Section 3

Terms to Learn

thunderstorm
lightning
thunder
tornado
hurricane

What You'll Do

- Explain what lightning is.
- Describe the formation of thunderstorms, tornadoes, and hurricanes.
- Describe the characteristics of thunderstorms, tornadoes, and hurricanes.

Severe Weather

Weather in the mid-latitudes can change from day to day. These changes result from the continual shifting of air masses. Sometimes a series of storms will develop along a front and bring severe weather. *Severe weather* is weather that can cause property damage and even death. Examples of severe weather include thunderstorms, tornadoes, and hurricanes. In this section you will learn about the different types of severe weather and how each type forms.

Thunderstorms

Thunderstorms, as shown in **Figure 17,** are small, intense weather systems that produce strong winds, heavy rain, lightning, and thunder. As you learned in the previous section, thunderstorms can occur along cold fronts. But that's not the only place they develop. There are only two atmospheric conditions required to produce thunderstorms: the air near the Earth's surface must be warm and moist, and the atmosphere must be unstable. The atmosphere is unstable when the surrounding air is colder than the rising air mass. As long as the air surrounding the rising air mass is colder, the air mass will continue to rise.

Thunderstorms occur when warm, moist air rises rapidly in an unstable atmosphere. When the warm air reaches its dew point, the water vapor in the air condenses, forming cumulus clouds. If the atmosphere is extremely unstable, the warm air will continue to rise, causing the cloud to grow into a dark, cumulonimbus cloud. These clouds can reach heights of more than 15 km.

Figure 17 *A typical thunderstorm produces approximately 470 million liters of water and enough electricity to provide power to the entire United States for 20 minutes.*

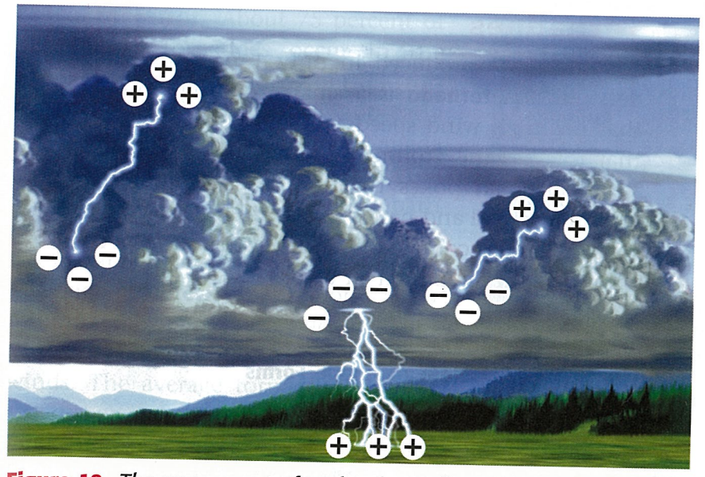


Figure 18 *The upper part of a cloud usually carries a positive electrical charge, while the lower part of the cloud carries mainly negative charges.*

Lightning Thunderstorms are very active electrically. **Lightning** is a large electrical discharge that occurs between two oppositely charged surfaces, as shown in **Figure 18.** Have you ever touched someone after scuffing your feet on the carpet and received a mild shock? If so, you have experienced how lightning forms. While walking around, friction between the floor and your shoes builds up an electrical charge in your body. When you touch someone else, the charge is released.

When lightning strikes, energy is released. This energy is transferred to the air and causes the air to expand rapidly and send out sound waves. **Thunder** is the sound that results from the rapid expansion of air along the lightning strike.

Severe Thunderstorms Severe thunderstorms produce one or more of the following conditions—high winds, hail, flash floods, and tornadoes. Hailstorms damage crops, dent the metal on cars, and break windows. Sudden flash flooding due to heavy rains causes millions of dollars in property damage annually and is the biggest cause of weather-related deaths.

Lightning, which occurs with all thunderstorms, is responsible for thousands of forest fires each year in the United States. Lightning also kills or injures hundreds of people a year in the United States.

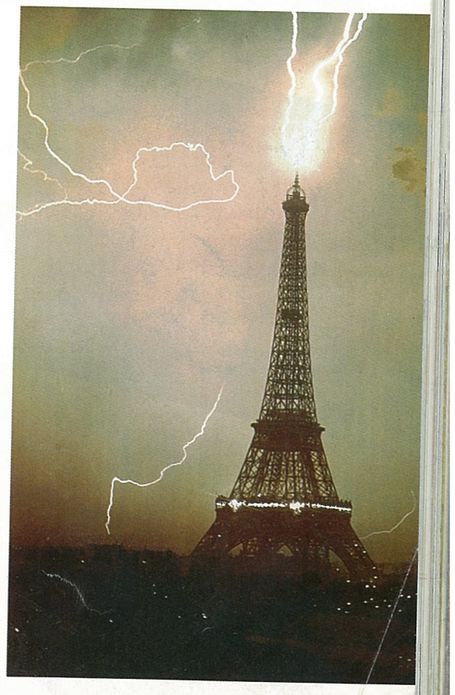


Figure 19 *Lightning often strikes the highest object in an area.*

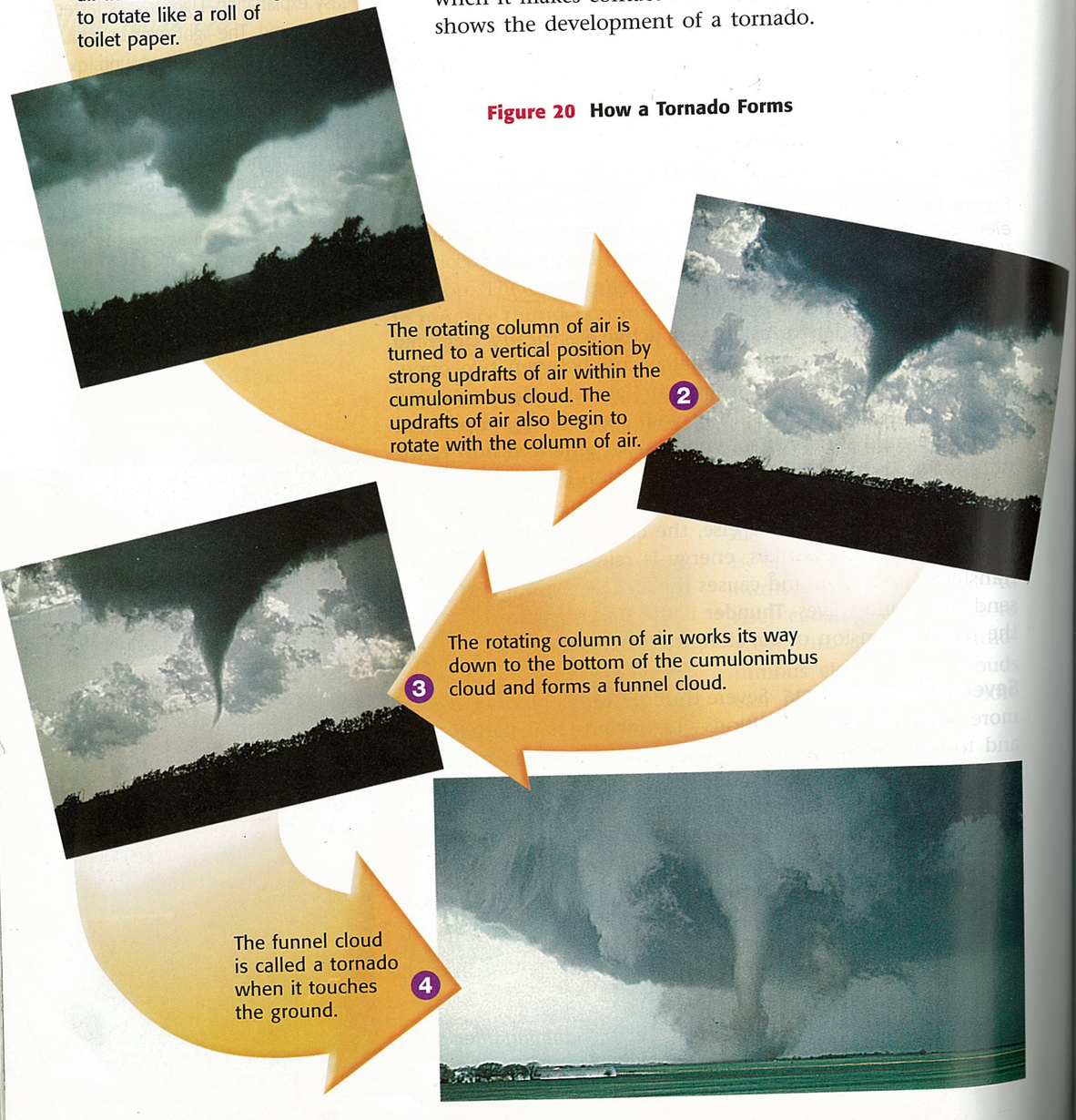
Physics CONNECTION

Have you ever wondered why you don't see lightning and hear thunder at the same time? Well, there's an easy explanation. Light travels faster than sound. The light reaches you almost instantly, but the sound travels only 1 km every 3 seconds. The closer the lightning is to where you are, the sooner you will hear the thunder.

Tornadoes

Tornadoes are produced in only 1 percent of all thunderstorms. A **tornado** is a small, rotating column of air that has high wind speeds and low central pressure and that touches the ground. A tornado starts out as a funnel cloud that pokes through the bottom of a cumulonimbus cloud and hangs in the air. It is called a tornado when it makes contact with the Earth's surface. **Figure 20** shows the development of a tornado.

Figure 20 How a Tornado Forms



Twists of Terror About 75 percent of the world's tornadoes occur in the United States. The majority of these tornadoes happen in the spring and early summer when cold, dry air from Canada collides with warm, moist air from the Tropics. The length of a tornado's path of destruction can vary, but it is usually about 8 km long and 10–60 m wide. Although most tornadoes last only a few minutes, they can cause a lot of damage. This is due to their strong spinning winds. The average tornado has wind speeds between 120 and 180 km/h, but rarer, more violent tornadoes can have spinning winds up to 500 km/h. The winds of tornadoes have been known to uproot trees and destroy buildings, as shown in **Figure 21.** Tornadoes are capable of picking up heavy objects, such as mobile homes and cars, and hurling them through the air.

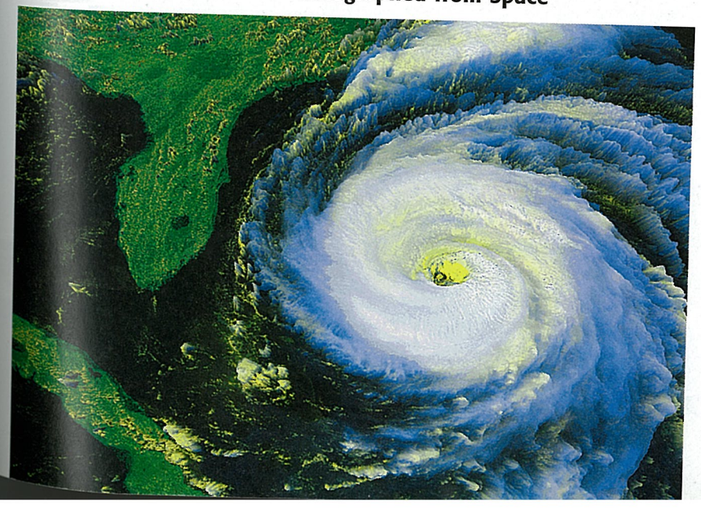
Figure 21 *The tornado that hit Kissimmee, Florida, in 1998 had wind speeds of up to 416 km/h.*

Hurricanes

A **hurricane,** as shown in **Figure 22,** is a large, rotating tropical weather system with wind speeds of at least 119 km/h. Hurricanes are the most powerful storms on Earth. Hurricanes have different names in other parts of the world. In the western Pacific Ocean, they are called *typhoons*. Hurricanes that form over the Indian Ocean are called *cyclones*.

Hurricanes generally form in the area between 5° and 20° north and south latitude over warm, tropical oceans. At higher latitudes, the water is too cold for hurricanes to form. Hurricanes vary in size from 160 km to 1,500 km in diameter, and they can travel for thousands of miles.

Figure 22 Hurricane Fran Photographed from Space



Did you know that fish have been known to fall from the sky? Some scientists think the phenomenon of raining fish is caused by waterspouts. A waterspout is a tornado that occurs over water.

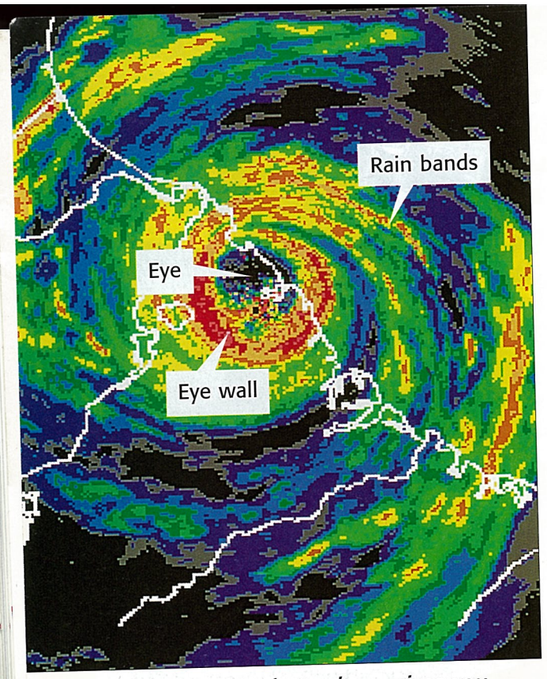
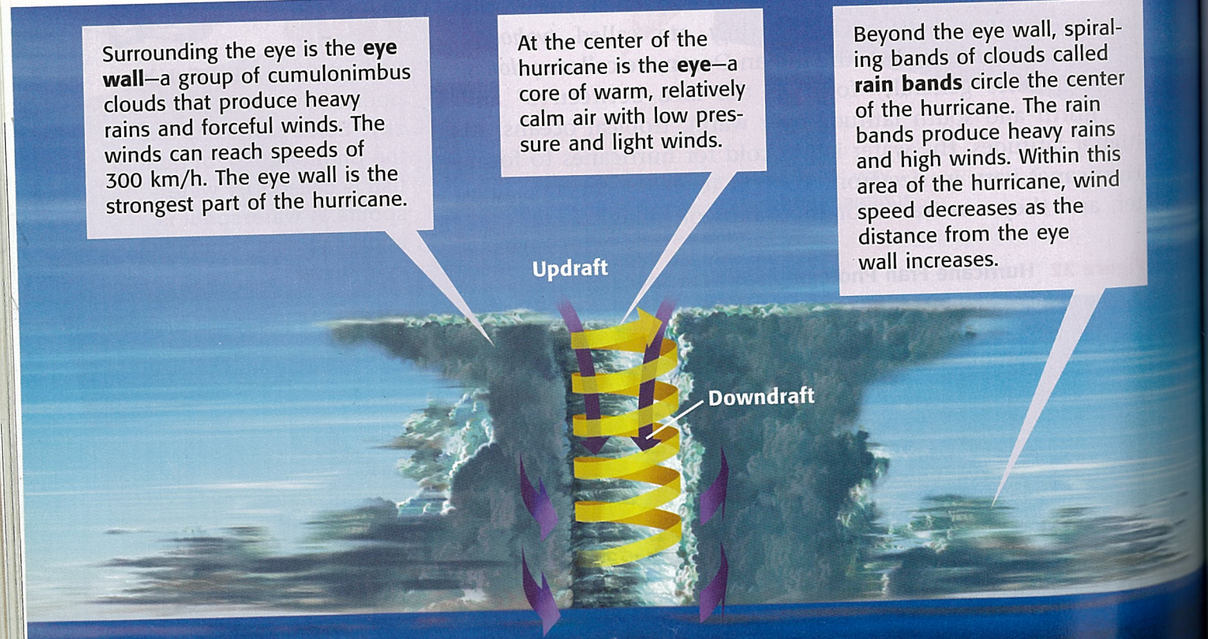


Figure 23 *The photo above gives you a bird's-eye view of a hurricane.*

Formation of a Hurricane A hurricane begins as a group of thunderstorms moving over tropical ocean waters. Winds traveling in two different directions collide, causing the storm to rotate over an area of low pressure. Because of the Coriolis effect, the storm turns counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

Hurricanes get their energy from the condensation of water vapor. Once formed, the hurricane is fueled through contact with the warm ocean water. Moisture is added to the warm air by evaporation from the ocean. As the warm, moist air rises, the water vapor condenses, releasing large amounts of energy. The hurricane continues to grow as long as it is over its source of warm, moist air. When the hurricane moves into colder waters or over land, it begins to die because it has lost its source of energy. **Figure 23** and **Figure 24** show two views of a hurricane.

Figure 24 *The view below shows how a hurricane would look if you cut it in half and looked at it from the side. The arrows indicate the flow of air.*



Damage Caused by Hurricanes Hurricanes can cause a lot of damage when they move near or onto land. The speed of the steady winds of most hurricanes ranges from 120 km/h to 150 km/h, and they can reach speeds as high as 300 km/h. Hurricane winds can knock down trees and telephone poles and can damage and destroy buildings and homes.

While high winds cause a great deal of damage, most hurricane damage is caused by flooding associated with heavy rains and storm surges. A *storm surge* is a wall of water that builds up over the ocean due to the heavy winds and low atmospheric pressure. The wall of water gets bigger and bigger as it nears the shore, reaching its greatest height when it crashes onto the shore. Depending on the hurricane's strength, a storm surge can be 1 m to 8 m high and 65 km–160 km long. Flooding causes tremendous damage to property and lives when a storm surge moves onto shore, as shown in **Figure 25.**

Astronomy CONNECTION

The weather on Jupiter is more exciting than that on Earth. Wind speeds reach up to 540 km/h. Storms last for decades, and one—the Great Red Spot of Jupiter—has been swirling around since it was first discovered, in 1664. The Great Red Spot has a diameter of more than one and a half times that of the Earth. It is like a hurricane that has lasted more than 300 years.

Figure 25 *In 1998, the flooding associated with Hurricane Mitch devastated Central America. Whole villages were swept away by the flood waters and mudslides. Thousands of people were killed, and damages were estimated to be more than $5 billion.*

REVIEW

1. What is lightning?
2. Describe how tornadoes develop. What is the difference between a funnel cloud and a tornado?
3. Why do hurricanes form only over certain areas?
4. **Inferring Relationships** What happens to a hurricane as it moves over land? Why?

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