

Chapter Quiz

Write your answers on a separate sheet of paper.

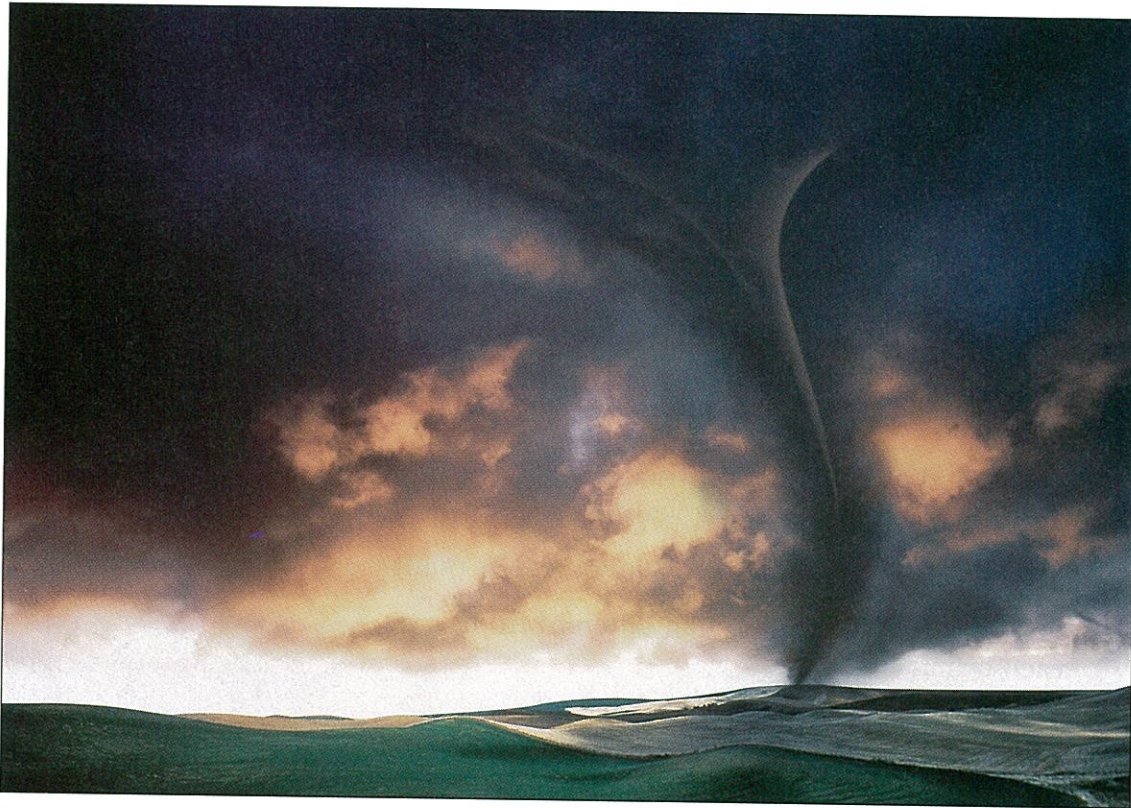
1. What are the layers of the atmosphere, starting from the nearest to the Earth?
2. What causes air pressure?
3. What happens when sunlight hits clouds?
4. How does uneven heating of the atmosphere cause winds?
5. What are three surface features that can cause local winds?
6. What kind of wind occurs when the warm air over land rises and the cold air over the ocean rushes in?
7. What happens to air cooled below the dew point?
8. How are sleet, snow, and hail different from each other?
9. What are the three main groups of clouds?
10. What kind of cloud is a thunderhead?

Test Tip

Review the pictures and captions in the chapter. Try explaining to a friend what each picture shows.

Research Project

The Beaufort scale is a scale of wind speed. Do research and write a report on the Beaufort scale. The report should describe the scale and explain how it is used. Use the Beaufort scale to estimate the wind speed near your home each day for a week. Include this information in your report.



Tornadoes are the Earth's most violent windstorms. A tornado may last only a few minutes. However, in that time, it can completely destroy buildings. What other problems might tornadoes cause?

Learning Objectives

- Compare and contrast weather and climate.
- Describe how air masses and fronts affect weather.
- Explain how air pressure affects weather.
- Identify different kinds of violent storms.
- Identify the three main types of climate.
- LAB ACTIVITY: Observe the movements of cold fronts and warm fronts.
- ON-THE-JOB SCIENCE: Relate gathering weather data to weather forecasting.

Words to Know

weather	the condition of the atmosphere at a certain time and place
climate	the average weather in a region over many years
air mass	a huge body of air that moves from place to place
front	the place where two air masses of different temperatures meet
occluded front	the front that forms when a cold front overtakes a warm front
meteorology	the scientific study of the Earth's atmosphere and weather
cumulonimbus cloud	a tall, thick, white cumulus cloud that is dark at the bottom; also known as a thunderhead
cyclone	an area of low air pressure with circling winds
hurricane	a stormy cyclone with high winds that forms over the Atlantic Ocean
typhoon	a stormy cyclone with high winds that forms over the Pacific Ocean
tornado	a cyclone that extends down from a cumulonimbus cloud and forms a funnel-shaped cloud

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Remember

Air pressure is the weight of the atmosphere pressing down on the Earth's surface. Humidity is the amount of water vapor in the air. Precipitation is any form of water that falls to the Earth's surface from clouds.

What Are Weather and Climate?

Some people live where palm trees grow. They enjoy warm **weather** all year long. Other people live where it snows throughout most of the year. They usually have cold weather. Weather is the condition of the atmosphere at a certain time and place. **Climate** is the average weather in a region over many years.

Weather and climate affect people's lives in many ways. Weather affects what people wear and what activities they can do outside. Climate affects outdoor jobs such as farming, construction, and tourism. Many people choose where to live depending on the climate.

✓ How are weather and climate different?

Air Masses

Temperature, air pressure, humidity, wind speed, clouds, and precipitation are all part of what makes up weather. However, the weather in an area changes because of air masses. An **air mass** is a huge body of air that moves from place to place.

Air masses can cover land or ocean areas. They can have high or low humidity. They can be cold or hot. An air mass over the North Pole is very cold. An air mass over the equator is very warm. As an air mass travels over an area, it can change the area's temperature or humidity.

Air masses can meet, but they do not mix together. The place where two air masses of different temperatures meet is called a **front**. Clouds and precipitation, such as rain and snow, often form at fronts.

When a warm air mass moves into a cold air mass, a *warm front* forms. As the warm air rises over the cold air, the warm air cools. As it cools, water vapor condenses and forms precipitation. There is usually rain or snow along a warm front. After a warm front passes, the temperature rises.

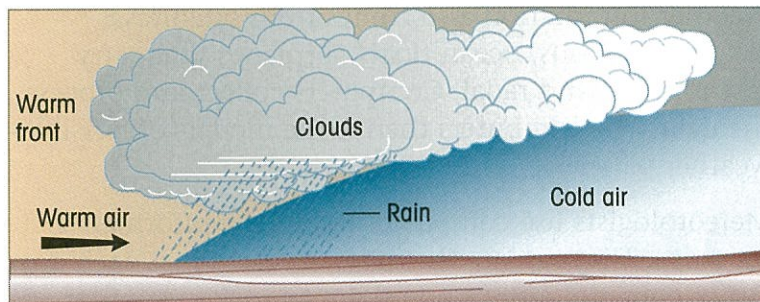


Figure 24-1 A warm front forms when a warm air mass meets and rises over a cold air mass.

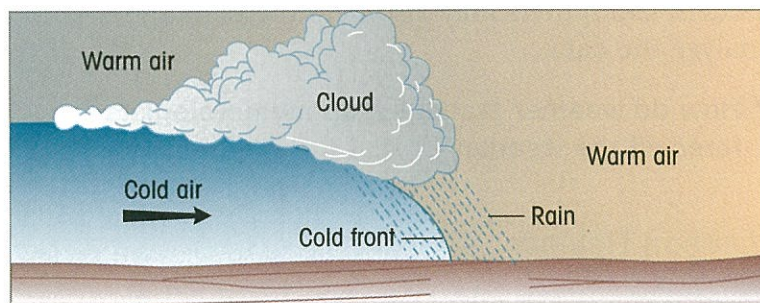


Figure 24-2 A cold front forms when a cold air mass meets and moves under a warm air mass.

When a cold air mass moves against a warm air mass, a *cold front* forms. The cold air pushes forward. This forces the warm air up over the cold air. The rising warm air quickly cools, causing short but heavy rain or snow showers. Temperatures drop as the cold front passes.

Cold fronts move much faster than warm fronts. Sometimes a cold front overtakes a warm front. This is called an **occluded front**. An occluded front produces calmer weather than a cold front or a warm front.

✓ **What is the difference between a warm front and a cold front?**

Weather Forecasting

Weather forecasting is based on **meteorology**, the scientific study of the Earth's atmosphere and weather. Information used for weather forecasts comes from many places. Weather stations have instruments that measure air pressure, humidity, wind speed and direction, air temperature, and the amount of precipitation.

Weather information also comes from satellites, weather balloons, ocean floats, airplanes that carry instruments, and radar. Computers collect and process the data. The computers then make models of possible weather patterns.

Meteorologists use computers to put the information on maps. They update the maps several times each day. Other meteorologists study the maps and computer models. Computers may also help meteorologists analyze the data.



Weather station

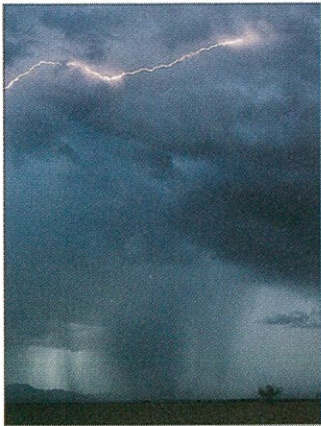
✓ **How do weather stations help meteorologists forecast the weather?**

Lesson Review

1. What happens when a cold air mass passes?
2. What are three ways meteorologists gather weather data?
3. **CRITICAL THINKING** How would our lives be different if there were no weather forecasts?

Words to Know

cumulonimbus cloud	a tall, thick, white cumulus cloud that is dark at the bottom; also known as a thunderhead
cyclone	an area of low air pressure with circling winds
hurricane	a stormy cyclone with high winds that forms over the Atlantic Ocean
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Thunderstorms can produce heavy rainfall.

Thunderstorms

A thunderstorm is a short, violent storm with rain, lightning, and thunder. It happens when warm, moist air rises quickly. The air may be forced upward by a mountain or a cold front. The warm, humid air cools quickly as it rises. This turns the moisture in the air into rain.

Thunderstorms may also occur on hot summer afternoons, when the Earth's surface heats moist air. As the warm air rises and then cools, it forms cumulus clouds. More warm air, called an *updraft*, blows up through the clouds. The updraft turns the cumulus cloud into a **cumulonimbus cloud**. Cumulonimbus clouds are tall, thick, white cumulus clouds with dark bases. You may also know them as thunderheads.

Electric charges build up in thunderheads. When these electric charges are thrown off, or *discharged*, they cause lightning. The heat from the lightning suddenly expands the air. This causes the sound of thunder.

If you are outdoors during a thunderstorm, look for shelter. If you cannot find shelter, lie down or crouch in a low spot, such as a ditch. Do not look for shelter under a tree. The tree might be hit by lightning, or the wind might break off branches.

✓ What causes thunderstorms?

Highs and Lows

If you watch weather reports on TV, you probably have heard about *highs* and *lows*. A high is an area where the air pressure is very high. A low is an area where the air pressure is very low.

Wind is moving air. It forms when air moves from high-pressure areas to low-pressure areas. Usually winds blow out from the center of a high toward a low.

Most of the time, high air pressure means clear weather. Low air pressure means rainy or stormy weather. Almost all storms are caused by lows.

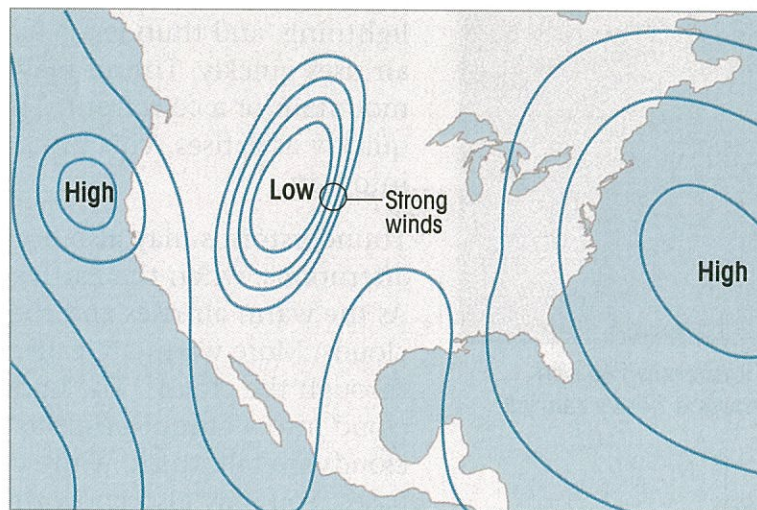


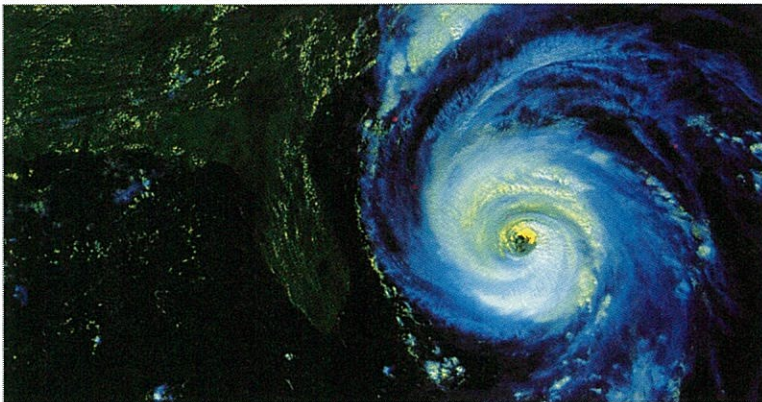
Figure 24-3 The blue lines on this weather map show the differences in air pressure. The closer the lines are to each other, the stronger the wind in that area is.

✓ What causes wind?

Low Pressure Storms

A **cyclone** is an area of low air pressure. It has circling winds. The low pressure is caused by warm air rising. Winds blow toward the opening left by the rising air. As the winds blow, they circle around the center of the low. Cyclones travel as they spin around. They move across land at a rate of 500 to 1,000 miles (800 to 1,600 kilometers) a day.

A **hurricane** is a stormy cyclone with high winds. It forms over the Atlantic Ocean near the equator. A hurricane gets energy from warm ocean water. As a hurricane moves into colder northern waters or over land, it usually weakens. However, it can do a lot of damage along the coast and cause flooding inland.



This satellite photo shows a hurricane moving toward the United States.

A storm has to have winds of at least 74 miles (119 kilometers) per hour to be a hurricane. However, hurricane winds of more than 130 miles (208 kilometers) per hour are common. A stormy cyclone with high winds that forms over the Pacific Ocean has a different name. It is called a **typhoon**.

A **tornado** is a cyclone that extends down from a cumulonimbus cloud and forms a funnel-shaped cloud. The spinning winds sometimes reach speeds of 300 miles (480 kilometers) per hour.

Science Fact



Between 1953 and 1978, hurricanes were named for women, in alphabetical order. Since 1979, the list has included male names.



Safety Alert

Always stay inside if there is a tornado warning. It is best to go to the basement. If there is no basement, stay on the ground floor. Keep away from windows. Crawl under a stairway or heavy table and cover your head.



The swirling winds of a tornado can destroy everything in its path.

Tornadoes do not cover as much ground as most cyclones. However, they are much more violent. Most of the tornadoes on Earth occur in the Great Plains and the Mississippi Valley of the United States.

✓ What are four low-pressure storms, and how are they formed?

Lesson Review

1. Why does lightning form in thunderstorms?
2. What kind of weather does high air pressure bring? What does low air pressure bring?
3. **CRITICAL THINKING** Why do hurricanes get weaker over cold water and land?

A Closer Look

MORE ABOUT HURRICANES

Hurricanes produce strong winds. They also produce heavy rain and *storm surges*. A storm surge is a rise in sea level that is caused by winds pushing seas onto the shore. About 90 percent of hurricane deaths are caused by flooding, not by wind.

The Saffir-Simpson scale measures the wind speed of hurricanes. The category number tells the strength and amount of damage they can cause.

Hurricanes are violent storms, except at their centers. The center of a hurricane is called its eye. The eye is usually about 20 miles (32 kilometers) across. There are no winds in the eye. The air pressure in the eye is extremely low. The sun might even shine in the eye of a hurricane.

CRITICAL THINKING Why do people sometimes think a hurricane has ended when the eye passes over?

The Saffir-Simpson Scale

Category	Wind Speed (miles per hour)	Damage
1	74–95	Minor
2	96–110	Moderate
3	111–130	Extensive
4	131–155	Extreme
5	more than 155	Catastrophic

What Affects Climate?

Many things affect an area's climate, such as latitude, mountains, water, and ocean currents.

Latitude

Regions near the equator get a lot of sunlight. The rays of the sun strike the Earth most directly at the equator. Near the poles, the rays spread out over a much larger area. This makes the rays weaker. The sun's rays also lose some of their energy as they pass through the denser atmosphere near the poles.

Mountains

Mountains can affect climate. They stop the flow of moist winds. The land on the side of a mountain facing the wind gets a lot of rainfall. This happens because winds drive clouds over the mountains. As the clouds rise, they cool and drop rain or snow. After crossing the mountain, the winds are drier. Often a desert is on the *leeward* side of a mountain, which is the side away from the wind.

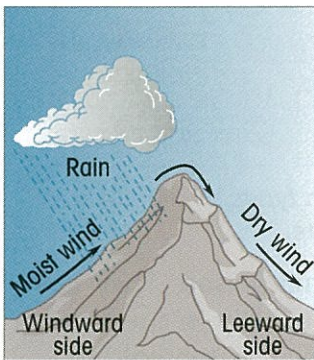


Figure 24-4 Warm air rises and drops its rain on the windward side of mountains.

Water

Large bodies of water affect climate, too. This is because water absorbs and holds heat well. Places near water have milder temperatures all year than places inland.

Ocean Currents

Ocean currents also affect climate. For example, the warm Gulf Stream current flows across the northern Atlantic Ocean toward Europe. This current warms the winter air over northwestern Europe.

✓ What are four things that affect climate?

Types of Climate

The three main types of climate zones are *tropical*, *polar*, and *temperate*. Tropical climate zones are very warm and have no true winter season. These climates often have heavy rainfall. Hawaii has a tropical climate.

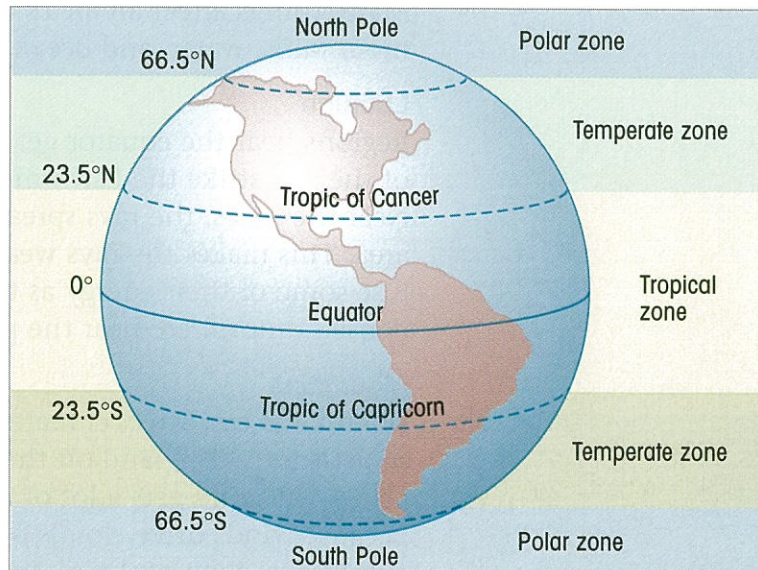


Figure 24-5 *The Earth has three main types of climate. They are tropical, polar, and temperate.*

Polar climates have no true summer season. They have only a little precipitation. This is usually in the form of fine, dry snow. This is because the air is too cold to hold much water. Northern Alaska has a polar climate.

Temperate climates are warmer than polar climates. They are also cooler than tropical climates. Summers are warm. Winters are cold. The precipitation varies. Most of the United States has a temperate climate.

Any kind of climate can be dangerous for people. People can get frostbite from being out in the cold and wind too long. Exposure to too much sun can cause sunburn. High heat and humidity can cause heat stroke.

✓ **What are the three main types of climates? How are they different?**

Lesson Review

1. How can mountains affect climate?
2. How are seasons in polar climates different from seasons in tropical climates?
3. **CRITICAL THINKING** Which climate would require the greatest variety of clothing? Why?

Great Moments in Science

BENJAMIN BANNEKER AND THE *FARMER'S ALMANAC*

Benjamin Banneker was an African-American scientist and inventor who lived at the time of the American Revolution. Most African Americans were slaves at that time. Banneker was a free man who owned his own farm.

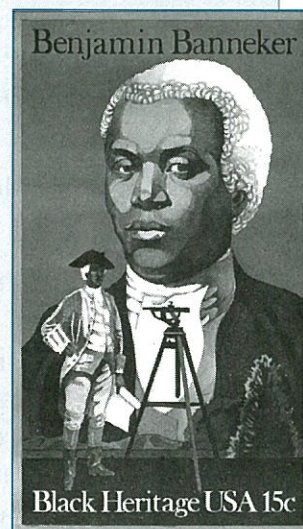
Banneker was excellent at math. The new president, George Washington, had heard of his skill. Banneker was invited to help do a land survey of the new country's capital in Washington, D.C.

In Banneker's time, most families had an almanac. An almanac is a book of dates, information, and weather forecasts. Since most Americans were farmers, this book was very important. Banneker decided to create his own almanac.

Banneker farmed by day and studied the sky at night. He used a compass and ruler to measure the movements of the sun and moon. He calculated exactly when the tides would come in and how high they would be. He used a telescope to study the rising and setting of the stars and planets. Then he forecast the weather for the coming year based on what he saw and calculated.

Banneker's almanac was a great success. Farmers all over the new United States used it. By 1797, at least 28 different versions of Banneker's *Farmer's Almanac* had been printed.

CRITICAL THINKING Why would an almanac be important to farmers?



Benjamin Banneker (1731–1806) was one of the first African-American scientists. The picture above shows him on a postage stamp.



LAB ACTIVITY

Observing Fronts

BACKGROUND

If you watch the weather, you can tell when a cold front or warm front has passed. A cold front often brings a short, heavy burst of rain or snow. Then the temperature drops. A warm front often brings a longer period of lighter precipitation. Then the temperature rises.

PURPOSE

You will observe the weather for three days to identify the passing of fronts.

MATERIALS

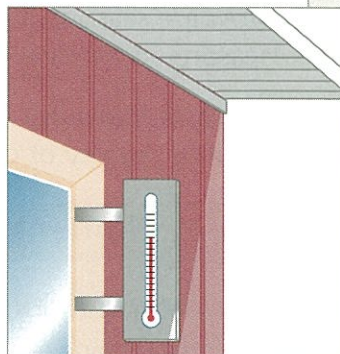
paper, pen, outdoor thermometer

WHAT TO DO

1. Make three copies of the chart to the right.
2. Set up a thermometer outside where you can take readings. Put it in a protected area that is not in direct sunlight.
3. Observe the weather four times during the day: 10:00 A.M., 12:00 noon, 2:00 P.M., and 4:00 P.M. Fill in and date your chart during each observation. Include the temperature reading on the thermometer; the type of precipitation if any; and whether the wind is strong, light, or calm (no wind).
4. Repeat Step 3 for two more days. Record your observations on your other two charts.

DRAW CONCLUSIONS

- Did you observe the passing of any fronts?
- If fronts did pass, what kind were they? Explain how you know.



Measure the outdoor temperature in the shade.

Date: ____	Temperature	Precipitation	Wind
10:00 A.M.			
12:00 NOON			
2:00 P.M.			
4:00 P.M.			

ON-THE-JOB SCIENCE

Television Meteorologist

Jane Franklin is a television meteorologist. Each day people see her weather forecast on TV. During weather emergencies, such as tornadoes, Jane gives information that helps people stay safe.

When Jane was growing up, she loved to watch clouds and lightning in the sky. She wanted to know how storms occur and why weather changes each day. After high school, Jane earned a degree in meteorology at college.

Jane could have worked for the National Weather Service, an airline, the military, or a university. However, Jane wanted to do weather forecasts for a TV station.

Jane's TV station has a computer that gets weather data and forecasts from the National Weather Service. They have radar and satellite photos that show approaching storms. Jane uses all of this data to come up with her own forecasts each day. She also uses the data to create weather maps. Jane writes her own script for the TV weather report. If there is severe weather, such as a flood or tornado, she works extra hours.

Jane made this chart of weather data one day. Use it to answer the questions below.

	12:00 NOON	1:00 P.M.	2:00 P.M.	3:00 P.M.	4:00 P.M.
Temperature	80°F	83°F	84°F	82°F	75°F
Precipitation	—	—	Rain	Rain	—

1. At what time was the temperature the highest?
2. At which times was rain recorded?
3. What happened to the temperature after the rain?



It takes Jane several hours to prepare for the 6:00 P.M. news.

Critical Thinking

Jane lives in a temperate climate zone. During which season were these readings recorded? Explain your answer.

Summary

Weather is the day-to-day condition of the atmosphere. Climate is the average weather in a region over many years. Both weather and climate affect people's lives.

Lesson 24.1

Air masses take on the characteristics of the land or water below them. Fronts are formed when two air masses meet. The National Weather Service gathers weather information. Meteorologists use this data to make forecasts.

Lesson 24.2

Severe storms are caused by low air pressure. Winds rush in to low-pressure centers. A cyclone is an area of low pressure. Hurricanes and typhoons are stormy cyclones. Tornadoes extend down from cumulonimbus clouds.

Lesson 24.3

The three main climates are tropical, polar, and temperate. Climate is affected by location, land features, and water.

Vocabulary Review

Match each definition with a term from the list.

1. The average weather in a region over many years
2. The study of the atmosphere and weather
3. A huge body of air that moves from place to place
4. A stormy cyclone that forms over the Pacific Ocean
5. A stormy cyclone that forms over the Atlantic Ocean
6. Where cold and warm air masses meet
7. The condition of the atmosphere at a certain time and place
8. A cyclone that extends down from a cumulonimbus cloud and forms a funnel-shaped cloud

air mass

climate

front

hurricane

meteorology

tornado

typhoon

weather

Chapter Quiz

Write your answers on a separate sheet of paper.

1. Which is more likely to change day to day, climate or weather?
2. How do air masses affect weather?
3. How does a cold front affect the weather?
4. How does an occluded front affect the weather?
5. What kind of weather do cumulonimbus clouds bring?
6. What type of weather would you find in a high-pressure area? What type would you find in a low-pressure area?
7. How are hurricanes and typhoons alike?
8. How do mountains affect weather?
9. Why is there so little precipitation in polar climates?
10. How are tropical and temperate climates different?

Test Tip

Read all of the direction lines before you begin a test. If you do not understand some of them, ask your teacher to explain what you have to do *before* you start to write.

Research Project

Choose an important recent weather event in your area. Find a newspaper or magazine article or an Internet site about how this event affected your community. Then write a report about the event. If possible, interview someone in your community or write to someone at a disaster relief organization. Ask about his or her experiences during the event. Add the person's comments to the report.

Unit 6 Review

Choose the letter for the correct answer to each question.

Use the diagram to answer Questions 1 to 3.



- Which layer of the Earth does a globe show?
 - inner core
 - outer core
 - crust
 - mantle
- What are the north-south lines on a globe called?
 - equator lines
 - lines of latitude
 - lines of longitude
 - degree lines
- What happens to time if you go from the Eastern time zone in New York City to the Pacific time zone in San Francisco?
 - The time does not change.
 - You gain several hours.
 - You lose several hours.
 - You lose one whole day.
- Which kind of plates form the Earth's crust?
 - plates of melted rock
 - plates of solid rock that slowly shift position
 - plates of solid rock that do not move
 - plates that hold only the continents
- Which type of rock forms from particles pressed together?
 - sedimentary rock
 - marble rock
 - igneous rock
 - metamorphic rock
- In which layer of the atmosphere can you find the Earth's weather?
 - thermosphere
 - mesosphere
 - stratosphere
 - troposphere
- Which front forms when a warm air mass moves into a cold air mass?
 - a cold front
 - an occluded front
 - a hot front
 - a warm front

Critical Thinking

Which climate is probably easiest to live in: tropical, polar, or temperate? Explain your answer.