Water is AWESOME – Notes

Water is everywhere. It covers 71% of the Earth's surface. Water makes up about 60% of the human body. Water is the most important resource in the world.

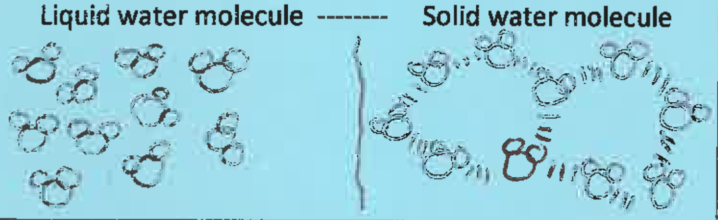
In your own words explain what a **RESOURCE** is:

Water has many unique properties including:

1. Being the ultimate Solvent
   (aka. universal solvent)
2. Being less dense when frozen

Draw

Liquid water molecule -------- Solid water molecule



3. Having a high Heat Capacity

Water's unique properties are a result of its chemical composition H_2O

This means that it is ONE Oxygen molecule that is bound to TWO Hydrogen molecules.

Draw a water molecule in more detail:

Because the Oxygen has a negative charge, and the hydrogen is positive … water is a POLAR MOLECULE which very strong covalent bonds.

Definitions:

Solvent: The substance (often liquid) that is able to dissolve another substance.

Important because: It dissolves more substances than any other liquid

* All life processes
* All body Functioning

Heat Capacity: Describes the amount of heat needed to increase the temperature of a substance by 1 degree celsius.

Important because: It takes a lot of energy to HEAT H_2O + it cools slowly

* Aquatic life stability

Because water is polar, it __sticks__ to most things depending on which molecule it comes into contact with (O or H). That is why water is so great at __washing__ things!

Because of water's tripod (bent) structure, it becomes **LESS DENSE when frozen** (or in a solid state).

This is important because we know, based on buoyancy, things with a lower density will float. In the winter (or colder climate regions) lake water, rivers, streams, ponds...etc. will freeze. However, because the solid form of water is less dense, it will float and some of the water will remain liquid at the bottom and help sustain life.

The strong hydrogen bonds also mean that water has a **high heat capacity.** This means that it takes a lot of energy to heat water, and that water cools slowly.

Water's ability to have a high heat capacity is very important for __aquatic life__, as well as for regulating the __global climate__.

Water is powerful. It has influence over life in many ways.
Group Brainstorm... Human Impact: Power of Water (Advantages/Disadvantages)

10.2

What Is Water?

Water is a very useful substance. Most major towns and cities are built near large bodies of water. We drink water, play with water, put out fires with water, and irrigate crops with water (Figure 1). All living things need water.

Figure 1 We use water in many ways. (a) We all drink water. (b) Sports, such as hockey, are played on frozen water (ice). (c) Firefighters use water to put out fires. (d) Farmers irrigate their crops with water.

Describing Water

Imagine a glass of water at room temperature. You would probably describe it as a liquid that has no colour, taste, or odour.

Many substances dissolve in water, including table salt, sugar, oxygen, and carbon dioxide. This is one reason why water is so important for life. Plants and animals are largely made up of water. Over half of the human body is water.

Water in the body helps to transport substances to all the tissues and organs. Water is an important solvent in which essential chemical reactions can take place. Water also keeps us cool: as sweat evaporates, it transfers thermal energy away from the body. A person can live for over a month without food, but a person can live for only a few days without water. A supply of clean water is essential for our health.

Is Water a Pure Substance or a Mixture?

Pure water is clear, colourless, and has no taste or odour. You might have noticed, however, that natural bodies of water can appear to be blue or green, or even an unpleasant grey colour. Perhaps you have noticed that water from different locations can taste different or have an odour. This is because most of the water in nature is not pure. Rather, it is a mixture of pure water and other substances. Dissolved substances in water can give it colour, taste, and odour. Some of these substances are desirable. Other substances are dangerous. In Section 11.2, we will look at some of the substances that dissolve in water.

LINKING TO LITERACY

Making Predictions

Prepare for reading by making a prediction about the information you will learn about in this section.

- Scan the section for information: the title, subtitles, pictures, and margin features.
- Skim the first sentences of the first one or two paragraphs of the text.

What do these sentences tell you about this text? What kind of information will be described or explained on this page?

Make a prediction about the text. As you read, confirm or change your prediction. Make new predictions about what will come next. Making predictions helps to make informational text easier to read.

The Water Particle

According to the particle theory of matter, pure water is made up of many identical water particles. However, water particles are composed of two even smaller kinds of particles—oxygen and hydrogen. Each particle of water is made up of one oxygen particle and two hydrogen particles joined together (Figure 2).

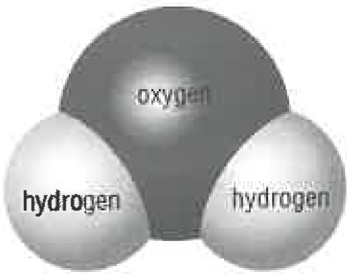


Figure 2 Water particles are made up of one oxygen particle and two hydrogen particles joined together.

States of Water

Water can exist as a solid (ice), as a liquid (water), or as a gas (water vapour). The particles of each state of water behave differently.

Solid ice has a definite shape. This is because the water particles of ice cannot move freely around each other; they can only vibrate (Figure 3(a)). In liquid water, particles vibrate faster and are free to move around each other in all directions (Figure 3(b)). In water vapour, the particles are very far apart. They have lots of energy and move very quickly in all directions (Figure 3(c)).

To learn more about the structure and states of water,

Go to Nelson Science

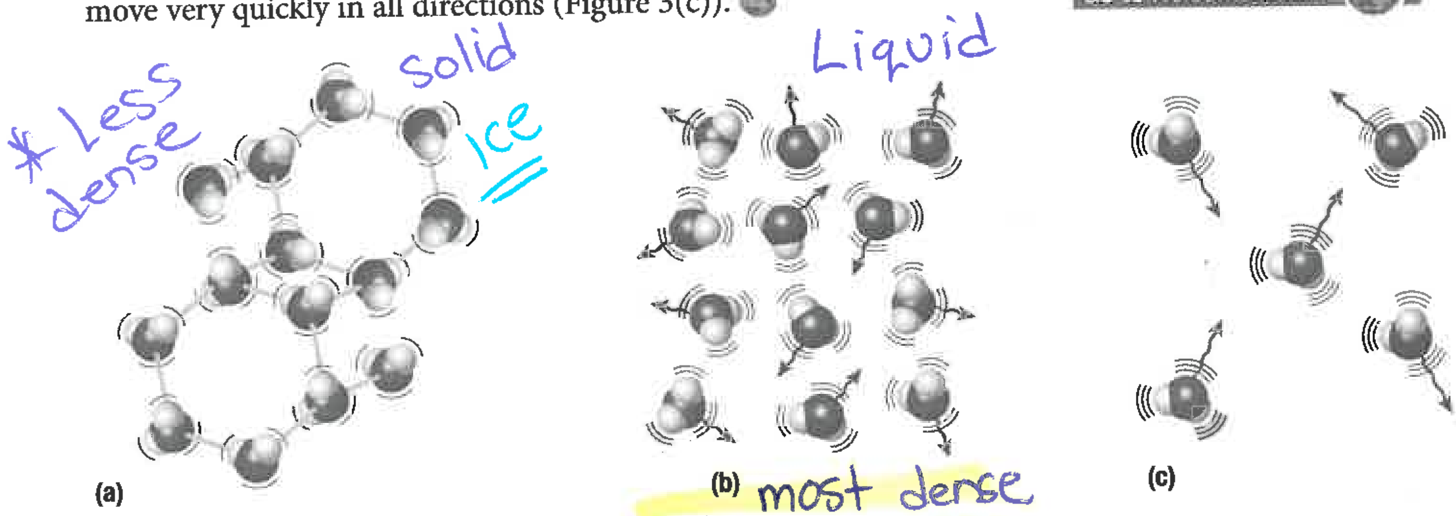


Figure 3 Water on Earth can be found as a solid (a), a liquid (b), or a gas (c).

Think about the temperatures at which each state of water exists. Where might you expect to find each state of water on Earth?

CHECK YOUR LEARNING

1. Describe a particle of water. What other particles make up a particle of water?
2. You are given a sample of tap water that is clear, yellowish, and odourless. Is this a sample of pure water? Explain.
3. Choose one of the states of water.
   (a) Draw a labelled diagram to show the arrangement of water particles in this state.
   (b) Describe the arrangement of water particles in this state.

What is Water?

1. Why is water important to life on the planet? - All living things need it
• irrigate crops (grow food) • put out fires

2. What are three ways that water is useful in the human body:

a) transports substances to tissues and organs

b) allows helpful chemical reactions to happen

c) Keeps us cool (sweat evaporates)

3. How does pure water compare to the water found in nature

a) pure water - clear, colourless, no taste, no odour.

b) water in nature - Dissolved substances
sometimes colour, sometimes taste, sometimes odour

4. You are given a sample of tap water that is clear, yellowish and odourless.
Is this a sample of pure water? Explain.

* colour means there must be something dissolved into it.

* must be mixture

11.1 Fresh Water and Salt Water

If all the water on Earth were drinkable fresh water, it would be a very long time before we ran short of water (Figure 1). Unfortunately, most of the water is in the oceans, and it is salt water. Only 3 % of Earth's water is fresh water—not salty—and most of that is deep under the surface or frozen in glaciers and polar ice. Only 0.4 % of Earth's water is liquid fresh water at, or near, the surface. Even so, "fresh water" does not always mean "water suitable for drinking."

Figure 1 About 70 % of Earth's surface is covered in water.

salinity: a measure of the quantity of dissolved salt in water

concentration: a measure of the quantity of dissolved substance contained per unit volume of solution

Comparing Fresh Water and Salt Water

How are fresh water and salt water different? To begin to answer this question, consider the Dead Sea. Swimmers can float in the Dead Sea with little effort (Figure 2). This is because the Dead Sea has a very high salinity—it contains a lot of dissolved salt. **Salinity** refers to the amount of salt dissolved in water. Salinity is expressed either as a percentage or as a concentration in g/L. Remember that **concentration** is the amount of solute in a particular volume of solution. The Dead Sea is a 30 % salt solution. Therefore, the concentration of salt in the Dead Sea is 300 g/L.

In comparison, the average salinity of the world's oceans is only 3 to 4 %. The salinity of any freshwater source (such as the Great Lakes) is less than 1 %.

Salt water has a greater density than fresh water (Figure 3). Objects that are more dense than a liquid will sink in that liquid; objects that are less dense than a liquid will float in it. For example, the water in the Dead Sea contains so much salt that the water is much more dense than a human body. The high density of salt water allows swimmers to float easily on the surface.

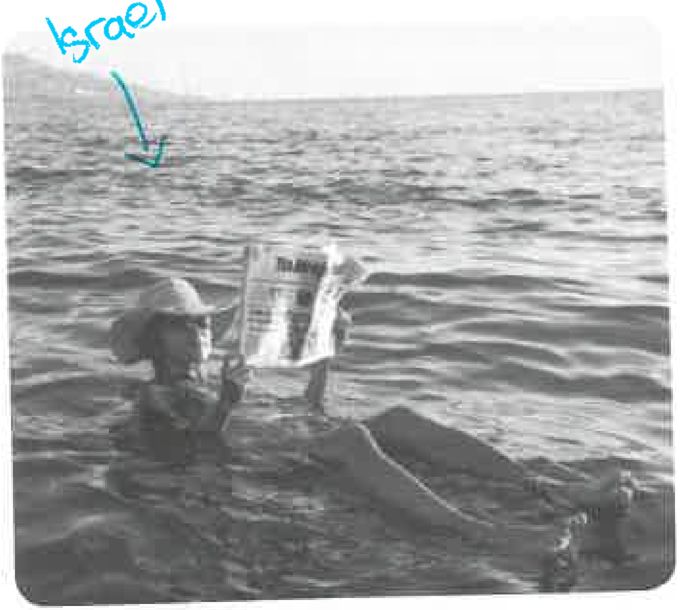


Figure 2 The salinity of the Dead Sea allows swimmers to float.

Figure 3 Fresh water (blue) is poured into a beaker containing salt water (red). Which is more dense?

Desalination

Is there a way to change salt water into fresh water? To answer this question, think about the changes of state that water undergoes as it moves in the water cycle.

TRY THIS: What's Left Behind?

SKILLS MENU: performing, observing

SKILLS HANDBOOK 2.B.6., 6.A.2.

In this activity, you will compare what is left behind when a sample of salty water and a sample of tap water are left in open containers for several days.

Equipment and Materials: small graduated cylinder; 2 cups or small bowls; marker; teaspoon; warm tap water; 2 paper labels; salt

1. Measure 10 mL of warm tap water. Pour the water into one of the cups. Label the cup "tap water."
2. Measure about half a teaspoon of salt into the graduated cylinder. Add warm tap water to the cylinder until the total volume of the solution is 10 mL. Swirl the salt-and-water mixture until the salt dissolves completely. Pour the salt solution into the second cup. Label this cup "salt water."
3. Place the two cups in a warm place where they will be undisturbed for several days. Check on them periodically and record your observations.

A. What did you learn from your observations? Does salt evaporate along with water?

B. How could you use what you learned to change salt water into a source of drinking water?

The Try This activity shows us that only water evaporates from the oceans, leaving the solid salt behind. This is why rain is not salty!

There are many places on Earth that have plenty of salt water but not enough fresh water to meet people's needs. Engineers have developed ways to separate fresh water from salt water to solve this problem. **Desalination** is any process that removes salt from water, producing pure water and solid salt.

Some desalination technologies involve evaporating and then condensing water to remove the salt. This process requires a lot of thermal energy, which makes it very expensive compared to using fresh surface water or groundwater directly. Some desalination technologies involve using renewable energy sources, such as energy from the Sun (Figure 4), or geothermal energy.

A recent advance in desalination technology uses osmosis across a membrane with tube-like pores called nanotubes. Water particles can easily pass through the little nanotubes, but salt particles and other large non-water particles cannot.

desalination: the technology of removing salt and other minerals from water

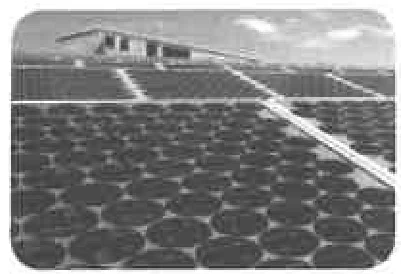


Figure 4 This solar power station in a desalination plant converts the Sun's energy into electricity. The electricity is used to run the plant.

To learn more about osmosis and nanotubes,
Go to Nelson Science

CHECK YOUR LEARNING

1. What percentage of water on Earth is fresh water?
2. Describe two special characteristics of salt water.
3. (a) Why are engineers developing desalination technologies?
   (b) Briefly describe a desalination process.
4. (a) What can make desalination expensive?
   (b) Name two renewable energy sources that can be used in desalination.

Fresh Water Vs. Salt Water

Define the following terms:

Salinity:
A measure of the quantity of dissolved salt in water

Concentration:
A measure of the quantity of dissolved substance contained per unit volume of solution.

Desalination:
Any process of removing salt from water
* Distillation (evaporation / condensation)

Questions:

What percentage of Earth's water is fresh water? 3%

What percentage of Earth's water is LIQUID FRESH WATER? 0.4%

Is all fresh water suitable for drinking? NO
potable

Which has a higher density… salt water or fresh water?
Salt water

10.3 The Water Cycle

Review!

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

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.

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.

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.

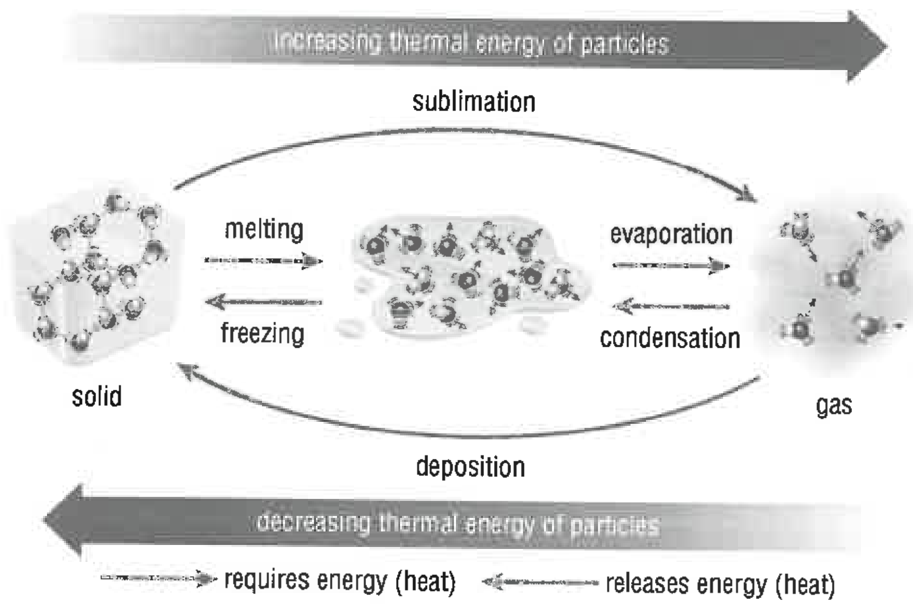


Figure 1 Energy is gained or lost whenever water changes state.

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.

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?

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.

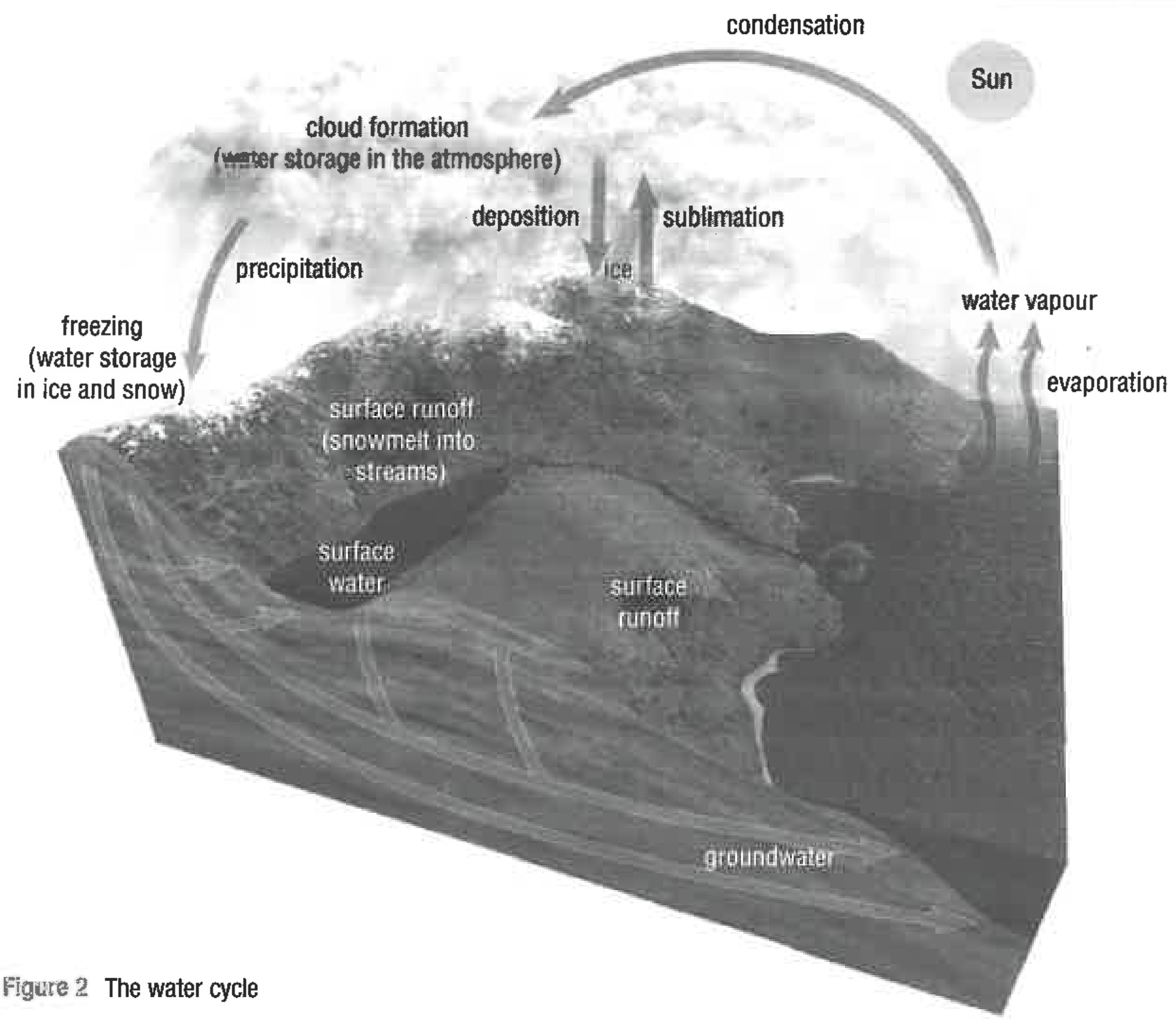


Figure 2 The water cycle

Melting, Evaporation, and Sublimation in Nature

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

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.

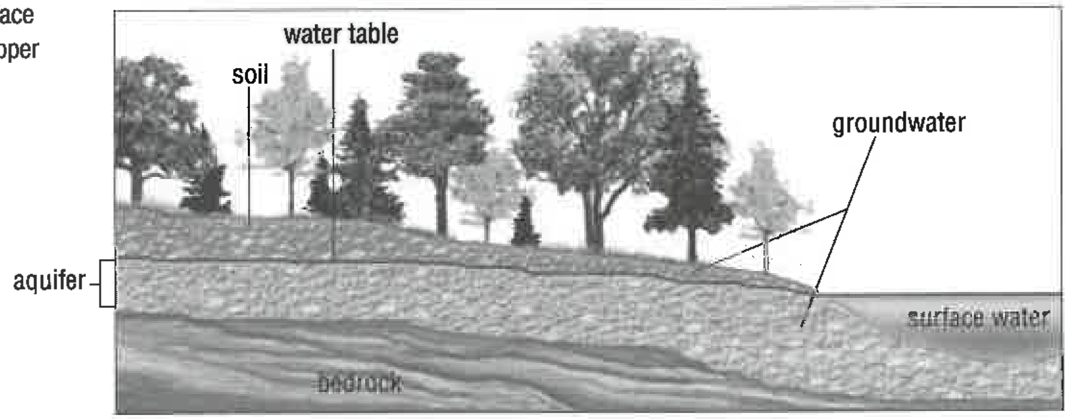


Figure 3 Groundwater saturates loose rock and soil to the level of the water table, forming an aquifer.

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).

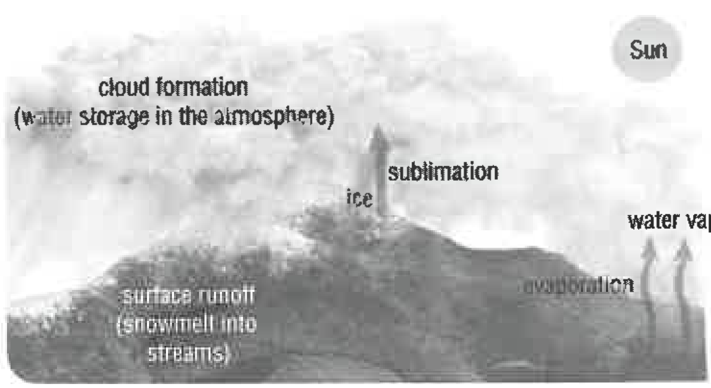


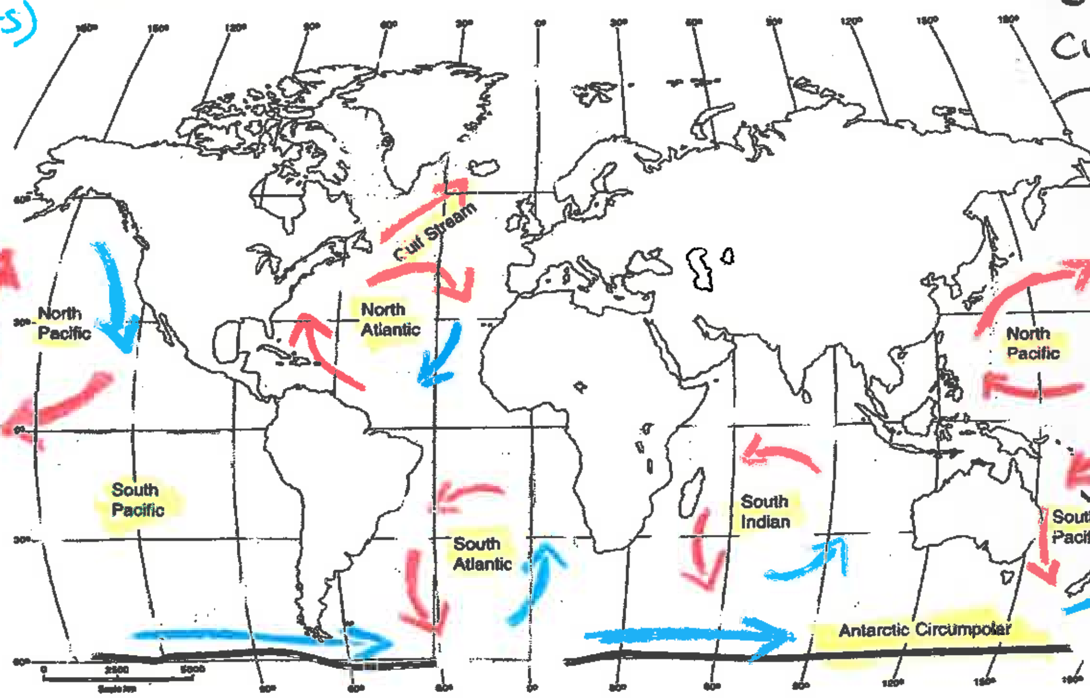
Figure 4 Ice melts into water or sublimes to form water vapour. Liquid water evaporates when thermal energy is added.

Power of Water

Moving water has the power to change the land around it

Vocabulary word	*Describe it*	*Draw it*
Erosion	**Erosion** is the gradual breaking down of materials caused by moving water. Erosion can dissolve rock, weakening it or turning it into tiny bits or fragments. These fragments can then be carried from one location to another.	
Deposition	**Deposition** is the transporting and dropping off of sediments / rock/soil carried by erosion.	
Weathering	**Weathering** is the breaking down of the rocks, soils, and minerals (as well as artificial materials) through contact with the Earth's atmosphere → water (storms... weather) → wind	
Ocean Currents • wind • Salinity • Heat capacity • Earth's rotation • Land (continents)	Ocean currents greatly impact the climate of the areas close to them. **Surface oceanic currents** are sometimes wind driven and develop their typical clockwise spirals in the northern hemisphere and counter-clockwise rotation in the southern hemisphere due to imposed wind stresses. **Deep ocean currents** are driven by density and temperature gradients.	 consistent circular pattern of ocean currents called Gyres

World Map: Ocean Currents



6 Major currents
- North Pacific
- South Pacific
- North Atlantic
- South Atlantic
- Indian ocean
- Antarctic Circumpolar

How can erosion impact human activity?

____

Power of Water

Natural disasters such as floods impact human activity

What are some of the ways people have protected the land as well as our structures against flooding or erosion *(preventing moving water from contacting structures)*

Type of protection	*Describe it*	*Draw it*
planting extra-vegetation (plants, trees...)	• plants will absorb + retain water	
Floodway	• A channel (large ditch) built to take flooding river water	
Sandbagging	• act as a barrier to divert moving water	