The Water Cycle

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.

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.

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**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

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**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.

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).
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).

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.