Name _____ Class _____ Date _____

CHAPTER 16 Understanding Weather

SECTION 3

Severe Weather

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What are some types of severe weather?
- How can you stay safe during severe weather?

National Science Education Standards

ES 1i, 1j

What Causes Thunderstorms?

A **thunderstorm** is an intense storm with strong winds, heavy rain, lightning, and thunder. Many thunderstorms happen along cold fronts. However, thunderstorms can also happen in other areas. Two conditions are necessary for a thunderstorm to form: warm, moist air near Earth's surface and an unstable area of the atmosphere.

The atmosphere is unstable when a body of cold air is found above a body of warm air. The warm air rises and cools as it mixes with the cool air. When the warm air reaches its dew point, the water vapor condenses and forms cumulus clouds. If the warm air keeps rising, the clouds may become dark cumulonimbus clouds.

STUDY TIP

Describe After you read this section, make a flow chart showing how a tornado forms.

Critical Thinking

1. Infer Why does air near the surface have to be moist in order for a thunderstorm to form?

_____

_____

_____

LIGHTNING

As a cloud grows bigger, parts of it begin to develop electrical charges. The upper parts of the cloud tend to become positively charged. The lower parts tend to become negatively charged. When the charges get big enough, electricity flows from one area to the other. Electricity may also flow between the clouds and the ground. These electrical currents are **lightning**. ☑

READING CHECK

2. Describe How does lightning form?

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_____

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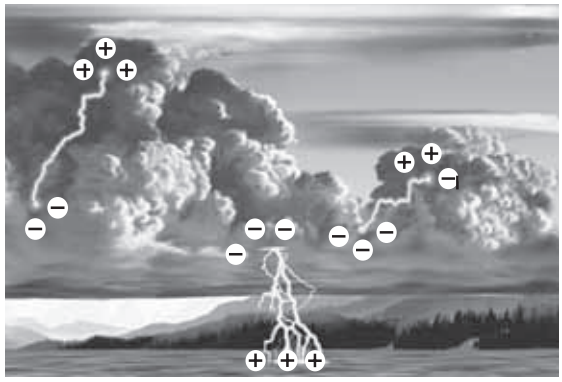

Different parts of thunderclouds and the ground can have different electrical charges. When electricity flows between these areas, lightning forms.

THUNDER

You have probably seen large lightning bolts that travel between the clouds and the ground. When lightning moves through the air, the air gets very hot. The hot air expands rapidly. As it expands, it makes the air vibrate. The vibrations release energy in the form of sound waves. The result is **thunder**. ☑

READING CHECK

3. Define What is thunder?

_____

_____

_____

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SEVERE THUNDERSTORMS

Severe thunderstorms can cause a lot of damage. They can produce strong winds, hail, flash floods, or tornadoes. Hail can damage crops, cars, and windows. Flash flooding from heavy rain can cause serious property damage. Flash flooding is the leading cause of weather-related deaths. Lightning can start fires and cause injuries and deaths.

How Do Tornadoes Form?

Fewer than 1% of thunderstorms produce tornadoes. A **tornado** can form when a rapidly spinning column of air, called a *funnel cloud*, touches the ground. The air in the center of a tornado has low pressure. When the area of low pressure touches the ground, material from the ground can be sucked up into the tornado. ☑

READING CHECK

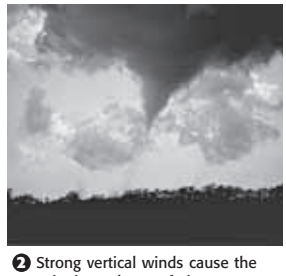
4. Explain Why can material be sucked up into a tornado?

_____

_____

A tornado begins as a funnel cloud that pokes through the bottom of a cumulonimbus cloud. The funnel cloud becomes a tornado when the funnel cloud touches the ground. The pictures below show how a tornado forms.

❶ Wind moving in opposite directions causes a layer of air in the middle of a cloud to begin to spin.



❷ Strong vertical winds cause the spinning column of air to turn into a vertical position.

❸ The spinning column of air moves to the bottom of the cloud and forms a funnel cloud.

❹ The funnel cloud becomes a tornado when it touches down on the ground.

TAKE A LOOK

5. Describe When does a funnel cloud become a tornado?

_____

_____

TORNADO FACTS

About 75% of the world's tornadoes happen in the United States. Most happen in the spring and early summer. During these times, cold, dry air from Canada meets warm, moist air from the Tropics. This causes the thunderstorms that produce tornadoes.

Most tornadoes last for only a few minutes. However, their strong, spinning winds can cause a lot of damage. An average tornado has wind speeds between 120 km/h and 180 km/h, but some can be much higher. Winds from tornadoes can tear up trees and destroy buildings. They can even be strong enough to lift cars and trailers up into the air. The area damaged by a tornado is usually about 8 km long and 10 to 60 m wide.

Math Focus

6. Convert What is the average wind speed in a tornado in miles per hour?

1 km = 0.62 mi.

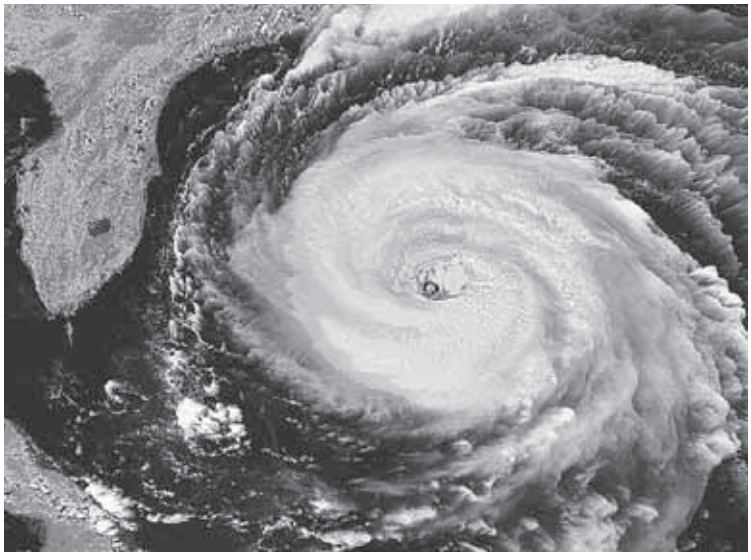
How Do Hurricanes Form?

A **hurricane** is a large, rotating tropical weather system. Hurricanes have wind speeds of over 120 km/h. They can be 160 km to 1,500 km in diameter and can travel for thousands of miles. They are the most powerful storms on Earth. Hurricanes are also called typhoons and cyclones.

Most hurricanes form between 5°N and 20°N latitude or between 5°S and 20°S latitude. They form over the warm, tropical oceans found at these latitudes. At higher latitudes, the water is too cold for hurricanes to form. ☑

READING CHECK

7. Explain Why don't hurricanes form at high latitudes?



Hurricanes can be so large that they are visible from space. This photograph of a hurricane was taken by a satellite.

HOW HURRICANES FORM

A hurricane begins as a group of thunderstorms traveling over tropical ocean waters. Winds traveling in two different directions meet and cause the storm to spin. Because of the Coriolis effect, hurricanes rotate counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. ☑

READING CHECK

8. Explain What causes hurricanes to rotate in different directions in the Northern and Southern Hemispheres?

_____

Hurricanes are powered by solar energy. The sun's energy causes ocean water to evaporate. As the water vapor rises in the air, it cools and condenses. A group of thunderstorms form and produce a large, spinning storm. A hurricane forms as the storm gets stronger.

TAKE A LOOK

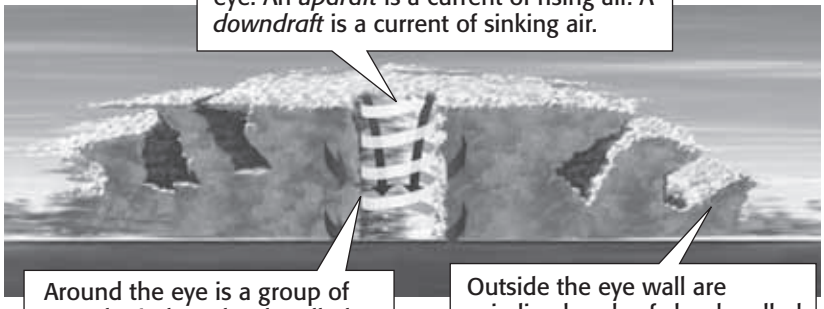
9. Define What is the eye of a hurricane?

_____

_____

_____

_____



At the center of the hurricane is the eye. The *eye* is a core of warm, relatively calm air with low pressure and light winds. There are updrafts and downdrafts in the eye. An *updraft* is a current of rising air. A *downdraft* is a current of sinking air.

Around the eye is a group of cumulonimbus clouds called the *eye wall*. These clouds produce heavy rain and strong winds. The winds can be up to 300 km/h. The eye wall is the strongest part of the hurricane.

Outside the eye wall are spiraling bands of clouds called *rain bands*. These bands also produce heavy rain and strong wind. They circle the center of the hurricane.

The hurricane will continue to grow as long as it is over warm ocean water. When the hurricane moves over colder waters or over land, the storm loses energy. This is why hurricanes are not common in the middle of continents. The storms lose their energy quickly when they move over land.

DAMAGE CAUSED BY HURRICANES

Hurricanes can cause serious damage when they move near or onto land. The strong winds from hurricanes can knock down trees and telephone poles. They can damage or destroy buildings and homes.

Many people think that the winds are the most damaging part of a hurricane. However, most of the damage from hurricanes is actually caused by flooding from heavy rains and storm surges. A *storm surge* is a rise in sea level that happens during a storm. A storm surge from a hurricane can be up to 8 m high. The storm-surge flooding from Hurricane Katrina in 2005 caused more damage than the high-speed winds from the storm. ☑

READING CHECK

10. Define What is a storm surge?

_____

_____

How Can You Stay Safe During Severe Weather?

Severe weather can be very dangerous. During severe weather, it is important for you to listen to a local TV or radio station. Severe-weather announcements will tell you where a storm is and if it is getting worse. Weather forecasters use watches and warnings to let people know about some kinds of severe weather. A *watch* means that severe weather may happen. A *warning* means that severe weather is happening somewhere nearby.

The table below gives ways to stay safe during different kinds of severe weather. ☑

READING CHECK

11. Explain Why should you listen to weather reports during severe weather?

_____

_____

Severe weather	How to stay safe
Thunderstorms	If you are outside, stay away from tall objects that can attract lightning. If you are in an open area, crouch down. Stay away from water. If you are inside, stay away from windows.
Tornadoes	During a tornado warning, find shelter quickly in a basement or cellar. If you cannot get to a basement, go to a windowless room in the center of the building (such as a closet or bathroom). If you are outside, lie down in an open field or a deep ditch.
Floods	Find a high place to wait out the flood. Always stay out of floodwaters.
Hurricanes	Protect the windows in your home by covering them with wood. Stay inside during the storm. If you are told to leave your home, do so quickly and calmly.

Name _____ Class _____ Date _____

Section 3 Review

NSES ES 1i, 1j

SECTION VOCABULARY

hurricane a severe storm that develops over tropical oceans and whose strong winds of more than 120 km/h spiral in toward the intensely low-pressure storm center

lightning an electric discharge that takes place between two oppositely charged surfaces, such as between a cloud and the ground, between two clouds, or between two parts of the same cloud

thunder the sound caused by the rapid expansion of air along an electrical strike

thunderstorm a usually brief, heavy storm that consists of rain, strong winds, lightning, and thunder

tornado a destructive, rotating column of air that has very high wind speeds and that may be visible as a funnel-shaped cloud

1. Explain Why do thunder and lightning usually happen together?

2. Identify How can severe thunderstorms cause damage?

3. Identify Where do most tornadoes happen?

4. Explain Why do most tornadoes happen in the spring and early summer?

5. Analyze How does energy from the sun power hurricanes?

6. Describe When do hurricanes lose energy?

7. Identify Give three ways to stay safe if you are caught outside in a thunderstorm.

4. about 30 g/cm^3
5. 10 g/m^3 ÷ 23 g/m^3 = 0.43
   0.43 × 100 = 43% relative humidity
6. Humidity is the absolute amount of water vapor in the air. Relative humidity is a measure of how saturated with water vapor the air is.
7. wet-bulb and dry-bulb thermometers
8. about 87%
9. Water vapor condenses into liquid water.
10. The glasses are as cold as the air outside. They absorb heat from the air inside. As a result, the air inside cools below its dew point. Water condenses on the glasses.
11. water vapor in the air
12. by shape and by altitude
13. A nimbostratus cloud is producing precipitation.
14. water that falls to Earth from clouds
15. They get bigger.
16. several ice crystals joined together
17. when it is too heavy to be carried by updrafts

Review

1. Possible answer: Water can condense from air that is below its dew point.
2. the sun
3. Air rises and cools. When it cools below its dew point, water vapor condenses to form liquid water droplets or ice crystals. These droplets or ice crystals form a cloud.
4. Sleet forms when liquid water freezes in clouds and falls to the ground as ice. Snow forms when water vapor turns directly into a solid.
5.

Name	Altitude	Shape	Precipitation?
Cirro-stratus	high	layered	no
Alto-cumulus	middle	puffy	no
Nimbo-stratus	low	layered	yes
Cumulo-nimbus	low to middle	puffy	yes

SECTION 2 AIR MASSES AND FRONTS

1. by water content and temperature of the air
2. dry, warm
3. northern Canada
4. Warm air masses form over warm water or land, and the North Atlantic and Pacific are cold.
5.

Air mass	How it affects weather
cP from northern Canada	very cold winter weather and cool, dry summer weather
mP from the North Pacific Ocean	rain and snow in the Pacific in the winter, fog in the summer
mT from the Gulf of Mexico	heat, humidity, hurricanes, thunderstorms in East Coast and Midwest
cT from the deserts	clear, dry, hot weather in the summer

6. a place where two or more air masses meet
7. It rises because the cold air pushes it up.
8. a place where a warm air mass moves over a cold air mass
9. The cold air masses push it out of the way.
10. Stationary fronts do not move, so the weather they bring stays in one place.
11. Cyclones have lower pressures than surrounding areas, but anticyclones have higher pressures. Cyclones bring rainy or stormy weather, but anticyclones bring dry, clear weather.
12. anticyclone to cyclone

Review

1. A front is a place where two air masses meet.
2. First row, from left to right: rises and cools; cloudy, rainy, and stormy
   Second row, from left to right: ... higher than surrounding pressure; dry and clear
3. cold, warm, occluded, stationary
4. Pacific Ocean, Atlantic Ocean, Gulf of Mexico
5. cT

SECTION 3 SEVERE WEATHER

1. It must contain enough water vapor to form clouds.
2. Electricity travels between an area with a positive charge and an area with a negative charge.
3. sound produced by vibrations in expanding air that was superheated by lightning
4. The center of the tornado has low pressure.
5. when it touches the ground
6. 74 mph to 112 mph
7. Ocean water is too cold there.
8. the Coriolis effect
9. the center of the hurricane that contains warm, fairly calm air with low pressure

10. a rise in sea level because of a storm
11. to learn where the storm is and whether it is getting worse

Review

1. Lightning superheats the air to produce thunder.
2. They can produce strong winds, tornadoes, hail, or flash floods.
3. in the United States
4. Cold, dry air from Canada meets warm, moist air from the Tropics, producing thunderstorms.
5. Solar energy causes water to evaporate. As it rises, cools, and condenses, it releases the energy. Thunderstorms form, which can combine to form hurricanes.
6. when they move over cooler water or land
7. If you are outside, stay away from tall objects that can attract lightning. If you are in the open, crouch down. Stay away from water.

SECTION 4 FORECASTING THE WEATHER

1. information on atmospheric conditions
2. The balloons transmit the data using radio signals.
3. Possible answer: Wind direction can indicate which way a weather system is moving.
4. a device that measures wind speed
5. Locate weather systems; determine how much precipitation is being produced.
6. NWS, NOAA
7. 27°F
8. No, because the air temperature is above the dew point (temperature).
9. The three **H**s on the map should be circled.

Review

1. An anemometer measures wind speed; windsocks and wind vanes measure only wind direction.
2. temperature, pressure, relative humidity
3. tracking storms, imaging weather systems, measuring wind speed/humidity/temperature from different altitudes
4. Station A has higher air temperatures and higher wind speeds.
5. Station A: southwest

   Station B: north

Chapter 17 Climate

SECTION 1 WHAT IS CLIMATE?

1. temperature and precipitation
2. The sun's energy is focused on a small area.
3. The equator receives about the same amount of sunlight all year round.
4. differences in air pressure
5. west to east
6. Temperature decreases as elevation increases.
7. The air cools as it rises and drops below its dew point.
8. Water absorbs and releases heat more slowly than land, so the water helps to stabilize the temperatures on land.
9. The cool water absorbs heat from the air, causing the temperature of the air to decrease.
10. a warm current
11. latitude
12. tropical zone
13. The climate of an area affects the organisms that live there.
14. along the equator

Review

1. Climate describes the average weather conditions in an area over a long period of time. Weather describes the state of the atmosphere in a specific location at a specific point in time.
2. San Diego receives more sunlight because it lies closer to the equator.
3. Earth is tilted on its axis of rotation, causing some areas to receive more sunlight during some parts of the year than during others.
4. latitude, large bodies of water, topography, ocean currents, winds
5. Air rises to move over a mountain. The air cools as it rises, causing the water vapor in the air to condense into clouds. Precipitation falls on the windward side of the mountain, causing the area to have a wet climate. The air rises over the mountain and sinks. As it sinks, it gets warmer and causes water to evaporate from the land on the other side of the mountain. As a result, the far side of the mountain has a dry climate.