CHAPTER

17 Weather Fronts and Storms

the BIG idea

The interaction of air masses causes changes in weather.

Key Concepts

SECTION 1 **Weather changes as air masses move.**
Learn about air masses, fronts, and high- and low-pressure systems.

SECTION 2 **Low-pressure systems can become storms.**
Learn about hurricanes and winter storms.

SECTION 3 **Vertical air motion can cause severe storms.**
Learn about thunderstorms, lightning, and tornadoes.

SECTION 4 **Weather forecasters use advanced technologies.**
Learn about different types of weather data and how forecasters predict weather.

Internet Preview

CLASSZONE.COM

Chapter 17 online resources: Content Review, two Visualizations, two Resource Centers, Math Tutorial, Test Practice

What types of weather can move a house?

EXPLORE the BIG idea

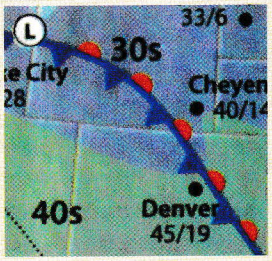
How Does Cold Air Move?

Hold one hand near the top of a refrigerator door and the other hand near the bottom. Open the refrigerator door just a little bit.

Observe and Think
How did each hand feel before and after you opened the door? How did the air move?

How Does Weather Move?

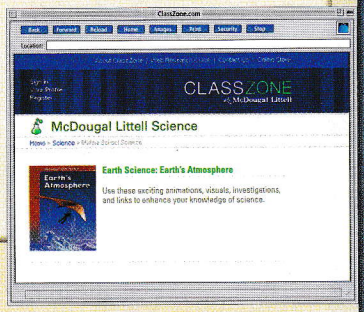
Collect newspaper weather maps for three consecutive days. Identify at least one flagged line on a map (identifying a weather front) and track the line's movement over the three days.



Observe and Think
What type of weather did you find each day where the line passed? Why did this line move the way it did?

Internet Activity: Weather Safety

Go to **ClassZone.com** to find information about weather safety. Find out the types of dangerous weather that may affect your region.



Observe and Think
What can you do ahead of time to be ready for severe weather?

NSTA scilinks.org SCILINKS
Severe Weather **Code: MDL011**

CHAPTER 17

Getting Ready to Learn

CONCEPT REVIEW

- Air temperature decreases as you rise in the troposphere.
- Temperature affects air density.
- Pressure differences make air move.
- Uneven heating of Earth's surface produces winds.
- Clouds form as air rises, expands, and cools.

VOCABULARY REVIEW

altitude p. 506
convection p. 515
evaporation p. 552
condensation p. 552
relative humidity p. 554

CONTENT REVIEW
CLASSZONE.COM
Review concepts and vocabulary.

TAKING NOTES

MAIN IDEA WEB

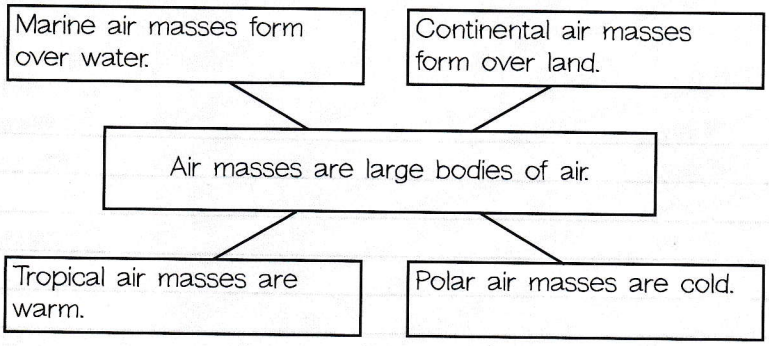
Write each new blue heading—a main idea—in a box. Then put notes with important terms and details into boxes around the main idea.

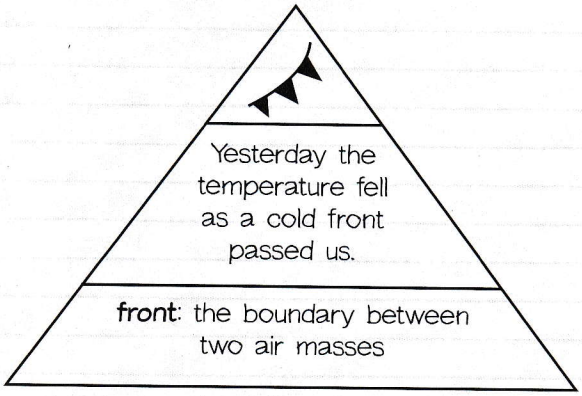
VOCABULARY STRATEGY

Draw a **word triangle** diagram for each new vocabulary term. In the bottom row write and define the term. In the middle row, use the term correctly in a sentence. At the top, draw a small picture to help you remember the term.

See the Note-Taking Handbook on pages R45–R51.

SCIENCE NOTEBOOK





KEY CONCEPT

17.1 Weather changes as air masses move.

BEFORE, you learned

- Air pressure changes with location and altitude
- Water vapor in the atmosphere condenses when air rises

NOW, you will learn

- What air masses are
- What happens when air masses meet
- How pressure systems affect the weather

VOCABULARY

air mass p. 575
front p. 578
high-pressure system p. 580
low-pressure system p. 581

EXPLORE Air Masses

How does an air mass form?

PROCEDURE

1. Put ice into one bowl and warm water into a second bowl. Leave the third bowl empty.
2. Place each bowl in a different box and cover the box with plastic wrap. Wait a few minutes.
3. Put your hand into each box in turn.

WHAT DO YOU THINK?

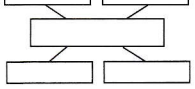
- How would you describe the air in each box?
- Which box's air feels the most humid? Why?

MATERIALS

- 3 bowls
- ice
- warm water
- 3 shoeboxes
- plastic wrap

Air masses are large bodies of air.

MAIN IDEA WEB
Organize important terms and details about air masses.

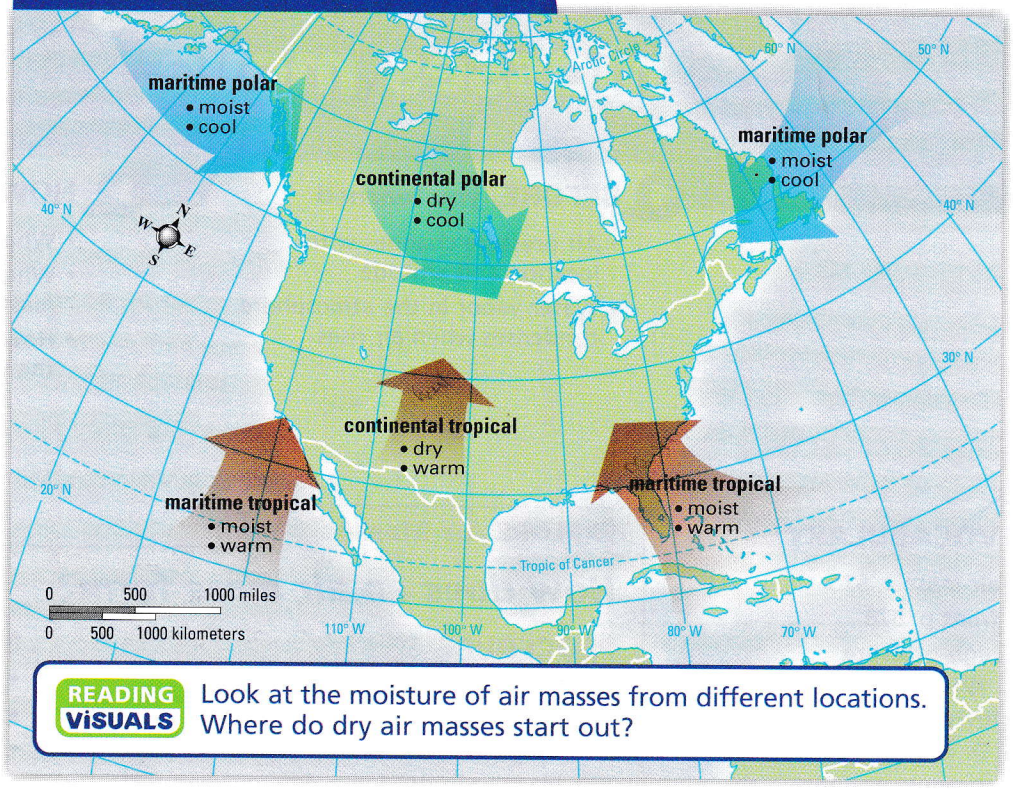


You have probably experienced the effects of air masses—one day is hot and humid, and the next day is cool and pleasant. The weather changes when a new air mass moves into your area. An **air mass** is a large volume of air in which temperature and humidity are nearly the same in different locations at the same altitude. An air mass can cover many thousands of square kilometers.

An air mass forms when the air over a large region of Earth sits in one place for many days. The air gradually takes on the characteristics of the land or water below it. Where Earth's surface is cold, the air becomes cold. Where Earth's surface is wet, the air becomes moist. As an air mass moves, it brings its temperature and moisture to new locations.

CHECK YOUR READING Explain how the weather can change with the arrival of a new air mass. Your answer should include two ways that weather changes.

North American Air Masses



READING VISUALS Look at the moisture of air masses from different locations. Where do dry air masses start out?

Characteristics of an Air Mass

Some regions of Earth's surface, such as those shown in the map above, produce air masses again and again. The characteristics of an air mass depend on the region where it forms. A hot desert produces dry, hot air masses, while cool ocean waters produce moist, cool air masses. Scientists classify air masses into categories according to the characteristics of regions. Each category name is made of two words—one for moisture, one for temperature.

The first word of an air mass's category name tells whether the air mass formed over water or dry land. It describes the moisture of the air mass.

- **Continental** air masses form over land. Air becomes dry as it loses its moisture to the dry land below it.
- **Maritime** (MAR-ih-TYM) air masses form over water. Air becomes moist as it gains water vapor from the water below it.

The second word of a category name tells whether an air mass formed close to the equator. It describes the air mass's temperature.

- **Tropical** air masses form near the equator. Air becomes warm as it gains energy from the warm land or water.
- **Polar** air masses form far from the equator. Air becomes cool as it loses energy to the cold land or water.

READING TiP

The word *maritime* has the same root as the word *marine*. Both come from the Latin word *mare*, which means "sea."

The combination of words gives the characteristics of the air mass. A maritime tropical air mass is moist and warm, while a continental polar air mass is dry and cold.

CHECK YOUR READING What can you tell from each word of an air mass's name?

Movement of an Air Mass

Air masses can travel away from the regions where they form. They move with the global pattern of winds. In most of the United States, air masses generally move from west to east. They may move along with the jet stream in more complex and changing patterns.

When an air mass moves to a new region, it carries along its characteristic moisture and temperature. As the air moves over Earth's surface, the characteristics of the surface begin to change the air mass. For example, if a continental polar air mass moves over warm water, the air near the surface will become warmer and gain moisture. These changes begin where the air touches the surface. It may take days or weeks for the changes to spread upward through the entire air mass. An air mass that moves quickly may not change much. If it moves quickly enough, a continental polar air mass can move cold air from northern Canada all the way to the southern United States.

INVESTIGATE Air Masses

What happens when air masses collide?

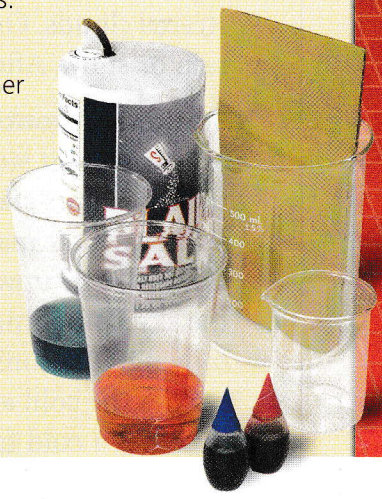
SKILL FOCUS
Inferring

MATERIALS
- 500 mL beaker
- stiff cardboard
- scissors
- 2 cups
- small beaker for measuring
- salt
- water
- food coloring

TIME
25 minutes

PROCEDURE

1. Cut the cardboard to create a snug barrier that divides your beaker in half.
2. Mix about 5 mL of salt, 50 mL of water, and a drop of blue food coloring in one cup. This dense mixture represents a cold air mass.
3. Mix 50 mL of water with a drop of red food coloring in the other cup. This less-dense mixture represents a warm air mass.
4. Carefully pour the red water into one side of your divided beaker and the blue saltwater into the other side. As you look through the side of the beaker, quickly remove the barrier.



WHAT DO YOU THINK?
- What happened when the two liquids met?
- To what extent did the liquids mix together?

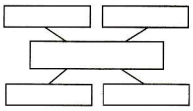
CHALLENGE How are the liquids like air masses?

Weather changes where air masses meet.

When a new air mass moves over your area, you can expect the weather to change. Perhaps you have heard a weather forecaster talk about fronts. A **front** is a boundary between air masses. The weather near a front can differ from the weather inside the rest of an air mass. As one air mass pushes another, some of the air at the boundary will be pushed upward. Clouds can form in this rising air. The weather often becomes cloudy or stormy as a front passes. Afterward, you experience the temperature and humidity of the air mass that has moved in.

Fronts and Weather

MAIN IDEA WEB
Organize the notes you take about fronts.



Different types of fronts produce different patterns of weather. When a cold, dense air mass pushes warmer air, it produces a cold front. When a warm air mass pushes colder air, it produces a warm front. These names tell you which way the temperature will change but not how much it will change. A cold front can turn a heat wave into normal summer weather or turn cold winter air into very cold weather.

CHECK YOUR READING How would the weather change if a cold front moved into your area?

1. **Cold fronts** can move into regions quickly. As you can see on page 579, a cold front is steeper than the other types of fronts. As a mass of cold, dense air moves forward, warmer air ahead of it is pushed upward. Water vapor in the warm air condenses as the air rises. Cold fronts often produce tall cumulonimbus clouds and precipitation. Brief, heavy storms are likely. After the storms, the air is cooler and often very clear.

2. **Warm fronts** move more slowly than cold fronts. Warm air moves gradually up and over a mass of denser and colder air. Moisture in the warm air condenses all along the sloping front, producing cloud-covered skies. As a warm front approaches, you may first see high cirrus clouds, then high stratus clouds, then lower and lower stratus clouds. Often, a warm front brings many hours of steady rain or snow. After the front passes, the air is warmer.

3. **Stationary fronts** occur when air masses first meet or when a cold or warm front stops moving. For a while, the boundary between the air masses stays in the same location—it stays stationary. The air in each air mass can still move sideways along the front or upward. The upward air motion may produce clouds that cover the sky, sometimes for days at a time. When the front starts moving, it becomes a warm front if the warm air advances and pushes the cold air. If the cold air moves forward instead, the front becomes a cold front.

VISUALIZATION
CLASSZONE.COM
See how the air moves in warm fronts and cold fronts.

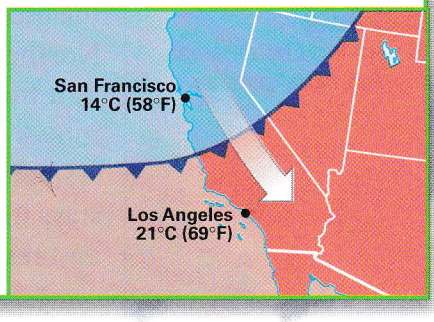
Fronts and Weather

As fronts move across Earth's surface, they produce changes in the weather.

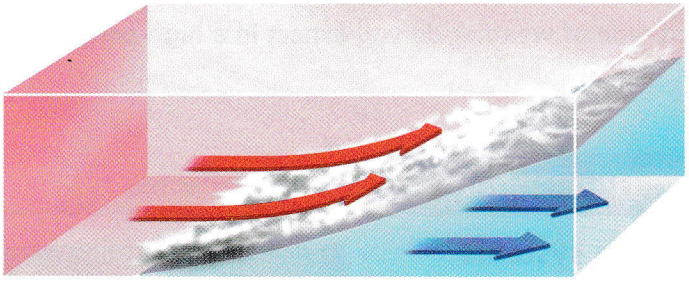
1 Cold Front

A **cold front** forms when a cold air mass pushes a warm air mass and forces the warm air to rise. As the warm air rises, its moisture condenses and forms tall clouds.

Triangles show the direction that a cold front moves.

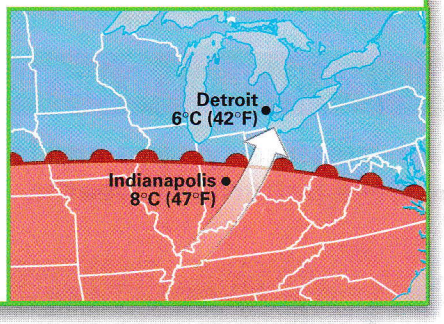


2 Warm Front

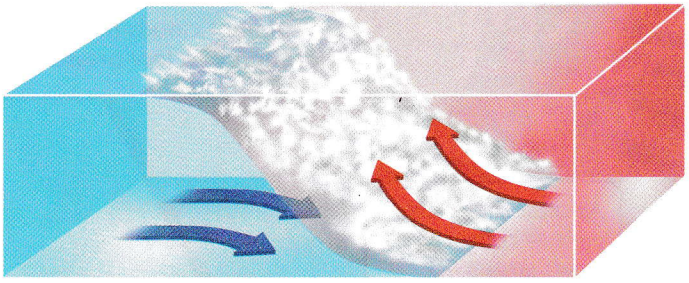


A **warm front** forms when a warm air mass pushes a cold air mass. The warm air rises slowly over the cold air and its moisture condenses into flat clouds.

Semicircles show the direction that a warm front moves.

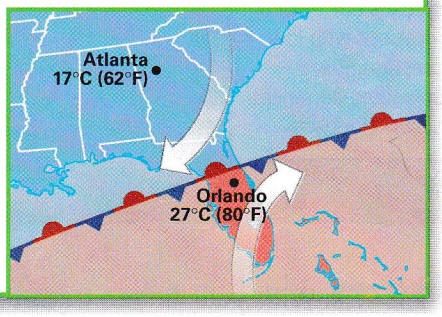


3 Stationary Front



A **stationary front** occurs when two air masses push against each other without moving. A stationary front becomes a warm or cold front when one air mass advances.

Alternating triangles and semicircles show a stationary front.



READING VISUALS **PREDICT** Which city will the cold front affect next?

High-Pressure Systems

You may have seen the letters H and L on a weather map. These letters mark high-pressure centers and low-pressure centers, often simply called highs and lows. Each center is the location of the highest or lowest pressure in a region. The pressure differences cause air to move in ways that may make a high or low become the center of a whole system of weather.

READING TiP
A *system* includes different parts that work together.

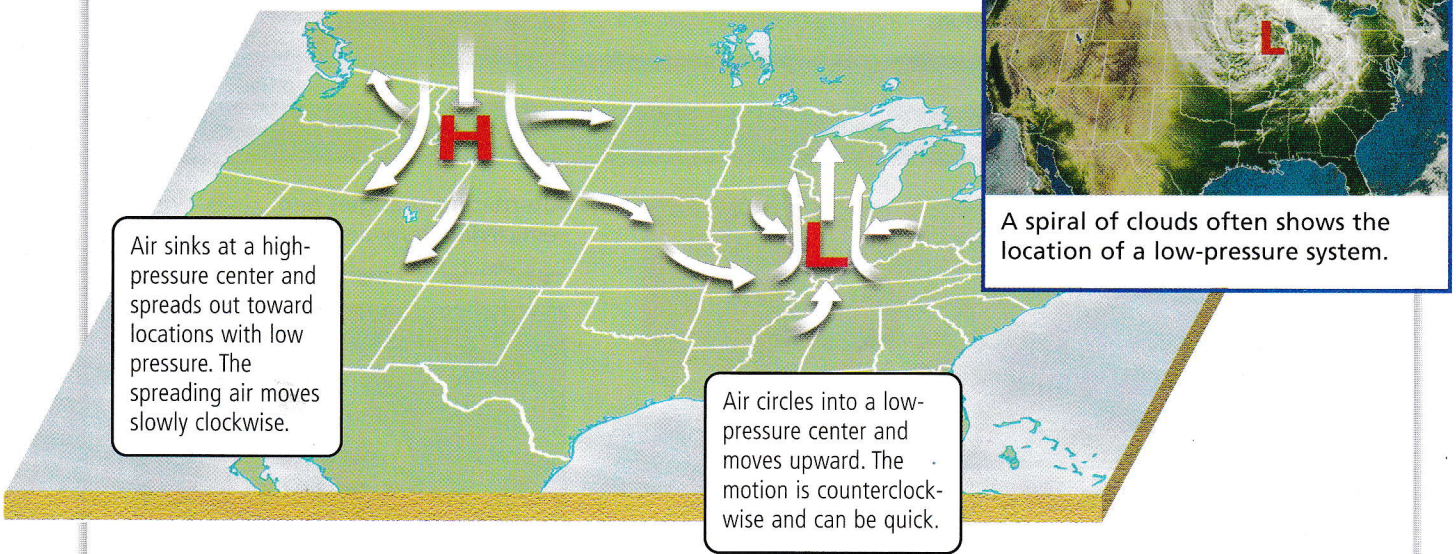
At a high-pressure center, air sinks slowly down. As the air nears the ground, it spreads out toward areas of lower pressure. In the Northern Hemisphere, the Coriolis effect makes the air turn clockwise as it moves outward. A **high-pressure system** is formed when air moves all the way around a high-pressure center. Most high-pressure systems are large and change slowly. When a high-pressure system stays in one location for a long time, an air mass may form. The air—and resulting air mass—can be warm or cold, moist or dry.

A high-pressure system generally brings clear skies and calm air or gentle breezes. This is because as air sinks to lower altitudes, it warms up a little bit. Water droplets evaporate, so clouds often disappear.

CHECK YOUR READING What type of weather do you expect in a high-pressure system?

Weather Systems in the Northern Hemisphere

High-pressure systems and low-pressure systems produce patterns of weather across Earth's surface.



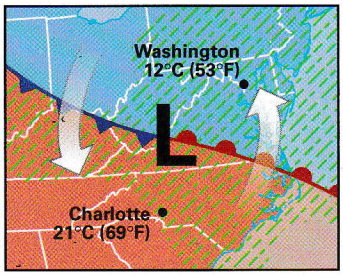
A spiral of clouds often shows the location of a low-pressure system.

READING VISUALS With your finger, trace the motion of air, starting above the high. Where have you seen similar patterns in earlier chapters?

Low-Pressure Systems

A small area of low pressure can also develop into a larger system. A **low-pressure system** is a large weather system that surrounds a center of low pressure. It begins as air moves around and inward toward the lowest pressure and then up to higher altitudes. The upward motion of the air lowers the air pressure further, and so the air moves faster. The pattern of motion strengthens into a low-pressure weather system. The rising air produces stormy weather. In the Northern Hemisphere, the air in a low-pressure system circles in a counterclockwise direction.

A low-pressure system can develop wherever there is a center of low pressure. One place this often happens is along a boundary between a warm air mass and a cold air mass. The diagram shows an example of this process.



- Part of the boundary between the air masses moves south and becomes a cold front.
- Part of the boundary moves north and becomes a warm front.
- A center of low pressure forms where the ends of the two fronts meet.

The low-pressure center and fronts become parts of a whole system of weather. Rising air at the fronts and at the low can cause very stormy weather.

The diagram on page 580 shows how air moves between pressure centers. Air moves down, out, and around a high-pressure center. Then it swirls around and into a low-pressure center and moves upward. Highs and lows affect each other as they move across the surface. Large weather systems generally move with the pattern of global winds—west to east over most of North America. But, within a weather system, winds can blow in different directions.

17.1 Review

KEY CONCEPTS

1. What are the two characteristics of an air mass that you need to know in order to classify it?
2. What happens when a warmer air mass pushes a cooler air mass?
3. What type of weather system brings calm, clear weather?

CRITICAL THINKING

4. **Compare and Contrast** Explain how air moves differently in low- and high-pressure systems.
5. **Apply** If the weather becomes stormy for a short time and then becomes colder, which type of front has passed?

CHALLENGE

6. **Synthesize** You check a barometer and observe that the air pressure has been dropping all day. Is tonight's weather more likely to be calm or stormy?

MATH in SCIENCE

SKILL: DETERMINING RATES

Movement of a Front

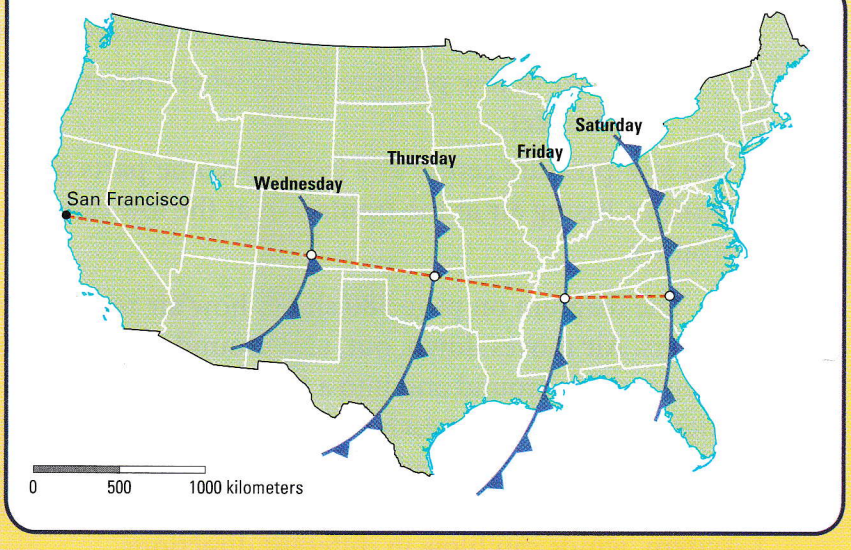
MATH TUTORIAL
CLASSZONE.COM
Click on Math Tutorial for more help with rates as ratios.

Scientists measure the speeds of weather fronts to forecast weather conditions. The speed at which a front moves is an example of a rate. A rate can be written as a ratio. For example, the rate of a front that moves a distance of 500 kilometers in 1 day can be written as follows:

500 kilometers : 1 day

The map below shows the movement of a cold front over four consecutive days. Use the map scale to determine the distance that the front moves on each day.

Cold Front Movement



Answer the following questions.

1. What was the front's rate of movement between Wednesday and Thursday? Express your answer as a ratio.

   ? : 1 day

2. What was the front's rate of movement between Friday and Saturday? Express your answer as a ratio.

3. What was the mean rate of the front's movement from Wednesday to Saturday? Remember, *mean* means "average." Express your answer as a ratio.

CHALLENGE Use the rate from Wednesday to Saturday to estimate the day on which the front must have moved through San Francisco.

KEY CONCEPT

17.2 Low-pressure systems can become storms.

BEFORE, you learned

- Moving air masses cause changes in weather
- A low-pressure system brings stormy weather

NOW, you will learn

- How hurricanes develop
- About the dangers of hurricanes
- About different types of winter storms

VOCABULARY

tropical storm p. 583
hurricane p. 583
storm surge p. 585
blizzard p. 586

EXPLORE Hurricanes

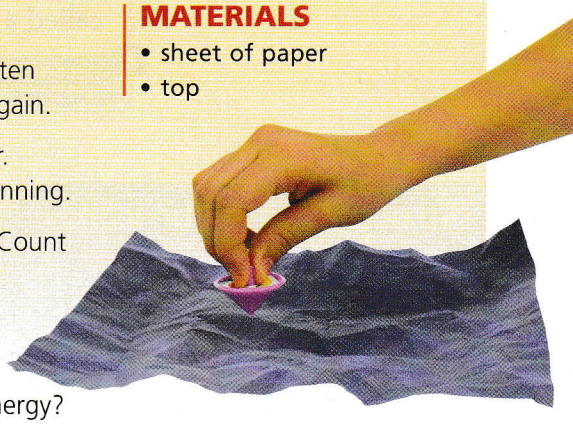
What things make hurricanes lose strength?

PROCEDURE

1. Crumple a piece of paper, then flatten it out. Crumple and flatten it out again.
2. Spin the top on the flattened paper. Count the seconds until it stops spinning.
3. Spin the top on a smooth surface. Count the seconds until it stops spinning.

MATERIALS

- sheet of paper
- top

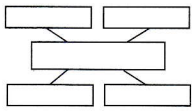


WHAT DO YOU THINK?

How does the texture of the surface affect the rate at which the top loses energy?

MAIN IDEA WEB

Remember to make notes about hurricanes.



Hurricanes form over warm ocean water.

Near the equator, warm ocean water provides the energy that can turn a low-pressure center into a violent storm. As water evaporates from the ocean, energy moves from the ocean water into the air. This energy makes warm air rise faster. Tall clouds and strong winds develop. As winds blow across the water from different directions into the low, the Coriolis effect bends their paths into a spiral. The winds blow faster and faster around the low, which becomes the center of a storm system.

A **tropical storm** is a low-pressure system that starts near the equator and has winds that blow at 65 kilometers per hour (40 mi/h) or more. A **hurricane** (HUR-ih-KAYN) is a tropical low-pressure system with winds blowing at speeds of 120 kilometers per hour (74 mi/h) or more—strong enough to uproot trees. Hurricanes are called typhoons or cyclones when they form over the Indian Ocean or the western Pacific Ocean.

Formation of Hurricanes

VISUALIZATION
CLASSZONE.COM
Watch the progress of a hurricane.

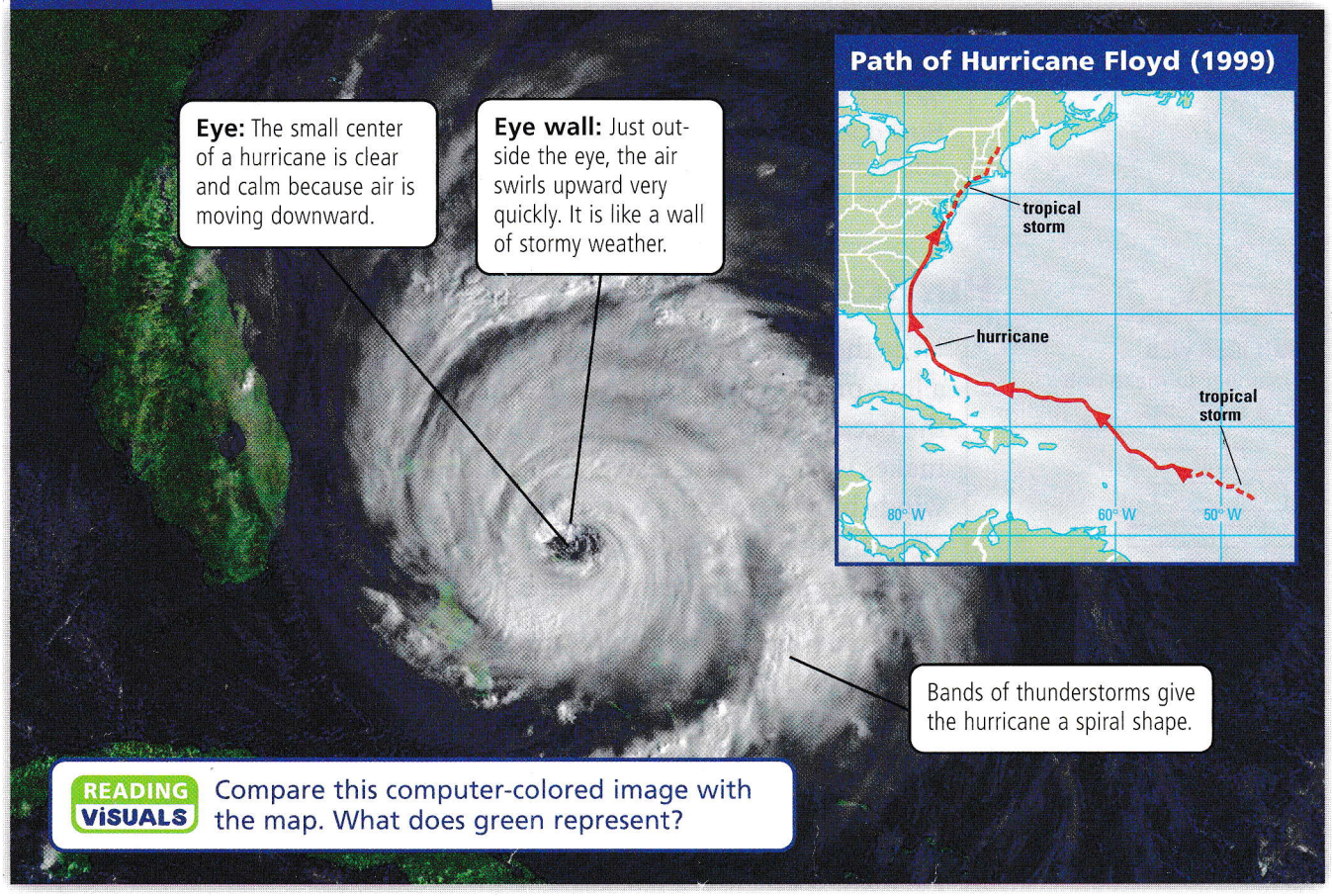
In the eastern United States, hurricanes most often strike between August and October. Energy from warm water is necessary for a low-pressure center to build into a tropical storm and then into a hurricane. The ocean water where these storms develop only gets warm enough—26°C (80°F) or more—near the end of summer.

Tropical storms and hurricanes generally move westward with the trade winds. Near land, however, they will often move north, south, or even back eastward. As long as a storm stays above warm water, it can grow bigger and more powerful. As soon as a hurricane moves over land or over cooler water, it loses its source of energy. The winds lose strength and the storm dies out. If a hurricane moves over land, the rough surface of the land reduces the winds even more.

The map below shows the progress of a storm. The tropical storm gained energy and became a hurricane as it moved westward. When the hurricane moved north, the storm lost energy and was called a tropical storm again as its winds slowed.

CHECK YOUR READING What is the source of a hurricane's energy?

Structure of a Hurricane



READING VISUALS Compare this computer-colored image with the map. What does green represent?

At the center of a hurricane is a small area of clear weather, 20–50 kilometers (10–30 mi) in diameter, called the eye. The storm's center is calm because air moves downward there. Just around the eye, the air moves very quickly around and upward, forming a tall ring of cumulonimbus clouds called the eye wall. This ring produces very heavy rains and tremendous winds. Farther from the center, bands of heavy clouds and rain spiral inward toward the eye.

Effects of Hurricanes

A hurricane can pound a coast with huge waves and sweep the land with strong winds and heavy rains. The storms cause damage and dangerous conditions in several ways. Hurricane winds can lift cars, uproot trees, and tear the roofs off buildings. Hurricanes may also produce tornadoes that cause even more damage. Heavy rains from hurricanes may make rivers overflow their banks and flood nearby areas. When a hurricane moves into a coastal area, it often pushes a huge mass of ocean water known as a **storm surge.** In a storm surge, the sea level rises several meters, backing up rivers and flooding the shore. A storm surge can be destructive and deadly. Large waves add to the destruction. A hurricane may affect an area for a few hours or a few days, but the damage may take weeks or even months to clean up.

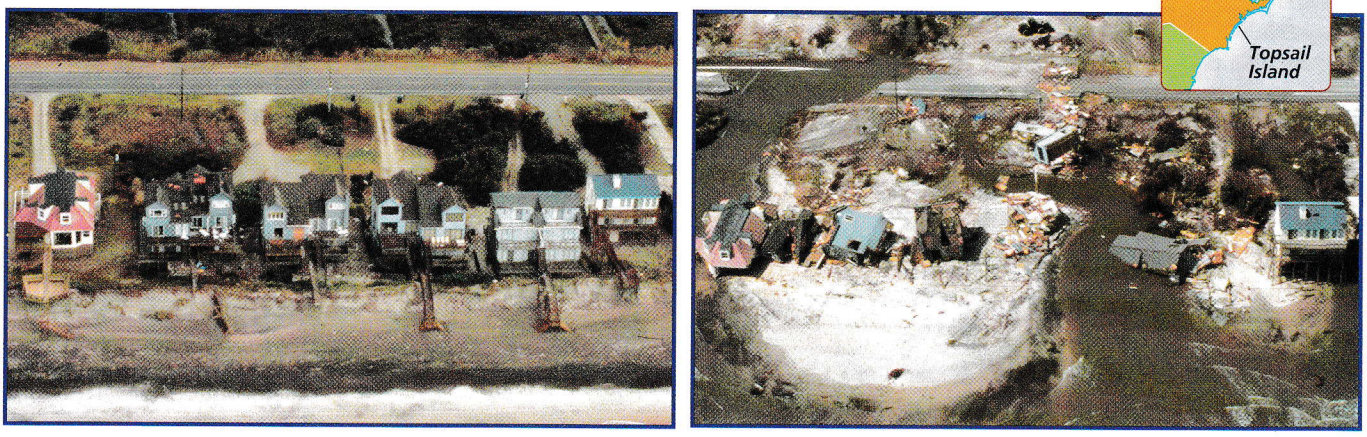
CHECK YOUR READING What are the effects of hurricanes? Make a list for your answer.

The National Hurricane Center helps people know when to prepare for a hurricane. The center puts out a tropical-storm or hurricane watch when a storm is likely to strike within 36 hours. People may be evacuated, or moved away for safety, from areas where they may be in danger. As the danger gets closer—24 hours or less—the center issues a tropical-storm or hurricane warning. The warning stays in effect until the danger has passed.

SAFETY TIPS

HURRICANES

- Before a storm, prepare a plan to leave the area. Gather emergency supplies.
- Listen to weather reports for storm updates.
- Secure loose objects outside, and cover windows.
- If ordered to evacuate, leave immediately.
- During a storm, stay indoors and away from windows.
- After a storm, be aware of power lines, hanging branches, and flooded areas.



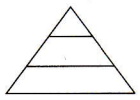
COMPARE AND CONTRAST These pictures show a shoreline in North Carolina before and after Hurricane Fran in 1996. Compare the houses, road, and water in the two pictures.

Winter storms produce snow and ice.

Most severe winter storms in the United States are part of low-pressure systems. Unlike hurricanes, the systems that cause winter storms form when two air masses collide. A continental polar air mass that forms over snow-covered ground is especially cold, dry, and dense. It can force moist air to rise very quickly, producing a stormy low-pressure system.

The National Weather Service (NWS) alerts people to dangerous weather. The NWS issues a winter storm watch up to 48 hours before a storm is expected. A winter storm warning means that dangerous conditions are already present or will affect an area shortly.

VOCABULARY
Remember to add a word triangle diagram for *blizzard*.



Blizzards Strong winds can blow so much snow into the air at once that it becomes difficult to see and dangerous to travel. **Blizzards** are blinding snowstorms with winds of at least 56 kilometers per hour (35 mi/h) and low temperatures—usually below –7°C (20°F). Blizzards occur in many parts of the northern and central United States. Wind and snow can knock down trees and power lines. Without heat, buildings can become very cold, and water in pipes may freeze. Schools, hospitals, and businesses may have to close. Deep, heavy snow on top of a building may cause the roof to cave in.

Lake-Effect Snowstorms Some of the heaviest snows fall in the areas just east and south of the Great Lakes. Cold air from the northwest gains moisture and warmth as it passes over the Great Lakes. Over cold land, the air cools again and releases the moisture as snow. The lake effect can cover areas downwind of the Great Lakes with clouds and snow even when the rest of the region has clear weather.

INVESTIGATE Ice

Why put salt on icy roads?

SKILL FOCUS
Observing

MATERIALS
- 2 ice cubes
- 2 cups
- table salt

TIME
10 minutes

PROCEDURE

1. Place one ice cube in each cup.
2. Sprinkle salt onto the top of one of the ice cubes and observe the cubes for several minutes.

WHAT DO YOU THINK?

- Which ice cube melted more?
- Why do people put salt on roads in winter?

CHALLENGE Why do people put sand or cinders on icy roads? Design an experiment to test your ideas.

Ice Storms When rain falls onto freezing-cold ground, conditions can become dangerous. The cold rain freezes as it touches the ground and other surfaces. This freezing rain covers everything with heavy, smooth ice. The ice-covered roads become slippery and dangerous. Drivers may find it hard to steer and to stop their cars. Branches or even whole trees may break from the weight of ice. Falling branches can block roads, tear down power and telephone lines, and cause other damage. Damage from ice storms can sometimes shut down entire cities.

CHECK YOUR READING What type of precipitation occurs in each type of winter storm?

SAFETY TIPS

WINTER STORMS

- Before a storm, prepare emergency kits for home and car.
- Listen to weather reports for updates.
- If caught in a storm, find or make a shelter and try to stay dry.
- If you are in a car or truck, make sure the exhaust pipe is clear and open a window a little bit.
- Use a colored cloth, fire, or light to help rescuers find you.
- Exercise a little to keep warm and keep blood flowing to your fingers and toes.
- If at home, stay inside even if there is no heat or power. Wear layers of clothing.

17.2 Review

KEY CONCEPTS

1. Where and when do hurricanes form?
2. In what two ways can hurricanes cause floods?
3. List three of the possible dangers from winter storms.

CRITICAL THINKING

4. **Compare and Contrast** What are the differences between the eye and the eye wall of a hurricane?
5. **Compare** What do hurricanes and winter storms have in common?

CHALLENGE

6. **Apply** If the wind is blowing from the west and the conditions are right for lake-effect snow, will the snow fall to the north, south, east, or west of a lake? Drawing a diagram may help you work out an answer.

KEY CONCEPT

17.3 Vertical air motion can cause severe storms.

BEFORE, you learned

- Fronts produce changes in weather
- Rising moist air can produce clouds and precipitation

NOW, you will learn

- How thunderstorms develop
- About the effects of thunderstorms
- About tornadoes and their effects

VOCABULARY

thunderstorm p. 588
tornado p. 591

EXPLORE Lightning

Does miniature lightning cause thunder?

PROCEDURE

1. Use a thumbtack to attach the eraser to the center of a piece of foil.
2. Rub the foam tray quickly back and forth several times on the wool. Set the tray down.
3. Using the eraser as a handle, pick up the foil and set it onto the tray. Slowly move your finger close to the foil.

MATERIALS

- thumbtack
- eraser
- aluminum foil
- plastic foam tray
- wool fabric

WHAT DO YOU THINK?

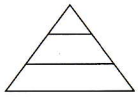
What happened when you touched the foil?

Thunderstorms form from rising moist air.

If you have ever shuffled your shoes on a carpet, you may have felt a small shock when you touched a doorknob. Electrical charges collected on your body and then jumped to the doorknob in a spark of electricity.

In a similar way, electrical charges build up near the tops and bottoms of clouds as pellets of ice move up and down through the clouds. Suddenly, a charge sparks from one part of a cloud to another or between a cloud and the ground. The spark of electricity, called lightning, causes a bright flash of light. The air around the lightning is briefly heated to a temperature hotter than the surface of the Sun. This fast heating produces a sharp wave of air that travels away from the lightning. When the wave reaches you, you hear it as a crack of thunder. A **thunderstorm** is a storm with lightning and thunder.

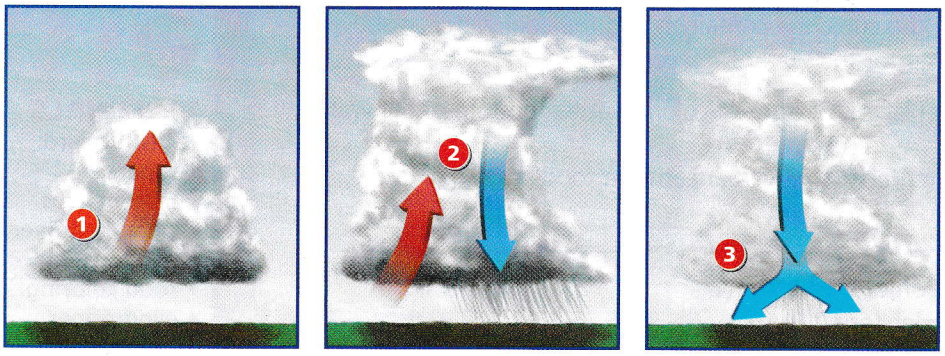
VOCABULARY
Put new terms into a word triangle diagram.



CHECK YOUR READING Is thunder a cause or an effect of lightning?

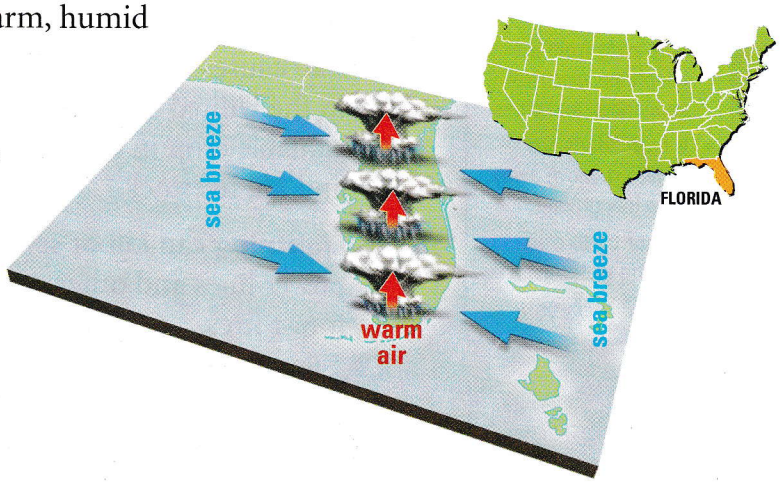
Formation of Thunderstorms

Thunderstorms get their energy from humid air. When warm, humid air near the ground moves vertically into cooler air above, the rising air, or updraft, can build a thunderstorm quickly.



1. Rising humid air forms a cumulus cloud. The water vapor releases energy when it condenses into cloud droplets. This energy increases the air motion. The cloud continues building up into the tall cumulonimbus cloud of a thunderstorm.
2. Ice particles form in the low temperatures near the top of the cloud. As the ice particles grow large, they begin to fall and pull cold air down with them. This strong downdraft brings heavy rain or hail—the most severe stage of a thunderstorm.
3. The downdraft can spread out and block more warm air from moving upward into the cloud. The storm slows down and ends.

Thunderstorms can form at a cold front or within an air mass. At a cold front, air can be forced upward quickly. Within an air mass, uneven heating can produce convection and thunderstorms. In some regions, the conditions that produce thunderstorms occur almost daily during part of the year. In Florida, for example, the wet land and air warm up during a long summer day. Then, as you see in the diagram, cool sea breezes blow in from both coasts of the peninsula at once. The two sea breezes together push the warm, humid air over the land upward quickly. Thunderstorms form in the rising air.



In contrast, the summer air along the coast of California is usually too dry to produce thunderstorms. The air over the land heats up, and a sea breeze forms, but there is not enough moisture in the rising warm air to form clouds and precipitation.

INVESTIGATE Updrafts

How do updrafts form?

SKILL FOCUS
Inferring

MATERIALS
- 4 cardboard squares
- 5 foam cups
- clear container
- cool water
- food coloring
- eyedropper
- hot tap water

TIME
20 minutes

PROCEDURE

1. Set up the cardboard, the cups, the container, and the cool water as shown in the photograph. Wait for the water to become still.
2. Use the eyedropper to place 2–3 drops of coloring at the bottom of the water.
3. Slide a cup of hot water (about 70°C) beneath the food coloring.

WHAT DO YOU THINK?

In what ways was the motion of the water like the air in a thunderstorm?

CHALLENGE How could you observe updrafts in air?

Effects of Thunderstorms

A thunderstorm may provide cool rain at the end of a hot, dry spell. The rain can provide water for crops and restore lakes and streams. However, thunderstorms are often dangerous.

Flash floods can be strong enough to wash away people, cars, and even houses. One thunderstorm can produce millions of liters of rain. If a thunderstorm dumps all its rain in one place, or if a series of thunderstorms dump rain onto the same area, the water can cover the ground or make rivers overflow their banks.

Winds from a thunderstorm can be very strong. They can blow in bursts that exceed 270 kilometers per hour (170 mi/hr). Thunderstorm winds once knocked down a stretch of forest in Canada that was about 16 kilometers (10 mi) wide and 80 kilometers (50 mi) long. Thunderstorms can also produce sudden, dangerous bursts of air that move downward and spread out.

Hail causes nearly $1 billion in damage to property and crops in the United States every year. Hail can wipe out entire fields of a valuable crop in a few minutes. Large hailstones can damage roofs and kill livestock.

Lightning can kill or seriously injure any person it hits. It can damage power lines and other equipment. Lightning can also spark dangerous forest fires.

CHECK YOUR READING In what ways are thunderstorms dangerous? Did any surprise you?

SAFETY TIPS

THUNDERSTORMS

- Stay alert when storms are predicted or dark, tall clouds are visible.
- If you hear thunder, seek shelter immediately and stay there for 30 minutes after the last thunder ends.
- Avoid bodies of water, lone trees, flagpoles, and metal objects.
- Stay away from the telephone, electrical appliances, and pipes.
- If flash floods are expected, move away from low ground.
- Do not try to cross flowing water, even if it looks shallow.

Tornadoes form in severe thunderstorms.

Under some conditions, the up-and-down air motion that produces tall clouds, lightning, and hail may produce a tornado. A **tornado** is a violently rotating column of air stretching from a cloud to the ground. A tornado moves along the ground in a winding path underneath the cloud. The column may even rise off the ground and then come down in a different place.

READING TiP

A spinning column of air is not called a tornado unless it touches the ground. If it touches water instead, it is called a waterspout.

You cannot see air moving. A tornado may become visible when water droplets appear below the cloud in the center of the rotating column. A tornado may lift dust and debris from the ground, so the bottom of the column becomes visible, as you see in the photographs below. Water droplets and debris may make a tornado look like an upright column or a twisted rope.

CHECK YOUR READING What makes a tornado become visible?

More tornadoes occur in North America than anywhere else in the world. Warm, humid air masses move north from the Gulf of Mexico to the central plains of the United States. There, the warm air masses often meet cold, dense air and form thunderstorms. In the spring, the winds in this region often produce the conditions that form tornadoes. A thunderstorm may form a series of tornadoes or even a group of tornadoes all at once.

Tornado Formation

Effects of Tornadoes

The powerful winds of a tornado can cause damage as the bottom of the tornado moves along the ground. Tornado winds can also pick up and slam dirt and small objects into buildings or anything else in the tornado's path.

The most common tornadoes are small and last only a few minutes. Their winds may be strong enough to break branches off trees, damage chimneys, and tear highway billboards. A typical path along the ground may be 100 meters (300 ft) wide and 1.5 kilometers (1 mi) long.

Larger tornadoes are less common but have stronger winds and last longer. About 20 percent of tornadoes are strong enough to knock over large trees, lift cars off the ground, and tear the roofs off houses. Very few—about 1 percent of all tornadoes—are violent enough to lift or completely demolish sturdy buildings. These huge tornadoes may last more than two hours. You can find more details about tornadoes in the Appendix.

SAFETY TIPS

TORNADOES

- Listen for tornado warnings when severe weather is predicted.
- If you are in a car or mobile home, get out and go into a sturdy building or a ditch or depression.
- Go to the basement if possible.
- Avoid windows and open areas.
- Protect your head and neck.

Paths of Tornadoes

A tornado moves along with its thunderstorm. It travels at the same pace and weaves a path that is impossible to predict. A tornado may appear suddenly and then disappear before anyone has time to report it. However, the conditions that form tornadoes may persist, so citizens' reports are still useful. The National Weather Service issues a tornado watch when the weather conditions might produce tornadoes. A tornado warning is issued when a tornado has been detected.

17.3 Review

KEY CONCEPTS

1. What conditions produce thunderstorms?
2. How can rain from thunderstorms become dangerous?
3. How do tornadoes cause damage?

CRITICAL THINKING

4. **Compare** What do hail and tornadoes have in common? **Hint:** Think about how each forms.
5. **Synthesize** Which type of front is most likely to produce thunderstorms and tornadoes? Explain why.

CHALLENGE

6. **Compare and Contrast** If you saw the photograph above in a newspaper, what details would tell you that the damage was due to a tornado and not a hurricane?

Think SCIENCE

SKILL: EVALUATING HYPOTHESES

What Type of Weather Buried This Truck?

This picture was taken soon after a weather event partly buried this truck in Britannia Beach, British Columbia.

Observations and Inferences

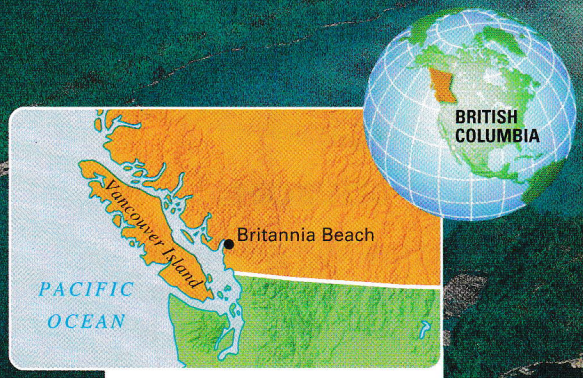
One observer made this analysis.

a. The truck, the tree, and two fences in the background were partly buried by sand and stones.
b. No stones are visible inside the truck.
c. The rounded stones must have come from an ocean or river.
d. The tree near the truck has green leaves. The wind must have been too weak to tear off the leaves.
e. The area is near the Pacific Ocean. It is far from the equator. There is a very large island between the location and the ocean.

Hypotheses

The observer made the following hypotheses.

a. A storm surge carried sand and stones from the Pacific Ocean. The material covered a large area. The truck floated, so it was not filled with material.
b. A tornado picked up the truck with other material. It dumped everything together, and the material partly buried the truck, fences, and tree.
c. Thunderstorms produced a flash flood that carried sand and stones from a riverbed to this area. The flood receded and left material that covered the area.
d. The truck was parked on a pile of snow during a blizzard. When the snow melted, the area under the truck collapsed and the truck sank into the ground.



A waterway leads south and west from Britannia Beach to a bay, around an island, to the Pacific Ocean.

Evaluate Each Hypothesis

Review each hypothesis and think about whether the observations support it. Some facts may rule out some hypotheses. Some facts may neither support nor weaken some hypotheses.

CHALLENGE How could you model one or more of the hypotheses with a toy truck, sand, and a basin of water?

KEY CONCEPT

17.4 Weather forecasters use advanced technologies.

BEFORE, you learned

- Weather changes when air masses move
- High-pressure systems bring fair weather
- Fronts and low-pressure systems bring stormy weather

NOW, you will learn

- How weather data are collected
- How weather data are displayed
- How meteorologists forecast the weather

VOCABULARY

meteorologist p. 594
isobar p. 597

EXPLORE Weather Maps

What does a weather map show?

PROCEDURE

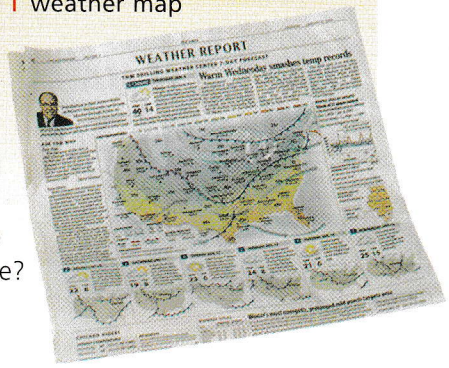
1. Look at the weather outside. Write down the conditions you observe.
1. Use the map to check the weather conditions for your region.

WHAT DO YOU THINK?

- What symbols on the map do you recognize?
- How does the information on the weather map compare with the weather you observed outside?

MATERIALS

newspaper
weather map

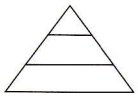


Weather data come from many sources.

Looking at the weather outside in the morning can help you decide what to wear. Different things give you clues to the current weather. If you see plants swaying from side to side, you might infer that it is windy. If you see a gray sky and wet, shiny streets, you might decide to wear a raincoat.

You might also check a weather report to get more information. A weather report can show conditions in your area and also in the region around you. You can look for weather nearby that might move into your area during the day. More detailed predictions of how the weather will move and change may be included in a weather report by a meteorologist. A **meteorologist** (MEE-tee-uh-RAHL-uh-jihst) is a scientist who studies weather.

VOCABULARY
Make a word triangle for *meteorologist*.



CHECK YOUR READING What information can a weather report show?

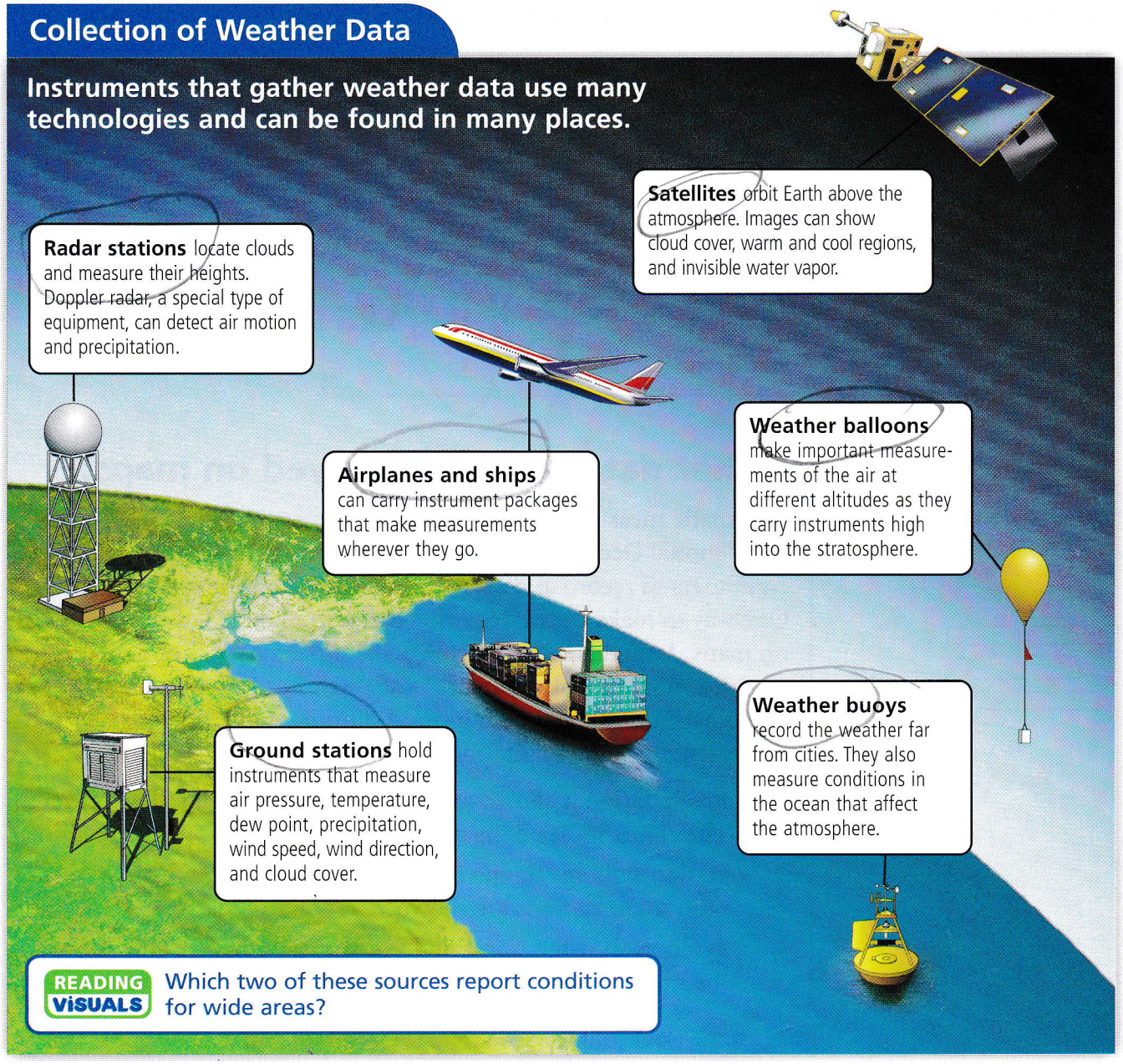
In order to predict the weather, meteorologists look at past and current conditions. They use many forms of technology to gather data. The illustration below shows how weather information is gathered. For example, radar stations and satellites use advanced technologies to gather data for large areas at a time.

Instruments within the atmosphere can make measurements of local weather conditions. Newer instruments can make measurements frequently and automatically and then report the results almost instantly. Instruments are placed in many ground stations on land and weather buoys at sea. Instruments can also be carried by balloons, ships, and planes. These instruments report a series of measurements along a path within the atmosphere.

RESOURCE CENTER
CLASSZONE.COM
Learn more about weather forecasting and your local weather.

Collection of Weather Data

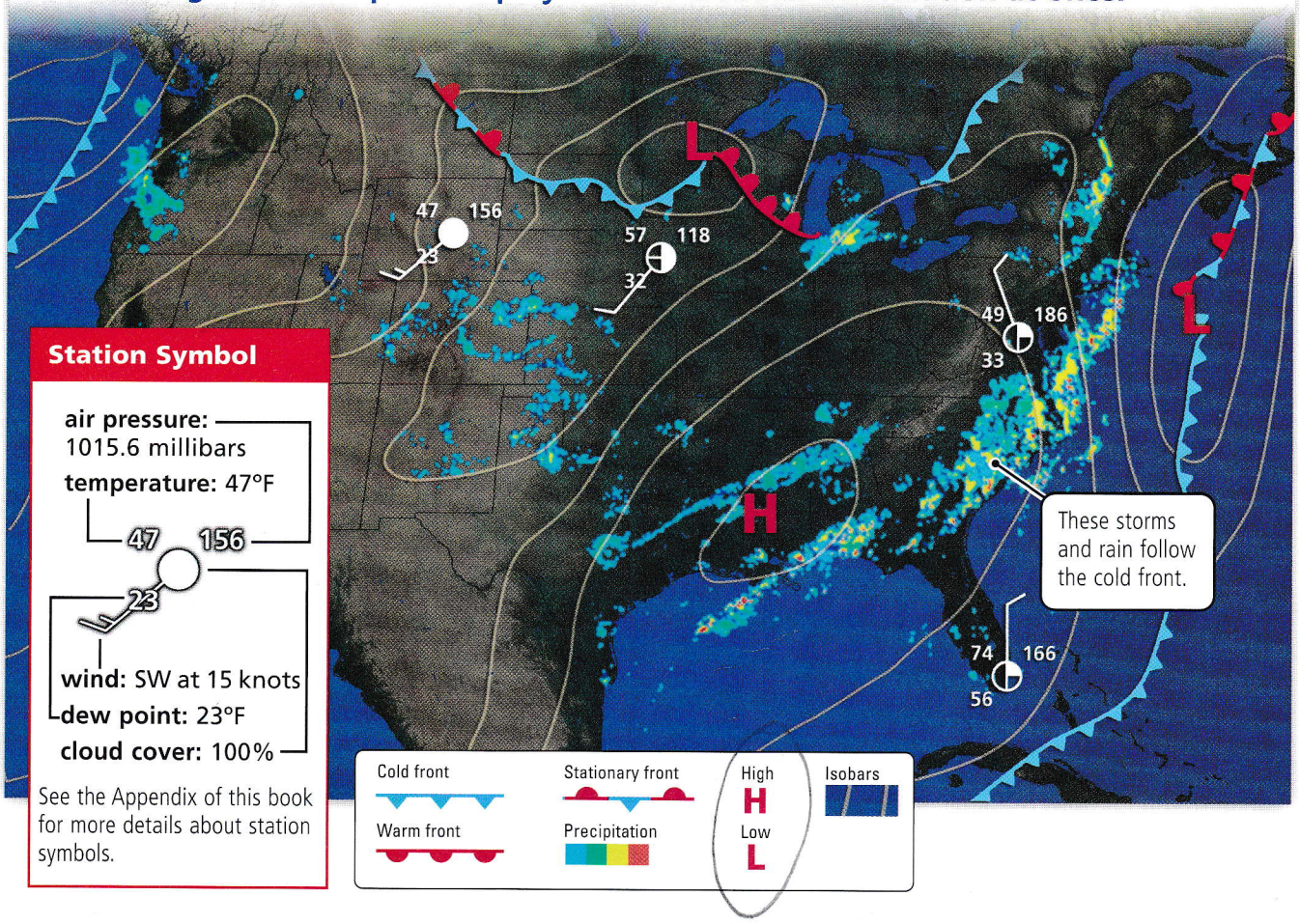
Instruments that gather weather data use many technologies and can be found in many places.



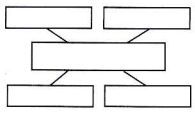
READING VISUALS Which two of these sources report conditions for wide areas?

Information on a Weather Map

Meteorologists use maps to display a lot of weather information at once.



MAIN IDEA WEB
Add to your notebook information about weather data.



Weather data can be displayed on maps.

Automatic measurements from many sources constantly pour in to the National Oceanic and Atmospheric Administration. Scientists use computers to record and use the enormous amount of data gathered. One way to make the information easier to understand is to show it on maps. A single map can show many different types of data together to give a more complete picture of the weather. The map above combines information from ground stations with Doppler radar measurements of precipitation.

- Precipitation is shown as patches of blue, green, yellow, and red. The colors indicate the amounts of rain or other precipitation.
- Station symbols on the map show data from ground stations. Only a few stations are shown.
- Symbols showing fronts and pressure patterns are added to the map to make the overall weather patterns easier to see.

CHECK YOUR READING How is information from Doppler radar shown?

Computer programs are used to combine information from many ground stations. The resulting calculations give the highs, lows, and fronts that are marked on the map. The cold front near the East Coast has triangles to show that the front is moving eastward. This cold front produced the heavy rain that is visible in the Doppler radar data.

Air Pressure on Weather Maps

The map below shows conditions from the same date as the map on page 596. Thin lines represent air pressure. An **isobar** (EYE-suh-BAHR) is a line that connects places that have the same air pressure. Each isobar represents a different air pressure value. All the isobars together, combined with the symbols for highs and lows, show the patterns of air pressure that produce weather systems.

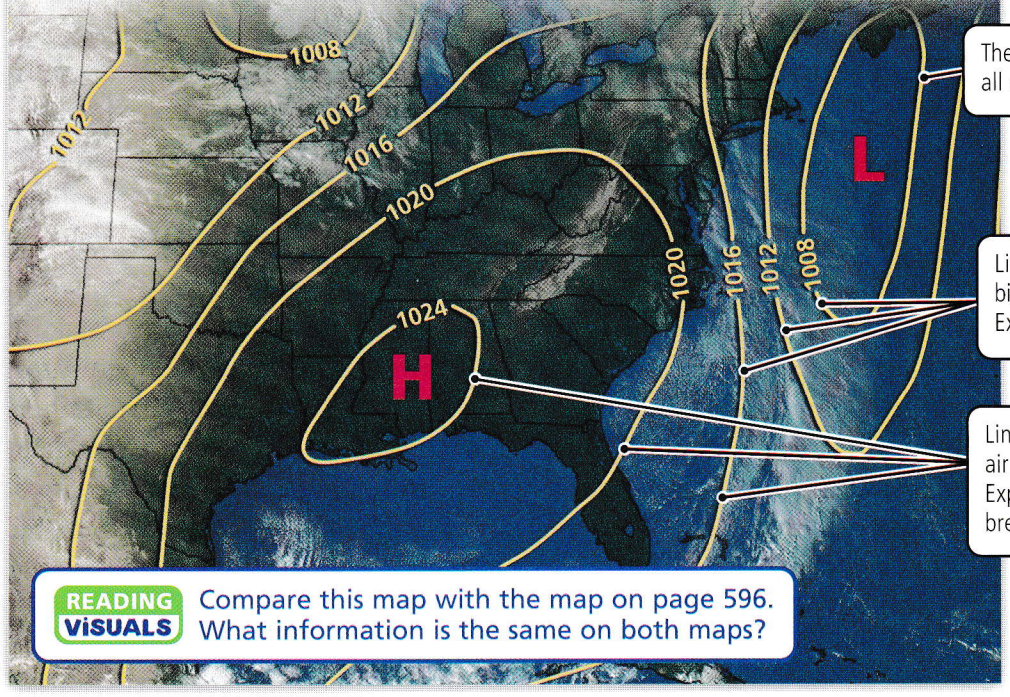
READING TiP
Iso- means "equal," and *bar* means "pressure."

Each isobar is labeled with the air pressure for that whole line in units called millibars (MIHL-uh-BAHRZ). A lower number means a lower air pressure. As you read earlier, differences in pressure cause air to move. Meteorologists use isobars to understand air motion.

Sometimes air-pressure measurements are listed in inches of mercury. This unit comes from an old type of barometer that measures how high the air pressure pushes a column of mercury, a liquid metal. Computer-controlled instruments are used more often today, but the measurements may be converted to inches of mercury.

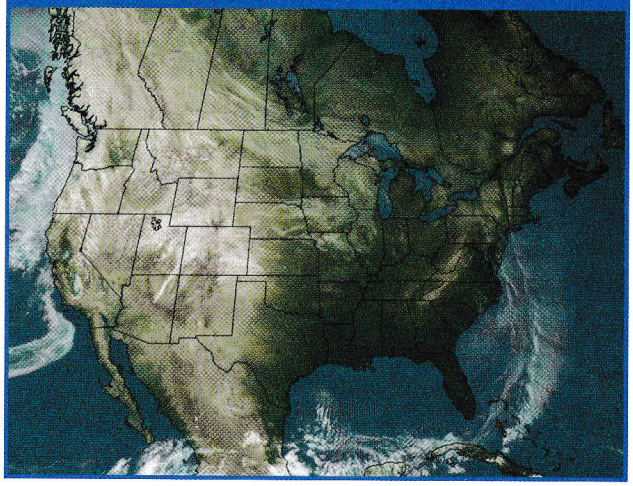
Understanding Isobars

Isobars show pressure patterns, which determine winds.



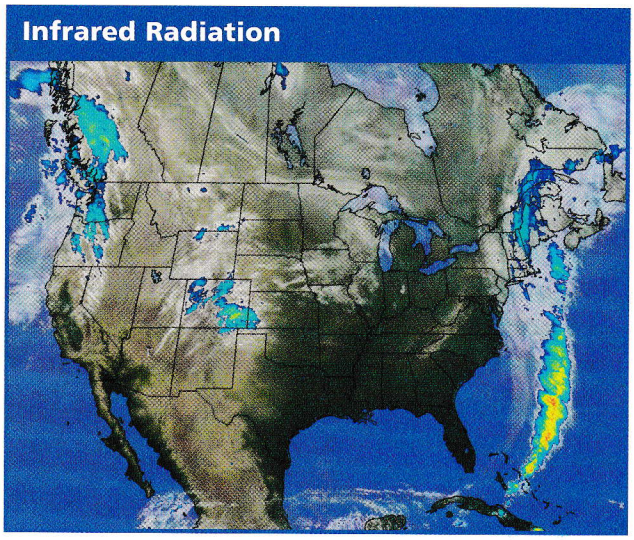
Satellite Images

Visible Light



This visible-light satellite image shows clouds from above. The patches of white are clouds.

Infrared Radiation



This infrared satellite image also shows clouds, but uses colors to show where there are tall clouds.

READING VISUALS Find a location on these maps and the map on page 596. What were the weather conditions?

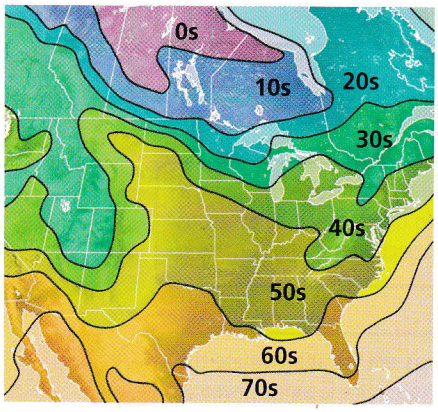
Satellite Images and Special Maps

Satellites take different types of images from space. Some images record the visible light that reflects off clouds and Earth's surface. Clouds and snow-covered land look white in sunlight. Unfortunately, visible-light images do not show much at night.

Another type of image shows infrared radiation given off by the warm surface and cooler clouds. These infrared images can show cloud patterns even at night because objects with different temperatures show up differently. Air temperatures change with altitude, so infrared images also show which clouds are low and which are high or tall. You can see in the maps above how visible and infrared satellite images show similar clouds but different details. Outlines of the states have been added to make the images easier to understand.

Data from ground stations and other sources can be used to make other types of maps. The map at left shows the pattern of temperatures on the same date as the images above and the map on page 596. Other maps may show winds or amounts of pollution. A map can be made to show any type of measurement or weather prediction. Different types of maps are often used together to give a more complete picture of the current weather.

The colors on this map represent different ranges of temperature (°F).



CHECK YOUR READING Why would a weather report show more than one map?

Forecasters use computer models to predict weather.

Instruments can only measure the current weather conditions. Most people want to know what the weather will be like in the future.

Forecasters can make some predictions from their own observations. If they see cirrus clouds above and high stratus clouds to the west, they might infer that a warm front is approaching. They would predict weather typical for a warm front—more clouds, then rain, and eventually warmer weather. If they also have information from other places, the forecasters might be able to tell where the warm front is already and how fast it is moving. They might be able to predict how soon it will arrive and even how warm the weather will be after the front passes.

Forecasters use maps and satellite images to communicate weather conditions and predictions.

Computers have become an important tool for forecasting weather. When weather stations send in data, computers can create maps right away. Computer models combine many types of data to forecast what might happen next. Different computer models give different types of forecasts. Scientists study the computer forecasts, then apply their knowledge and experience to make weather predictions.

Forecasting the weather is complicated. As a result, some forecasts are more dependable than others. The farther in advance a forecast is made, the more time there is for small differences between the predicted and the actual weather to add up. For this reason, short-range forecasts—up to three days in advance—are the most accurate. Forecasts of fast-changing weather, such as severe storms, are less accurate far in advance. It is best to watch for new predictions close to the time the storm is forecast.

17.4 Review

KEY CONCEPTS

1. List three of the sources of weather data.
2. What does a map with isobars show?
3. How do meteorologists use computers?

CRITICAL THINKING

4. **Draw Conclusions** Why do meteorologists not combine all their weather information into one map?
5. **Analyze** How is the information from radar and satellites different from the information from ground stations?

CHALLENGE

6. **Apply** Suppose you are planning an afternoon picnic a week in advance. Fair weather is forecast for that day, but a storm is expected that night. What will you do? Explain your reasoning.

CHAPTER INVESTIGATION

Design a Weather Center

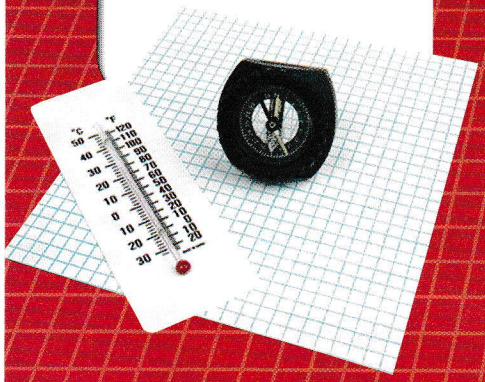
DESIGN YOUR OWN

OVERVIEW AND PURPOSE The accuracy of a weather forecast depends largely on the type and quality of the data that it is based on. In this lab, you will use what you have learned about weather to

- observe and measure weather conditions
- record and analyze the weather-related data

MATERIALS

- thermometer
- magnetic compass
- other weather instruments
- graph paper

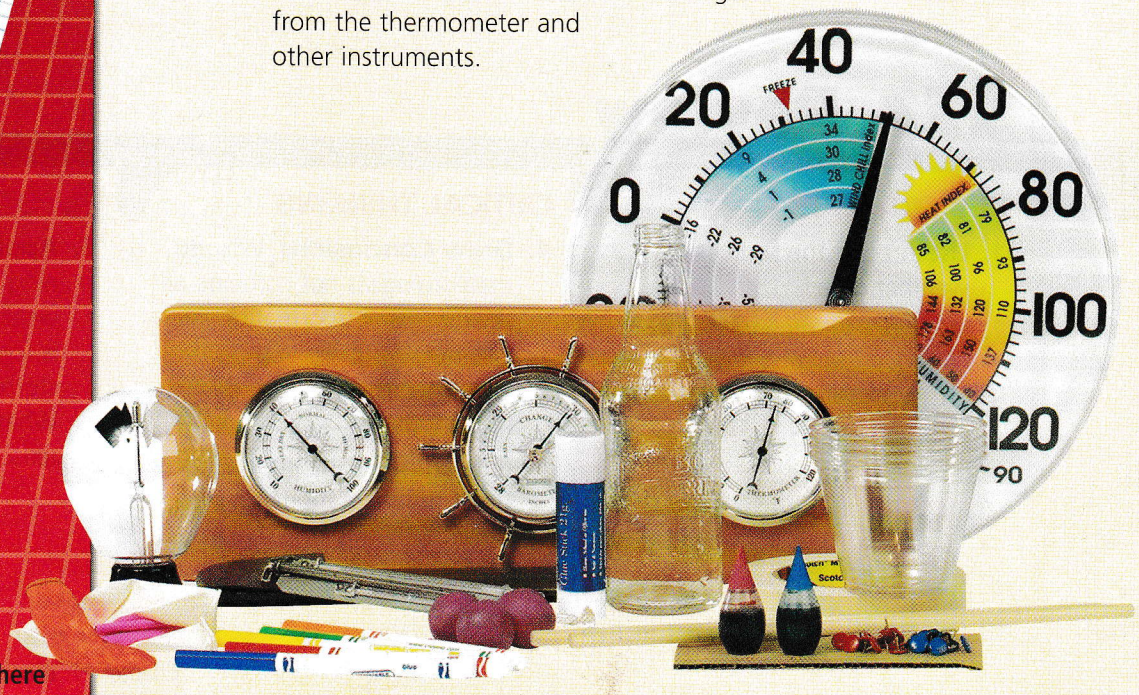


Procedure

1. Survey the possible sources of weather data in and around your classroom. You can use a thermometer to record the outside air temperature. You can observe cloud types and the amount of cloud cover from a window or doorway. You can also observe precipitation and notice if it is heavy or light. If there is a flag in view, use it to find the wind direction and to estimate wind speed.

2. Assemble or make tools for your observations. You may want to make a reference chart with pictures of different cloud types or other information. Decide if you wish to use homemade weather instruments. You may have made a barometer, a psychrometer, and a rain gauge already. If not, see the instructions on pages 541, 560, and 563. You may also wish to do research to learn how to make or use other weather instruments.

3. Make an initial set of observations. Write down the date and time in your **Science Notebook.** Record the readings from the thermometer and other instruments.



4 Decide how to record your observations of the clouds, the wind, and any precipitation. Organize your notes to make it easy for you to record later observations in a consistent way.

5 Create a chart with a row for each type of observation you are making. You might darken fractions of circles to record amounts of cloud cover, as in the station symbols on page 596. Make sure each row has a heading and enough room for numbers, words, or sketches. Include a row for notes that do not belong in the data rows.

6 Record your observations every day at the same time. Try to make the observations exactly the same way each time. If you have to redraw your chart, copy the information carefully.

Observe and Analyze

Write It Up

1. **GRAPH** Graph the data you collected that represent measurable quantities. Use graphs that are appropriate to your data. Often a simple line graph will work. Choose an appropriate scale and interval based on the range of your data. Make the *x*-axis of each graph the same so that you can compare the different types of data easily.

2. **COMPARE AND CONTRAST** Look at your graphs for patterns in your data. Some aspects of weather change at the same time because they are related to each other. Did one type of change occur before a different type of change? If so, this pattern may help you predict weather.

Conclude

Write It Up

1. **INTERPRET** Did a front pass through your area during the period you observed? What observations helped you answer this question?
2. **EVALUATE** Why was it necessary to observe at the same time each day?
3. **APPLY** If you predicted that each day's weather would be repeated the next day, how often would you be right?

INVESTIGATE Further

CHALLENGE Locate a newspaper weather page for the period during which you were making your weather observations. How do the weather data reported for your area compare with your measurements? How do you account for any differences you notice in the data?

Design a Weather Center

Table 1. Daily Weather Chart

Date/time of observations			
Temperature (°C)			
Cloud types			
Cloud coverage	○	○	○
Precipitation (cm) and notes			
Wind direction			
Other notes			

17 Chapter Review

the BIG idea

The interaction of air masses causes changes in weather.

CONTENT REVIEW
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KEY CONCEPTS SUMMARY

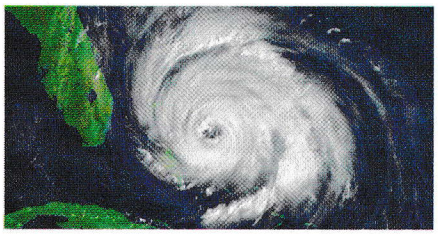
1 Weather changes as air masses move.

Air masses meet and produce **fronts,** which can bring lowered pressure and stormy weather. Fronts can be cold, warm, or stationary.

VOCABULARY
air mass p. 575
front p. 578
high-pressure system p. 580
low-pressure system p. 581

2 Low-pressure systems can become storms.

Hurricanes and winter storms develop from low-pressure systems.

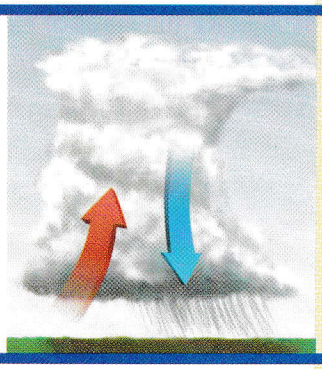


Hurricanes form over warm ocean water.

VOCABULARY
tropical storm p. 583
hurricane p. 583
storm surge p. 585
blizzard p. 586

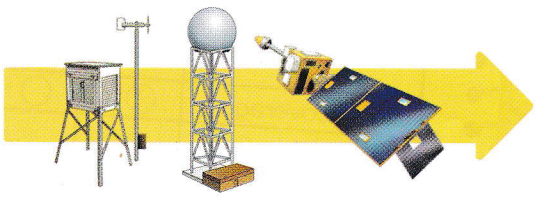
3 Vertical air motion can cause severe storms.

Rising moist air can produce **thunderstorms.** The up-and-down motion of air in a thunderstorm can produce a **tornado.**

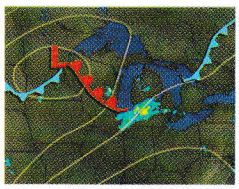


VOCABULARY
thunderstorm p. 588
tornado p. 591

4 Weather forecasters use advanced technologies.



Weather information comes from many sources.



Meteorologists use weather data and computer models to forecast weather.

VOCABULARY
meteorologist p. 594
isobar p. 597

Reviewing Vocabulary

Describe each term below, using the related term as part of the description.

Term	Related Term	Description
EXAMPLE hurricane	low-pressure system	a low-pressure system in the tropics with winds at least 120 km/h
1. front	air mass	
2. low-pressure system	low-pressure center	
3. storm surge	hurricane	
4. tropical storm	low-pressure system	
5. air mass	humidity	
6. thunderstorm	convection	
7. tornado	thunderstorm	
8. blizzard	low-pressure system	

Reviewing Key Concepts

Multiple Choice *Choose the letter of the best answer.*

9. What qualities are nearly the same at different locations in a single air mass?
- **a.** temperature and pressure
- **b.** temperature and humidity
- **c.** air pressure and wind speed
- **d.** air pressure and humidity

10. Which is the name for an air mass that forms over the ocean near the equator?
- **a.** maritime tropical
- **b.** maritime polar
- **c.** continental tropical
- **d.** continental polar

11. A meteorologist is a scientist who
- **a.** predicts meteor showers
- **b.** studies maps
- **c.** studies the weather
- **d.** changes the weather

12. An isobar shows locations with the same
- **a.** temperature
- **b.** rainfall
- **c.** air pressure
- **d.** wind speed

13. Which is produced when a warm air mass pushes a colder air mass?
- **a.** a stationary front
- **b.** a cold front
- **c.** a warm front
- **d.** a thunderstorm

14. Which can be measured in inches of mercury?
- **a.** air pressure
- **b.** temperature
- **c.** hail
- **d.** lightning

15. Which source provides measurements for just one location?
- **a.** ground station
- **b.** radar station
- **c.** weather balloon
- **d.** satellite

16. Compared with warm fronts, cold fronts are
- **a.** faster moving
- **b.** less dense
- **c.** more cloudy
- **d.** less steep

17. Which statement is usually true of high-pressure systems in North America?
- **a.** They bring fair weather.
- **b.** They change quickly.
- **c.** The air in them is cold and dense.
- **d.** The air in them moves counterclockwise.

18. Thunderstorms often begin with the rising of
- **a.** cool, dry air
- **b.** cool, humid air
- **c.** warm, dry air
- **d.** warm, humid air

19. What is the relationship between lightning and thunder?
- **a.** They have separate causes.
- **b.** They have the same cause.
- **c.** Lightning causes thunder.
- **d.** Thunder causes lightning.

Short Answer *Write a short answer to each question.*

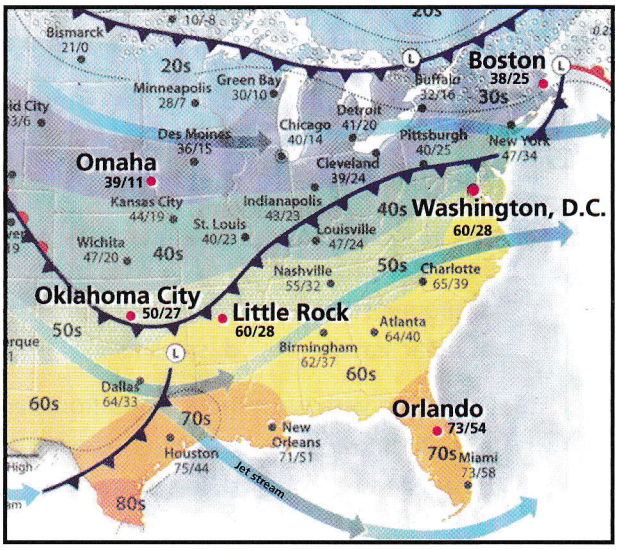
20. Why are hurricanes in the eastern United States more likely in autumn than in spring?

21. What causes lake-effect snow?

22. In what four ways can thunderstorms be dangerous?

Thinking Critically

Use this weather map to answer the next six questions. The numbers under each city name are the highest and the lowest temperature for the day in degrees Fahrenheit.



23. **INFER** Name and describe the air mass that has moved south to Omaha from Canada.

24. **IDENTIFY EFFECTS** How are two low-pressure systems affecting the weather near Boston?

25. **PREDICT** Explain whether Washington, D.C., or Orlando is more likely to have a big change in weather in the next two days.

26. **COMPARE AND CONTRAST** Explain the difference in temperature between Oklahoma City and Little Rock.

27. **PREDICT** How will the weather in Little Rock change in the next day or two?

28. **APPLY** Does this map indicate that it is hurricane season? Explain your reasoning.

29. **CONNECT** Describe today's weather and explain what fronts and pressure systems might be influencing it.

30. **COMPARE AND CONTRAST** Use a Venn diagram to compare images from visible light and infrared radiation.

PREDICT *For each set of conditions listed in the chart, write a weather prediction.*

Conditions	Prediction
31. A cold front is moving into an area that has warm, moist air.	
32. A warm front is moving into an area that has cold, dense air.	
33. A cool sea breeze is blowing inland, causing warm, humid air to rise.	
34. Air pressure is falling and the temperature is rising.	
35. Air pressure is increasing and the temperature is steady.	
36. A thunderstorm is developing spinning winds at its center.	
37. A low-pressure center is over the Atlantic Ocean where the water temperature is above 27°C (81°F).	
38. Cold air is pushing warm air where the air is 2°C (36°F) and the ground is -3°C (27°F).	

39. **COMPARE** How is the air motion in the eye of a hurricane similar to the air motion at a high-pressure center?

40. **EVALUATE** Which type of storm is most dangerous? Explain your reasoning.

the BIG idea

41. **APPLY** Look again at the photograph on pages 572–573. Now that you have finished the chapter, how would you change your response to the question on the photograph?

42. **SEQUENCE** Draw a storyboard with at least four sketches to show how cool, sunny weather might change into warm, rainy weather.

UNIT PROJECTS

Check your schedule for your unit project. How are you doing? Be sure that you have placed data or notes from your research in your project folder.

Standardized Test Practice

For practice on your state test, go to . . .
TEST PRACTICE
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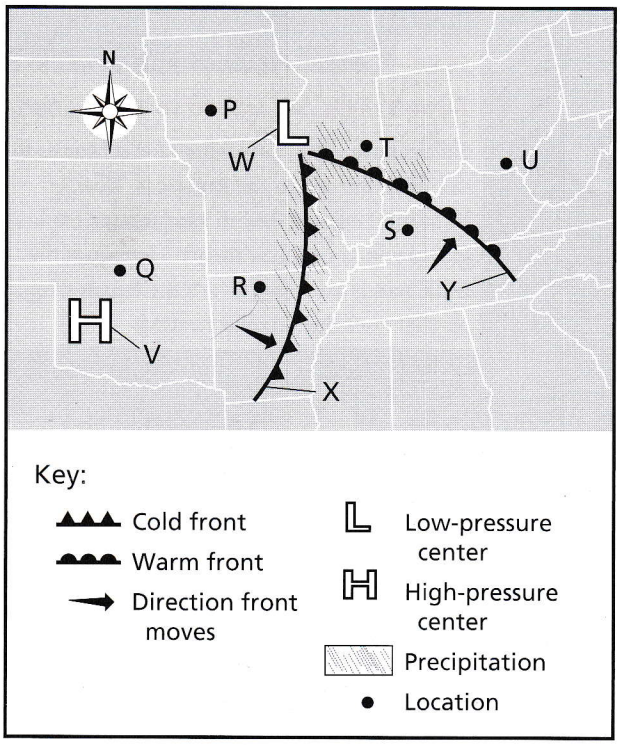
Analyzing a Map

Use this weather map to answer the questions below.



1. Which letter labels a cold front?

a. Q **c.** X

b. U **d.** Y

2. Which word best describes the general movement of the fronts?

a. to the north **c.** clockwise

b. to the east **d.** counterclockwise

3. A warm front occurs where warm air moves into colder air. Which of these locations is probably warmest?

a. R **c.** T

b. S **d.** U

4. Temperatures usually change quickly near a front and more slowly away from a front. The temperature at Q is 10°C (50°F). The temperature at S is 20°C (68°F). Which is the best estimate for the temperature at R?

a. 6°C (43°F) **c.** 20°C (68°F)

b. 11°C (52°F) **d.** 24°C (75°F)

5. If the fronts continue to move as shown, which location will get warmer soon?

a. Q **c.** S

b. R **d.** T

6. Low pressure often brings stormy weather, and high pressure often brings fair weather. Which of these locations is most likely to have clear skies?

a. Q **c.** S

b. R **d.** U

Extended Response

Use the map above to answer the two questions below in detail. Include some of the terms shown in the word box. Underline each term you use in your answers.

cold front	humid	west
warm front	east	prevailing winds

7. Along which front on the weather map above would you expect to find cumulonimbus clouds? Explain why.

8. The weather system shown on the map above is in the continental United States. In which direction do you expect it to move? Explain why.