KEY CONCEPT

2.2 Fresh water flows and freezes on Earth.

Sunshine State STANDARDS

SC.D.1.3.1: The student knows that mechanical and chemical activities shape and reshape the Earth's land surface by eroding rock and soil in some areas and depositing them in other areas, sometimes in seasonal layers.

SC.D.1.3.3: The student knows how conditions that exist in one system influence the conditions that exist in the other systems.

SC.G.1.3.4: The student knows that the interactions of organisms with each other and with the non-living parts of their environments result in the flow of energy and the cycling of matter throughout the system.

BEFORE, you learned

- Water covers most of Earth's surface
- Water continually cycles
- Water falls to Earth's surface as precipitation

NOW, you will learn

- How fresh water flows and collects on land
- How surface water forms lakes
- How frozen water exists on Earth

VOCABULARY

divide p. 57
drainage basin p. 57
turnover p. 59
eutrophication p. 60
iceberg p. 62

MAIN IDEA AND DETAILS
Record in your notebook this main idea and details about it.

EXPLORE Water Collection

How does water flow and collect?

PROCEDURE

1. With the open egg carton on a level tray, pour water slowly into the center of the carton until the cups are three-quarters full.
2. Empty the carton. Tip it slightly, as shown in the photograph, and pour water into the higher end. Stop pouring when the carton is about to overflow.

MATERIALS

- plastic-foam egg carton
- tray or pan
- plastic bottle
- water

WHAT DO YOU THINK?

- How did the water flow when you poured it into the level carton? into the tilted carton? Where did it collect in the carton? Where did it not collect?
- What might your observations tell you about how water flows when it falls on land?

Water flows and collects on Earth's surface.

Imagine you are in a raft on a river, speeding through whitewater rapids. Your raft splashes around boulders, crashing its way downriver. Then the raft reaches a lake. You glide across the surface, slowing down. At the end of the lake, your raft enters a river again and floats down it.

In your raft you are following the path a water drop might take on its way to the ocean. All over the planet, the force of gravity pulls water downhill. Fresh water flows downhill in a series of streams and rivers, collects in lakes and ponds, and eventually flows into the ocean. All of this water flows between high points called divides, in areas called drainage basins.

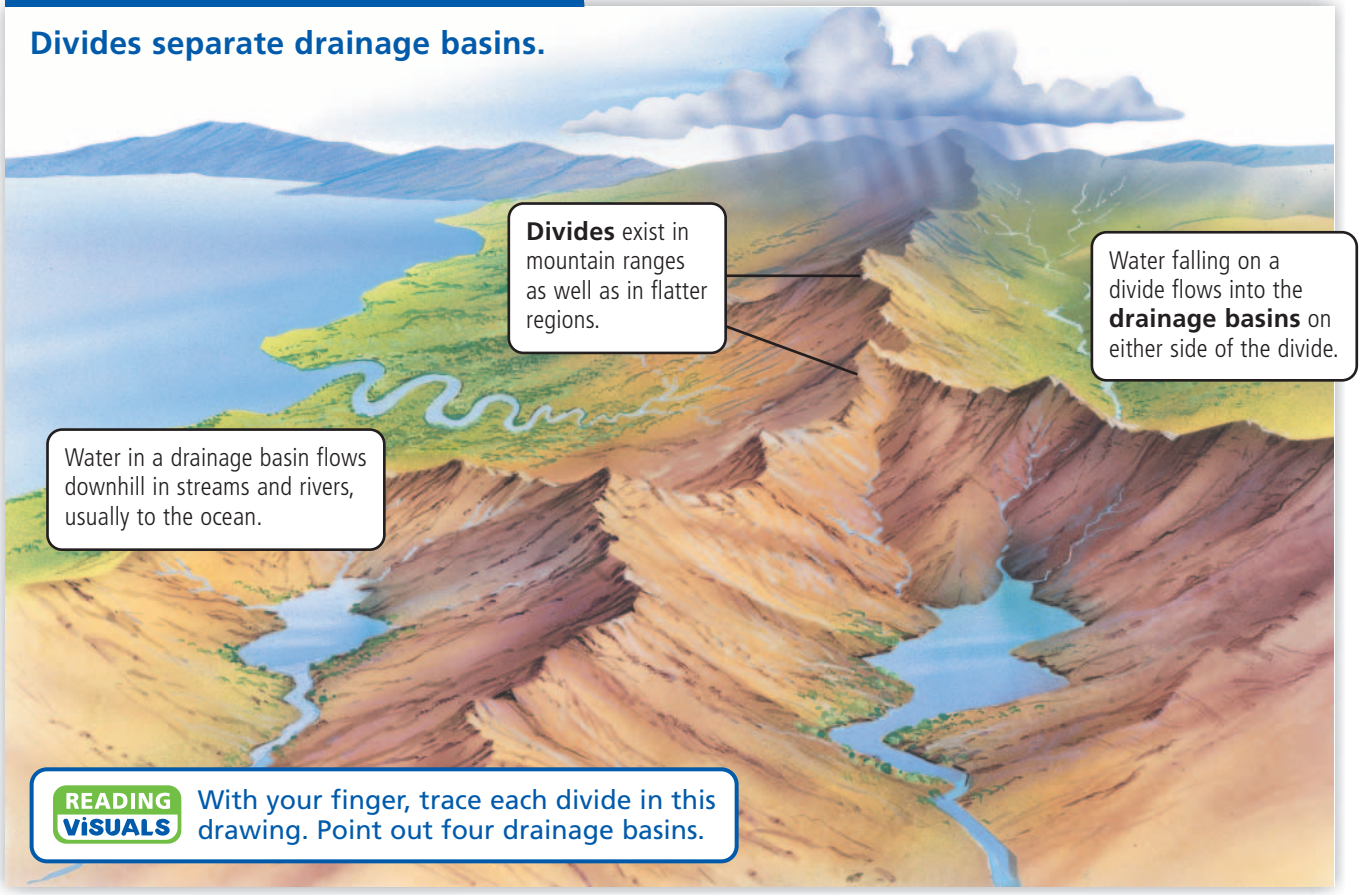
Divides and drainage basins affect the way water flows on land. A **divide** is a ridge, or continuous line of high land, from which water flows in different directions. If you were on a skateboard and began at the top of a hill, you would ride in one general direction down the hillside. On the other side of the hill, you would ride downhill in a completely different direction. The top of the hill is like a divide. A divide can be a continuous ridge of high mountains. On flatter ground, a divide can simply be the line of highest ground.

A **drainage basin,** or watershed, is an area into which all of the water on one side of a divide flows. If you pour water into the basin of your bathroom sink, it will flow down the side from high points to low, and eventually down the drain, which is at the lowest point. In mountainous areas, hills and mountains form the sides of basins, and valleys form the low points. Flatter regions also have basins. The basins may not be obvious in these regions, but they still drain water.

When it rains in a drainage basin, the water forms streams and rivers or sinks into the ground. Every stream, river, and lake is in a basin. In most places, the water eventually flows to the sea. In a bowl-shaped basin, the water may collect at the bottom of the basin or evaporate.

Divides and Drainage Basins

Divides separate drainage basins.



READING VISUALS With your finger, trace each divide in this drawing. Point out four drainage basins.

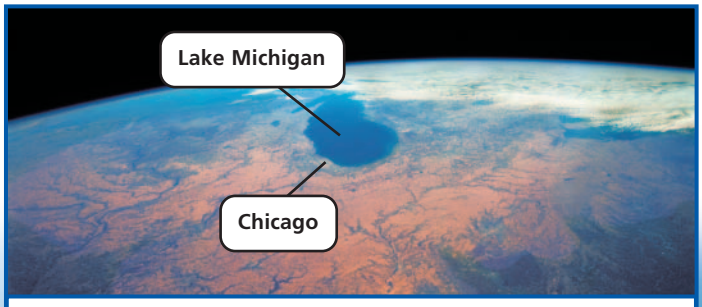
Surface water collects in ponds and lakes.

Lakes and ponds form where water naturally collects in low parts of land. Some lakes were formed during the last ice age. For example, the Great Lakes were formed when huge sheets of ice scraped out a series of giant depressions. Other lakes, such as Crater Lake in Oregon, were formed when water collected inside the craters of inactive volcanoes.

Water can fill a lake in several ways. Where the land surface dips below the level of underground water, the low land area fills with water. Rainfall and other precipitation contribute water to all lakes. Water may flow through a lake from a stream or river. Water may also flow away from a lake through a stream running downhill from the lake. Many lakes maintain fairly steady levels because of the balance of flow in and flow out.

The main difference between a pond and a lake is in their overall size. A pond is smaller and shallower than a lake, and there are many plants, such as water lilies and cattails, rooted in its muddy bottom. A lake may have water so deep that sunlight can't reach the bottom. In the deeper part of the lake, plants can't take root, so they grow only around the lake's edges. Ponds and lakes provide homes for many kinds of fish, insects, and other wildlife. They also provide resting places for migrating birds.

CHECK YOUR READING Name two differences between a pond and a lake.



Lake Michigan is the third largest of the five Great Lakes, which border eight states and Canada's Ontario province.

Chicago, Illinois, at the southwest corner of Lake Michigan, is the largest city on a Great Lake. Note that the lake is so wide that from Chicago you cannot see Michigan on the other side.

Lake Turnover

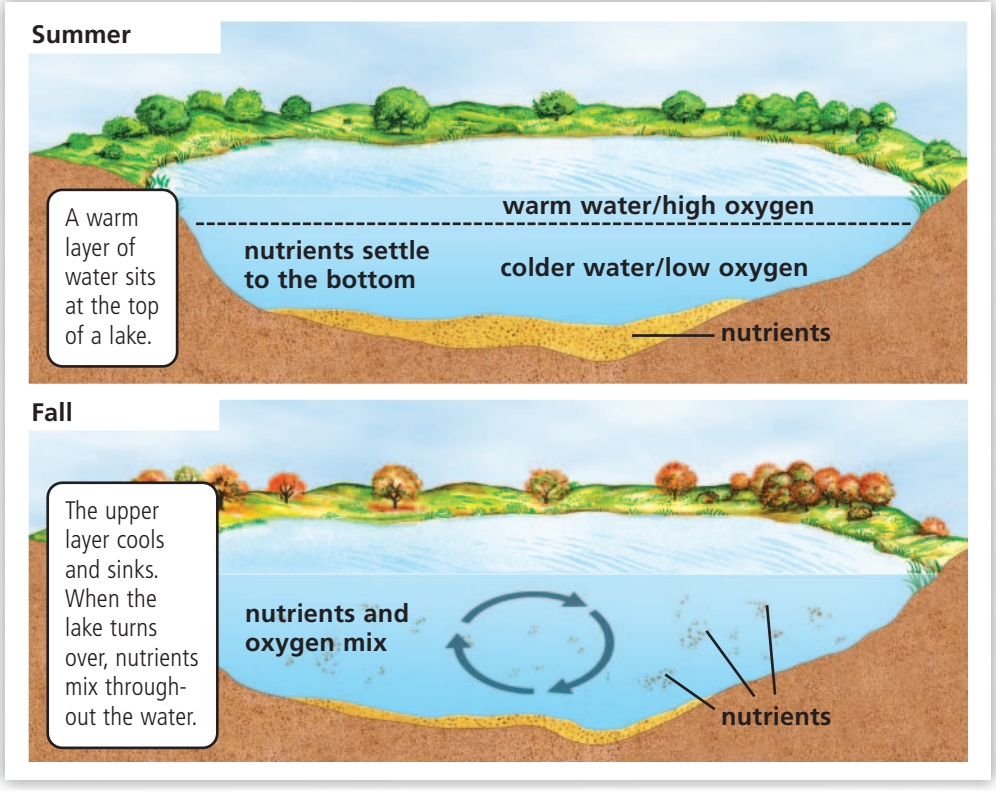
The water in a lake is not as still as it might appear. The changing temperatures of the seasons affect the water and cause it to move within the lake in a yearly cycle.

In a place with cold winters, ice may form on a lake, so that the wind cannot ruffle the surface. The water temperature in the lake remains steady, and the water stops moving. The water just below the surface ice is near freezing, so the fish move to the bottom, where the water is a bit warmer.

In many lakes the water temperatures at different levels vary as the seasons change. In the spring and summer, sunlight can warm a layer of water at the top of a lake. Because the colder water beneath the top layer is denser than the warmer water above it, the water levels do not mix easily. The warm water contains more oxygen, so fish may be more plentiful in the upper part of the lake.

READING TiP

Cold water is denser than (has more mass than the same amount of) warm water.



In the fall, days cool and the surface water cools too. The upper layer becomes heavy and sinks, so that the lake water "turns over." Nutrients from minerals and from dead plants and organisms are stirred up from the bottom. These nutrients are used by many life forms in the lake. The rising and sinking of cold and warm water layers in a lake is called **turnover.** Turnover occurs twice each year as the seasons change.

CHECK YOUR READING What happens to surface water when the weather cools in the fall?

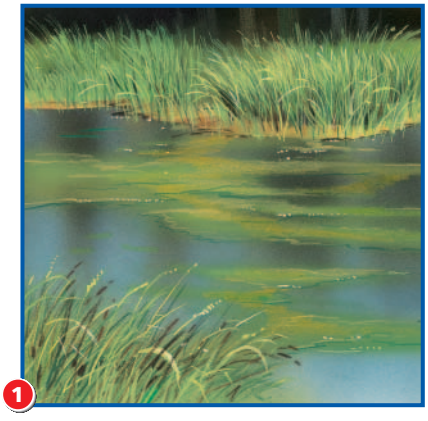
Eutrophication

A lake does not remain a lake forever. Through natural processes that take thousands of years, most lakes eventually are filled in and become meadows—fields covered with grass and other plants. A lake can become filled in as sediments, including the remains of dead fish, plants, and other organisms, pile up on the bottom.

The activity of life in a lake is affected by nutrients. Nutrients are the foods and chemicals that support living things. When the amounts of such nutrients as phosphorus and nitrogen in a lake increase, algae and other organisms in the water grow more rapidly. An increase of nutrients in a lake or pond is called **eutrophication** (yoo-TRAHF-ih-KAY-shuhn). As eutrophication occurs, algae form a thick scum on the water. The amount of oxygen in the water decreases, until fish and other organisms that require oxygen cannot survive. The illustration below shows what happens to a lake when nutrient levels increase.

READING TiP

Eutrophication comes from the Greek word *eutrophos,* meaning "well-nourished."



1 When the amounts of such nutrients as nitrogen and phosphorus increase, algae grow faster and form a scum layer at the surface.

2 Dead algae, plants, and fish pile up. Plants grow more quickly, leaving more debris as they die. Water evaporates, and the lake becomes shallower.

3 The lake becomes a soggy marsh, then finally a completely filled-in meadow.

The process of eutrophication is usually slow. In some cases, however, eutrophication happens more quickly than it normally would because of pollution from human activities. Nitrogen in fertilizers used on farms and gardens may be washed into lakes. Phosphates from laundry detergents may be present in wastewater that reaches lakes. The extra nutrients cause algae and plants in lakes to grow faster and more thickly than they normally would grow. Eutrophication from pollution causes clear lakes to become clogged with algae and plants.

CHECK YOUR READING How does human activity contribute to eutrophication?

Most fresh water on Earth is frozen.

If you want fresh water, take a trip to Greenland or the South Pole. Two-thirds of the world's fresh water is locked up in the ice covering land near the poles.

The ice sheet that covers Antarctica is almost one and a half times as big as the United States and is in places more than a kilometer thick. Ice on Earth's surface contains more than 24 million cubic kilometers of fresh water. Just how much water is that? Imagine that you have three glasses of lemonade. If you take one sip from one of the glasses of lemonade, you have drunk the water in all the lakes and rivers on Earth. The rest of the glass represents liquid ground water. The other two glasses of lemonade represent all the frozen water on the planet.

Ice on Land

In Earth's coldest regions—near both poles and in high mountains—more snow falls each year than melts. This snow builds up to form glaciers. A glacier is a large mass of ice and snow that moves over land. There are two types of glaciers. The ice sheets of Antarctica and Greenland are called continental glaciers because they cover huge landmasses. The other type of glacier is a valley glacier, which builds up in high areas and moves slowly down between mountains.

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INVESTIGATE Icebergs

Why do icebergs float?

SKILL FOCUS
Calculating

MATERIALS
- balance
- ice cube
- water
- 250 mL graduated cylinder
- paper clip
- calculator

for Challenge:
- cork

TIME
30 minutes

PROCEDURE

1. Find the masses of the empty graduated cylinder and the ice cube.
2. Add 200 mL of water to the cylinder. Find the volume of the ice cube by measuring how much water it displaces. Make sure the water is extremely cold to prevent the ice cube from melting. Use the point of a paper clip to completely submerge the ice.
3. Remove the water and let the ice melt in the cylinder.
4. Calculate the density (Density = mass/Volume) of the ice cube. Now find the mass and volume of the liquid water from the melted ice and calculate its density.

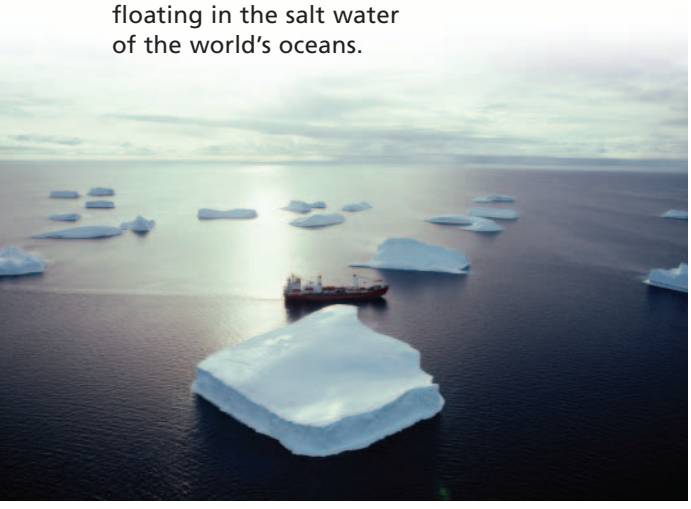
WHAT DO YOU THINK?
- What was the density of the ice cube? the water?
- Why do icebergs float?

CHALLENGE Float a cork in water. How does its behavior compare with that of floating ice?

Icebergs

An **iceberg** is a mass of ice floating in the ocean. An iceberg starts out as part of a glacier. In places such as Antarctica and Greenland, glaciers form ice shelves that extend out over the ocean. When a large chunk of a shelf breaks off and floats away, it becomes an iceberg.

Thousands of icebergs break off from ice sheets each year. In the Northern Hemisphere, ocean currents push icebergs south into the warmer Atlantic Ocean. It may take an iceberg two to three years to float down to the area off the coast of Canada. In that region, it breaks apart and melts in the sea. A North Atlantic iceberg sank the *Titanic*.



Icebergs are masses of frozen fresh water floating in the salt water of the world's oceans.

How big is an iceberg? One iceberg that recently broke off an Antarctic ice shelf was the size of Connecticut. Off the coast of eastern Canada, some icebergs tower 46 meters (150 ft) above the surface of the ocean. This is impressive, because most of a floating iceberg is below the surface. Only about one-eighth of the total weight and volume of the iceberg can be seen above the surface of the sea. When people say "It's only the tip of the iceberg," they mean that a lot of something is unrevealed.

The water in an iceberg may have been frozen for 15,000 years. However, the ice in the center, if melted, can be clean, clear drinking water. And an iceberg can hold a lot of water. An iceberg as big as a city block holds enough drinking water to supply a city of 50,000 people for about ten years. Unfortunately, no one knows how to cheaply move icebergs to cities in order to use the frozen water.

CHECK YOUR READING How much of an iceberg is below the surface?

2.2 Review

KEY CONCEPTS

1. Why is it important that fresh water flows over Earth's surface?
2. Explain the relationship between a drainage basin and a divide.
3. Where and in what form is most of the fresh water on Earth?

CRITICAL THINKING

4. **Apply** If you were going on a fishing trip in a northern state, why would you want to know about lake turnover?
5. **Connect** Explain the connection between living things in a lake and eutrophication.

CHALLENGE

6. **Synthesize** How is the water in icebergs involved in the water cycle on Earth?