KEY CONCEPT

24 Water falls to Earth's surface as precipitation.

BEFORE, you learned

- Water moves between Earth's surface and the atmosphere
- Water vapor condenses into clouds

NOW, you will learn

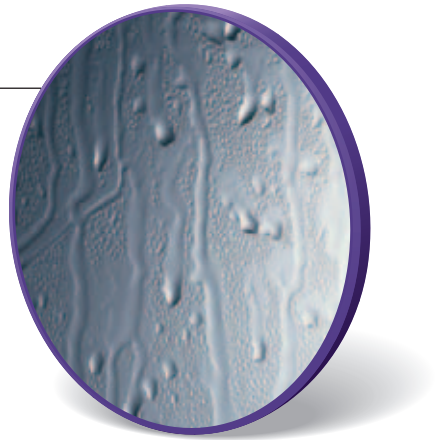
- How precipitation forms
- How precipitation is measured
- About acid rain

VOCABULARY

freezing rain p. 68
sleet p. 68
hail p. 68
acid rain p. 70

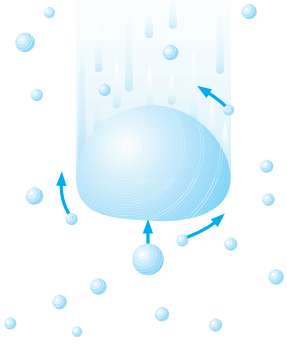
THINK ABOUT

Why does steam from a shower form large drops?



When you run a hot shower, the bathroom fills up with water vapor. The vapor condenses into tiny droplets that make it seem as if you are standing in fog. You may also see larger drops running down cool surfaces, such as a mirror. Why do some drops fall while others remain suspended?

Precipitation forms from water droplets or ice crystals.



Water droplets combining to form a raindrop

All precipitation comes from clouds. For example, rain occurs when water droplets in a cloud fall to the ground. Then why doesn't every cloud produce precipitation? Cloud droplets are much smaller than a typical raindrop. They weigh so little that it takes only a slight upward movement of air to hold them up. In order for rain to fall from a cloud and reach Earth's surface, the cloud droplets must become larger and heavier.

One way that precipitation can form is through the combining of cloud droplets. The tiny droplets of water move up and down in clouds. Some collide with each other and combine, forming slightly bigger droplets. As the droplets continue to combine, they grow larger and larger. Eventually they become heavy enough to fall. It takes about a million droplets to make a single raindrop.

Another way that precipitation can form is through the growth of ice crystals. When the temperature inside a cloud is below freezing, water vapor changes into tiny ice crystals. The crystals grow by collecting more water vapor or by colliding and merging with one another. When the crystals become heavy enough, they fall from the cloud. Snow isn't the only type of precipitation that forms this way. Most rain in the United States actually starts out as falling ice crystals. Before the crystals reach the ground, they melt in a layer of warm air.

CHECK YOUR READING How do cloud droplets become large enough to fall as precipitation?

Measuring Precipitation

Scientists use a rain gauge to measure rainfall. A funnel or opening at the top of the gauge allows rain to flow into a cylinder. By measuring the water collected, you can find out how much rain fell in a storm or over a period of time.

Snow depth can be measured with a long ruler. Because the amount of water in snow varies, scientists use a special gauge to find out how much water the snow contains. A built-in heater melts the snow so that it can be measured just like rain.

READING TiP
A gauge (gayj) is an instrument used for measuring or testing.

INVESTIGATE Precipitation

How much rain falls during a storm?

SKILL FOCUS
Measuring

MATERIALS
- scissors
- 1-liter plastic bottle
- gravel
- water
- permanent marker
- ruler

TIME
15 minutes

PROCEDURE

1. Cut off the top third of the bottle. Set this part aside.
2. Put some gravel at the bottom of the bottle to keep it from tipping over. Add water to cover the gravel. Draw a horizontal line on the bottle at the top of the water. Use a ruler to mark off centimeters on the bottle above the line that you drew. Now take the part of the bottle that you set aside and turn it upside down. Fit it inside the bottle to create a funnel.
3. Place the bottle outside when a rainstorm is expected. Make sure that nothing will block rain from entering it. Check your rain gauge after 24 hours. Observe and record the rainfall.

WHAT DO YOU THINK?
- How much rain fell during the time period?
- How do the measurements compare with your observations?

CHALLENGE Do you think you would measure the same amount of rain if you used a wider rain gauge? Explain.

When you watch weather reports on television, you often see storm systems passing across a weather map. Some of these images are made with Doppler radar. The radar shows which areas are getting precipitation and how fast it is falling. Forecasters use this information to estimate the total amount of precipitation an area will receive.

COMBINATION NOTES
Record information on precipitation in your combination notes.

Types of Precipitation

Precipitation reaches Earth's surface in various forms. Some precipitation freezes or melts as it falls through the atmosphere.

1. **Rain and Drizzle** Rain is the most common type of precipitation. Raindrops form from liquid cloud droplets or from ice crystals that melt as they fall. A light rain with very small drops is called drizzle. Drizzle usually comes from stratus clouds, which don't have enough air movement to build up larger raindrops.

2. **Freezing Rain** Raindrops may freeze when they hit the ground or other surfaces in cold weather. **Freezing rain** covers surfaces with a coating of ice. During an ice storm, roads become slippery and dangerous. The weight of ice can also bring down trees and power lines.

3. **Sleet** When rain passes through a layer of cold air, it can freeze before hitting the ground. The small pellets of ice that form are called **sleet.**

Most snowflakes have six branches or sides.

4. **Snow** As ice crystals grow and merge in clouds, they become snowflakes. Snowflakes come in many different shapes and sizes. Usually they have six sides or branches. When snow falls through moist air that is near freezing, the flakes tend to join together in clumps. When snow falls through colder and drier air, snowflakes don't join together, and the snow is powdery.

5. **Hail** Surprisingly, the largest type of frozen precipitation often arrives in warm weather. Lumps or balls of ice that fall from cumulonimbus clouds are called **hail.** During a thunderstorm, violent air currents hurl ice pellets around the cloud. These pellets grow as water droplets freeze onto them at high elevations. Some start to fall and then are pushed back up again. They may repeat this process several times, adding a layer of ice each time. Eventually they fall to the ground.

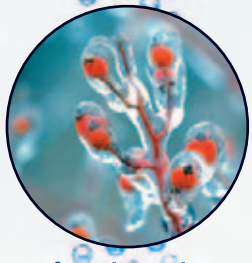
   Large hailstones can damage property and injure people and animals. The biggest hailstone ever found in the United States weighed 1.7 pounds and was about as wide as a compact disc.

CHECK YOUR READING Which forms of precipitation undergo a change after they leave a cloud?

How Precipitation Forms

All precipitation forms from water droplets or ice crystals in clouds. Some precipitation freezes or melts after it falls from the clouds.

1. **Rain** and **drizzle** form from water droplets or ice crystals that melt as they fall.
2. **Freezing rain** is rain that freezes when it hits the ground or other surfaces.
3. **Sleet** is rain that freezes into ice pellets while falling through cold air.
4. **Snow** forms from ice crystals that merge in clouds.
5. **Hail** forms when ice pellets move up and down in clouds, growing larger as they gain layers of ice.



freezing rain

hail

READING VISUALS

What forms of precipitation occur most often where you live?

These trees have few needles because acid rain has damaged the trees.

Precipitation can carry pollution.

VOCABULARY
Add a description wheel for *acid rain* to your notebook.

Rainwater is naturally a little acidic. **Acid rain** is rain that has become much more acidic than normal because of pollution. Factories, power plants, automobiles, and some natural sources release sulfur dioxide and nitrogen oxides into the air. These gases can combine with water vapor to form sulfuric acid and nitric acid. The acids mix with cloud droplets or ice crystals that eventually fall to Earth's surface as precipitation.

Because wind can blow air pollution hundreds of kilometers, acid rain may fall far from the source of the pollution. Acid rain harms trees and raises the acidity of lakes, making it difficult for fish to live in them. Acid rain also damages the surfaces of buildings and sculptures.

CHECK YOUR READING How does acid rain form? Your answer should mention water vapor.

2.4 Review

KEY CONCEPTS

1. What are the two ways that rain can form?
2. How are rain and snow measured?
3. What human activities cause acid rain?

CRITICAL THINKING

4. **Compare and Contrast** How are sleet and freezing rain similar? How are they different?
5. **Draw Conclusions** When a large hailstone is cut open, four layers can be seen. What conclusions can you draw about the formation of the hailstone?

CHALLENGE

6. **Predict** Temperatures in a cloud and on the ground are below freezing. A warmer layer of air lies between the cloud and the ground. What type of precipitation do you predict will occur? Explain.