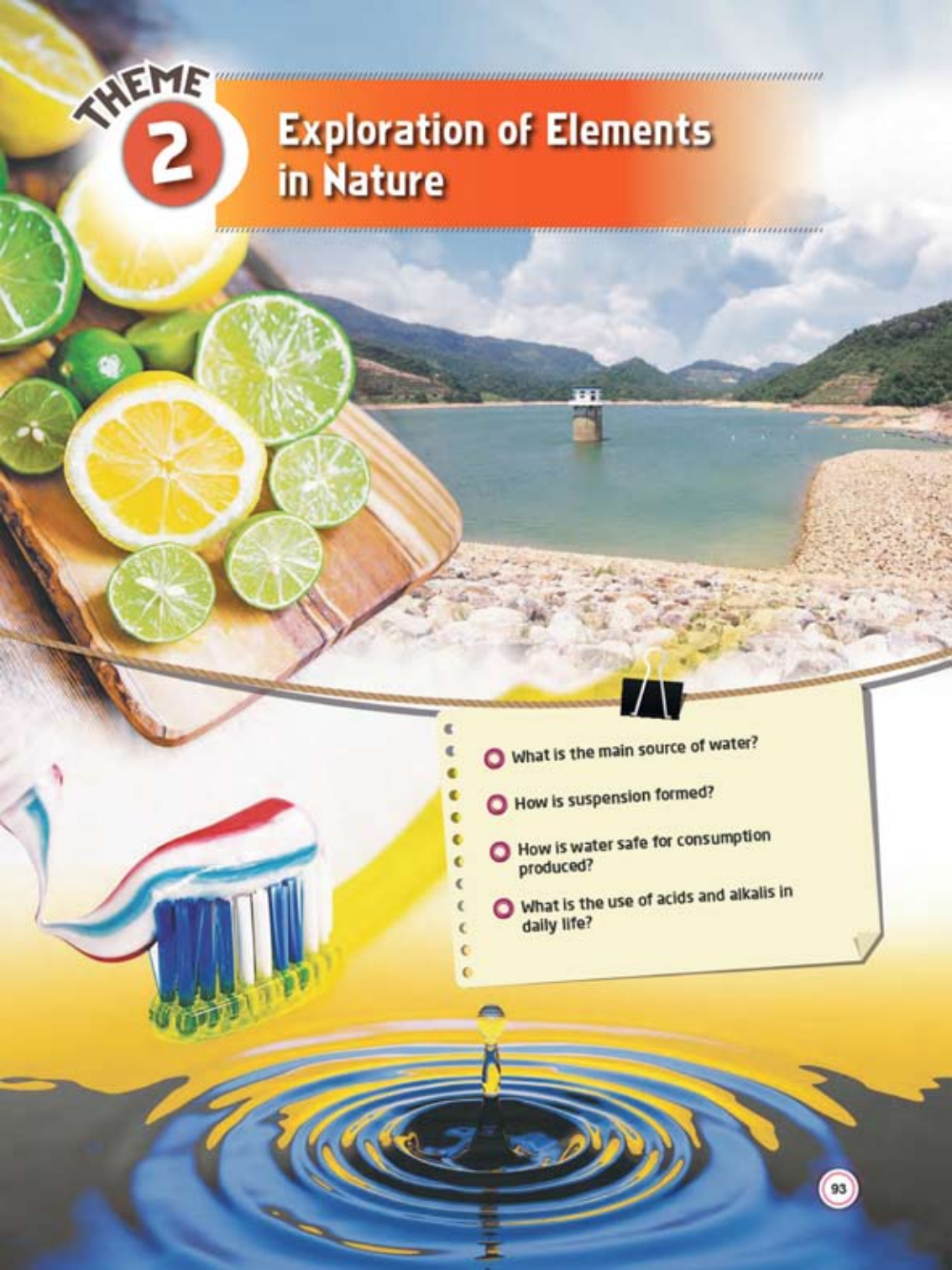


THEME 2

Exploration of Elements in Nature

- What is the main source of water?
- How is suspension formed?
- How is water safe for consumption produced?
- What is the use of acids and alkalis in daily life?

Chapter 5

Water and Solution

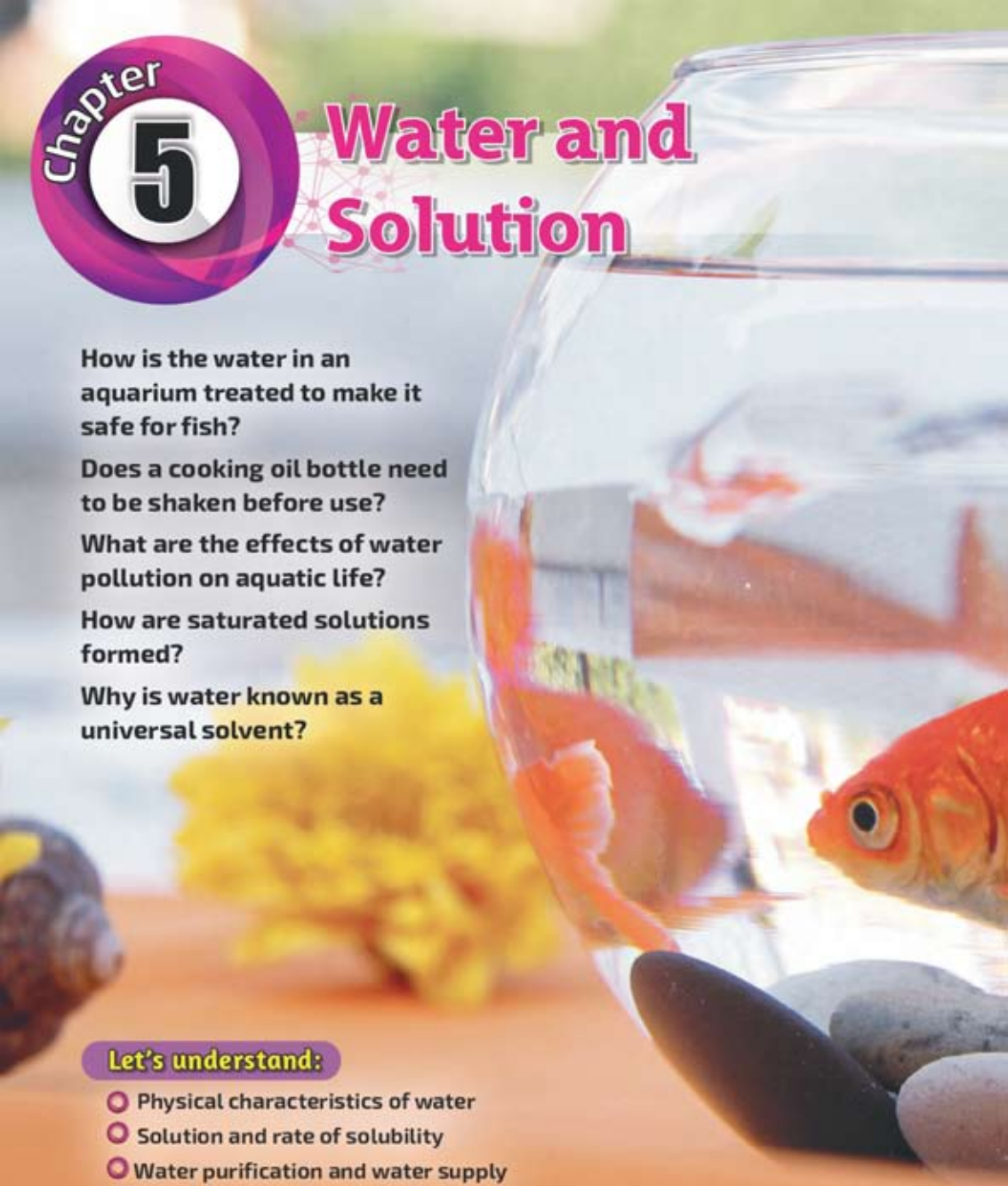
How is the water in an aquarium treated to make it safe for fish?

Does a cooking oil bottle need to be shaken before use?

What are the effects of water pollution on aquatic life?

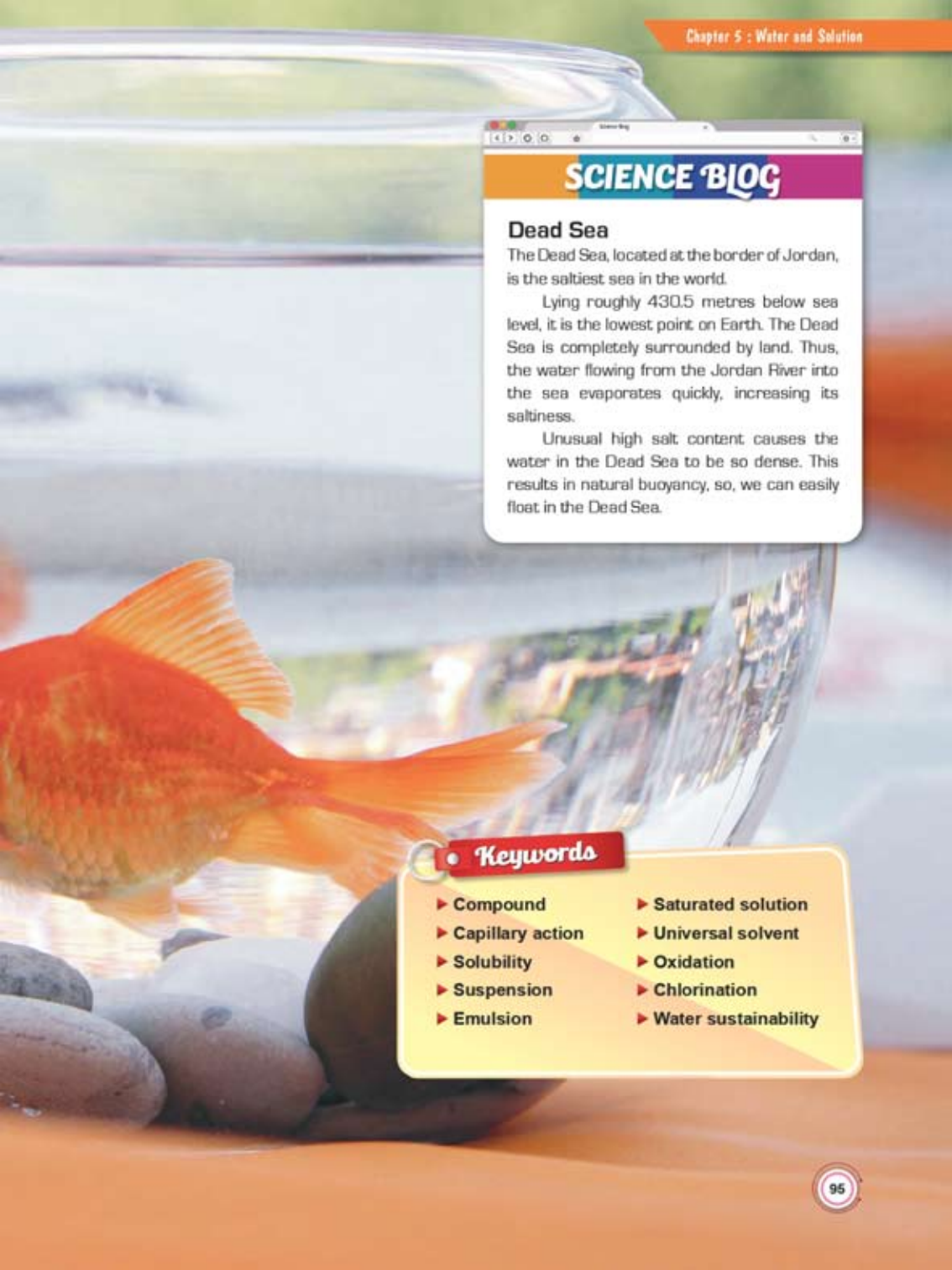
How are saturated solutions formed?

Why is water known as a universal solvent?



Let's understand:

- Physical characteristics of water
- Solution and rate of solubility
- Water purification and water supply



SCIENCE BLOG

Dead Sea

The Dead Sea, located at the border of Jordan, is the saltiest sea in the world.

Lying roughly 430.5 metres below sea level, it is the lowest point on Earth. The Dead Sea is completely surrounded by land. Thus, the water flowing from the Jordan River into the sea evaporates quickly, increasing its saltiness.

Unusual high salt content causes the water in the Dead Sea to be so dense. This results in natural buoyancy, so, we can easily float in the Dead Sea.

Keywords

- Compound
- Capillary action
- Solubility
- Suspension
- Emulsion
- Saturated solution
- Universal solvent
- Oxidation
- Chlorination
- Water sustainability

5.1 Physical Characteristics of Water

Water is a basic need of all life on Earth. No life would survive without water. More than 70% of the Earth's surface is covered by water. Water has its own unique properties. Pure water is colourless, odourless and tasteless. It exists as liquid at room temperature. Figure 5.1 shows several physical characteristics of pure water.

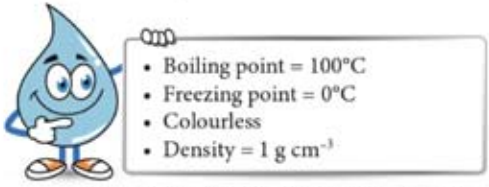


Figure 5.1 *Physical characteristics of pure water*

Water has a **high surface tension**. Surface tension is a result of **cohesive force** between the molecules of water at the surface that allows insects like daddy longlegs to stay afloat on water (Photograph 5.1).

Cohesive force between water molecules and **adhesive force** between water molecules and the cell walls of xylem allow water to be drawn up from the roots to the leaves of plants. This phenomenon is known as **capillary action** (Figure 5.2).

Photograph 5.1 *Daddy longlegs on the surface of water*

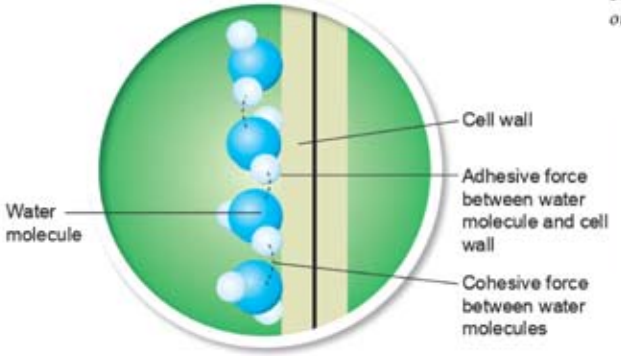


Figure 5.2 *Capillary action in plant*

Science Info

- Attractive force between same molecules is cohesive force
- Attractive force between different molecules is adhesive force

Do you still remember the three states of water that you have learned in Form One? Absorption and release of heat to the surroundings result in the change of the state of water.

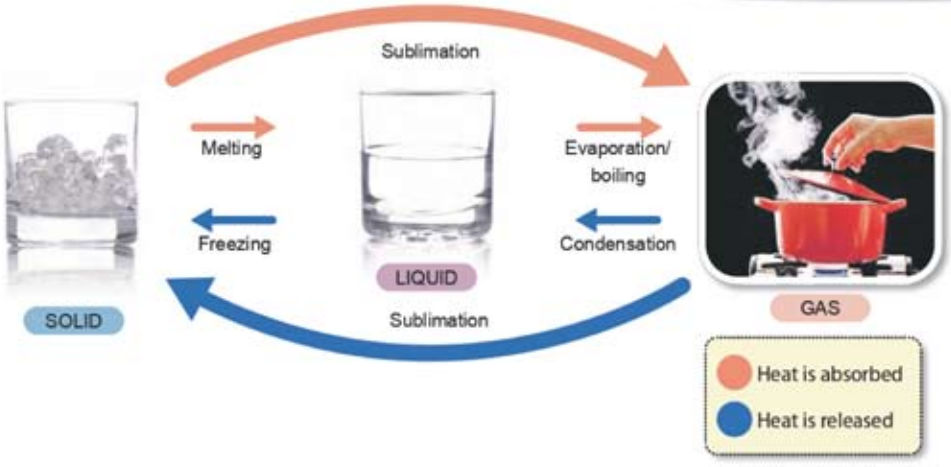


Figure 5.3 *Effects of absorption and release of heat on the state of water*

Activity 5.1

21st Century

Aim: To gather information and make a multimedia presentation on water.

Instruction

1. Work in groups.
2. Gather the following information from various resources.
   (a) The importance of water for living things
   (b) Physical characteristics of water
   - Boiling point
   - Colour
   - Surface tension
   - Effects of absorption and release of heat on water
   - Freezing point
   - Density
   - Capillary action
3. Present your findings in the form of a multimedia presentation.

Composition of Water

Teacher, is it true that water is a compound? How can we determine the composition of elements in a water molecule?

Yes, it is. Water is a **compound** which is made up of **oxygen** and **hydrogen** that combine chemically. We can determine the composition of elements in a water molecule through electrolysis.

Activity 5.2

Aim: To determine the composition of elements in a water molecule.

Materials: Distilled water, dilute hydrochloric acid, wooden splinters and matches

Apparatus: Electrolysis cell, switch, two measuring cylinders, dropper and crocodile clips

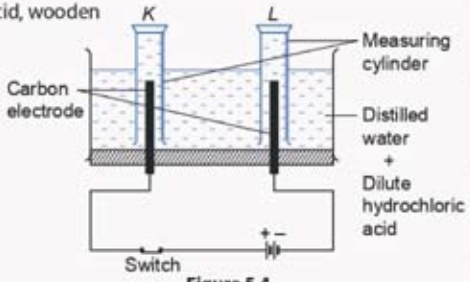


Figure 5.4

Instruction

1. Label two measuring cylinders as *K* and *L*.
2. Set up the apparatus as shown in Figure 5.4 by adding a few drops of dilute hydrochloric acid to the distilled water.
3. Connect the switch for 10 minutes.
4. Observe the changes that occur at both measuring cylinders.
5. After 10 minutes, turn off the switch and record the volumes of gas in each measuring cylinder.
6. Test the gases collected using wooden splinters.
   (a) The gas in measuring cylinder *K* is tested with a glowing wooden splinter
   (b) The gas in measuring cylinder *L* is tested with a burning wooden splinter
7. Record all your observations in a table.

Observation

Measuring cylinder	Volume of gas (ml)	Effect on wooden splinter
K		
L		

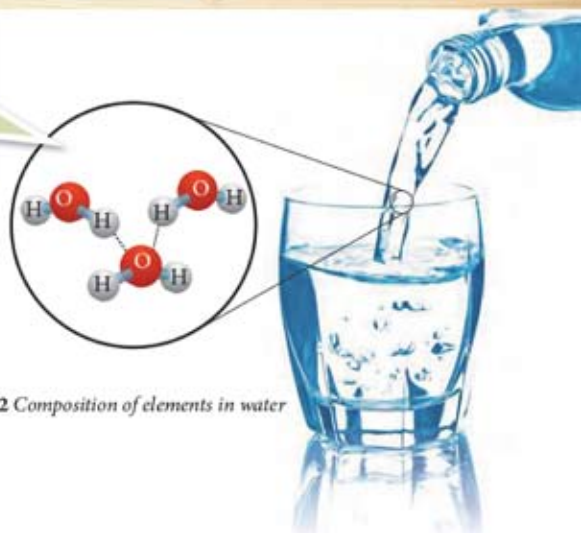
Questions

1. Name the gases collected in measuring cylinders *K* and *L*.
2. (a) What is the ratio of the volume of gas in measuring cylinder *K* to *L*?
   (b) Give an inference for your answer in **2** (a).
3. Why is dilute hydrochloric acid added into the distilled water?

- During electrolysis, oxygen gas is produced at the anode while hydrogen gas is produced at the cathode.
- A water molecule is made up of two hydrogen atoms and one oxygen atom.
- The chemical symbol of water is H_2O.

Science Info

- Anode is the electrode that is connected to the positive terminal of a battery.
- Cathode is the electrode that is connected to the negative terminal of a battery.



Photograph 5.2 *Composition of elements in water*

Effects of Impurities on the Melting Point and Boiling Point of Water

Photograph 5.3 shows two pots containing water and chicken soup respectively. The pot containing water boils faster than the one containing chicken soup. Do you know the reason for this? Let us carry out Activity 5.3 to study the effects of impurities on the melting and boiling points of water.

(a) Water (b) Chicken soup

Photograph 5.3 *Effects of impurities on the boiling point of water*

Activity 5.3

Aim: To observe the effects of impurities on the melting point and boiling point of water.

Materials: Distilled water, ice cubes, two thick towels and table salt

Apparatus: Beaker, conical flasks, thermometer, spatula, Bunsen burner, tripod stand, wire gauze, two-hole rubber stopper, glass tube and stopwatch

A The effect of table salt on the melting point of ice

Instruction

1. Wrap two similar-sized beakers in thick towels and label them as *P* and *Q*.
2. Add the same number of ice cubes into both beakers.
3. Add one spatula of salt into beaker *P* (Figure 5.5).
4. Record the temperature of the ice in both beakers every 2 minutes until the temperature becomes constant.

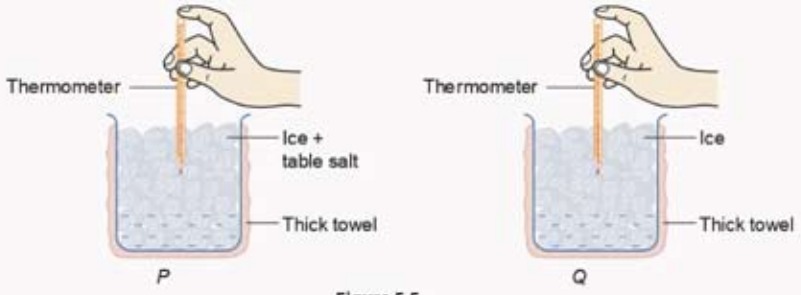


Figure 5.5

Observation

Time (min)		2	4	6
Temperature of ice in beaker (°C)	*P*			
	Q			

B The effect of table salt on the boiling point of water

Instruction

1. Set up the apparatus as shown in Figure 5.6 and label the conical flasks as *K* and *L*.
2. Heat the distilled water in both conical flasks until they reach 80°C.
3. Start recording the temperature of the water in both conical flasks every 2 minutes until the temperature becomes constant.

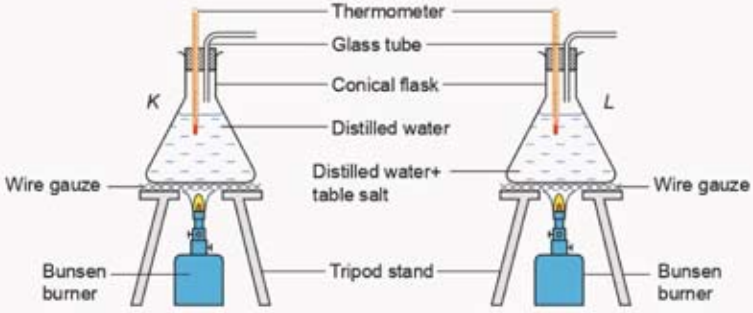


Figure 5.6

Observation

Time (min)		2	4	6
Temperature of water in conical flask (°C)	*K*			
	L			

Questions

1. Using the Kinetic Theory of Matter, explain the change in the state of ice in Activity A.
2. Give an inference for the boiling point of distilled water and the boiling point of distilled water mixed with salt.
3. What can be concluded about impurities from Activity A and B?

After completing Activity 5.3, you will find that salt lowers the melting point of ice and increases the boiling point of water. Other physical characteristics of water such as taste, smell and colour can also change in the presence of impurities. For example, seawater tastes salty because it contains dissolved salt.

Evaporation of Water

Evaporation of water is the process that happens at the **surface of water** that changes water to water vapour. This process occurs at any temperature. The changes in the water molecules that undergo evaporation can be seen in Figure 5.7.

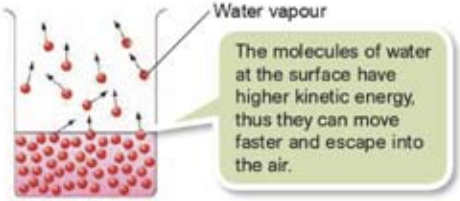


Figure 5.7 *The process of water evaporation*

Photograph 5.4 *Evaporation of water occurs when wet clothes dry*

Let us carry out Experiment 5.1 to know the factors affecting the rate of evaporation of water.

Experiment 5.1

Aim: To study the factors affecting the rate of evaporation of water.

A Humidity

Problem statement: Does humidity affect the rate of evaporation of water?

Hypothesis: The higher the humidity, the lower the rate of evaporation of water.

Variables:

(a) Constant variables: Surrounding temperature, volume of water, movement of air and exposed surface area of water
(b) Manipulated variable: Humidity
(c) Responding variable: Rate of evaporation of water

Materials: Anhydrous cobalt chloride papers, water, thread and anhydrous calcium chloride

Apparatus: Bell jar and beaker

Procedure:

1. Dip two anhydrous cobalt chloride papers into water until completely wet.
2. Set up the apparatus as shown in Figure 5.8.
3. Observe the cobalt chloride papers.
4. Record your observations in a table.

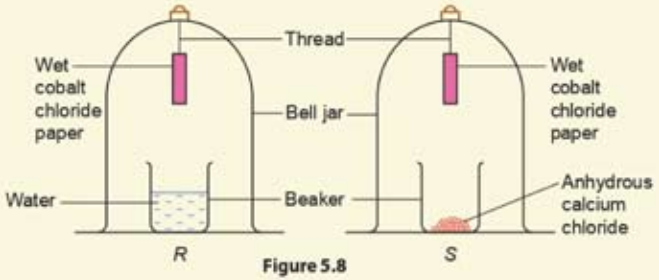


Figure 5.8

B Surrounding temperature

Problem statement: Does surrounding temperature affect the rate of evaporation of water?

Hypothesis: The higher the temperature of surrounding, the higher the rate of evaporation of water

Variables:
(a) Constant variables: Humidity, volume of air, movement of air, exposed surface area of water
(b) Manipulated variable: Surrounding temperature
(c) Responding variable: Rate of evaporation of water

Materials: Anhydrous cobalt chloride papers and water

Apparatus: Filament lamp and white tile

Procedure:
1. Label two anhydrous cobalt chloride papers as *J* and *K*.
2. Dip both papers, *J* and *K* in water until completely wet.
3. Place papers *J* and *K* on a table as shown in Figure 5.9.
4. Observe the cobalt chloride papers.
5. Record your observations in a table.

Science Info

Cobalt chloride paper is made of cobalt chloride powder, a substance that is very sensitive to water. The paper is blue when dry and turns pink when wet.

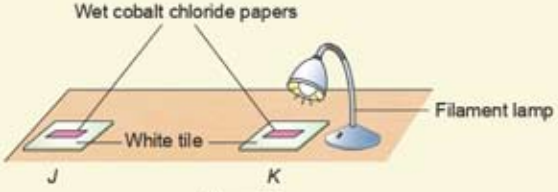


Figure 5.9

C Exposed surface area of water

Problem statement: Does exposed surface area of water affect the rate of evaporation of water?

Hypothesis: The larger the exposed surface area of water, the higher the rate of water evaporation.

Variables:
(a) Constant variables: Humidity, volume of air, movement of air and surrounding temperature
(b) Manipulated variable: Exposed surface area of water
(c) Responding variable: Rate of evaporation of water

Materials: Filter papers, water and thread

Apparatus: Retort stand with clamp

Procedure:
1. Prepare three filter papers, *P*, *Q* and *R*.
2. Dip all the three filter papers in water.
3. Fold filter paper *Q* into two and filter paper *R* into four.
4. Hang all the three filter papers on different retort stands (Figure 5.10).

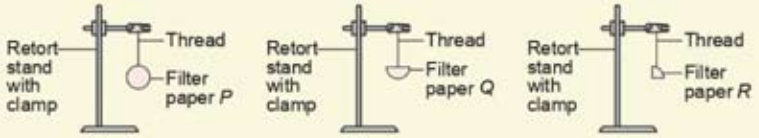


Figure 5.10

5. Record the time taken for the filter papers to dry in a table.

D Movement of air

Problem statement: Does movement of air affect the rate of evaporation of water?

Hypothesis: The faster the movement of air, the higher the rate of evaporation of water.

Variables:
(a) Constant variables: Humidity, volume of water, exposed surface area of water and surrounding temperature
(b) Manipulated variable: Movement of air
(c) Responding variable: Rate of evaporation of water

Materials: Anhydrous cobalt chloride papers, cellophane tape and water

Apparatus: Microscope slides, fan and dropper

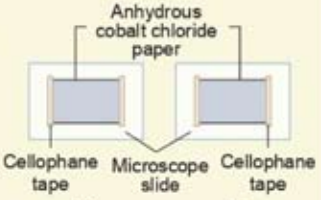


Figure 5.11

Procedure:
1. Stick two anhydrous cobalt chloride papers on microscope slides using cellophane tape and label them as *M* and *N* (Figure 5.11).
2. Add a few drops of water on each cobalt chloride paper.
3. Place slide *M* under a moving fan and slide *N* away from the fan.
4. Record your observations after 15 minutes in a table.

Conclusion:
Is the hypothesis for each experiment accepted? Give your reasons.

Questions

1. State the functions of water and anhydrous calcium chloride in Experiment A.
2. What is the use of the filament lamp in Experiment B?
3. How does surface area affect the rate of evaporation of water?
4. Why is a fan used in Experiment D?

There are four factors affecting the rate of evaporation of water, **humidity**, **surrounding temperature**, **exposed surface area of water** and **movement of air**.

Brain Teaser

Why do we feel cold when we sweat?

Humidity

Dry air contains less water vapour. So, dry air can hold more water molecules that escape from the surface of water. Thus, the rate of evaporation of water increases.

Surrounding temperature

When the surrounding temperature increases, the water molecules at the surface gain more energy, move faster and escape into the air easily. Thus, the rate of evaporation of water increases.

Exposed surface area of water

Exposed surface area of water that is larger allows more water molecules to escape, thus increasing the rate of evaporation of water.

Movement of air

Movement of air sweeps away water vapour in the air. High speed of wind causes the air at the surface of water to dry and increases the rate of evaporation of water.

Figure 5.12 *Factors affecting the rate of evaporation of water*

Applications of Evaporation of Water in Daily Life

Clothes hung on clothes lines have large exposed surface areas. So, the clothes will dry faster.

Sea salt is obtained from the evaporation of seawater.

Seafood that is dried can be kept longer as microorganisms cannot survive without water.

Hair dryer that blows hot air increases the temperature, thus increasing evaporation of water.

Photograph 5.5 *Applications of evaporation of water in daily life*

Activity 5.4

21st Century

Aim: To create a multimedia presentation on evaporation of water.

Instruction

1. Work in groups.
2. Gather information on:
   (a) the relationship between evaporation process and daily life activities
   (b) the ways to reduce water loss through evaporation process in agriculture
   (c) cooling through evaporation process in refrigerators
3. Use various resources such as Internet and library to gather information for **2** (a), (b) and (c).
4. Present the outcomes.

Formative Practice 5.1

1. Ikram needs pure water to prepare a solution. His friend gave him a bottle of water. Suggest a way that he can use to determine whether the water is pure or not.
2. Explain the difference between the movement of water molecules at room temperature and at 0°C.
3. Explain one importance of evaporation of water to the human body.

5.2 Solution and Rate of Solubility

Solute, Solvent and Solution

Have you ever wondered what happens to the sugar that is added to water? **Solute** is a substance that can dissolve in a liquid, whereas **solvent** is a liquid that dissolves a substance. Thus, sugar is a solute and water is a solvent. **Solution** is the mixture formed when a solute dissolves in a solvent. Thus, the sugar water formed is a solution (Photograph 5.6).

Photograph 5.6
Formation of solution

Dilute Solution, Concentrated Solution and Saturated Solution

The amount of solute in a solution affects the **concentration** of the solution. The solutions formed can be classified as **dilute solution**, **concentrated solution** and **saturated solution**. These solutions can be prepared in the laboratory by carrying out Activity 5.5.

Activity 5.5

Aim: To prepare dilute solution, concentrated solution and saturated solution.

Materials: Distilled water and copper(II) sulphate crystal

Apparatus: Beaker, measuring cylinder, glass rod and spatula

Instruction

1. Fill three beakers labelled as *P*, *Q* and *R* with 50 ml of distilled water (Figure 5.13).
2. Add two spatulas of copper(II) sulphate crystals into beaker *P* and stir until all the copper(II) sulphate crystals dissolve.
3. Add four spatulas of copper(II) sulphate crystals into beaker *Q* and stir until all the copper(II) sulphate crystals dissolve.
4. Add four spatulas of copper(II) sulphate crystals into beaker *R* and stir until all the copper(II) sulphate crystals dissolve. Add more copper(II) sulphate crystals little by little until excess copper(II) sulphate crystals deposit at the bottom of the beaker.
5. Observe all the three beakers and record your observations.

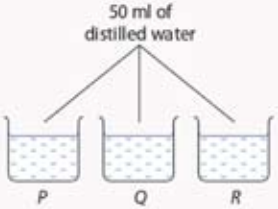


Figure 5.13

Observation

Beaker	Quantity of copper(II) sulphate crystals	Colour of solution
P		
Q		
R		

Questions

1. Identify the types of solutions formed in beakers *P*, *Q* and *R*.
2. Name the solute, solvent and solution used in this activity.
3. Why does a precipitate form in beaker *R*?

The three types of solutions formed in Activity 5.5 are uniform mixtures even though the saturated solution forms a precipitate. Table 5.1 shows the comparison between these three types of solutions.

Table 5.1 *Comparison between different types of solutions*

Dilute solution	Concentrated solution	Saturated solution
• Less amount of solute in the solvent • Can dissolve more solute	• More amount of solute in the solvent • Can dissolve less solute	• Excess amount of solute in the solvent • Cannot dissolve any more solute and form precipitate

Solution and Suspension

When two substances are mixed to form a mixture, a solution or a suspension is formed. What is the difference between a solution and a suspension? **Solution** is a clear mixture formed when a solute dissolves in a solvent, whereas **suspension** is a cloudy mixture formed from undissolved solute particles in a solvent. Figure 5.14 shows river water that contains a non-uniform mixture of water and sand.

Figure 5.14 *River water is an example of suspension*

Let us carry out Activity 5.6 to distinguish between a solution and a suspension.

Activity 5.6

Aim: To distinguish between a solution and a suspension.

Materials: Copper(II) sulphate crystal, water, filter paper and chalk powder

Apparatus: Beaker, spatula, conical flask, filter funnel, measuring cylinder, glass rod, torchlight and white screen

Instruction

1. Measure and pour 100 ml of water into a beaker and add one spatula of copper(II) sulphate crystals.
2. Stir the mixture until even and observe the appearance of the mixture formed.
3. Use a torchlight to direct a beam of light towards the beaker and observe whether the light can pass through the mixture as shown in Figure 5.15(a).
4. Let the mixture stand for 10 minutes and filter its content as shown in Figure 5.15(b).
5. Observe if there is any residue left on the filter paper.
6. Repeat steps 1 to 5 by replacing copper(II) sulphate crystals with chalk powder and record your observations.

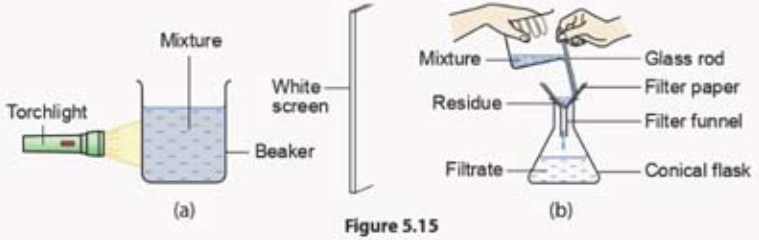


Figure 5.15

Questions

1. What is the appearance of the mixture of water and chalk powder?
2. How can the solute in the mixtures be related to the ability of light to pass through them?
3. Give your inference for the filtration test done on both mixtures.

A **solution** is formed when a solute is dispersed throughout a solvent. Thus, a solution has a uniform colour and appearance. Although the mixture of water and copper(II) sulphate crystals forms a coloured solution, the uniform colour of the mixture makes the solution appear transparent. The tiny size of the solute particles allows light to pass through a solution. This is also the reason why there is no residue left when a solution is filtered.

A **suspension** appears cloudy as the solute particles do not dissolve in the solvent, such as chalk powder that is insoluble in water. The size of the particles in a suspension is large enough to prevent light from passing through the suspension. Suspensions will settle if left undisturbed and leave residue when filtered.

My Science World

A medicine in the form of suspension must be shaken before using to ensure the active substances in it are equally dispersed throughout the liquid.

Solubility

You have already learned the definition of a solution. Now, what does solubility mean?

> **Solubility** of a solute is the maximum amount of the solute that can dissolve in 100 ml of solvent at a specific temperature.

Rate of Solubility

The rate of solubility of a substance is affected by several factors. Carry out Experiment 5.2 to determine these factors.

Experiment 5.2

Aim: To study the factors affecting the rate of solubility.

A Temperature of solvent

Problem statement: Does the temperature of solvent affect the rate of solubility?

Hypothesis: The higher the temperature of solvent, the higher the rate of solubility.

Variables:
(a) Constant variables: Volume of solvent, rate of stirring and size of solute
(b) Manipulated variable: Temperature of solvent
(c) Responding variable: Rate of solubility

Materials: Distilled water and table salt

Apparatus: Measuring cylinder, beaker, glass rod, thermometer, tripod stand, wire gauze, Bunsen burner and spatula

Procedure:

1. Pour 100 ml of distilled water into beakers labelled *K* and *L*.
2. Heat beaker *L* until 50°C, then add table salt into beakers *K* and *L*.
3. Stir the mixtures in beakers *K* and *L* at the same rate until the salt dissolves completely (Figure 5.16).
4. Observe and determine the beaker in which the salt dissolves faster.
5. Record your observation.

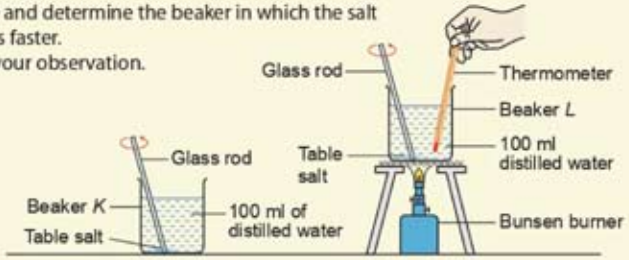


Figure 5.16

Conclusion:
Is the hypothesis accepted? Give your reason.

B Rate of stirring

Problem statement: Does the rate of stirring affect the rate of solubility?

Hypothesis: The higher the rate of stirring, the higher the rate of solubility.

Variables:
(a) Constant variables: Volume of solvent, temperature of solvent and size of solute
(b) Manipulated variable: Rate of stirring
(c) Responding variable: Rate of solubility

Materials: Distilled water and table salt

Apparatus: Beaker, glass rod, measuring cylinder and spatula

Procedure:
1. Set up the apparatus as shown in Figure 5.17.
2. Stir the mixture in beaker *K* slowly and the mixture in beaker *L* fast.
3. Determine in which beaker the salt dissolves faster.
4. Record your observation.

Figure 5.17

Conclusion:
Is the hypothesis accepted? Give your reason.

C Size of solute

Problem statement: Does the size of solute affect the rate of solubility?

Hypothesis: The smaller the size of solute, the higher the rate of solubility.

Variables
(a) Constant variables: Volume of solvent, temperature of solvent and rate of stirring
(b) Manipulated variable: Size of solute
(c) Responding variable: Rate of solubility

Materials: Distilled water, fine sugar and sugar cubes

Apparatus: Beaker, measuring cylinder, glass rod and spatula

Procedure:
1. Set up the apparatus as shown in Figure 5.18.
2. Stir the mixtures in beakers *K* and *L* at a same rate.
3. Determine in which beaker the sugar dissolves faster.
4. Record your observation.

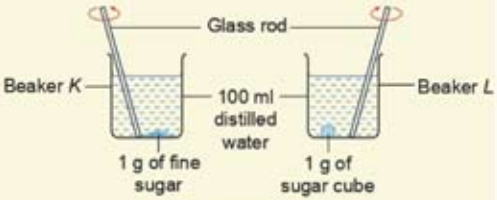


Figure 5.18

Conclusion:
Is the hypothesis accepted? Give your reason.

Summary:

Factor	Rate of solubility
Temperature	
Rate of stirring	
Size of solute	

We use the knowledge of solubility in our everyday life without even realising it. For example, to make a cup of coffee quickly, we use hot water, fine sugar and instant coffee powder. Then, the mixture is stirred fast. All these actions increase the rate of solubility.

Sugar dissolves faster in hot coffee when stirred.

High **temperature** and **rate of stirring** of solvent cause the particles to move rapidly. This causes the particles of solvent and solute to fill up the spaces between them faster.

Fine sugar dissolves faster compared to sugar cubes.

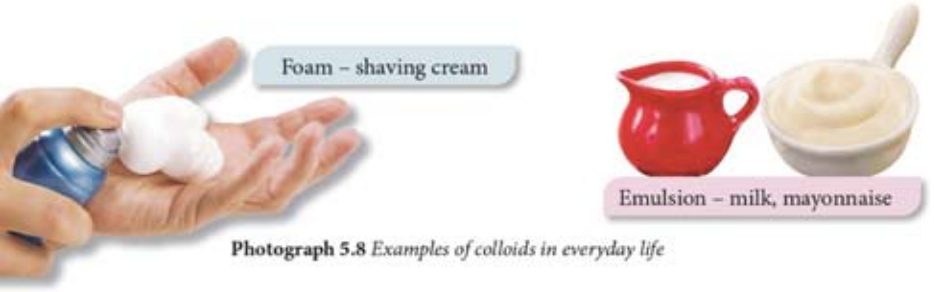
The smaller **the size of solute**, the bigger the **total surface area** that is exposed to the solvent particles. This allows the solute to dissolve faster in the solvent.

Photograph 5.7 *Factors affecting the rate of solubility*

Colloid

A colloid is a **mixture** of two or more solutes dispersed evenly in a solvent. However, colloids neither form a clear mixture nor precipitate. Thus, colloids are intermediate between a solution and a suspension (Figure 5.19).

Figure 5.19



Photograph 5.8 *Examples of colloids in everyday life*

Water as a Universal Solvent

Water is known as a **universal solvent** due to its ability to dissolve almost all substances, solids, liquids or gases. Water is used as a solvent in domestic use and also as a raw material in the manufacturing industry, agriculture and medicine.

Photograph 5.9 *Uses of water as a universal solvent*

Organic Solvents

Organic solvents which are carbon-based can be used to dissolve solutes that are insoluble in water.

Organic solvents

Alcohol	Kerosene	Acetone	Turpentine	Ether
Perfume	Lamp oil	Nail varnish	Paint remover	Oil extractor
Antiseptic		Lacquer	Paint thinner	

Figure 5.20 *Examples of organic solvents in everyday life*

The characteristic of organic solvents which is volatile enables these solvents to be used widely in manufacturing aerosol substances such as spray paint, perfumes and pesticides. Organic solvents must be handled carefully as there are certain organic solvents which can be harmful to health.

Formative Practice 5.2

1. Explain with examples the meaning of solute, solvent and solution.
2. Explain one difference between solution and suspension.
3. Name the substances at home that can remove rust, blood stains and ink stains.
4. Why is hot water suitable for making coffee?

5.3 Water Purification and Water Supply

Water Purification Method

Water is one of the most valuable natural resources on Earth. Water covers two-thirds of the Earth's surface, however most of the water cannot be used directly as it contains impurities, microorganisms and dissolved substances.

Thus, water needs to be purified and treated in order to be safe for human consumption. Water purification can remove odour, taste, colour, microorganisms and dissolved substances so that the water can be used for various purposes.

Let us carry out Activity 5.7 to study the water purification method.

Activity 5.7

Aim: To study various water purification methods.

Materials: Pond water, chlorine water, sterile nutrient agar, filter paper and cellophane tape

Apparatus: Beaker, glass rod, filter funnel, measuring cylinder, Bunsen burner, wire gauze, Petri dish, distillation flask, Liebig condenser, retort stand with clamp, thermometer and one-hole rubber stopper

Instruction

1. Set up the apparatus as shown in Figure 5.21(a) and collect the filtrate.
2. Set up the apparatus as shown in Figure 5.21(b) and collect the distillate.
3. Prepare five Petri dishes containing nutrient agar and label them as *A*, *B*, *C*, *D* and *E*.
4. Add the following substances into the Petri dishes.
   Petri dish *A* is added with five drops of pond water
   Petri dish *B* is added with five drops of filtrate of pond water
   Petri dish *C* is added with five drops of distillate of pond water
   Petri dish *D* is added with five drops of boiled pond water
   Petri dish *E* is added with five drops of pond water mixed with chlorine water
5. Close all the Petri dishes and seal them with cellophane tape.
6. Keep all the Petri dishes in a dark place for four days.
7. After four days, observe and record the growth of microorganisms on the nutrient agar.

Figure 5.21(a)

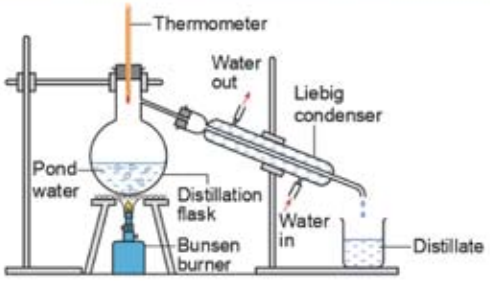


Figure 5.21(b)

Observation

Petri dish	Observation
A	
B	
C	
D	
E	

Questions

1. Which method produces pure water?
2. What is the function of chlorine in Petri dish *E*?
3. Give an inference for your observation on the nutrient agar in Petri dishes *B* and *C*.

You have studied water purification methods from Activity 5.7. Overall, water purification methods include boiling, chlorination, filtration and distillation (Figure 5.22).

Figure 5.22 *Water purification methods*

Solving the Problems of Water Supply

Some countries with limited water sources use alternative ways to get water supply to meet their nations' water needs.

Info

NEWater
https://www.pub.gov.sg/watersupply/fournationaltaps/newater

Activity 5.8

STEM

Aim: To gather information on the initiatives taken by countries with water shortage to get water supply.

Instruction

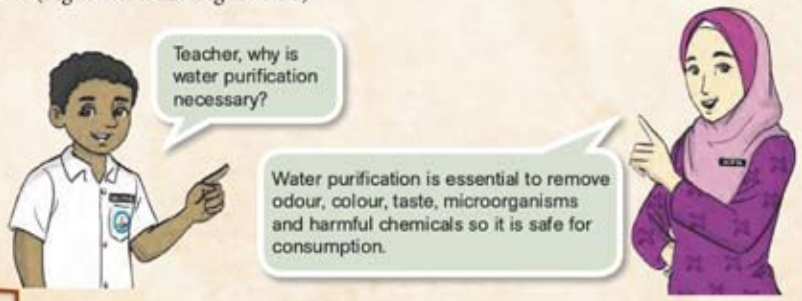
1. Work in groups.
2. Gather information on how the countries with water shortage find alternatives for water supply. The alternative methods include:
   (a) recycle of water
   (b) fog harvesting
   (c) water purification from seawater (reverse osmosis)
3. Present the outcomes using a multimedia presentation.

Career in STEM

A water treatment engineer designs a system that can treat wastewater into clean water which is safe for human use.

Water Supply System

We use water every day for bathing, drinking, washing the dishes as well as many other things. Have you ever wondered where the tap water comes from? Water collected from sources such as rivers and rain is conveyed to water treatment plants prior to its distribution to consumers. Bacteria, algae and minerals are some of the substances removed during the water purification process (Figure 5.23 and Figure 5.24).



5.3.2

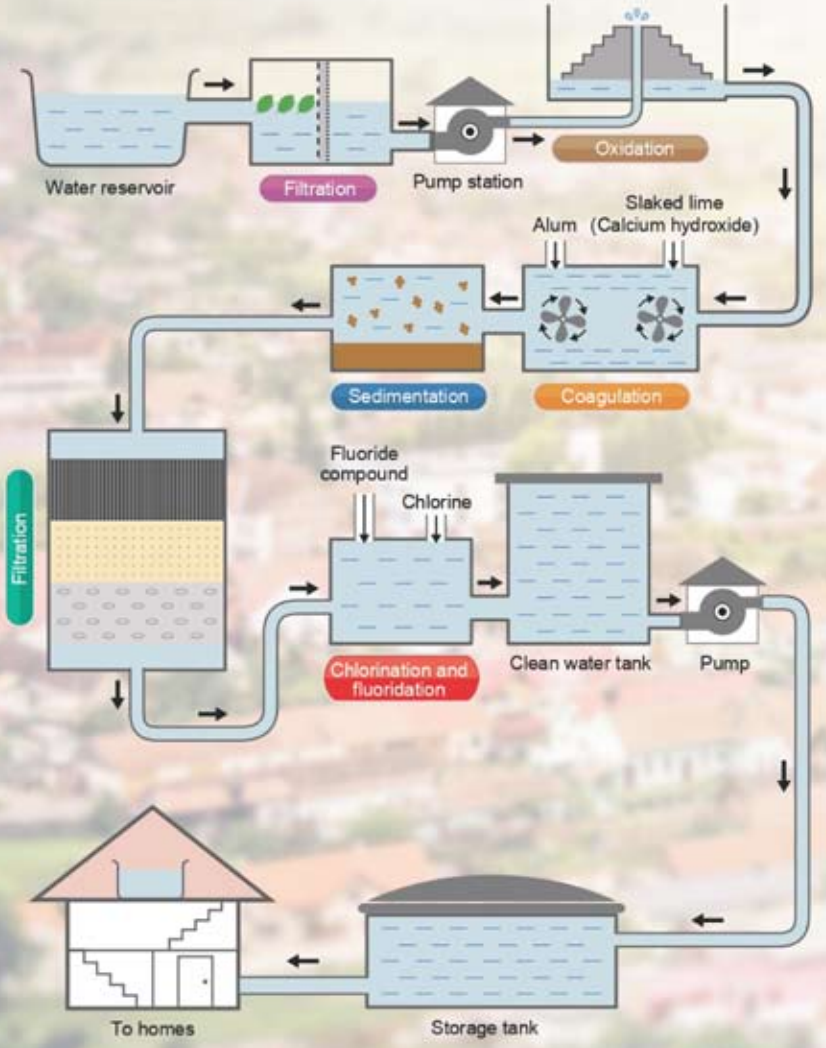


Figure 5.23 *The water supply system*

Process	Function
Filtration	Removes large suspended particles such as tree branches and leaves
Oxidation	Increases oxygen content in the water to get rid of unpleasant smell and taste
Coagulation	• Alum is added so that mud particles stick together and sink to the bottom of the tank • Slaked lime (calcium hydroxide) is added to reduce the acidity of water
Sedimentation	Suspended particles deposit at the bottom of the tank
Filtration	Removes remaining suspended particles through sand filters
Chlorination and fluoridation	• Chlorine is added to kill microorganisms in water • Sodium fluoride is added to prevent tooth decay

Figure 5.24 *Water purification process*

Activity 5.9

STEM 21st Century

Aim: To gather information on the stages of the water supply system.

Instruction

1. Work in groups.
2. Build a model of water supply system using scrap materials to show the following stages:
   (a) filtration
   (b) oxidation
   (c) coagulation
   (d) sedimentation
   (e) filtration
   (f) chlorination and fluoridation
3. Gather information about each stage.
4. Explain the model built and present the outcomes.

Water Sustainability

Rivers are the main water source in Malaysia. Unfortunately, water pollution makes the water unsuitable for consumption and also results in negative impacts on the environment (Photograph 5.10). Development projects, industrial and agricultural activities are among the main sources of water pollution. Figure 5.25 shows the main water pollutants and ways to overcome water pollution.

Photograph 5.10 *Water pollution*

Water pollutants	Ways to overcome water pollution
Domestic waste 	• Upgrade sewerage systems nationwide • Educate people on how to manage rubbish correctly • Improve sanitation facilities in rural areas

Industrial waste 	• Enforce laws to ensure industrial waste is treated before being discharged into the river. Examples of laws on water pollution:
	  • Environmental Quality (Scheduled Wastes) Regulations 2005
	  • Environmental Quality (Industrial Effluent) Regulations 2009
	  • Environmental Quality (Sewage) Regulations 2009

Chemicals in agriculture 	• Educate farmers to use biodegradable fertilisers and pesticides.
Oil spillage 	• Surround and contain oil spilled at sea using National Oil Spill Contingency Plan Revised Year 1999/2000. • Improve air surveillance with the cooperation of Air Police Unit.

Figure 5.25 *Water pollutants and the ways to overcome water pollution*

Activity 5.10

Aim: To discuss water sustainability.

Instruction

1. Work in groups.
2. Gather information on one of the topics below:
   (a) the importance of realising safe water content for consumption
   (b) effects of water pollution on living things and environment based on real cases such as mercury poisoning in Minamata Bay, Japan
   (c) river pollution and river cleaning methods
   (d) the role of individuals in ensuring water sustainability
3. Share the outcomes.

Activity 5.11

STEM 21st Century

Aim: To carry out water audit activity.

Instruction

1. Work in groups.
2. Based on the water bills of the past few months, calculate the average water consumed at home or school.
3. Identify the acts of wasting water and record them.
4. Discuss and suggest water conservation steps.
5. Think of an innovative method to conserve water and increase efficiency of water usage.
6. Write a report.

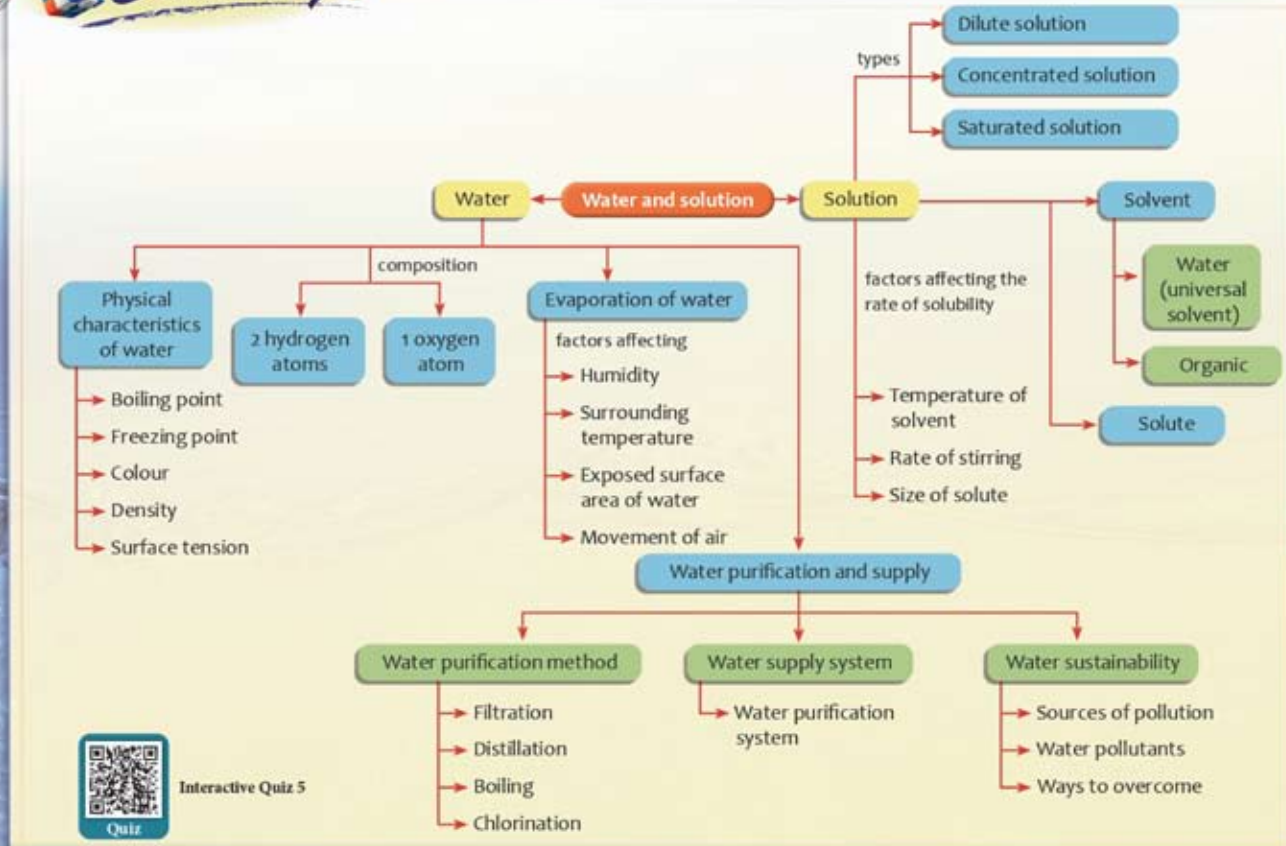
Formative Practice 5.3

1. Name three impurities found in natural water resources.
2. State water purification methods that can remove impurities in water.
3. What are the major water pollution problems in coastal areas and in the sea?
4. Determine whether the following statements are **True** or **False**. Write your answers in the space provided.

Statement	True / False
(a) River water and sewage are natural water resources.	
(b) Alum and slaked lime are added in the coagulation tank.	
(c) Chlorination can remove impurities in the water.	

5. Explain three ways to control water pollution.

Summary


Water and solution
Water
Solution
types
Dilute solution
Concentrated solution
Saturated solution
Solvent
Water (universal solvent)
Organic
Solute
factors affecting the rate of solubility
Temperature of solvent
Rate of stirring
Size of solute
composition
Physical characteristics of water
Boiling point
Freezing point
Colour
Density
Surface tension
2 hydrogen atoms
1 oxygen atom
Evaporation of water
factors affecting
Humidity
Surrounding temperature
Exposed surface area of water
Movement of air
Water purification and supply
Water purification method
Filtration
Distillation
Boiling
Chlorination
Water supply system
Water purification system
Water sustainability
Sources of pollution
Water pollutants
Ways to overcome
Quiz
Interactive Quiz 5

SELF-REFLECTION

After learning this chapter, you are able to:

5.1 Physical Characteristics of Water

- ☐ Elaborate and communicate about water.
- ☐ Carry out experiments and communicate about the water evaporation process in daily life.

5.2 Solution and Rate of Solubility

- ☐ Explain with examples the meaning of solution and solubility.
- ☐ Carry out experiment to determine the factors affecting the rate of solubility.
- ☐ Explain with examples the meaning of colloids in daily life.
- ☐ Elaborate and communicate the uses of water as a universal solvent in daily life and manufacturing industry.
- ☐ Demonstrate examples of organic solvents and their uses in daily life.

5.3 Water Purification and Water Supply

- ☐ Demonstrate the water purification method.
- ☐ Solve problems in getting water supply for daily life usage.
- ☐ Build a model and communicate about water supply system.
- ☐ Justify water sustainability as a key to healthy living.

Summative Practice 5

1. Johan started attending swimming lessons . On the first day, he suffered from pain on his body as he had used a wrong technique to jump into the water (Photograph 1). Explain the reason for Johan's injury. (Relate to water surface tension).

Photograph 1

2. Aliya carried out an investigation to study the type of solution formed when a solute is dissolved in a solvent. She found that three spatulas of salt produced a saturated solution when dissolved in 50 ml of water.

   (a) Draw the particles of the salt water produced when:
   (i) one spatula of salt is added into 50 ml of water
   (ii) five spatulas of salt are added into 50 ml of water

   (b) Does heating the water increase the rate of solubility? Give your explanation.

3. Figure 1 shows the water evaporation process.

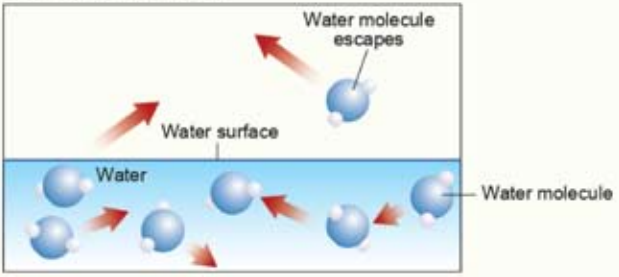


Figure 1

(a) Explain the process above using the Kinetic Theory of Matter.

(b) State four factors that affect the water evaporation process. Explain two of them.

(c) Which of the following shows the composition of elements in water? Tick (✓) the correct answer.

(i) 

(ii) 

(iii) 

(iv) 

4. Match the following substances to the correct type of compound.

(a) Salad sauce	•	
(b) Apple juice	•	
(c) Blood	•	• Colloid
(d) Carbon dioxide in water	•	• Suspension
(e) Mixture of water and chalk	•	• Solution
(f) Milk	•	
(g) Vinegar	•	

5. Suggest an organic solvent that can be used to remove chlorophyll stain.

6. *K*, *L*, *M* and *N* are the stages involved in the water purification system.

K : Coagulation	*M* : Sedimentation
L : Chlorination	*N* : Filtration

(a) Arrange *K*, *L*, *M* and *N* in a correct sequence.

(b) Name two chemicals used to treat water in water treatment plants. State the functions of both substances.

(c) How is the process in stage *K* done?

(d) Predict what will happen if the mixture is stirred in stage *N*.

7. Vicki carried out an activity to study several water purification methods. She used cloudy river water as her study sample.

Sample *A* : Filtered
Sample *B* : Boiled
Sample *C* : Distilled
Sample *D* : Added chlorine

(a) Which sample would become clear?

(b) Which sample would still contain suspended particles?

(c) Which sample would turn to pure water?

(d) In which sample would microorganisms be removed?

HOTS Mastery 5

8. Water pollution is one of the major problems faced by our country.

Based on the situation above, prepare a poster on water pollution and its effects on humans.

9. You are required to distinguish between two unknown substances blindfolded. You were told that the two substances are a mixture. What are the questions you would ask to identify the types of mixture?