operation in parentheses first.

$(76°F - 32 = 44°F)$

b. Divide the answer from Step a by 1.8.

$$\frac{(44°F)}{1.8} = 24°C$$

To convert Celsius (°C) units to Fahrenheit (°F) units, use this equation:

$$°F = (°C \times 1.8) + 32$$

3. Conversions

a. Convert 86°F to °C.

_____

b. Convert 37°C to °F.

_____

Key Concept Check

4. Describe What drives weather patterns?

_____

_____

_____

Cold Fronts

The figure below on the left shows a cold front. A cold front forms when a colder air mass moves toward a warmer air mass. Cold air is denser than warm air. As a result, the cold air pushes underneath the warm air mass. The warm air rises and begins to cool. Water vapor in the air condenses, and clouds form. Rain showers and thunderstorms often form along cold fronts. It is common for temperatures to decrease. The wind becomes gusty and changes direction. In many cases, cold fronts give rise to severe storms.

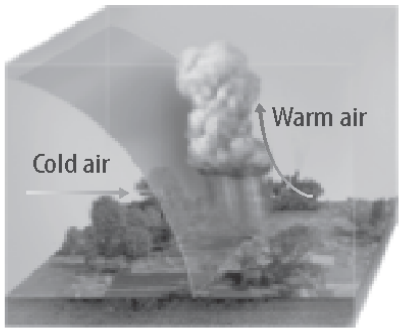
Reading Check

5. Specify What types of weather are associated with cold fronts?

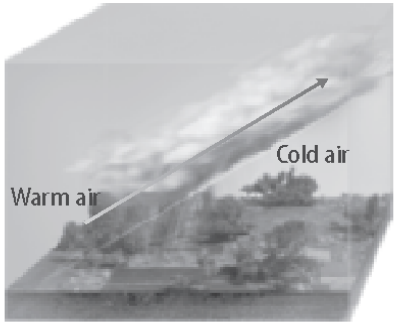
Warm Fronts

The figure on the right shows a warm front. A warm front forms when less dense, warmer air moves toward colder, denser air. The warm air rises above the cold air mass. When the water vapor in the warm air condenses, a wide blanket of clouds forms. These clouds often bring steady rain or snow for several hours or days. A warm front brings warmer temperatures and causes the wind to shift directions.

Cold Front



Warm Front



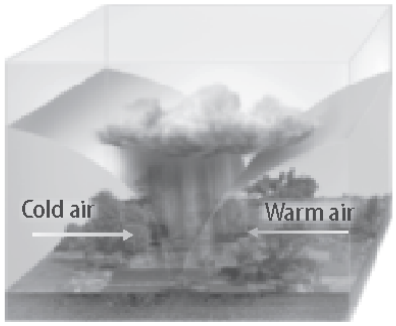
Visual Check

6. Describe the difference between a cold front and a warm front.

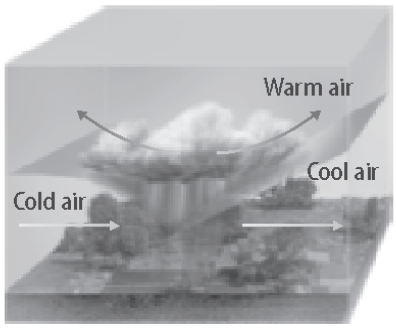
Stationary and Occluded Fronts

In addition to cold fronts and warm fronts, meteorologists have identified stationary fronts and occluded fronts. These two types of fronts are illustrated below and described on the next page.

Stationary Front



Occluded Front



Visual Check

7. Contrast Highlight the label "Warm air" in both of the figures. How is the location of warm air different in the two types of fronts?

Stationary Front Sometimes an approaching front stalls, or stops, for several days. Warm air is located on one side of the front and cold air on the other side. When the boundary between two air masses stalls, the front is called a stationary front. Cloudy skies and light rain are common along stationary fronts.

Occluded Front Cold fronts move faster than warm fronts. When a fast-moving cold front catches up with a slow-moving warm front, an occluded, or blocked, front forms. Occluded fronts usually bring precipitation.

Severe Weather

Severe weather can cause major damage, injuries, and death. Types of severe weather include thunderstorms, tornadoes, hurricanes, and blizzards.

Thunderstorms

Thunderstorms are also known as electrical storms because of their lightning. Thunderstorms have warm temperatures, moisture, and rising air. A low-pressure system brings these conditions. Thunderstorms can form quickly. For example, a cumulus cloud can grow into a 10-km-tall thundercloud in as little as 30 minutes.

A typical thunderstorm has three stages. During the cumulus stage, clouds form and updrafts occur. Updrafts are air currents that move vertically up from the ground. After the cumulus cloud has been created, downdrafts begin to appear. Downdrafts are air currents that move vertically down toward the ground. In the mature stage, heavy winds, rain, and lightning occur. Within 30 minutes of reaching the mature stage, the thunderstorm begins to fade, or dissipate. In the dissipation stage, updrafts stop, winds die down, lightning stops, and precipitation weakens.

Strong updrafts and downdrafts in a thunderstorm cause tiny ice crystals to crash into each other. This creates positively and negatively charged particles in the cloud. The difference between the charges of the particles in the cloud and the charges of the particles on the ground creates electricity. This electricity is seen as a bolt of lightning. Lightning can heat the nearby air to more than 27,000°C.

Lightning can move from cloud to cloud, cloud to ground, or ground to cloud. The extreme thermal energy from the lightning causes air molecules to rapidly expand and then contract. Thunder is the sound made by the rapid expansion and contractions of the air molecules.

Key Concept Check

8. Interpret Why is it useful to understand weather patterns associated with fronts?

Reading Check

9. Identify At which stage of the thunderstorm can you expect it to begin to die down? (Circle the correct answer.)

a. the cumulus stage

b. the mature stage

c. the dissipation stage

Think it Over

10. Apply What causes molecules in the air near lightning to make the sound known as thunder?

Tornadoes

A **tornado** *is a violent, whirling column of air in contact with the ground.* Most tornadoes have a diameter of several hundred meters. The largest tornadoes are more than 1,500 m in diameter.

Wind speeds within a tornado can reach more than 400 km/h. The strong, swirling wind in a tornado can send cars, trees, and houses flying through the air. Most tornadoes last only a few minutes. The more destructive ones, however, can last for several hours.

Formation of Tornadoes A tornado forms when thunderstorm updrafts begin to rotate. Swirling winds spiral downward from the base of the thunderstorm. This creates a funnel cloud. When the funnel reaches the ground, it becomes a tornado. Swirling air is invisible. The funnel cloud you see is the dirt and debris lifted by the tornado.

Tornado Alley More tornadoes occur in the United States than anywhere else on Earth. The most tornadoes occur in an area in the central United States. This area has been named Tornado Alley. It extends from Nebraska to Texas. In Tornado Alley, cold air blowing southward from Canada often bumps into warm, moist air moving northward from the Gulf of Mexico. These conditions are ideal for severe thunderstorms and tornadoes.

Classifying Tornadoes Dr. Ted Fujita developed a system for classifying the strength of tornadoes. Tornadoes are classified on the Fujita intensity scale based on the damage they cause. F0 tornadoes cause little damage. Damage might include broken tree branches and damaged billboards. F1 through F4 tormadoes cause moderate to devastating damage. F5 tornadoes cause incredible damage. Concrete and steel buildings can be destroyed. F5 tornados can pull bark from trees.

Reading Check

11. Explain How do tornadoes form?

_____

_____

_____

Think it Over

12. Apply Would you expect an F4 tornado to cause more damage or less damage than an F3 tornado?

_____

Hurricanes

Hurricanes are the most destructive storms on Earth. *A* **hurricane** *is an intense tropical storm with winds exceeding 119 km/h.* Hurricanes typically form in late summer over warm, tropical ocean water.

Hurricanes, like tornadoes, have strong, swirling winds. A hurricane is much larger than a tornado. A typical hurricane is 480 km across, more than 150 thousand times larger than a tornado. At the center of a hurricane is the eye. The eye is an area of clear skies and light winds.

WORD ORIGIN

hurricane
from Spanish *huracan,* means "tempest"

Hurricane Formation

1. Low-Pressure Area	2. Tropical Depression	3. Tropical Storm	4. Hurricane
Warm, moist air rises. As air rises, it cools. Water vapor condenses and clouds form. More rising air creates an area of low pressure over the ocean.	Air moves toward the low pressure in the center. The center begins to rotate. The storm becomes a tropical depression with winds of 37–62 km/h.	Air continues to rise and rotate. The storm builds to a tropical storm with winds of more than 63 km/h. The storm produces strong thunderstorms.	When winds exceed 119 km/h, the storm becomes a hurricane. Only one percent of tropical storms become hurricanes.

The figure above shows how a hurricane forms. Damage from hurricanes occurs as the result of strong winds and flooding. Hurricanes create high waves that can flood coastal areas. As a hurricane crosses the coastline, strong rains contribute to flooding that can damage or destroy entire areas. Once a hurricane moves over land or colder water, it loses energy and dies out. In Asia, this type of storm is called a typhoon. In Australia, it is called a tropical cyclone.

Visual Check

13. Identify How do hurricanes form?

Winter Storms

Winter weather can be severe. When temperatures are close to freezing (0°C), rain can freeze when it hits the ground. Ice storms coat the ground, trees, and buildings with a layer of ice. The weight of the ice can break trees and power lines.

A **blizzard** *is a violent winter storm characterized by freezing temperatures, strong winds, and blowing snow.* The blowing snow can reduce visibility to a few meters or less. Strong winds and cold temperatures can rapidly cool exposed skin. The loss of body heat can result in frostbite and hypothermia (hi poh THER mee uh), a dangerous condition in which a person's body temperature is lowered.

Key Concept Check

14. Summarize What are examples of severe weather?

Severe Weather Safety

The U.S. National Weather Service issues watches and warnings for severe weather. A watch means that severe weather is possible. A warning means that severe weather is already occurring. Paying attention to watches and warnings is important and could save your life.

During thunderstorms, stay inside and away from metal objects and electrical cords. If you are outside, stay away from water, high places, and trees that stand alone. When wind-chill temperatures are below −20°C, dress in layers, keep your head and fingers covered, and limit your time outdoors.

After You Read

Mini Glossary

air mass: a large body of air with distinct temperature and moisture characteristics

blizzard: a violent winter storm characterized by freezing temperatures, strong winds, and blowing snow

front: a boundary between two air masses

high-pressure system: a large body of circulating air with high pressure at its center and lower pressure outside of the system

hurricane: an intense tropical storm with winds exceeding 119 km/h

low-pressure system: a large body of circulating air with low pressure at the center and higher pressure outside of the system

tornado: a violent, whirling column of air in contact with the ground

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains how an air mass and a front are related.

2. Use the terms below to complete the chart about air masses.

arctic
continental polar
continental tropical
maritime polar
maritime tropical

Air masses that form over . . .	are . . .
warm ocean water	(a) air masses.
warm land	(b) air masses.
cold land	(c) air masses.
the coldest areas	(d) air masses.
cold ocean water	(e) air masses.

3. Describe how tracing the details on a graphic helped you better understand one of the processes described in this lesson.

What do you think NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?

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Log on to ConnectED.mcgraw-hill.com and access your textbook to find this lesson's resources.

END OF LESSON