

10.3

The Water Cycle

water cycle: a continuous pattern in nature in which water moves as it changes state above, on, and below the surface of Earth

LINKING TO LITERACY

Questioning the Text

To maintain your reading focus and get more meaning from a text, ask questions as you read.

Begin by scanning the page and reading the title and headings. What questions come to mind about the water cycle?

Read the first few paragraphs. Stop and reflect on what you have read. What questions do you have? What more do you want to learn about this topic?

Move to the next paragraph and, again, stop to ask questions. The conversation in your head will help you think more deeply about your reading.

Water is the only substance that exists on Earth in each of its three states. Water easily changes from one state to another. Water sometimes changes its location by changing state in a continuous pattern called the **water cycle**. The water cycle is self-renewing and constant. The Sun provides the energy to power the water cycle.

Changes of State

When water changes state in the water cycle, the total number of water particles remains the same. The changes of state include melting, sublimation, evaporation, freezing, condensation, and deposition. All changes of state involve the transfer of energy. Figure 1 shows how the water particles in each state behave as energy is added or removed.

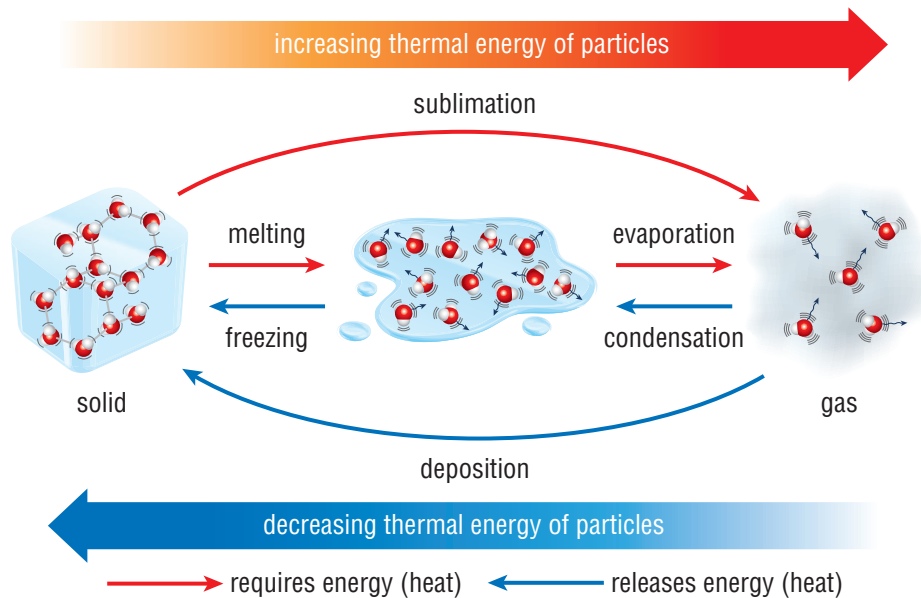


Figure 1 Energy is gained or lost whenever water changes state.

melting: the change of state from a solid to a liquid; occurs when a solid gains thermal energy

sublimation: the change of state from a solid to a gas without first becoming a liquid; occurs when a solid gains thermal energy

evaporation: the change of state from a liquid to a gas; occurs when a liquid gains thermal energy

When solid ice gains thermal energy, it changes state from solid ice to liquid water in a process called **melting**. Ice cubes in a cold drink, for example, gradually melt. Each spring you see snow melt into slush and puddles.

Sometimes adding thermal energy to solid ice causes a change of state from a solid to a gas. This change, directly from a solid to a gas without becoming a liquid, is called **sublimation**. On crisp, dry winter days you might notice that snow banks shrink, or ice gradually disappears, without first becoming slushy and wet.

When water absorbs enough thermal energy, it becomes a gas (water vapour). This process is called **evaporation**. Water vapour mixes with the air and seems to disappear. For example, wet clothes on a washing line dry because the water evaporates into the air.

When water vapour loses thermal energy and becomes liquid water, **condensation** has occurred. Rain and dew are examples of condensation. A cold can of pop placed outside on a hot summer day often collects water droplets. This is because water vapour in the air condenses when it is cooled by the cold can.

Sometimes, removing thermal energy from water vapour causes it to become a solid, rather than a liquid. **Deposition** occurs when water vapour changes state directly from a gas to a solid. Deposition is the reverse of sublimation. One example of deposition occurs high in the atmosphere where the temperature is very low. In these conditions, water vapour forms snow without becoming a liquid first.

Liquid water can also lose thermal energy and undergo **freezing**: changing state from a liquid to a solid. We see many examples of this in everyday life. Puddles, ponds, lakes, and even parts of oceans freeze when the water becomes cold enough.

Changes of State in the Water Cycle

Water moves around Earth in the water cycle. Figure 2 shows where water is found, the state in which it exists, and how it changes from one state to another. Look at Figure 2 carefully to find water in each of its three states.

condensation: the change of state from a gas to a liquid; occurs when a gas loses thermal energy

deposition: the change of state from a gas to a solid; occurs when a gas loses thermal energy

freezing: the change of state from a liquid to a solid; occurs when a liquid loses thermal energy

LINKING TO LITERACY

Reading Visual Text: The Cycle Map

A cycle map is used to illustrate a process that repeats itself. In nature, the water cycle and the life cycle can be illustrated using a cycle map. Can you think of other processes that are repeated in nature?

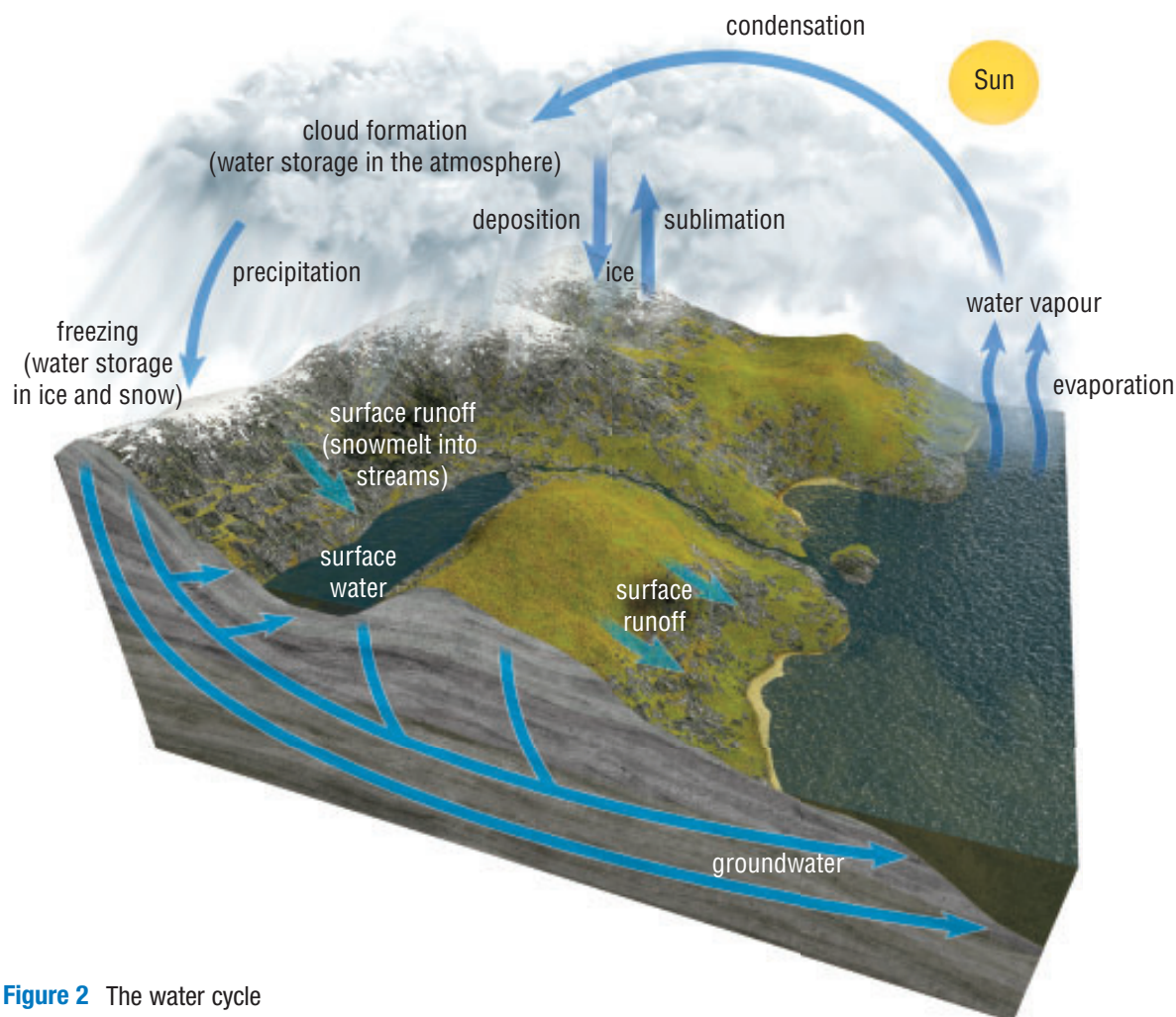


Figure 2 The water cycle

Melting, Evaporation, and Sublimation in Nature

Solid water includes permanent ice and snow in glaciers and over the polar regions, and ice and snow that form in the winter. Liquid water falls to the ground in the form of rain. Liquid water also forms when winter ice and snow begin to melt. Much of this water is called **runoff**. Runoff water flows downhill under the influence of gravity, through streams, rivers, and lakes. Some of the water eventually reaches the oceans. All the water on the surface of Earth is called surface water.

Some liquid water seeps into the ground. This water, called **groundwater**, trickles down through openings in the soil and cracks in rocks until it hits bedrock and cannot flow down any farther. The water spreads out until it fills all the available spaces in the loose rock and soil above the bedrock. The loose rock and soil become saturated with water. This saturated area is called an **aquifer**. The top surface of the aquifer is the **water table** (Figure 3). Occasionally, natural underground caverns also fill up with water.

runoff: water from precipitation and snowmelt that flows over Earth's surface

groundwater: water that seeps through soil and cracks in rock; source of water for underground springs and wells

aquifer: a geological formation of loose rock or soil that is saturated with groundwater

water table: the depth at which loose rock and soil below Earth's surface are saturated with water; the upper boundary of an aquifer

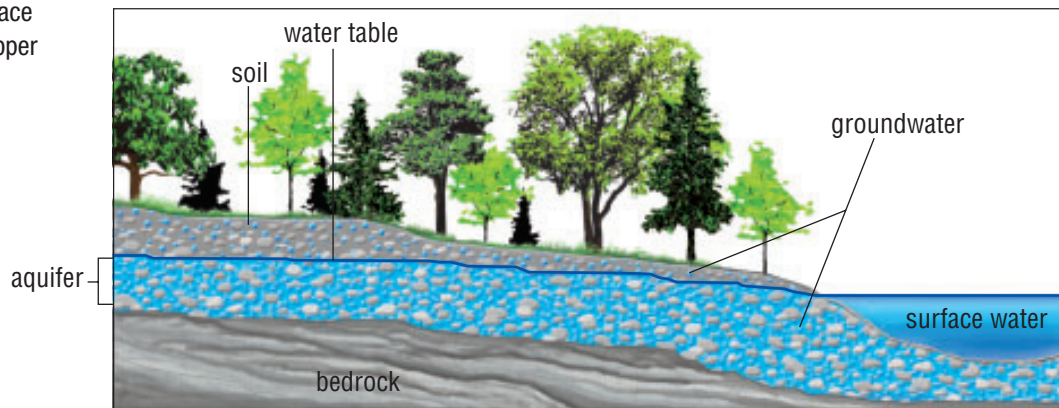


Figure 3 Groundwater saturates loose rock and soil to the level of the water table, forming an aquifer.

Surface water evaporates and snow and ice sublime from Earth's surface to become water vapour. Water vapour in Earth's atmosphere acts like a blanket that traps thermal energy close to Earth. Melting, evaporation, and sublimation are processes that occur as a result of the increasing thermal energy of water particles (Figure 4).

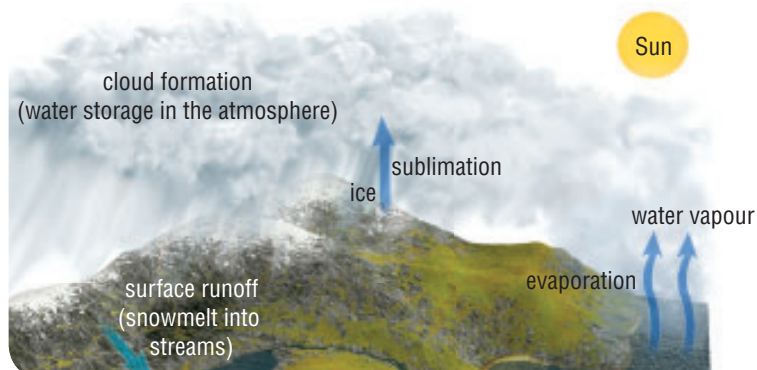


Figure 4 Ice melts into water or sublimates to form water vapour. Liquid water evaporates when thermal energy is added.

Condensation, Freezing, and Deposition in Nature

Once water vapour is in the atmosphere, low temperatures cause the vapour to either condense into a liquid or undergo deposition to form ice crystals. Water droplets and ice crystals in the atmosphere form clouds. Air currents move the clouds around the planet. The water droplets in clouds collide to form larger droplets that fall as rain. Ice crystals fall to the ground as snowflakes. Both rain and snow are forms of **precipitation**—water that falls to Earth’s surface. Fallen snow may gradually accumulate as **polar ice sheets** (areas of ice at the North and South Poles), **icecaps** (permanent ice that covers land), and **glaciers** (rivers of ice that slowly flow down mountainsides).

At low temperatures, Earth’s surface water freezes and forms solid ice. Ice is slightly less dense than liquid water. This explains why, in the winter, lakes and ponds develop a layer of ice that floats on the liquid water underneath. As a result, animals and plants can survive through the winter without being frozen solid. Condensation, deposition, and freezing are processes that occur as a result of a decrease in the thermal energy of water particles (Figure 5).

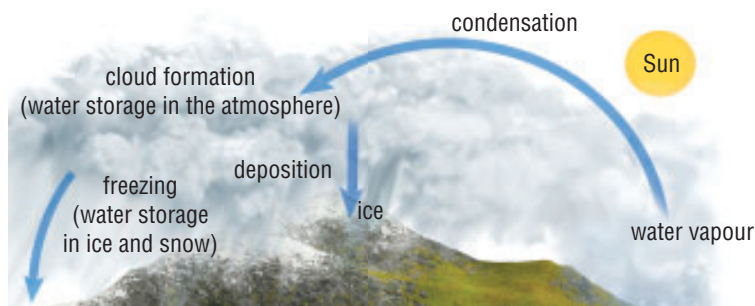


Figure 5 Water vapour condenses and liquid water freezes when thermal energy is removed.

precipitation: solid or liquid water that falls to Earth’s surface

polar ice sheet: a frozen field of ice covering either the North Pole or the South Pole

icecap: a large area of ice that permanently covers land

glacier: a river of ice, formed from snow accumulated over hundreds of years, that moves slowly downhill under the force of gravity

To watch an animation of the water cycle,

[Go to Nelson Science](#)



Changes with the Seasons

Winter snow melts as spring arrives. The snowmelt flows into streams and rivers, and eventually into the oceans. Some of the snowmelt sinks into the ground, becoming groundwater. As surface water evaporates to become water vapour, the water cycle is repeated.

Unit Task

How can you apply what you have learned about the water cycle to the Unit Task?

CHECK YOUR LEARNING

1. Look at Figure 2. Where can you find each of the three states of water?
2. Describe the water cycle. Draw your own labelled diagram.
3. Briefly describe how solid and liquid water may be converted to water vapour.
4. Describe how water vapour changes into solid and liquid water above Earth’s surface.
5. Does all surface runoff move directly into rivers, lakes, and oceans? Explain.