1

SCIENCE FORM 1

DUAL LANGUAGE PROGRAMME

SCIENCE

FORM 1

KSSM
KURIKULUM STANDARD SEKOLAH MENENGAH
KEMENTERIAN PENDIDIKAN MALAYSIA

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KEMENTERIAN PENDIDIKAN MALAYSIA

RUKUN NEGARA

Bahawasanya Negara Kita Malaysia
mendukung cita-cita hendak;

Mencapai perpaduan yang lebih erat dalam kalangan
seluruh masyarakatnya;

Memelihara satu cara hidup demokrasi;

Mencipta satu masyarakat yang adil di mana kemakmuran negara
akan dapat dinikmati bersama secara adil dan saksama;

Menjamin satu cara yang liberal terhadap
tradisi-tradisi kebudayaan yang kaya dan pelbagai corak;

Membina satu masyarakat progresif yang akan menggunakan
sains dan teknologi moden;

MAKA KAMI, rakyat Malaysia,
berikrar akan menumpukan
seluruh tenaga dan usaha kami untuk mencapai cita-cita tersebut
berdasarkan prinsip-prinsip yang berikut:

KEPERCAYAAN KEPADA TUHAN
KESETIAAN KEPADA RAJA DAN NEGARA
KELUHURAN PERLEMBAGAAN
KEDAULATAN UNDANG-UNDANG
KESOPANAN DAN KESUSILAAN

(Sumber: Jabatan Penerangan, Kementerian Komunikasi dan Multimedia Malaysia)

KURIKULUM STANDARD SEKOLAH MENENGAH

SCIENCE
FORM 1

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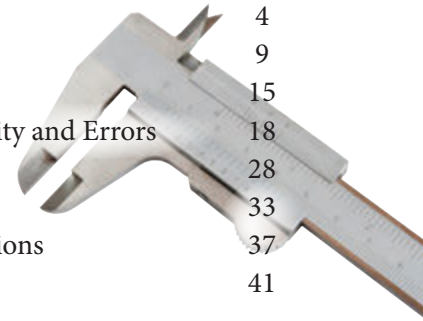
Contents

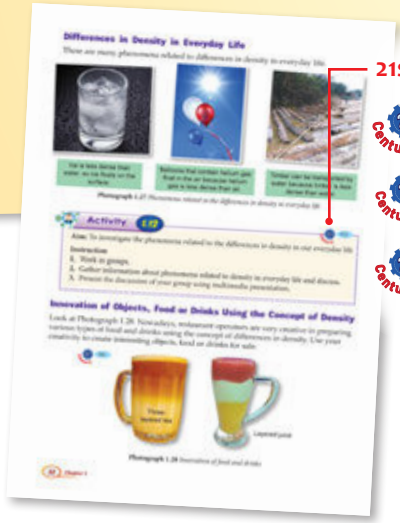


Introduction

Introduction

The Science Form 1 *Kurikulum Standard Sekolah Menengah (KSSM)* Textbook is written for Form 1 students based on *Dokumen Standard Kurikulum dan Pentaksiran Tingkatan 1* prepared by the Ministry of Education. KSSM is developed to cater to the new policies under the Malaysian Education Blueprint 2013 - 2025. For the successful implementation of KSSM, this book is written with more emphasis on thinking skills, information and communication skills, decision-making and problem-solving skills so that students can master the skills needed in the 21st century.

To achieve this objective, this book incorporates special features as follows:



21st Century Skills

- CPS Critical Thinking & Problem Solving Skills
- ISS Interpersonal & Self-Reliance Skills
- ICS Information & Communication Skills

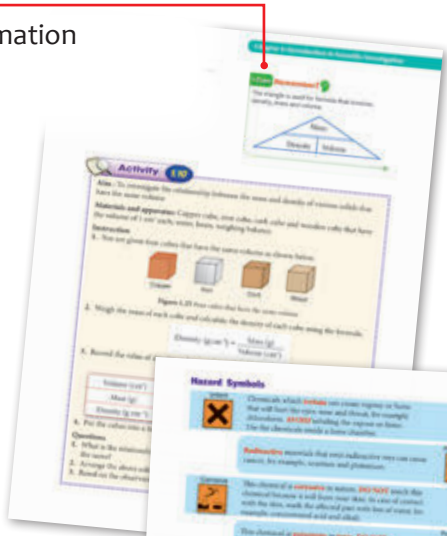
Science Exploration
Provides extra information related to the topics studied.

QR code
Download the free app from Google Play to your mobile smartphone device. Scan this QR code with your mobile smartphone device to obtain additional information.
(Websites in the public domain proposed in this book may be subject to change from time to time).

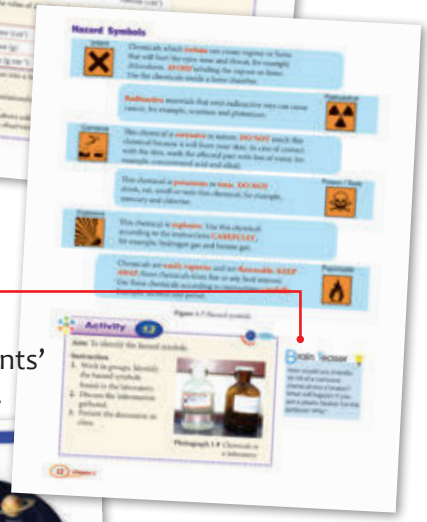
Science in Life
Applications of science in the daily life of students.

My Malaysia
Latest information regarding science in Malaysia.

I Can Remember!
Formulae or important information for students to remember.

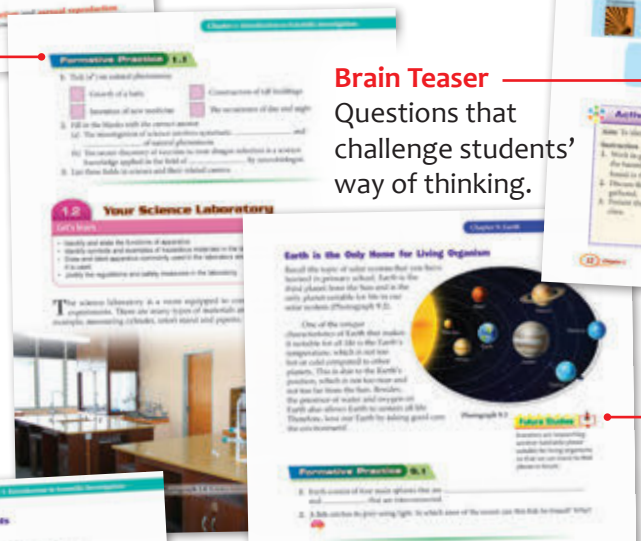


Science Careers
Information on careers related to science.

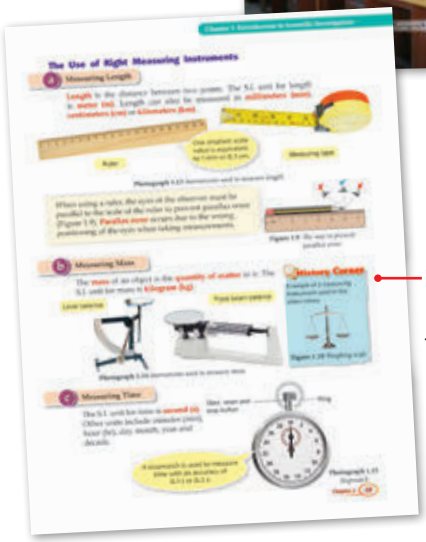


Formative Practice
Provides questions to test students' understanding at the end of each subtopic.

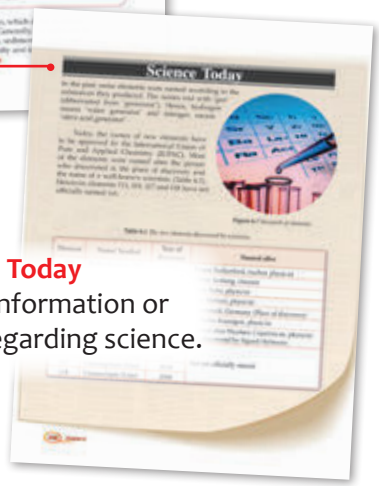
Brain Teaser
Questions that challenge students' way of thinking.



Future Studies
Studies for the development of technology in the future.



History Corner
Information about the history of science.



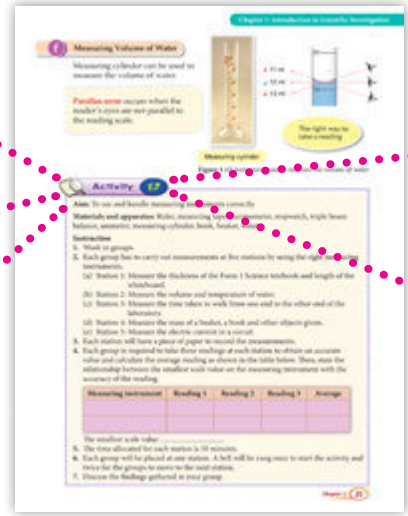
Science Today
Latest information or news regarding science.

There are five types of activities in this book

Experiments

Discussion

Technology-based activities

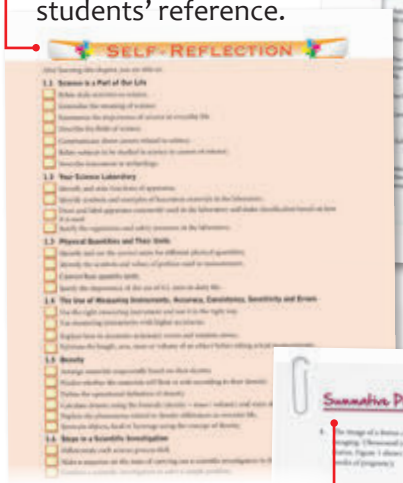


Creation and innovation

Inquiry-based activities

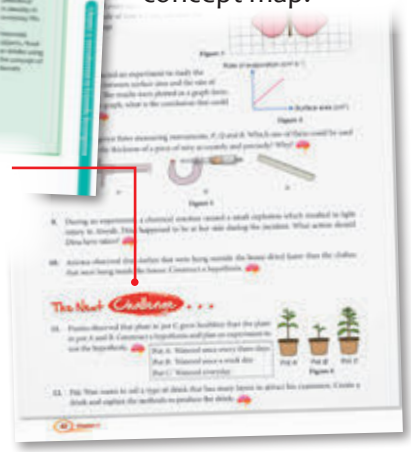
At the end of each chapter

Self-Reflection
Simple checklist of learning contents for students' reference.

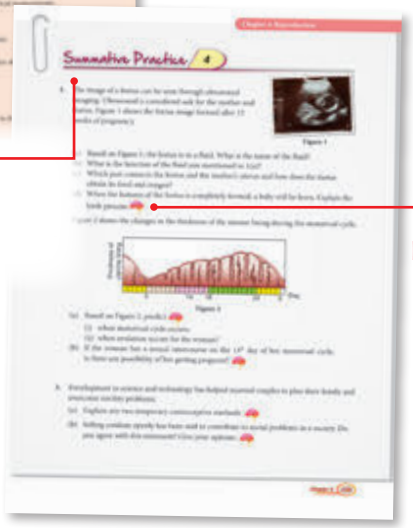


Concept Map
Summary of each chapter is presented in the form of concept map.

The Next Challenge
Level 5 and level 6 HOTS questions.



Summative Practice
Provides questions to test students' understanding at the end of each chapter.



HOTS Questions

Analysing

Evaluating

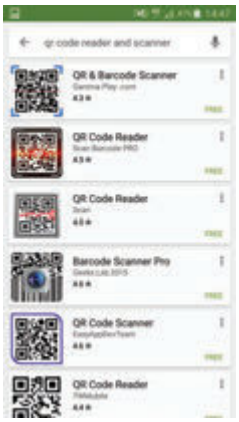
Applying

Creating

How to scan three-dimensional animations

1 Step 1

Download the free QR reader application from the App Store or Play Store.



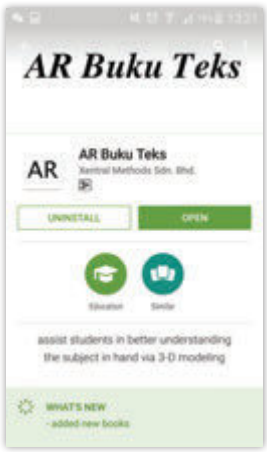
2 Step 2

Download the free *AR Buku Teks* application by scanning the QR Code below.

or

Download on the App Store

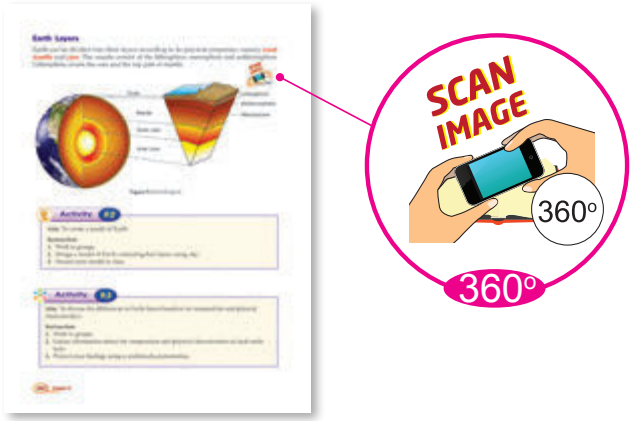
Get it on Google play



3 Step 3

Find pages that have this icon.

Three-dimensional animation



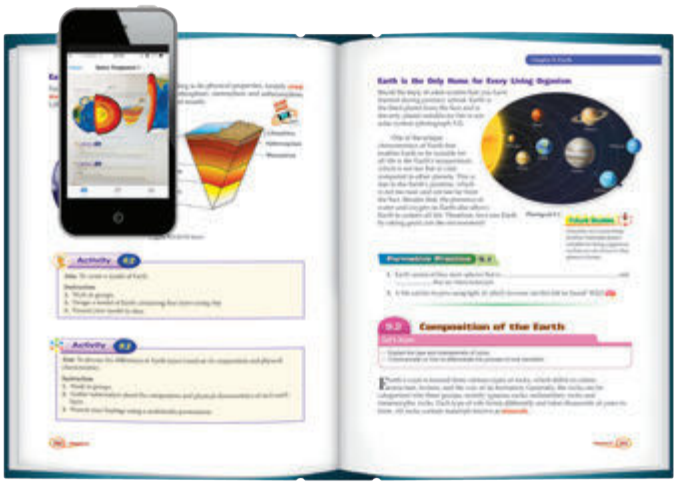
Key:

Use the QR reader application to access websites and videos

Use the *AR BUKU Teks* application to view 360° pictures

4 Step 4

Then, scan the image on the page with your smartphone or tablet and enjoy the three-dimensional animations!



THEME 1

Scientific Methodology

Do you realise that our life is based on science? This includes the food we eat, the clothes we wear, our modes of transportation and the energy we use.

Chapter 1

Introduction to Scientific Investigation

What is science?
What are physical quantities?
How do we measure density?

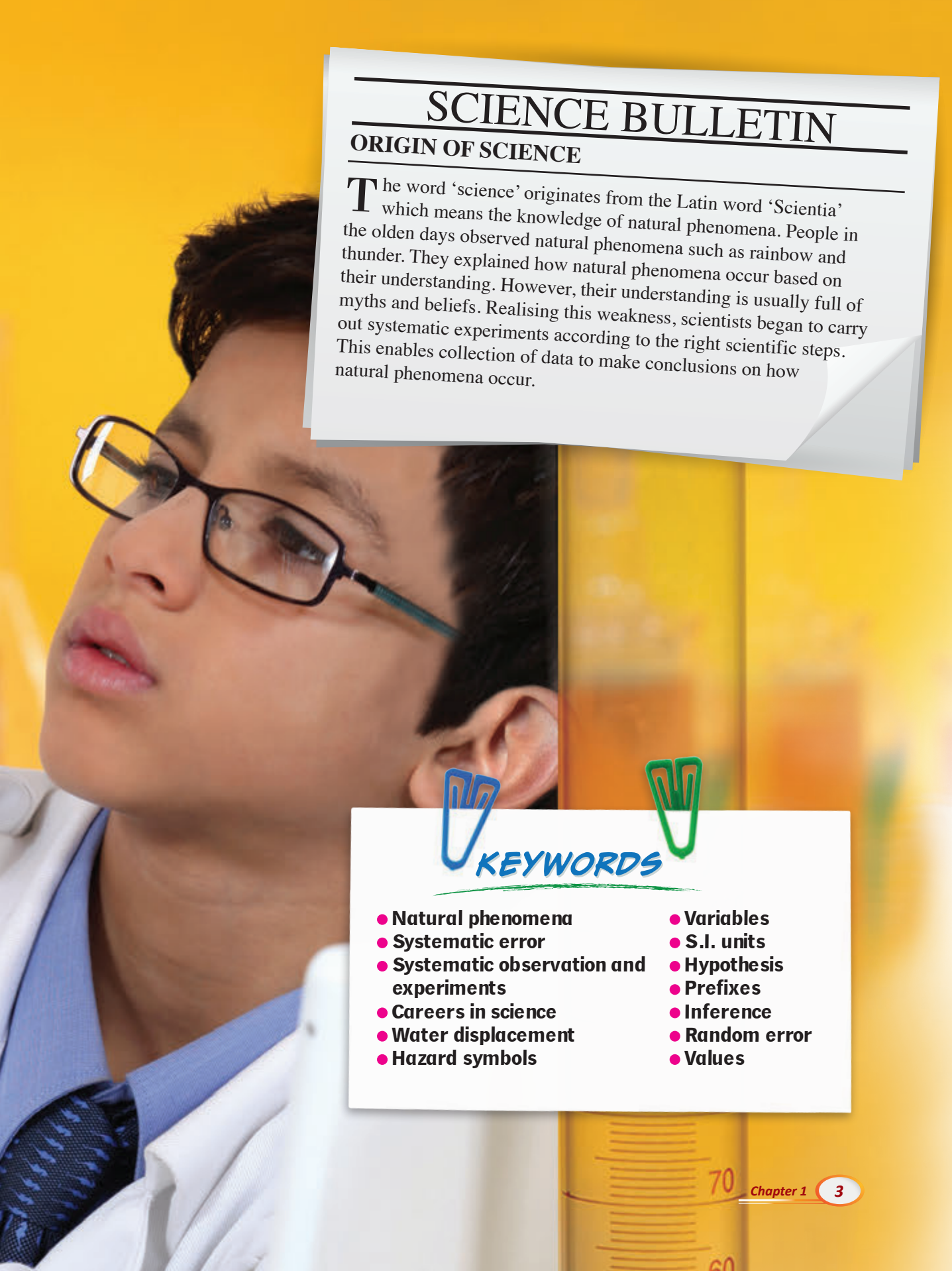
Let's study:

- Science is Part of Daily Life
- Your Science Laboratory
- Physical Quantities and Their Units
- The Use of Measuring Instruments, Accuracy, Consistency, Sensitivity and Errors
- Density
- Steps in a Scientific Investigation
- Scientific Attitudes and Values in Carrying Out Scientific Investigations

SCIENCE BULLETIN

ORIGIN OF SCIENCE

The word 'science' originates from the Latin word 'Scientia' which means the knowledge of natural phenomena. People in the olden days observed natural phenomena such as rainbow and thunder. They explained how natural phenomena occur based on their understanding. However, their understanding is usually full of myths and beliefs. Realising this weakness, scientists began to carry out systematic experiments according to the right scientific steps. This enables collection of data to make conclusions on how natural phenomena occur.



KEYWORDS

- Natural phenomena
- Systematic error
- Systematic observation and experiments
- Careers in science
- Water displacement
- Hazard symbols
- Variables
- S.I. units
- Hypothesis
- Prefixes
- Inference
- Random error
- Values

1.1 Science is Part of Daily Life

Let's learn

- Relate daily activities to science.
- Generalise the meaning of science.
- Summarise the importance of science in everyday life.
- Describe the fields of science.
- Communicate about careers related to science.
- Relate subjects to be studied in science to careers of interest.
- Describe innovation in technology.

What is Science?

Observe the phenomena around you.

Photograph 1.1 *Natural phenomena*

In order to understand the factors involved and how natural phenomena occur, we have to carry out scientific investigations. **Science** is a discipline that involves systematic observations and experiments of natural phenomena.

Observe our daily activities.

Photograph 1.2 *Daily activities*

Does science change or affect our daily activities? Give a few other examples of daily activities that are related to science.

The Importance of Science in Everyday Life

The examples of the importance of science in everyday life are shown in the figure below.

The Importance of Science in Everyday Life

Contributes to the area of engineering such as construction of tall buildings.

Invention of satellites has made communication more effective and faster.

Increases crop yields by invention of fertilisers, pesticides and hydroponic method.

Discovery of vaccines and antibiotics in the field of medicine helps in controlling infectious diseases and reduces death rate.

Figure 1.1 *Examples of the importance of science in everyday life*

Fields in Science

Science can be divided into various fields. The tree map below shows some examples of important fields in science.

Fields in Science

- **Physics**
  - Study of energy and its influence on matter
  - **Example:** Engineering
- **Biology**
  - Study of living things
  - **Examples:** Zoology, microbiology, physiology, botany
- **Chemistry**
  - Study of matter and its reactions
  - **Examples:** Pharmacology, forensics, toxicology
- **Geology**
  - Study of rocks, soil and minerals
  - **Examples:** Geochemistry, geomorphology and geophysics
- **Astronomy**
  - Study of planets, stars and other objects in the universe
  - **Example:** Astrophysics
- **Meteorology**
  - Study of weather and climate change
  - **Example:** Hydrometeorology

Figure 1.2 *Classification in the fields of science*

Careers in Science

What is your ambition? List the science subjects that you need to study in order to achieve your ambition.

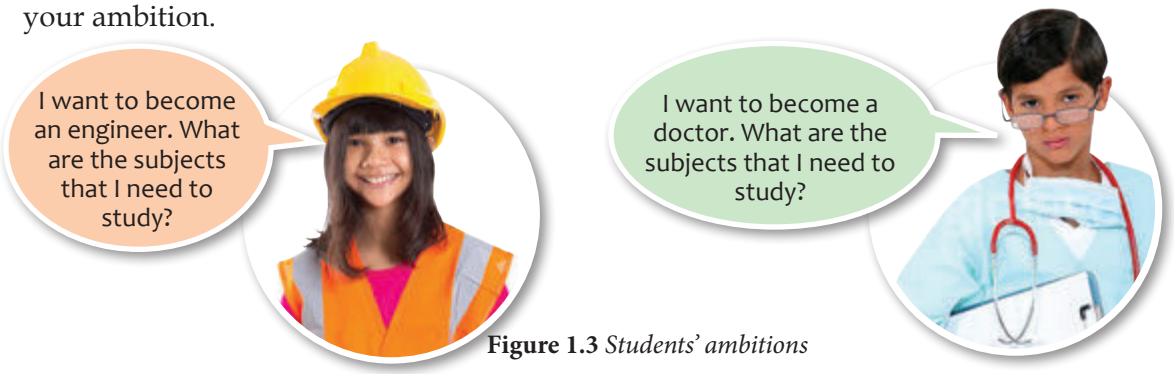


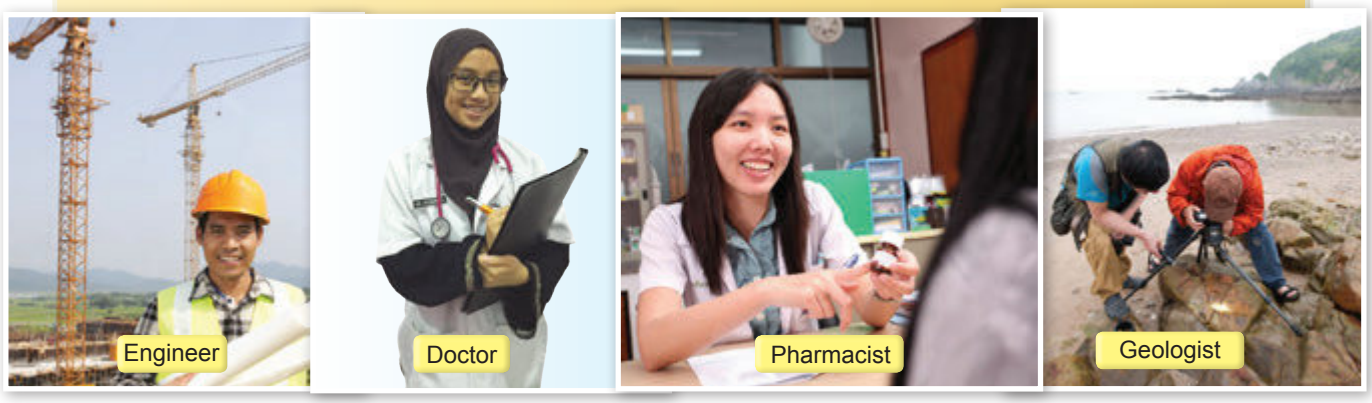
Figure 1.3 *Students' ambitions*

A few examples of careers in science are shown in the tree map below.

Careers in Science

Physics	Biology	Chemistry	Geology
Astronomer	Medical doctor	Pharmacist	Geologist
Oceanographer	Botanist	Oceanographer	Teacher
Teacher	Zoologist	Teacher	
Meteorologist	Teacher	Forensic scientist	
Engineer	Oceanographer	Chemist	
Physicist	Microbiologist		
	Biologist		

Figure 1.4 *Careers in science*



Photograph 1.3 *Careers in science*

Innovation in Technology

Most machines and inventions that we use every day are scientific innovations. For example, cars, aeroplanes, telephones and computers. These machines and instruments help us solve problems in our life.

Photograph 1.4 *Development of technology*

Activity 1.1

21st Century ICS

Aim: To give examples of innovations in technology to solve problems in life

Instruction

1. In groups, search for examples of innovations in technology. Information can be obtained from the Internet, magazines, newspapers or from other sources.
2. Discuss the information that you have collected and present your discussion in class by using multimedia presentation such as PowerPoint.
3. Discuss how robots can help us in our life. Look at Figure 1.5.

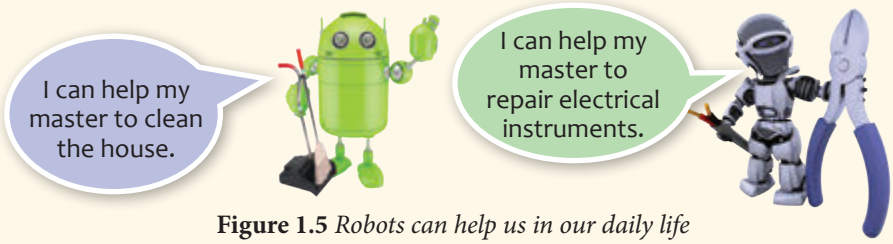


Figure 1.5 *Robots can help us in our daily life*

Science Today

Do you know?

The Nobel Prizes in Science are awarded every year to the outstanding scientists in fields of science every year in Stockholm, Sweden. You can browse the following website for further information.

Nobel prize
http://www.nobelprize.org

Photograph 1.5 *The Nobel Prize*

Formative Practice 1.1

1. Tick (✓) on natural phenomena.

☐ Growth of a baby	☐ Construction of tall buildings
☐ Discovery of new medicine	☐ The occurrence of day and night

2. Fill in the blanks with the correct answers.
   (a) Investigation of science involves systematic _____ and _____ of natural phenomena.
   (b) The recent discovery of vaccines to treat dengue infection is a science knowledge applied in the field of _____ by microbiologists.
3. List three fields in science and their related careers.

1.2 Your Science Laboratory

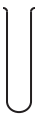
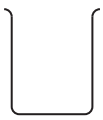
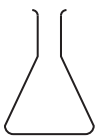
Let's learn

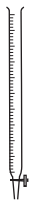
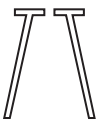
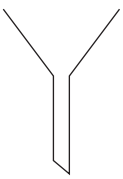
- Identify and state the functions of apparatus.
- Identify symbols and examples of hazardous materials in the laboratory.
- Draw and label apparatus commonly used in the laboratory and classify based on how it is used.
- Justify the regulations and safety measures in the laboratory.

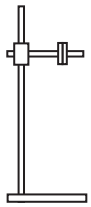
The science laboratory is a room equipped to conduct scientific investigations and experiments. There are many types of materials and apparatus found in the laboratory, for example, measuring cylinder, retort stand and pipette.

Photograph 1.6 *Science laboratory*

Table 1.1 *The apparatus commonly used in a laboratory and their functions*

Apparatus		Function
	 Boiling tube	To heat small amounts of chemicals
	 Test tube	To hold small amounts of chemicals
	 Beaker	To hold larger amounts of chemicals
	 Conical flask	
	 Flat-bottom flask	
	 Measuring cylinder	To measure volume of liquid

Apparatus		Function
	 Burette	To measure volume of liquid accurately
	 Pipette	To measure a fixed volume of liquid
	 Tripod stand	To support apparatus during heating
	 Wire gauze	To spread heat evenly during heating
	 Filter funnel	To filter or separate insoluble solids from mixtures
	 Gas jar	To contain gas

	 Retort stand with clamp	To hold or support apparatus		 Evaporating dish	To evaporate excess solvent

Activity 1.2

Aim: To identify the apparatus commonly used in the laboratory

Instruction

1. In groups, observe the apparatus commonly used in the laboratory.
2. Identify the apparatus and state their functions. Record them in your practical book.
3. Draw and label the apparatus in your practical book.
4. Then, discuss the classification of the apparatus according to their usage.
5. Present your discussion in class by using a tree map.

Symbols of Hazardous Materials in the Laboratory

Have you seen the symbol as in Figure 1.6? What is the meaning of the symbol?

Figure 1.6 *A hazard symbol*

Science Exploration

Some chemicals like potassium and lithium will react if exposed to air. So, these chemicals must be kept in paraffin oil.

Most chemicals that we use in the laboratory are hazardous. We must observe the hazard symbols on chemical bottles before using them to prevent accidents.

Photograph 1.7 *Hazardous materials with hazard symbols*

Photograph 1.8 *Lithium is kept in paraffin oil*

Hazard Symbols

Irritant

Chemicals which **irritate** give out vapour or fumes that will hurt the eyes, nose and throat. **AVOID** inhaling the vapour or fumes. Use the chemicals inside a fume chamber. Examples: chloroform and ammonia.

Radioactive

Radioactive materials that emit radioactive rays can cause cancer. Examples: uranium and plutonium.

Corrosive

These chemicals are **corrosive**. **DO NOT** touch these chemicals because it will burn your skin. In case of contact with the skin, wash the affected part with lots of water. Examples: concentrated acid and alkali.

Poison / Toxic

This chemical is **poisonous** or **toxic**. **DO NOT** drink, eat, smell or taste this chemical. Examples: mercury and chlorine.

Explosive

This chemical is **explosive**. Use this chemical according to the instructions **CAREFULLY**. Examples: hydrogen gas and butane gas.

Flammable

This chemical **easily vaporises** and is **flammable**. **KEEP AWAY** this chemical from fire or heat sources. Use this chemical according to instructions **carefully**. Examples: alcohol and petrol.

Figure 1.7 *Hazard symbols*

Activity 1.3

21st Century CPS

Aim: To identify the hazard symbols

Instruction

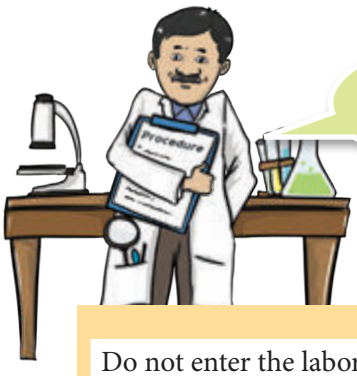
1. Work in groups. Identify the hazard symbols found in the laboratory.
2. Discuss the information gathered.
3. Present the discussion in class.

Photograph 1.9 *Chemicals in a laboratory*

Brain Teaser

How would you transfer 10 ml of a corrosive chemical into a beaker? What will happen if you use a plastic beaker for this purpose? Why?

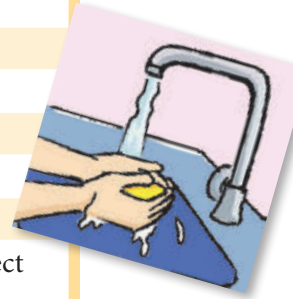
Rules and Safety Measures in the Laboratory



To prevent unwanted incidents, we should follow the rules and safety measures in the laboratory.

Laboratory Rules

- Do not enter the laboratory without permission.
- Never start an experiment without the teacher's instructions.
- Read and understand the instructions of the experiment beforehand.
- Use the chemicals and apparatus correctly and carefully.
- Eating, drinking and playing are prohibited in the laboratory.
- Do not take the apparatus and chemicals out of the laboratory.
- After using, keep the apparatus and chemicals in their original places.
- Make sure the place to conduct the experiments is always neat and clean.
- Wash all the apparatus and throw away waste materials according to the correct procedures.
- Wash your hands with soap and water before leaving the laboratory.



Safety Measures when Using Chemicals and Apparatus

Do not point the mouth of the test tube at your face or at other people.

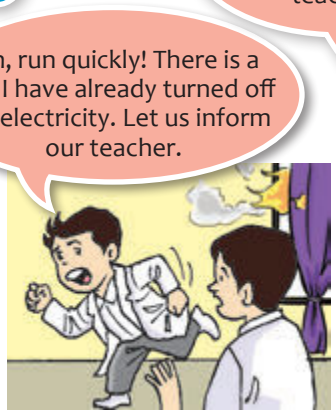
Use safety goggles when mixing or heating chemicals.

Keep highly flammable chemicals away from any heat sources.

Do not taste or smell anything unless allowed by the teacher.

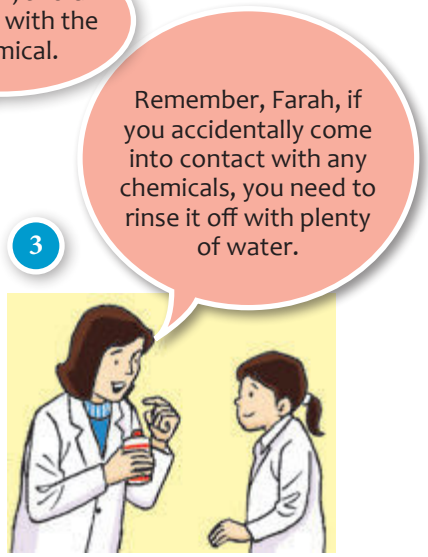
If an accident occurs, do not panic. Take the necessary actions as demonstrated in the situations below:

1



2

3



Activity 1.4

Aim: To discuss the rules and safety measures in the laboratory

Instruction

1. Work in groups. Each group has to look for information about one of the topics given below:
   (a) Rules in a laboratory
   (b) Safety measures in a laboratory
   (c) Steps to prevent fire in a laboratory
   (d) Actions to be taken in the event of an accident in a laboratory
2. Discuss the information gathered in your group and present it in the class.

Formative Practice 1.2

1. Draw the following apparatus.
   (a) Flat-bottom flask (b) Conical flask (c) Boiling tube (d) Measuring cylinder
2. (a) What is the meaning of the hazard symbols below?

   (i)  (ii)  (iii)  (iv)  (v) 

   (b) State two examples of chemicals with the hazard symbol in (a)(i).
3. Suhaimi sees a small fire on the laboratory table. What actions should he take?

1.3 Physical Quantities and Their Units

Let's learn

- Identify and use the correct units for different physical quantities.
- Identify the symbols and values of prefixes used in measurement.
- Convert base quantity units for mass, length and time such as grams to kilograms, centimetres to metres, seconds to hours and vice versa.
- Justify the importance of the use of S.I. units in daily life.

Recall the measurements that you have learned in primary school. A physical quantity in science is defined as a physical characteristic that can be measured. The common base quantities used are **length**, **mass**, **time**, **temperature** and **electric current** (Table 1.2).

Table 1.2 *Base quantities*

Base quantity	S.I. unit	Symbol of S.I. unit
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A

The International System of Units, known as **S.I. units (Système Internationale d'Unités)** is used for the consistency of measurement. This allows accurate exchange of data and scientific knowledge to the entire world.

History Corner

S.I. units have been used as the standard unit of physical quantities since 1960 to prevent problems of inconsistent units in measurement.

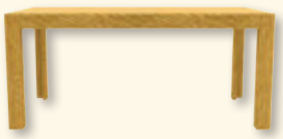
Activity 1.5

Aim: To identify physical quantities, values and S.I. units

Instruction

1. Look at the objects in Photograph 1.10. State the S.I. unit that you can use to measure the physical quantity of each object.

(a) Length of table



(b) Mass of onion

(c) Temperature of water

Photograph 1.10 *Objects*

2. Observe the values and units that are used on the specification and labels of daily products.
3. Record your observation in your practical book.

Photograph 1.11 *Daily products*

Prefixes can be used if the value of a physical quantity unit is too big or too small.

Table 1.3 *The values of prefixes and symbols for physical quantity units*

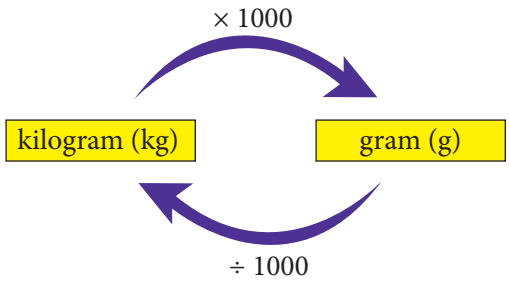
Prefix	Value	Standard form	Symbol
giga	1 000 000 000	10^9	G
mega	1 000 000	10^6	M
kilo	1 000	10^3	k
deci	0.1	10^{-1}	d
centi	0.01	10^{-2}	c
milli	0.001	10^{-3}	m
micro	0.000 001	10^{-6}	μ
nano	0.000 000 001	10^{-9}	n

I Can Remember!

Prefix values are important and are used widely in calculations.

Converting Units of Base Quantity

a Mass



Example:

1. 1.9 kg = _____ g

1.9 kg = 1.9 × 1000

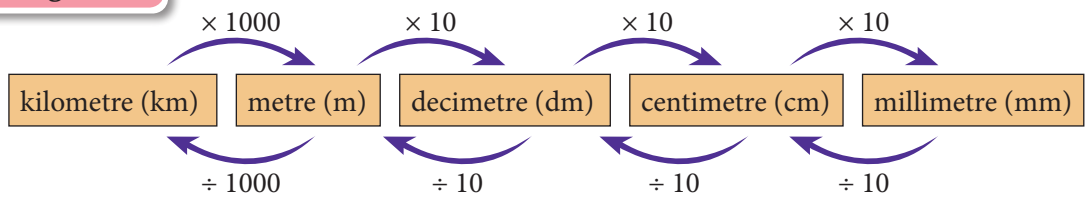
= 1900 g

2. 8200 g = _____ kg

8200 g = 8200 ÷ 1000

= 8.2 kg

b Length



Example:

1. 80 m = _____ cm

80 m = 80 × 100

= 8 000 cm

Example:

2. 600 cm = _____ m

600 cm = 600 ÷ 100

= 6 m

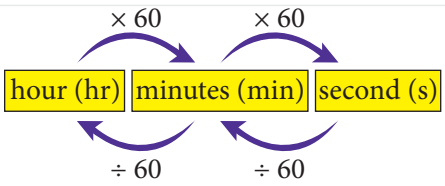
Example:

3. 95 mm = _____ m

95 mm = 95 ÷ 1000

= 0.095 m

c Time



Example:

1. 7 min = _____ s

7 min = 7 × 60

= 420 s

Example:

2. 450 s = _____ hr

450 s = 450 ÷ 60 ÷ 60

= 0.125 hr

The Importance of S.I. units in Life

Inconsistencies of units used in daily life may cause a lot of problems. For example, people in certain places may measure things by using pound and ounce, whereas people in other places may use grain and stone. The use of a standard unit for measurement will make it easier for scientists to communicate at international level. Problems shown in the situations below may arise if we do not use standard units.

History Corner

Recall the measurements that you have learned in primary school such as span, fathom, pace and cubit.

(a) Span

(b) Fathom

(c) Pace

(d) Cubit

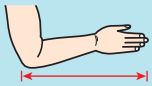
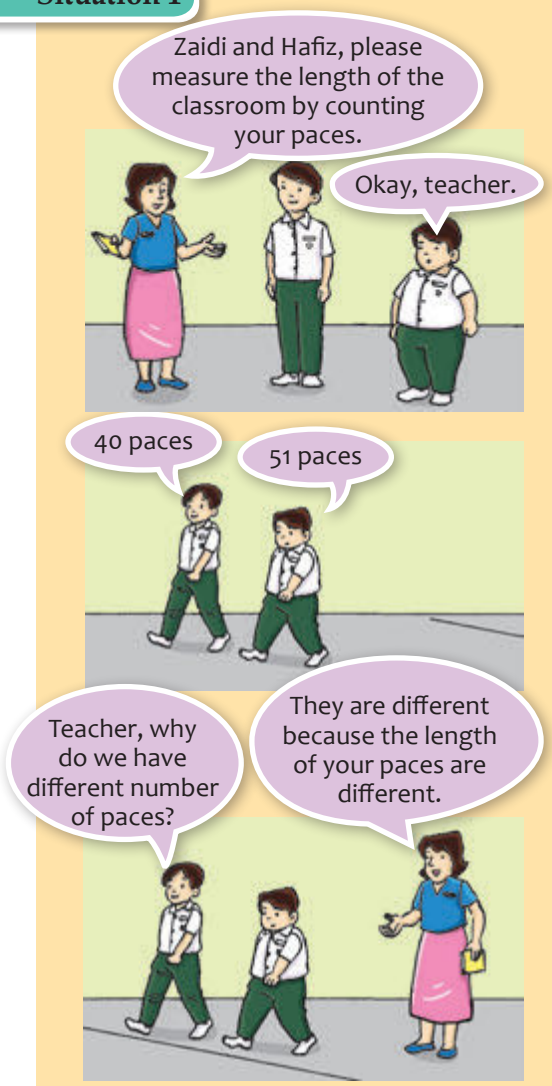
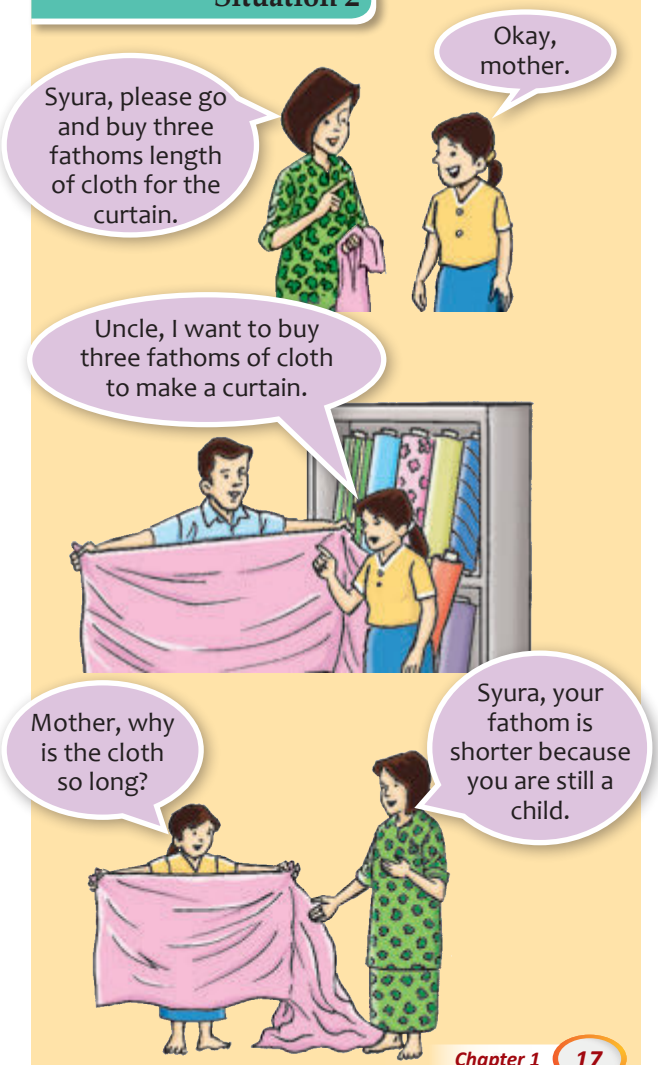


Figure 1.8 *Measurements in olden times*

Situation 1



Situation 2



Activity 1.6

21st Century ICS

Aim: To understand the implication of non-standardised units in our life

Instruction

1. Work in groups.
2. Each group should gather information on the implication of non-standardised units in life.
3. Each group will present their discussion in class by using multimedia presentation such as PowerPoint.

Formative Practice 1.3

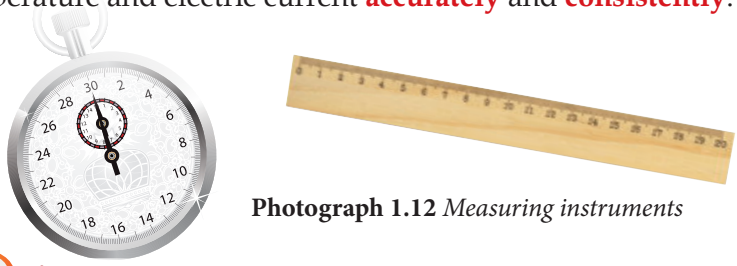
1. List **five** physical quantities that you have studied. What is the S.I. unit and the symbol used for each of the quantities?
2. Convert the values below.
   (a) 0.13 m = _____ cm
   (b) 18 000 mg = _____ kg
   (c) 4 m = _____ µm
   (d) 24 000 g = _____ kg
   (e) 0.006 A = _____ mA

1.4 The Use of Measuring Instruments, Accuracy, Consistency, Sensitivity and Errors

Let's learn

- Use the right measuring instrument and use it the right way to measure accurately and consistently the quantities of length, mass, time, temperature and electric current.
- Use measuring instruments with higher accuracy and compare the measurements in terms of accuracy, consistency and sensitivity.
- Explain how to minimise systematic errors and random errors.
- Estimate the length, area, mass or volume of an object before taking actual measurements.
- Explain with examples innovations of various types of measuring instruments through a multimedia presentation.

For the purpose of measurement, different measuring instruments are needed to collect data in an experiment. We need to ensure that we use the right measuring instruments to measure the quantities of length, mass, time, temperature and electric current **accurately** and **consistently**.



Photograph 1.12 *Measuring instruments*

I Can Remember!

Accuracy – The ability of measuring instruments to obtain a value closest to the actual value.

Consistency– The ability of measuring instruments to give the same readings with repeated measurements.

Sensitivity – The ability of measuring instruments to detect a small change in the measurement quantity.

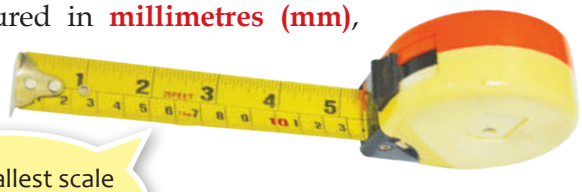
The Use of Right Measuring Instruments

a Measuring Length

Length is the distance between two points. The S.I. unit for length is **metre (m)**. Length can also be measured in **millimetres (mm)**, **centimetres (cm)** or **kilometres (km)**.

Ruler

One smallest scale value is equivalent to 1 mm or 0.1 cm.



Measuring tape

Photograph 1.13 *Instruments used to measure length*

When using a ruler, the eyes of the observer must be parallel to the scale of the ruler to prevent **parallax error** (Figure 1.9). Parallax error occurs due to the wrong positioning of the eyes when taking measurements.

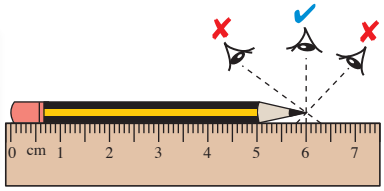


Figure 1.9 *How to prevent parallax error*

b Measuring Mass

The **mass** of an object is the **quantity of matter** in it. The S.I. unit for mass is **kilogram (kg)**.

Lever balance

Triple beam balance

Photograph 1.14 *Instruments used to measure mass*

History Corner

Example of a measuring instrument used in the olden times:

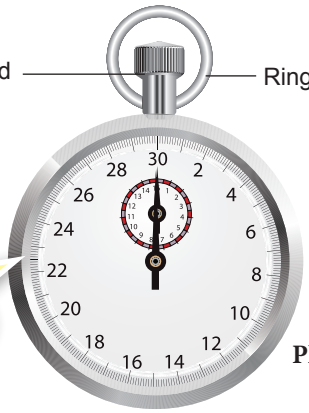
Figure 1.10 *A weighing scale*

c Measuring Time

The S.I. unit for time is **second (s)**. Other units include minute (min), hour (hr), day, month, year and decade.

Start, reset and stop button

Ring



A stopwatch is used to measure time with an accuracy of 0.1 s or 0.2 s.

Photograph 1.15 *A stopwatch*

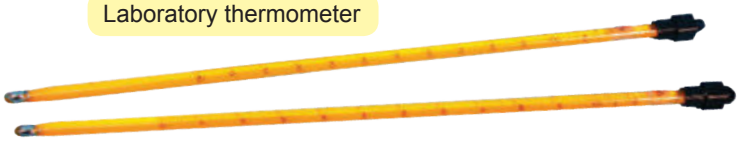
d Measuring Temperature

Temperature is the degree of heat of an object. The S.I. unit for temperature is **kelvin (K)**. However, **degree Celsius (°C)** is usually used as a measuring unit for temperature.

Science Exploration

To convert from degree Celsius to Kelvin, you have to add 273 to the temperature in degree Celsius.
0°C + 273 = 273 K

Laboratory thermometer



A laboratory thermometer can be used to measure temperature with an accuracy of 1°C.

A clinical thermometer can be used to measure temperature with an accuracy of 0.1°C.

Clinical thermometer

Photograph 1.16 *Instruments used to measure temperature*

e Measuring Electric Current

An ammeter is used to measure **electric current** in a circuit.

Ammeter

Photograph 1.17 *An ammeter*

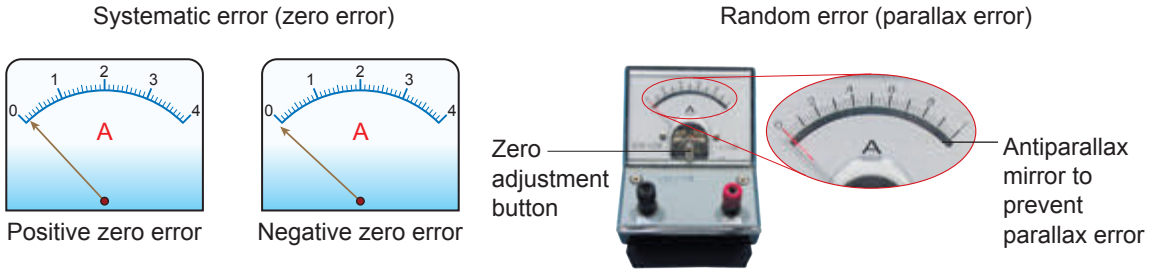


Figure 1.11 *Systematic error and random error*

f Measuring Volume of Water

A measuring cylinder can be used to measure the volume of water.

Parallax error occurs when the reader's eyes are not perpendicular to the reading scale.

Measuring cylinder

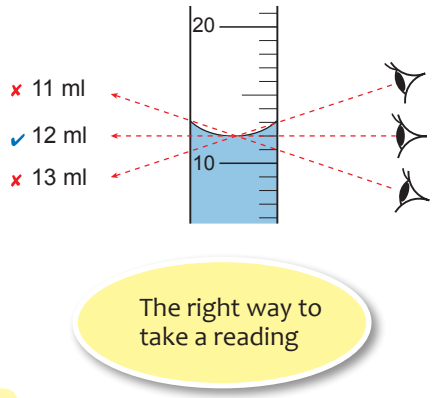


Figure 1.12 *The instrument used to measure the volume of water*

Activity 1.7

Aim: To use and handle measuring instruments correctly

Materials and apparatus: Ruler, measuring tape, thermometer, stopwatch, triple beam balance, ammeter, measuring cylinder, book, beaker, water.

Instruction

1. Work in groups.
2. Each group has to carry out measurements at five stations by using the right measuring instruments.
   (a) Station 1: Measure the thickness of the Form 1 Science textbook and length of the whiteboard.
   (b) Station 2: Measure the volume and temperature of water.
   (c) Station 3: Measure the time taken to walk from one end to the other end of the laboratory.
   (d) Station 4: Measure the mass of a beaker, a book and other objects given.
   (e) Station 5: Measure the electric current in a circuit.
3. Each station will have a piece of paper to record the measurements.
4. Each group is required to take three readings at each station to obtain an accurate value and calculate the average reading as shown in the table below. Then, state the relationship between the smallest scale value on the measuring instrument with the accuracy of the reading.

Measuring instrument	Reading 1	Reading 2	Reading 3	Average

The smallest scale value: _____

5. The time allocated for each station is 10 minutes.
6. Each group will be placed at one station. A bell will be rung once to start the activity and twice for the groups to move to the next station.
7. Discuss the findings gathered in your group.

Using Measuring Instruments with Higher Accuracy

a Measuring Length

Vernier Calipers

Vernier calipers is used to measure the **thickness or outer diameter**, **inner diameter and depth** of an object. The smallest division of the reading of a vernier calipers is **0.01 cm or 0.1 mm**. Therefore, vernier calipers is much more accurate compared to a ruler which can only measure the smallest reading up to 0.1 cm or 1 mm.

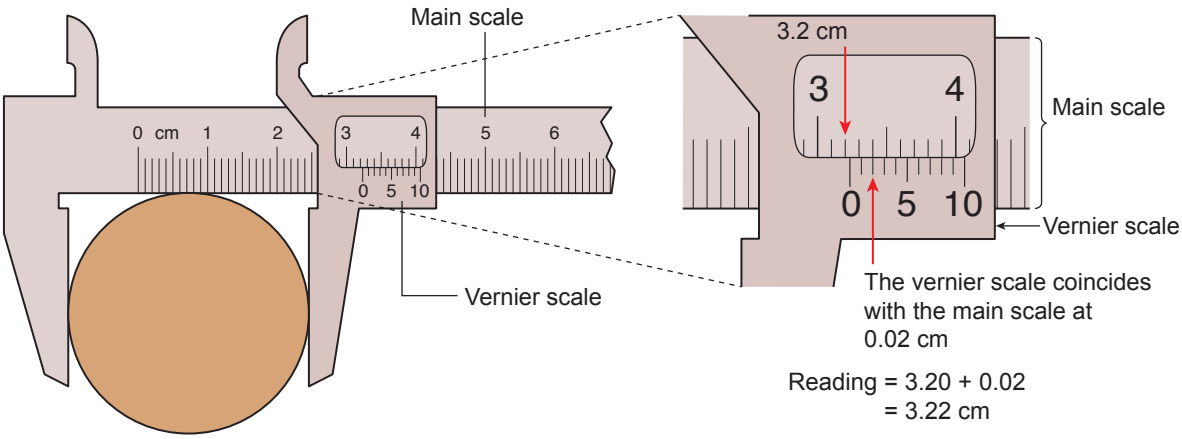
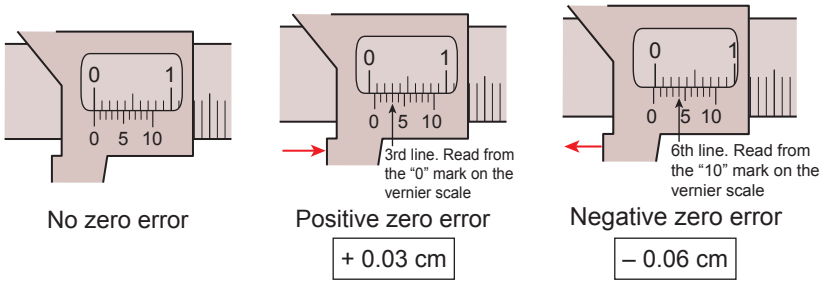


Figure 1.13 *Measurement of a round object by using vernier calipers*

Systematic errors are caused by using measuring instruments that are not accurate. For example, **zero error** that occurs on the measuring instruments, the error of the person who takes the measurement or environmental factors.

Zero error can be determined when the jaws of the vernier calipers are closed.



I Can Remember!

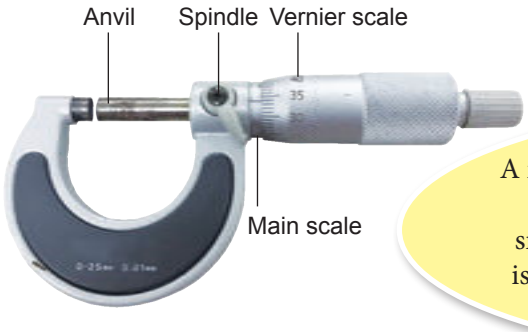
To determine the positive zero error, the error has to be read from the "0" mark on the vernier scale. To determine the negative zero error, the error has to be read from the "10" mark on the vernier scale.

Figure 1.14 *Zero errors in vernier calipers*

To obtain the actual reading, zero error has to be taken into consideration.

Actual reading = Reading of vernier calipers – zero error

Micrometer Screw Gauge



A micrometer screw gauge is used to measure the **thickness and diameter** of small objects like paper and hair. The smallest division of the micrometer screw gauge's reading is **0.001 cm or 0.01 mm**. Therefore, the micrometer screw gauge is more accurate than the vernier calipers.

Photograph 1.18
A micrometer screw gauge

The vernier scale has 50 divisions. Each division on the vernier scale is 0.01 mm.

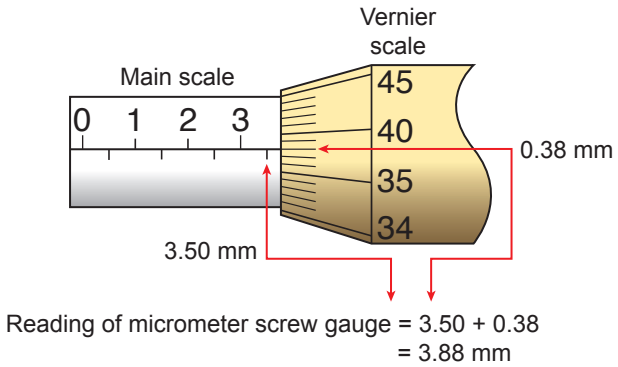


Figure 1.15 *Reading of micrometer screw gauge*

The eyes of the reader should be perpendicular to the reading to prevent **parallax error**.

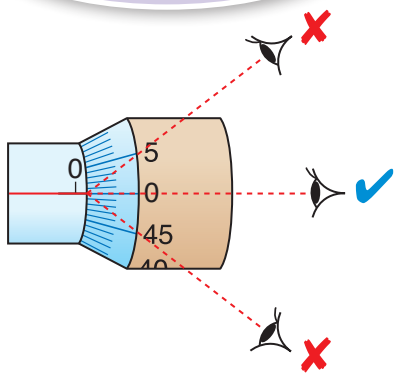


Figure 1.16 *The right way to take a reading*

Zero error of the micrometer screw gauge can be determined when the anvil is closed completely.

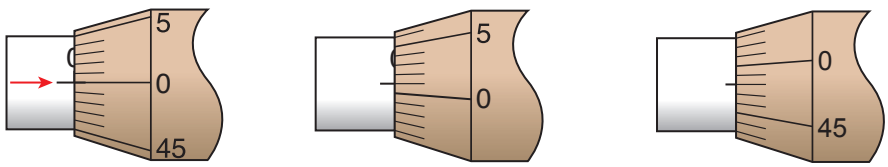


Figure 1.17 *Zero error of the micrometer screw gauge*

To get the actual reading from a micrometer screw gauge, zero error has to be taken into consideration.

Actual reading = Reading of micrometer screw gauge – zero error

Digital vernier calipers and digital micrometer screw gauge can measure measurements with more accuracy and precision.

Digital vernier calipers

Digital micrometer screw gauge

Photograph 1.19 *A digital vernier calipers and a digital micrometer screw gauge*

b Measuring Mass

A digital electronic balance can read measurement of mass more accurately and precisely.

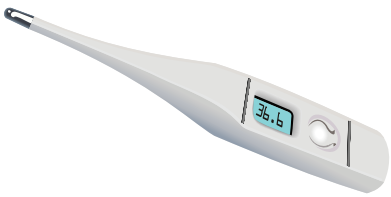
Photograph 1.20 *A digital electronic balance*

c Measuring Time

A digital stopwatch is more accurate than a normal stopwatch because it can measure time accurately up to **0.01 second** whereas the normal stopwatch can only measure up to 0.1 second.

Photograph 1.21 *A digital stopwatch*

d Measuring Temperature



A digital thermometer can give temperature readings more accurately and precisely because it can measure temperature with an accuracy up to **0.1°C**. Therefore, digital thermometers are widely used in clinics nowadays.

Photograph 1.22 *A digital thermometer*

e Measuring Electric Current

Digital ammeter

A digital ammeter gives more accurate and precise readings because this instrument can measure electric current with an accuracy up to **0.01A**.

Photograph 1.23 *A digital ammeter*

Activity 1.8

Aim: To measure, use and handle instruments with higher accuracy correctly

Materials and apparatus: Vernier calipers, micrometer screw gauge, digital electronic balance, digital ammeter, digital thermometer, clinical thermometer.

Instruction

1. Work in groups.
2. Each group has to conduct the following measuring activities by using higher accuracy instruments.
   (a) Measure the thickness of the Form 1 Science textbook using the vernier calipers and micrometer screw gauge
   (b) Measure the mass of the Form 1 Science textbook using a digital electronic balance
   (c) Measure the electric current of a circuit using a digital ammeter
   (d) Measure the body temperature with a clinical thermometer and a digital thermometer
3. Each group has to take three readings in order to obtain an accurate reading. State the average reading taken in the table below. Then, relate the smallest scale value on the measuring instrument to the accuracy of the reading.

Measuring instrument	Reading 1	Reading 2	Reading 3	Average

The smallest scale value: _____

4. Each group has to compare their readings obtained from Activity 1.7 with the reading obtained from this activity in terms of accuracy, consistency and sensitivity in the table below. Then, relate the smallest scale value on the measuring instrument to the sensitivity of reading. Make sure the units are recorded.

Measurement	Measuring instrument	Average reading	Accuracy	Consistency	Sensitivity
Thickness of book	Ruler				
	Vernier calipers				
	Micrometer screw gauge				
Mass of book	Triple beam balance				
	Digital electronic balance				
Electric current	Ammeter				
	Digital ammeter				
Body temperature	Clinical thermometer				
	Digital thermometer				

5. Present your findings in class.

Questions

1. Based on your findings, which measuring instrument is the most sensitive – ruler, vernier calipers or micrometer screw gauge?
2. Between the triple beam balance and digital electronic balance, which instrument can give a more precise and accurate reading?

How to Minimise Systematic Errors and Random Errors

Errors

Systematic errors	Random errors
Consistent errors obtained from a measuring instrument for every measurement. **Examples:** • Zero error • Inaccurate measuring instrument	The uncertainties in measurement caused by the observer when taking measurements. **Examples:** • Parallax error • Carelessness of observer when taking the reading • Wrong technique
Ways to overcome: • Conduct experiments with caution • Repeat the experiment using different measuring instruments	**Ways to overcome:** • Take a few readings of measurement and take the average reading • To reduce the impact of parallax errors, observer's eyes should be perpendicular to the scale reading

Making an Estimation before Taking the Actual Measurement

When a proper measuring instrument is not available during an experiment, the best way is to make an estimation beforehand. Later, a precise and accurate measuring instrument will be used.

a Estimating Length

Activity 1.9

Aim: To make a link between making estimation and taking the actual measurement

Materials and Apparatus: Pencil and ruler

Instruction

1. Measure the length of a pencil (p cm).
2. Measure and record the length of a table using the pencil.
   Length of table = number of pencil × p cm.
3. Measure and record the length of the table using a ruler.

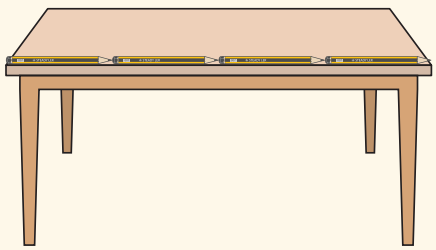


Figure 1.18 *Estimating the length of a table*

Question

What is the difference between the length of the table measured using a pencil (estimated measurement) and the length of the table measured using a ruler (actual measurement)?

b Estimating Area

Area is the size of a surface. The S.I. unit for area is **m²**. For objects with regular shapes, area can be measured by using formulae. For example, the area of a square is length × width. What is the formula of the area of other objects as shown in Figure 1.19?

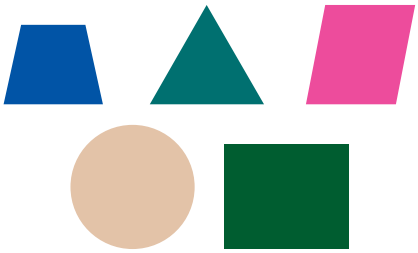
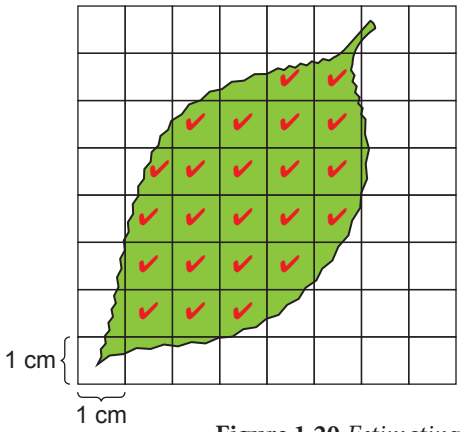


Figure 1.19 *Objects with regular shapes*

For objects with irregular shapes, area can be estimated by using the graph paper method.

Example:



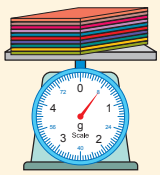
Mark '✔' on squares that are half and more than half covered by the leaf. Count the total number of squares marked '✔' and record your result.

The area of the shape = 23 cm²

Figure 1.20 *Estimating the area of a leaf*

c Estimating Mass

What is the mass of a sheet of paper which is light and cannot be measured? If the mass of 100 sheets of paper is 500 g, the mass of 1 sheet of paper is estimated at 5 g.

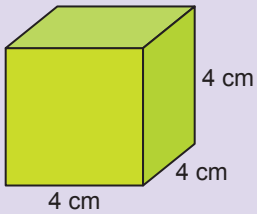


Mass of 100 sheets of paper = 500 g

Figure 1.21 *The mass of 100 sheets of paper*

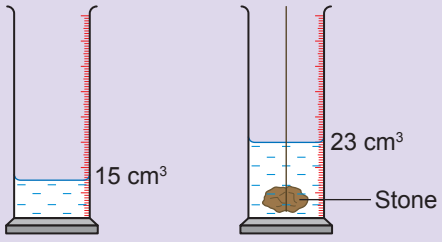
d Estimating Volume

The volume of an object with a regular shape can be calculated by using formula, whereas the volume of objects with irregular shapes can be estimated by using the **water displacement method**.



Volume = height × width × length
= 4 × 4 × 4
= 64 cm³

Object with regular shape



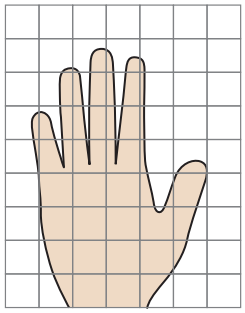
Initial volume Final volume

Object with irregular shape

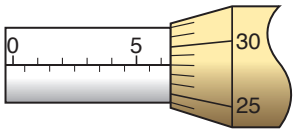
Volume of the stone
= 23 cm³ – 15 cm³
= 8 cm³

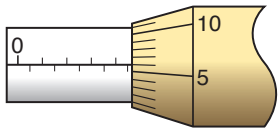
Figure 1.22 *Calculating volume*

Formative Practice 1.4



1. What is the reading of the micrometer screw gauge below?

(a) 

(b) 

2. Estimate the area of the drawing if every square represents an area of 1 cm × 1 cm or 1 cm^2.

3. Chong is standing on a weighing balance. The value shown is 55 kg. What is the meaning of the value?

Technology and Innovation in Measuring Instruments

Measuring blood pressure is made easier by using the digital blood pressure monitor (Photograph 1.24). Patients who have blood pressure problems can obtain precise and reliable blood pressure reading within a few seconds. Can you give examples of other types of innovation in measuring instruments?

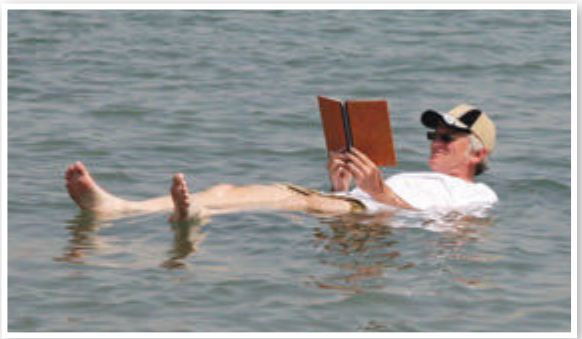
Photograph 1.24 *A digital blood pressure measuring instrument*

1.5 Density

Let's learn

- Arrange materials sequentially based on their density.
- Predict whether the materials will float or sink according to their density.
- Define the operational definition of density.
- Calculate density using the formula (density = mass / volume) and water displacement method.
- Explain the phenomena related to density differences in everyday life.
- Innovate objects, food or beverage using the concept of density.

Look at the picture. Why do people float on the Dead Sea easily? This is because the Dead Sea has an extremely high salt content. This makes the waters of the Dead Sea higher in density compared to other seas. What is density? **Density** of a material is the **mass per unit volume** of the material.



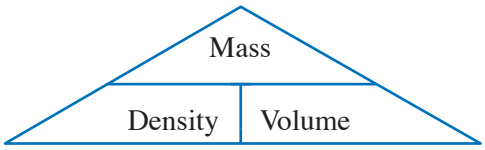
Photograph 1.25 *The density of water in the Dead Sea is extremely high and can make people float easily*

The formula of density is as below:

$$\text{Density (g cm}^{-3}) = \frac{\text{Mass (g)}}{\text{Volume (cm}^3)}$$

I Can Remember!

A triangle can be used for the formula that relates density, mass and volume.



Activity 1.10

Aim : To investigate the relationship between the mass and density of various solids that have the same volume

Materials and apparatus: Copper cube, iron cube, cork cube and wooden cube that have the volume of 1 cm³ each, water, basin, weighing balance.

Instruction

1. You are given four cubes that have the same volume as shown below.

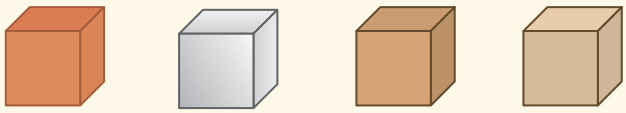


Figure 1.23 *Four cubes that have the same volume*

2. Weigh the mass of each cube and calculate the density of each cube using the formula:

$$\text{Density (g cm}^{-3}) = \frac{\text{Mass (g)}}{\text{Volume (cm}^3)}$$

3. Record the value of mass and density in the table below.

	Copper	Iron	Cork	Wood
Volume (cm³)	1	1	1	1
Mass (g)				
Density (g cm⁻³)				

4. Put the cubes into a basin of water. Observe whether they float or sink.

Questions

1. What is the relationship between mass and density if the volume of all the four solids is the same?
2. Arrange the above solids according to their density in an ascending order.
3. Based on the observation from step 4, state the operational definition of density.

Recall the information that you have learned in primary school. Materials that are less dense will float and will be above the materials which are denser whereas materials which are denser will sink and will be under the materials which are less dense (Figure 1.24). For example, ice will float on water surface and stones will sink to the bottom.

Table 1.4 *Density of various materials*

Material	Density (g cm^{-3})
Gold	19.30
Lead	11.30
Copper	8.92
Aluminium	2.70
Ice	0.92
Cork	0.24
Mercury	13.60
Seawater	1.03
Pure water (at 40°C)	1.00
Petrol	0.80

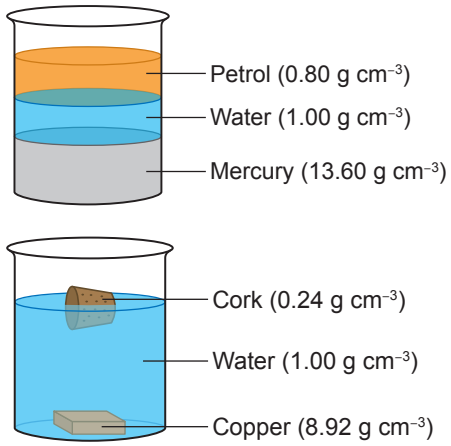


Figure 1.24 *Materials which are less dense than water will float whereas materials which are more dense than water will sink*

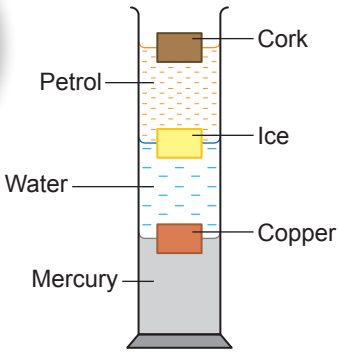
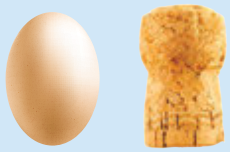


Figure 1.25 *Arrangement of materials in the measuring cylinder*

Brain Teaser

Predict what will happen if both objects are put into a pail of tap water? How can you float the two objects?



Photograph 1.26 *Objects*

Calculation of Density by Using Formula

Example:
The mass of a measuring cylinder is 230 g. After 50 cm^3 of liquid X is poured into it, the mass of the measuring cylinder and liquid X becomes 320 g. What is the density of liquid X?

Solution:

Mass of liquid X = 320 g – 230 g
= 90 g

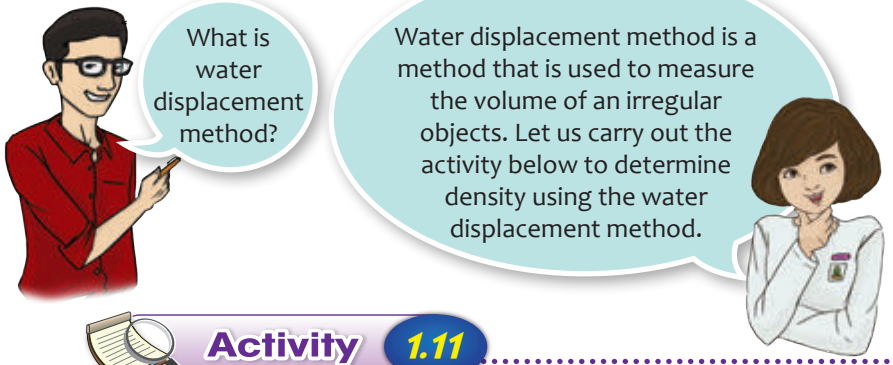
$$\text{Density (g cm}^{-3}\text{)} = \frac{\text{Mass (g)}}{\text{Volume (cm}^3\text{)}}$$

$$= \frac{90\text{ g}}{50\text{ cm}^3}$$

$$= 1.8\text{ g cm}^{-3}$$

Determining the Density of Objects Using the Water Displacement Method

The density of irregular objects can be determined by using water displacement method.



History Corner

Figure 1.26 *Archimedes*
The water displacement method was discovered by a Greek scientist named Archimedes.

Activity 1.11

Aim: To determine the volume of objects using the water displacement method

Materials and apparatus: Stone, thread, 100 ml measuring cylinder, weighing balance, water.

Instruction

1. Weigh and record the reading of the mass of a stone.
2. Pour 50 ml water into a 100 ml measuring cylinder. Take the initial reading of the volume of water.
3. Tie the stone with a piece of thread.
4. Lower the stone slowly into the measuring cylinder until the stone is immersed in the water (Figure 1.27).

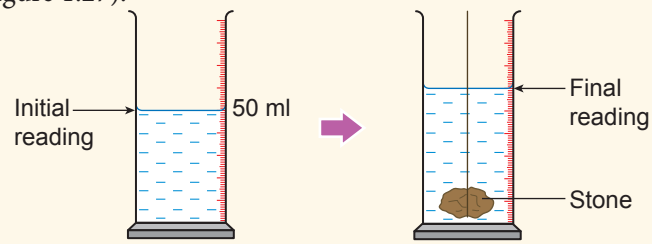


Figure 1.27

5. Read the new water level (final reading of volume). Next, determine and record the volume of the stone in cm^3.
6. Calculate the density of the stone.

Results

Mass of stone = _____ g

Initial reading of volume: _____ cm^3

Final reading of volume: _____ cm^3

Volume of stone = Final reading of volume – Initial reading of volume

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Question

What is the density of the stone?

Differences in Density in Everyday Life

There are many phenomena related to differences in density in everyday life.

Ice is less dense than water, so ice floats on the surface.

Balloons that contain helium gas float in the air because helium gas is less dense than air.

Timber can be transported by water because timber is less dense than water.

Photograph 1.27 *Phenomena related to the differences in density in everyday life*

Activity 1.12

21 Century ICS

Aim: To investigate the phenomena related to the differences in density in our everyday life

Instruction

1. Work in groups.
2. Gather information about phenomena related to density in everyday life and discuss.
3. Present the discussion of your group using multimedia presentation.

Innovation of Objects, Food or Drinks Using the Concept of Density

Look at Photograph 1.28. Nowadays, restaurant operators are very creative in preparing various types of food and drinks using the concept of differences in density. Use your creativity to create interesting objects, food or drinks for sale.

21 Century ISS

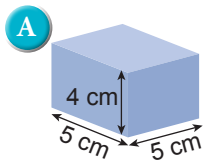
Three-layered tea

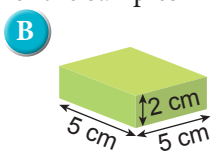
Layered juice

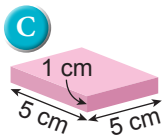
Photograph 1.28 *Innovation of food and drinks*

Formative Practice 1.5

1. Determine the density of the samples in the diagram below.

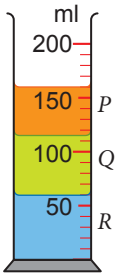






Mass of sample *A* = 200 g Mass of sample *B* = 100 g Mass of sample *C* = 50 g

2. Three types of liquid which do not mix, *P*, *Q* and *R* are poured together in a measuring cylinder as shown in the diagram. Which liquid is the most dense? Why?



1.6 Steps in a Scientific Investigation

Let's learn

- Differentiate each science process skill.
- Make a sequence on the steps of carrying out a scientific investigation in the correct order.
- Conduct a scientific investigation to solve a simple problem.

Recall the science process skills that you have learned in primary school. There are **twelve important science process skills** in a scientific investigation. Can you differentiate each skill?

Observing | Classifying | Measuring and using numbers | Making inferences

Predicting | Communicating | Using time-space relationships | Interpreting data

Defining operationally | Controlling variables | Making a hypothesis | Experimenting

Activity 1.13

Aim: To differentiate each science process skill

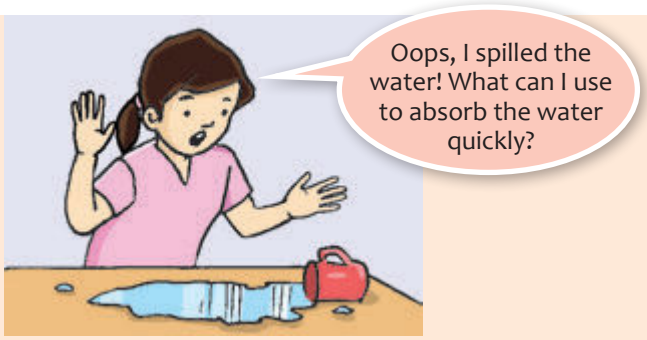
Instruction

1. Work in groups. Each group will be given one station with a science process skill.
2. Each group has to look for information about the science process skill and present their findings in class.

Scientific Method

Scientific method is a **systematic method** used to solve problems in science. This method consists of a few important steps to enable a problem to be solved or explained using the correct method.

1 **Identify a problem** – Identify a problem that could be tested with a scientific investigation.



2 **Construct a hypothesis** – We need to build a hypothesis as an initial explanation of the observation or phenomenon being investigated. The hypothesis has to be tested.

3 **Control variables** – Identify the type of variables involved. Variables are physical quantities that influence the observation or scientific phenomena and it consists of manipulated variables, constant variables and responding variables.

4 **Plan an experiment** – We have to design an experiment carefully beforehand. We also need to choose the right materials and apparatus for the experiment.

5 **Conduct the experiment** – While conducting the experiment, precautions must be practised at all times to obtain a more accurate data. Safety measures must also be followed to prevent accidents.

6 **Collect data** – Data collection is carried out carefully using suitable instruments while taking into consideration any random or systematic error that might occur. Make sure the measurements are carried out at least three times to obtain a more accurate and precise reading. Use a table to record your data.

7 **Analyse and interpret data** – Analysis must be accompanied by effective communication forms such as graphs and tables. Graphs and tables assist us to easily interpret the data.

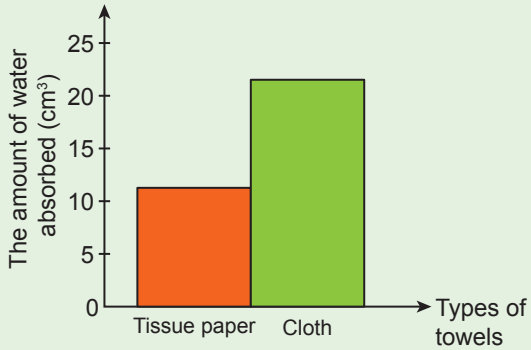


Figure 1.28 *The amount of water absorbed against types of towels*

8 **Make a conclusion** – Conclusions are made based on experimental analysis; either hypothesis is accepted or rejected. If rejected, we need to make a new hypothesis and carry out the experiment again.

9 **Write a report** – When writing a report, all important data and information must be included.

- Problem statement:
- Hypothesis:
- Aim:
- Variables:
- Materials and Apparatus:
- Procedure:
- Observation/results:
- Analysis and interpretation of data:
- Conclusion:

Example of a Complete Experiment Report

Experiment 1.1

1 Identify the problem

Problem Statement: How does the length of a pendulum influence the period of one complete oscillation?

2 Construct a hypothesis

Hypothesis: The longer the length of a pendulum, the longer the period taken for one complete oscillation.

Aim: To investigate the relationship between the length of a pendulum and the period of oscillation

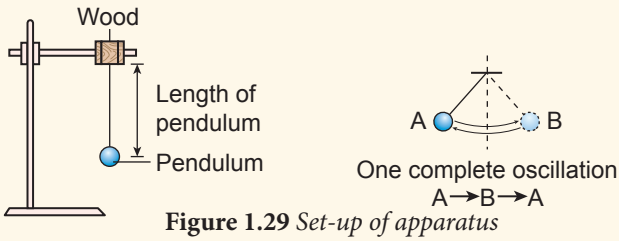


Figure 1.29 *Set-up of apparatus*

3 Control variables

Manipulated variable: Length of pendulum
Responding variable: Time taken for 10 complete oscillations
Constant variable: Mass of pendulum, angle of oscillation

Materials and apparatus: Wood, retort stand with clamp, pendulum, string, stopwatch, metre ruler.

4 Plan and conduct the experiment

Procedure

1. A pendulum with a length of 20 cm is used.
2. The pendulum is pulled to one side and then released to make 10 complete oscillations.
3. The time taken for 10 complete oscillations is recorded.
4. The experiment is repeated using different lengths of pendulum.

Note

Students have to write procedure in the passive form.

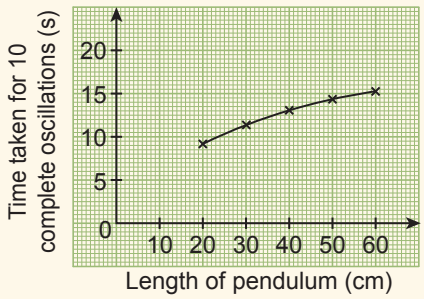
5 Present the data collected

Results

Length of pendulum (cm)	Time taken for 10 complete oscillations (s)			
	Reading 1	Reading 2	Reading 3	Average
20	9.1	9.2	9.0	9.1
30	11.3	11.4	11.4	11.4
40	13.1	13.0	13.1	13.1
50	14.4	14.3	14.3	14.3
60	15.2	15.1	15.3	15.2

6 Interpret data and results with scientific reasoning

Discussion



The longer the length of the pendulum, the longer the time taken for 10 complete oscillations.

Figure 1.30 *Graph*

7 Make a conclusion

Conclusion: Hypothesis is accepted. The longer the length of the pendulum, the longer the time taken for 10 complete oscillations.

Formative Practice 1.6

1. What is an inference?
2. State the manipulated, responding and constant variables when conducting an experiment regarding water evaporation from containers with different surface area.

1.7 Scientific Attitudes and Values in Carrying Out Scientific Investigations

Let's learn

- Support the scientific attitudes and values practised by scientists.
- Justify the need to practise scientific attitudes and values when carrying out an investigation.
- Practise scientific attitudes and values while carrying out a scientific investigation.

What are the scientific approach and values that must be practised by a scientist?

21 Century ISS

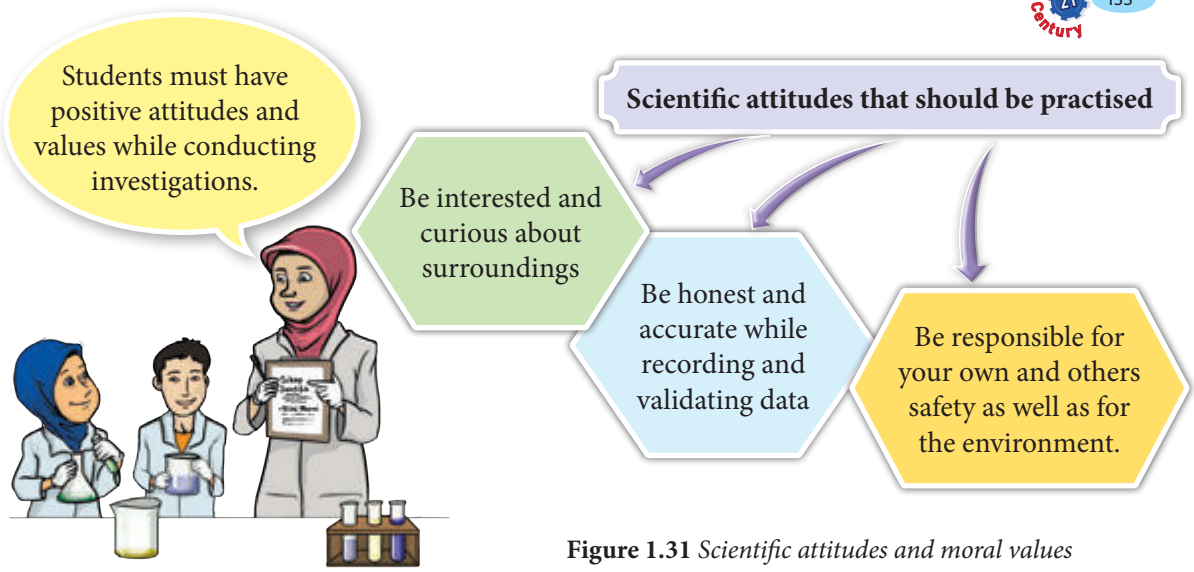
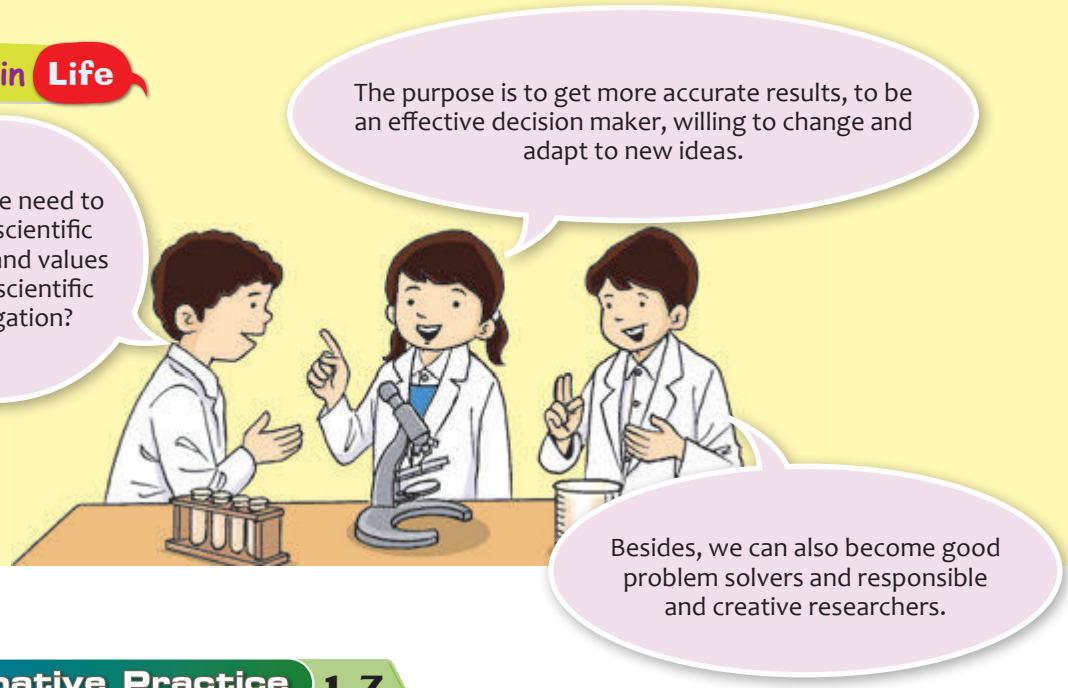


Figure 1.31 *Scientific attitudes and moral values*

Examples of other values that need to be practised during a scientific investigation:

1. Realise that scientific knowledge is one way to understand our environment
2. Appreciate and practise a clean and healthy lifestyle
3. Appreciate the balance in the natural environment
4. Be polite and respect each other
5. Be grateful that the natural environment is a gift from God

Science in Life



Formative Practice 1.7

1. Conclusions of a scientific investigation can be influenced by scientific attitudes and values practised when carrying out experiments. What are the scientific attitudes and values that need to be practised by a student to make accurate conclusions?
2. What are the attitudes that will assist scientists to understand the haze phenomenon that causes air pollution?

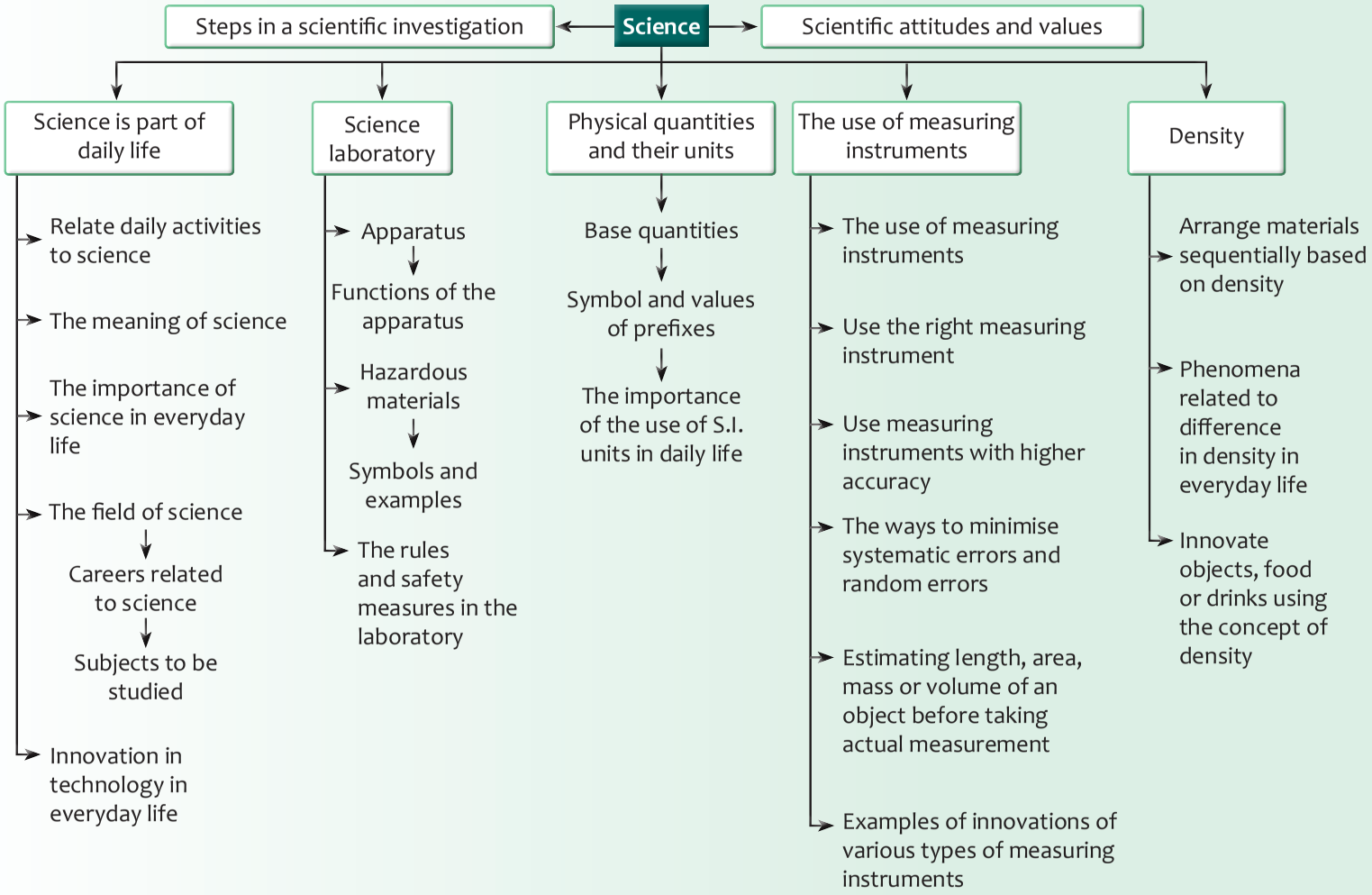
My Malaysia

The National Science Centre (*Pusat Sains Negara*) was built to create a generation of scientists. Students can learn new things when visiting the centre. There are exhibitions about the earth's ecosystem, the history of science and much more.

Photograph 1.29 *National Science Centre*

National Science Centre
http://www.psn.gov.my

Concept Map


Science
Steps in a scientific investigation
Scientific attitudes and values
Science is part of daily life
Relate daily activities to science
The meaning of science
The importance of science in everyday life
The field of science
Careers related to science
Subjects to be studied
Innovation in technology in everyday life
Science laboratory
Apparatus
Functions of the apparatus
Hazardous materials
Symbols and examples
The rules and safety measures in the laboratory
Physical quantities and their units
Base quantities
Symbol and values of prefixes
The importance of the use of S.I. units in daily life
The use of measuring instruments
The use of measuring instruments
Use the right measuring instrument
Use measuring instruments with higher accuracy
The ways to minimise systematic errors and random errors
Estimating length, area, mass or volume of an object before taking actual measurement
Examples of innovations of various types of measuring instruments
Density
Arrange materials sequentially based on density
Phenomena related to difference in density in everyday life
Innovate objects, food or drinks using the concept of density

SELF-REFLECTION

After learning this chapter, you are able to:

1.1 Science is Part of Daily Life

- ☐ Relate daily activities to science.
- ☐ Generalise the meaning of science.
- ☐ Summarise the importance of science in everyday life.
- ☐ Describe the fields of science.
- ☐ Communicate about careers related to science.
- ☐ Relate subjects to be studied in science to careers of interest.
- ☐ Describe innovation in technology.

1.2 Your Science Laboratory

- ☐ Identify and state functions of apparatus.
- ☐ Identify symbols and examples of hazardous materials in the laboratory.
- ☐ Draw and label apparatus commonly used in the laboratory and classify based on how it is used.
- ☐ Justify the regulations and safety measures in the laboratory.

1.3 Physical Quantities and Their Units

- ☐ Identify and use the correct units for different physical quantities.
- ☐ Identify the symbols and values of prefixes used in measurement.
- ☐ Convert base quantity units for mass, length and time such as grams to kilograms, centimetres to metres, seconds to hours and vice versa.
- ☐ Justify the importance of the use of S.I. units in daily life.

1.4 The Use of Measuring Instruments, Accuracy, Consistency, Sensitivity and Errors

- ☐ Use the right measuring instrument and use it in the right way.
- ☐ Use measuring instruments with higher accuracy.
- ☐ Explain how to minimise systematic errors and random errors.
- ☐ Estimate the length, area, mass or volume of an object before taking actual measurements.
- ☐ Explain with examples innovations of various types of measuring instruments through a multimedia presentation.

1.5 Density

- ☐ Arrange materials sequentially based on their density.
- ☐ Predict whether the materials will float or sink according to their density.
- ☐ Define operational definition of density.
- ☐ Calculate density using the formula (density = mass / volume) and water displacement method.
- ☐ Explain the phenomena related to density difference in everyday life.
- ☐ Innovate objects, food or beverage using the concept of density.

1.6 Steps in a Scientific Investigation

- ☐ Differentiate each science process skill.

- Make a sequence on the steps of carrying out a scientific investigation in the correct order.
- Conduct a scientific investigation to solve a simple problem.

1.7 Scientific Attitudes and Values in Carrying Out Scientific Investigations

- Support scientific attitudes and values practised by scientists.
- Justify the need to practice scientific attitudes and values when carrying out an investigation.
- Practise scientific attitudes and values while carrying out a scientific investigation.

Summative Practice 1

1. Figure 1 shows a chemical bottle with a hazard symbol. Mark (✔) at the correct hazard symbol.

☐ Radioactive material ☐ Explosive material

☐ Corrosive material ☐ Highly flammable material

Figure 1

2. *P*, *Q*, *R*, *S*, *T*, *U*, *V* and *W* are steps to carry out scientific investigations based on inquiry. Arrange the steps according to the correct sequence.

P – Control variables	*T* – Plan the experiment
Q – Conduct the experiment	*U* – Analyse and interpret data
R – Construct a hypothesis	*V* – Identify the problem
S – Make a conclusion	*W* – Collect data

☐ → ☐ → ☐ → ☐ → ☐ → ☐ → ☐ → ☐

3. Convert 100 g to kg.

100 g = _____

4. Name the measuring instruments below.

(a) (b)

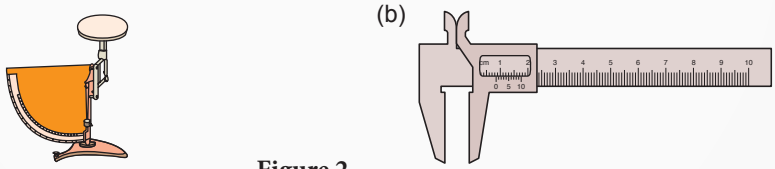


Figure 2

5. Azman is asked by his teacher to heat alcohol in a test tube. What are the steps that need to be taken while handling alcohol? How should these steps be taken? Explain.

6. A biologist is investigating a butterfly. One of the required information is the area of both wings of the butterfly. If every square on the graph paper represents a scale of 1 cm × 1 cm, calculate the area of the wings.

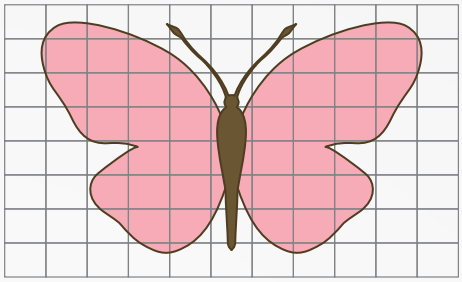


Figure 3

7. Wendy conducted an experiment to study the relationship between surface area and the rate of evaporation. The results were plotted in a graph form. Based on the graph, what is the conclusion that could be made?

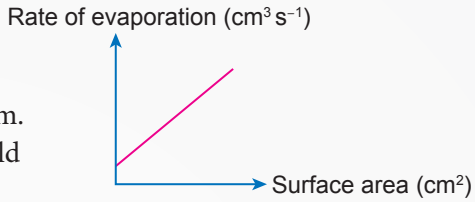
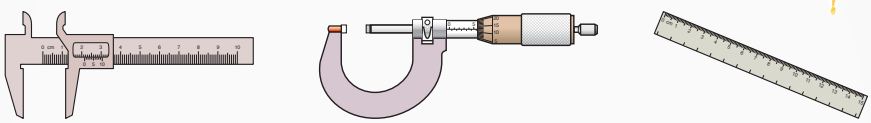


Figure 4

8. Henry was given three measuring instruments, *P*, *Q* and *R*. Which one of these could be used to measure the thickness of a piece of wire accurately and precisely? Why?



P *Q* *R*

Figure 5

9. During an experiment, a chemical reaction caused a small explosion which resulted in light injury to Aisyah. Dina happened to be at her side during the incident. What action should Dina have taken?

10. Aziema observed that clothes that were hung outside the house dried faster than the clothes that were hung inside the house. Construct a hypothesis.

The Next Challenge . . .

11. Punita observed that the plant in pot *C* grew healthier than the plants in pot *A* and *B*. Construct a hypothesis and plan an experiment to test the hypothesis.

Pot *A*: Watered once every three days
Pot *B*: Watered once a week
Pot *C*: Watered everyday

Figure 6

12. Pak Wan wants to sell a type of drink that has many layers to attract his customers. Create a drink and explain the methods to produce the drink.

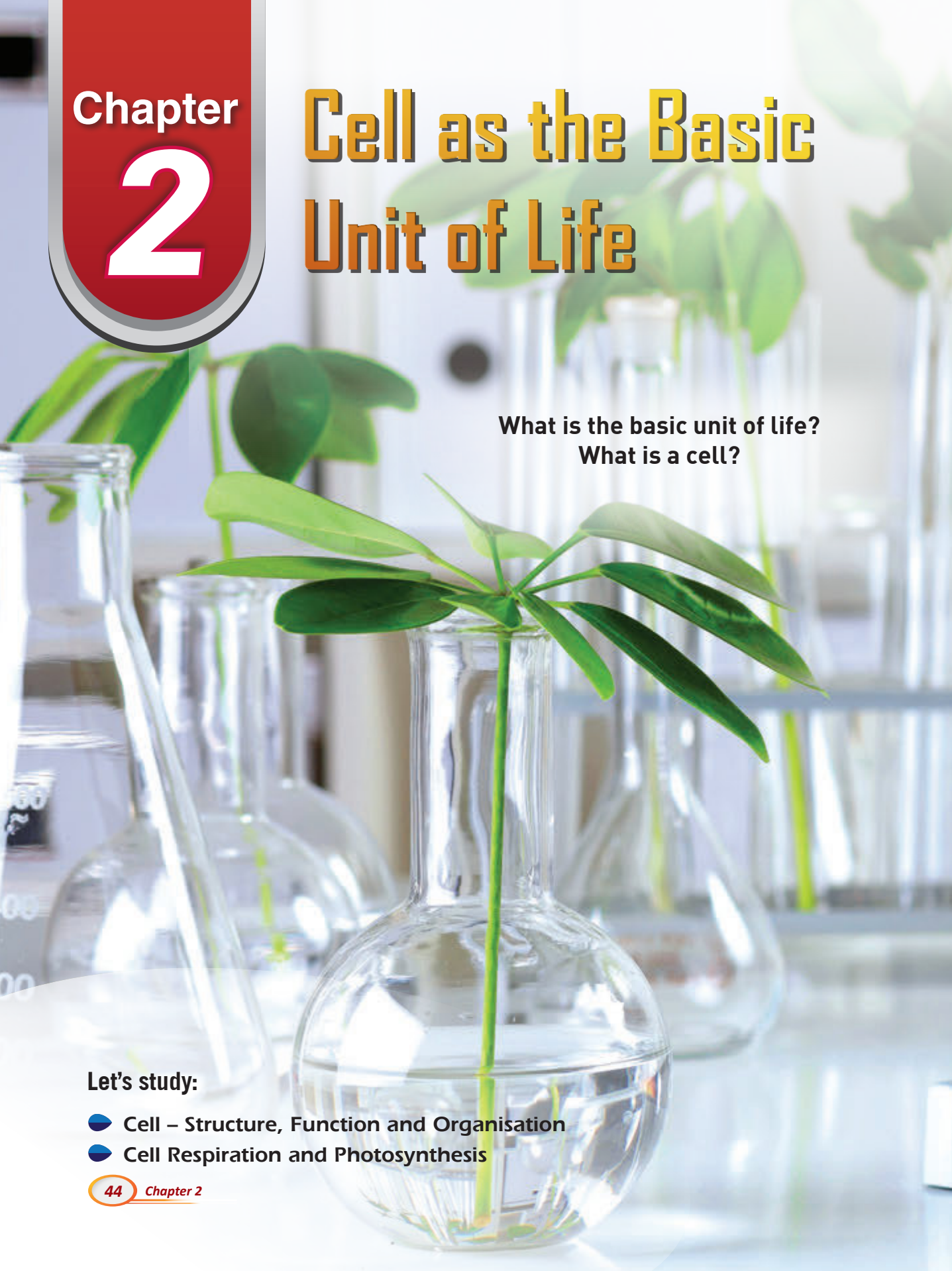
THEME 2

Maintenance and Continuity of Life

- What is cell?
- Why do plants carry out photosynthesis?
- What is homeostasis?
- How do humans produce offsprings?
- How do seeds and fruits of plants form?

Chapter 2

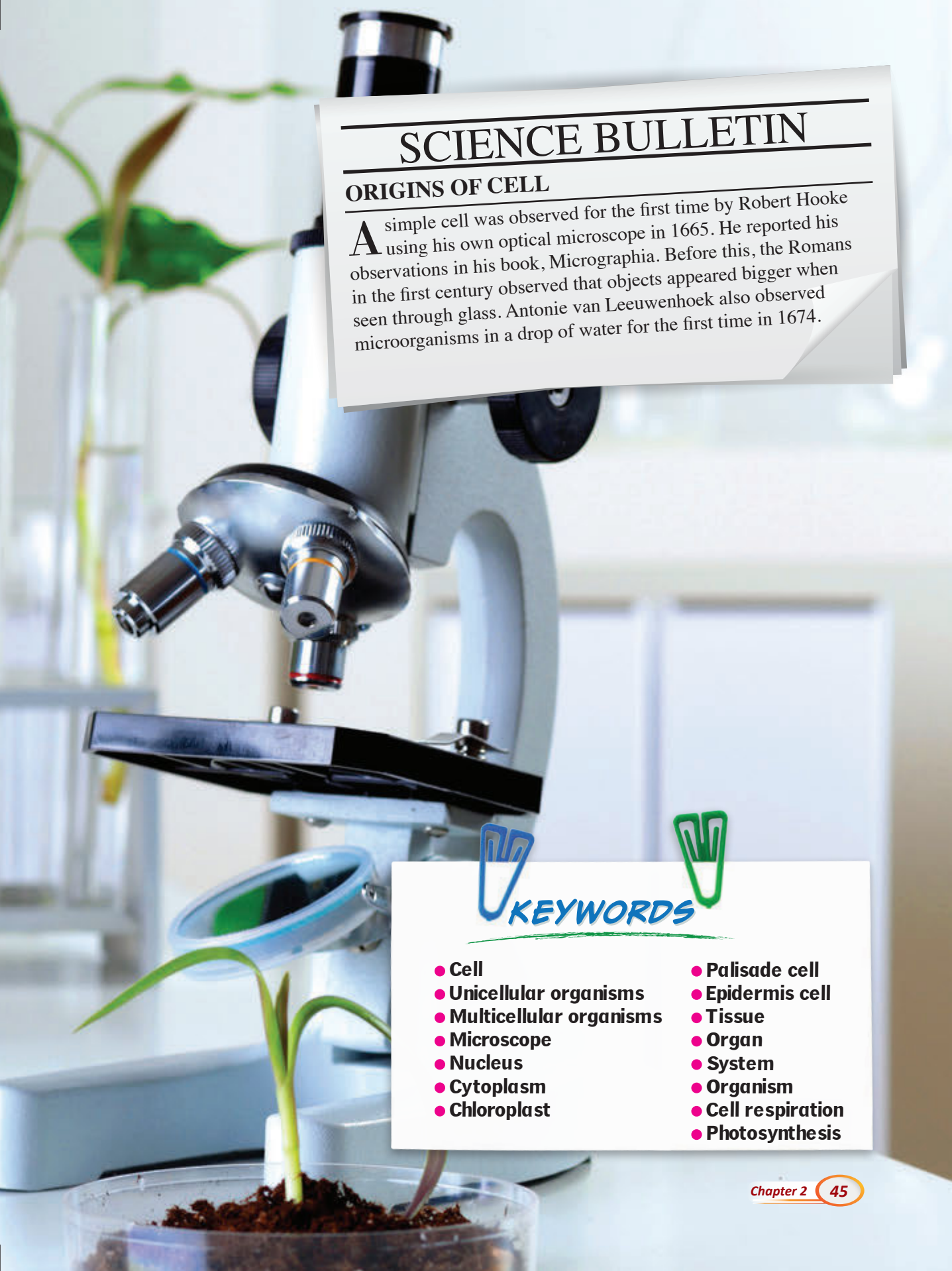
Cell as the Basic Unit of Life



What is the basic unit of life?
What is a cell?

Let's study:

- Cell – Structure, Function and Organisation
- Cell Respiration and Photosynthesis



SCIENCE BULLETIN

ORIGINS OF CELL

A simple cell was observed for the first time by Robert Hooke using his own optical microscope in 1665. He reported his observations in his book, Micrographia. Before this, the Romans in the first century observed that objects appeared bigger when seen through glass. Antonie van Leeuwenhoek also observed microorganisms in a drop of water for the first time in 1674.

KEYWORDS

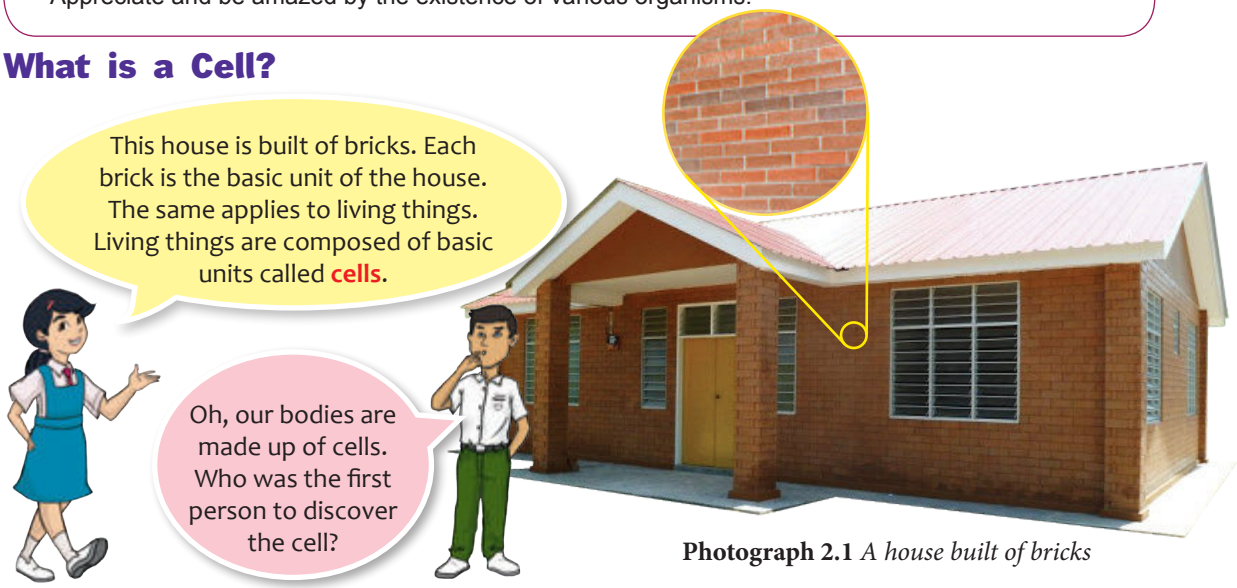
- Cell
- Unicellular organisms
- Multicellular organisms
- Microscope
- Nucleus
- Cytoplasm
- Chloroplast
- Palisade cell
- Epidermis cell
- Tissue
- Organ
- System
- Organism
- Cell respiration
- Photosynthesis

2.1 Cell - Structure, Function and Organisation

Let's learn

- Explain that living things are made up of cells that carry out life's functions and undergo cell division.
- Demonstrate the preparation of slides of animal cells and plant cells using the correct procedures.
- Communicate about each structure in cells with their functions as well as compare and contrast animal cells with plant cells.
- Explain with examples the characteristics of unicellular and multicellular organisms for animal cells and plant cells.
- Differentiate the types and functions of animal cells and plant cells.
- Conceptualise the formation of a plant and an animal with reference to the sequence of cell organisation:
  Cell → tissue → organ → system → organism
- Appreciate and be amazed by the existence of various organisms.

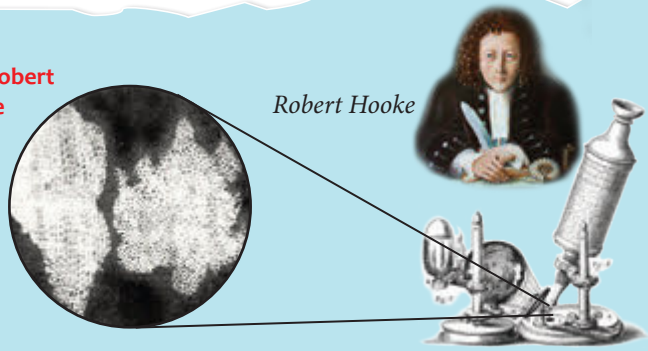
What is a Cell?



Photograph 2.1 *A house built of bricks*

History Corner

- In 1665, an English scientist named **Robert Hooke** invented a **simple microscope** to observe a piece of cork. He saw lots of small box-shaped structures within the cork. Therefore, he named the structures as **cells**.



Photograph 2.2 *Cork cells observed by Robert Hooke*

- In 1674, Antonie van Leeuwenhoek invented a powerful microscope. He observed moving microorganisms in a drop of rain water using his microscope.

Cells carry out all life's functions such as growth, respiration, reproduction and excretion.

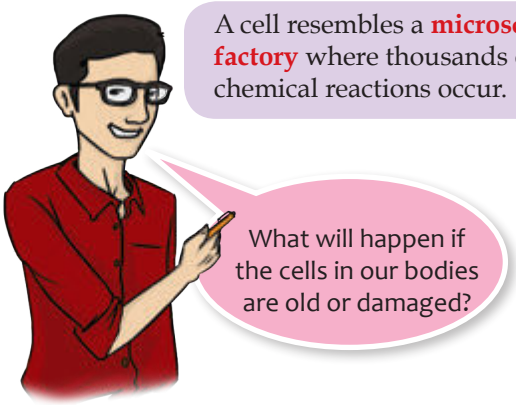
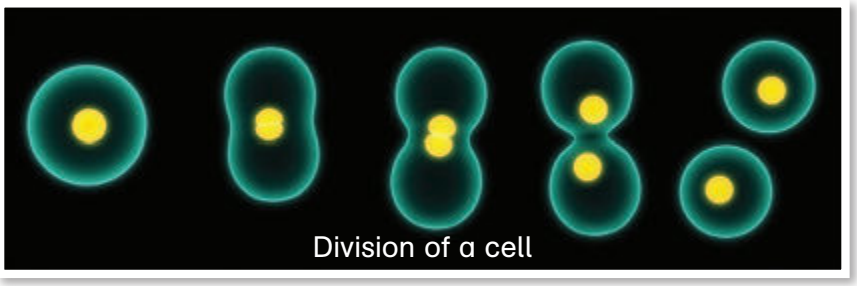


Figure 2.1 *A cell resembles a microscopic factory*

Cells undergo **division process** to form new cells and replace damaged cells. One individual cell becomes two cells and so on. Scan the picture below to see a video on cell division.

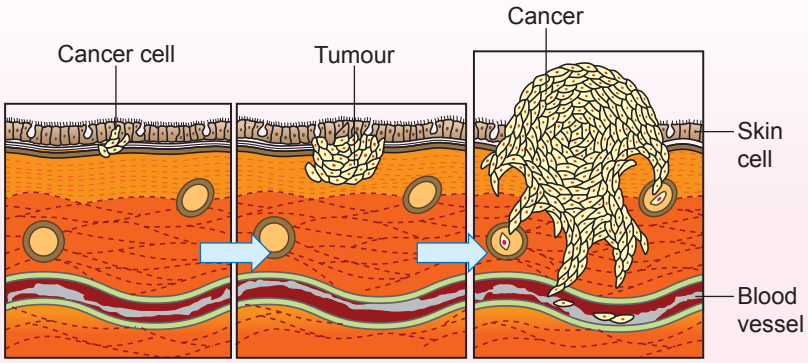
Video on cell division



Photograph 2.3 *Process of division of a cell*

Science Exploration

In controlled conditions, cells divide normally. Cancer occurs when normal cells divide continuously without control. Figure 2.2 shows three stages of cancerous cell development. What is the main cause of cancer? How can cancer be detected? Discuss.



The formation of cancer
www.cancercenter.com/what-is-cancer/

Figure 2.2 *Stages of cancerous cell development*

The Structure of Animal Cells and Plant Cells

How does the structure of animal cells and plant cells look like? Let us carry out the activity below.

Activity 2.1

Aim: To investigate the structure of animal cells using cheek cells

Materials and apparatus: Glass slide, cover glass, microscope, toothpick, mounting needle, methylene blue solution, filter paper, dropper.

Instruction

1. Put a drop of distilled water onto a glass slide.
2. Scrape the inside of your cheek using a toothpick (Figure 2.3).
3. Place the cells onto the glass slide.
4. Add a drop of methylene blue solution on the cells.
5. Gently close the cells with a cover glass using a mounting needle to make sure no air bubbles get trapped.
6. Use a filter paper to absorb any excess methylene blue solution.
7. Observe the glass slide under a microscope using low power objective lens, followed by high power lens.
8. Draw and label the structure of the cheek cells observed in your practical book.

Figure 2.3 *Scrape the inside of the cheek*

Note

Methylene blue solution is used to dye the cells observed under a microscope.

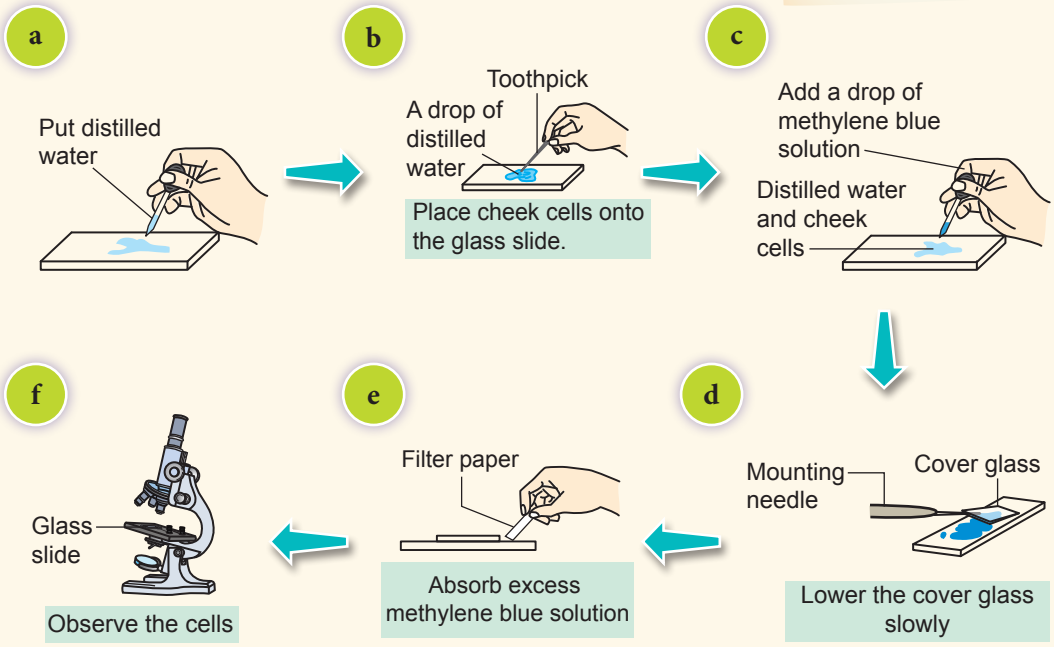


Figure 2.4 *Preparing a cheek cell slide*

Activity 2.2

Aim: To investigate the structure of plant cells using onion cells

Materials and apparatus: Glass slide, cover glass, microscope, knife, mounting needle, dropper, iodine solution, onion, filter paper, forceps.

Instruction

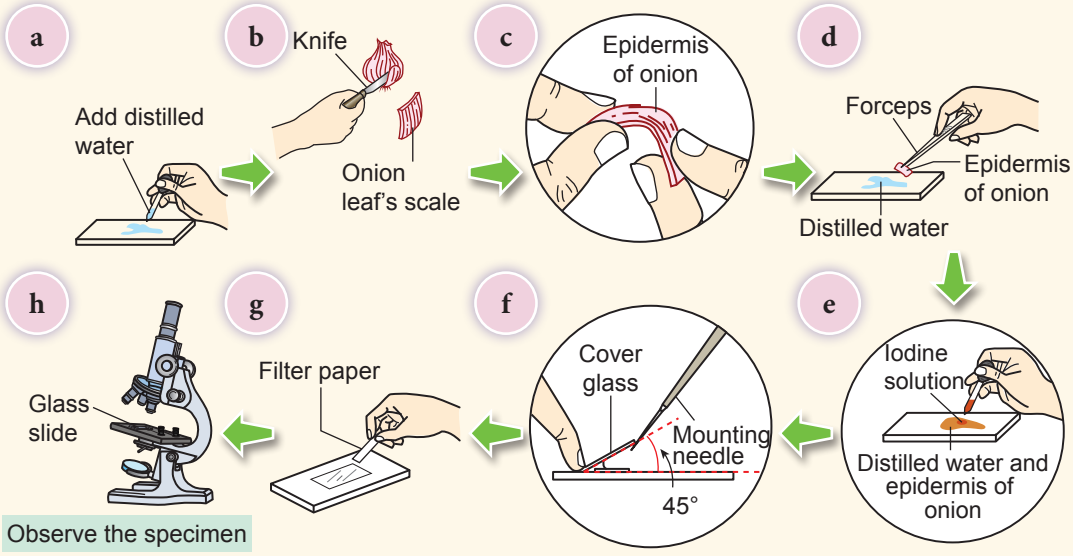


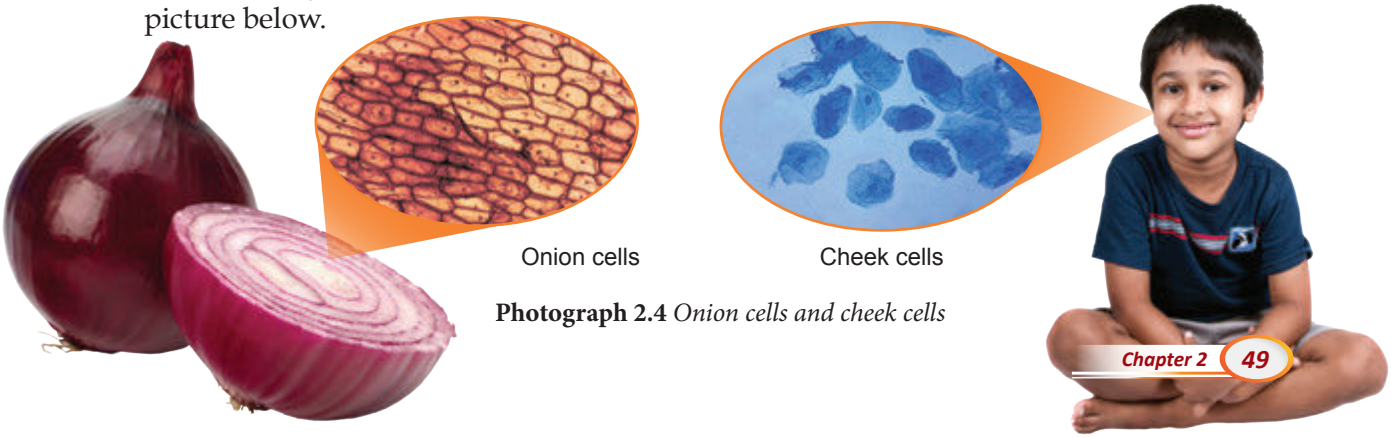
Figure 2.5 *Preparing an onion cell slide*

1. Peel a layer of epidermis from an onion bulb using a knife.
2. Place the epidermis layer onto a glass slide.
3. Add a drop of iodine solution onto the epidermis layer.
4. Gently place a cover glass on the epidermis layer using a mounting needle to make sure no air bubbles get trapped.
5. Use a filter paper to absorb any excess iodine solution.
6. Observe the slide under a microscope using low power objective lens, followed by high power lens.
7. Draw and label the structure of onion cells in your practical book.

PRECAUTION

Be careful when using a knife.

From Activity 2.1 and 2.2, the structure of plant cells and animal cells are shown as in the picture below.



Photograph 2.4 *Onion cells and cheek cells*

Functions of Structures in Animal Cells and Plant Cells

What is the function of each structure?

Chloroplast
- Absorbs light energy for the process of photosynthesis.

Cell membrane
- Controls the flow of materials in and out of the cell.

Mitochondria
- Produces energy for reactions.

Nucleus
- Controls all activities in the cell.
- Contains chromosomes consisting of deoxyribonucleic acid (DNA) that carries genetic information.

Vacuole
- Provides support to cells when filled with cell sap.

Plant cell

Cell wall
- Provides support, protection and fixed shape to the cell.

Cytoplasm
- Acts as a medium where chemical reactions occur.

Figure 2.6 *The function of structures in a plant cell*

Cell membrane
- Controls the flow of materials in and out of the cell.

Mitochondria
- Produces energy for reactions.

Nucleus
- Controls all activities in the cell.
- Contains chromosomes consisting of deoxyribonucleic acid (DNA) that carries genetic information.

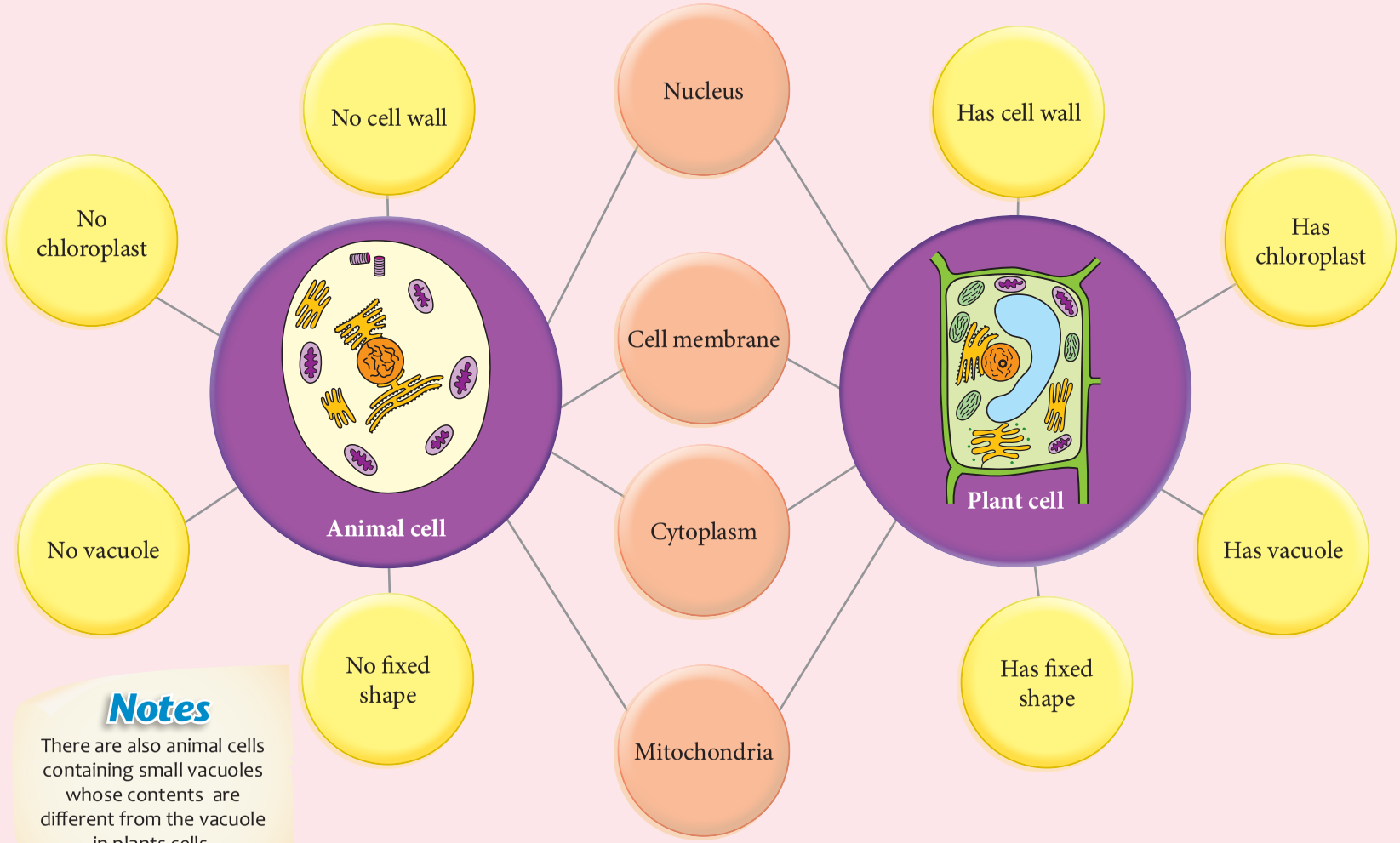
Animal cell

Cytoplasm
- Acts as a medium where chemical reactions occur.

Figure 2.7 *The function of structures in an animal cell*

Comparison between Animal Cells and Plant Cells

The double bubble map below shows the similarities and differences between animal cells and plant cells.



Notes

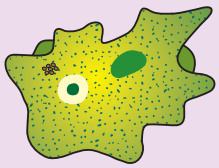
There are also animal cells containing small vacuoles whose contents are different from the vacuole in plants cells.

Figure 2.8 *The similarities and differences between animal cells and plant cells*

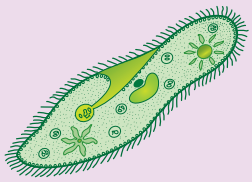
Unicellular and Multicellular Organisms

Unicellular organisms ("uni" means one) are organisms that consist of only one cell while **multicellular organisms** ("multi" means many) are organisms that consist of more than one cell. Even though unicellular organisms consist of only one cell, the organisms can carry out all the processes of life such as growth and reproduction.

Unicellular organisms



Amoeba



Paramecium

Unicellular organisms in the **animal** kingdom are *Amoeba* and *Paramecium* that live in watery areas.

Euglena has the characteristics of both **plants** and **animals**. *Euglena* can make its own food using sunlight like plants and move like animals.

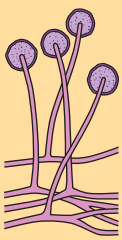
Euglena

A unicellular organism in the **plant** kingdom is *Chlamydomonas*.

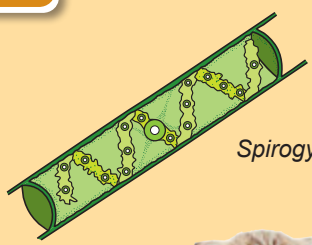
Chlamydomonas

Figure 2.9 *Examples of unicellular organisms*

Multicellular organisms



Mucor



Spirogyra

Hydra

My body consists of many cells.

I am a multicellular organism.

I am also a multicellular organism.

Figure 2.10 *Examples of multicellular organisms*

Activity 2.3

21st Century CPS

Aim: To identify the characteristics of unicellular organisms and multicellular organisms

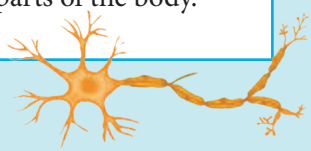
Instruction

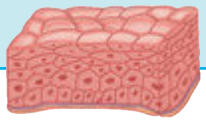
1. Work in groups.
2. Each group has to present the characteristics of unicellular organisms and multicellular organisms in class using a mind map.

The Types and Functions of Animal Cells and Plant Cells

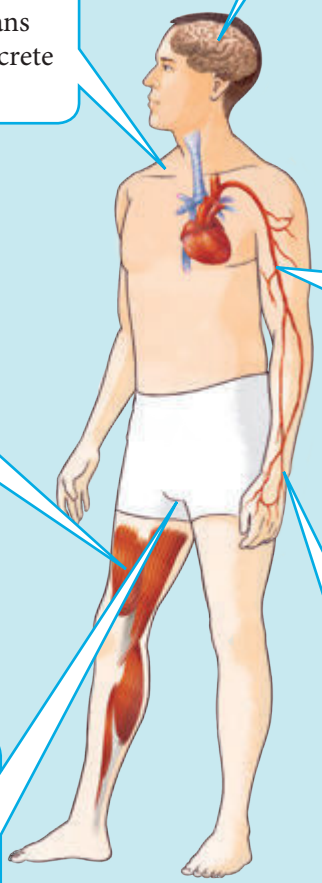
Animal Cells

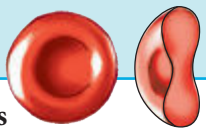
Nerve cells
Contain long fibres that function to carry information in the form of impulse to all parts of the body.





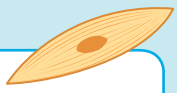
Epithelium cells
Form a layer that protects organs in the body. These cells also secrete mucus.





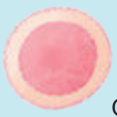
Red blood cells

- Have no nucleus.
- Biconcave disc shaped to increase surface area
- Contain haemoglobin that functions to transport oxygen to all parts of the body.
- Transport carbon dioxide from cells in all parts of the body to the lungs.

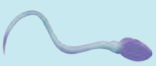


Muscle cells
Contract and relax muscles to enable movement.

Video on Cell Structure and Function

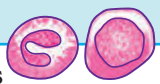


Ovum



Sperm

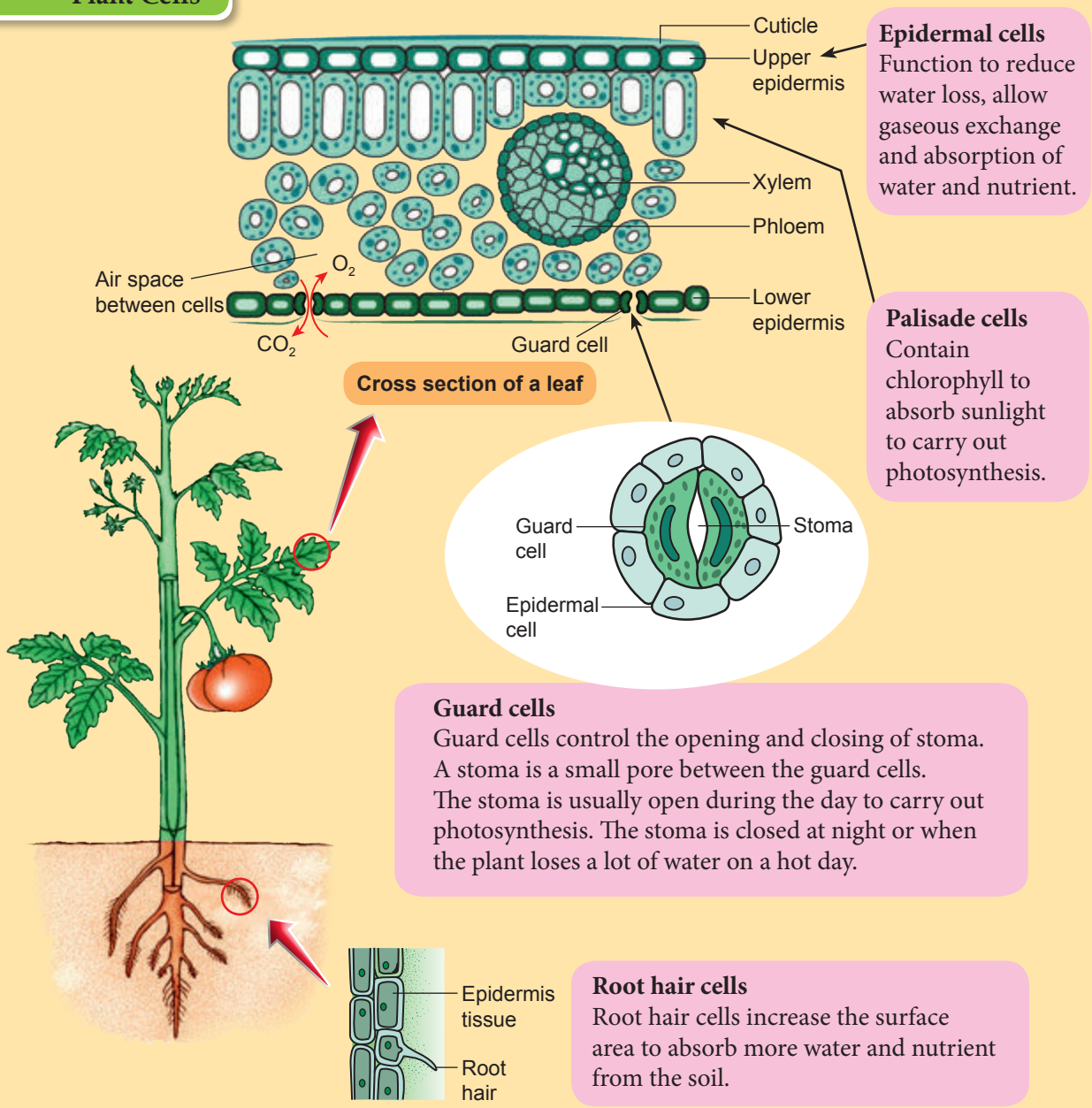
Reproductive cells
Sperms carry male genetic materials and an ovum carries female genetic materials.



White blood cells
Change their form to surround foreign particles and destroy them.

Figure 2.11 *The types of cells in our bodies*

Plant Cells



Epidermal cells
Function to reduce water loss, allow gaseous exchange and absorption of water and nutrient.

Palisade cells
Contain chlorophyll to absorb sunlight to carry out photosynthesis.

Guard cells
Guard cells control the opening and closing of stoma. A stoma is a small pore between the guard cells. The stoma is usually open during the day to carry out photosynthesis. The stoma is closed at night or when the plant loses a lot of water on a hot day.

Root hair cells
Root hair cells increase the surface area to absorb more water and nutrient from the soil.

Figure 2.12 *The types of cells in plants*

The Formation of an Organism

A group of cells with specific functions combine to form a tissue. A group of tissues combine to form an organ. A group of organs combine to form a system. Various systems combine to form an organism. The cell organisation of forming multicellular organisms is shown in Figure 2.13.

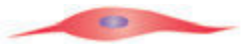
Science Exploration

Skin is the largest organ in the human body.

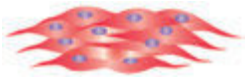
The order of cell organisation

Cell → Tissue → Organ → System → Organism

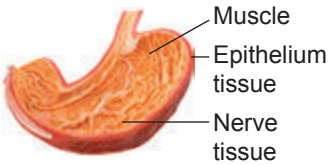
In animals



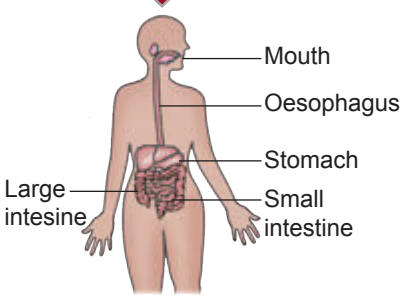
Epithelium cell



Epithelium tissue



Stomach



Digestive system

Organism

Cell

Most cells inside an organism have specific functions.

Tissue

Cells with the same function combine to form a tissue.

Organ

Different tissues that work together to perform a specific function forms an organ.

System

A few organs with related functions that work together for a specific function forms a system.

Organism

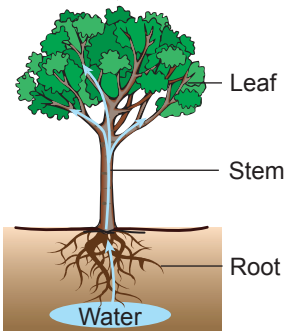
All the systems work together to support an organism.

In plants

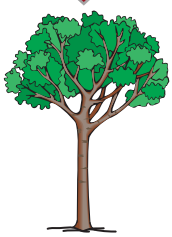
Epidermal cell

Epidermal tissue

Leaf



Transportation system



Organism

Figure 2.13 *Cell organisation in organisms*

Activity 2.4

21st Century ICS

Aim: To study the way organisms are formed from basic unit of cells

Instruction

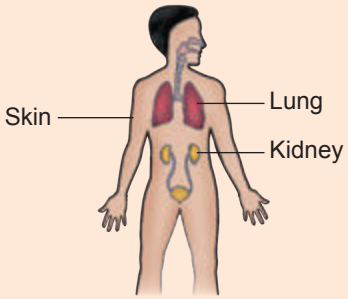
1. Work in groups.
2. Each group has to present how cells form an organism using multimedia presentation in class.

Systems in the Human Body

There are various systems that carry out important functions inside the human body. Each system consists of a few organs that work together to carry out a specific function. The various functions of all systems must be coordinated so that the human body can carry out all life processes or activities effectively.

Systems in the human body
https://en.wikipedia.org/wiki/Human_body

Excretory system



Removes excretory waste from the body.

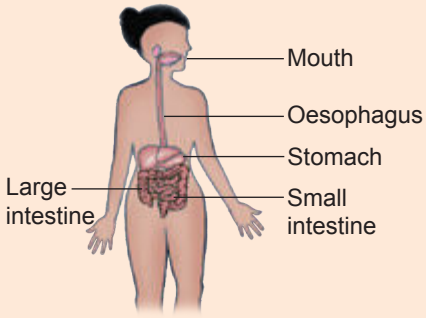
Skeletal system

Supports the body and protects the inner organs such as the lung and heart.

Lymphatic system

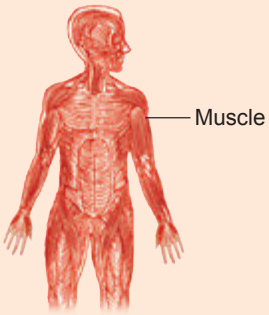
Drains lymphatic fluid into blood vessels to protect the body from infections of bacteria, virus and others.

Digestive system



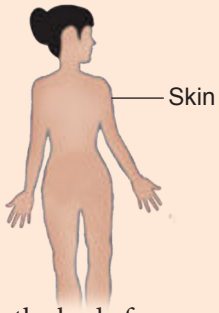
Breaks down complex food into simpler form so that it is more easily absorbed by the body.

Muscular system



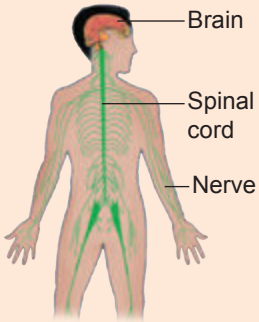
Helps in the movements of the body and inner organs.

Integumentary system



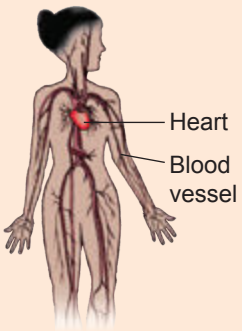
Protects the body from dehydration and regulates body temperature.

Nervous system



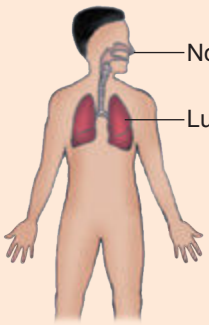
Carries information from the brain to the entire body in the form of impulse.

Blood circulatory system



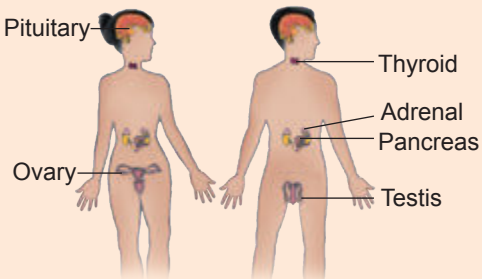
Carries oxygen, nutrients and hormones to all parts of the body.

Respiratory system



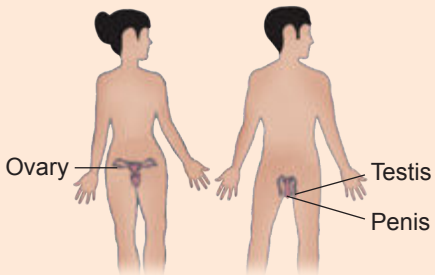
Absorbs oxygen and releases carbon dioxide from the body.

Endocrine system



Produces hormones required to coordinate reactions in the body.

Reproductive system



Produces sperms and ovum to produce offspring.

Figure 2.14 *Examples of systems in the human body*

Cell organisation form various organisms. We should be thankful to God for the existence of various organisms that are beneficial to us.

Formative Practice 2.1

1. Fill in the blanks with correct answers.

   (a) Blood plasma, red blood cells, white blood cells and _____ in blood are the basis for the _____ system.

   (b) _____, _____ and _____ play a role in the excretory system in humans.

2. Match each plant cell with its correct function.

Palisade cell	▶	◀ Absorbs sunlight for photosynthesis
Epidermis cell	▶	◀ Controls the opening and closing of stoma
Root hair cell	▶	◀ Reduces water loss
Guard cell	▶	◀ Absorbs water from soil

3. Name the structure in a plant cell which has the following function.

   Protects and maintains cell shape = _____

2.2 Cell Respiration and Photosynthesis

Let's learn

- Communicate about the process of cell respiration.
- Communicate about the process of photosynthesis.
- Differentiate the process of cell respiration and photosynthesis.
- Explain how the process of cell respiration and photosynthesis complement each other.

What is Respiration?

Respiration can be divided into **external respiration (breathing)** and **internal respiration (cell respiration)**. Breathing involves exchange of gases between the organism and environment whereas cell respiration is the **oxidation process** and **break down of glucose** that occur inside living cells to release energy.

Cell Respiration

Cell respiration is the process of breaking down food to release energy. The energy released will be used for all life processes that occur inside the body. Cell respiration requires **oxygen** and **glucose** to produce **energy**, **carbon dioxide** and **water**.

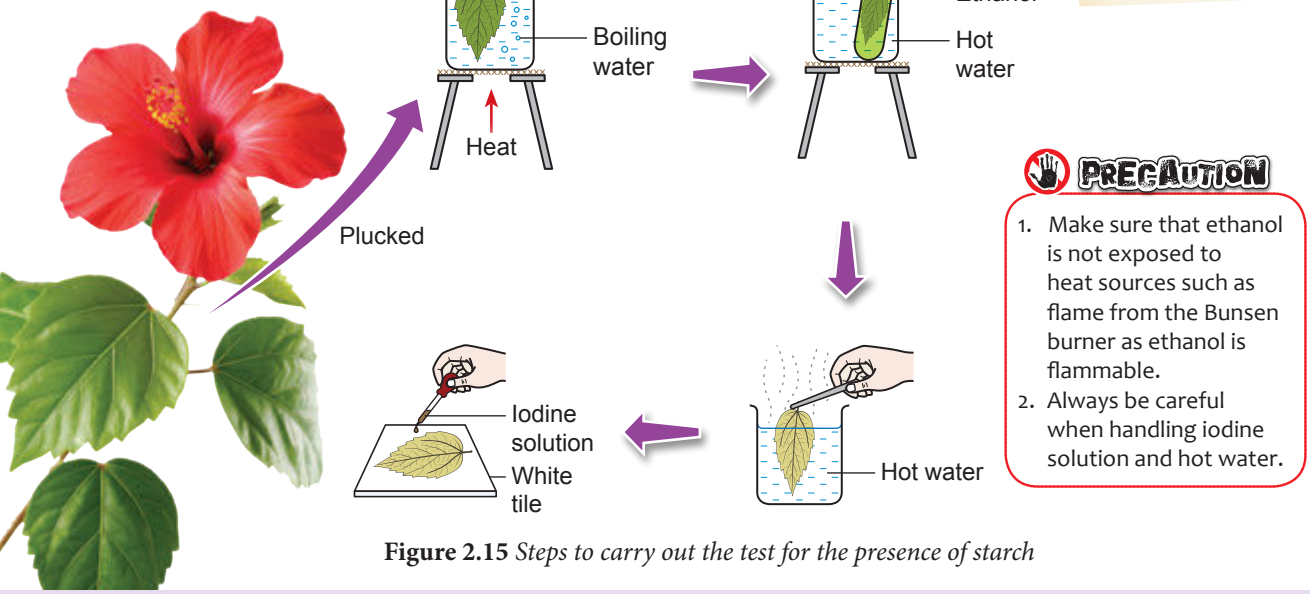
Glucose + Oxygen → Carbon dioxide + Water + Energy

Photosynthesis

Plants make their own food through photosynthesis. Food made by plants is kept in the form of glucose known as starch. Therefore, the presence of starch in leaves shows the occurrence of photosynthesis.

What are the requirements for photosynthesis? Light energy, carbon dioxide, water and chlorophyll are needed for photosynthesis. Before investigating the requirements for photosynthesis (Experiment 2.1 to 2.4), we need to know how to carry out a test to identify the presence of starch in a leaf first.

Test for the presence of starch



Notes

Ethanol removes chlorophyll in the leaf.

PRECAUTION

1. Make sure that ethanol is not exposed to heat sources such as flame from the Bunsen burner as ethanol is flammable.
2. Always be careful when handling iodine solution and hot water.

Figure 2.15 *Steps to carry out the test for the presence of starch*

Instruction:

(a) Dip a leaf into boiling water to break the cell wall of the leaf to soften it.
(b) Half fill a boiling tube with ethanol and put the leaf into it.
(c) Place the boiling tube into a beaker containing hot water.
(d) After 5 minutes, take out the leaf from the boiling tube. Observe the colour changes on the leaf.
(e) Dip the leaf into the hot water for a few seconds to soften the leaf.
(f) Place the leaf on a white tile and put a few drops of iodine solution on it.

Observation: The colour of iodine solution changes from brown to dark blue if starch is present.

Experiment 2.1

Problem statement: Is light energy needed in photosynthesis?

Hypothesis: Plants need light energy for photosynthesis.

Aim: To investigate the need for light energy in photosynthesis.

Variables
Manipulated variable: The presence of sunlight
Responding variable: The colour change of iodine solution
Constant variable: Type of plants

Materials and apparatus: Two similar plants in different pots, hot water, ethanol, iodine solution, boiling tube, white tile, dropper, forceps, beaker, Bunsen burner, tripod stand, wire gauze.

Procedure
1. Keep two similar plants in a dark place for two days to remove starch.
2. After two days, place one of the plants under sunlight (Figure 2.16).
3. After a week, pluck a leaf from each plant.
4. Test for the presence of starch on both leaves and record the observations.

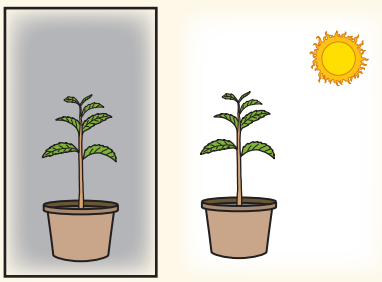


Figure 2.16

Conclusion: Is the hypothesis accepted or rejected? Give your reasons.

Experiment 2.2

Problem statement: Is chlorophyll needed in photosynthesis?

Hypothesis: Plants need chlorophyll for photosynthesis.

Aim: To investigate the need for chlorophyll in photosynthesis.

Variables
Manipulated variable: The presence of chlorophyll
Responding variable: The colour change of iodine solution
Constant variable: Type of plants

Notes

A variegated leaf is a leaf which has a few colours. Some leaves are reddish and has little chlorophyll behind the red pigment.

Materials and apparatus: A variegated leaf, hot water, ethanol, iodine solution, boiling tube, white tile, dropper, forceps, beaker, Bunsen burner, tripod stand, wire gauze.

Procedure
1. Pluck a variegated leaf which has been exposed to sunlight for a few hours (Figure 2.17).
2. Draw a diagram showing the green colour distribution of the leaf.

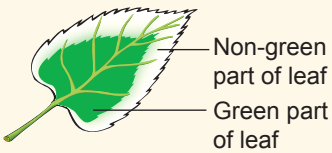


Figure 2.17 *A variegated leaf*

3. Test for the presence of starch on the leaf.
4. Record your observations.

Conclusion
Is the hypothesis accepted or rejected? Give your reasons.

Experiment 2.3

Problem statement: Is carbon dioxide needed in photosynthesis?

Hypothesis: Plants need carbon dioxide for photosynthesis.

Aim: To investigate the need for carbon dioxide in photosynthesis.

Video on photosynthesis

Variables
Manipulated variable: The presence of carbon dioxide
Responding variable: The colour change of iodine solution
Constant variable: Type of plants

Materials and apparatus: Two similar plants in different pots, hot water, ethanol, iodine solution, potassium hydroxide solution, bell jar, boiling tube, white tile, dropper, forceps, beaker, Bunsen burner, tripod stand, wire gauze, glass plate with vaseline.

Procedure
1. Place two similar plants in a dark place for two days to remove starch.
2. Place the two plants in two different bell jars and label *A* and *B* for each plant (Figure 2.18).
3. In bell jar *A*, put a beaker of potassium hydroxide solution. Potassium hydroxide solution is used to absorb carbon dioxide in the air.
4. Place both plants under sunlight for four days.

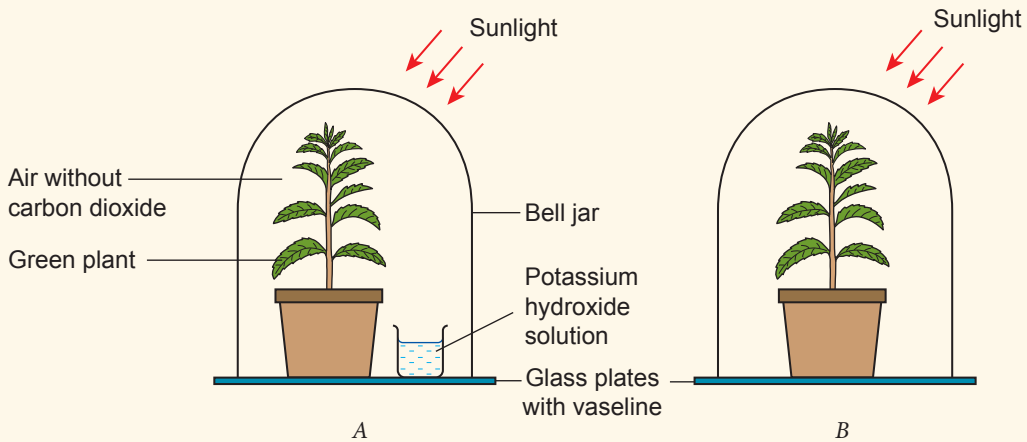


Figure 2.18

5. Test for the presence of starch on the leaves.
6. Record your observations.

Conclusion:
Is the hypothesis accepted or rejected? Give your reasons.

Experiment 2.4

Problem statement: Is water needed for photosynthesis?

Hypothesis: Plants need water for photosynthesis.

Aim: To investigate the need for water in photosynthesis.

Variables
Manipulated variable: The presence of water
Responding variable: Colour change of the iodine solution
Constant variable: Type of plants

Materials and apparatus: Two similar plants in different pots, water, hot water, ethanol, iodine solution, boiling tube, white tile, dropper, forceps, beaker, Bunsen burner, tripod stand, wire gauze.

Procedure
1. Keep two similar plants in a dark place for two days to remove starch.
2. After two days, place the two plants under sunlight. Label the plants as *A* and *B*.
3. Water plant *A* everyday (Figure 2.19).
4. After a week, pluck a leaf from each plant.

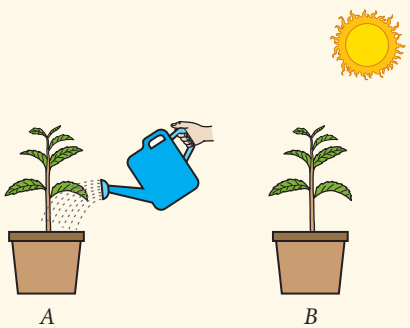


Figure 2.19

5. Test for the presence of starch on the leaves.
6. Record your observations.

Conclusion
Is the hypothesis accepted or rejected? Give your reasons.

From the results of Experiment 2.1 to 2.4, it can be concluded that the process of photosynthesis requires light energy, chlorophyll, carbon dioxide and water to produce glucose and oxygen as shown in Figure 2.20.

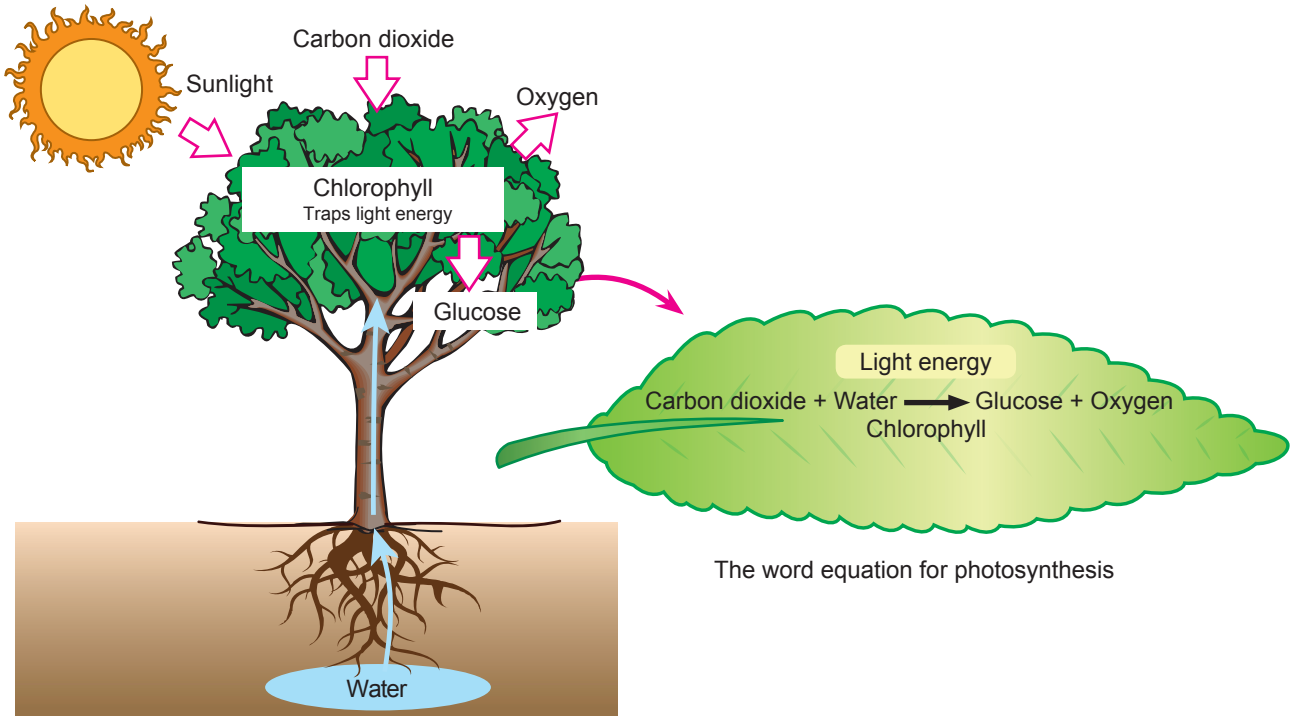


Figure 2.20 *The process of photosynthesis*

The Differences between Cell Respiration and Photosynthesis

Table 2.1 shows the differences between cell respiration and photosynthesis.

Table 2.1 *The differences between cell respiration and photosynthesis*

Cell Respiration	Photosynthesis
Occurs in **mitochondria**	Occurs in **chloroplast**
Process to release energy	Process to absorb energy
Uses chemical energy in food	Uses energy from light
Occurs in humans, animals, plants and microorganisms	Occurs in plants and microorganisms
Breaks down glucose to produce energy	Synthesises glucose
Uses glucose and oxygen to produce carbon dioxide, water and energy	Uses carbon dioxide and water to produce oxygen and glucose
Occurs at all times	Occurs only in the presence of light

The processes of cell respiration and photosynthesis **complement each other**. During cell respiration, oxygen is absorbed and carbon dioxide is released. Released carbon dioxide will be used by plants to carry out photosynthesis. On the other hand, photosynthesis produces oxygen that is needed by all organisms for cell respiration.

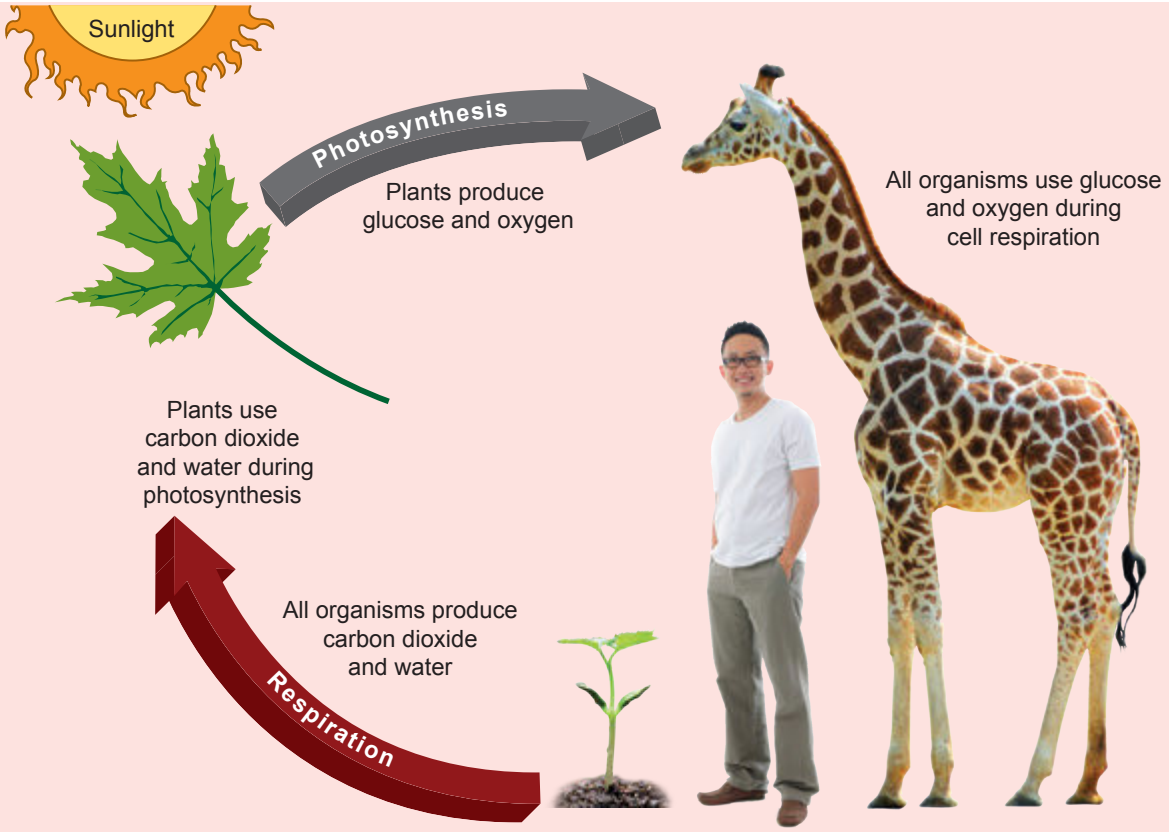
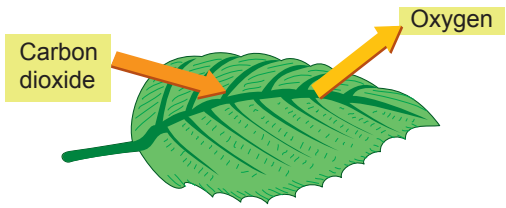


Figure 2.21 *The processes of cell respiration and photosynthesis complement each other*

Formative Practice 2.2

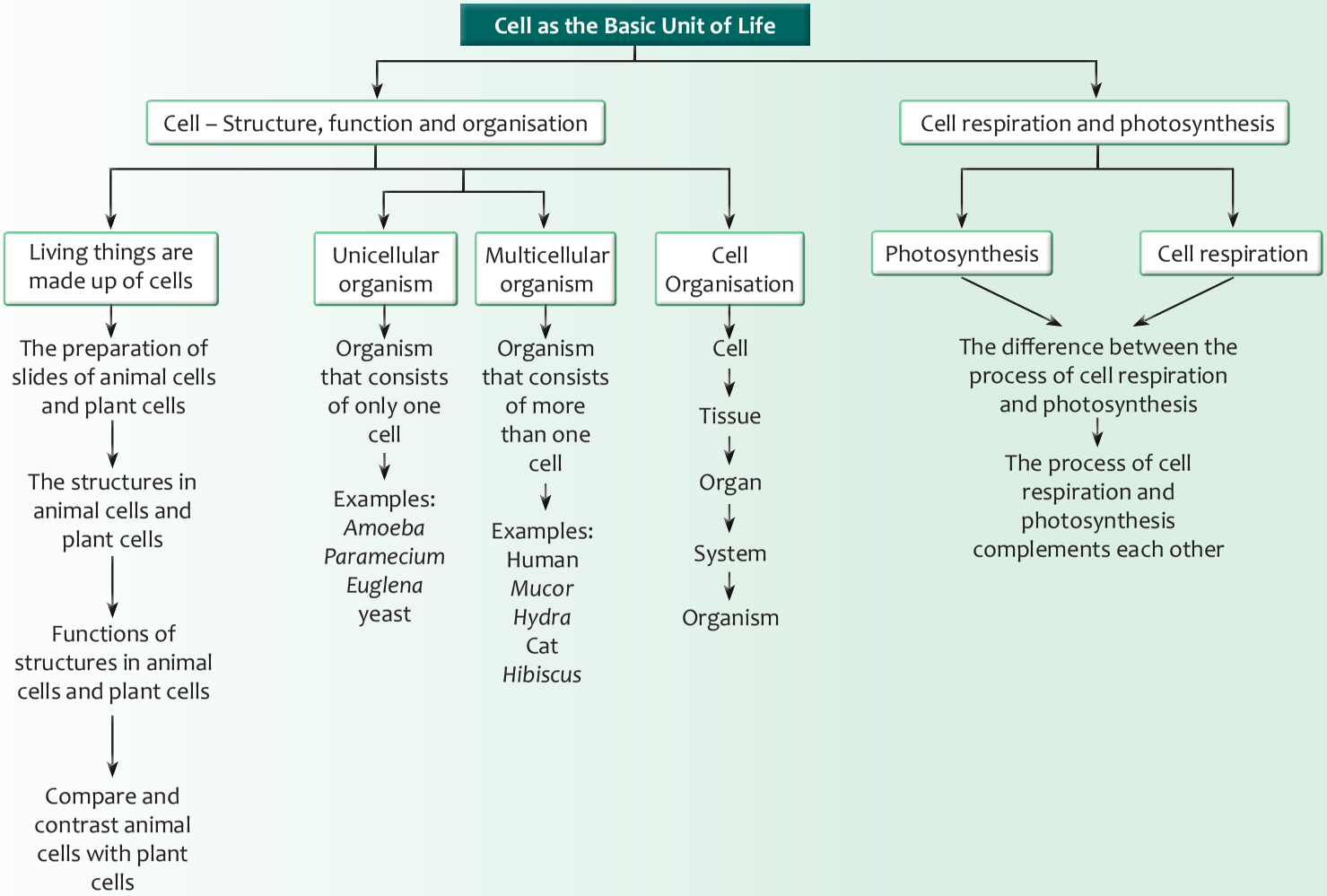
1. Name the process that occurs in the diagram. What is the purpose of this process?



2. Fill in the blanks in the diagram shown below.

Green plants → produce → [ ] → changes to → energy to maintain process of life and activity → during → [ ]

Concept Map


Cell as the Basic Unit of Life
Cell – Structure, function and organisation
Cell respiration and photosynthesis
Living things are made up of cells
Unicellular organism
Multicellular organism
Cell Organisation
Photosynthesis
Cell respiration
The preparation of slides of animal cells and plant cells
The structures in animal cells and plant cells
Functions of structures in animal cells and plant cells
Compare and contrast animal cells with plant cells
Organism that consists of only one cell
Examples: Amoeba Paramecium Euglena yeast
Organism that consists of more than one cell
Examples: Human Mucor Hydra Cat Hibiscus
Cell
Tissue
Organ
System
Organism
The difference between the process of cell respiration and photosynthesis
The process of cell respiration and photosynthesis complements each other

SELF-REFLECTION

After learning this chapter, you are able to:

2.1 Cell – Structure, Function and Organisation

- ☐ Explain that living things are made up of cells that carry out life's functions and undergo cell division.
- ☐ Demonstrate the preparation of slides of animal cells and plant cells using the correct procedures.
- ☐ Communicate about each structure in cells with their functions as well as compare and contrast animal cells with plant cells.
- ☐ Explain with examples the characteristics of unicellular and multicellular organisms for animal cells and plant cells.
- ☐ Differentiate the types and functions of animal cells and plant cells.
- ☐ Conceptualise the formation of a plant and an animal with reference to the sequence of cell organisation:
  Cell → tissue → organ → system → organism
- ☐ Appreciate and be amazed by the existence of various organisms.

2.2 Cell Respiration and Photosynthesis

- ☐ Communicate about the process of cell respiration.
- ☐ Communicate about the process of photosynthesis.
- ☐ Differentiate the process of cell respiration and photosynthesis.
- ☐ Explain how the process of cell respiration and photosynthesis complement each other.

Summative Practice 2

1. Label structures *P*, *Q* and *R* in Figure 1.

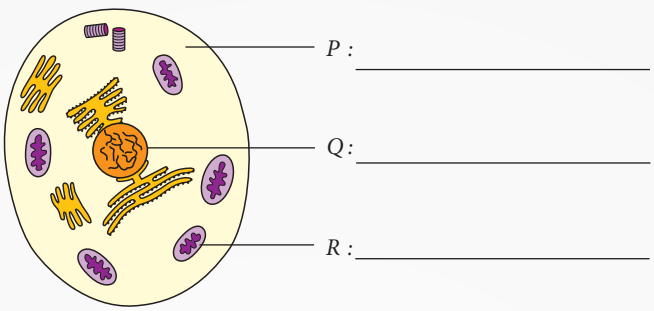


Figure 1

2. Mark (✓) in the boxes which represent organs.

☐ Epithelium ☐ Sperm ☐ Kidney ☐ Ovum ☐ Lung

3. Name the cells below.

(a) (b) (c)

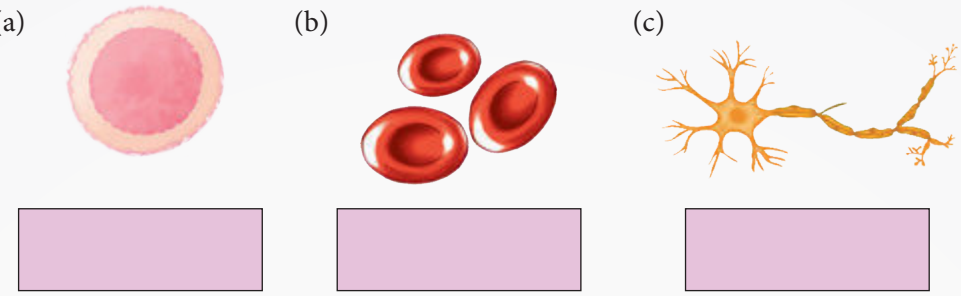


Figure 2

4. If a plant cell and an animal cell are observed under a microscope, what are the characteristics of the cells that enable you to identify the cell as a plant cell?

5. Explain why the skin is an organ and not a tissue.

6. Give one example of an organ. Predict the condition of a human if he loses the organ.

7. Figure 3 shows the organisation of a system in a human.

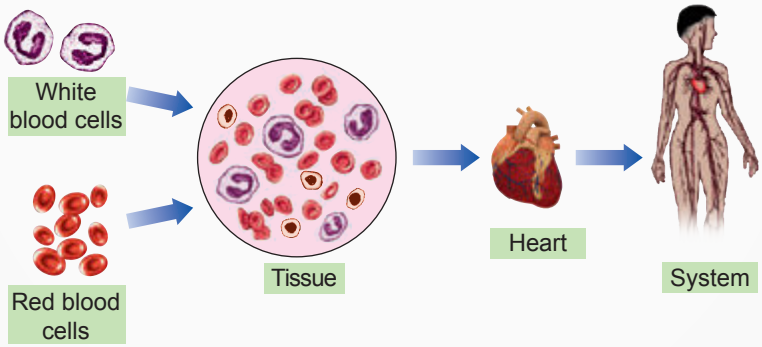


Figure 3

State the system and discuss its functions.

8. Herbivores such as the cow shown in Photograph 1 eat grass. Energy from the grass reaches the cow and returns to the grass. How do living things depend on each other in this case? Discuss.

Photograph 1

9. Amirah and Azma collected a water sample from a pond. They found an organism inside a drop of the water when it was observed using a microscope.

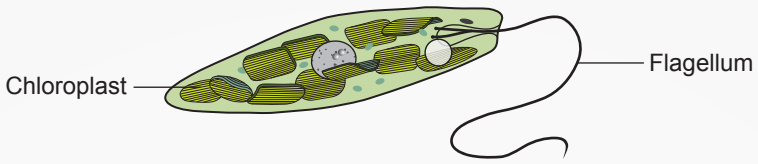


Figure 4

Amirah thinks that the organism is a type of animal but Azma feels that the organism is a type of plant. In your opinion, which is the better statement regarding the organism above? Give a reason.

10. Zuliha carried out an investigation to study cells that formed the heart. In your opinion, which cell in Figure 5 assists in the contraction and relaxation of the heart muscles? Give your reasons.

Figure 5

The Next Challenge . . .

11. Three students are talking about cells. Their conversation is as below.

Mei Foong: In my opinion, all organisms consist of one cell only.

Keetha: My opinion is that some organisms consist of one cell while other organisms consist of many cells to carry out various functions.

Hidayah: I do not agree. All living things are complex and consist of many cells to carry out various functions.

In your opinion, which student's statement is correct? Give reasons to support your choice.

Chapter 3

Coordination and Response

Humans and living things move all the time. How do humans and living things regulate the internal environment inside the body?

Let's study:

- *Homeostasis in Living Things*

SCIENCE BULLETIN

OUR BODY IS THE BEST TEMPERATURE REGULATOR

Our body temperature generally stays at 37°C so that chemical reactions in the body can function efficiently. Therefore, 37°C is the normal body temperature. Do you know that mammals and birds also have a normal body temperature? Normal body temperature differs according to the types of animals. For example, normal body temperature for a magpie is about 39°C while normal body temperature for a porcupine is around 31°C.

When we are running, our body produces heat that will increase the body temperature. Thus, the sweat glands in our body will produce sweat to reduce the body temperature. If the body temperature does not drop to its normal range, our body cells cannot function efficiently and it might cause death. Body temperature exceeding 6°C from the normal temperature will cause death. Therefore, patients with fever should be monitored closely to prevent their body temperature from rising too high.

KEYWORDS

- Homeostasis
- Regulation
- Transpiration
- Response
- Pulse count
- Biological action

3.1 Homeostasis in Living Things

Let's learn

- Communicate about meaning of homeostasis.
- Explain with examples the systems involved with homeostasis in humans and animals.
- Explain with examples the systems involved in plant homeostasis.
- Appreciate the importance of homeostasis in humans and living things.

What is meant by homeostasis? **Homeostasis** refers to the maintenance of the internal environment in the body of an organism, such as temperature, water, pH and blood pressure to be in a balanced and stable condition. The maintenance of the internal environment in the body of an organism in a balanced and stable condition, allows all living processes in the body of the organism to work well. If the internal conditions are not balanced, for example the temperature is too high, the cells of the organism may die.

History Corner

Homeostasis comes from two Greek words, 'homeo' meaning 'similar' and 'stasis' meaning 'stable'.

Homeostasis in Humans

Have you ever used an oven? Do you know that a thermostat is used to control the temperature of an oven? If the thermostat detects the temperature of the oven is too high, the heating function in the oven will switch off and the temperature will decrease. If the thermostat detects the temperature of the oven is too low, the heating function in the oven will switch on to increase the temperature.

Photograph 3.1 *Thermostat of an oven*

The same goes to our body which has a mechanism that can regulate body temperature, water content and others to be in a balanced and stable condition.

Photograph 3.2 *Homeostasis in our body allows processes in the body to function efficiently*

Homeostatic Control Process

When the internal environment in our body such as the body temperature increases, the control centre at the brain will detect the changes. A corrective mechanism will then take place and the temperature will reduce to its normal range. When the body temperature decreases, a corrective mechanism will take place and the temperature will rise to its normal range (Figure 3.1).

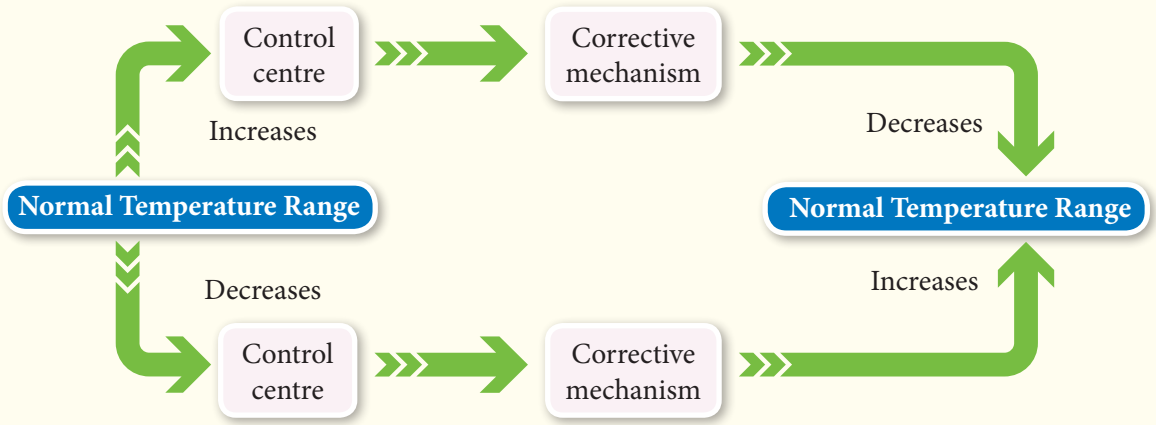


Figure 3.1 *Homeostatic control process*

Homeostasis is important to humans. Among the most important homeostasis in the human body are the **regulation of water** and **body temperature**.

Activity 3.1

21st Century ICS

Aim: To gather information about homeostasis in our body

Instruction

1. Work in groups.
2. Each group has to collect information on homeostasis such as regulation of water content and body temperature. Information can be obtained from the Internet, magazines and other sources.
3. Discuss the information that you have collected in your group.
4. After that, each group has to present their discussion in class using multimedia presentation.

Regulation of Water Content

Systems that are involved in water regulation are the **excretory system** and **endocrine system**. Examples of organs involved are **kidneys** and **brain**.

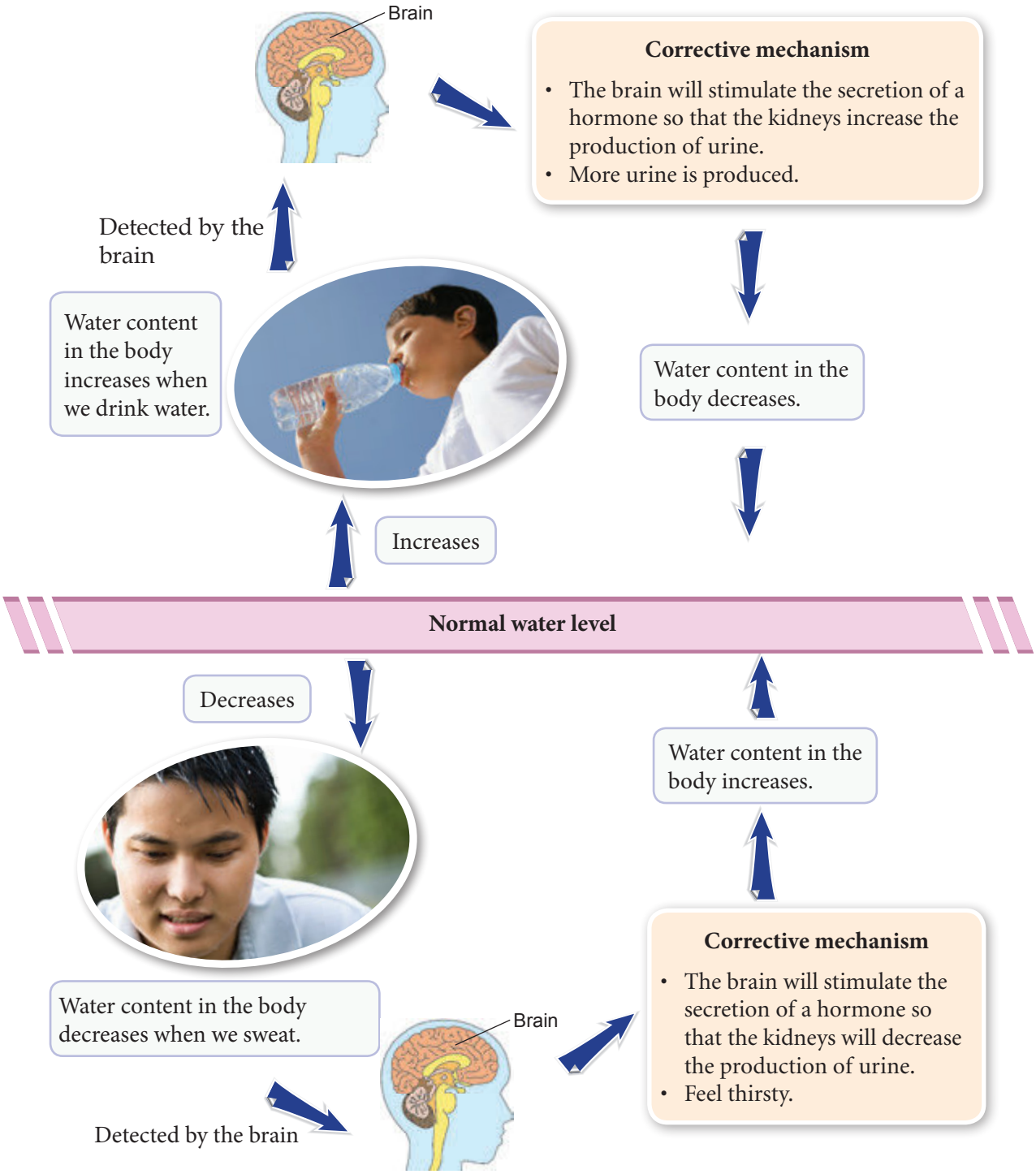


Figure 3.2 *The regulation of water content*

Regulation of Body Temperature

Systems that are involved in regulation of body temperature are the **excretory system** and **endocrine system**. Examples of organs involved are skin, brain and skeletal muscles.

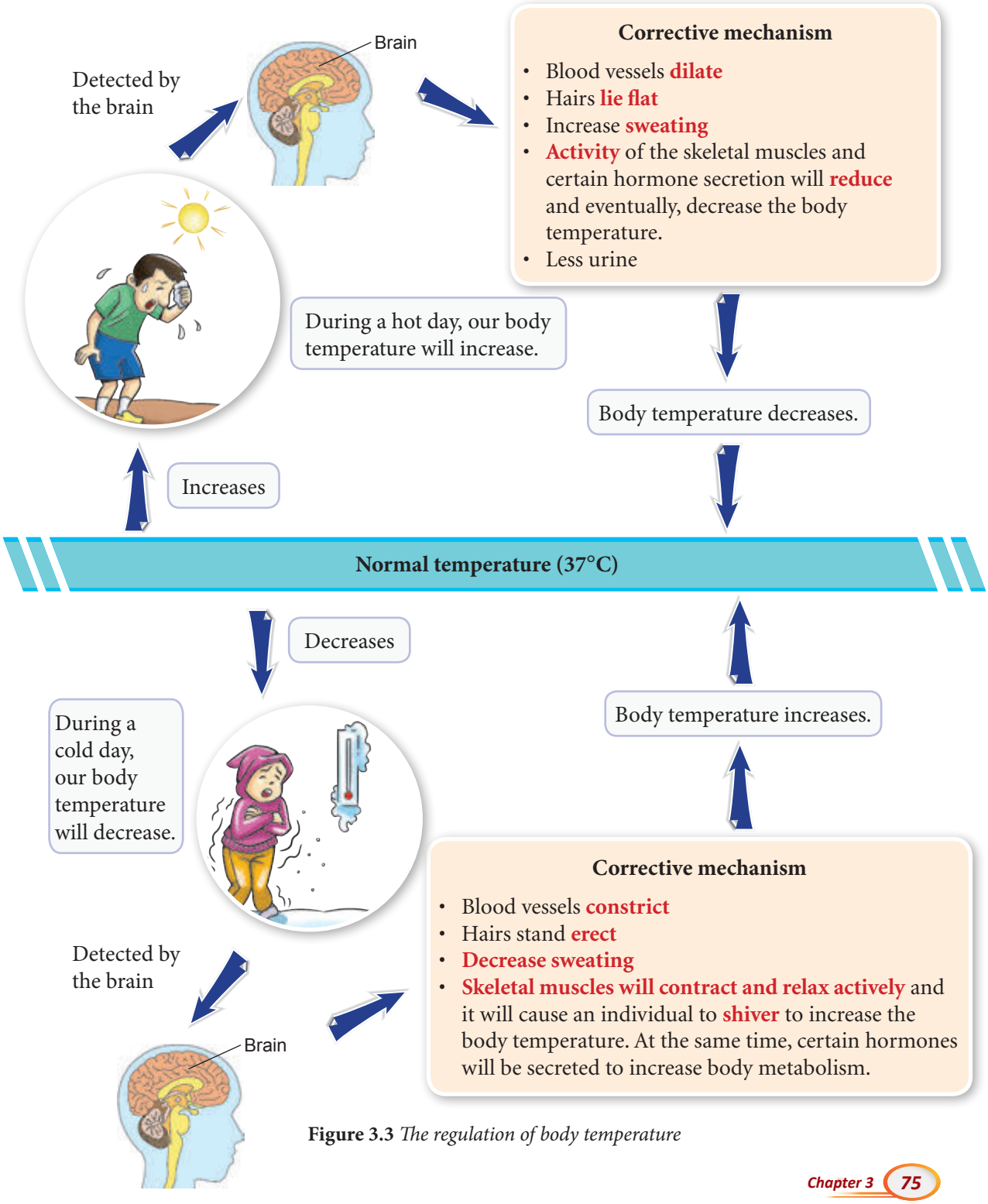
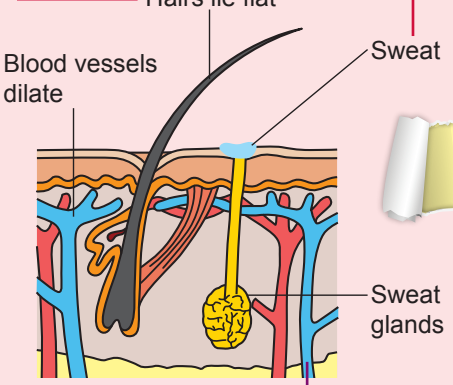


Figure 3.3 *The regulation of body temperature*

Higher surrounding temperature

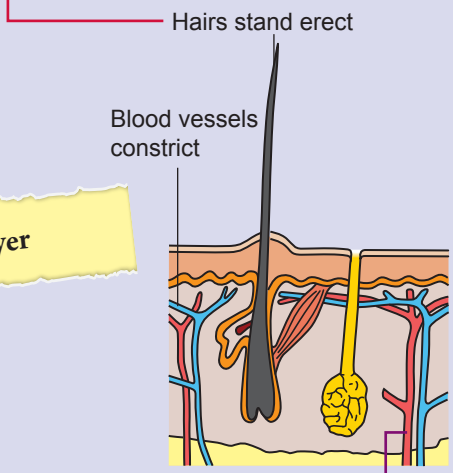
- Sweat glands produce more sweat to cool the skin when sweat is evaporated.
- Hairs **lie flat** to reduce air trapped on the skin so that heat can be released easily.



- Blood vessels **dilate** to let more blood flow close to the skin to increase heat loss.

Lower surrounding temperature

- **Erect** hairs trap a layer of air that acts as a heat insulator.



- Blood vessels **constrict** to let more blood flow away from the skin to reduce heat loss.

Figure 3.4 *The condition of skin layer during higher and lower surrounding temperature*

Video of the role of skin thermoregulation

Experiment 3.1

Problem statement: Do we sweat in a hot or cold condition?

Hypothesis: We sweat in a hot condition.

Aim: To study how the biological actions respond to changes in temperature.

Variables
Manipulated variable: The surrounding temperature
Responding variable: Presence of sweat
Fixed variable: Time taken

Materials and Apparatus: Stopwatch

Procedure

1. Enter the laboratory without switching on the fans for 10 minutes.
2. Record whether or not you are sweating.
3. Then, switch on the fans for 10 minutes.
4. Record whether or not you are sweating.

Results

The surrounding temperature	Presence of sweat
Hot (Fan is switched off)	
Cool (Fan is switched on)	

Question

1. What will happen to the body when we are in a higher surrounding temperature?

Conclusion: Is the hypothesis accepted? Give your reason.

Experiment 3.2

Problem statement: Does the pulse count increase when executing heavy tasks?

Hypothesis: Pulse count will increase when executing heavy tasks.

Aim: To study how biological actions respond to pulse count.

Variables

Manipulated variable: Types of activities
Responding variable: Pulse count
Fixed variable: Time taken

Materials and apparatus: Stopwatch, a student from each group.

Procedure

1. Choose one student from each group to carry out the activities planned which are at rest, walking and jogging for 5 minutes.
2. Then, count the pulse of each student for a minute by placing two fingers on their wrist and record the reading after each activity (Photograph 3.3).

Photograph 3.3 *The way to count pulse*

3. Record the results in the table as shown below.

Results

Group number	Student's name	Pulse count		
		At rest	Walking	Jogging
1				
2				
3				
4				

Questions

1. What is shown by the data collected?
2. What other observations can be seen on students after doing heavy tasks?
3. Why is sweat produced when doing heavy tasks?

Conclusion: Is the hypothesis accepted or rejected? Give your reason.

Homeostasis in Animals

Homeostasis also occurs in animals. Animals like cats and dogs do not have sweat glands except on their sole. How do they maintain homeostasis during changes in surrounding temperature?

Photograph 3.4 *Responses of animals towards changes in surrounding temperature*

How do reptiles such as lizards maintain homeostasis towards changes in surrounding temperature?

Cold Surrounding:

- Body activities become slower
- Muscles function more slowly
- Movements become slower
- Metabolism rate decreases
- Body temperature decreases

Hot Surrounding:

- The heart beats faster
- Movements become faster
- Metabolism rate increases
- Body temperature increases

Photograph 3.5 *Lizards regulate body temperature when the surrounding temperature changes*

How do snails and bees maintain homeostasis towards the increase in surrounding temperature?

Loses a lot of water through evaporation on skin surface.

Produces fluid and looks for humid places to reduce water loss.

Brain Teaser

How does homeostasis occur in the body of snakes and polar bears?

21 Century CPS

Photograph 3.6 *Snail*

Has waxy skin layer and loss of water vapour occurs through its spiracles.

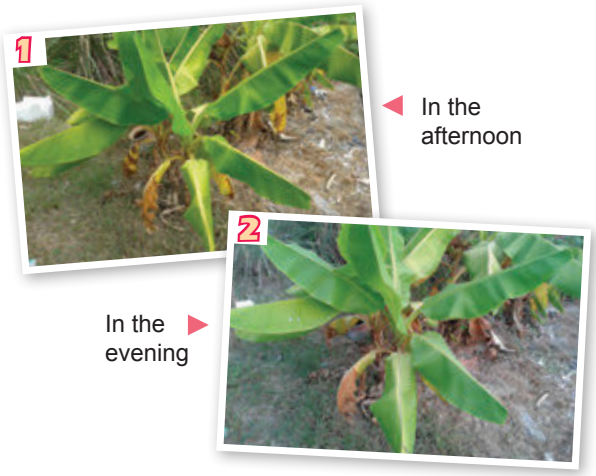
Closes spiracles between two breathing movements to reduce water loss.

Photograph 3.7 *Bee*

Homeostasis in Plants

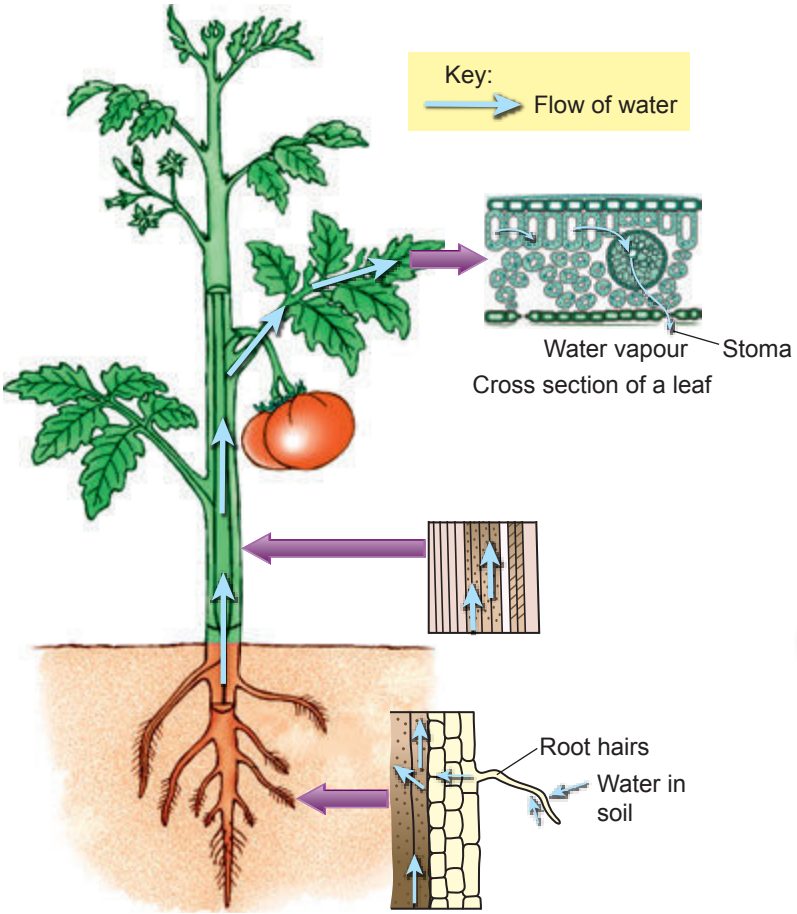
Observe the plant condition during different times in a day. Plants need sufficient water to prevent them from withering and die. How do plants regulate water content during hot and cold days?

Water from plants are lost through a process known as **transpiration**. During transpiration, plants lose water from leaves in the form of water vapour to the surrounding through the **stoma**. This involves the transport system in plants.



Photograph 3.8 *Banana tree leaves roll up in the afternoon to avoid excessive water loss*

- Transpiration helps plants to absorb and carry water and minerals from the soil to all parts of the plant (Figure 3.5).
- Evaporation of water from the leaves cools the plant during hot days.



Science Exploration

Almost 90% of water absorbed by the roots of plants is lost through transpiration.

2 Transpiration on leaves produces force that draws water from the stems of plants.

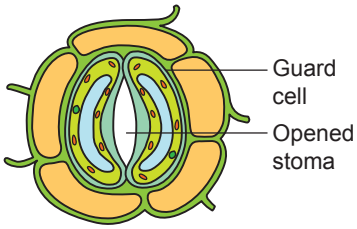
1 Roots of plants absorb water and minerals from soil.

Figure 3.5 *Transpiration helps in water transportation from roots to leaves*

Stoma

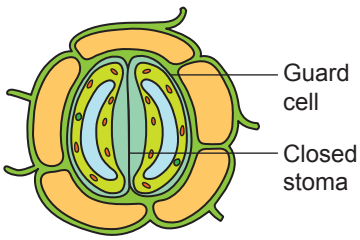
Guard cells control the **opening** and **closing** of stoma. During the day, stoma opens to enable exchange of gas. At the same time, water vapour will be lost from the leaves and this will increase the rate of water intake by the roots.

During the day



During the day, **stoma opens** to enable more water to be evaporated from the leaves through transpiration.

When the temperature is too high



When the temperature is too high, **stoma closes** to reduce water evaporated from the leaves through transpiration.

Figure 3.6 *The opening and closing of stoma*

Activity 3.2

Aim: To gather information on transpiration

Instruction

1. Work in groups.
2. Each group has to collect information on transpiration such as its function in the regulation of water content in plants. Information can be obtained from the Internet, magazines and other sources.
3. Discuss the information that you have collected.
4. After that, each group has to present their discussion in class using multimedia presentation.

Importance of Homeostasis to Humans and Living Things

Homeostasis in human body and living things is to provide the optimum conditions in the body so that cells can carry out metabolism activities efficiently. All chemical reactions in living cells are controlled by enzymes that are sensitive to surrounding changes. Changes in temperature will influence the enzyme activities.

We should be grateful that homeostasis enables the internal environment of our body to be regulated and maintained in a balanced and stable condition. Imagine our life without homeostasis. What would happen if the temperature in our body or other living things continue to increase or decrease? What would happen if the water content in our body or other living things is lost without control?

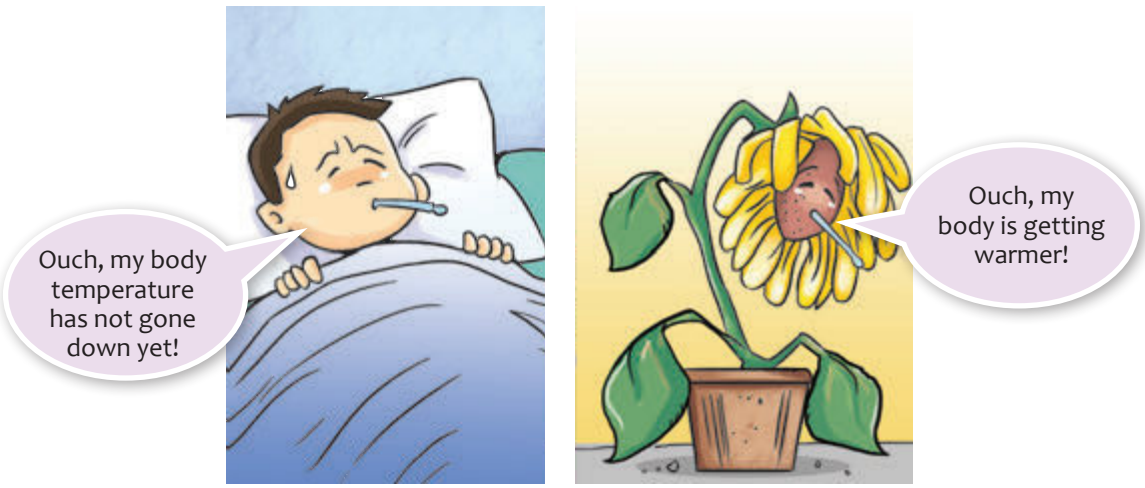


Figure 3.7 *Condition of humans and plants without homeostasis*

Activity 3.3

21st Century ICS

Aim: To discuss the importance of homeostasis.

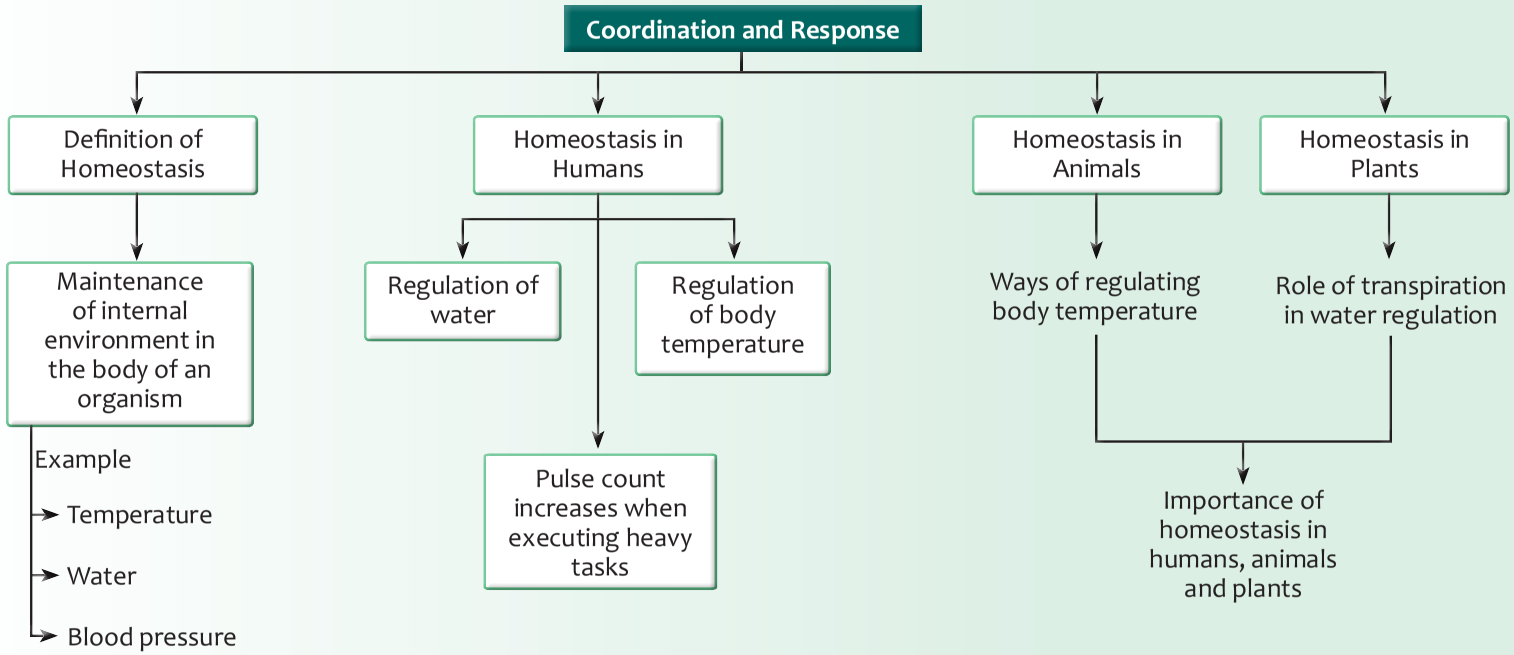
Instruction

1. Work in groups.
2. Discuss the importance of homeostasis. Each student must give at least one idea.
3. Present the group discussion in the form of multimedia presentation such as PowerPoint in class.

Formative Practice 3.1

1. What is homeostasis?
2. Give two examples of important regulation in the human body.

Concept Map


Coordination and Response
Definition of Homeostasis
Maintenance of internal environment in the body of an organism
Example
Temperature
Water
Blood pressure
Homeostasis in Humans
Regulation of water
Regulation of body temperature
Pulse count increases when executing heavy tasks
Homeostasis in Animals
Ways of regulating body temperature
Homeostasis in Plants
Role of transpiration in water regulation
Importance of homeostasis in humans, animals and plants

SELF-REFLECTION

After learning this chapter, you are able to:

3.1 Homeostasis in Living Things

- ☐ Communicate about meaning of homeostasis.
- ☐ Explain with examples the systems involved with homeostasis in humans and animals.
- ☐ Explain with examples the systems involved in plant homeostasis.
- ☐ Appreciate the importance of homeostasis in humans and living things.

Summative Practice 3

1. How do plants control homeostasis?

2. How do our bodies respond to changes in temperature when we enter a very cold room?

3. What is the role of blood vessels in increasing heat loss?

4. What is the advantage of having a constant body temperature?

5. During exercise, our body loses a lot of water. Why do people who exercise need to drink water before feeling thirsty?

6. Why does our face look red after doing an active exercise but pale when feeling cold?

7. The graph in Figure 1 shows that the quantity of sweat and urine changes with temperature.

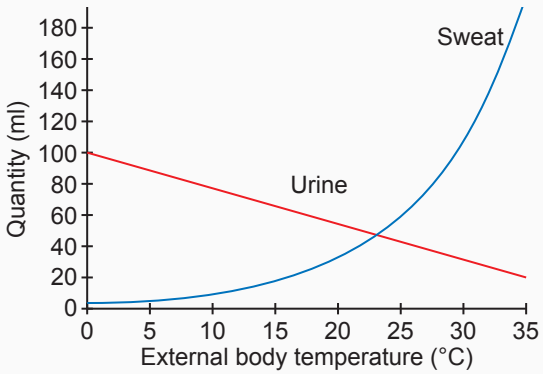


Figure 1

(a) What would happen to the quantity of sweat when temperature increases? Explain why it happens.
(b) What would happen to the quantity of urine when temperature increases? Explain why it happens.
(c) Relate the relationship between both reasons in answers (a) and (b).

8. Khairul stayed in a house and was given the same quantity of food and drinks for three days. The quantity of urine produced was collected and measured.

Table 1

Day	Quantity of urine (ml)
Day one	1900
Day two	500
Day three	850

(a) Why must we ensure that the quantity of food and drinks for all three days is the same?
(b) On which day did Khairul do the most vigorous activity? Give your reason(s). (Answer guide: relate it with the quantity of urine produced)

9. Why is wearing a few layers of thin clothing better than wearing a layer of thick clothing to maintain body temperature?

10. The statement below shows a hypothesis.

> Plants regulate water content through the stoma.

Design an experiment to prove the hypothesis above.

The report must include:

- Problem statement
- Hypothesis
- Aim
- Variables
- Apparatus and materials
- Procedure
- Data tabulation

The Next Challenge . . .

11. The statement below shows the functions of skin.

> Skin is an excretory organ, protective organ of other organs and the organ that regulates body temperature.

In your opinion, is the statement true? Give your reason.

12. The statement below shows a hypothesis.

> More urine is produced when we drink a lot of water compared to when we drink less water.

Design an experiment to prove the hypothesis above.

The report must include:

- Problem statement
- Hypothesis
- Aim
- Variables
- Apparatus and materials
- Procedure
- Data tabulation

Chapter 4

Reproduction

The average of live births occuring daily in Malaysia is 1,400 births. (Department of Statistics Malaysia, 2014). What is the importance of birth?

Let's Study:

- Sexual and Asexual Reproduction
- Human Reproductive System
- Menstrual Cycle
- Fertilisation and Pregnancy
- Factors Affecting the Development of a Foetus and Baby
- Infertility and Contraception
- Plant Reproduction

SCIENCE BULLETIN

ROBERT EDWARDS, NOBEL LAUREATE

A British scientist, Robert Edwards, was awarded the 2010 Nobel Prize for Medicine. He had successfully invented the *in vitro fertilisation* (IVF) technology, a method of fertilisation which takes place in a glass dish (test tube).

How is the IVF procedure done? The IVF procedure involves fertilising an egg cell that has been removed from the mother in a glass dish with sperm cells obtained from the father in a laboratory. The fertilised egg cell is left to grow until it develops into an early stage of embryo. Then, the embryo is placed in the uterus. The embryo grows in the uterus until it is born as a baby.

Edwards's research began in the 1950s. His research succeeded for the first time on 25th July 1978 when the world's first test tube baby was born. The baby was named Louise Brown.

His achievement has helped many married couples with fertility problems to have children. The IVF technology has since brought millions of test tube babies into the world.

KEYWORDS

- Sexual reproduction
- Asexual reproduction
- Fertilisation
- Vegetative reproduction
- Puberty
- Menstruation
- Ovulation
- Implantation
- Placenta
- Pollination

4.1 Sexual and Asexual Reproduction

Let's learn

- Compare and contrast sexual and asexual reproduction in animals and plants.
- Reason the importance of reproduction.
- Be grateful for the ability to reproduce and the continuation of life as a gift from God.

Science Career

Doctors who specialise in this field are known as obstetricians and gynaecologists.

Do you know what **reproduction** is? Reproduction is the process of producing new individuals from living organisms. Reproduction is the basic characteristic of each living organism. Photograph 4.1 indicates how humans and animals reproduce.

Photograph 4.1 *Ways of reproduction for humans and animals*

Reproduction can be divided into, **sexual reproduction** and **asexual reproduction**. The classification of reproduction can be seen in the following thinking map.

Reproduction

Sexual

Involves reproductive cells

Occurs in:

- humans
- higher animals (mammal, bird, fish, reptile and amphibian)
- flowering plants

Asexual

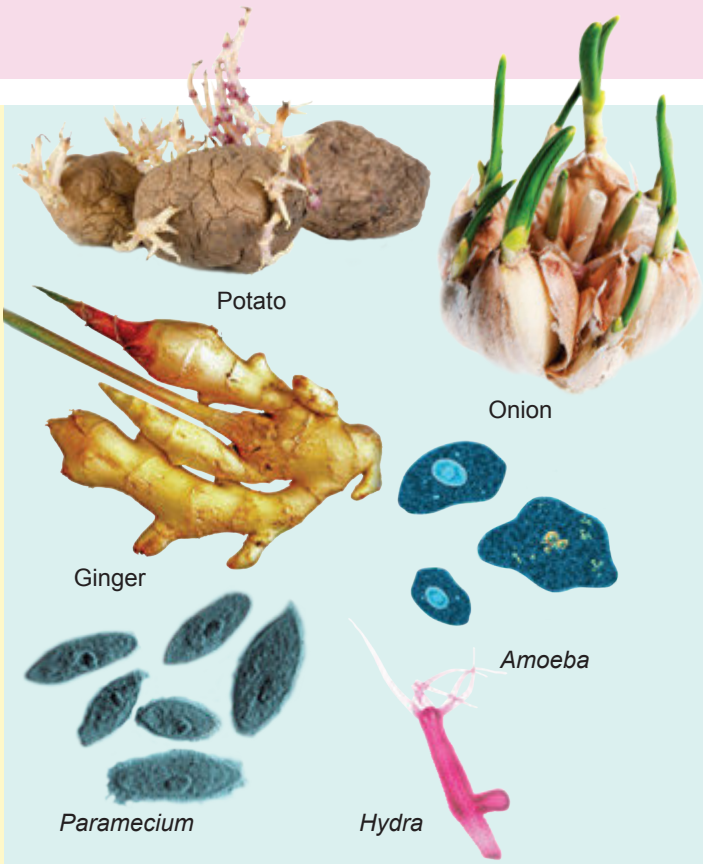
Does not involve reproductive cells

Occurs in:

- plants (onion, ginger, potato)
- simple organisms (*Amoeba*, *Hydra*, *Paramecium*)

Photograph 4.2 *Humans reproduce sexually*

Photograph 4.3 *A few examples of living organisms that reproduce sexually*



Photograph 4.4 *A few examples of living organisms that reproduce asexually*

Sexual Reproduction

Sexual reproduction is the main type of reproduction that is carried out by human, higher animals and plants. Human reproduction is not only to produce offsprings, but it also involves family bonding and love.

Sexual reproduction involves two parents, which are

- male parent that carries male reproductive cell
- female parent that carries female reproductive cell

History Corner

Antonie van Leeuwenhoek was the first scientist who studied sperm cell using a microscope in 1677.

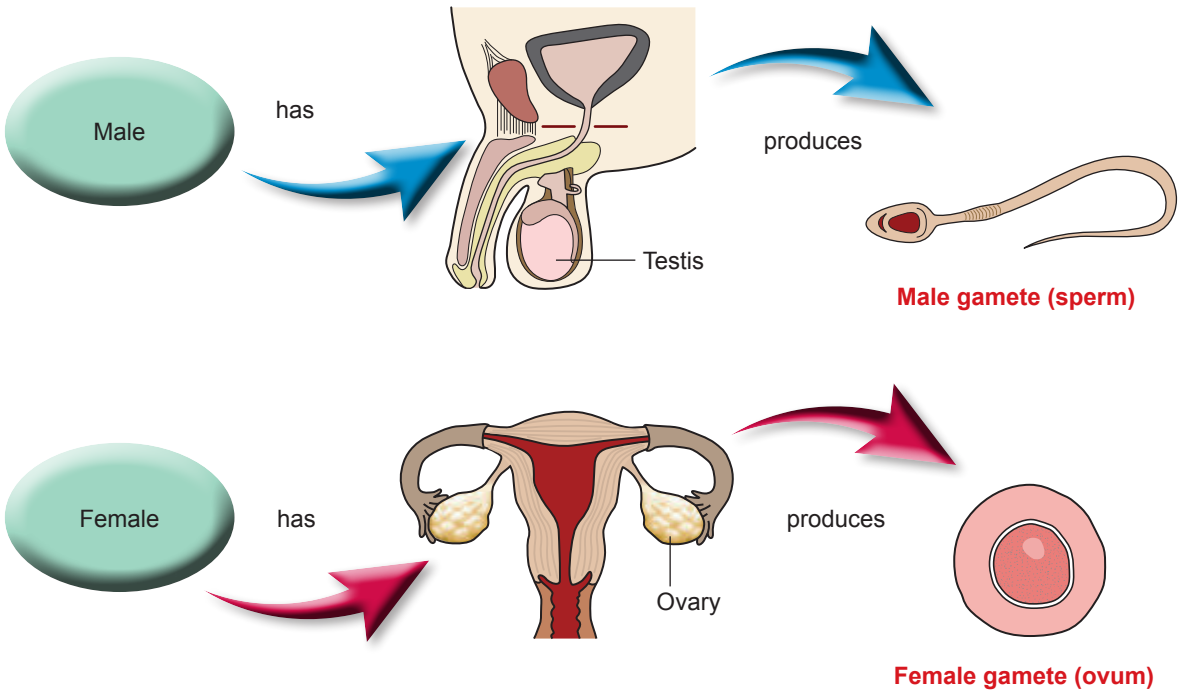


Figure 4.1 *Process of gamete production*

Sexual reproduction produces a new generation that is different from its parents and shows genetic variation. Do you know how a new generation is formed? What causes the formation of babies in the body of pregnant mothers? The first process involved is known as **fertilisation**.

There are two types of sexual fertilisation which are **internal fertilisation** and **external fertilisation**. The differences between internal and external fertilisation are summarised in Table 4.1.

Table 4.1 *Differences between internal and external fertilisation*

Internal fertilisation	Characteristics	External fertilisation
Nucleus of the male gamete fuses with the nucleus of the female gamete **inside** the body of the female parent.	Happens when	Nucleus of the male gamete fuses with the nucleus of the female gamete **outside** the body of the female parent.
The male parent releases sperm into the body of the female parent.	Place of fusion	The male parent releases sperm and the female parent releases ovum. This fertilisation occurs in the water.
The male gamete from the male reproductive organ will be released into the female reproductive organ which has the female gamete and fuses to form a zygote.	Process	The male gamete usually swims towards the ovum and fuses with it.

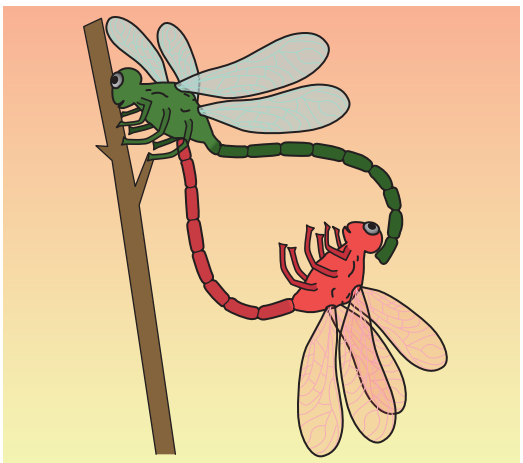


Figure 4.2 *Internal fertilisation of dragonflies*

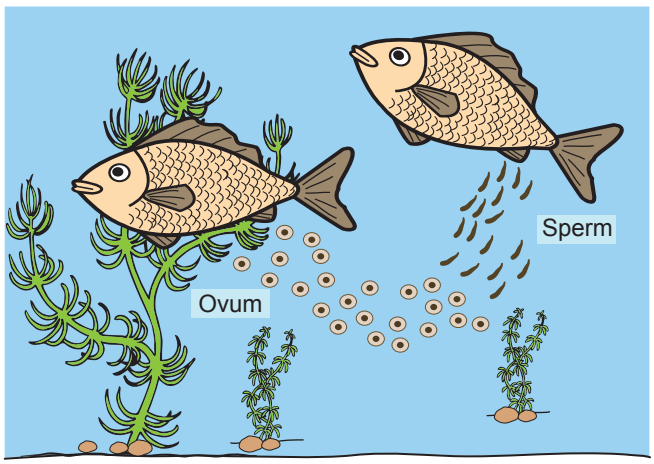
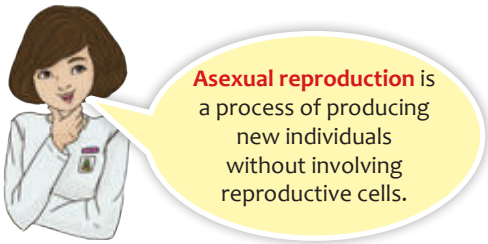


Figure 4.3 *External fertilisation of fish*

Brain Teaser

Why do fish ova have a layer of gel coating?

Asexual Reproduction



Asexual reproduction occurs in simple organisms like *Amoeba*, *Paramecium* and *Hydra*. Plants like onion, ginger and potato also reproduce asexually.

For asexual reproduction, only **one parent** is involved. Fertilisation does not occur in asexual reproduction. The new individuals produced are genetically identical to their parents. Variations do not occur among the new individuals. Various types of asexual reproduction is explained in Figure 4.5.

Tissue culture
www.isaaa.org

Science Exploration

Tissue culture is an example of biotechnology that produces new individuals. This technique produces new plants in a short time.

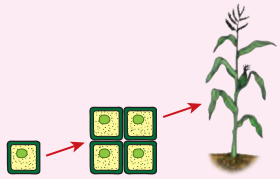


Figure 4.4 *Tissue culture*

Activity 4.1

Aim: To gather and interpret information about sexual and asexual reproductions

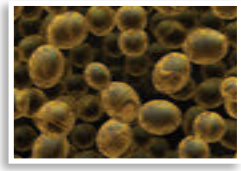
Instruction

1. Work in groups.
2. Discuss the differences and similarities between internal and external fertilisation.
3. Record your discussion in a table as below.

Internal fertilisation	Characteristics	External fertilisation

4. Collect information from the Internet on the following types of asexual reproductions:
   (a) binary fission
   (b) budding
   (c) spore formation
   (d) vegetative reproduction
   (e) regeneration

Bacteria



Yeast

Asexual Reproduction

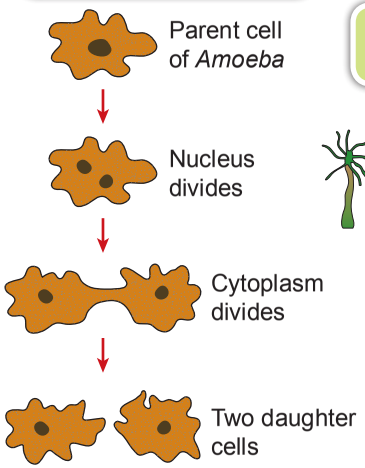
Fern

Carrot

Binary fission

- Binary fission is the division of a single parent cell into two daughter cells.

Examples:
Amoeba, *Paramecium* and bacteria

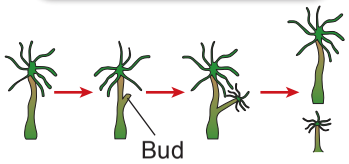


Binary fission of Amoeba

Budding

- Budding is the process of forming a bud on the organism's body.
- A bud starts off as a swelling. Then, it develops and breaks off as a new young.

Examples:
Hydra and yeast

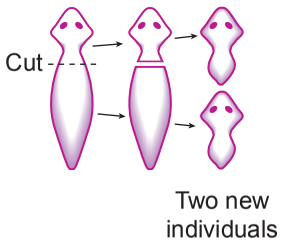


Budding of Hydra

Regeneration

- Regeneration occurs from the ability of the fragments of some organisms to grow and develop into completely new individuals.

Examples:
Flatworm, starfish and *Planaria*

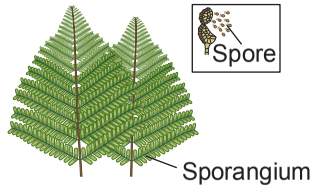


Regeneration of Planaria

Spore formation

- Spore formation is the process of producing spores in the sporangium.
- After the sporangium breaks, the tiny and light spores get scattered by the wind.
- When they land on a moist place, they grow into new plants.

Examples:
Algae, fungus, fern and bacteria

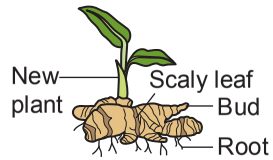


Spore formation of ferns

Vegetative reproduction

- Vegetative reproduction is a method of producing new plants from a vegetative part of a plant except the flower.
- Example of vegetative parts are the roots, underground stems, runners, bulbs and leaves.

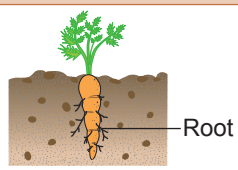
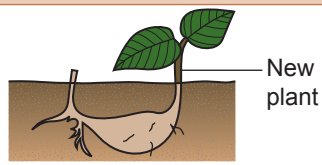
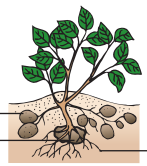
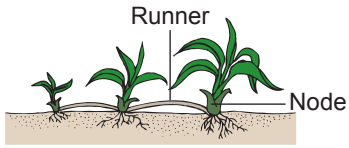
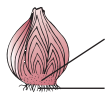
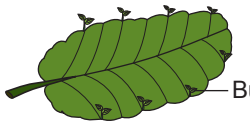
Examples:
Carrot, strawberry, ginger, yam and potatoes



Vegetative reproduction of ginger

Figure 4.5 *Asexual reproduction*

Vegetative Reproduction

Vegetative part	Example of plant
Root • Roots of parent plant will grow into new plants.	 Carrot  Sweet potato
Stem • Stems of parent plant will grow into new plants.	(a) Underground stem  Potato (b) Runner  Grass (c) Bulb  Onion
Leaf • Leaves of parent plant will grow into new plants.	 *Bryophyllum*  *Begonia*

The Importance of Reproduction

All living organisms reproduce to produce new individuals. What would happen if a living organism does not reproduce?

Reproduction is very important to **increase** the number of organisms of the species. The failure of an organism to reproduce can cause **extinction**. What are the other importance of reproduction?

Reproduction increases the number of individuals of the same species

Reproduction transfers the genetic information to the new generation

Photograph 4.5 *Importance of reproduction*

I incubate my eggs and take care of my offsprings to ensure my species keep on living.

Brain Teaser

Predict what would happen to humans if the extinction of animal and plant species increases?

Be Grateful for the Ability to Reproduce and the Continuation of Life as a Gift from God

Baby dumping cases have been increasing tremendously day by day. Do you know that the ability to reproduce is a gift from God which has to be appreciated? Baby dumping is a barbaric act and should not happen. The babies born are the descendants of the human species.

Activity 4.2

21st Century ICS

Aim: To discuss the importance of reproduction and the problems that will arise if reproduction decreases for all living things.

Instruction

1. Work in groups.
2. Each group has to collect information on the importance of reproduction and the problems that will arise if an organism does not reproduce.
3. Present your discussion using a multimedia presentation.

Formative Practice 4.1

1. What are the differences between sexual and asexual reproduction?
2. State the parts of the following plants that reproduce vegetatively.
   (a) Onion (c) Ginger (e) Potato
   (b) Yam (d) Lallang (f) *Bryophyllum*
3. What is the importance of reproduction to living things?

4.2 Human Reproductive System

Let's learn

- Identify the structures and function of the male and female reproductive systems.
- Communicate about the physical changes that occur during puberty.
- Compare and contrast the male gamete with the female gamete in the reproductive system.

Humans reproduce sexually. The human reproductive system consists of the male and female reproductive system. What are the organs involved in both systems?

Both the male and female reproductive systems are very important. Married couples cannot produce offsprings if any of their reproductive system malfunctions. Let us study the structure of the male and female reproductive systems.

Male Reproductive System

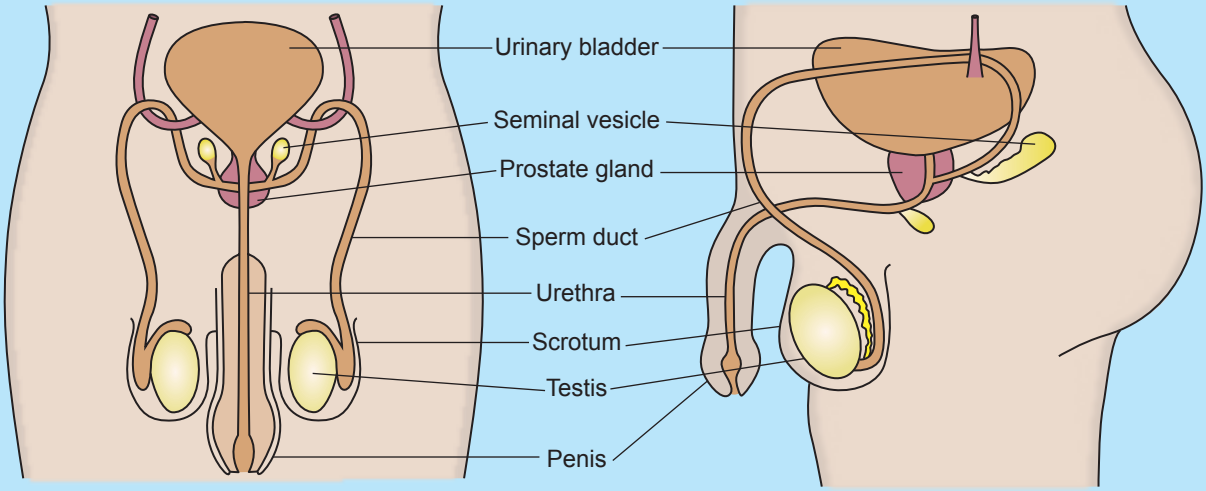


Figure 4.6 *The front view of male reproductive system*

Figure 4.7 *The side view of male reproductive system*

Table 4.2 *Parts and functions of the male reproductive system*

Part	Function
Seminal vesicle	Secretes nutritional fluid for the sperms
Urethra	A channel to discharge sperms and urine from the body
Sperm duct	Transports sperms from the testis to the urethra inside the body
Penis	Transfers sperms into the vagina of the female during copulation
Scrotum	Holds and protects the testes
Testis	Produces male gametes (sperms) and male sex hormones
Prostate glands	Secrete fluid which contains nutrients and protects sperm cell.

Female Reproductive System

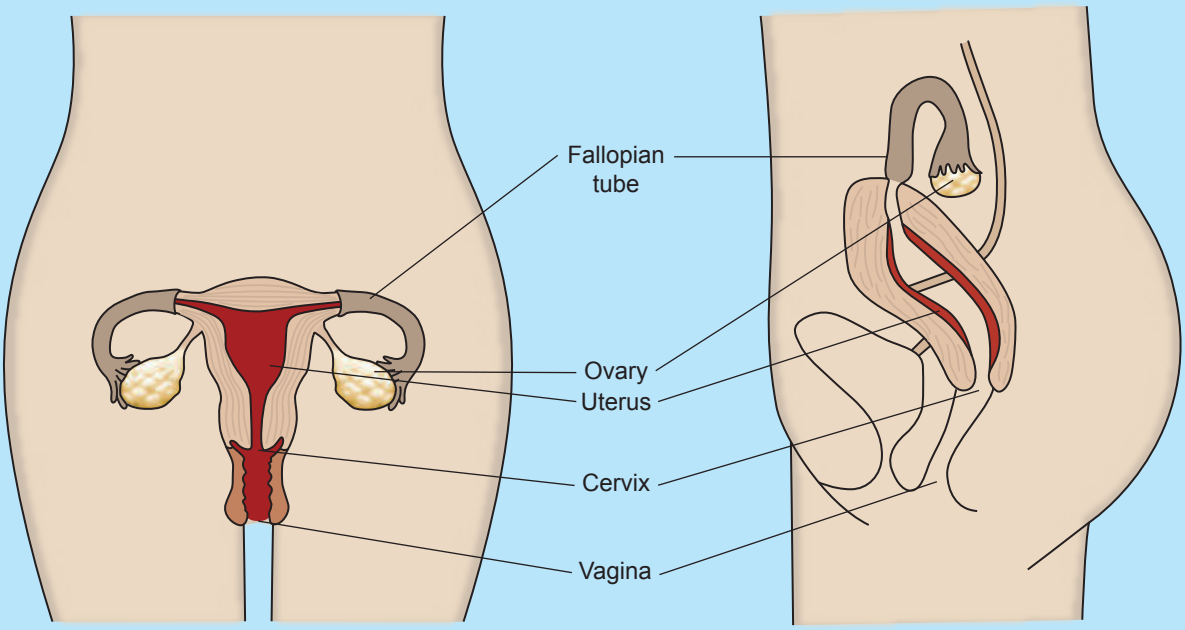


Figure 4.8 *The front view of female reproductive system*

Figure 4.9 *The side view of female reproductive system*

Table 4.3 *Parts and functions of the female reproductive system*

Part	Function
Fallopian tube	Place where fertilisation between sperm and ovum occurs
Ovary	Produces female gamete (ovum) and female sex hormones
Uterus (womb)	Place where the embryo develops and grows
Cervix	Produces mucus to enable sperms to swim into the uterus
Vagina	Receives sperms and as a channel through which a baby is born

Activity 4.3

Aim: To observe the structures and function of the reproductive system.

Instruction

1. Work in groups.
2. Observe the structures of the male and female reproductive systems from the Internet.
3. Draw and label the male and female reproductive organs on a manila card.
4. Present your drawing in class.
5. Display your work at the science corner of your class or in the laboratory.

Physical Changes that Occur During Puberty

Puberty is the early stage of the maturity of the reproductive system. Adolescents who have reached puberty will experience growth and change emotionally, physically and physiologically.

Science in Life

Figure 4.10 *Puberty causes changes in individuals*

Boys reach puberty at approximately 14-17 years old. Meanwhile, girls reach puberty earlier than boys, which is 10-12 years old. What are the changes that occur to boys and girls when they reach puberty?

Male

Voice
- Vocal cord (larynx) enlarges
- Voice becomes deeper

Body
- Moustache and beard begin to grow
- Hair grows on the face, armpits and chest

Reproductive organs
- Testes produce sperms and sex hormones
- Hair grows at pubic region
- Penis and scrotum enlarge

Female

Body
- Breasts grow
- Hips become firm and broader
- Hair grows on the armpits

Reproductive organs
- Ovaries produce ova and sex hormones
- Hair grows at pubic region
- Menstrual cycle begins

Figure 4.11 *Changes that occur during puberty*

Activity 4.4

Aim: To discuss the changes that occur during puberty.

Instruction

1. List the physical changes that occur during puberty.
2. Is it normal if an 18-year-old girl still has not had her menstruation yet? Explain your answer.
3. Suppose that you work as a magazine editor for an advice column. A teenager wants your advice on a serious acne problem. What advice will you give to him/her?

Comparison between the Male and Female Gametes

You have learned from the previous subtopic that sperm is a male gamete or male reproductive cell, while ovum is the female gamete or female reproductive cell. **Sperm** is the **smallest cell** in the male's body and its shape is like a tadpole. **Ovum** is the **largest cell** in the female's body. Figure 4.12 shows the structures of sperm and ovum.

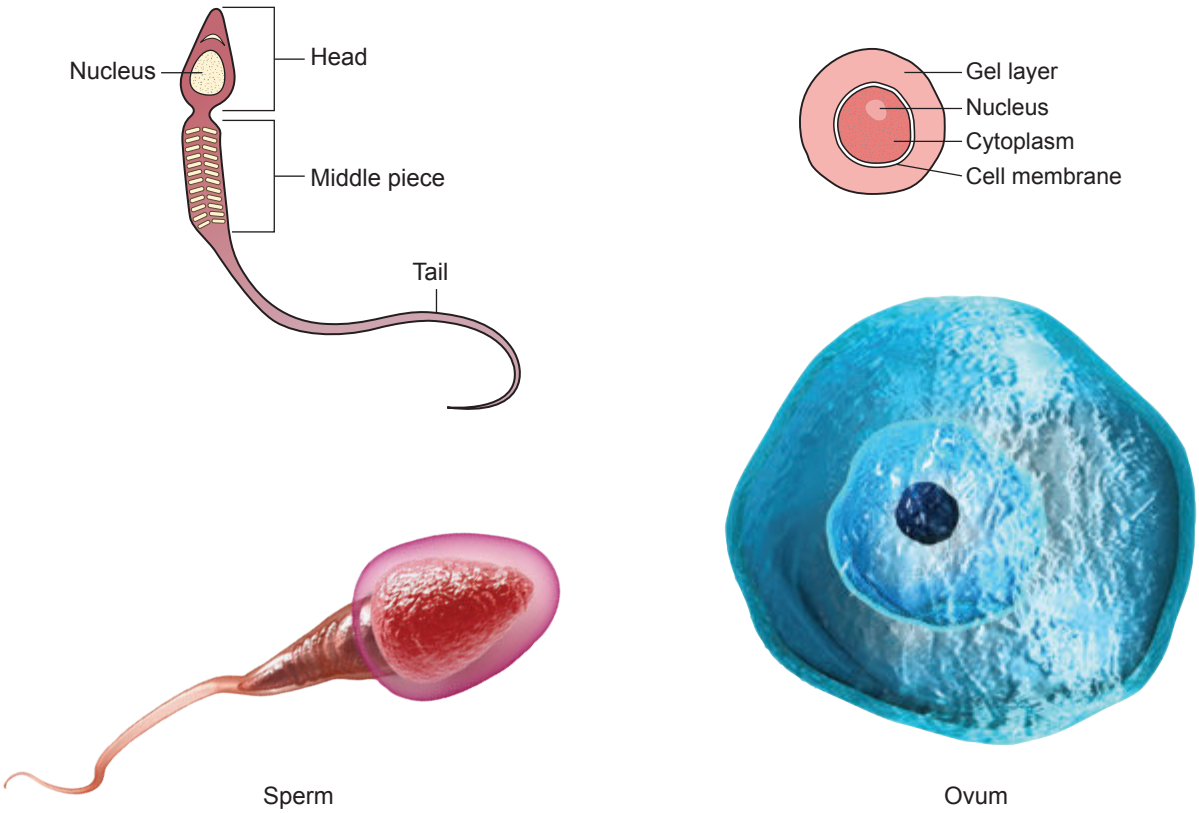


Figure 4.12 *The structures of a sperm and an ovum*

The head of a sperm contains nucleus that carries genetic and hereditary information to be transferred to the offspring. The tail enables the sperm to move or swim in the semen inside the vagina, uterus and Fallopian tube of the female reproductive system. The normal number of sperms released is 60 million per cubic centimetre.

Ovum is spherical in shape with a diameter of about 0.1 mm. The nucleus contains genetic and hereditary information to be transferred to the offspring. The ovum is not able to move by itself. A normal woman usually produces one ovum per month. Figure 4.13 shows the comparison between sperm and ovum.

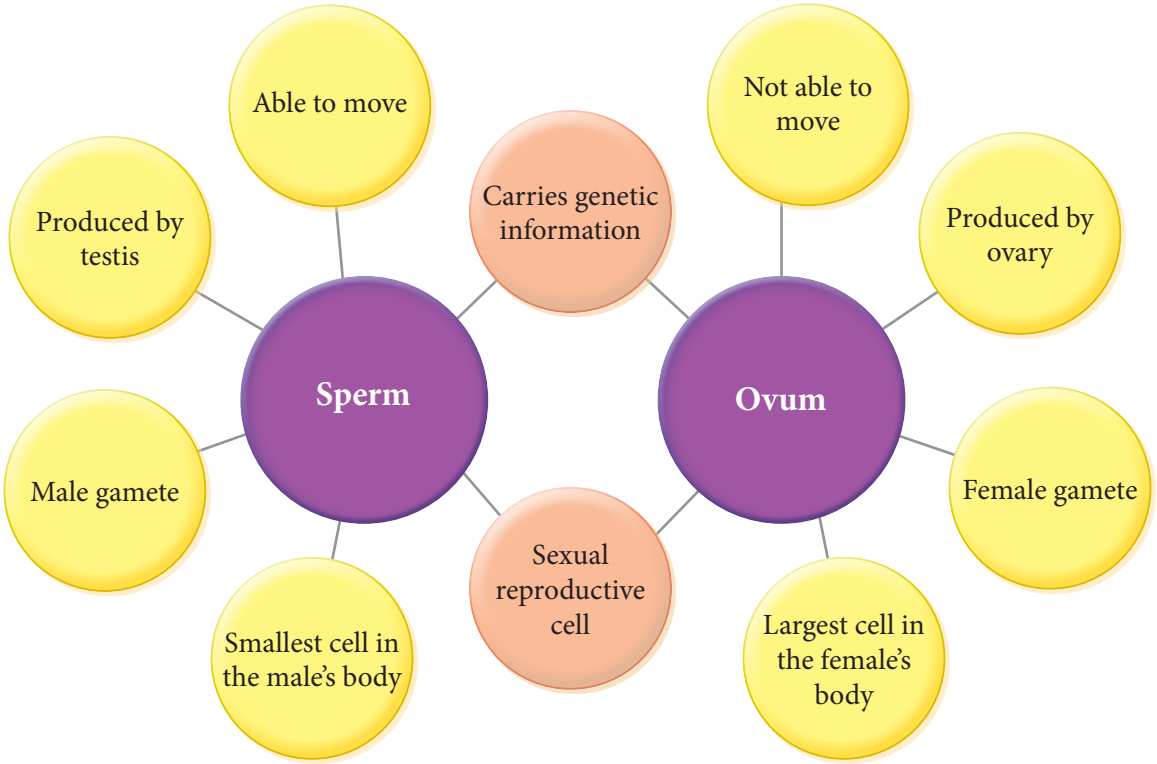


Figure 4.13 *Comparison between sperm and ovum*

Science Exploration

Ovum can live up to two days after being released from the ovary while sperms can live up to three or four days.

Brain Teaser

If a woman releases her ovum every 28 days for 35 years, how many ova has she released? Show your calculation.

Formative Practice 4.2

1. What is the importance of the reproductive system to males and females?
2. State the functions of the urethra, penis and scrotum in the male reproductive system.
3. State the functions of the Fallopian tube, vagina and uterus in the female reproductive system.
4. What is meant by puberty?
5. During puberty, teenagers will encounter body odour problem. Explain how this problem occurs.
6. If a woman's ovaries are damaged, can she still get pregnant? Explain your answer.

4.3 The Menstrual Cycle

Let's learn

- Communicate about the menstrual cycle and the sequence of changes in the uterus lining during menstruation.
- Relate the fertile phase of the menstrual cycle to the process of fertilisation.
- Justify the importance of personal hygiene during menstruation.

Women will undergo menstruation when they reach puberty. Menstruation marks the beginning of the menstrual cycle for each woman. **Menstruation** is the breakdown of the lining of the uterine wall and discharge of blood through the vagina. Menstrual cycle refers to a series of changes that occurs in the uterine wall and the ovaries. Menstrual cycle also involves the formation and release of mature ovum.

Science Exploration

The menstruation of a female will stop when she reaches menopause which is around 48 – 55 years old.

Menstrual cycle is controlled by the brain and endocrine system which secretes hormone. Normally, a menstrual cycle lasts for 28 days and it differs for each individual. There are various factors that affect the menstrual cycle such as nutrient intake, abrupt change in body weight, emotional changes and mental pressure. Figure 4.14 shows the phases in the menstrual cycle.

Menstruation
www.ubykotex.com/en-us/periods

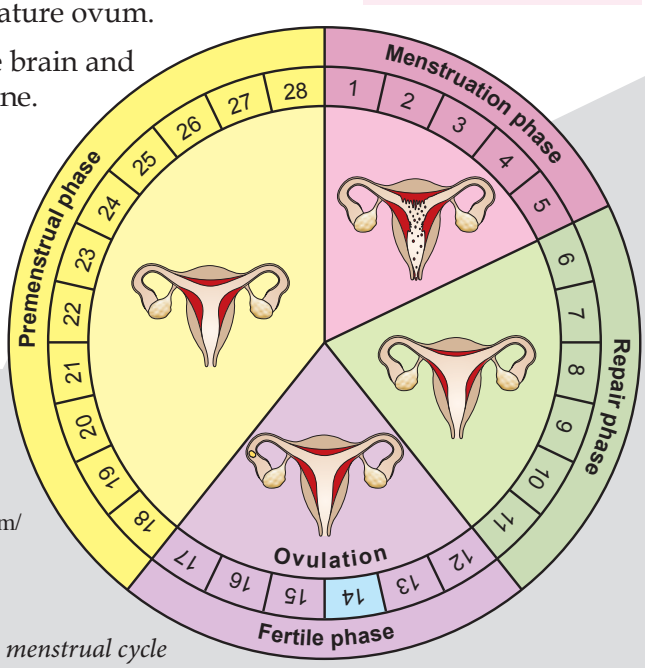
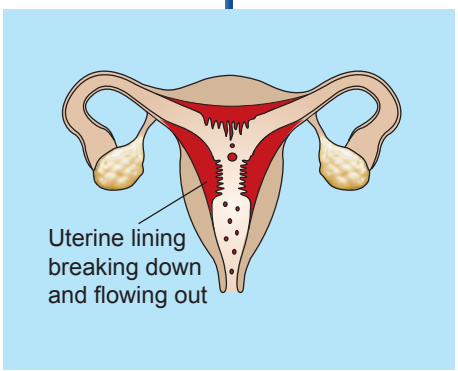


Figure 4.14 *The menstrual cycle*

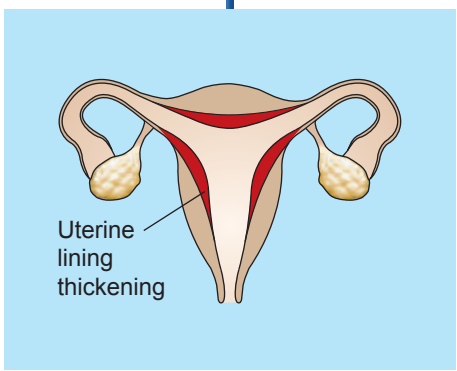
Day 1 – 5

Menstruation phase
The uterine lining breaks down as menstruation begins and is discharged together with blood, unfertilised ovum and mucus.



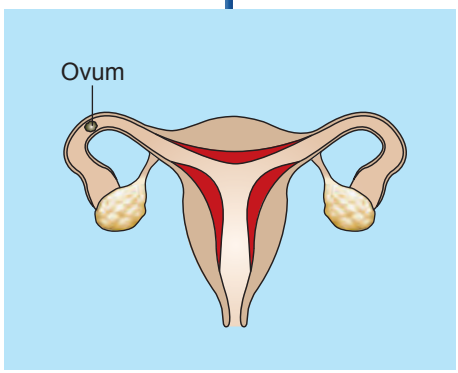
Day 6 – 11

Repair phase
Uterine lining starts to rebuild and thicken. Blood vessels in uterine lining are formed and ready to receive the implantation of fertilised ovum.



Day 12 – 17

Fertile phase
An ovum is released from the ovary on the 14th day of the menstrual cycle (ovulation). The uterine lining continues to thicken. Fertilisation is likely to occur if sperms are present.



Day 18 – 28

Premenstrual phase
The uterine lining continues to thicken and becomes richly supplied with blood vessels. Implantation of an embryo is ready if fertilisation occurs. The menstrual cycle will repeat if fertilisation does not occur.

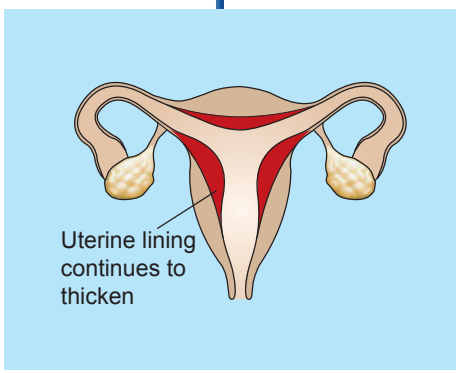


Figure 4.15 *The phases in the menstrual cycle*

Importance of Personal Hygiene During Menstruation

Personal hygiene during menstruation is very important to ensure the reproductive system is not infected with microorganisms like bacteria, virus and fungi. How do you manage your personal hygiene during menstruation? Figure 4.16 shows the ways of practising good personal hygiene during menstruation and their importance.

Urinary Tract Infection (UTI)
http://www.dettol.com.my/my/illnesses/urinary-tract-infections/

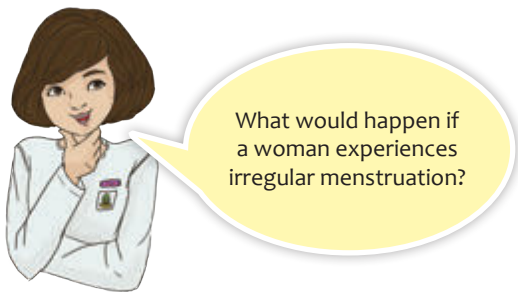
Change sanitary pad 3-4 times a day

1 During menstruation, a woman must change her sanitary pad 3-4 times a day to prevent the infection of bacteria and virus that might cause urinary tract infection (UTI).

Clean your body

2 A menstruating woman is encouraged to bathe frequently to clean her body.

Figure 4.16 *The importance of personal hygiene during menstruation*



An irregular menstruation refers to a condition where a woman does not experience menstruation every month, has too long or too short menstrual cycles. Irregular menstruation might be caused by several factors such as an increase in body weight, hormonal imbalance, emotional disruption, excessive exercise and can also be caused by cervical tumour.

Brain Teaser

Why does the emotional state of a woman affect her menstrual cycle?

Irregular menstruation can cause negative effects to a woman's health. Some of the negative effects of irregular menstruation to woman are:

1. **Infertility** – Irregular menstrual cycle is an early sign of having reproductive system problems. A late treatment can cause serious health problems such as ovarian cancer, cervical cancer and uterus cancer.
2. **Having difficulties in family planning** – Irregular menstrual cycle causes a woman to have difficulties in determining her fertile day. Hence, it is hard to plan a pregnancy.
3. **Health problems such as anaemia** – Irregular menstrual cycle can cause a long menstruation. This causes an excessive loss of blood. The body becomes weak and the woman faints easily.

Formative Practice 4.3

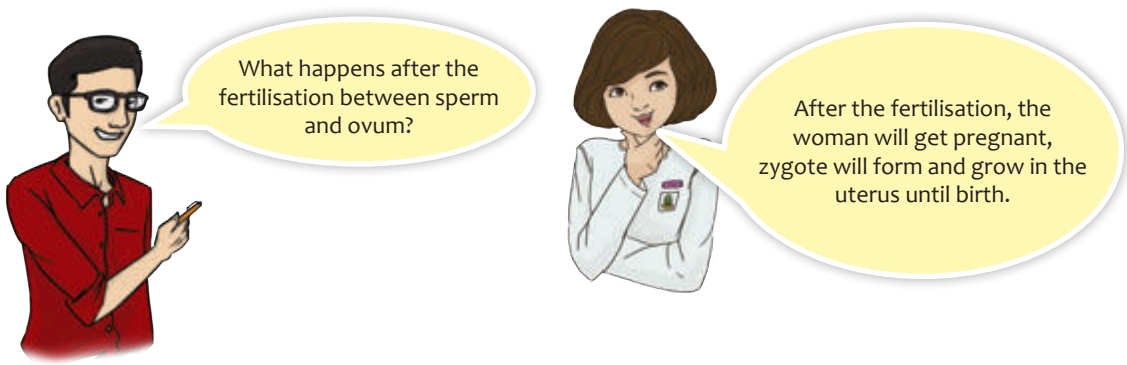
1. Explain the phases of menstrual cycle.
2. At what age does a woman start to experience menstruation and how long does it last?
3. What is ovulation and where does ovulation normally occur?
4. Is it true that you cannot wash your hair, drink cold water, eat ice cream or play sport during menstruation? Explain your answer.

4.4 Fertilisation and Pregnancy

Let's learn

- Communicate about the process of fertilisation and the implantation of embryo.
- Justify the importance and functions of placenta and umbilical cord.
- Describe the development of a zygote into an embryo and subsequently into a foetus during pregnancy until birth.

You have learned in subtopic 4.1, that fertilisation is a fusion between sperm and ovum. What happens after fertilisation?



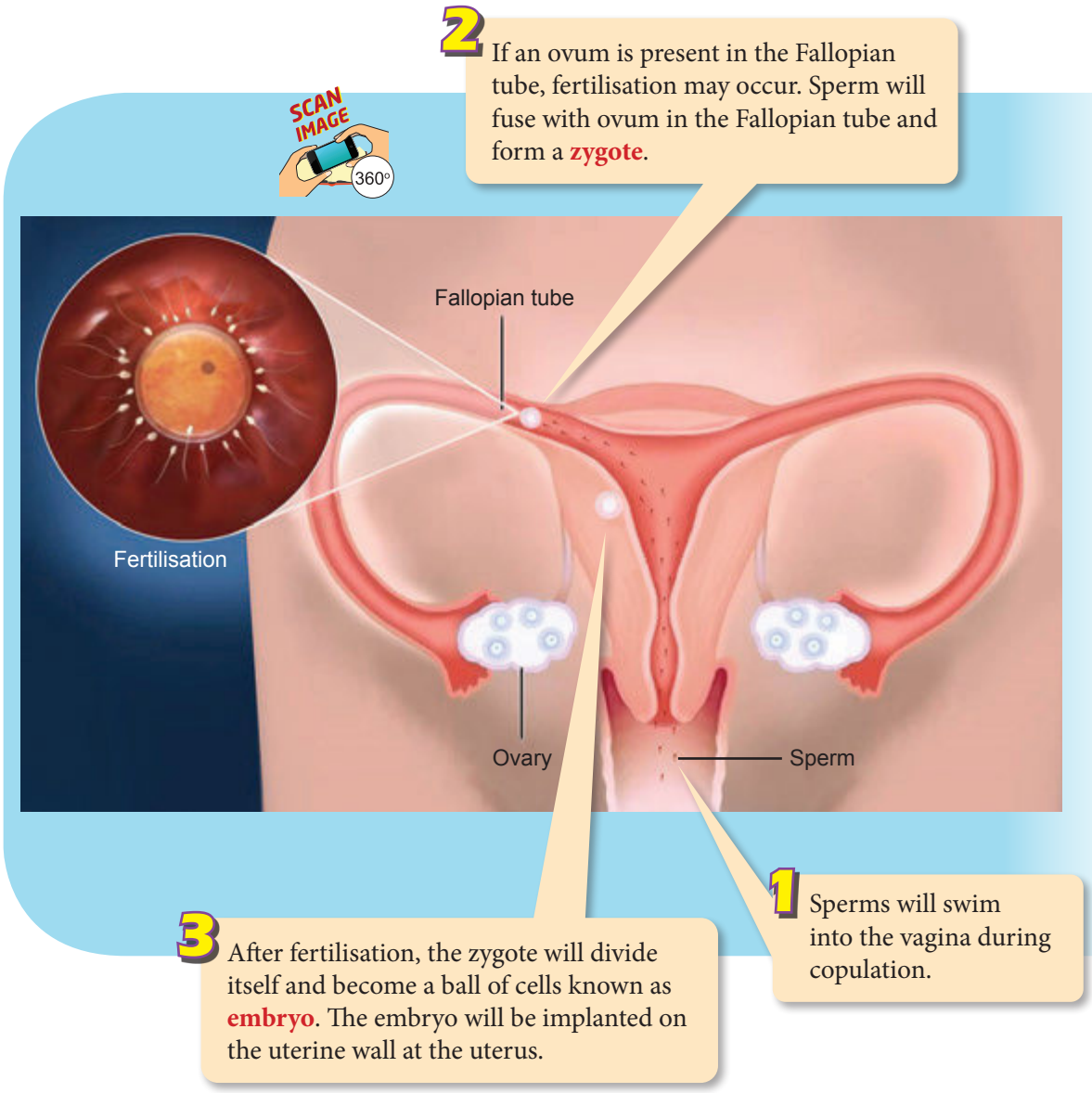
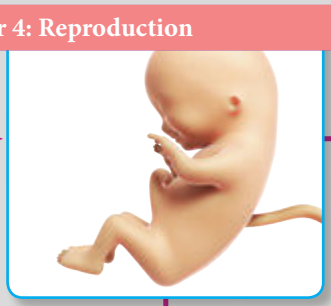


Figure 4.17 *The process of fertilisation and embryo implantation*

The implanted embryo will grow and become a foetus that resembles a human (baby). This process is known as **pregnancy**. After approximately 38 weeks, the foetus will be born. Figure 4.18 shows the development of zygote to embryo until birth.

Week 1 – 4
- Hands and feet will start to form.
- The **embryo** has a tiny tail.

Week 7-9
- Nose, ears and fingers will be visible.



Week 10-19
- Embryo will look like a baby.
- The embryo is now known as a **foetus**.

Video on Embryonic Development

Week 20-37
- Foetus will resemble a baby.

Week 38-40
- Foetus is formed completely.
- The foetus turns until the head is engaged at the cervix.
- The muscle of the uterine lining will contract strongly, the amnion will burst and amniotic fluid will be released.
- Foetus is pushed out of the uterus through the vagina and then out of the body.

Figure 4.18 *The growth of zygote to embryo and foetus until birth*

The Importance and Functions of the Placenta and the Umbilical Cord

An embryo grows and develops into a foetus in a sac that is surrounded by a membrane known as amnion. Amnion contains fluid to protect the foetus. How does a foetus obtain nutrients and oxygen inside the uterus? How does a foetus remove its waste?

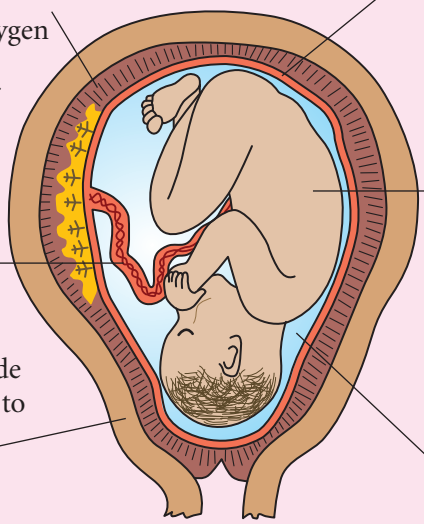
Science Exploration

Amniocentesis test is done to detect a few types of birth defect such as Down syndrome and muscle contraction. An amount of amniotic fluid is taken and tested.

Placenta
- Made up of tissue from both mother and the embryo
- Place where exchange of oxygen and carbon dioxide, supply of nutrients and removal of waste materials through the mother's blood and the foetus occur.

Umbilical cord
- Tube which connects the foetus to the placenta
- There are blood vessels inside the tube to transport blood to and from the foetus

Uterine wall
- Consists of muscular wall
- The place where the embryo is implanted and develops



Amnion
- Membrane that forms a sac and contains fluid

Foetus
- Embryo develops to form a foetus

Amniotic fluid
- Acts as a cushion to absorb concussion and protects the foetus from injuries

Figure 4.19 *Functions of placenta, umbilical cord, uterine wall, amniotic fluid and amnion*

Formative Practice 4.4

1. If embryo implantation occurs on the uterine lining, will menstruation occur?
2. Explain the development of zygote after fertilisation.
3. Complete the flow chart below on the development of zygote.

4. State the functions of amnion, placenta and umbilical cord.

4.5 Factors Affecting the Development of a Foetus and Baby

Let's learn

- Relate the importance of taking nutritious food during pregnancy to the health of both mother and foetus.
- Justify the importance of avoiding the intake of harmful substances to the foetus.
- Justify the benefits of breastfeeding compared to formula milk on the infant's development.
- Realise that every living creature has a right to live even if it is in the womb.

Why is the nutritional requirement between a woman who is pregnant and one who is not pregnant different? You have learned foetus obtains nutrients and oxygen from the mother in subtopic 4.4. A pregnant woman must have a healthy and balanced diet and take good care of her health to deliver a healthy baby. The calorie requirement for a pregnant woman is higher. Figure 4.20 shows the daily calorie requirement of a pregnant woman.

Figure 4.20 *Daily calorie requirement of a pregnant woman*

The intake of nutrients by a pregnant woman must be balanced and contain more carbohydrate, fat, protein, folic acid, vitamin C, calcium, phosphorus, iron and fibre. Each of the nutrients plays a vital role for the health of the mother and her baby. Figure 4.21 shows the nutrients which are needed by a pregnant woman.

Fibre
- Examples: cereal, vegetables and fruits
- Function: prevents constipation

Iron
- Examples: liver, red meat and fish
- Function: formation of haemoglobin to prevent anaemia

Carbohydrate and fat
- Examples: rice, bread, butter and cheese
- Function: provide energy for daily activities

Vitamin C
- Examples: citrus fruits, guava and tomatoes
- Functions: for skin health of foetus and mother and to prevent bleeding gums

Folic acid
- Examples: broccoli, spinach and groundnuts
- Function: important for the nervous system development of the foetus

Protein
- Examples: chicken, red meat, fish, milk and cheese
- Function: important for the growth of new cells of the foetus

Calcium and phosphorus
- Examples: anchovies, cheese and milk
- Functions: for a healthy formation of foetus bones and to protect the bones and teeth of the mother

Figure 4.21 *Nutrients needed by a pregnant woman*

Pregnant women must not smoke and consume alcohol or drugs. The effects of smoking, alcoholic drinks and drugs on a pregnant woman are explained in Table 4.4.

Table 4.4 *The effects of smoking, intake of alcoholic drinks and drugs on a pregnant woman*

Substance	Effects
Cigarette 	• The baby may have low birth weight • The baby may have a higher mortality rate • The baby may become retarded and have physical disabilities • The baby may be born premature • Miscarriage of foetus may happen
Alcoholic drink 	• The baby may be born with Foetal Alcohol Syndrome • Foetal development may be delayed • The brain, nervous system and the heart may be damaged
Drug 	• Foetal defects may occur

Science Exploration

Characteristics of a baby who suffers from Foetal Alcohol Syndrome:

- born with a low birth weight
- small head measurement
- retarded
- facial abnormalities

Brain Teaser

Why is having frequent x-ray tests not good for a pregnant woman?

Importance of Breast Milk

A newborn baby does not have teeth and cannot eat solid food.

Babies depend solely on milk as their source of nutrients. Breast milk is the best food for them because it is more nutritious compared to formula milk.

- Breast milk contains all the essential nutrients for a baby.
- Breast milk contains antibodies that can protect a baby from certain diseases.
- Relationship between mother and baby will become closer and it is important for the emotional development of the baby.
- Baby who consumes breast milk has better digestion compared to formula milk.

Photograph 4.6 *Breast milk is important for the development of a baby*

Pregnant women must take good care of their health because every living thing has the right to live even though it is still in the womb.

Therefore, a mother must ensure that her baby gets sufficient nutrients and avoid the intake of substances that might harm her own health and her baby.

Photograph 4.7 *A healthy baby is born from a healthy family*

Activity 4.5

21st Century ICS

Aim: To suggest ways to solve problem of abnormality in newborn babies due to the unhealthy lifestyle of pregnant mothers.

Instruction

Read the situation below carefully.

> A pregnant woman practises an unhealthy lifestyle such as smoking, consumption of alcoholic drinks and drugs.

In groups, discuss

(a) the risks towards the baby.
(b) the healthy lifestyle that should be practised by the woman during pregnancy.
(c) suggest ways to reduce the number of abnormal babies born due to the unhealthy lifestyle of mothers during pregnancy.

Formative Practice 4.5

1. Why does a pregnant woman need more nutrients?
2. Why do the teeth and bones of a pregnant woman decay more easily?
3. Compare between breast milk and formulated milk.

4.6 Infertility and Contraception

Let's learn

- Communicate the meaning of infertility and how to overcome them.
- Differentiate methods of contraception.
- Realise the importance of practising frequent health screening and to get immediate treatment for problems related to the reproductive system.
- Criticise the abuse of knowledge on contraception methods and its effect to society.

Infertility

Infertility is the inability to produce offsprings. When a married couple is unable to bear children, the husband or wife or both may be sterile. Figure 4.22 shows the various factors of sterility in males and females.

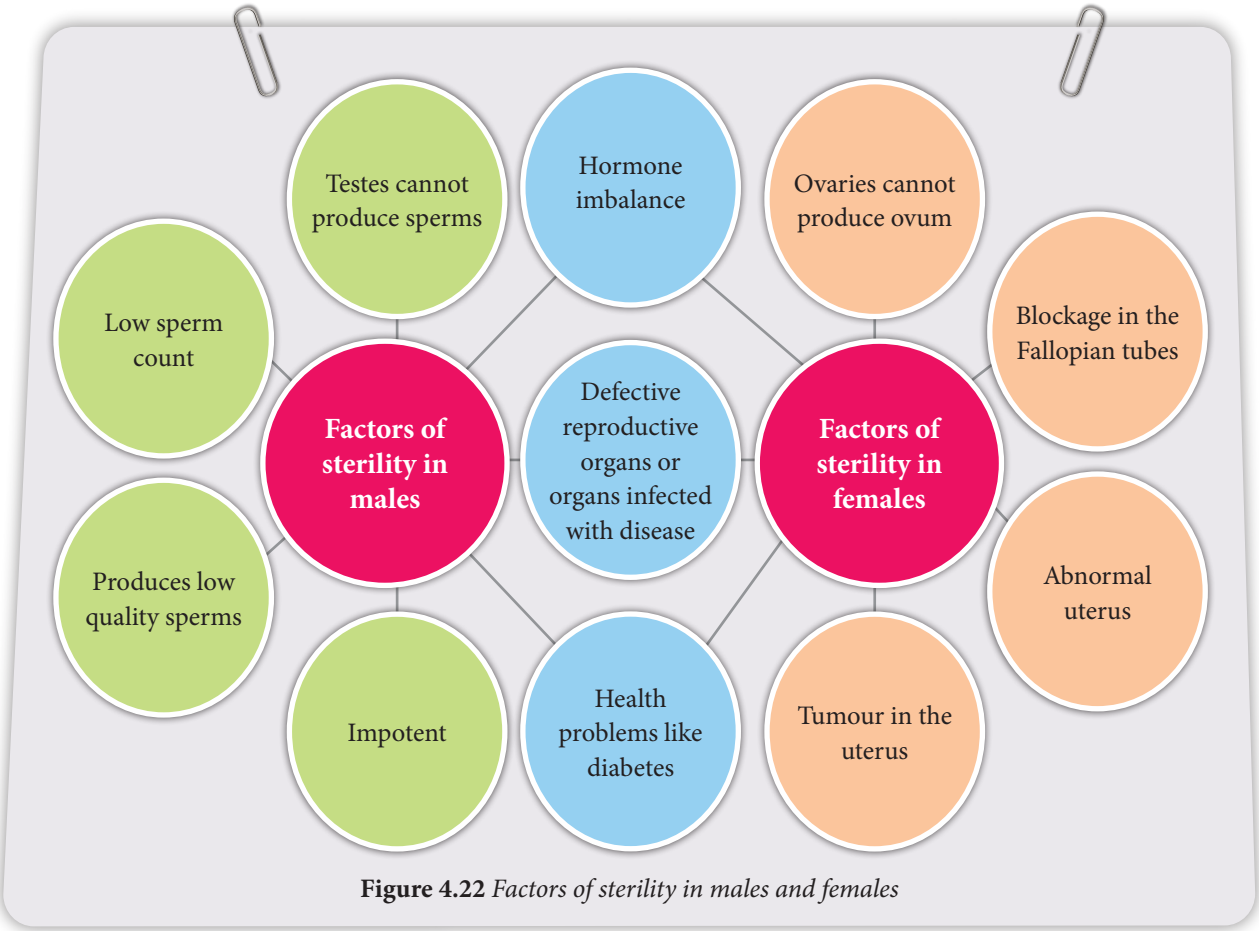


Figure 4.22 *Factors of sterility in males and females*

When the married couple has tried to conceive for more than a year, but they are still not successful, the couple is advised to seek medical consultation.

Figure 4.23 *Scene of a couple consulting a doctor*

Methods to Overcome Sterility

1 Hormone treatment

- This treatment is suitable for individuals who have imbalanced hormone.

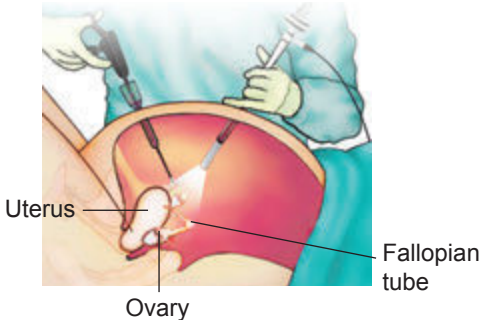
Hormone being injected

2 Surgery

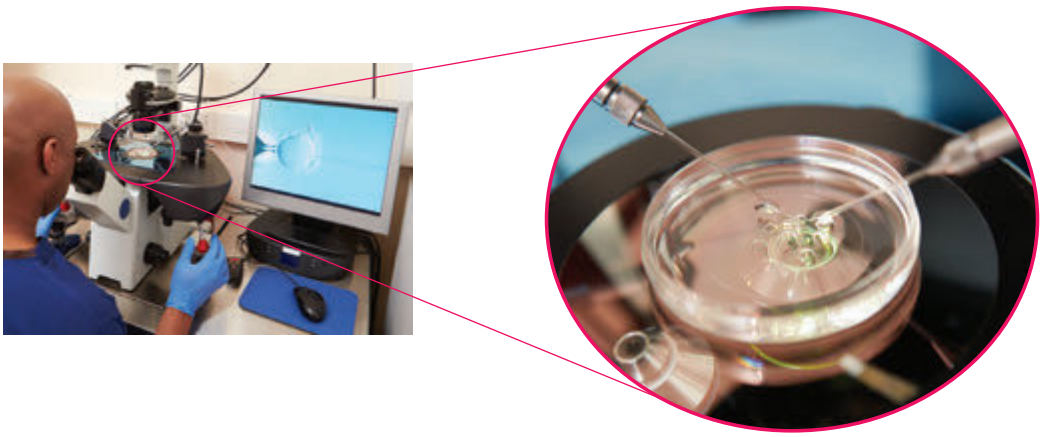
- Surgery is done on women who have blockage in their Fallopian tube or men who have blockage in their sperm duct.

3 *In vitro* fertilisation (IVF)

- This procedure is done on women who have blockage in their Fallopian tube.
- This method takes out the ovum to be fertilised with the sperm outside the body in a glass dish.
- The embryo formed is then put inside the uterus.



Laparoscope surgery for blockage in Fallopian tube

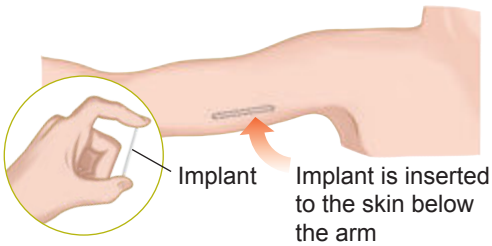


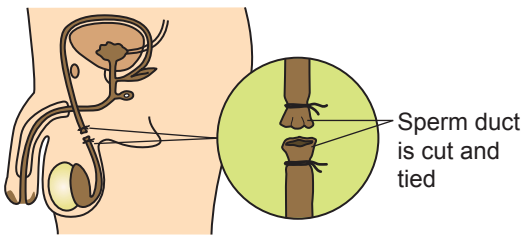
Ovum and sperm are fertilised in a glass dish to form a zygote through in vitro fertilisation

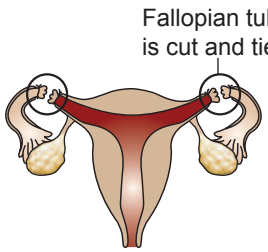
Figure 4.24 *Methods to overcome sterility*

Methods of Contraception

There are several methods of contraception for married couples who want to plan their family as shown in Figure 4.25.

<table>
<tr><th>Contraceptive pills</th><th>Implants</th></tr>
<tr><td>Contraceptive pills can prevent ovulation.
 
Video on artificial methods of contraception
Contraceptive pills</td><td>Implants secrete a hormone that prevent the ovary from producing ovum.
 

Implants</td></tr>
<tr><th>Use of condom</th><th>Intrauterine Contraceptive Device, IUCD</th></tr>
<tr><td>Condom is worn over the penis before copulation to prevent the sperm from entering the vagina during ejaculation.
 
Condom</td><td>This contraceptive device is inserted inside the woman's uterus to prevent implantation.
 
IUCD</td></tr>
<tr><th>Vasectomy</th><th>Ligation</th></tr>
<tr><td> 

Tied sperm duct
Surgery is carried out to cut the sperm duct and the two ends are then tied to prevent the sperms from being transported to the urethra.</td><td> 

Tied Fallopian tube
Surgery is carried out to cut the Fallopian tubes and the two ends are then tied to prevent the ovum from meeting the sperms.</td></tr>
</table>

Figure 4.25 *Methods of contraception*

The Importance of Practising Frequent Health Screening to Get Immediate Treatment for Problems Related to Reproductive System

- Health screening is done as an evaluation to detect early symptoms of chronic diseases.
- Cancer involving reproductive system such as uterine cancer, cervical cancer and prostate cancer can still be treated if it is detected earlier.
- Practising health screening can reduce the risk of health problems which require high-cost treatments.
- The correct and safe contraceptive method can be understood by consulting a doctor during the health screening.

Photograph 4.8 *Health screening*

Activity 4.6

21st Century ICS

Aim: To debate on the abuse of knowledge regarding contraception methods and the effects to society.

Instruction

1. In group, organise a debate competition between the proposition and the opposition regarding the motion below.

   "Birth control should be allowed in our country"

2. Find the information on the motion using reference materials such as magazines, flyers and the Internet to prepare for the debate.
3. Carry out the debate.
4. After the debate, summarise the main points from the speeches.

Formative Practice 4.6

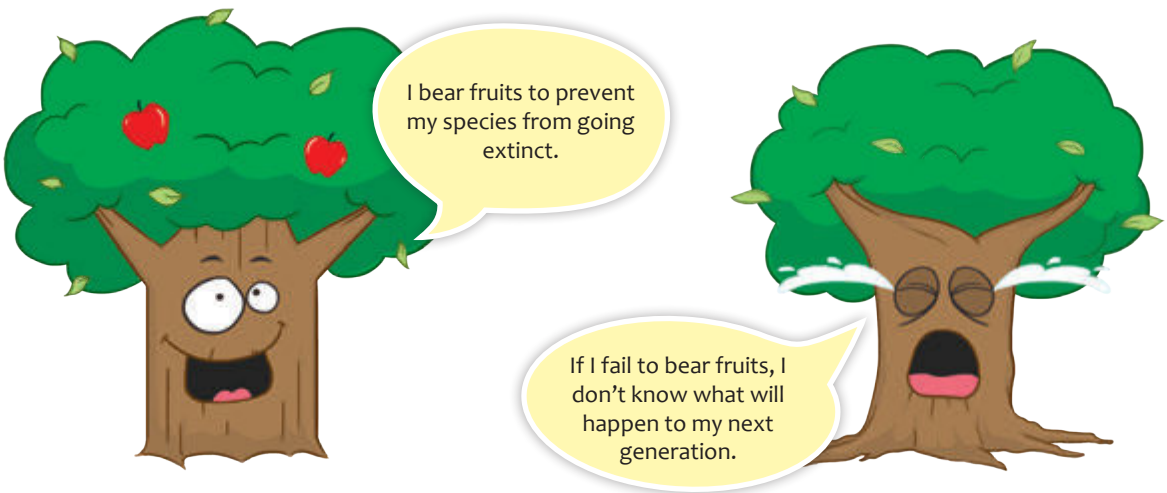
1. List four factors of sterility in males and females.
2. What methods can be used to help a married couple to have a child if
   (a) the husband is sterile?
   (b) the wife has a blockage in her Fallopian tubes?
3. Explain vasectomy and ligation method.
4. What is meant by test tube baby?
5. State two importance of practising frequent health screening for an individual.
6. Abortion should not be the method to prevent birth. Give your opinion.

4.7 Plant Reproduction

Let's learn

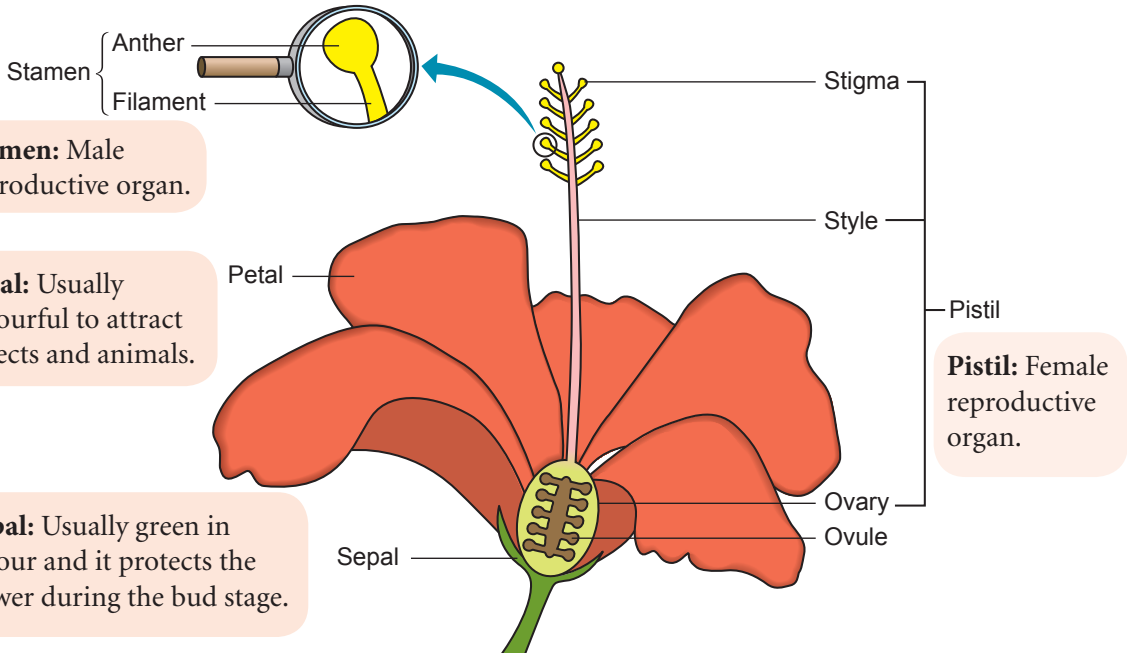
- Communicate about the structure and function of each part of a flower.
- Justify the pollination process.
- Describe the process of fertilisation and explain the formation of seeds and fruits in plants.
- Describe the germination process of a seed.
- Solve problems if germination does not occur.

Just like any other living things, plants also need to reproduce to ensure their survival. All living things will undergo growth and finally die. They have to be replaced with new organisms.



Structure and Function of Each Part of a Flower

Have you ever observed a flower? If you remove the petals, what are the other parts of the flower that you can observe? What are their names and functions? Figure 4.26 shows a longitudinal section of a flower and its function.



Stamen: Male reproductive organ.

Petal: Usually colourful to attract insects and animals.

Pistil: Female reproductive organ.

Sepal: Usually green in colour and it protects the flower during the bud stage.

Figure 4.26 *Longitudinal section of a flower and its functions*

Activity 4.7

Aim: To examine different types of flowers to identify their structures and functions.

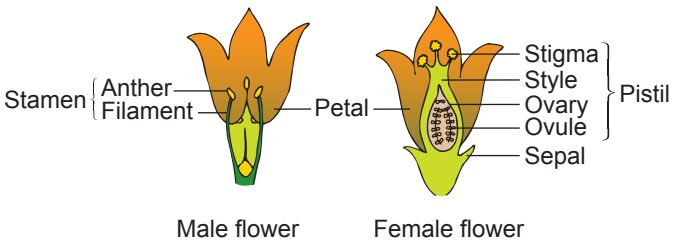
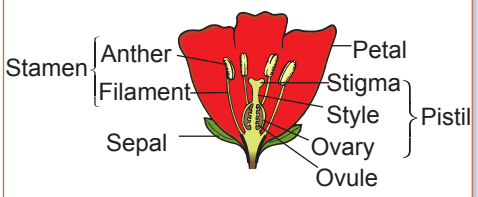
Instruction

1. Find a few types of flowers in your school compound.
2. Dissect your specimens. Identify the following parts:
   (a) flower petal and sepal.
   (b) male reproductive organ.
   (c) female reproductive organ.
3. Draw and label the structures of the flowers that you have observed.
4. Display your drawing with labels on the notice board in your class.

Pollination

There are two types of flowers, **bisexual** and **unisexual flowers**. Most flowers are bisexual because they have both male (stamen) and female (pistil) reproductive organs in the same flower. Unisexual flowers are incomplete because they only have stamen or pistil.

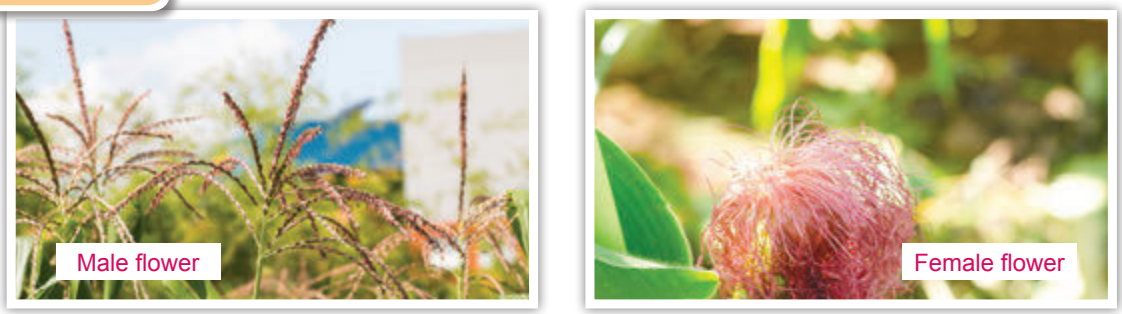
Table 4.5 *Types of flower*

Unisexual	Bisexual
	

Some examples of unisexual flowers are corn flower and papaya flower, in which only female flowers can produce fruits and seeds. Can you state another example of a unisexual flower?

Papaya plant

Corn plant



Photograph 4.10 *Examples of unisexual flowers*

The **pollination** is the process of transferring matured pollen grains from anther to stigma. The matured anther will burst and spread the pollen grains. Some pollen grains might fall on soil and some are brought by pollinating agents to the stigma of a flower. Pollination is divided into two, self-pollination and cross-pollination as shown in Figure 4.27.

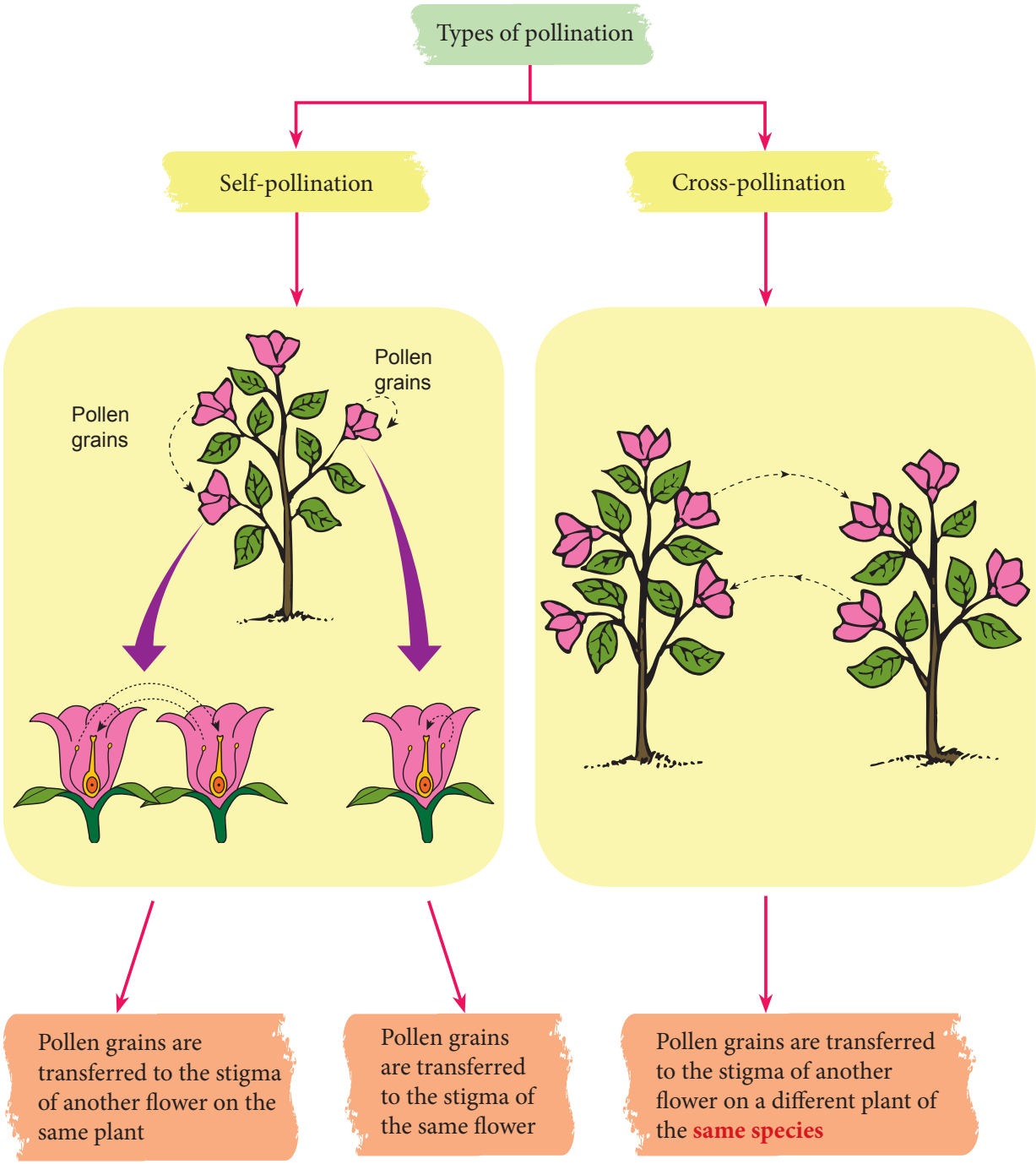


Figure 4.27 *Types of pollination*

Activity 4.8

Aim: To gather and interpret data on pollination

Instruction

1. Surf the Internet and watch an animation on pollination of a flowering plant.
2. Gather the information obtained from websites and other references.
3. Discuss the following matter:
   (a) definition of pollination and types of pollination.
   (b) comparison between self-pollination and cross-pollination.
   (c) advantages of cross-pollination.
   (d) application of cross-pollination in agriculture.
4. Present your discussion in your class.

Pollinating Agents

How do pollen grains from a plant get transferred from the anther to the stigma of the flower? Figure 4.28 shows the transferring process carried out by a pollinating agent.

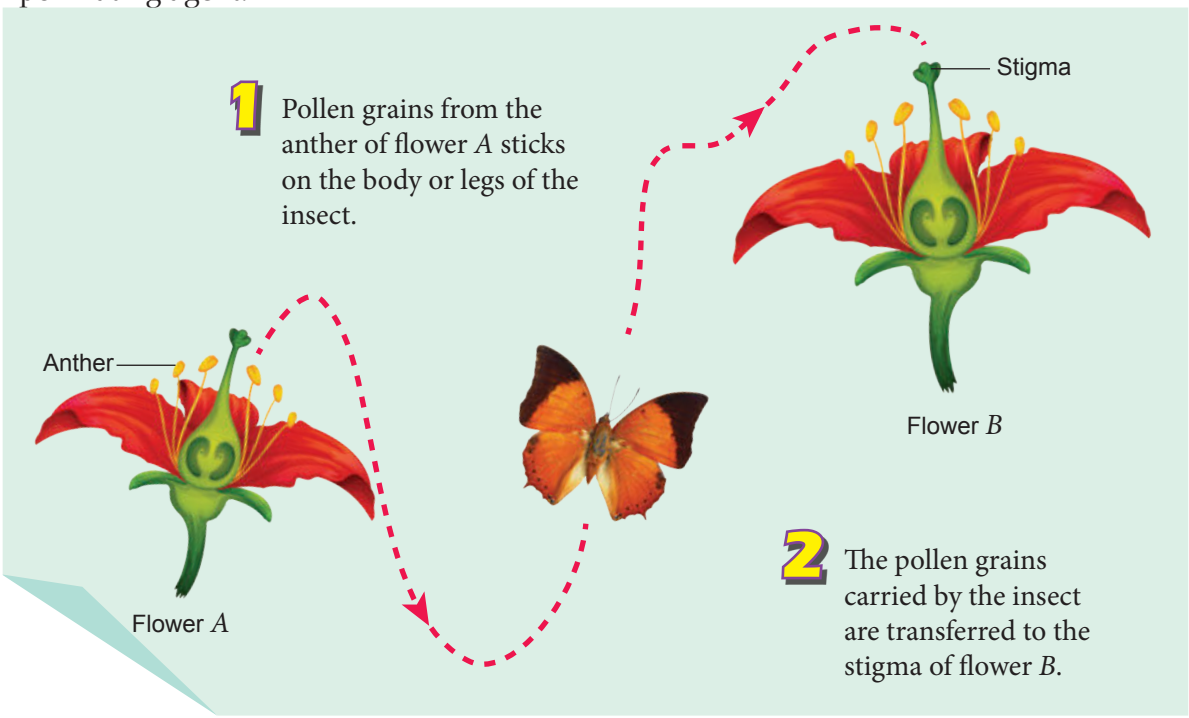


Figure 4.28 *The transferring process of pollen grains by a pollinating agent*

Wind, animals, and insects are pollinating agents that help in the transferring process (Figure 4.29). What are the characteristics of the flower that determine its pollinating agent?

1 Animals and insects

- Pollen grains usually stick on the beak or body of the animal.
- When an insect lands on a flower to suck its nectar, pollen grains will stick to its furry feet and body.
- The characteristics of animal-pollinated and insect-pollinated flowers:
  - have big and colourful petals
  - have nectar and smell nice
  - produce rough and sticky pollen grains
- Examples of animal-pollinated flowers and insect-pollinated flowers are durian, rambutan, papaya, hibiscus, sunflower and rose.

2 Wind

- Light pollen grains are blown by the wind and reaches the stigma of another flower.
- The characteristics of wind-pollinated flowers:
  - have white or pale petals
  - have a long and furry stigma
  - have plenty of small, smooth and light pollen grains
  - have a long filament and style
- Examples of wind-pollinated flowers are corn, grass and paddy.

Figure 4.29 *Pollinating agents and the characteristics of the flowers they pollinate*

The Advantages of Cross-Pollination

Cross-pollination combines genetic materials from two parent plants of the same species. Cross-pollination has many advantages.

Photograph 4.10 *Cross-pollination ensures cross products inherit good characteristics from both parents.*

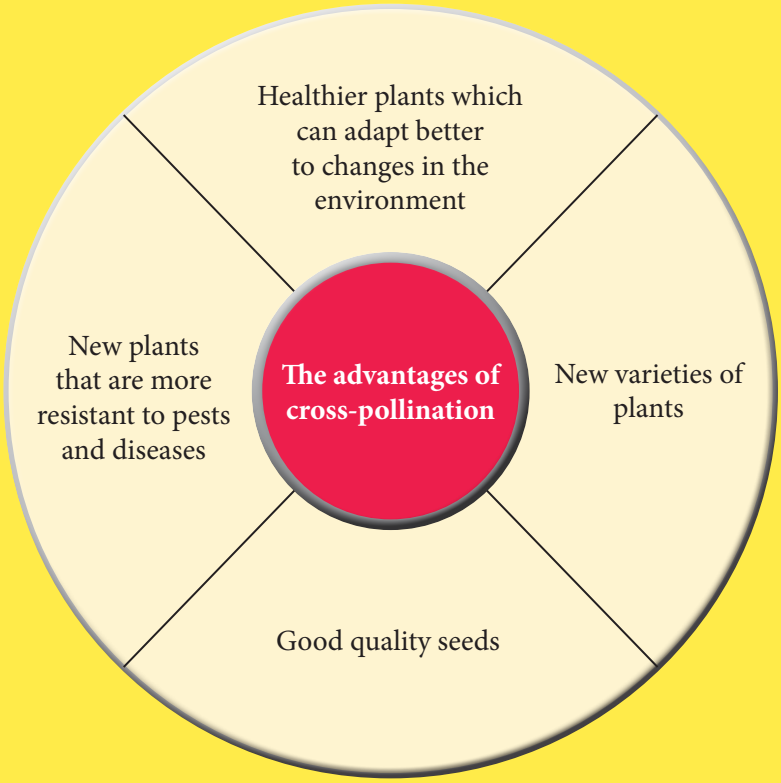


Figure 4.30 *The advantages of cross-pollination*

My Malaysia

Agencies involved in research to improve the quality and quantity of Malaysian agriculture products are:

- Malaysia Agriculture Research and Development Institute (MARDI)
- Malaysia Palm Oil Board (MPOB)

The Innovation of Cross-Pollination in Agriculture

In Malaysia, the application of cross-pollination in agriculture is not something new. This technique has been widely used to produce better crops with higher quality. Examples of innovation of cross pollination in agriculture are summarised in Table 4.6.

Table 4.6 *Innovation of cross-pollination in agriculture*

Plant	Parent plants	Hybrid plant	Characteristics of hybrid plant
Palm oil	Pisifera and Dura	Tenera	More fruits and flesh, thinner shell
Papaya	Subang 6 and Sunrise Solo	Eksotika	Sweeter fruits and more flesh
Corn	Sweet corns from Taiwan and Mexico	Masmadu	Sweeter and bigger fruits and higher resistance towards diseases and drought
Paddy	Siam-29 and Pebifun	Malinja	More harvest and ripe faster

Fertilisation Process

After pollination, fertilisation will occur. The male gamete carried by the pollen fuses with the female gamete in the ovule. How does this process occur? Figure 4.31 shows the process of fertilisation between male and female gametes in plants.

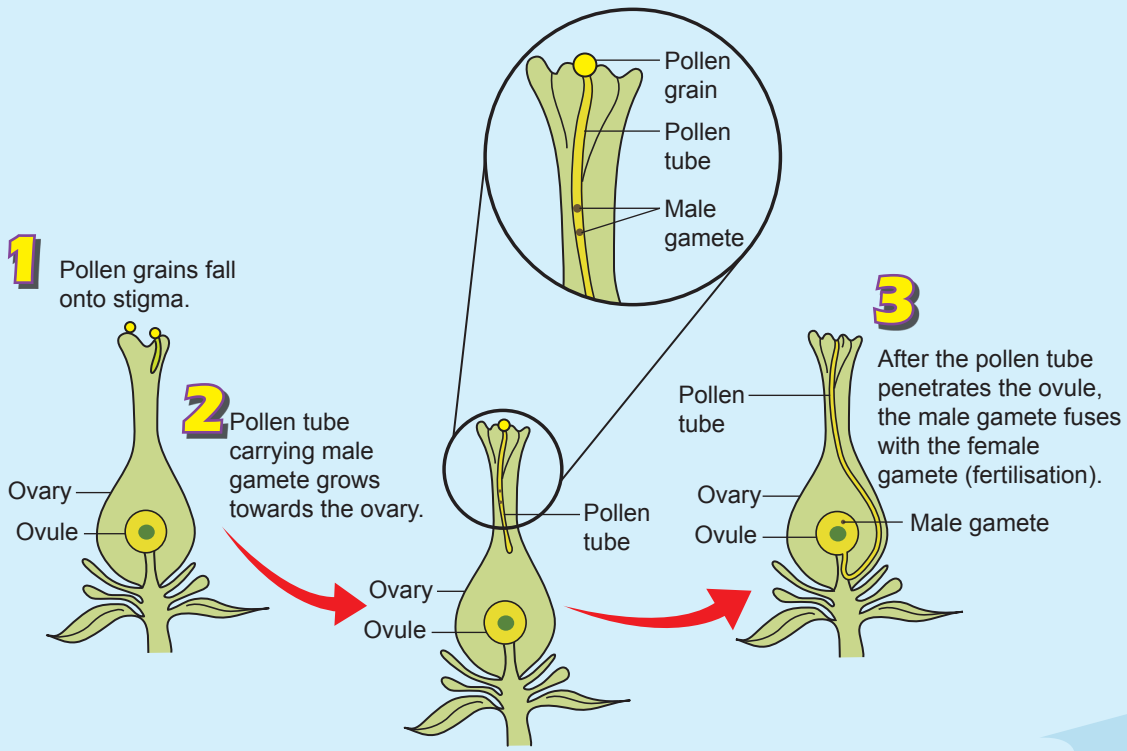


Figure 4.31 *Fertilisation of male and female gametes in plants*

Structures of a Seed and Their Functions

After fertilisation, the ovule grows inside the ovary and then develops into seeds. A seed is made up of an embryo wrapped in a seed coat or testa. The other parts of the flower will wither and fall.

Seeds are divided into two which are monocotyledonous and dicotyledonous. Figure 4.32 and Figure 4.33 show the structure of monocotyledonous and dicotyledonous seeds.

Brain Teaser

Nowadays, many seedless fruits are produced. Justify this action.

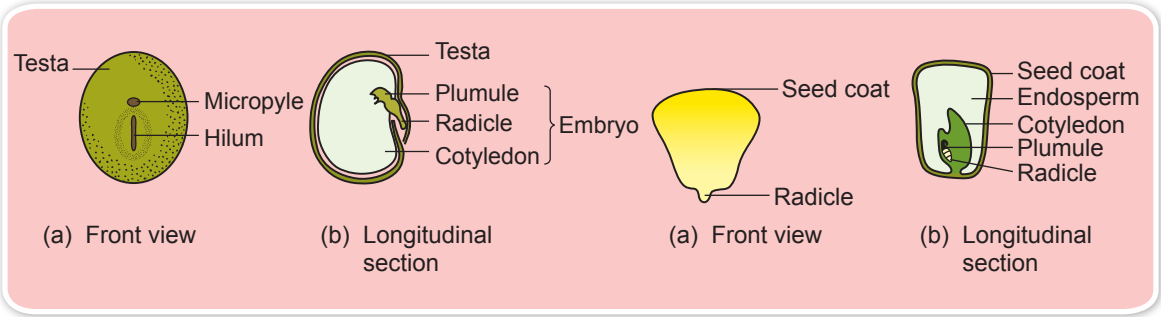


Figure 4.32 *The structure of a green bean (dicotyledonous)*

Figure 4.33 *The structure of a maize grain (monocotyledonous)*

Table 4.7 shows the structure and function of a seed.

Table 4.7 *The structure and functions of a seed*

Part	Structure	Function
External	Testa	Protects the seed
	Hilum	Place where the seed sticks to the fruit
	Micropyle	Small hole to allow air and water to enter the seed
Embryo	Plumule	Part of the embryo which develops into a new shoot
	Radicle	Part of the embryo which develops into the root
	Cotyledon / Endosperm	Stores and provides food for the seed

Photograph 4.11 *Sprouting seeds*

Germination of Seeds

How does the shape of a germinating seed change in terms of the growth of the radicle, plumule and the condition of the cotyledon?

During germination, the testa bursts and the radicle starts to appear and grow downwards into the soil to form root. Meanwhile, the plumule grows upwards to form a new shoot. Certain cotyledons are carried out of the soil and this is known as **epigeal** germination (Figure 4.34). There are also cotyledons that remain in the soil during germination. This germination is known as **hypogeal** germination (Figure 4.35).

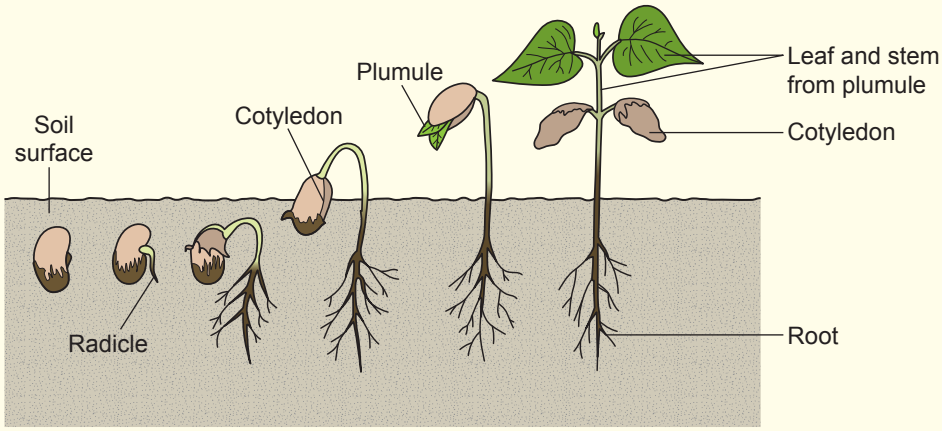


Figure 4.34 *Epigeal germination*

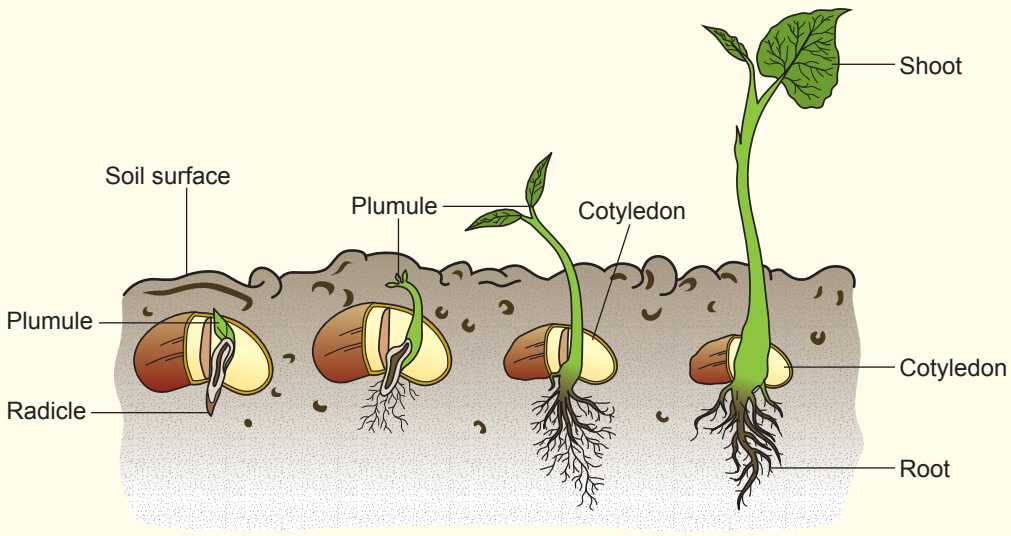


Figure 4.35 *Hypogeal germination*

The Conditions Required for Germination of Seeds

What are the conditions required by seed to germinate? Let us carry out Experiment 4.1 to determine the required conditions for seed germination. Seeds will germinate if conditions are suitable as in Figure 4.39.

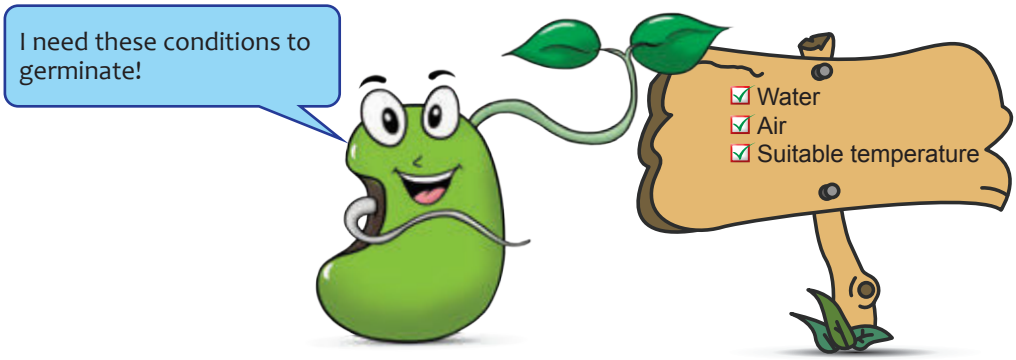


Figure 4.39 *The required conditions for germination of seeds*

Experiment 4.1

Problem statement: Are air, water and suitable temperature necessary for seeds to germinate?

Hypothesis: Seed needs air, water and suitable temperature to germinate

Aim: To determine the required conditions for the germination of seeds

Variables
Manipulated variable: Germination conditions
Responding variable: Seed germination
Constant variable: Type of seed

Materials and apparatus: Boiling tube, cotton wool, water, cooking oil, sugar paper, green beans, refrigerator

Procedure

1. Prepare four boiling tubes labelled *A*, *B*, *C* and *D* as shown in Figure 4.37 (a) and 4.37 (b).

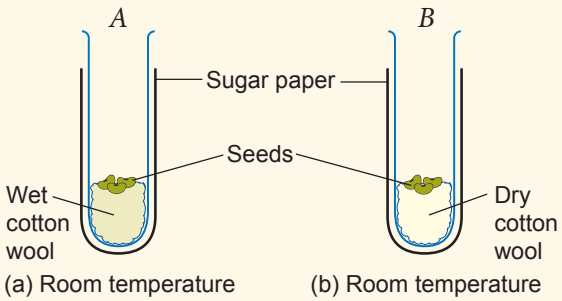


Figure 4.37 (a)

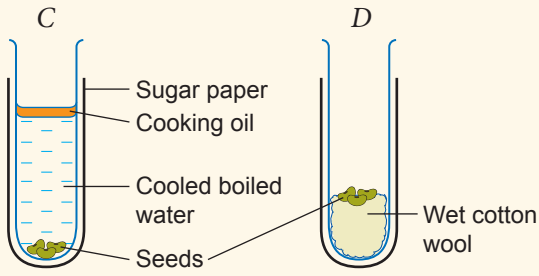


Figure 4.37 (b)

2. Test tube *A*, *B* and *C* are put in the laboratory while test tube *D* is put inside a refrigerator.
3. Observe all the seeds after five days for each of the boiling tube.
4. Record your observation in a table.

Result

Test tube	Presence of			Seed germination (Germinate/ Does not germinate)
	Water	Air	Suitable temperature	
A				
B				
C				
D				

Conclusion

Is the hypothesis accepted?

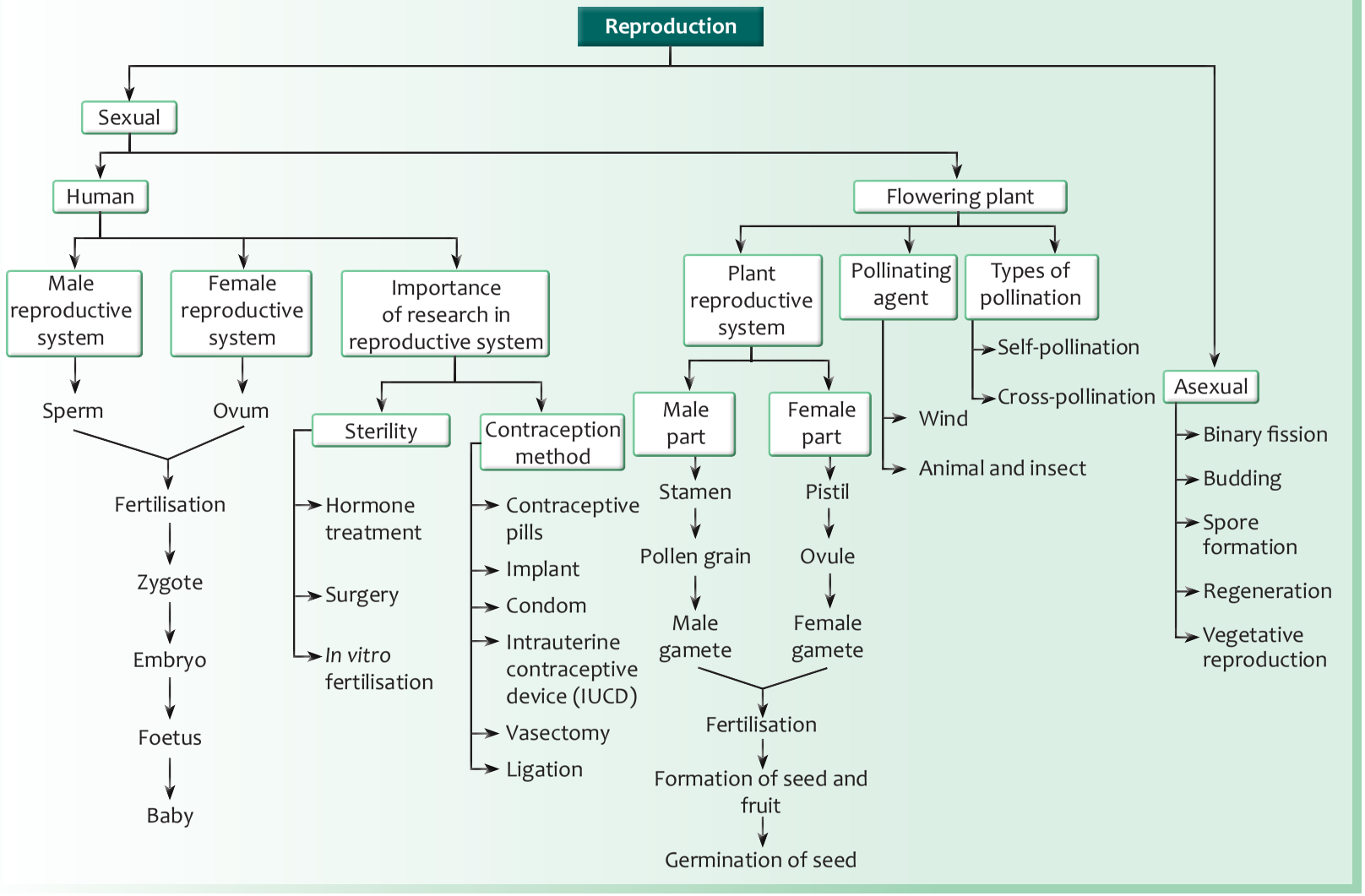
Questions

1. How do you set up a control experiment?
2. What is the purpose of using cooking oil in this experiment?

Formative Practice 4.7

1. What is the function of flower petal in plant reproduction?
2. Why is sepal different from petals?
3. Why do some papayas bloom but not bear fruits?
4. Explain the function of the following parts of a flower in plant reproduction.
   (a) Stigma
   (b) Style
   (c) Anther
5. State the differences between a wind-pollinated flower and an insect-pollinated flower.

Concept Map


Reproduction
Sexual
Asexual
Human
Flowering plant
Male reproductive system
Female reproductive system
Importance of research in reproductive system
Plant reproductive system
Pollinating agent
Types of pollination
Sperm
Ovum
Fertilisation
Zygote
Embryo
Foetus
Baby
Sterility
Hormone treatment
Surgery
In vitro fertilisation
Contraception method
Contraceptive pills
Implant
Condom
Intrauterine contraceptive device (IUCD)
Vasectomy
Ligation
Male part
Female part
Stamen
Pistil
Pollen grain
Ovule
Male gamete
Female gamete
Fertilisation
Formation of seed and fruit
Germination of seed
Wind
Animal and insect
Self-pollination
Cross-pollination
Binary fission
Budding
Spore formation
Regeneration
Vegetative reproduction

SELF-REFLECTION

After learning this chapter, you are able to:

4.1 Sexual and Asexual Reproduction

- [ ] Compare and contrast sexual and asexual reproduction in animals and plants.
- [ ] Reason the importance of reproduction.
- [ ] Be grateful for the ability to reproduce and the continuation of life as a gift from God.

4.2 Human Reproductive System

- [ ] Identify the structures and function of the male and female reproductive systems.
- [ ] Communicate about the physical changes that occur during puberty.
- [ ] Compare and contrast male gamete with the female gamete in the reproductive system.

4.3 Menstrual Cycle

- [ ] Communicate about the menstrual cycle and the sequence of changes in the uterus lining during menstruation.
- [ ] Relate the fertile phase of the menstrual cycle to the process of fertilisation.
- [ ] Justify the importance of personal hygiene during menstruation.

4.4 Fertilisation and Pregnancy

- [ ] Communicate about the process of fertilisation and the implantation of embryo.
- [ ] Justify the importance and functions of placenta and umbilical cord.
- [ ] Describe the development of a zygote into an embryo and subsequently into foetus during pregnancy until birth.

4.5 Factors Affecting the Development of a Foetus and Baby

- [ ] Relate the importance of taking nutritious food during pregnancy to the health of both mother and foetus.
- [ ] Justify the importance of avoiding the intake of harmful substances to the foetus.
- [ ] Justify the benefits of breastfeeding compared to formula milk on the infant's development.
- [ ] Realise that every living creature has a right to live even if its in the womb.

4.6 Infertility and Contraception

- [ ] Communicate the meaning of infertility and how to overcome them.
- [ ] Differentiate methods of contraception.
- [ ] Realise the importance of practising frequent health screening and to get immediate treatment for problems related to the reproductive system.

4.7 Plants Reproduction

- [ ] Communicate about the structure and function of each part of a flower.
- [ ] Justify the pollination process.
- [ ] Describe the process of fertilisation and explain the formation of seeds and fruits in plants.
- [ ] Describe the germination process of a seed.
- [ ] Solve problems if germination does not occur.

Summative Practice 4

1. The image of a foetus can be seen through ultrasound imaging. Ultrasound is considered safe for the mother and the foetus. Figure 1 shows the foetus image formed after 12 weeks of pregnancy.

Figure 1

(a) Based on Figure 1, the foetus is in a fluid. What is the name of the fluid?
(b) What is the function of the fluid you mentioned in 1(a)?
(c) Which part connects the foetus and the mother's uterus and how does the foetus obtain its food and oxygen?
(d) When the features of the foetus is completely formed, a baby will be born. Explain the birth process.

2. Figure 2 shows the changes in the thickness of the uterine lining during the menstrual cycle.

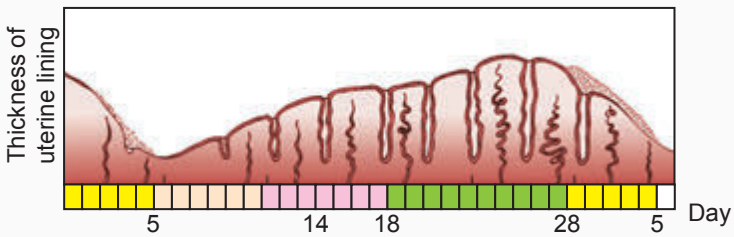


Figure 2

(a) Based on Figure 2, predict
  (i) when menstruation phase occurs;
  (ii) when ovulation occurs for the woman?
(b) If the woman has sexual intercourse on the 13th day of her menstrual cycle, is there any possibility of her getting pregnant?

3. Development in science and technology has helped married couples to plan their family and overcome sterility problems.

(a) Explain any two temporary contraceptive methods.
(b) Selling condoms openly has been said to contribute to social problems in a society. Do you agree with this statement? Give your opinion.

4. An experiment was done by a group of researchers to study the effect of nicotine on sperm production. Sixty rats were divided into three groups. The first group was not given any nicotine, the second group was given a low dose of nicotine every day and the third group was given a high dose of nicotine every day. This research was done for 30 days. Then, the number of abnormal sperms produced by each rat was recorded in Table 1.

Table 1

Nicotine dose	None	Low	High
Percentage of abnormal sperm	7	20	33

(a) Based on Table 1, draw a bar chart.

(b) What are the two variables that must be kept constant in this experiment?

(c) What is the conclusion that can be made by the researchers from this experiment?

(d) Suggest one reason why the first group of rats were not given any nicotine.

(e) State one effect of nicotine on a baby who is born to a mother who smokes during pregnancy. What is the best solution for a mother who is addicted to nicotine?

5. Figure 3 shows the general structure of a flower.

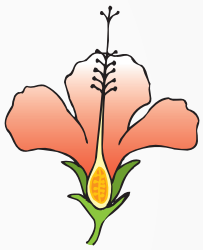


Figure 3

(a) State the structure that forms
  (i) the female reproductive organ.
  (ii) the male reproductive organ.

(b) If we go to a flower park, a lot of insects are seen flying around flowers.
  (i) What are the characteristics of the flowers that attract the insects?
  (ii) How do insects help in the plant reproduction process?

The Next Challenge . . .

6. Sterility is always the main problem for newly married couples and it is caused by various factors. Is it true that sterility only happens to women? Give your opinion.

7. A married couple has been married for 12 years, but they still do not have a child.

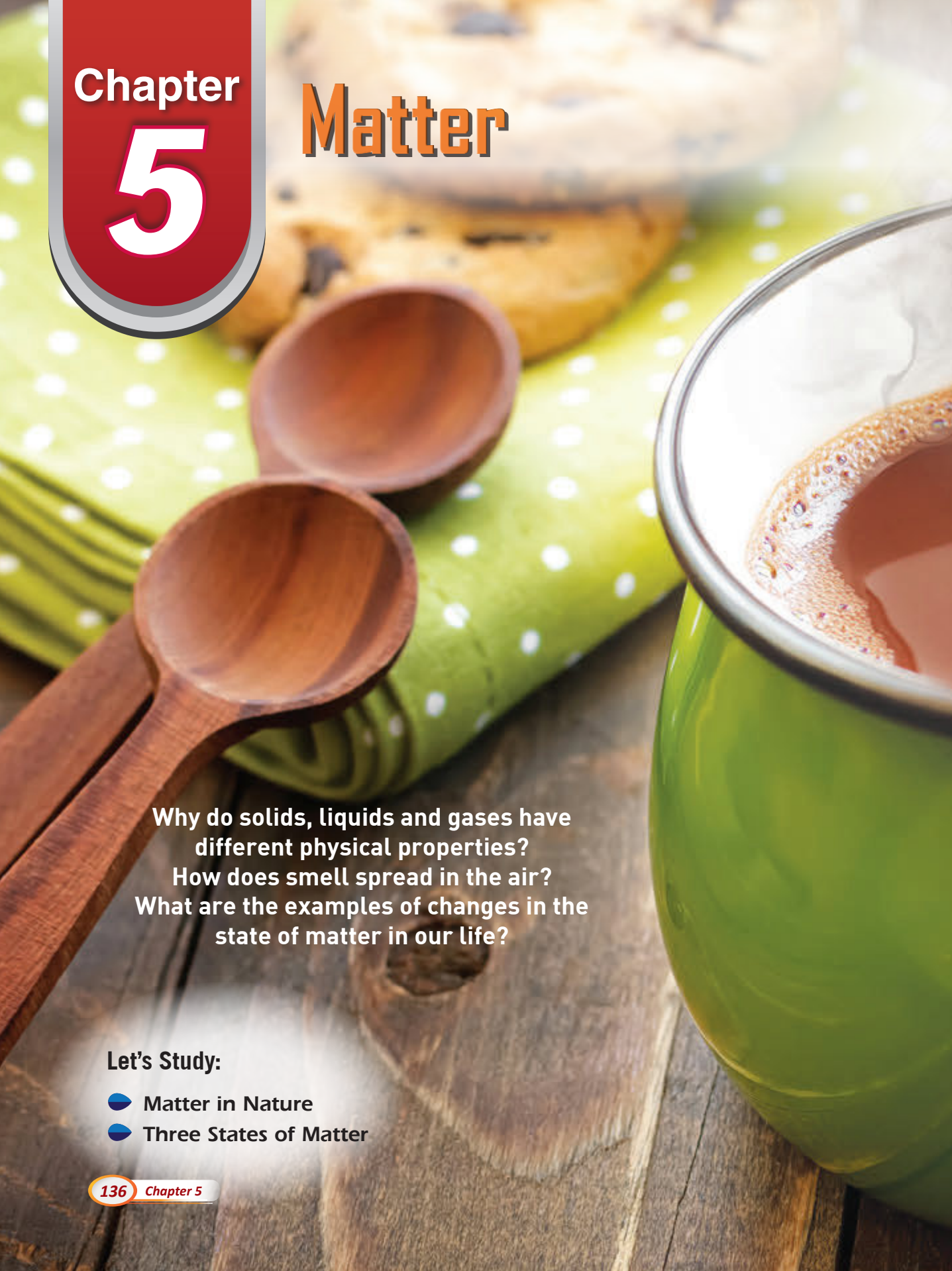
(a) From a medical perspective, what is your assumption on why they still do not have a child?

(b) Based on your answer in 7(a), suggest one method to overcome their problem. Explain the benefits of the method.

THEME 3

Exploration of Elements in Nature

- What causes ice cream to melt, water vapour to form from hot water and balloon to float in the air?
- What differentiates atom from molecule, and element from compound?
- How can we prevent and control air pollution?



Chapter 5 Matter

Why do solids, liquids and gases have different physical properties?
How does smell spread in the air?
What are the examples of changes in the state of matter in our life?

Let's Study:

- Matter in Nature
- Three States of Matter

Gas

Liquid

Solid

SCIENCE BULLETIN

BEE ATTACKS

Have you ever been attacked by a swarm of bees? Do you realise that when one bee starts to attack, a few minutes later, a swarm of bees will start to attack too? The first bee that attacks you will release a kind of chemical substance which produces a smell to alert other bees.

How does the smell of the chemical substance spread in the air and get detected by other bees? The smell spreads through diffusion. The odour particles of the chemical substance move in the air randomly in various directions. Therefore, other bees can smell the chemical substance from various directions.

KEYWORDS

- Matter
- Particle
- Extraction
- Melting
- Boiling
- Solubility
- Solid
- Liquid
- Gas
- Diffusion
- Evaporation
- Condensation
- Freezing
- Sublimation

5.1 Matter in Nature

Let's learn

- State that almost everything that exists in nature is matter.
- Prove that living things and non-living things have mass and occupy space.
- Differentiate the physical properties and chemical properties of matter.
- Classify materials by the different characteristics.

Can you list all the things that you can see in Photograph 5.1? Do they have mass and occupy space? Do you know that all the things you have listed are matter? **Matter** can be defined as a substance that **has mass** and **occupies space**.

Photograph 5.1 *Matter*

All living things including humans, plants and animals are classified as matter. Non-living things such as water, soil, rocks and air are also matter.

Can you state examples of non-matter? Let us do Activity 5.1 to show that almost every living and non-living thing in nature is a matter.

Brain Teaser

1. Is there any object that has mass but does not occupy space?
2. Is there any object that occupies space but does not have mass?

Activity 5.1

A **Aim**: To show that living and non-living things have mass and occupy space

Materials and apparatus: Lever balance, beaker, soil, water, bean sprouts

Instruction

1. Weigh an empty beaker with a lever balance. Record its mass.
2. Fill half of the beaker with soil. Does the soil occupy space inside the beaker?
3. Weigh the beaker with the soil by using the lever balance as shown in Figure 5.1. Does soil have mass?
4. Repeat steps 1 – 3 by replacing soil with water and bean sprouts.

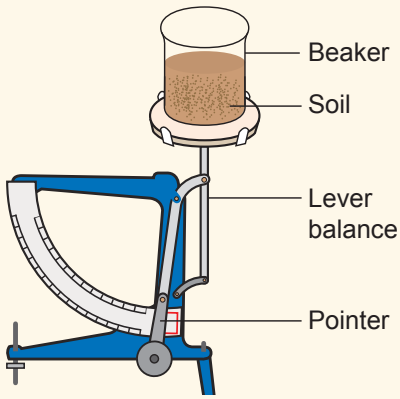


Figure 5.1 *Set-up of apparatus*

5. Complete the table below.

Material	Living/ non-living things	Mass (g)	Occupy space
Soil			
Water			
Bean sprouts			

Questions

1. Classify the materials in this activity into living and non-living things.
2. Are soil, water and bean sprouts matter? Explain your answer.
3. Give five other examples of things that are matter.

B **Aim**: To show that air has mass and occupies space

Materials and apparatus: Balloons, pin, rope, cellophane tape, wooden rod.

Instruction

1. Blow up two balloons and make sure they are of the same size.
2. Stick a piece of cellophane tape on one of the balloons.
3. Attach the balloons to a wooden rod. Balance both balloons (Figure 5.2).
4. Use a pin to prick the balloon through the cellophane tape. Observe any changes.

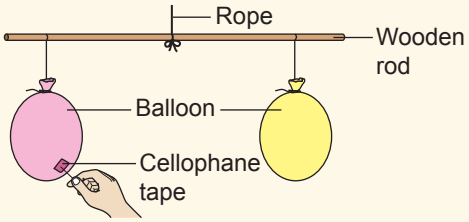


Figure 5.2

Questions

1. Did the balloons expand when you blew them up? Why?
2. What happened to the wooden rod when one of the balloons was pricked with the pin?
3. Why do we stick a cellophane tape to the balloon that we want to prick?

Conclusion

What conclusion can you make from these activities?

Physical Properties of Matter

Every matter has its own **physical properties**. What is meant by physical properties? Physical properties are the properties that can be identified by using our five senses or measuring tools. Physical properties of matter depend on the type of material it is made of. Look at Photograph 5.2. What is the main material to make a kayak? Can you state the physical properties of the kayak? Figure 5.3 shows some examples of physical properties of matter.

Photograph 5.2 *Kayak*

Figure 5.3 *Physical properties of matter*

Chemical Properties of Matter

Besides physical properties, each matter has its own **chemical properties**. What is meant by chemical properties? **Chemical properties** are the properties of a substance that become evident when it changes to a new substance. Chemical properties depend on the reaction that occurs upon the substances. Figure 5.4 shows some examples of chemical properties of matter. The new substance produced from the chemical reaction has a different composition from its original substance.

Figure 5.4 *Chemical properties of matter*

Let us carry out Activity 5.2 to differentiate between physical properties and chemical properties of matter.

Activity 5.2

Aim: To differentiate physical and chemical properties of matter

Instruction

1. Work in groups.
2. Identify each of the situation below whether it is a chemical or physical property of matter. Then, state the process involved.

Water boils at 100°C

Ice cream melts when exposed to a certain temperature

Paper burns when it is lit

Iron spoon becomes hot when it is put in a cup of hot coffee

Iron key rusts when it is exposed to air and water

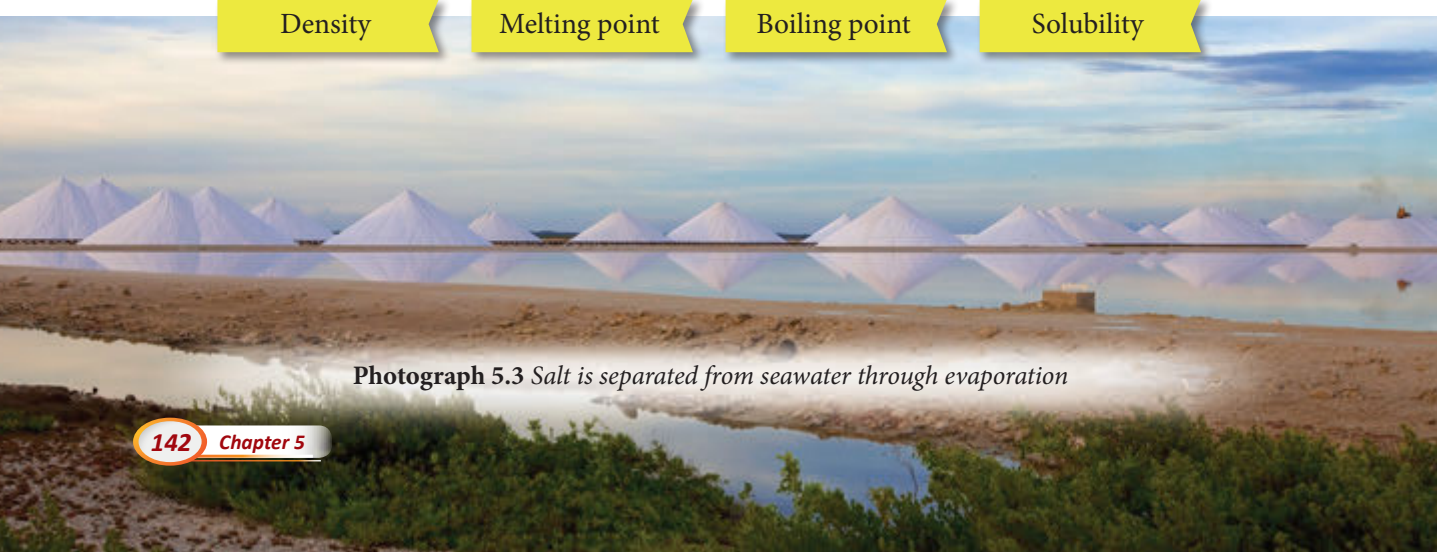
Medicine tablet dissolves in water

3. Present your discussion in front of your friends and teacher.

How Can We Classify Materials by their Different Characteristics?

Seawater is salty because of the salt content in it. What are the differences between the properties of salt and seawater? Salt and seawater have different boiling points. Water evaporates into water vapour as its boiling point is lower than salt. Eventually, only the salt crystals are left behind. We can classify various materials by the following characteristics:

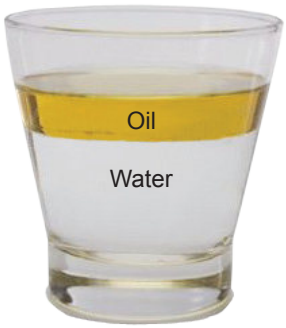
Density | Melting point | Boiling point | Solubility



Photograph 5.3 *Salt is separated from seawater through evaporation*

Density

The **density** of a material is the mass per unit volume of that material. Density determines the ability of a material to float or sink in water. A material that has a lower density will float, while a material that has a higher density will sink. For example, oil has a lower density which causes it to float on water. Table 5.1 shows some examples of classification of substances by density.



Photograph 5.4 *The layers of oil and water*

Table 5.1 *Classification of substances by density*

Substance	Higher density	Lower density
Mixture of glycerol and water	Glycerol	Water
Mixture of petrol and mercury	Mercury	Petrol
Mixture of sand and water	Sand	Water
Mixture of oil and cork	Oil	Cork

Melting Point and Boiling Point

Melting point is the temperature at which a substance changes from solid to liquid. **Boiling point** is the temperature at which a substance changes from liquid to gas. Matter can also be classified by its melting and boiling point.

Iron melts at 1536°C

Ice melts at 0°C

Water boils at 100°C

Photograph 5.5 *Melting and boiling point of various substances*

Melting and boiling points of some substances are listed in Table 5.2.

Table 5.2 *Melting and boiling points of various substances*

Substance	Melting point (°C)	Boiling point (°C)
Water	0	100
Alcohol	-117	78
Copper	1085	2562
Oxygen	-218	-183

Solubility

Solubility is the ability of a substance to dissolve in a given amount of solvent to form a solution. The solubility of a substance depends on the physical and chemical properties of its solute and solvent. As different substances have different solubility, matter can also be classified by its solubility. For example, we dissolve sugar (solute) in a cup of coffee (solvent) to drink.

Photograph 5.6 *Examples of solute and solvent*

Activity 5.3

Aim: To classify materials by the different characteristics from various physical properties

Instruction

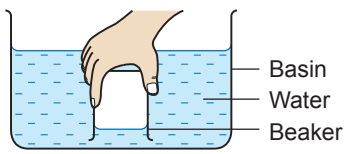
1. Work in groups.
2. Classify each of the following materials according to its density compared to water and solubility in water.

Material	Density compared to water	Solubility in water
(a) Salt		
(b) Twig		
(c) Cooking oil		
(d) Cork		
(e) Glass marble		
(f) Sand		
(g) Sugar crystals		
(h) Cocoa powder		

3. Record your findings in your practical book.

Formative Practice 5.1

1. List five examples of matter around you.
2. What are two characteristics of matter?
3. Are all living things matter? Explain your opinion.
4. Sarah turns over an empty beaker into a basin of water. She finds that the water cannot flow into the beaker. What can you conclude from her observation?



5. State the difference between physical and chemical properties.

5.2 Three States of Matter

Let's learn

- Generalise that matter consists of particles.
- Compare and contrast three states of matter based on the kinetic theory in terms of the arrangement and movement of particles.
- Use space-time relationships to compare rate of diffusion in three states of matter.
- Describe the change in state of matter, in terms of movement of particles caused by the absorption and the release of heat, based on kinetic theory.
- Conclude that temperature remains constant during melting/ freezing and boiling.
- Conclude that mass remains constant during physical changes.
- Explain with examples the changes of the state of matter in daily life.

Matter is made up of discrete particles. These particles are so tiny and cannot be seen with our naked eye or even by using a light microscope. It can only be seen through an electron microscope. Let's do Activity 5.4 to understand the concept of matter which is made up of small and discrete particles.

Activity 5.4

Aim: To show that matter is made up of small and discrete particles

Materials and apparatus: Copper(II) sulphate crystal, water, beaker

Instruction

1. Pour 50 ml of water into a beaker.
2. Put a few crystals of copper(II) sulphate into the beaker of water. Observe the changes in colour of the solution.
3. Add another 50 ml of water into the beaker and record your observation.

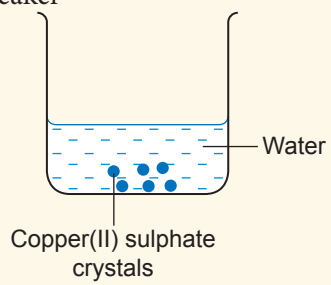
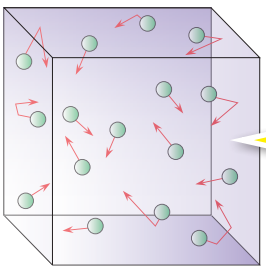


Figure 5.5

Questions

1. What can you observe when more water is added into the beaker? Explain your observation.
2. What conclusion can be made from this activity?



Kinetic theory of matter states that matter is made up of constantly moving small and discrete particles.

Figure 5.6 *Kinetic theory of matter*

Science Career

Material scientist is a person who studies the composition and characteristics of matter that is used in agricultural, industrial and medical fields.

Particles of matter always collide with one another. When heat is supplied, the particles will move faster. On the other hand, the particles will move slower when it is cooled.

Matter exists in three different states, solid, liquid and gas. Examples of the three states of matter are shown in Figure 5.7.

Three states of matter
idahoptv.org/sciencetrek/topics/matter/facts.cfm

Video on substances and their states

Solid

Ceramic cup is solid

Liquid

Honey is liquid

Gas

Vapour produced from hot tea is gas

Figure 5.7 *The three states of matter*

Water is the only substance in this nature that exists in all three states naturally. Water is in a liquid state at room temperature. When it is frozen, water changes to ice. Meanwhile, water that is heated at 100°C will change to steam.

Ice is water in solid state

Water exists as a liquid at room temperature

Steam is water in gas state

Table 5.3 *Comparison of characteristics of three states of the matter*

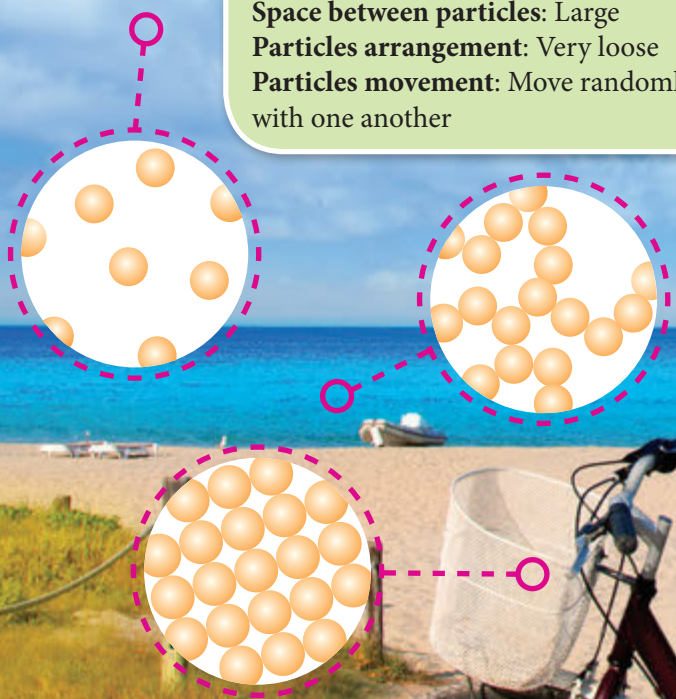
	State of matter		
Characteristic	**Solid**	**Liquid**	**Gas**
Shape	Fixed shape	Takes the shape of the container	Takes the shape of the container
Mass	Fixed mass	Fixed mass	No fixed mass
Volume	Fixed volume	Fixed volume	Follows the volume of the container
Compressibility	Incompressible	Difficult to compress	Compressible

GAS

Space between particles: Large
Particles arrangement: Very loose
Particles movement: Move randomly and collide with one another

Science Exploration

The Sun is not categorised as a solid nor gas. The Sun is in a state called plasma.



LIQUID

Space between particles: Moderate
Particles arrangement: Close
Particles movement: Move freely and collide with one another

SOLID

Space between particles: Small
Particles arrangement: Very close
Particles movement: Vibrate in a fixed position

Wood or iron are used to build bridges because it has a compact arrangement and a fixed shape.

Figure 5.8 *Comparison of characteristics of the three states of matter*

Activity 5.5

Aim: To prepare a visual presentation on the three states of matter

Instruction

1. Work in groups.
2. Each group has to choose one state of matter that represents their group.
3. Prepare a PowerPoint presentation to explain about the matter that you have chosen. Your presentation must include the following aspects:
   (a) physical properties of the matter
   (b) arrangement and movement of particles in the matter
   (c) relationship between the arrangement and movement of the particles in the matter to the physical properties of the matter.

Question

1. List other examples of matter.

Diffusion Rate in Three States of Matter

Have you ever wondered why a spray of perfume can be detected from afar? The **smell spreads** because its small discrete particles travel with the air particles. These particles move randomly in various directions which cause the smell of perfume to spread. We could say that **diffusion** has just occurred. **Diffusion** is a process in which the particles of substances diffuse from a high concentration area to a low concentration area.

Brain Teaser

What is the purpose of heating aromatic oil as shown in the photograph below?

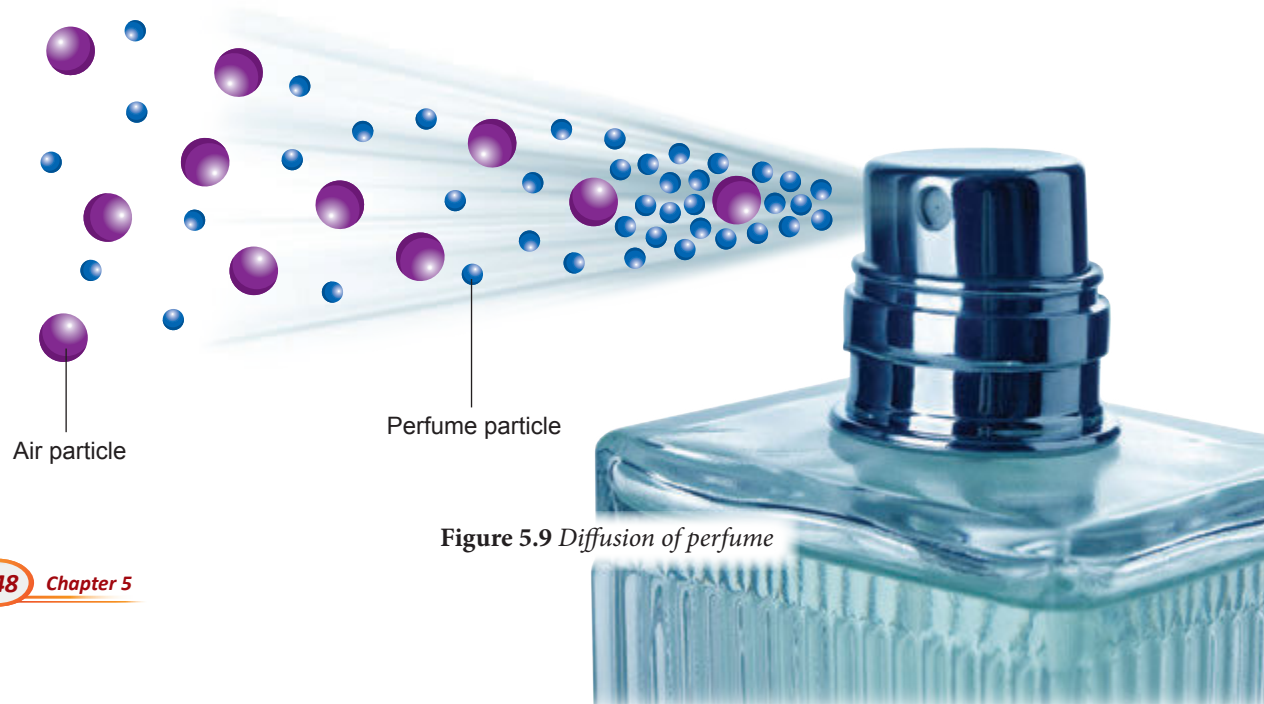


Figure 5.9 *Diffusion of perfume*

Is there a difference in the rate of diffusion in solids, liquids and gases? Let us carry out Experiment 5.1 to compare the rate of diffusion between the different states of matter.

Experiment 5.1

Problem statement: What is the difference in the rate of diffusion between solids and liquids?

Hypothesis: The rate of diffusion is low in a solid, but high in a liquid.

Aim: To determine the rate of diffusion of copper(II) sulphate in two states of matter.

Variables
(a) Constant variable: Temperature
(b) Manipulated variable: Diffusion medium
(c) Responding variable: Rate of diffusion

Materials and apparatus: Copper(II) sulphate crystals, colourless gel, distilled water, test tube, rubber stopper, measuring cylinder, stopwatch.

Procedure

A Diffusion in a solid

1. Set up the apparatus as shown in Figure 5.10.
2. Observe the changes after two days.
3. Record your observation.

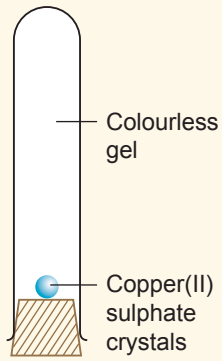


Figure 5.10

B Diffusion in a liquid

1. Put in one spatula of copper(II) sulphate crystals into a measuring cylinder filled with 50 ml of distilled water (Figure 5.11).
2. Observe the changes after 15 minutes.
3. Record your observation.

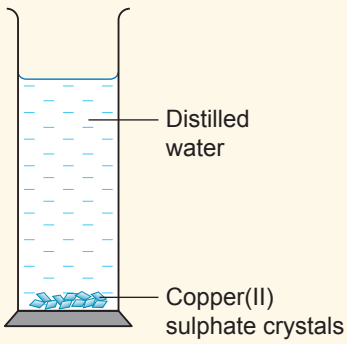


Figure 5.11

Result

Activity	Observation
A	
B	

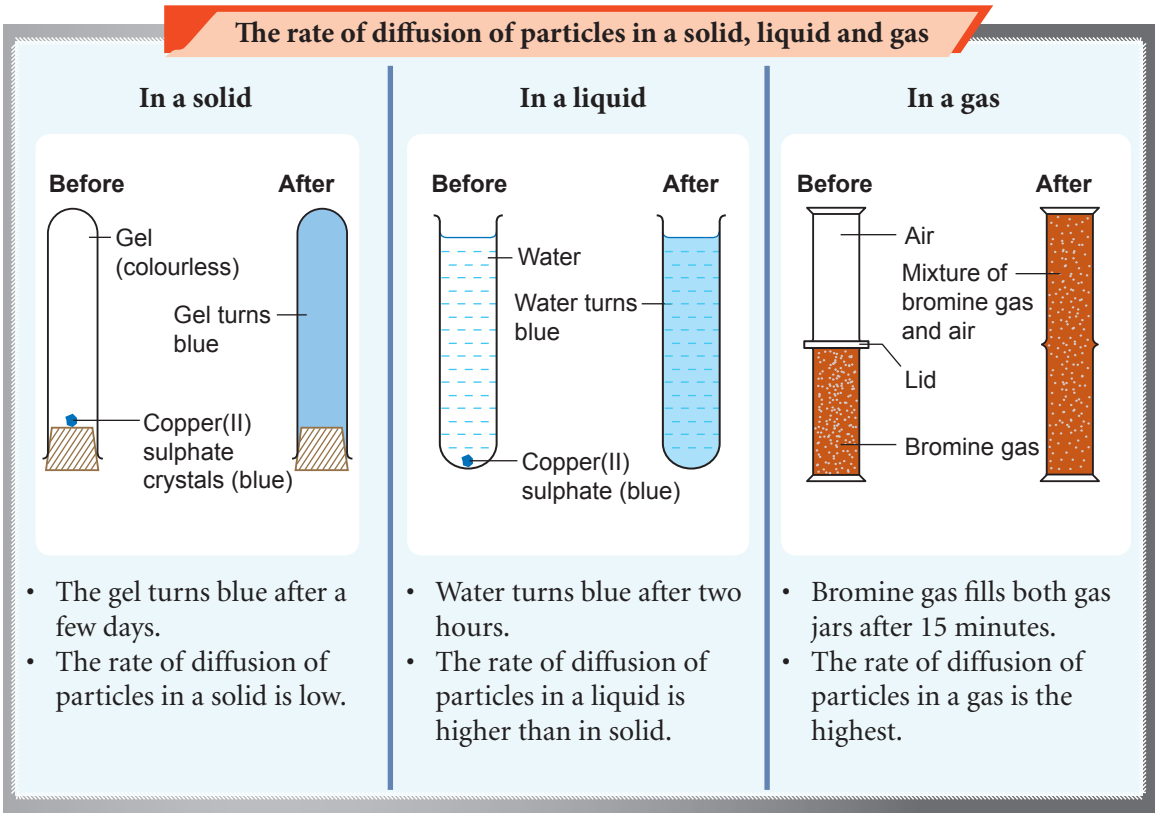
Conclusion

Is the hypothesis accepted?

Questions

1. State the observation for Activity *A* and *B*.
2. Compare the rate of diffusion of copper(II) sulphate in a solid and a liquid.

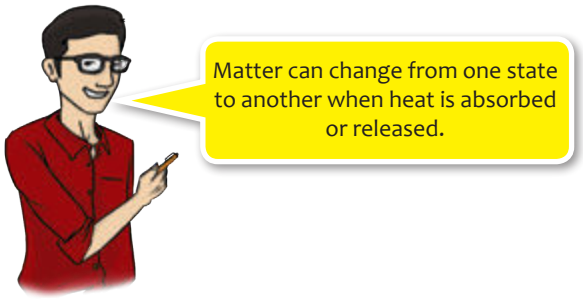
Figure 5.12 shows the difference between the rate of diffusion in the three states of matter.



- The gel turns blue after a few days.
- The rate of diffusion of particles in a solid is low.
- Water turns blue after two hours.
- The rate of diffusion of particles in a liquid is higher than in solid.
- Bromine gas fills both gas jars after 15 minutes.
- The rate of diffusion of particles in a gas is the highest.

Figure 5.12 *The rate of diffusion of particles in a solid, liquid and gas*

Changes in the State of Matter Caused by the Absorption and the Release of Heat Based on Kinetic Theory of Matter



There are many substances that undergo changes of matter due to absorption or release of heat in our life. What happens to the matter when heat is absorbed or released? Heating or cooling can cause changes in the state of matter. For example, when a liquid is cooled, it will release heat. The particles in the liquid will lose kinetic energy and move slower. The particles will attract one another and change into solid. The liquid undergoes the freezing process.

When a solid is heated, the substance will change to liquid and lastly change to gas during the boiling process. Some substances will change directly from solid to gas. This process is called sublimation. During sublimation, the kinetic energy of the particles increases as they absorb heat until it can change directly from solid to gas.

Photograph 5.7 *Heat is absorbed when water is heated*

Photograph 5.8 *Heat is released when water is cooled*

Video of effect on heat on matter

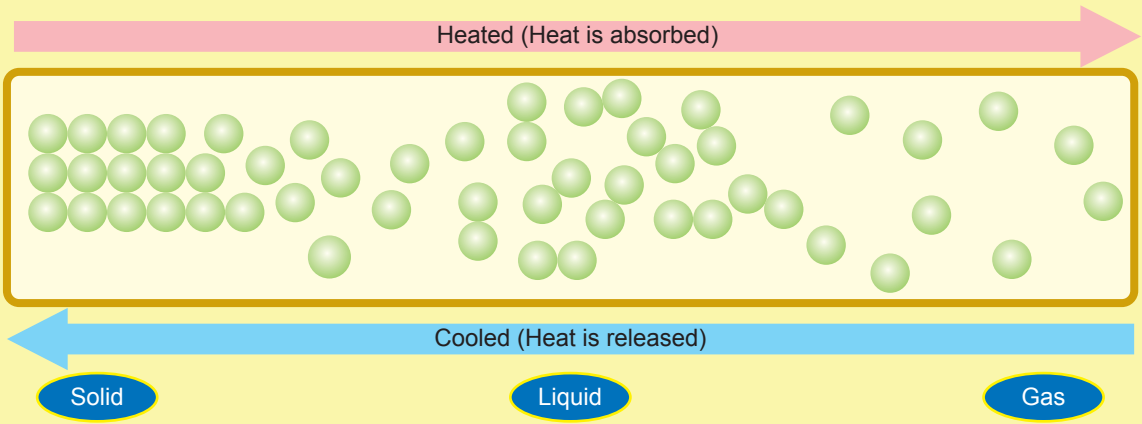


Figure 5.13 *The changes in the arrangement of particles when heated or cooled*

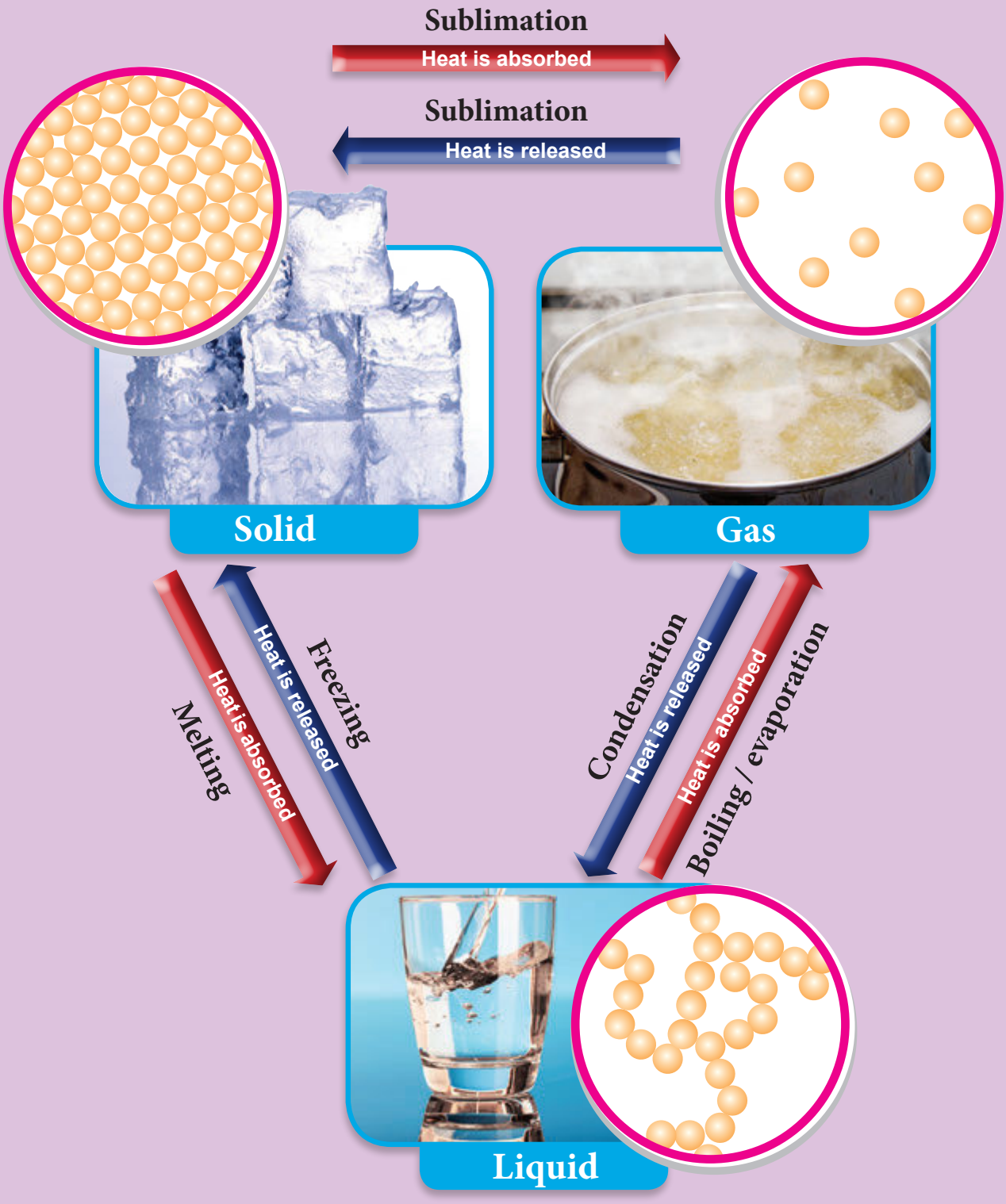


Figure 5.14 *The effect of heat on matter*

Melting

- Solid **absorbs heat** when heated.
- The particles obtain energy and vibrate faster.
- Heat is used to overcome the force of attraction between the particles.
- Particles move freely when the temperature reaches melting point.
- **Solid** turns into **liquid**.

Boiling

- Boiling occurs when the temperature of the liquid is equal to the boiling point of the liquid.
- Liquid **absorbs heat** when heated.
- The particles obtain energy and move faster.
- Heat is used to break the bond between the liquid particles.
- When the temperature reaches the boiling point, the particles move freely and randomly.
- **Liquid** turns into **gas**.

Evaporation

- Evaporation occurs at any temperature.
- Liquid **absorbs heat** from the surroundings.
- The particles obtain energy and move faster.
- **Liquid** is evaporated slowly and turns into **gas**.

Condensation

- Heat is **released** when gas is cooled.
- The particles lose energy and move slower and closer to one another.
- When the temperature is equal to or below the boiling point, **gas** will turn into **liquid**.

Freezing

- Liquid **releases heat** when it is cooled.
- Particles lose energy and move slower.
- Particles start to vibrate at a fixed position when they reach freezing point.
- **Liquid** turns into **solid**.

Sublimation

- **Sublimation** is a process in which a solid directly turns into gas or a gas directly turns into solid.

Science in Life

Activity 5.6

A Temperature remains constant during boiling of water

Aim: To investigate whether temperature remains constant during boiling of water

Materials and apparatus: Bunsen burner, tripod stand, wire gauze, beaker, thermometer, 100 ml of water, retort stand with clamp.

Instruction

1. Pour 100 ml of water into a beaker. Record the initial temperature of water.
2. Heat the water. Record the temperature of water at 10 minutes interval until the temperature remains constant (Figure 5.15).

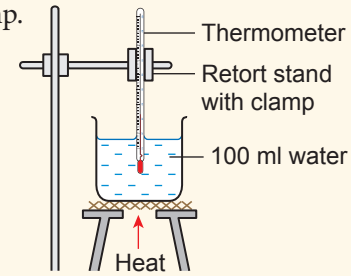


Figure 5.15

Questions

1. Why does the temperature of water remain constant when boiling?
2. Plot a graph of temperature against time for the boiling of water.

B Mass remains unchanged during physical change

Aim: To investigate whether mass remains unchanged during physical change

(I) Change in mass when ice melts into water

Materials and apparatus: Ice cubes, beaker, lever balance

Instruction

1. Weigh an empty beaker. Record the mass of the empty beaker.
2. Put ice cubes into the beaker. Record the mass of the beaker filled with ice cubes.
3. Then, let the ice cubes melt. Weigh the beaker filled with water.
4. Record the mass (Figure 5.16).

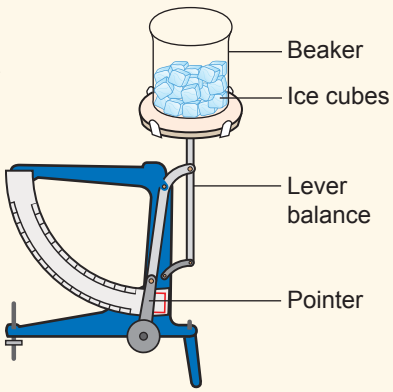


Figure 5.16

Question

1. Is there any difference between the mass of the ice cubes and water?

(II) Change in mass when salt dissolves

Materials and apparatus: Ten spatulas of fine salt, 100 ml of water, glass rod, beaker, lever balance.

Instruction

1. Weigh a beaker filled with 100 ml of water. Record the mass.
2. Put ten spatulas of fine salt into the beaker. Weigh it and record its mass.
3. Stir the water until the salt dissolves. After that, weigh the solution and record the mass (Figure 5.17).

Question

1. Is there any difference in mass before and after the salt dissolves?

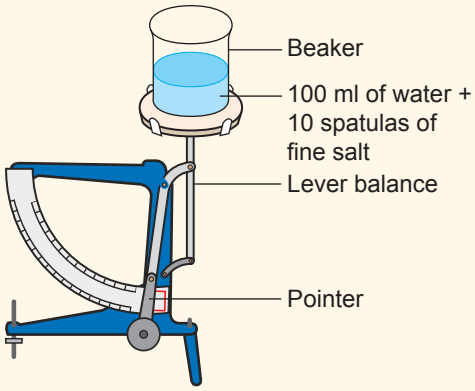


Figure 5.17

(III) Change in mass during the expansion of solid

Materials and apparatus: Metal ball and ring, Bunsen burner, triple beam balance.

Instruction

1. Weigh a metal ball together with its ring. Record the mass.
2. Heat the metal ball for 5 minutes. Weigh the hot metal ball with its ring. Record the mass. (Figure 5.18)

Question

1. Is there any difference in the mass of the metal ball before and after heating?

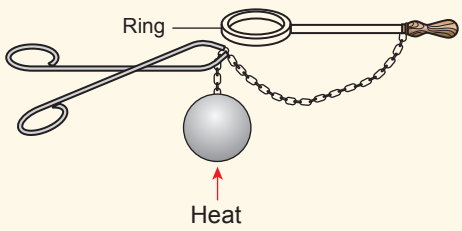


Figure 5.18

When a substance is heated, the temperature will increase and when a substance is cooled, the temperature will decrease. However, the temperature will not change when it reaches freezing point, melting point and boiling point during the freezing, melting and boiling processes. Heat is absorbed or released to overcome or form the force of attraction between the particles. During these physical changes, the mass remains constant because the quantity of particles does not change when heated or cooled. The only change that occurs is the kinetic energy of the particles.

Water from wet items evaporates and becomes vapour through the process of evaporation.

Examples of change of state of matter

Freezing allows sweet creams to freeze and become ice-cream

Dry ice is used by ice-cream vendors to prevent their ice-cream from melting

Moth balls becoming smaller is an example of direct change from solid to gas through sublimation

Dew is formed when water vapour in the air condenses and becomes water droplets

Figure 5.19 *Examples of change of state of matter*

Activity 5.7

21st Century ICS

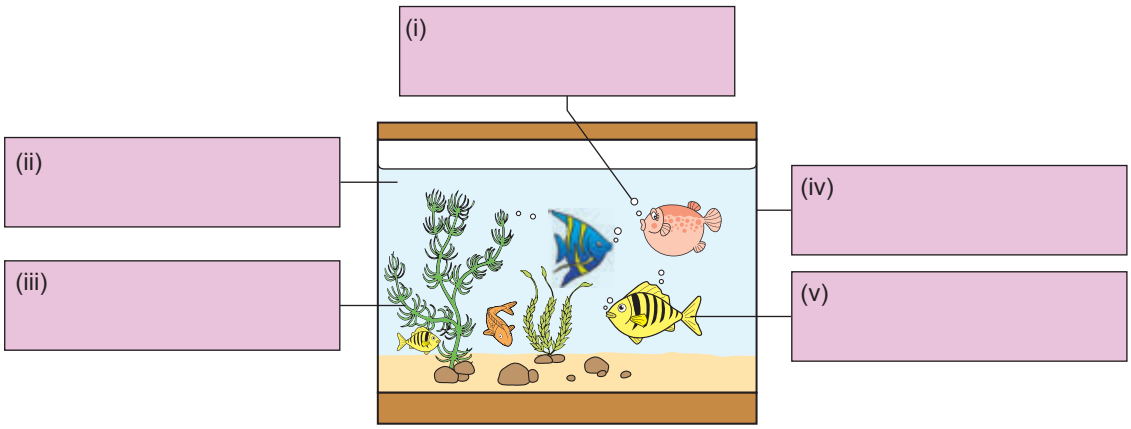
Aim: To search for information and do a presentation

Instruction

1. Work in groups.
2. Find information on two examples of change of matter for the following processes.
   (a) Freezing
   (b) Melting
   (c) Boiling
   (d) Evaporation
   (e) Condensation
   (f) Sublimation
3. Present your discussion using various forms of multimedia presentations.

Formative Practice 5.2

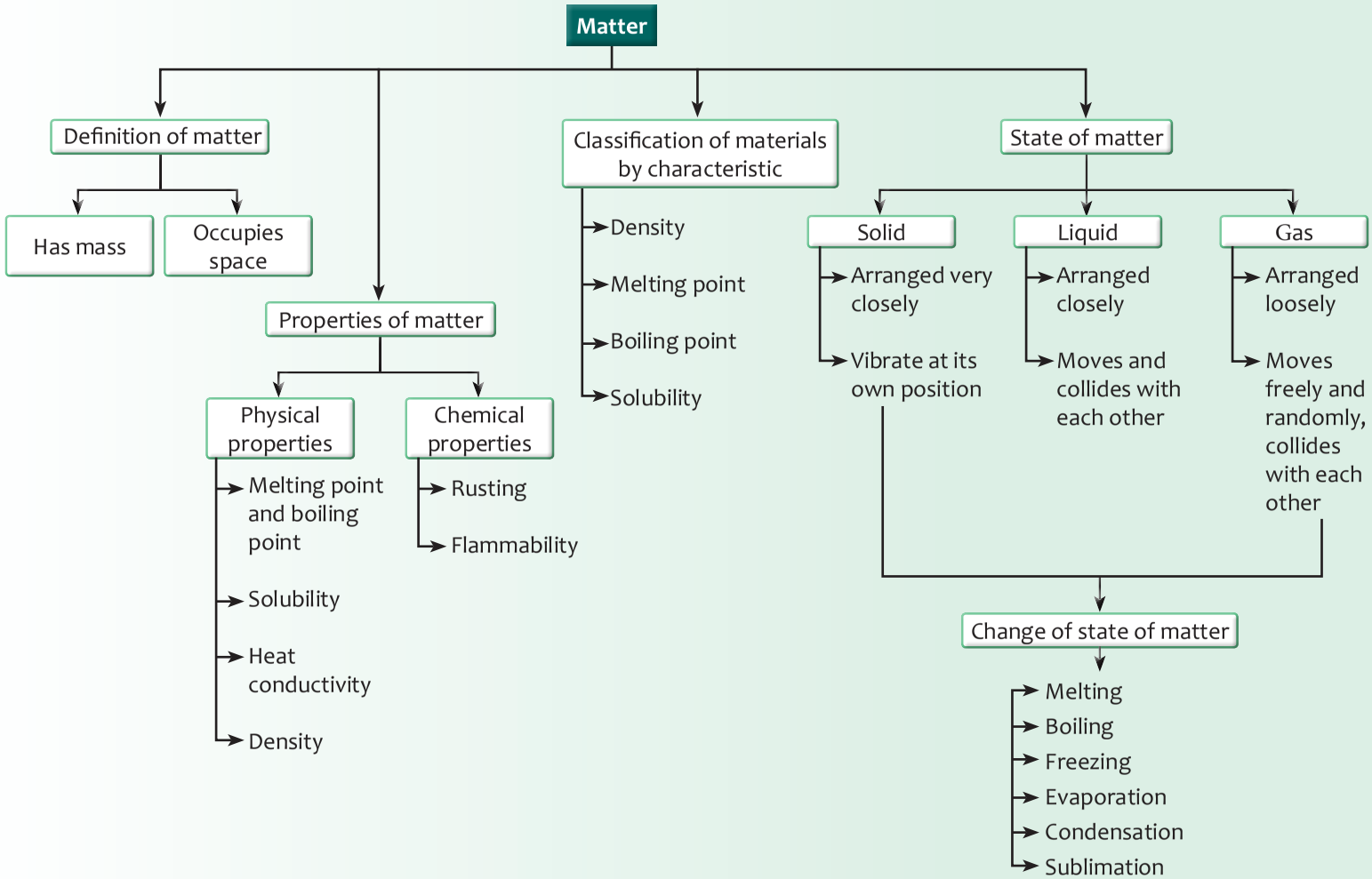
1. (a) State whether the matter is a solid, liquid or gas.



(b) Give three other examples for each state of matter.
(c) Draw a table to show the arrangement and movement of particles for each state of matter.

2. How does the smell of cooking spread all over the house?
3. State the kinetic theory of matter.
4. Why is the temperature constant during the boiling of water?
5. In four season countries, the temperature may drop till below 0°C during the peak of winter. Why does the surface of the river or lake freeze?

Concept Map


Matter
Definition of matter
Has mass
Occupies space
Properties of matter
Physical properties
Melting point and boiling point
Solubility
Heat conductivity
Density
Chemical properties
Rusting
Flammability
Classification of materials by characteristic
Density
Melting point
Boiling point
Solubility
State of matter
Solid
Arranged very closely
Vibrate at its own position
Liquid
Arranged closely
Moves and collides with each other
Gas
Arranged loosely
Moves freely and randomly, collides with each other
Change of state of matter
Melting
Boiling
Freezing
Evaporation
Condensation
Sublimation

SELF-REFLECTION

After learning this chapter, you are able to:

5.1 Matter in Nature

- ☐ State that almost everything that exists in nature is matter.
- ☐ Prove that living things and non-living things have mass and occupy space.
- ☐ Differentiate the physical properties and chemical properties of matter.
- ☐ Classify materials by their different characteristics.

5.2 Three States of Matter

- ☐ Generalise that matter consists of particles.
- ☐ Compare and contrast three states of matter based on the kinetic theory in terms of the arrangement and movement of particles.
- ☐ Use space-time relationship to compare rate of diffusion in three states of matter.
- ☐ Describe the change in state of matter in terms of movement of particles caused by the absorption and the release of heat based on kinetic theory.
- ☐ Conclude that temperature remains constant during melting / freezing and boiling.
- ☐ Conclude that mass remains constant during physical changes.
- ☐ Explain with examples the changes of the state of matter in daily life.

Summative Practice 5

1. Figure 1 shows three examples of matter.

Figure 1

(a) Identify the states of matter in Figure 1.
(b) Of the three state of matter, which one has a fixed volume?
(c) What is the difference between the movement of particles in the stones and the air in the balloon?

2. Umar builds a wooden tray with three partitions to separate some marbles into three sections, *P*, *Q* and *R* as shown in Figure 2.

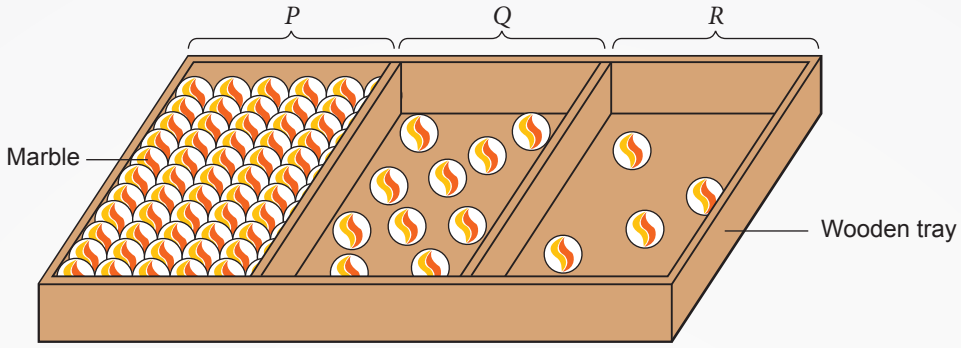


Figure 2

(a) Use the kinetic theory of matter to describe the movement of marbles in *P*, *Q* and *R* when Umar shakes the tray. Explain your answer.

(b) Based on the properties of matter that you have learned, explain how gas is

(i) compressed into liquid in a gas barrel.

(ii) changed back into gas when it exits the barrel.

3. Figure 3 shows Elisya blowing soap water.

Figure 3

(a) Determine the state of matter for the

(i) air inside the soap bubbles

(ii) soap bubble blower

(iii) soap water

(b) What happens to the soap water when Elisya blows it harder? Give your reason.

4. Tan wants to ride his bicycle to school but he finds that the tyre is flat. Tan pumps air into the tyre.

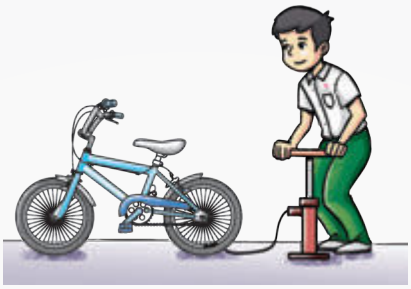


Figure 4

(a) Explain the state of the air particles inside the pumped tyre.
(b) Justify Tan's action of not pumping the tyre until it is too tight.
(c) Bicycle tyres become flat when the weather is cold. Explain.

The Next Challenge . . .

5. Ariana accidentally mixed salt and tea leaves. Suggest one way to separate the salt and tea leaves based on your knowledge of physical properties of matter.

Figure 5

6. A sailor runs out of drinking water in the middle of the sea. He cannot drink seawater directly to avoid dehydration.

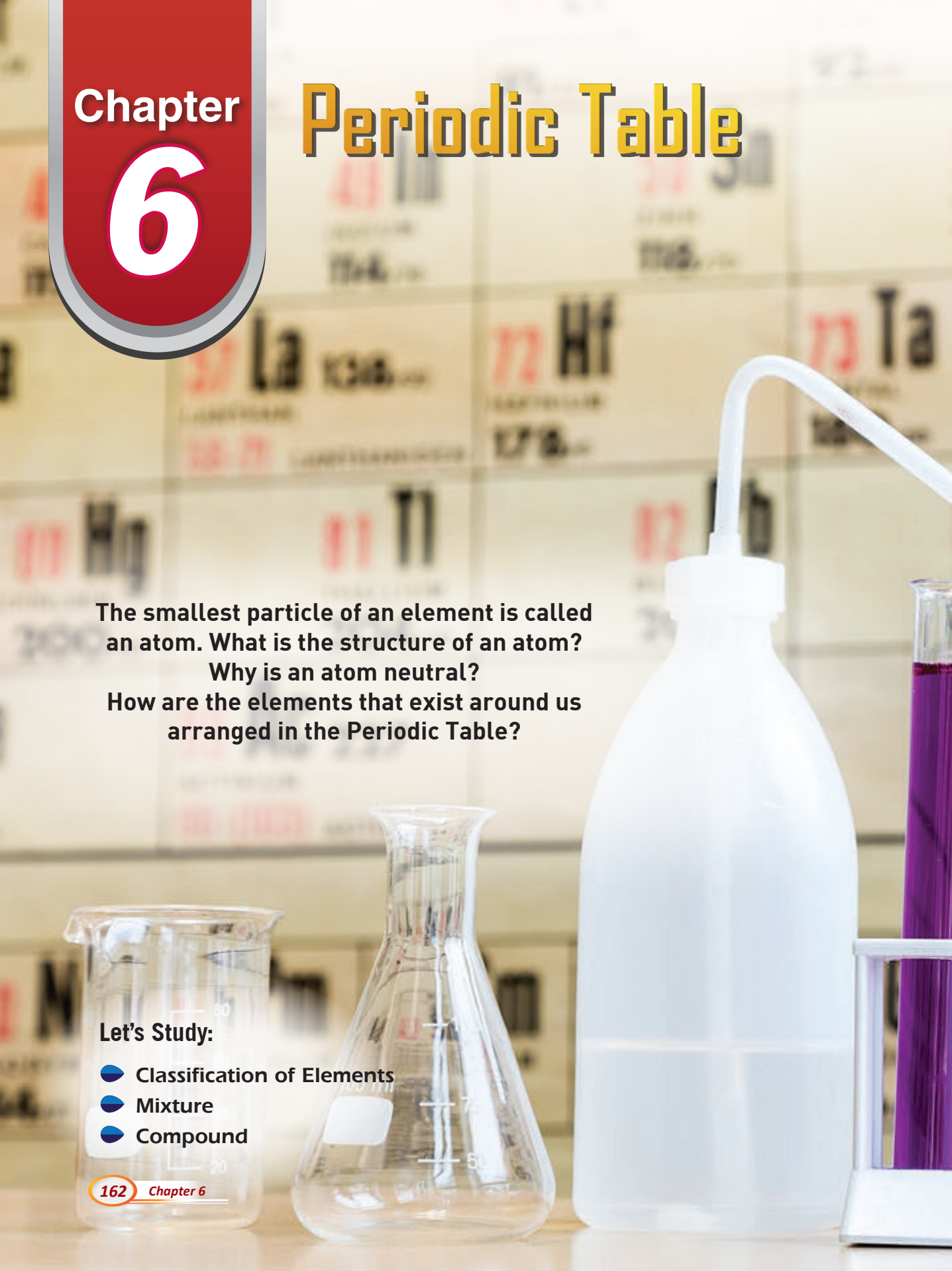
(a) How can you help the sailor to obtain pure water from seawater? Based on your knowledge on condensation, create an experiment that can be done using only the items in Figure 6.

Figure 6

(b) How can you prove that your experiment is a success? Suggest one simple way.

Chapter 6

Periodic Table



The smallest particle of an element is called an atom. What is the structure of an atom? Why is an atom neutral? How are the elements that exist around us arranged in the Periodic Table?

Let's Study:

- Classification of Elements
- Mixture
- Compound

SCIENCE BULLETIN

THE HISTORY OF PERIODIC TABLE

Have you ever seen the Periodic Table which is used by a chemist? Periodic Table is a compilation of chemical elements arranged in the form of a table. The elements in this table have a few common characteristics. The evolution of this table into the latest form is a great achievement by chemists and scientists.

Do you know that this table was introduced by Dimitri Mendeleev, a chemist from Russia? In 1869, Mendeleev wrote the characteristics for 63 found elements, together with the mass of the atom on a small piece of card and arranged in the form of a table. He left blank spaces to be filled with yet to be found elements. He had predicted the characteristics of the elements that have not been found yet. However, his prediction was doubted by other scientists.

In 1886, germanium was found. This new element fulfilled Mendeleev's prediction. Scientists finally accepted Mendeleev's idea. The Periodic Table has improved over time, in line with new findings of elements and theories.

KEYWORDS

- Atom
- Molecule
- Proton
- Electron
- Neutron
- Element
- Compound
- Periodic Table
- Non-metal
- Appearance
- Ductility
- Malleability
- Mixture
- Filtration
- Sedimentation
- Distillation
- Chromatography

6.1 Classification of Elements

Let's learn

- Conclude that all matter consists of atoms.
- Differentiate between atoms and molecules as well as elements and compounds.
- Identify the position of metal, non-metal and inert gases in the periodic table.
- Differentiate the characteristics of metals and non-metals.
- Appreciate the order of elements that exist in nature that has allowed people to organise them in the form of a table.

You have learned in Chapter 5 that all things that have mass and occupy space are matter. Matter consists of small and discrete particles which are known as atoms.

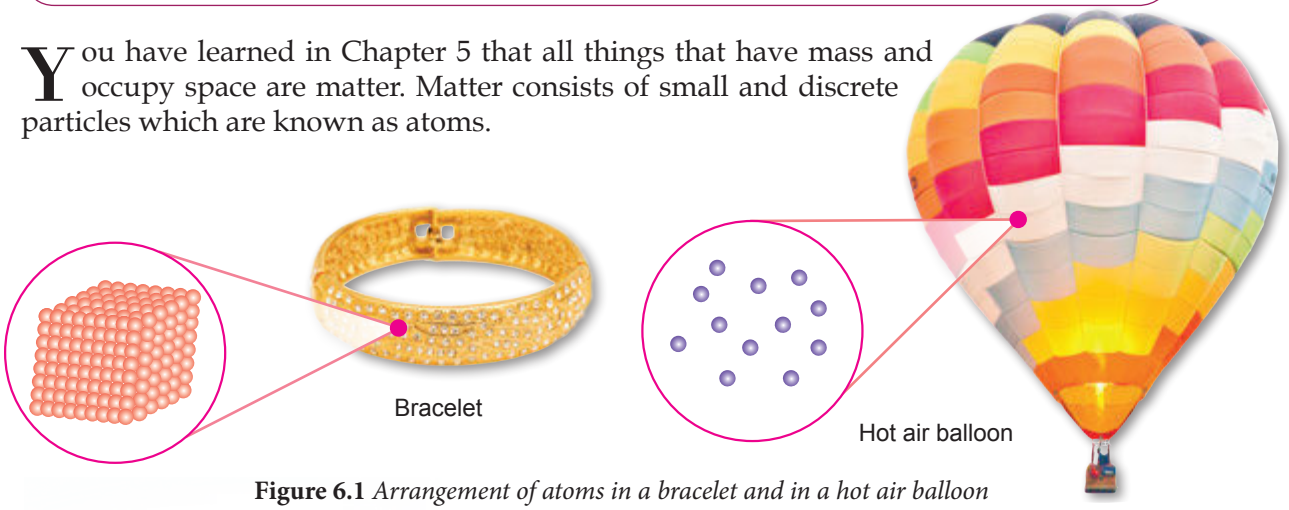


Figure 6.1 *Arrangement of atoms in a bracelet and in a hot air balloon*

An atom cannot be seen with our naked eyes because its size is too small. An atom can only be seen using an electron microscope by enlarging the atom to a million times. Imagine if an orange were an atom, it would be enlarged as big as the size of the Earth using an electron microscope (Figure 6.2).

Science Exploration

Metals and some non-metals like carbon and helium exist as atoms.

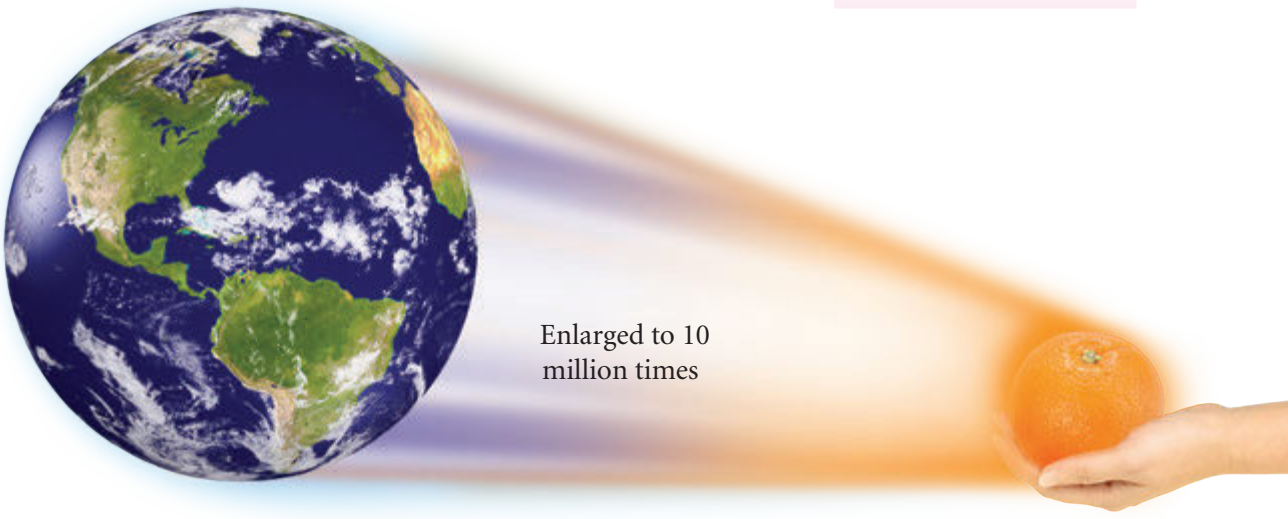


Figure 6.2

Atom and Molecule

An **atom** consists of three subatomic particles, which are **protons**, **neutrons** and **electrons**. Protons and neutrons are inside the nucleus of an atom, while the electrons circle around the nucleus.

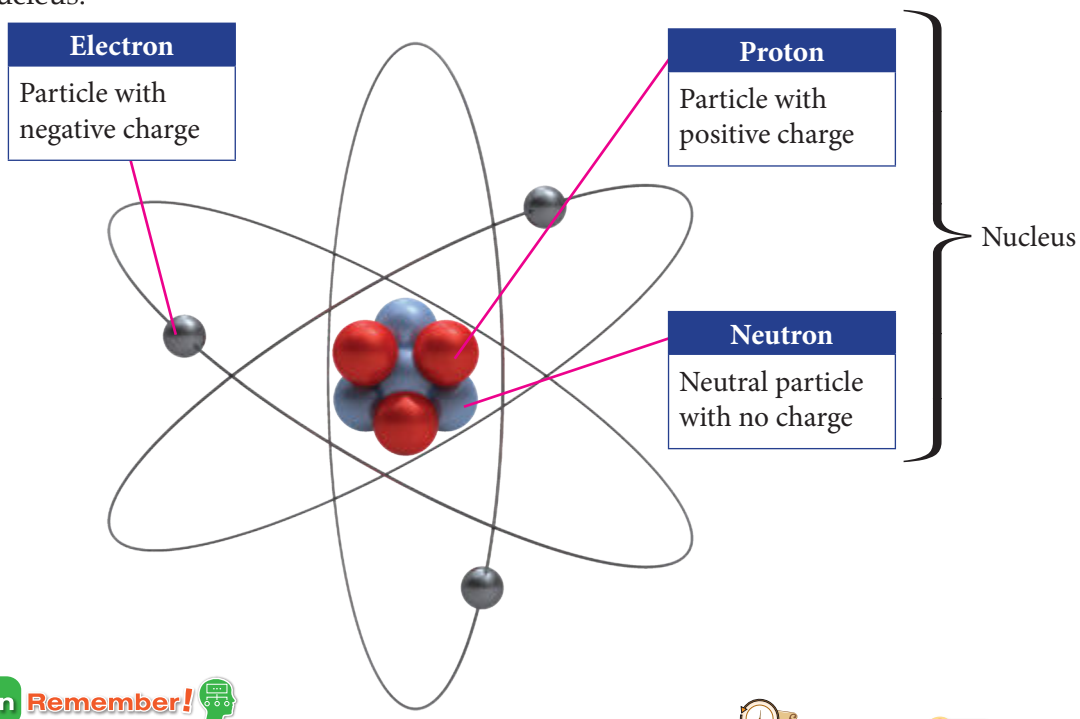


Figure 6.3 *The structure of an atom*

I Can Remember!

You can easily remember the subatomic particles in an atom by using the acronym

PEN

Proton
Electron
Neutron

History Corner

- Johnstone Stoney created the word **electron** in 1891.
- The word **nucleus** is derived from a Greek word which means *little nut*.

The nucleus has an overall positive charge due to the positively-charged protons in it. The number of electrons in an atom is equal to the number of protons. Thus, an atom is neutral.

Molecules are neutral particles made up of two or more atoms.

Figure 6.4 *Oxygen atom and oxygen molecule*

What is an Element?

An **element** is the simplest form of substance. It cannot be divided to two or more simpler substances. There is only one type of atom in an element.

Iron, oxygen, hydrogen, aluminium, carbon and copper are elements. Oxygen is the most abundant element that exists on Earth.

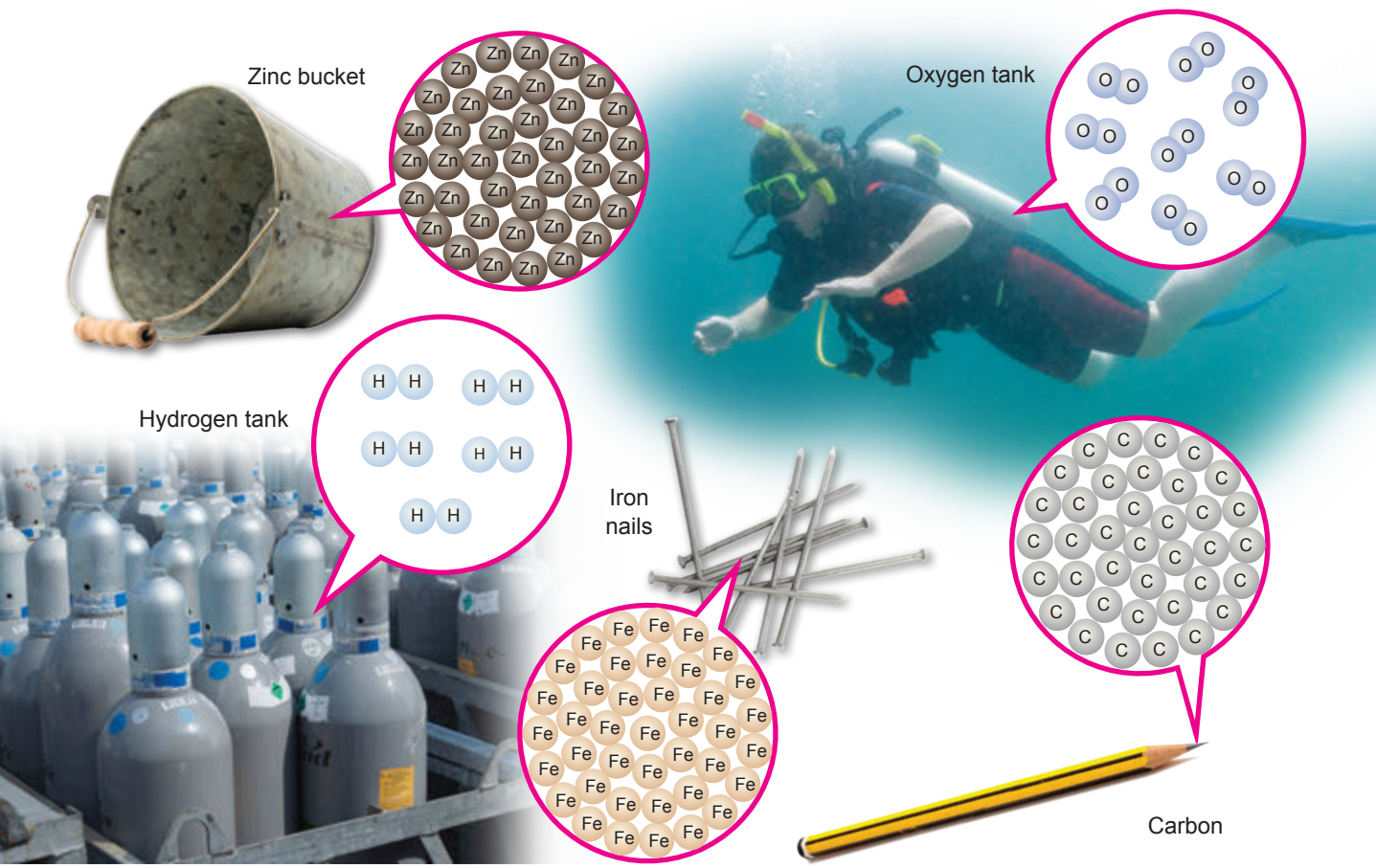
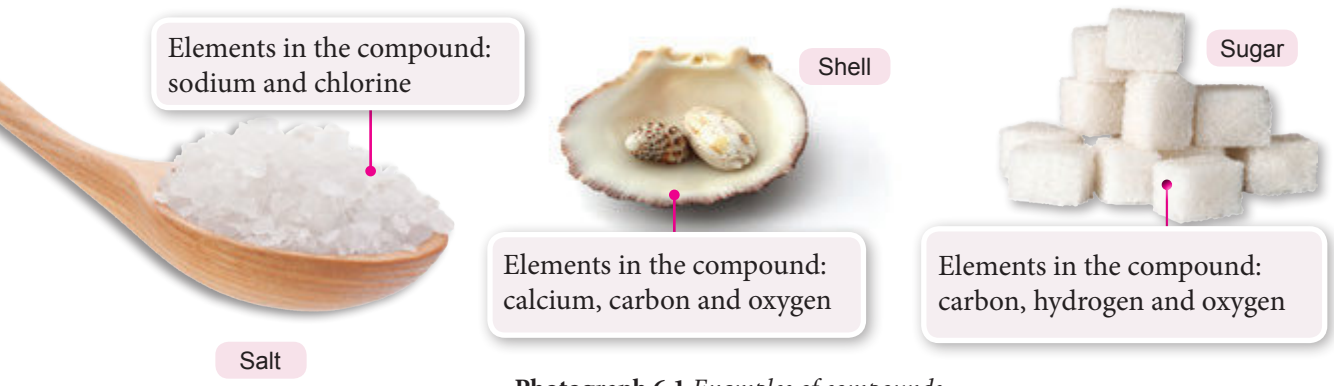


Figure 6.5 *An element consists of atoms of the same type*

What is a Compound?

A **compound** consists of two or more elements combined chemically. It is produced from a chemical reaction. Compounds can be produced in the laboratory or in a natural environment. Examples of compounds are aluminium oxide, zinc sulphide, iron chloride, sugar, water and salt.

How can the components of a compound be separated? The components in a compound cannot be separated physically but it can be done chemically, for example by using electrical energy (electrolysis). Photograph 6.1 shows examples of compounds.



Photograph 6.1 *Examples of compounds*

Periodic Table

During the 18th and 19th centuries, scientists discovered a lot of elements. They produced the **Periodic Table** which has been arranged in an orderly and in a systematic manner and is still being used today.

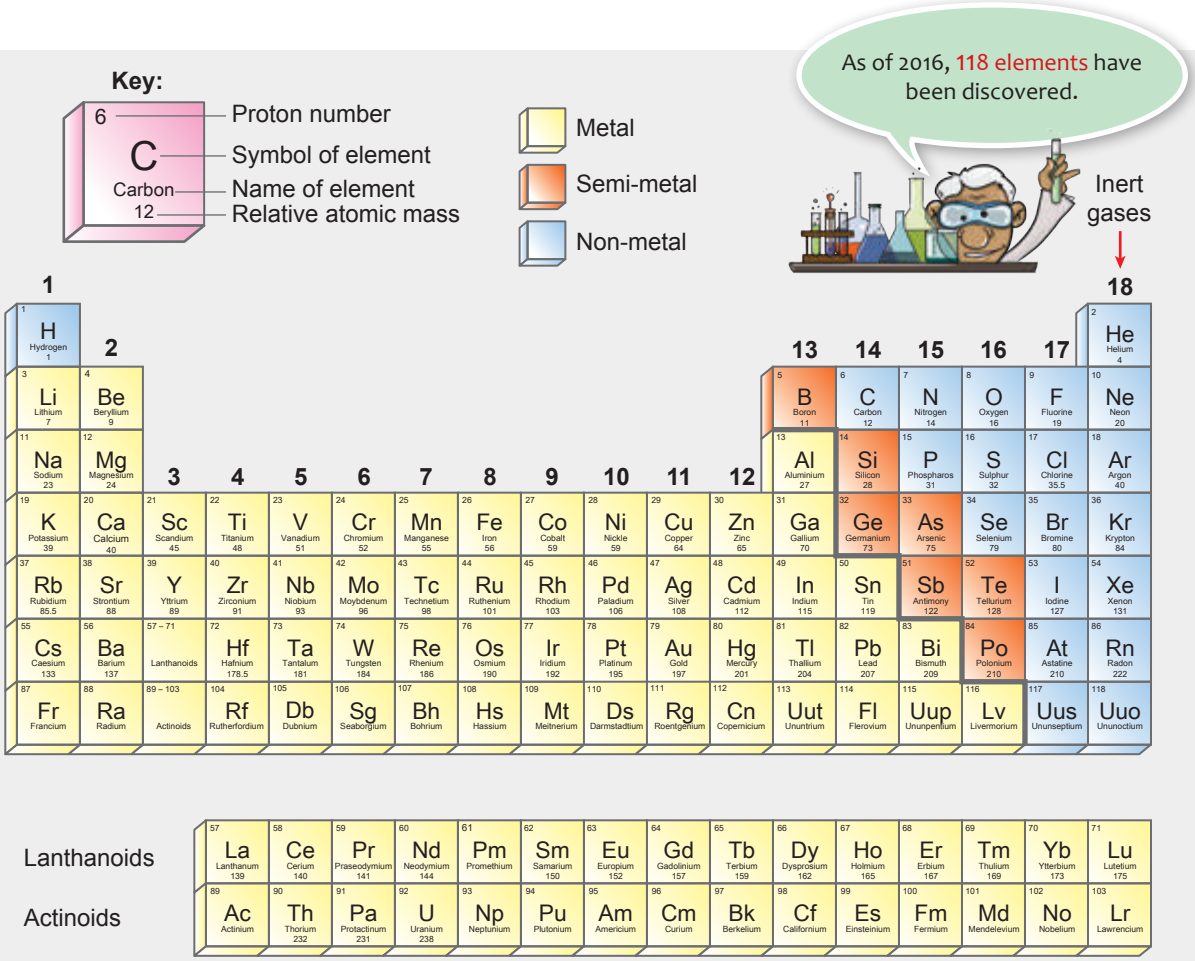


Figure 6.6 *The Periodic Table*

Science Today

In the past, some elements were named according to the substances they produced. The names end with 'gen' (abbreviated from 'generator'). Hence, hydrogen means 'water generator' and nitrogen means 'nitric acid generator'.

Today, the names of new elements have to be approved by the International Union of Pure and Applied Chemistry (IUPAC). Most of the elements were named after the person who discovered them, the place of discovery and the name of well-known scientists (Table 6.1). However, elements 113, 115, 117 and 118 have not been officially named yet.

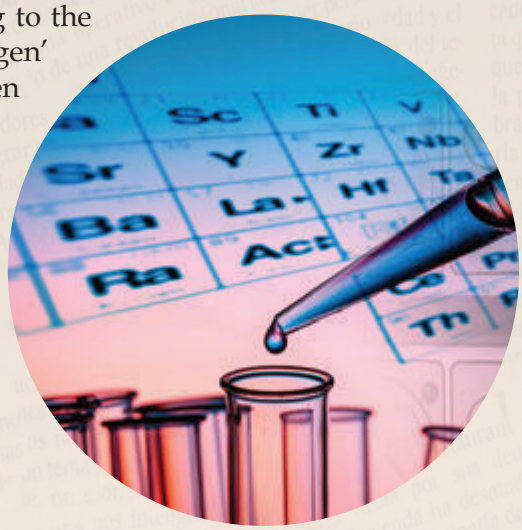


Figure 6.7 *Research of elements*

Table 6.1 *The new elements discovered by scientists*

Element	Name/ Symbol	Year of discovery	Named after
104	Rutherfordium (Rf)	1969	Ernest Rutherford, nuclear physicist
106	Seaborgium (Sg)	1974	Glenn Seaborg, chemist
107	Bohrium (Bh)	1976	Niels Bohr, physicist
109	Meitnerium (Mt)	1982	Lise Meitner, physicist
110	Darmstadtium (Ds)	1994	Darmstadt, Germany (place of discovery)
111	Roentgenium (Rg)	1994	Wilhelm Roentgen, physicist
112	Copernicium (Cn)	1996	Named after Nicolaus Copernicus, physicist, but discovered by Sigurd Hofmann
113	Ununtrium (Uut)	2003	Not officially named yet
115	Ununpentium (Uup)	2004	
117	Ununseptium (Uus)	2010	
118	Ununoctium (Uuo)	2006	

Activity 6.1

Aim: To identify the position of metals, non-metals and inert gases in the Periodic Table.

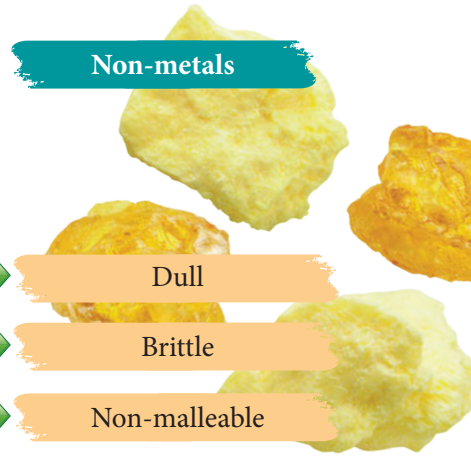
Instruction

1. Based on the Periodic Table, identify the position of metals, non-metals and inert gases.
2. State five examples of the elements in the following table.

Metal	Non-metal	Inert gas

Differences between Metals and Non-metals

Some elements have the same characteristics that allow these elements to be classified into two main categories, metal and non-metal. What are the differences between metals and non-metals?



Metals	Similarity	Non-metals
	• Both are elements	
	Differences	
Shiny	Appearance	Dull
Ductile	Ductility	Brittle
Malleable	Malleability	Non-malleable
High	Tensile strength	Low (break easily)
Good	Electrical conductivity	Poor (except carbon)
Good	Heat conductivity	Poor
High	Density	Low
High	Melting point and boiling point	Low

Figure 6.8 *The differences between metals and non-metals*

Metals

Aluminium

- Malleable
- Strong and light
- Grey and shiny

Hoe is made of iron

Science Exploration

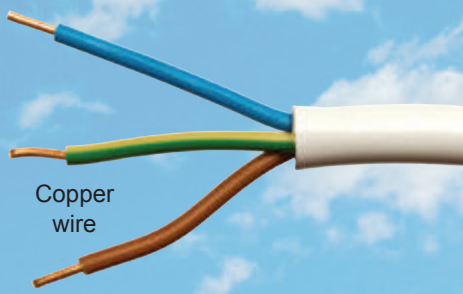
There are elements that cannot be classified into metals and non-metals such as germanium and silicon. These elements are semi-metals because both of them possess the characteristics of metals and non-metals.

Iron

- Strong
- Malleable
- Magnetic substance
- A good electric conductor
- Grey

Copper

- Strong
- Rustproof
- Ductile (bends easily)
- A good electric conductor
- Brown



Copper wire

Zinc roof

Zinc

- Strong
- Grey
- A good electric conductor

Figure 6.9 *Examples of metals and their characteristics*

Non-metals

Iodine

- Black crystal
- Poisonous
- Antiseptic (prevent injuries from bacterial infection)

Iodine

Iodine is used as an antiseptic substance

Chlorine

- Greenish yellow gas
- Bleaching agent
- Poisonous

Chlorine

Bleaching agent is made from chlorine

Sulphur

- Yellow powder
- Poisonous

Sulphur can harden rubber tyres

Carbon

- Black
- Smooth
- Light
- The only non-metal element that can conduct electricity

Pencil lead is made of carbon

Carbon is used to make racquets

Figure 6.10 *Examples of non-metals and their characteristics*

Experiment 6.2

Problem statement: What are the differences between metals and non-metals?

Aim: To study the characteristics of metals and non-metals

(I) Appearance of metals and non-metals

Hypothesis: Metals have a shiny surface

Variables
Manipulated variable: Type of material

Responding variable: The appearance of the material

Constant variable: Size of material

Materials and apparatus: Copper rod, carbon rod, sandpaper.

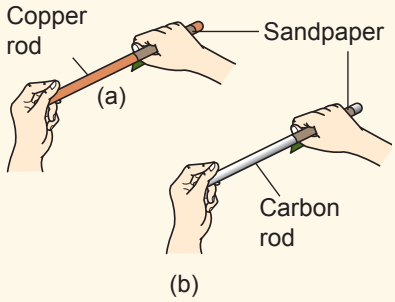


Figure 6.11

Procedure
1. Rub the surface of a copper rod and carbon rod with sandpaper (Figure 6.11).
2. Observe the appearance of the copper rod and carbon rod surface.
3. Record your observation.

(II) Ductility

Hypothesis: Metals are ductile.

Variables
Manipulated variable: Type of material

Responding variable: The ductility of material

Constant variable: Size of material

Materials and apparatus: Copper wire, pencil lead.

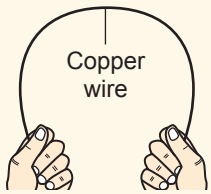


Figure 6.12

Procedure
1. Bend a copper wire to form a circle (Figure 6.12).
2. Repeat step 1 with a pencil lead (Figure 6.13).
3. Record your observation.

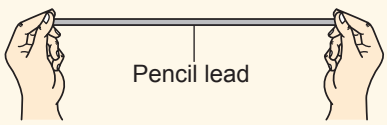


Figure 6.13

(III) Malleability

Hypothesis: Metals are malleable.

Variables
Manipulated variable: Type of material
Responding variable: The malleability of material
Constant variable: Size of material

Materials and apparatus : Iron piece, copper piece, sulphur piece, hammer, wooden block.

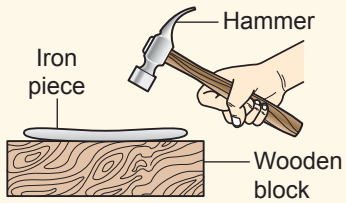


Figure 6.14

Procedure

1. Knock an iron piece on a wooden block using a hammer several times (Figure 6.14).
2. Observe the changes in the shape of the iron piece.
3. Repeat steps 1 and 2 using the copper and sulphur piece.
4. Record your observation.

(IV) Electrical conductivity

Hypothesis: Metals conduct electricity.

Variables

Manipulated variable: Type of material

Responding variable: The deflection of the ammeter's needle

Constant variable: Size of material

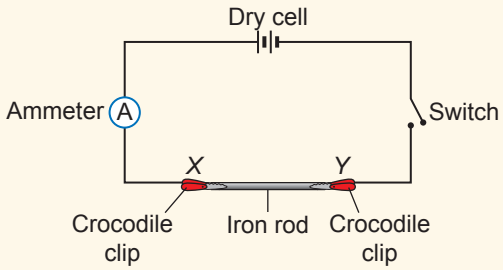


Figure 6.15

Materials and apparatus: Dry cell, ammeter, crocodile clips, iron rod, carbon rod, sulphur rod.

Procedure

1. Set up the apparatus as shown in Figure 6.15.
2. Connect the ends of an iron rod with crocodile clips.
3. Observe the deflection of the ammeter's needle.
4. Repeat steps 2 and 3 by replacing the iron rod with carbon rod and sulphur rod.
5. Record your observation.

(V) Heat conductivity

Hypothesis: Metals conduct heat.

Variables

Manipulated variable: Type of material

Responding variable: Time taken for the thumbtack to drop

Constant variable: Size of material

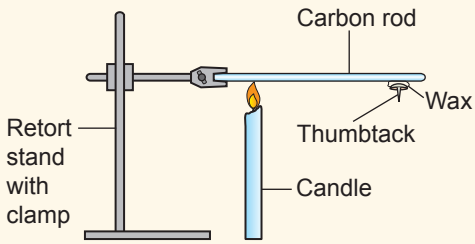


Figure 6.16

Materials and apparatus: Carbon rod, iron rod, copper rod, candle, stopwatch, thumbtack, wax, retort stand with clamp.

Procedure

1. Clamp a carbon rod to the retort stand.
2. Put the thumbtack at the end of the carbon rod.
3. Heat the other end of the carbon rod (Figure 6.16).
4. Observe and record the time taken for the thumbtack to drop.
5. Repeat steps 1-4 by using an iron rod and copper rod.

(VI) Melting point

Hypothesis: The melting point of metals are higher.

Variables
Manipulated variable: Type of materials

Responding variable: Melting point of material

Constant variable: Quantity of materials

Materials and apparatus: Thermometer (0-360°C), crucible, Bunsen burner, pipeclay triangle, tripod stand, tin powder, sulphur powder.

Procedure
1. Heat tin powder in a crucible (Figure 6.17).
2. Observe and record the melting point of the tin powder.
3. Repeat steps 1 and 2 with sulphur powder.
4. Record your observation.

CAUTION!

These activities might produce poisonous gases. Do these activities in a fume chamber.

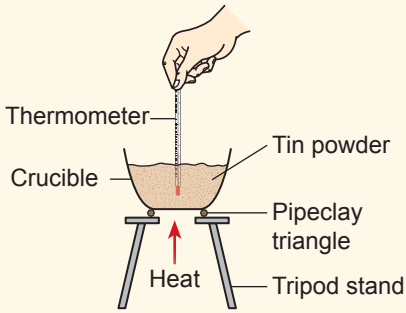


Figure 6.17

Results

Physical characteristic	Metal	Non-metal
Appearance		
Ductility		
Malleability		
Electrical conductivity		
Heat conductivity		
Melting point		

Conclusion:
Are the hypotheses accepted?

Questions
1. What is the difference between the appearance of copper rod and carbon rod surface?
2. Between copper wire and pencil lead, which one can be bent?
3. Between iron and sulphur pieces, which one is malleable?
4. Which one can conduct electricity - iron, carbon or sulphur?
5. Between iron and carbon rod, which one can conduct heat?
6. Between tin and sulphur powder, which one has a higher melting point?

Appreciate the Order of Elements that Exist in Nature

There are numerous natural elements found on Earth that benefit humans. Examples of the usage of these elements are:

- jewellery made of gold, silver and platinum.
- in construction, transportation, health, medicine, agriculture and industries.

History Corner

Antoine Lavoisier was the first scientist who classified elements as metals and non-metals.

Photograph 6.2 *Antoine Lavoisier*

We must also **appreciate the scientists** who have found and arranged the elements systematically in the Periodic Table. A lot of time was spent on researching the characteristics of these elements.

Activity 6.3

21st Century ISS

Aim: To present the order of elements that exist in nature

Instruction

1. Work in groups.
2. Do an Internet research on the reasons why scientists are still searching for a new way to present the Periodic Table.
3. Type the word "Periodic Table" on your search engine and click on "Images". You will find various versions of the Periodic Table including the table arranged by Stowe and Tarantola. Study how the elements were arranged by them.
4. Make a creative presentation of your findings from the Internet.

Formative Practice 6.1

1. State the subatomic particles.
2. Why is an atom neutral?
3. What is meant by element and compound?
4. Explain briefly the difference between atom and molecule.
5. How are the elements arranged in the Periodic Table?
6. Classify the elements below to metals and non-metals.

carbon, magnesium, iodine, chlorine, neon, argon, aluminium, copper, iron, gold, mercury

7. You are given element *X*. What should you do to identify the element?

6.2 Mixtures

Let's learn

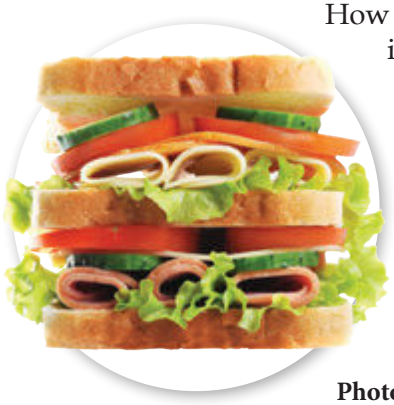
- Communicate about examples of mixtures in daily life.
- Solve problem of separating mixtures through activities based on the different characteristics of material and physical methods.

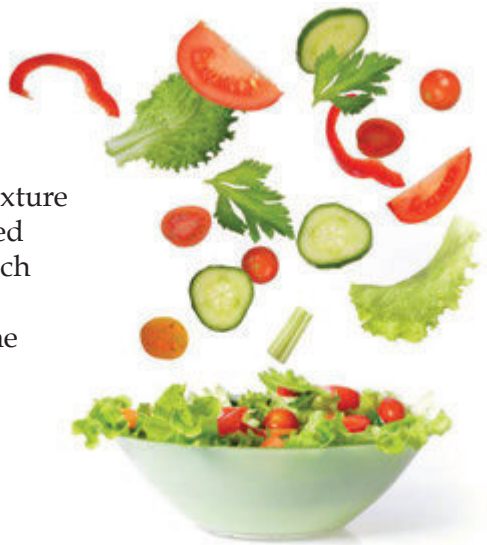
A mixture consists of **two** or **more elements** or **compounds mixed physically**. Let us see some examples of mixtures (Figure 6.18). Can you list a few more examples of a mixtures that you always use?

Figure 6.18 *Example of mixtures*

Methods to Separate Mixtures

How can a mixture be separated? As the mixture is formed **physically**, it can be separated physically too. For example, a sandwich is made of bread, vegetables and meat. Therefore, we can separate the ingredients easily through a physical method.





Photograph 6.3 *Salad and sandwich are examples of mixtures that can be separated easily through a physical method.*

Figure 6.19 shows a few methods to separate mixtures.

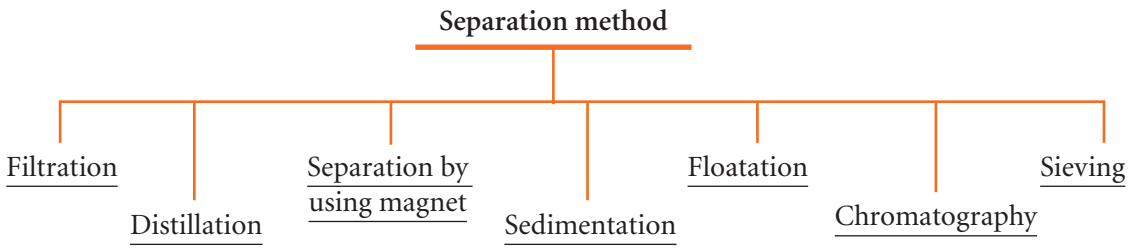


Figure 6.19 *Methods to separate mixtures*

Photograph 6.4 *Impurities can be removed from flour by the sieving method.*

Photograph 6.5 *Harmful substances in food colouring can be detected by the chromatography method.*

The separation method depends on:

- Physical properties of the substances present in the mixture
- Substance(s) to be obtained from the mixture

Science in Life

(a) Filtration

Filtration is a method used to separate an insoluble solid from a mixture of solid and liquid.

Photograph 6.6 *Example of filtration*

Let us do Activity 6.4 to learn how to separate a mixture using filtration method.

Activity 6.4

Aim: To separate a mixture using filtration method

Materials and apparatus: Sand, distilled water, filter paper, filter funnel, two 50 ml beakers, spatula, glass rod, retort stand with clamp.

Instruction

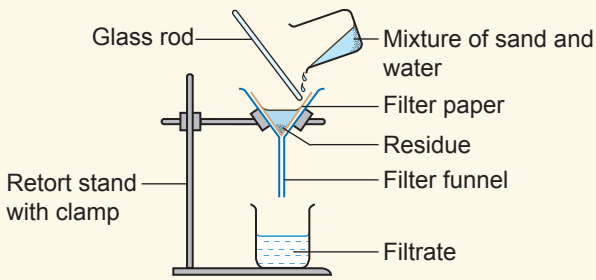


Figure 6.20

1. Add two spatulas of sand to 30 ml of water in a beaker.
2. Stir the mixture of sand and water for two minutes.
3. Filter the mixture (Figure 6.20).
4. Record your observation.

Questions

1. What are the states of matter of sand and water?
2. Can the sand be separated physically from water?
3. Name the residue and filtrate in this activity.

(b) Distillation

Distillation is the method used to separate a completely miscible liquid-liquid mixture that have different boiling points. How does distillation work? Do Activity 6.5 to find out how distillation is carried out.

Distillation
www.bbc.co.uk

Activity 6.5

Aim: To separate a mixture using distillation method.

Apparatus and Materials: Mixture of water and alcohol, porcelain chips, thermometer, tripod stand, Bunsen burner, wire gauze, Liebig condenser, retort stand with clamp, round-bottom flask, beaker.

Instruction

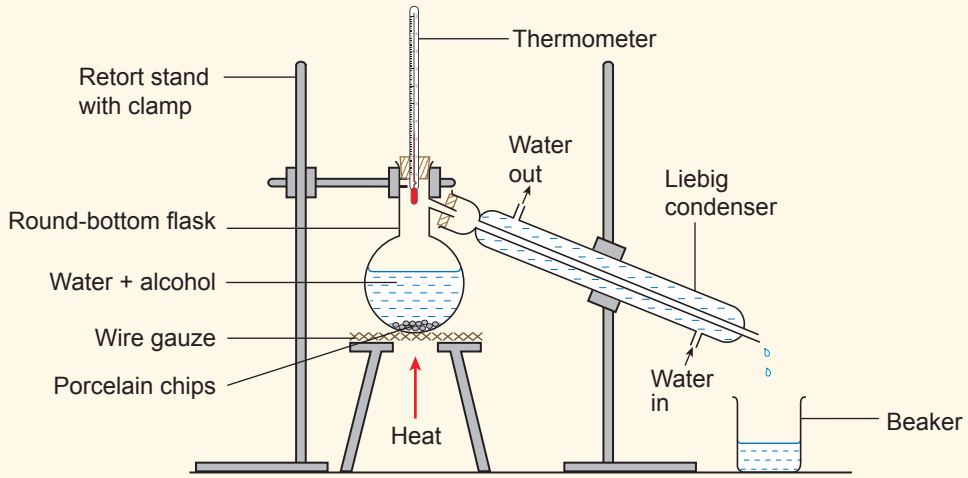


Figure 6.21

1. Pour the mixture of water and alcohol into the round-bottom flask until it is half full and add in some porcelain chips.
2. Flow the water through the Liebig condenser (Figure 6.21).
3. Heat the mixture of water and alcohol and collect the liquid that flows out of the Liebig condenser using a beaker.
4. Record the temperature of the liquid. Determine the boiling point of the liquid.

Questions

1. At what temperature does the liquid start to flow out of the condenser?
2. What is the use of porcelain chips in this experiment?

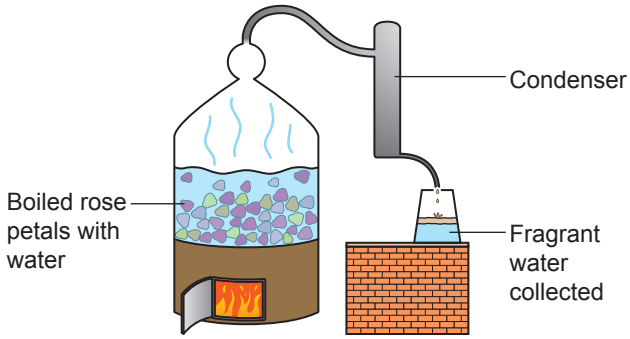


Figure 6.22 *Perfume is produced through distillation*

Photograph 6.7 *Perfume*

(c) Separation Using Magnet

If you hold a magnet close to a box of iron nails mixed with sand, what would happen? Iron nails are metals and magnetic substance. Hence, they will be attracted to the magnet. But, sand is not a magnetic substance. Therefore, it will remain inside the box.

Photograph 6.8 *Iron nails are attracted to a magnet*

Magnetic attraction can be used to separate two solid mixtures in which one of the substances is magnetic and the other is not. Iron, nickel and cobalt are examples of magnetic metals. Meanwhile, gold, bronze and aluminium are examples of non-magnetic metals.

Science Exploration

Most food industries use a magnet separator to ensure that iron particles are not mixed with the food products.

Photograph 6.9 *A strong magnet is used to salvage iron and steel from a junkyard*

Activity 6.6

Aim: To separate a mixture using magnet.

Materials and apparatus: Mixture of iron and sulphur powder, spatula, Petri dish, magnet bar, paper.

Instruction

1. Put one spatula of iron powder and sulphur powder into a Petri dish.
2. Hold a magnet bar near the mixture (Figure 6.23).

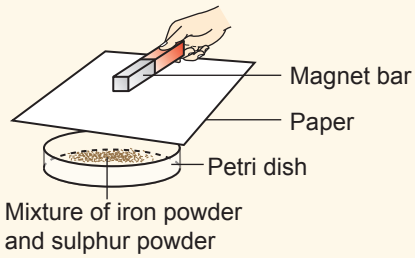


Figure 6.23

Questions

1. Which powder will be attracted to the magnet?
2. Is the powder that you answered in question 1, a metal or non-metal?

(d) Sedimentation method

What can you observe when sand is poured into a beaker filled with water? Look at Photograph 6.10. Two layers are formed in which the water is at the upper layer and the sand is deposited at the base of the beaker. This is because the sand is not soluble in water and has a higher density. Therefore, the **sedimentation method** is used to separate a liquid and insoluble solid mixture. Let us carry out the sedimentation method in Activity 6.7.

Photograph 6.10 *Sand deposited at the base of the beaker filled with water*

Activity 6.7

Aim: To separate a mixture using sedimentation method

Materials and apparatus: Silty solution, two 100 ml beakers, glass rod

Instruction

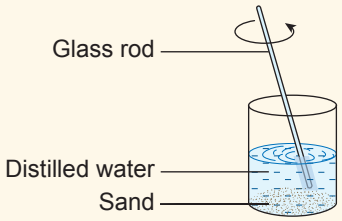


Figure 6.24 (a)

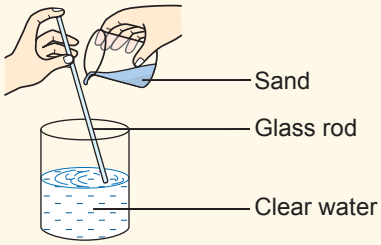


Figure 6.24 (b)

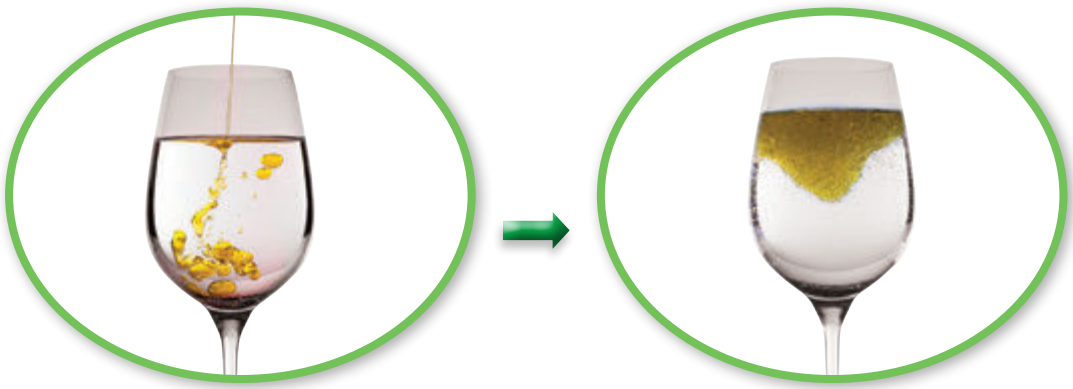
1. Pour 50 ml of silty solution into a 100 ml beaker.
2. Stir the silty solution by using a glass rod. (Figure 6.24 (a)).
3. Observe the water and silt after a while.
4. Slowly, pour the clear water from the beaker into an empty beaker (Figure 6.24(b)).
5. Observe the sediment left inside the beaker.

Questions

1. Which substance is left inside the beaker?
2. Can water and sand be separated physically?

(e) Floatation Method

Floatation method can be used to separate soluble and insoluble materials in water. For example, oil has a lower density than water. Therefore, oil will float on the water surface. A separating funnel can be used to separate the oil and water. Do Activity 6.8 to understand this method further.



Photograph 6.11 *Oil floats on the water surface*

Activity 6.8

Aim: To separate a mixture using the floatation method.

Materials and apparatus: Mixture of water and oil, beakers, separating funnel, 100 ml measuring cylinder, retort stand with clamp.

Instruction

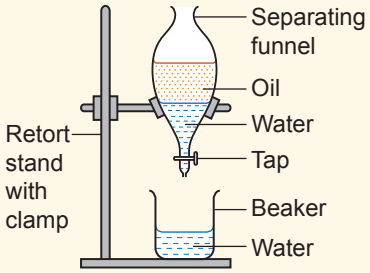


Figure 6.25

1. Pour 100 ml water and oil mixture into a beaker. Record your observation.
2. Pour the mixture into a separating funnel (Figure 6.25).
3. Separate the water and oil using different beakers.

Questions

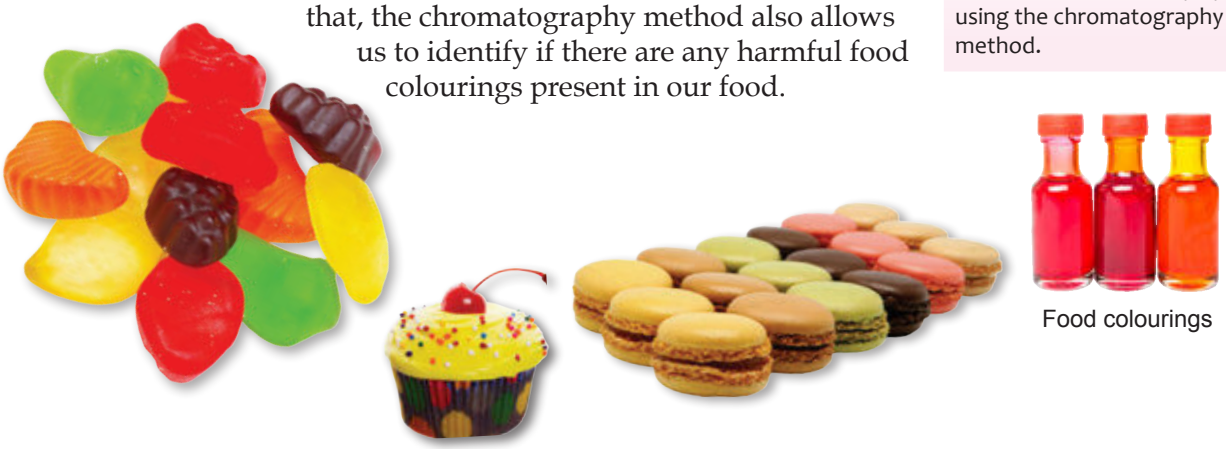
1. Between water and oil, which one floats? Why?
2. Can oil and water be separated physically?

(f) Chromatography Method

Separation methods like filtration and distillation need a large amount of mixture to separate the substances. How is a small amount of mixture separated? One of the methods is by using **chromatography**. This method is usually used to check document fraud by separating the colours from the ink used. Besides that, the chromatography method also allows us to identify if there are any harmful food colourings present in our food.

Science Exploration

There are athletes who use illegal drugs to increase their energy and stamina. Urine samples are tested to detect the drug content inside the body by using the chromatography method.



Photograph 6.12 *Various types of food with food colourings*

Activity 6.9

Aim: To separate a mixture by using chromatography method.

Materials and apparatus: 250 ml beaker, distilled water, filter paper, ruler, whiteboard marker pen (red, green and blue ink), skewer.

Instruction

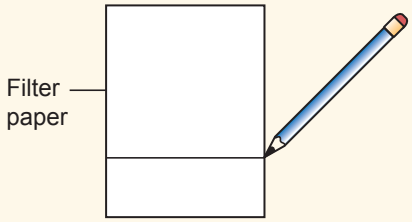


Figure 6.26

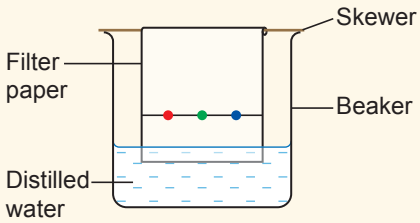


Figure 6.27

1. Prepare a piece of filter paper with the measurement of 5 cm × 12 cm.
2. Draw a line 1.5 cm from the edge of the paper with a pencil (Figure 6.26).
3. Draw three dots along the line using different whiteboard marker pens. Hang the filter paper in the beaker using a skewer and dip the end of the paper into the distilled water. Make sure the water does not touch the dots (Figure 6.27).
4. Observe for 30 minutes.
5. Record your observation.

Questions

1. What are the colours produced on the filter paper?
2. Is the colour produced the same as the ink of the whiteboard marker pen?

Chromatography method
www.bbc.co.uk

Formative Practice 6.2

1. Define mixture.
2. Match the following mixtures according to its suitable separation method.

Type of mixture		Separation method
Paper clips and glass fragments	•	• Filtration
Water and ethanol	•	• Distillation
Three types of water-soluble ink	•	• Chromatography
Soil and water	•	• Using magnet
Oil and water	•	• Sedimentation
Coffee powder and water	•	• Floatation

3. If you were given a mixture that contains rice and sand, can you separate them using filtration method? Why?

6.3 Compounds

Let's learn

- Communicate about compounds in daily life.
- Demonstrate the formation of compounds between metals and non-metals.
- Conclude that mass is conserved during a chemical change.
- Separate compounds using chemical methods.
- Differentiate between chemical change and physical change.
- Differentiate between mixtures and compounds.

A compound consists of two or more elements that are mixed chemically. This newly formed product has its own characteristics. There are a lot of compounds that we use such as salt, sugar, chalk, marble, polythene (a type of plastic) and water.

Science Exploration

Rusting is an example of a compound formed by a chemical reaction between iron and oxygen.

Photograph 6.13 *A rusty padlock*

Photograph 6.14 *Examples of compounds*

Activity 6.10

Aim: To show the usage of compounds in daily life.

Instruction

1. Work in groups.
2. Prepare a creative multimedia presentation on the examples of compounds that exist around you.
3. Present to your class.

How do metal and non-metal elements combine chemically to form a compound? Magnesium, zinc, iron and copper react with oxygen to form the metal oxide.

magnesium	+	oxygen	→	magnesium oxide
aluminium	+	oxygen	→	aluminium oxide
zinc	+	oxygen	→	zinc oxide
iron	+	oxygen	→	iron oxide
copper	+	oxygen	→	copper oxide

There are some metals that react with water to form alkali compounds and release hydrogen gas. These elements are known as alkali metals. Examples of alkali metals are lithium, sodium and potassium.

lithium	+	water	→	lithium hydroxide	+	hydrogen gas
sodium	+	water	→	sodium hydroxide	+	hydrogen gas
potassium	+	water	→	potassium hydroxide	+	hydrogen gas

Iron and sulphur powder will form iron sulphide when heated.

iron + sulphur → iron sulphide

Activity 6.11

Aim: To produce a compound

Materials and apparatus: Sulphur powder, iron powder, Bunsen burner, crucible with lid, tripod stand, pipeclay triangle, weighing balance

Procedure

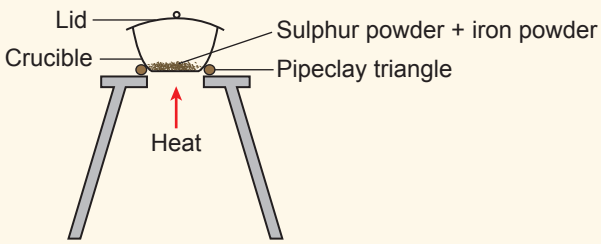


Figure 6.28

1. Put one spatula of sulphur powder and one spatula of iron powder into the crucible. Stir well. Record the colour of the mixture.
2. Weigh the mixture. Record the initial mass.
3. Heat the mixture until the colour changes (Figure 6.28).
4. Let the product cool. Weigh and record the final mass of the product.

Questions

1. What is the colour of the mixture when it is heated?
2. Write the word equation of the chemical reaction that occurred.
3. What is the product of this reaction?
4. Is there any change in the mass of the compound before and after heating?

After carrying out Activity 6.11, you can see that a metal and a non-metal form a compound when heated together and the total mass before and after heating is the same and does not change. This phenomenon always occurs in our daily life. All mineral salts that are found in nature exist in the form of compounds due to the chemical reaction that occurs, except for gold, silver and platinum.

Methods to Separate Compounds

Compounds cannot be separated physically like mixtures because the elements in a compound are bonded chemically. Therefore, a compound can only be separated chemically by electrolysis. What is electrolysis?

Electrolysis is a chemical decomposition of a compound to its elements by passing an electric current through the compound.

Let us see how oxygen and hydrogen are separated from water through electrolysis in Figure 6.29.

- Water consists of hydrogen and oxygen.
- Therefore, to separate the hydrogen and oxygen from water, the water must undergo the electrolysis process.
- Figure 6.29 shows how electrolysis is done. This process produces hydrogen gas at the negative electrode (cathode) and oxygen gas at the positive electrode (anode).

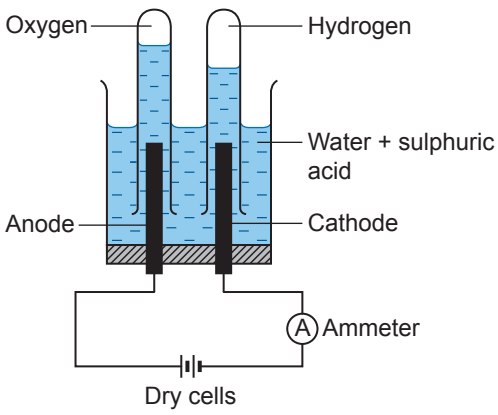


Figure 6.29 *Electrolysis of water*

Physical Change and Chemical Change

All substances undergo changes. These changes can be divided into two; physical change and chemical change. What is meant by physical change and chemical change?

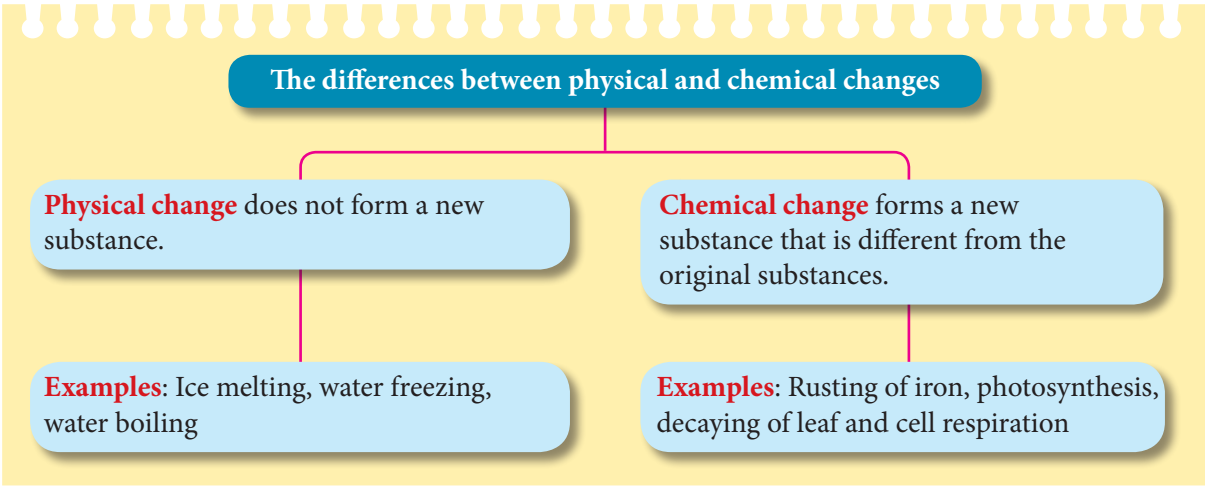


Figure 6.30 *The differences between physical and chemical changes*

Comparison between physical change and chemical change is shown in Figure 6.31

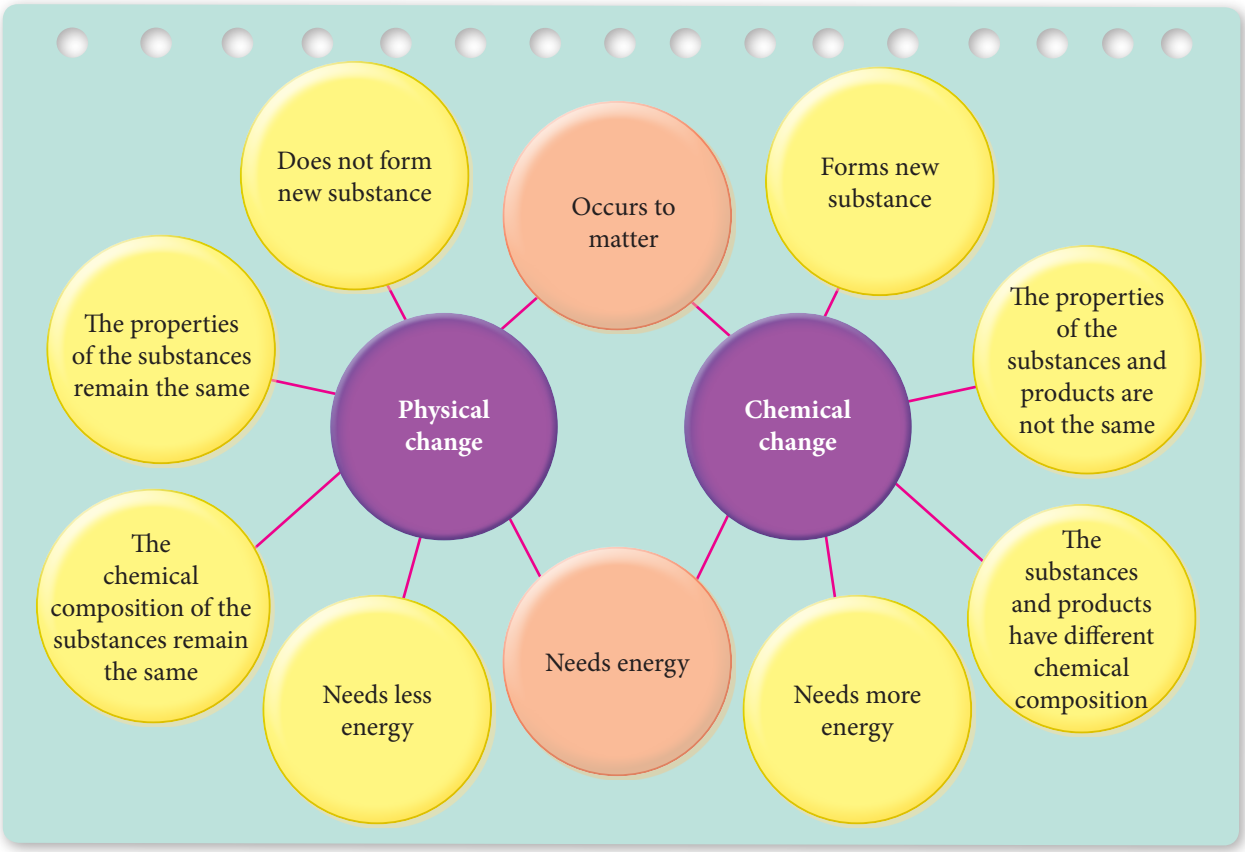


Figure 6.31 *Comparison between physical change and chemical change*

Differences between Mixtures and Compounds

After learning about mixtures and compounds, can you differentiate both of them? Table 6.2 shows the differences between mixtures and compounds.

Table 6.2 *The differences between mixtures and compounds*

Mixtures	Characteristic	Compounds
No	Formation of new substances	Yes
No	Chemical bond	Yes
Physical	Separation method	Chemical
Same	Properties of new substances compared to the original	Different

Activity 6.12

Aim: To prepare a multimedia presentation on the similarities and differences between mixtures and compounds

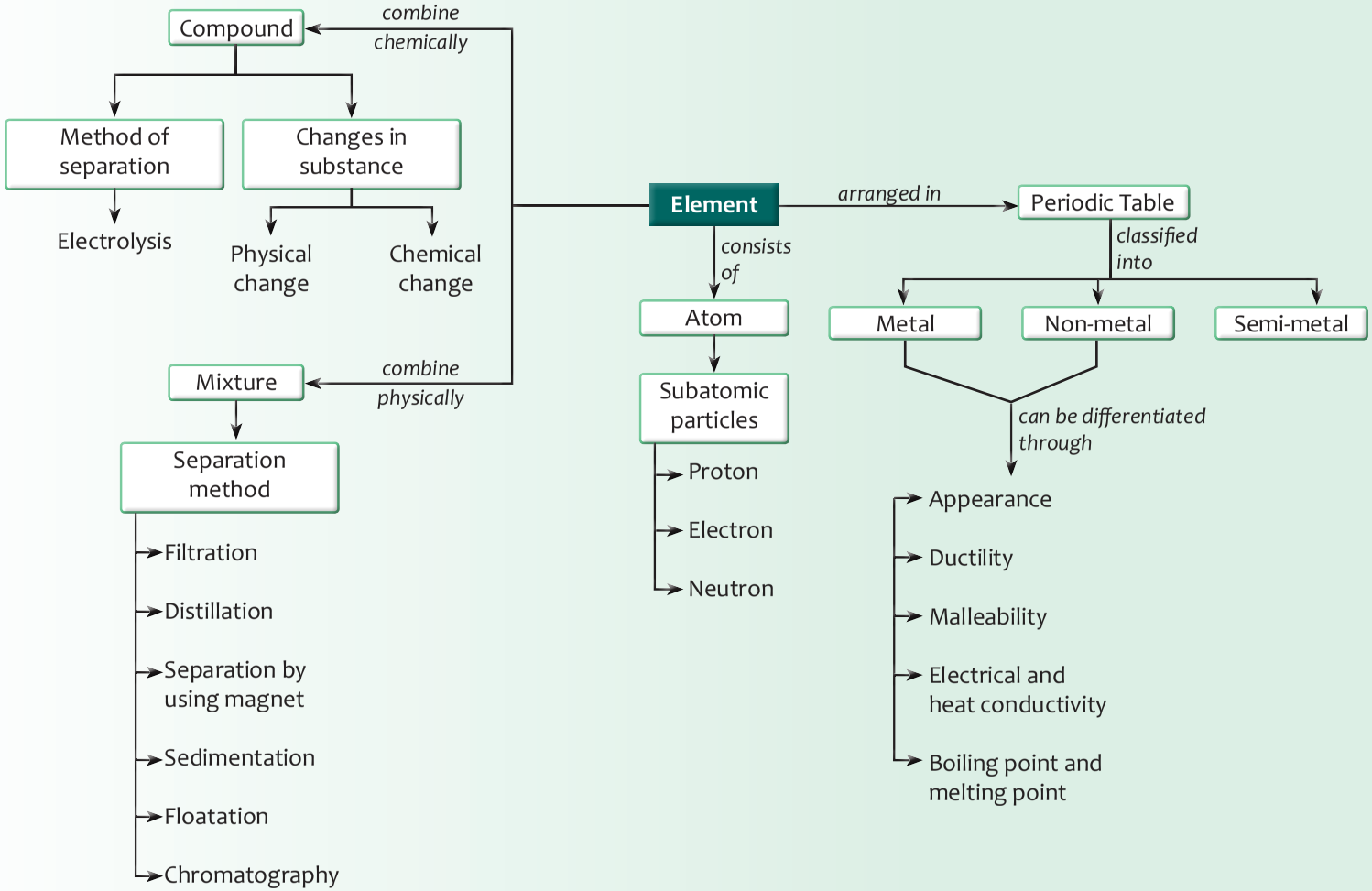
Instruction

1. Work in groups.
2. Compare and contrast between mixtures and compounds.
3. You must include pictures and graphics to show your understanding of this topic.
4. Prepare a multimedia presentation of your discussion.
5. Present your discussion in class.

Formative Practice 6.3

1. Define compound.
2. List five examples of compounds.
3. How can you separate a compound?
4. State the differences between a mixture and a compound.

Concept Map


Compound
combine chemically
Method of separation
Changes in substance
Electrolysis
Physical change
Chemical change
Element
arranged in
Periodic Table
classified into
consists of
Atom
Subatomic particles
Proton
Electron
Neutron
Metal
Non-metal
Semi-metal
can be differentiated through
Appearance
Ductility
Malleability
Electrical and heat conductivity
Boiling point and melting point
Mixture
combine physically
Separation method
Filtration
Distillation
Separation by using magnet
Sedimentation
Floatation
Chromatography

SELF-REFLECTION

After studying this chapter, you can:

6.1 Classification of Elements

- ☐ Conclude that all matter consists of atoms.
- ☐ Differentiate between atoms and molecules as well as elements and compounds.
- ☐ Identify the position of metals, non-metals and inert gases in the Periodic Table.
- ☐ Differentiate the characteristics of metals and non-metals.

6.2 Mixtures

- ☐ Communicate about examples of mixtures in daily life.
- ☐ Solve problems of separating mixtures.

6.3 Compounds

- ☐ Communicate about compounds in daily life.
- ☐ Demonstrate the formation of compounds from metals and non-metals.
- ☐ Conclude that mass is conserved during chemical change.
- ☐ Separate compounds through chemical methods.
- ☐ Differentiate between chemical change and physical change.
- ☐ Differentiate between mixtures and compounds.

Summative Practice 6

1. Figure 1 shows three shapes - circle, square and pentagon which represent atoms from different elements.

Based on Figure 1, identify the combination of atoms that represent

(a) molecule of a compound.

(b) molecule of an element that consists of two atoms.

(c) molecule of an element that consists of three atoms.

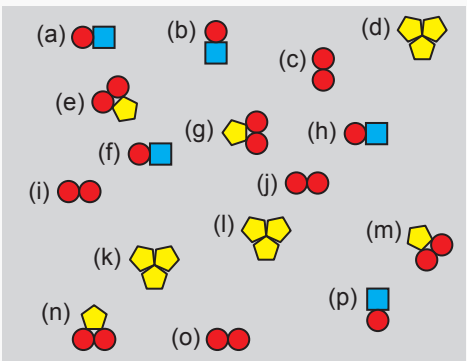


Figure 1

2. Figure 2 shows part of the Periodic Table.

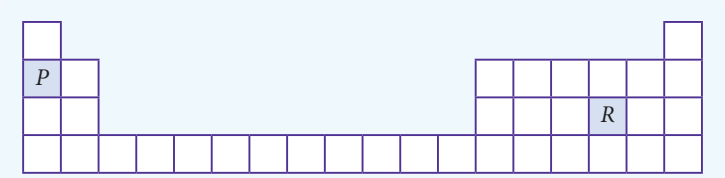


Figure 2

(a) State the type of element for *P* and *R*.
(b) What are the differences in physical characteristics of *P* and *R*?
(c) Iron is a type of metal that has a shiny surface. However, iron can rust easily. Explain.
(d) Graphite is an example of carbon. What are the characteristics of graphite that make it suitable to be used as pencil lead?

3. Noraini wants to make pineapple jam using the recipe given by her mother as shown in Figure 3.

Pineapple Jam

1. Remove pineapple skin and grate the pineapple.
2. Blend the pineapple using a blender.
3. Remove the excess juice.
4. Cook the blended pineapple on medium heat. Add some sugar, salt and yellow food colouring.
5. Stir the mixture until it thickens and is sticky.
6. Then, cool the jam and keep it in the refrigerator.

Figure 3

(a) Name the separation method used in the recipe.
(b) Which step involves the separation method that you stated in 3(a)?

4. Kumutha is given a mixture of sand, iron filings, sawdust and salt. She separates the mixture by following the four steps in Figure 4. The letters *A*, *B*, *C* and *D* represent the substances in the mixture.

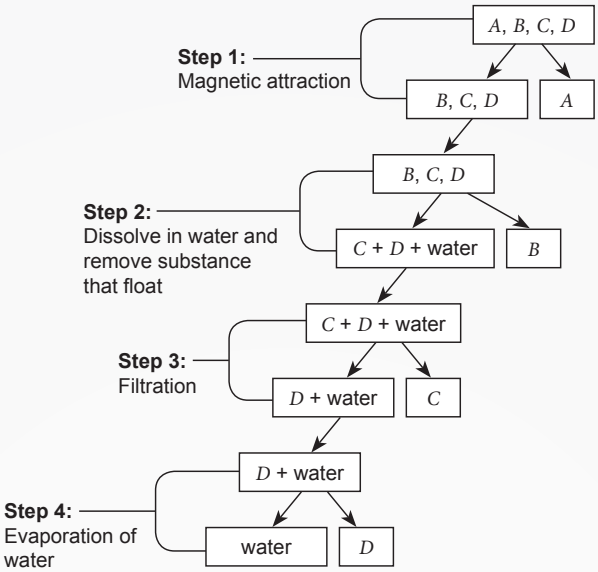


Figure 4

(a) Identify substance *A*, *B*, *C* and *D* whether they are sand, iron filings, sawdust or salt.

(b) Differentiate the density of *B* and *C*. Why can *B* be separated from the mixture in Step 2? Explain.

(c) If *D* is replaced with sugar, can it still be separated from the water by applying Step 4?

(d) Is there another way that Kumutha could do to separate the mixture in Step 4? Explain your answer.

The Next Challenge . . .

5. A few students set up the apparatus as shown in Figure 5 to separate sand and salt. They found out that the mixture took a longer time to be filtered. Therefore, they decided to stir the mixture on the filter paper using a glass rod. Is it a good idea? Give your reason (s).

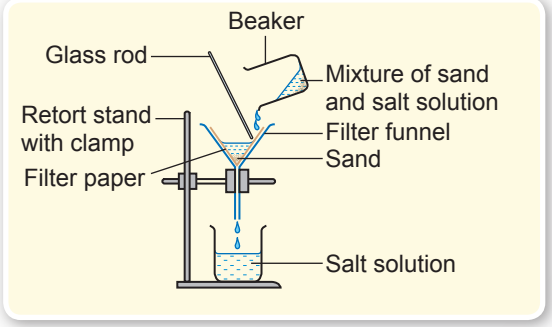


Figure 5

6. Athirah accidentaly spills sand into a salt container. How can she separate the salt and sand from the mixture? State the separation method that she needs to use. Explain the steps in the separation method.

Chapter 7

Air

Why must we take care of the air around us?
What is the composition of the air?
How can we maintain the quality of the air?

Let's Study:

- Composition of Air
- Combustion
- Air Pollution

SCIENCE BULLETIN

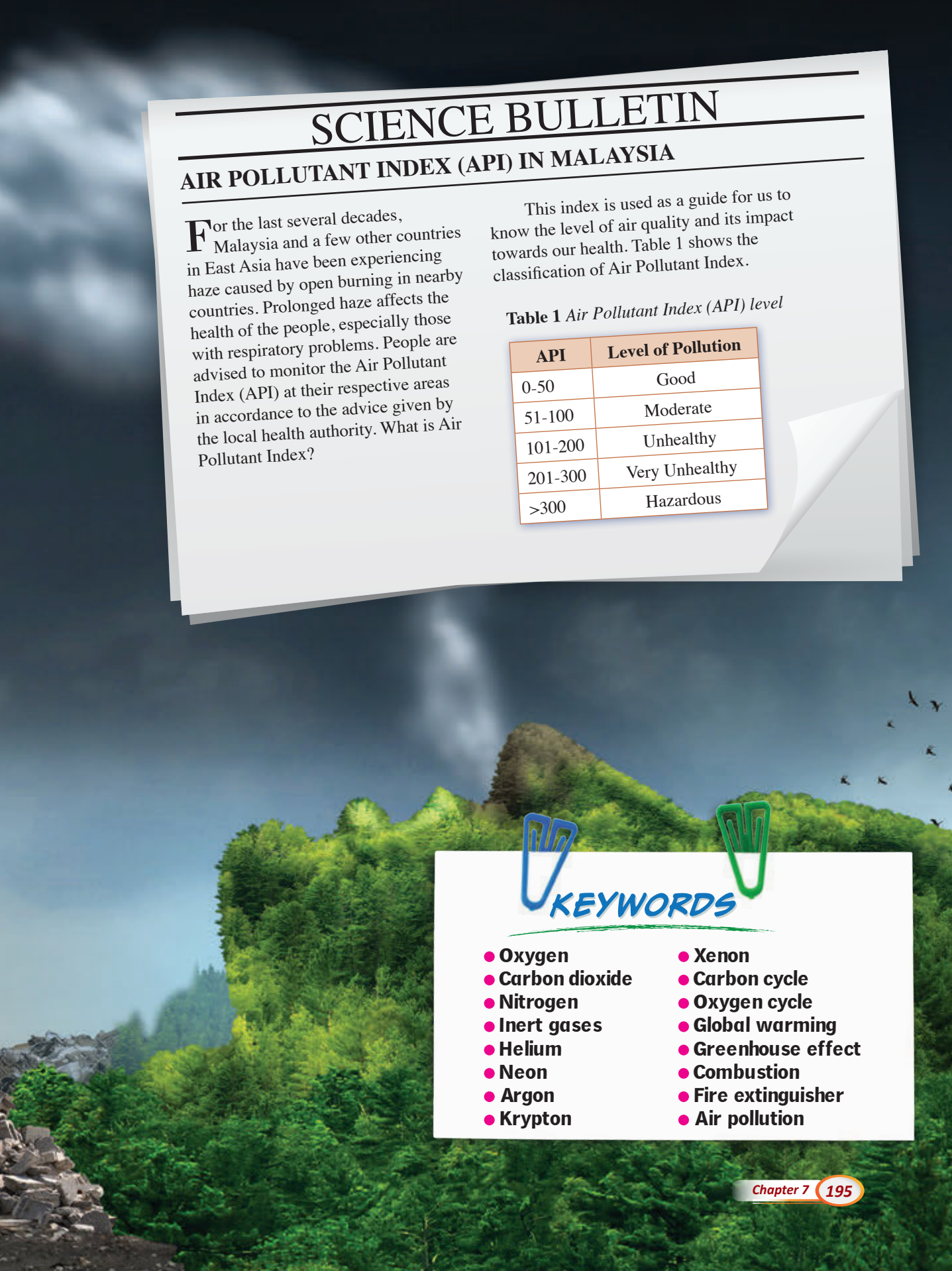
AIR POLLUTANT INDEX (API) IN MALAYSIA

For the last several decades, Malaysia and a few other countries in East Asia have been experiencing haze caused by open burning in nearby countries. Prolonged haze affects the health of the people, especially those with respiratory problems. People are advised to monitor the Air Pollutant Index (API) at their respective areas in accordance to the advice given by the local health authority. What is Air Pollutant Index?

This index is used as a guide for us to know the level of air quality and its impact towards our health. Table 1 shows the classification of Air Pollutant Index.

Table 1 *Air Pollutant Index (API) level*

API	Level of Pollution
0-50	Good
51-100	Moderate
101-200	Unhealthy
201-300	Very Unhealthy
>300	Hazardous



KEYWORDS

- Oxygen
- Carbon dioxide
- Nitrogen
- Inert gases
- Helium
- Neon
- Argon
- Krypton
- Xenon
- Carbon cycle
- Oxygen cycle
- Global warming
- Greenhouse effect
- Combustion
- Fire extinguisher
- Air pollution

7.1 Composition of Air

Let's learn

- Plan ways to determine and record the composition of air.
- Synthesise the composition of air from a pie chart.
- Justify the importance of oxygen, nitrogen, carbon dioxide and inert gases in daily life.
- Appreciate the carbon cycle and the oxygen cycle in maintaining the composition of gases in the air.
- Solve problems when there is/are interferences to the oxygen and the carbon cycle.

You have learned that air has mass and occupies space in Chapter 5. All living things need air to survive. Clean air does not have colour or smell. Therefore, we cannot see the air even though it has a lot of substances in it. (Photograph 7.1).

Photograph 7.1 *Air cannot be seen*

What are the contents of air? Air is a mixture of several gases which are nitrogen (78%), oxygen (21%), carbon dioxide (0.03%) and inert gases (0.97%) such as helium, argon, neon, xenon and krypton.

Other components that exist in the air are microorganisms, water vapour and dust. The quantity of these components is low and varies according to place and time. For example, there is more water vapour in forests or after the rain than during a hot day.

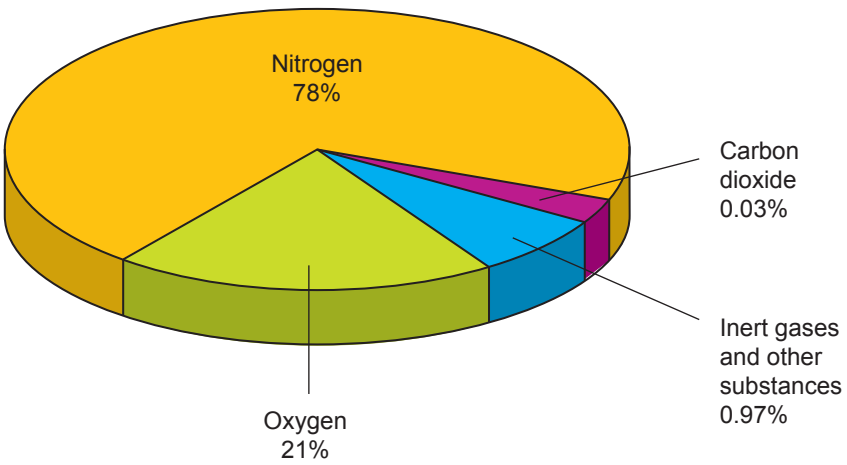


Figure 7.1 *Composition of air represented in a pie chart*

Brain Teaser

What is the relationship between the water vapour content in the air and formation of cloud and rain?

Science Exploration

Some sicknesses such as fever are caused by microorganisms in the air.

Carry out Activity 7.1 to determine the percentage of oxygen in the air.

Activity 7.1

Aim: To determine the percentage of oxygen in the air

Materials and apparatus: Candle, plasticine, matches, glass basin, permanent marker pen, gas jar, gas jar stand, water.

Instruction

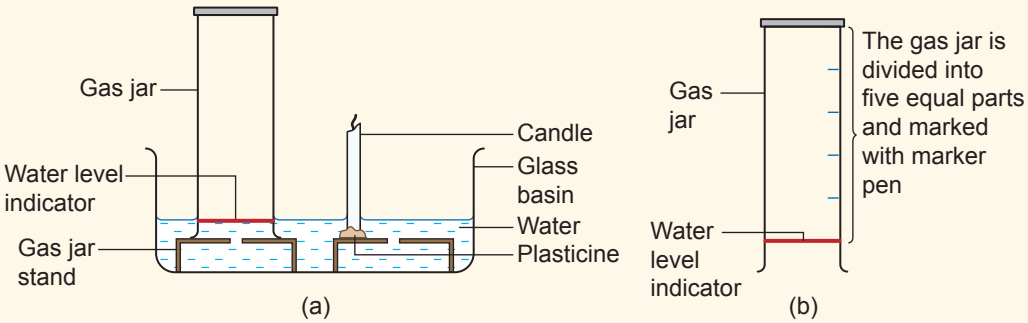


Figure 7.2 *Set-up of apparatus before the candle is lit*

1. Prepare the apparatus as shown in Figure 7.2 (a).
2. Divide the gas jar into five equal parts (Figure 7.2 (b)).
3. Light the candle and invert the gas jar over the candle (Figure 7.3).
4. Observe and record the changes in the water level when the flame extinguishes.
5. Make a conclusion on the percentage of oxygen in the air.

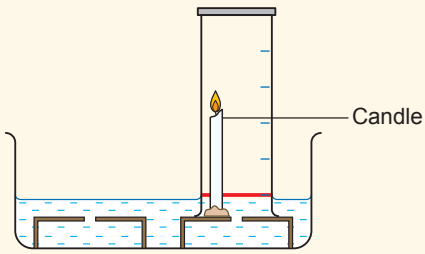


Figure 7.3 *Set-up of apparatus after the candle is lit*

Questions

1. What happened to the flame of the candle after a period of time? Why?
2. What happened to the water level at the end of this activity? Give reason(s) to the changes.
3. What is the percentage of oxygen in the air based on this activity?

At the end of Activity 7.1, the water rose to one fifth of the gas jar. This shows that one fifth of the air contains oxygen. Therefore, the air consists of 20% oxygen.

Is Air a Mixture?

Figure 7.4 *Air is a mixture*

Do you still remember the differences between mixtures and compounds which you have learned in Chapter 6? Why is air classified as a mixture and not a compound?

Air is a mixture because the components can be separated by a physical method, which is fractional distillation.

Science Exploration

Fractional distillation is separation of a liquid mixture into fractions with different boiling points through boiling and condensation.

The Importance of Gases

Have you ever imagined life without air? What is the importance of oxygen, carbon dioxide, nitrogen and inert gases?

Photograph 7.2 *One of the importance of oxygen is for combustion*

Importance of gases

Oxygen

Rocket

- Respiration
- Combustion of rocket engine at high altitudes
- Welding and steel cutting
- Preparation of various compounds

Carbon dioxide

Fire extinguisher

- Photosynthesis
- Production of carbonated drinks
- Fire extinguisher
- Carbon cycle

Nitrogen

Nitrogen fertiliser

- Production of nitric acid and ammonia
- Nitrogen cycle
- Liquid nitrogen as cooling agent

Inert gas

Light bulb

- Helium is used to fill hot air balloons and weather balloons
- Neon gas is used in advertising lights
- Argon gas is used in light bulbs

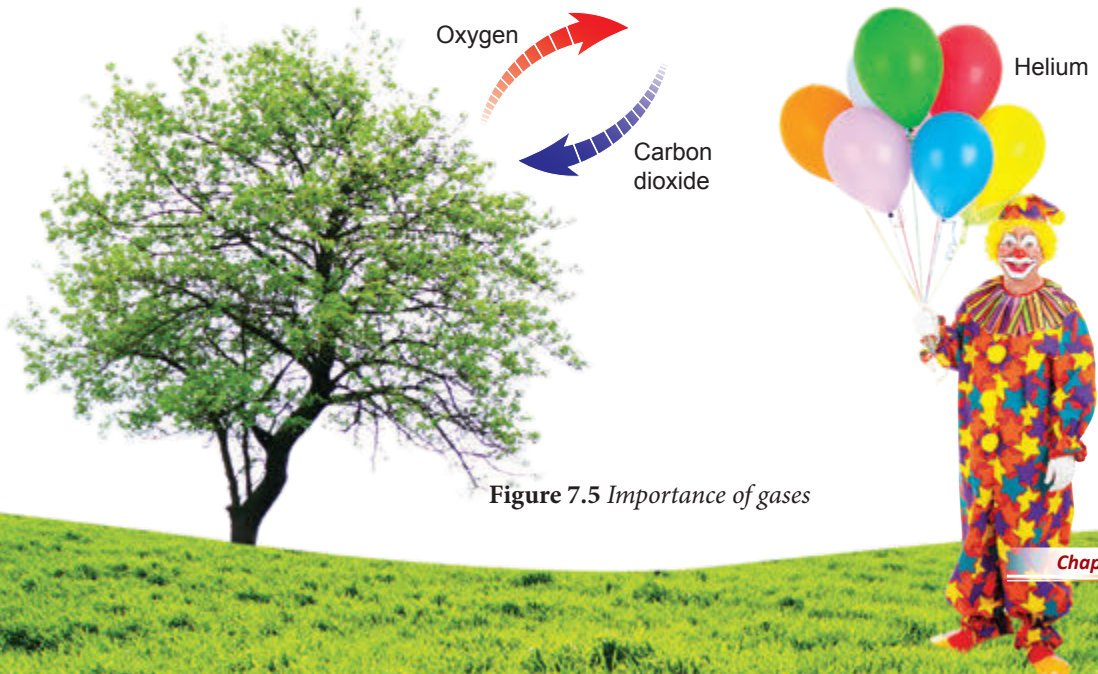


Figure 7.5 *Importance of gases*

Carbon cycle

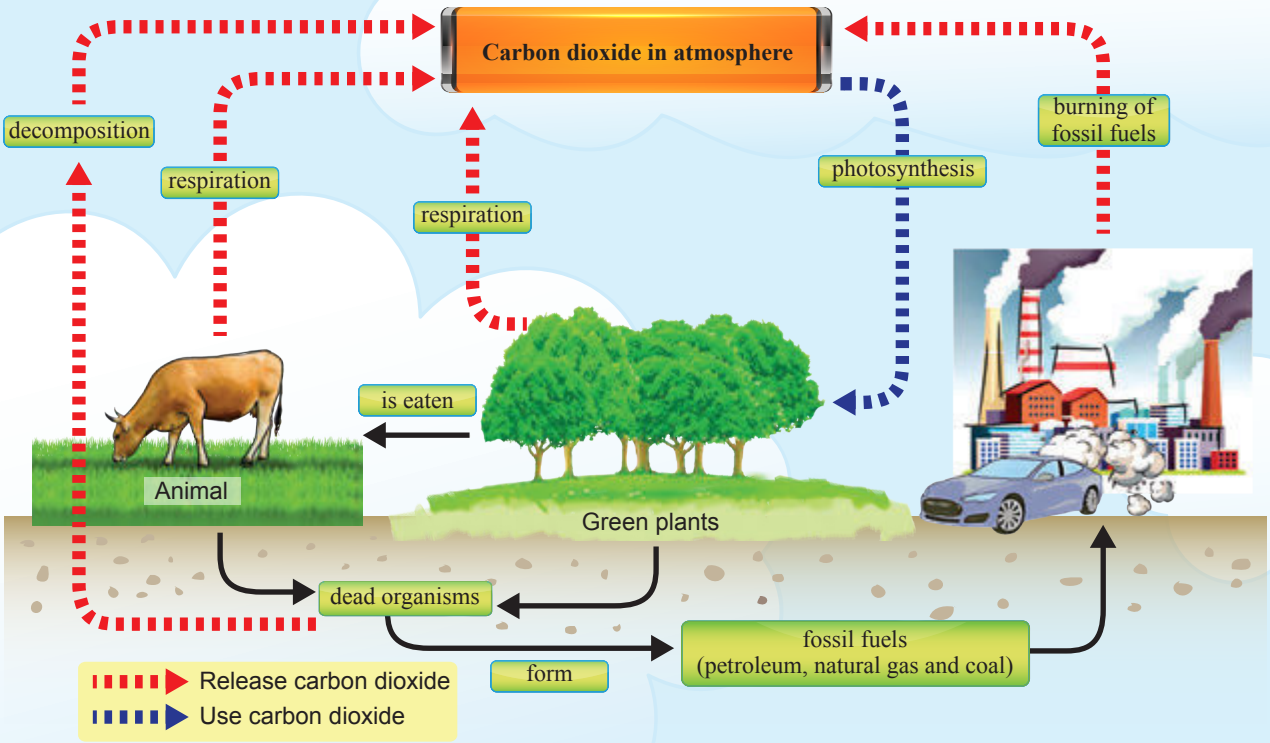


Figure 7.6 *The carbon cycle*

How does the carbon cycle maintain the content of carbon dioxide in the air?

Carbon cycle is the cycle that maintains the content of carbon dioxide in the air by continuously taking carbon dioxide from the air and returning it to the air.

- Carbon cycle begins when green plants absorb carbon dioxide through photosynthesis.
- Animals that eat the plants obtain carbon elements from them.
- When the plants and animals die, they decompose.
- Decomposition caused by bacteria and fungi in the soil releases carbon dioxide.
- Burning of fossil fuels that contain carbon like coal and petrol also releases carbon dioxide.
- During respiration, all plants and animals release carbon dioxide.
- These processes such as decomposition, combustion and respiration are balanced by photosynthesis.

Oxygen Cycle

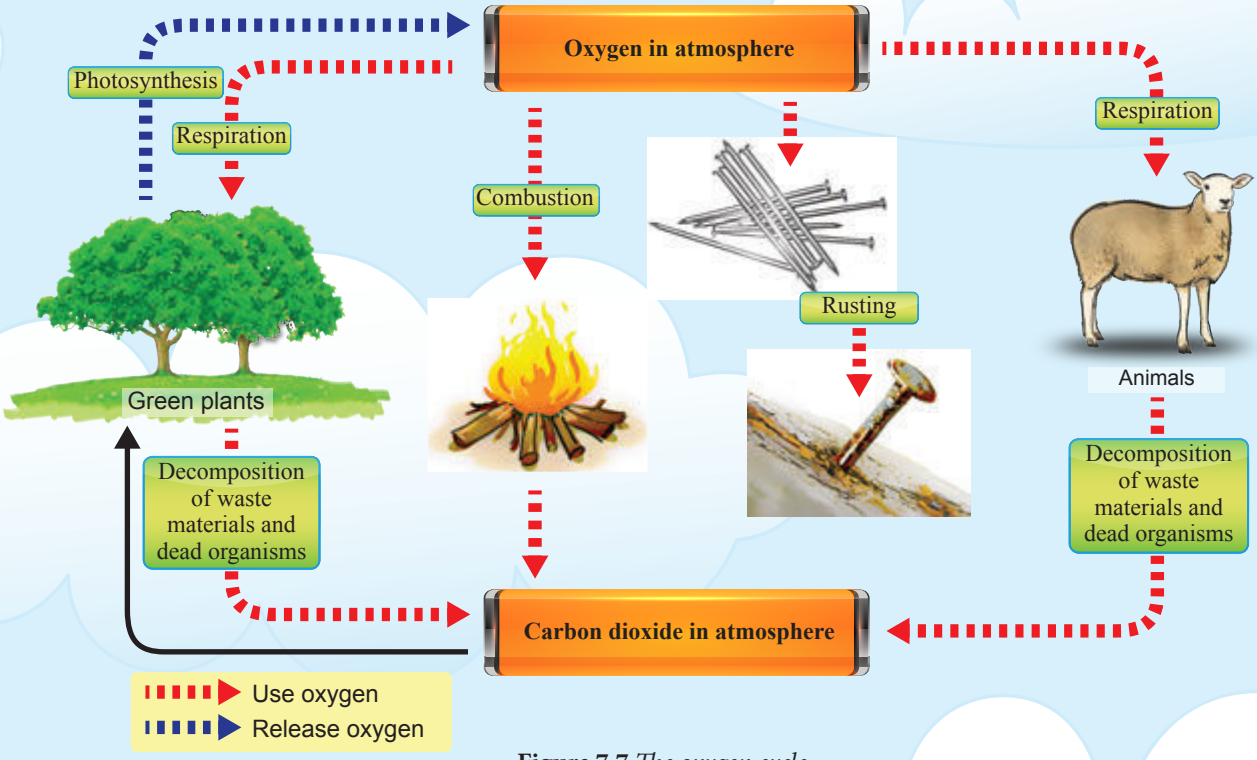


Figure 7.7 *The oxygen cycle*

Video on oxygen cycle

How does the oxygen cycle maintain the content of oxygen in the air?

Oxygen cycle is a continuous cycle that takes oxygen from the air and returns it to the air.

- Oxygen needed in respiration, rusting, combustion and decomposition is obtained from photosynthesis.

We must always appreciate the carbon and oxygen cycles that maintain the gas content in the air. All activities that harm the air must be reduced.

Activity 7.2

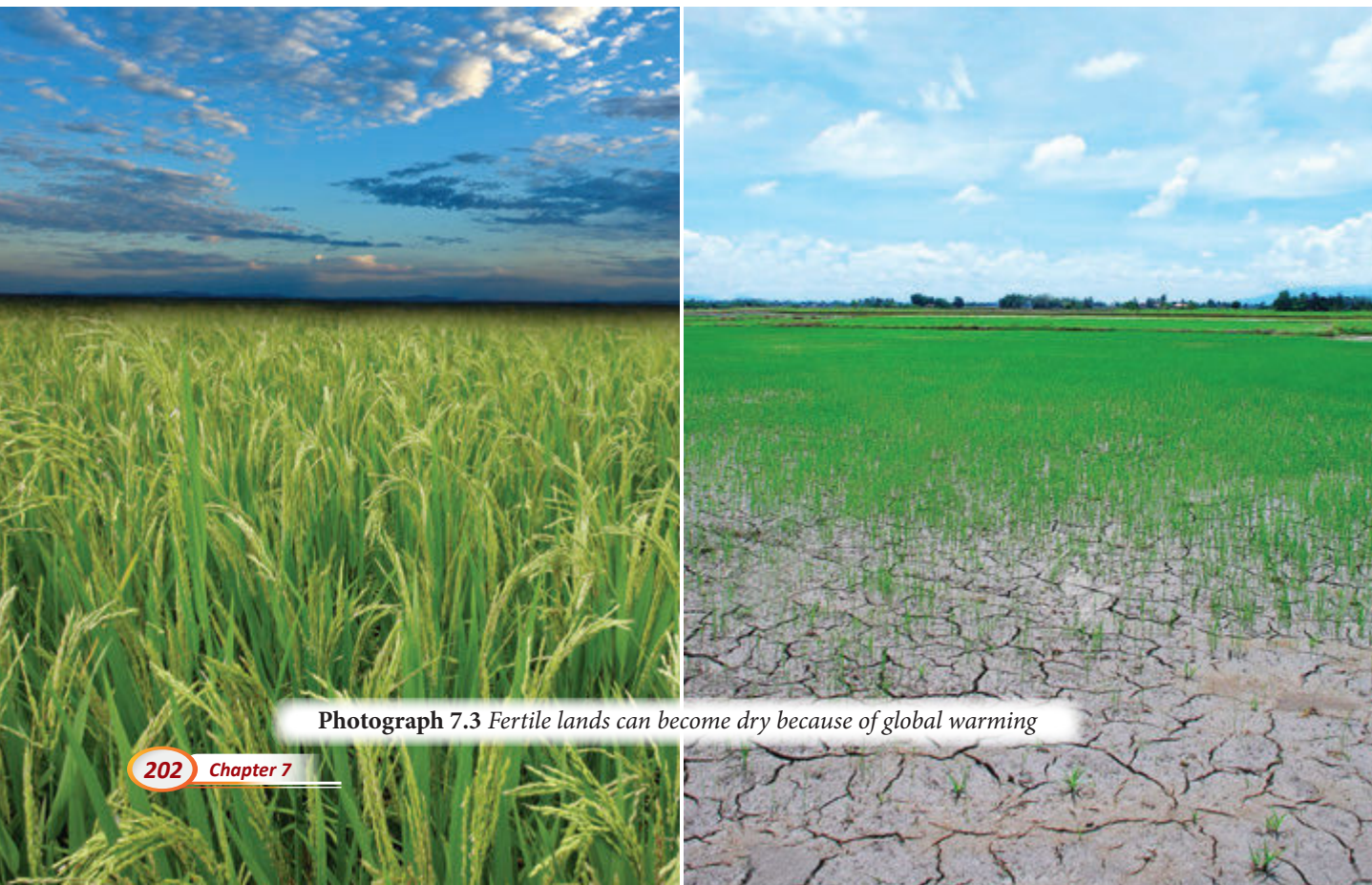
Aim: To gather information regarding the importance of gases, the oxygen cycle and carbon cycle

Instruction

1. Work in groups.
2. Find information on the importance of the following gases:
   (a) oxygen
   (b) carbon dioxide
   (c) nitrogen
   (d) inert gases
3. Record the information gathered using a suitable thinking map.
4. Find the information on oxygen and carbon cycles and how they maintain the percentage of gases in the atmosphere.
5. Present it in class.

Ways to Prevent Interferences in the Oxygen and Carbon Cycles

Our environment is being destroyed by human activities such as logging and the uncontrolled usage of pesticides in agriculture. This will increase the amount of carbon dioxide which interferes with natural cycles including the oxygen and carbon cycles. Global warming and the greenhouse effect are among the consequences of this interference.



Photograph 7.3 *Fertile lands can become dry because of global warming*

Photograph 7.4 shows some ways to reduce the problem of interferences to the oxygen and carbon cycles on Earth.

Photograph 7.4 *Ways to reduce problems of interferences to the oxygen and carbon cycle*

Formative Practice 7.1

1. List the composition of air.
2. How can you identify oxygen and carbon dioxide?
3. What is the importance of carbon dioxide to plants?
4. What are the effects of the increase of carbon dioxide in the air to humans?
5. As a student who appreciates the importance of the carbon and oxygen cycles, suggest ways to ensure a balance of carbon dioxide and oxygen content in the air.

7.2 Combustion

Let's learn

- Conclude about the conditions needed for combustion.
- Relate the conditions of combustion with the principles used in the manufacture of fire extinguishers.
- Practise safety measures to prevent the occurrence of fire which can lead to the destruction of life and property.

Combustion is the reaction that occurs when a substance is heated in the presence of oxygen which produces **heat energy** and **light energy**.

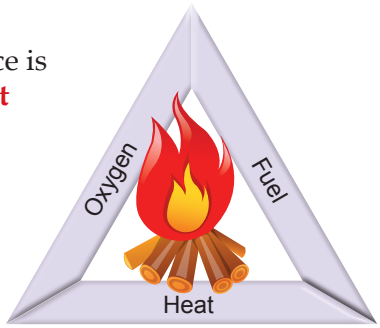
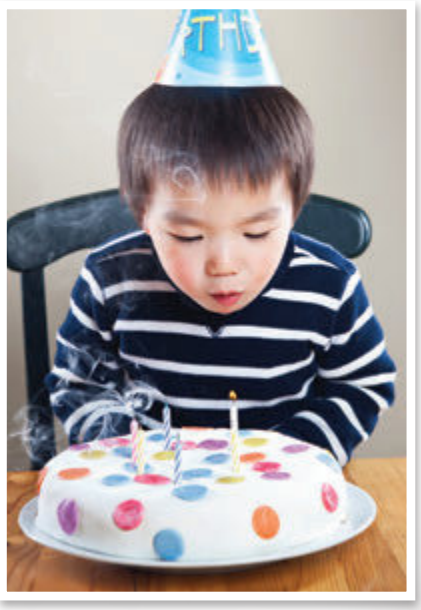


Figure 7.8 *Three conditions needed for combustion*



Photograph 7.5 *The candle flame is extinguished when oxygen is removed by blowing it*

We can prevent combustion if we remove one of the conditions needed for combustion.

Brain Teaser

Why do we use water to extinguish fire?

Photograph 7.6 *How can firefighters put out this fire?*

Carry out Activity 7.3 to prove that fuel, oxygen and heat are needed for combustion.

Activity 7.3

Aim: To prove that fuel, oxygen and heat are needed for combustion

I Fuel is needed for combustion

Materials and apparatus: Bunsen burner, tongs, lighter, glass rod, wood, candle, stone

Instruction

1. Light a Bunsen burner.
2. Hold a glass rod over the fire by using tongs.
3. Observe whether or not the glass rod burns.
4. Record your observation in a table.
5. Repeat steps 2 to 4 by using wood, candle and stone.

Material	Observation
(a) Glass rod	
(b) Wood	
(c) Candle	
(d) Stone	

Questions

1. Based on your observation, classify the materials into fuel and non-fuel.
2. What is the conclusion that you can make from this activity?

II Oxygen is needed for combustion

Materials and apparatus: Gas jar, two white tiles, two candles of the same size, plasticine, lighter

Instruction

1. Hold two candles of the same size on white tiles by using plasticine (Figure 7.9).
2. Light candles *X* and *Y*.
3. Turn a gas jar over candle *X*.
4. Observe which candle extinguishes first.

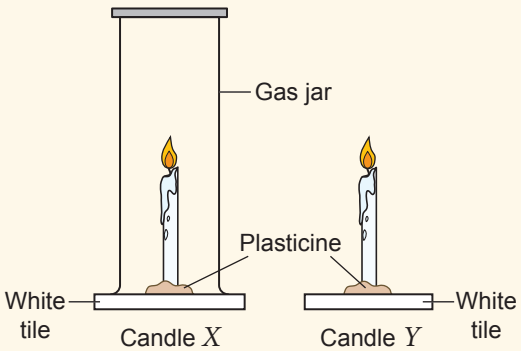


Figure 7.9

Questions

1. Which candle burns longer? Why?
2. What is the gas used during the burning of candle?
3. What is the conclusion that you can make from this activity?

III Heat is needed for combustion

Materials and apparatus: Match stick, match stick which has been stored inside the refrigerator, matchbox

Instruction

1. Label the match stick which has been stored inside the refrigerator as *P* and the other match stick as *Q*.
2. Light match sticks *P* and *Q*. Observe the changes that occur.

Question:

1. Do both match sticks ignite? Why?
2. What is the conclusion that you can make from this activity?

Fire Extinguisher

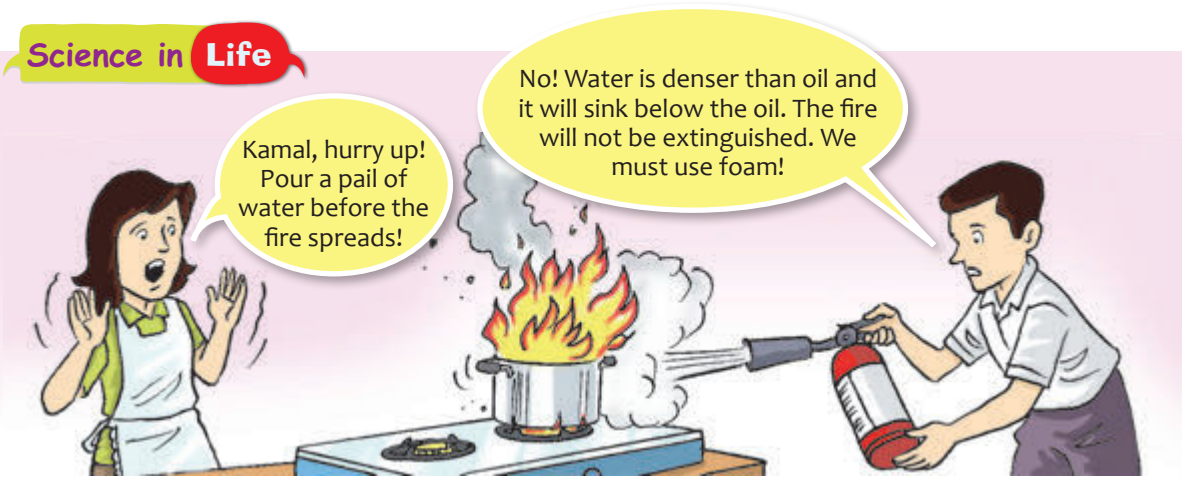
Have you gone through a fire drill at your school? The firefighters would have shown the correct way to use the fire extinguisher. The fire extinguisher is a protective tool that is used to put out a fire or handle a small fire, usually during an emergency. The substance used in a fire extinguisher differs based on the type of materials on fire as shown in Table 7.1.

Figure 7.10 *A fire extinguisher*

Table 7.1 *Types of fire extinguisher for different sources of fire*

Material on fire	Example of material	Type of fire extinguisher
Solid	Wood, cloth, paper	Water, dry powder
Liquid	Oil, varnish, paint	Foam, dry powder, carbon dioxide
Gas	Propane, acetylene, methane	Foam, dry powder, carbon dioxide
Metal	Potassium, sodium, magnesium, calcium	Dry powder, dry sand

Science in Life



As you have learned in subtopic 7.1, combustion needs oxygen, heat and fuel. Therefore, fire can be extinguished by removing one of the conditions needed for combustion using the following techniques.

(a) Covering: cutting off the contact of the fuel with oxygen or air. For example, covering the surface of fuel with fire blanket, wet sack, mud, sand, soil or foam.
(b) Cooling: cooling the surface of burning materials by spraying water or a layer of carbon dioxide.
(c) Reducing the amount of burning materials/cutting off the source of fuel: this technique can be used by separating the burning materials, keeping away materials that have not burnt yet and cutting off the supply of gas or oil.

Science Exploration

Fire blanket is a special blanket made of fire resistant substances. This blanket covers the fire and prevents oxygen from seeping below the blanket which will eventually extinguish the fire.

Photograph 7.7
A fire blanket

Safety Measures to Prevent the Occurrence of Fire

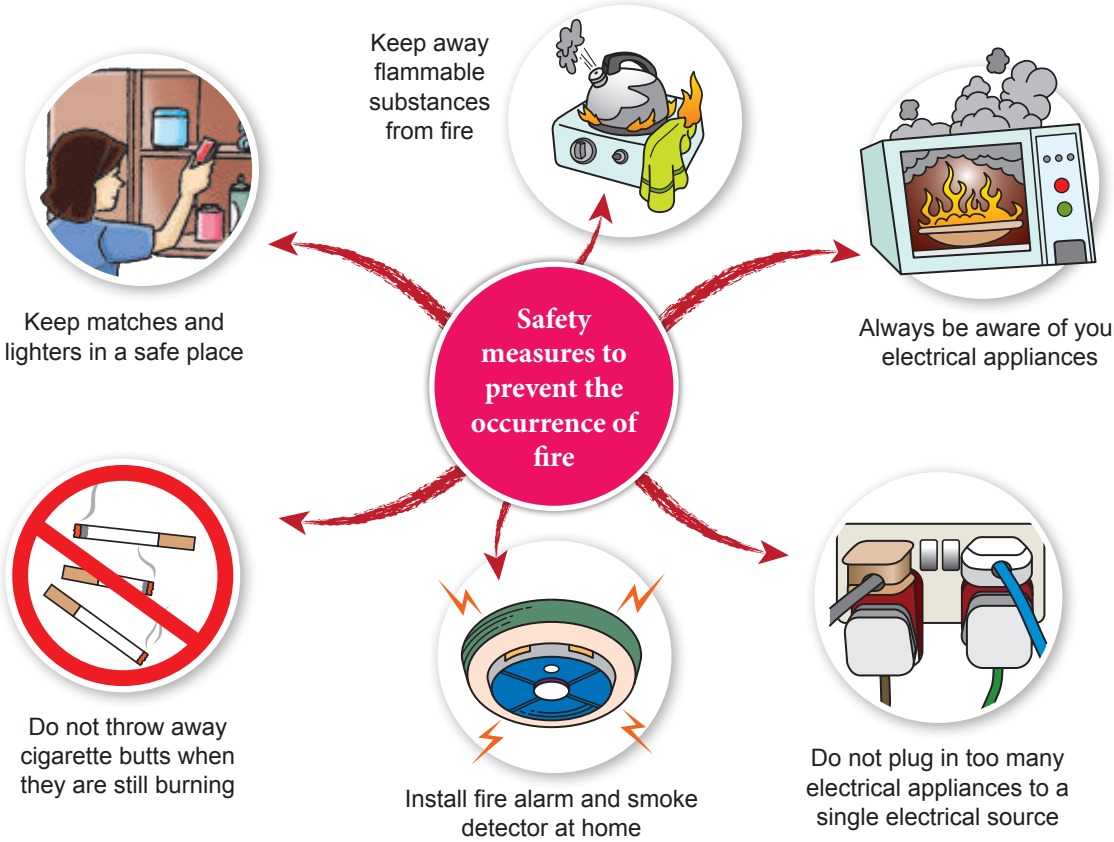


Figure 7.11 *Safety measures to prevent the occurrence of fire*

Formative Practice 7.2

1. Define combustion.
2. What are the conditions needed for combustion?
3. Luqman uses a fire blanket to put out a small fire at his house. How does the fire blanket work?
4. Give four ways to prevent fire.
5. Metals like potassium and sodium are kept in paraffin oil. Why?

Activity 7.4

21st Century ISS

Aim: To make a poster on causes of fire and ways to prevent it

Instruction

1. Prepare a poster entitled 'Causes of Fire and Ways to Prevent it' in a group.
2. Present the best three posters on the science board of your class.

7.3 Air Pollution

Let's learn

- Define air pollution and air pollutants.
- Communicate about air pollutants and the causes.
- Justify steps to prevent and control air pollution.
- Solve problems on the adverse effects of air pollution.

Air pollution is a situation which involves the presence of any pollutants in the air. This brings harm and discomfort to living things and destroys the environment. Air pollutants come from various sources. The sources of air pollutants are shown in Figure 7.12.

Photograph 7.8 *Air pollution from a factory*

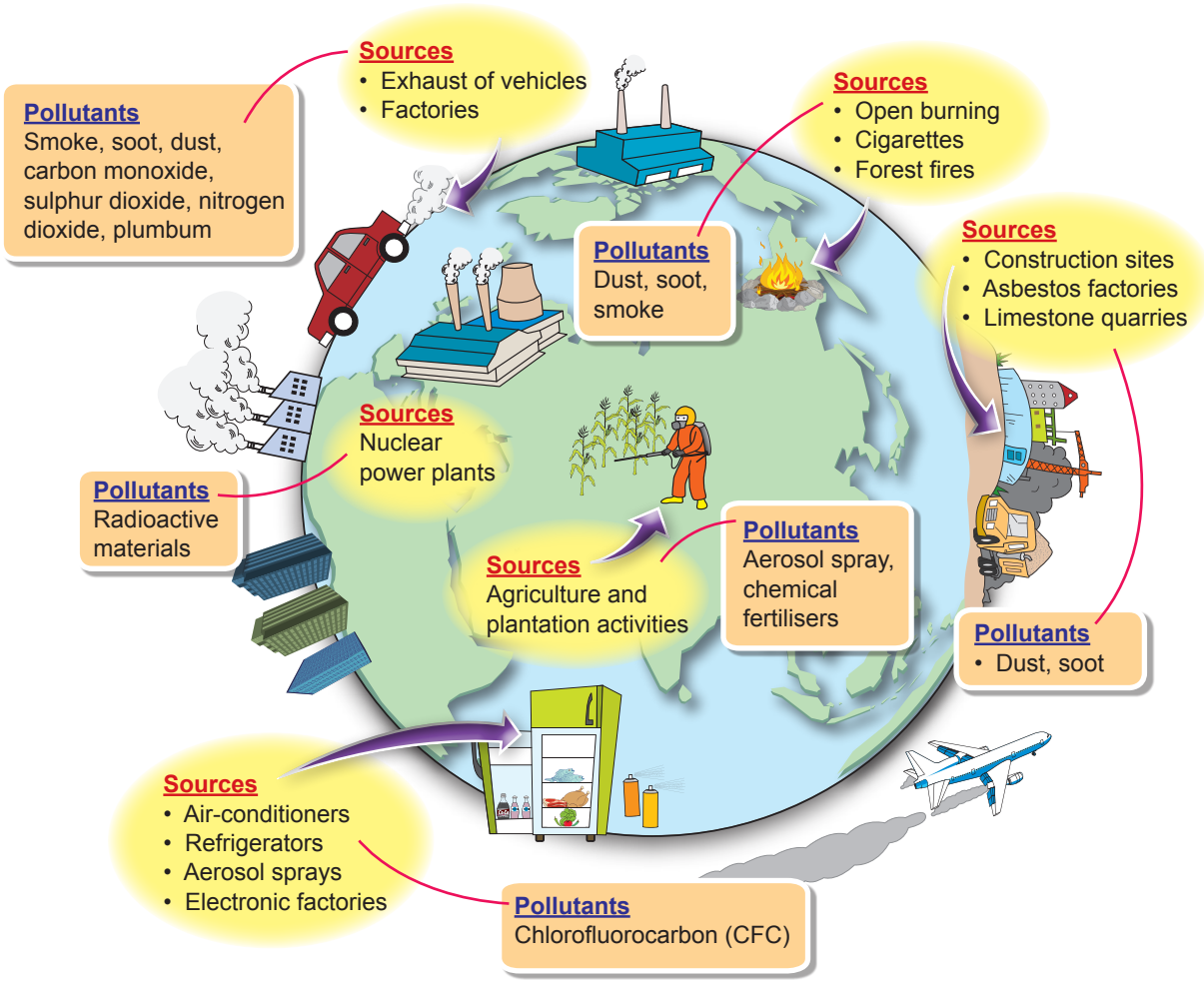


Figure 7.12 *Sources of air pollutants*

Activity 7.5

Aim: To discuss air pollution problems in Malaysia

Instruction

Photograph 7.9 shows the hazy condition in Kuala Lumpur in 2015. Discuss in groups the definition of air pollution and sources of air pollutants which cause haze. Then, present your discussion in class.

Photograph 7.9 *Haze in Kuala Lumpur*

Polluted air can cause illness and discomfort to humans. There are various steps that can be taken to prevent and control air pollution. Figures 7.13(a) and (b) show the effects of air pollution and ways to prevent and control it.

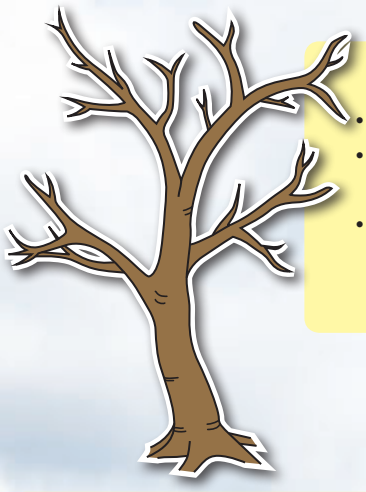
Health

- Smoke and dust can cause breathing problems
- Sulphur dioxide can cause respiratory problems
- Carbon monoxide can cause headache, mental retardation and death
- Asbestos particles can cause lung cancer
- Lead particles can cause intellectual disability among children and babies

Buildings and infrastructures

- Dust and soot stain buildings
- Acid rain corrodes concrete and limestone buildings
- Acid rain speeds up iron rusting

Causes and effects of air pollution



Plants and animals

- Acid rain makes the soil acidic and less fertile
- Acid rain makes the source of water acidic and not suitable for aquatic life
- Smoke and haze decrease the amount of sunlight reaching the Earth and decrease the rate of photosynthesis.

Climate

- Smoke from factories, vehicles and open burning lead to haze
- Excessive carbon dioxide contributes to greenhouse effect
- Excessive chlorofluorocarbons (CFC) causes the thinning of the ozone layer
- Sulphur dioxide and nitrogen dioxide cause acid rain

Figure 7.13 (a) *Causes and effects of air pollution*

Law Enforcement

- Fine smokers who smoke at restricted areas
- Fine individuals who conduct open burning
- Fine drivers whose vehicles emit excessive smoke
- Prohibit factories from being built at housing areas

Ways to prevent and control air pollution

Education

- Educate students about the effects of air pollution and ways to prevent it
- Organise anti-smoking campaigns
- Encourage the public to walk or ride bicycles
- Encourage the usage of public transport or car pooling

Science and Technology

- Implement hybrid technology in vehicles
- Choose refrigerators which use hydrochlorofluorocarbons (HCFC) instead of chlorofluorocarbons (CFC)
- Install filters in smoke chimneys at factories
- Use catalytic converters on vehicles
- Replace the use of pesticide with biological control to control pest

Figure 7.13 (b) *Ways to prevent and control air pollution*

Activity 7.6

Aim: To gather information on effects of air pollution on living things and the environment, and the steps taken by authorities in controlling air pollution.

Instruction

1. Work in groups.
2. Each group has to choose an area in Malaysia which has a high rate of air pollution.
3. Gather the information below from your chosen area:
   (a) the effects of air pollution towards the health of the community, animals, plants, buildings and infrastructures.
   (b) efforts taken by the authority, for instance *Jabatan Alam Sekitar*, to overcome the air pollution problem.
4. Present your findings in class.

Formative Practice 7.3

1. What are the pollutants that can cause haze?
2. As a student, how can you increase the awareness of air pollution in the community?
3. Give three reasons why it is important to keep the air clean.
4. Littering can also cause air pollution. Explain how littering causes air pollution.
5. Match each pollutant to its effect.

Pollutant	Effect
Carbon dioxide	Acid rain
Nitrogen dioxide	Greenhouse effect
Chlorofluorocarbons	Thinning of the ozone layer

6. Tick (✓) the correct statement on how to control and reduce air pollution.

   (a) Use materials free of chlorofluorocarbons (CFC). ☐

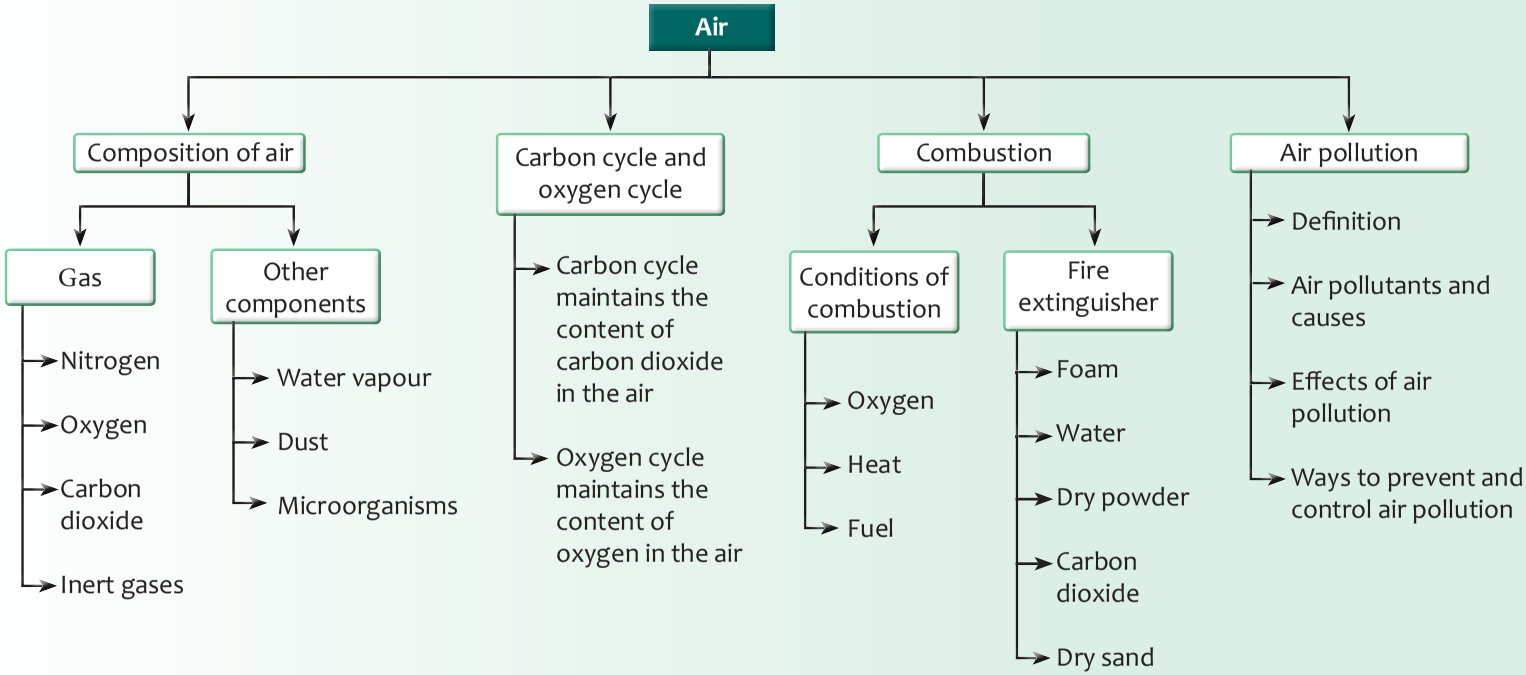
   (b) Use public transport. ☐

   (c) Conduct open burning. ☐

   (d) Practise reusing and recycling items. ☐

   (e) Use petrol and diesel that contain lead. ☐

Concept Map


Air
Composition of air
Gas
Nitrogen
Oxygen
Carbon dioxide
Inert gases
Other components
Water vapour
Dust
Microorganisms
Carbon cycle and oxygen cycle
Carbon cycle maintains the content of carbon dioxide in the air
Oxygen cycle maintains the content of oxygen in the air
Combustion
Conditions of combustion
Oxygen
Heat
Fuel
Fire extinguisher
Foam
Water
Dry powder
Carbon dioxide
Dry sand
Air pollution
Definition
Air pollutants and causes
Effects of air pollution
Ways to prevent and control air pollution

SELF-REFLECTION

After learning this chapter, you are able to:

7.1 Composition of Air

- ☐ Plan ways to determine and record the composition of air
- ☐ Synthesise the composition of air from a pie chart
- ☐ Justify the importance of oxygen, nitrogen, carbon dioxide and inert gases in daily life
- ☐ Appreciate the carbon cycle and the oxygen cycle in maintaining the composition of gases in the air
- ☐ Solve problems when there is/are interference to the oxygen and carbon cycles

7.2 Combustion

- ☐ Conclude about the conditions needed for combustion
- ☐ Relate the conditions of combustion with the principles used in the manufacture of fire extinguishers
- ☐ Practice safety measures to prevent the occurrence of fire which can lead to the destruction of life and property

7.3 Air Pollution

- ☐ Define air pollution and air pollutants
- ☐ Communicate about air pollutants and the causes
- ☐ Justify steps to prevent and control air pollution
- ☐ Solve problems on the adverse effects of air pollution

Summative Practice 7

1. The pie chart in Figure 1 shows the percentage of gas *P*, *Q*, *R* and *S* in the atmosphere.

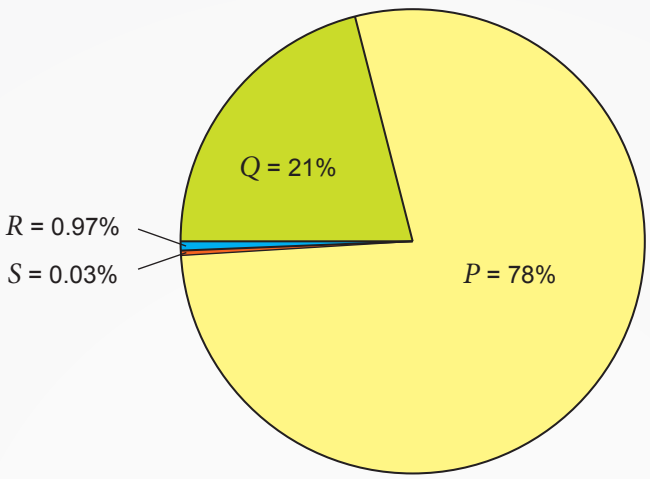


Figure 1

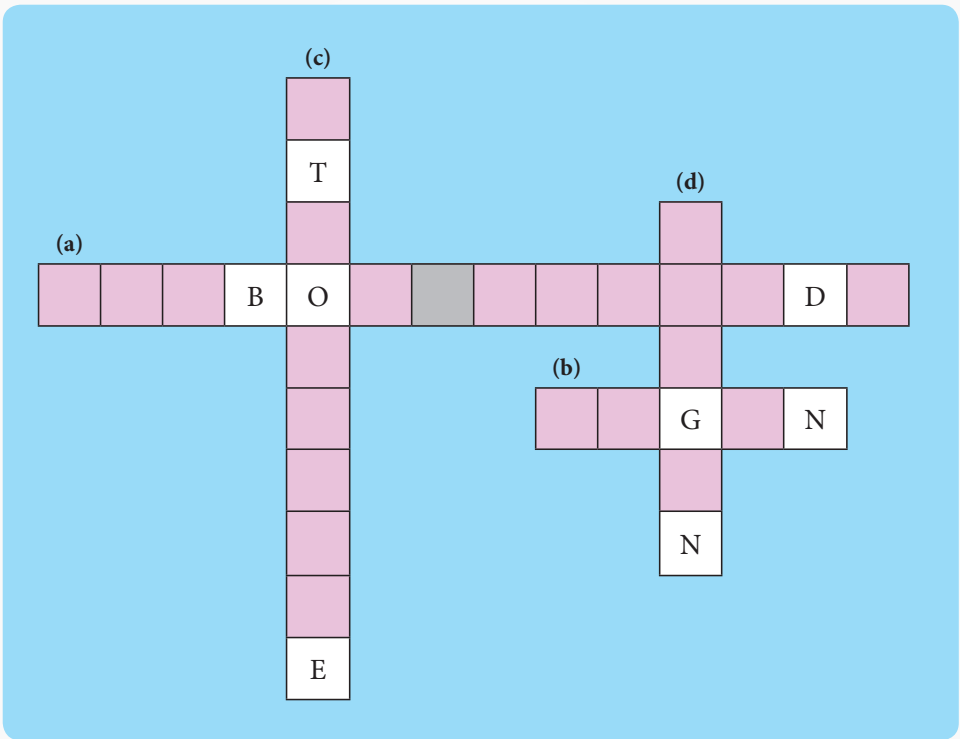
(a) Determine gas
   (i) *P*
   (ii) *Q*
   (iii) *R*
   (iv) *S*

(b) State the importance of gas *P*.

(c) What would happen to the temperature of Earth if the percentage of gas *S* increases? Give a reason for your answer.

(d) Give one reason why air is considered a mixture.

2. Solve the crossword puzzle below with the correct answer.



Horizontal:

(a) Carbon cycle maintains this gas in the air.

(b) This gas is used to fill up light bulbs.

Vertical:

(c) A layer that surrounds the Earth.

(d) This gas is needed in combustion.

3. Figure 2 shows the percentage of carbon dioxide in a period of time.

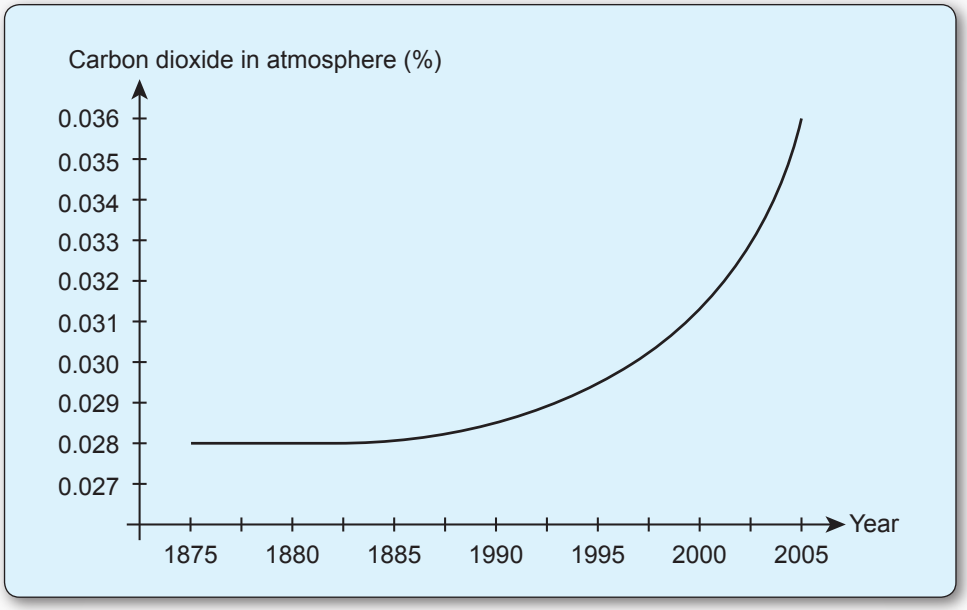


Figure 2

(a) Logging activities increase the amount of carbon dioxide in the atmosphere. How does it contribute to the increase of carbon dioxide level in the atmosphere? Explain.

(b) Other than logging, give one activity that contributes to the increase of carbon dioxide in the atmosphere.

(c) State two effects if the rate of carbon dioxide in the atmosphere increases continuously.

4. Ammar witnessed a fire at a workshop on his way home from school. The fire was caused by a short circuit.

(a) What is combustion?

(b) State the conditions of combustion.

(c) Based on the situation,

(i) how does one prevent such a fire from happening?

(ii) what fire extinguisher is suitable?

(d) State three precautions that should be practised to prevent fire from happening.

5. Figure 3 shows a situation that occurs in Kuala Lumpur.

Figure 3

(a) What is the environmental problem shown in Figure 3?
(b) State two effects of the problem you mentioned in 5(a) towards health.
(c) The road accident rate increases when this environmental problem occurs. Why?

6. The oxygen level in a cave would eventually decrease as we walk further into the cave.

Figure 4

(a) List a few reasons why the oxygen level decreases in the cave.
(b) If we want to go into a deep cave, we are encouraged to bring torches with us in addition to torchlights as an indicator to show the presence of oxygen. How does the torch function? Explain.
(c) Do you think it is good to bring torches into the cave?
(d) Suggest one way to detect the oxygen level in a safer way. Give one reason for your suggestion.

The Next Challenge . . .

7. A company wants to do a limestone quarry project near Kampung Permai. The village headman has conducted a meeting with the villagers. The result from the meeting is as follows:

Table 1

Percentage of villagers supporting the quarry project (%)	20
Percentage of villagers opposing the quarry project (%)	80

(a) Why do you think a majority of the Kampung Permai villagers oppose the quarry project? Give a cause for their concern.

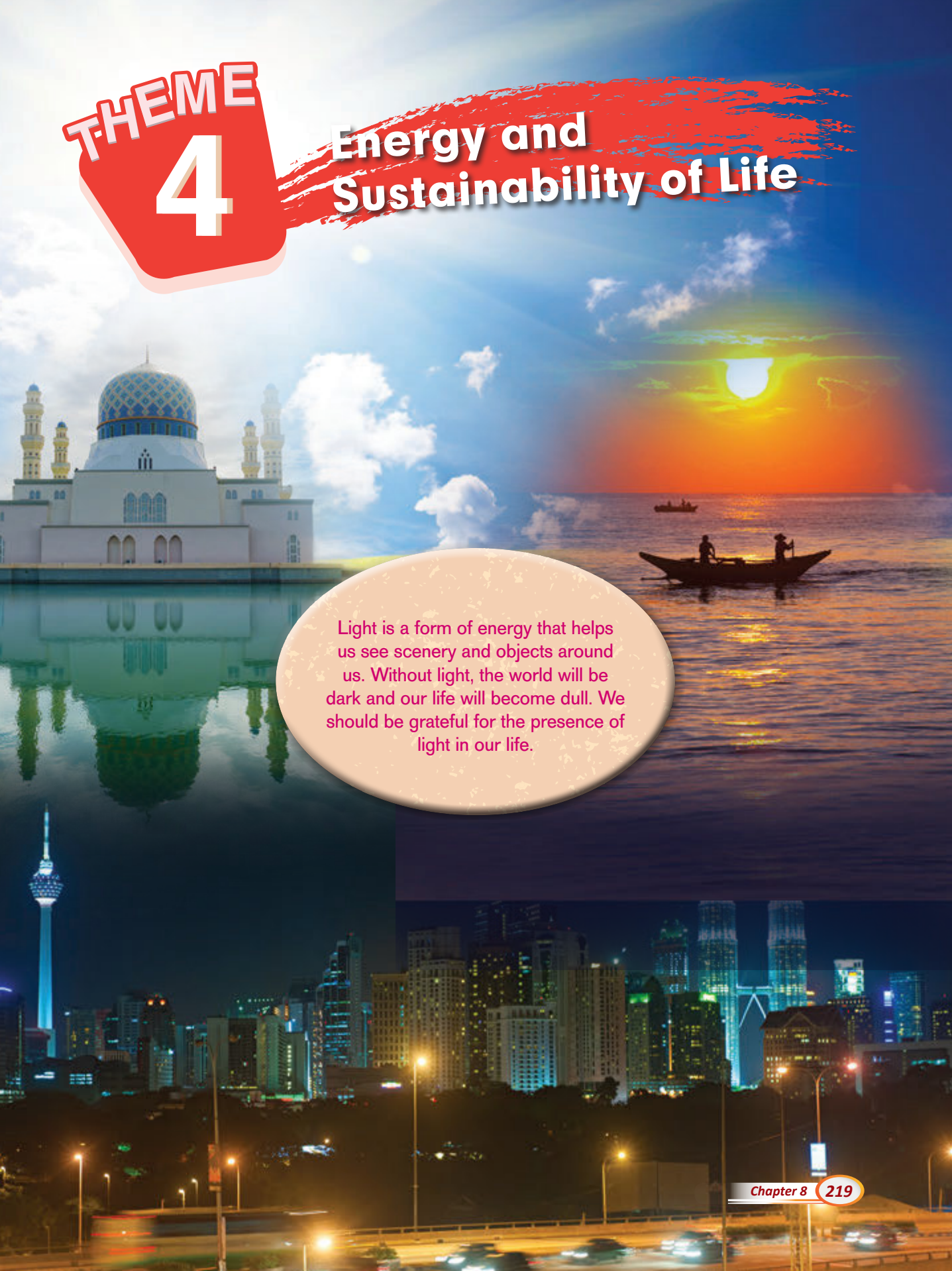
(b) Villagers who support the quarry project have a common reason, which gives them one advantage. What is the advantage?

(c) The village headman has decided to go against the quarry project.
Is it a rational decision?

8. Assume that you are a scientist. The amount of sunlight received in East Asia has decreased due to dust produced from natural disasters such as volcano eruptions and development activities. Consequently, many plants planted by farmers die. How does this happen? Suggest ways how the farmers can solve this problem.

THEME 4

Energy and Sustainability of Life

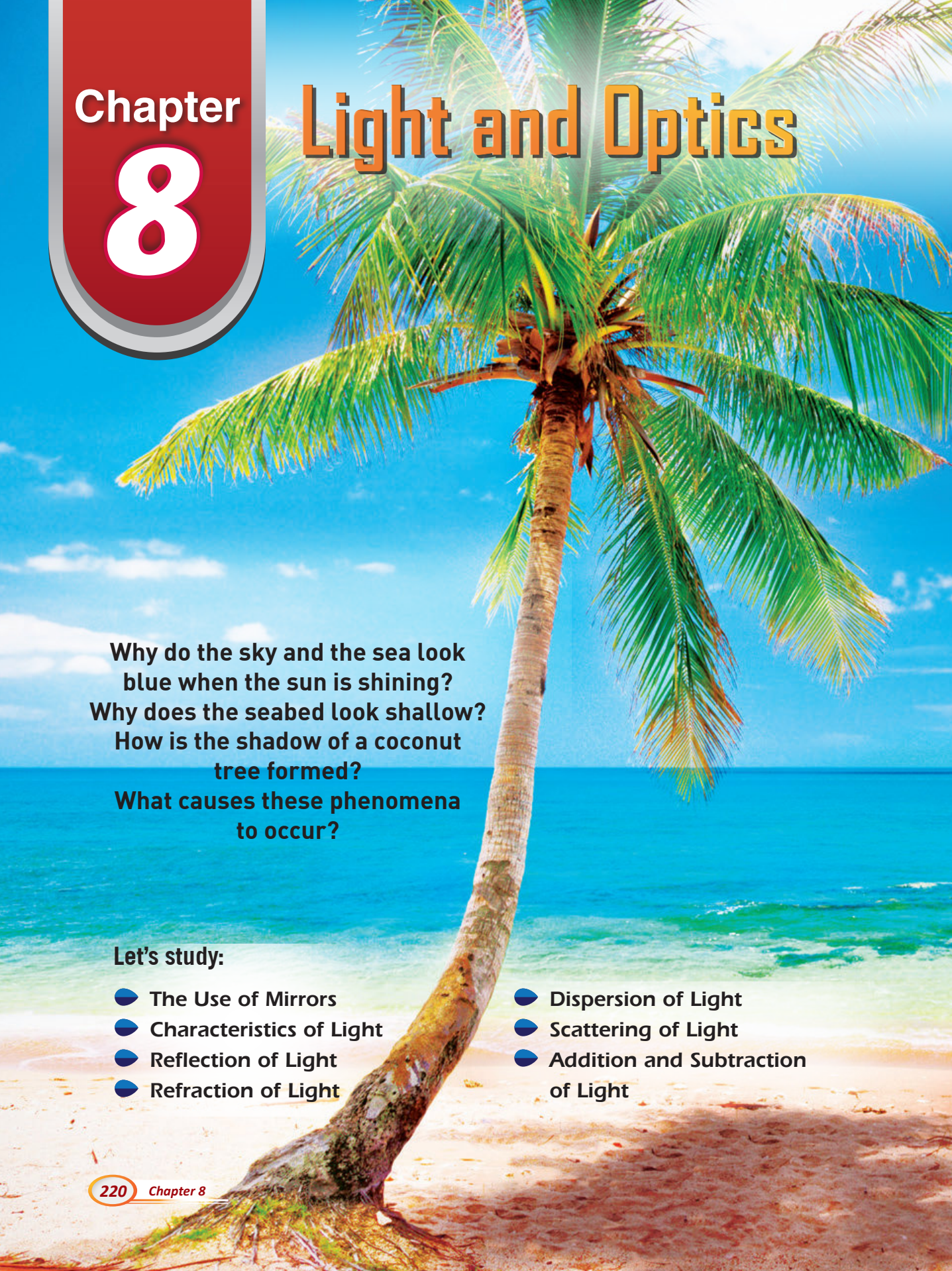


Light is a form of energy that helps us see scenery and objects around us. Without light, the world will be dark and our life will become dull. We should be grateful for the presence of light in our life.

Chapter

8

Light and Optics



Why do the sky and the sea look blue when the sun is shining?
Why does the seabed look shallow?
How is the shadow of a coconut tree formed?
What causes these phenomena to occur?

Let's study:

- The Use of Mirrors
- Characteristics of Light
- Reflection of Light
- Refraction of Light
- Dispersion of Light
- Scattering of Light
- Addition and Subtraction of Light

SCIENCE BULLETIN

PHENOMENON OF RAINBOW FORMATION

Our understanding of light and colours began with a series of experiments conducted by Sir Isaac Newton in the year 1672. He was the first person who managed to understand the phenomenon of the formation of rainbow. Newton used a prism to separate white light into its component colours.

KEYWORDS

- Angle of reflection
- Real
- Virtual
- Reflection
- Refraction
- Dispersion
- Object distance
- Image distance

8.1 The Use of Mirrors

Let's learn

- Differentiate between a real image and a virtual image.
- Communicate about the characteristics of image formed by a plane mirror, concave mirror and convex mirror.
- State that the object distance is equal to the image distance in a plane mirror.
- Use the plane mirror to apply the concept of reflection of light.
- Justify the application of concave mirrors and convex mirrors in daily life.
- Construct an optical instrument to appreciate the use of these optical instruments to enhance the ability of the human senses.
- Solve problems in daily life involving the application of plane mirrors, concave mirrors and convex mirrors.

We see our image in the mirror every day. Do you know what type of mirror we use?

This type of mirror is a **plane mirror**. What image is formed in the plane mirror? Real image or virtual image?

Photograph 8.1 *An image seen in a mirror*

Activity 8.1

Aim: To study the difference between real image and virtual image

Materials and apparatus: A piece of black A4 cardboard, a piece of white A4 cardboard, a candle, pin, mirror.

Instruction

1. Use a pin to pierce a hole in a black A4 cardboard.
2. Arrange the materials and apparatus as in Figure 8.1. Use a white A4 cardboard as a screen where the image will be formed.
3. Observe the image formed on the second cardboard which is used as a screen.
4. Choose a student to stand in front of a mirror as shown in Figure 8.2. Observe the image formed.

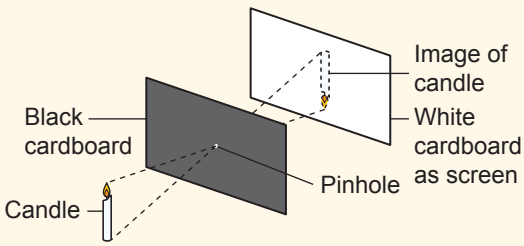


Figure 8.1

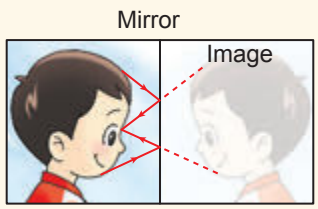


Figure 8.2

Questions

1. Is the image formed in Figure 8.1 real or virtual?
2. Compare the characteristics of the image formed in Figure 8.1 with Figure 8.2.

A **real image** is an image that forms on a screen, while a **virtual image** is an **image that cannot be formed on a screen**. Our image forms behind the mirror, not on the mirror screen. Therefore, the image formed by a plane mirror is a virtual image.

What are the characteristics of the image formed by a plane mirror, a concave mirror and a convex mirror (Figure 8.3)?

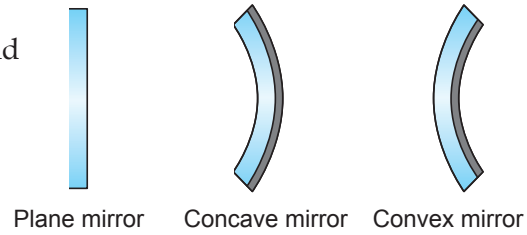


Figure 8.3 *Types of mirrors*

Activity 8.2

Aim: To determine the characteristics of the image formed by a plane mirror, concave mirror and convex mirror

Materials and apparatus: Plane mirror, concave mirror, convex mirror, candle, graph paper.

Instruction

1. Place a candle on a piece of graph paper in front of a plane mirror as shown in Figure 8.4.
2. Observe the image formed. Is the image the same size, smaller or bigger than the object?
3. Repeat steps 1 and 2 by replacing the plane mirror with a concave mirror and a convex mirror.
4. Record the results in a table.

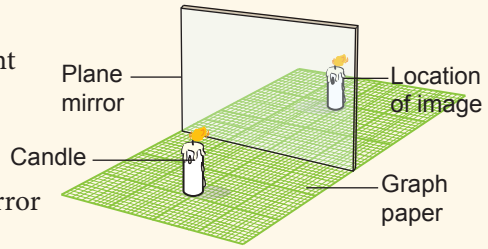


Figure 8.4

Type of mirror	Image formed (same size / smaller / bigger) than object
Plane mirror	
Concave mirror	
Convex mirror	

5. Then, measure the distance of the image from the plane mirror.
   Distance of image from the plane mirror = _____ squares on graph paper.

Questions

1. Compare the size of the image formed in the mirrors with the size of the object.
2. Compare the distance of the image formed in the plane mirror with the distance of the object.

A plane mirror applies the concept of **light reflection** as in Figure 8.5. Light rays that shine on the mirror will be reflected.

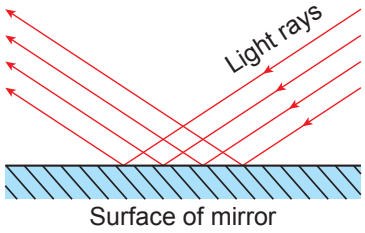
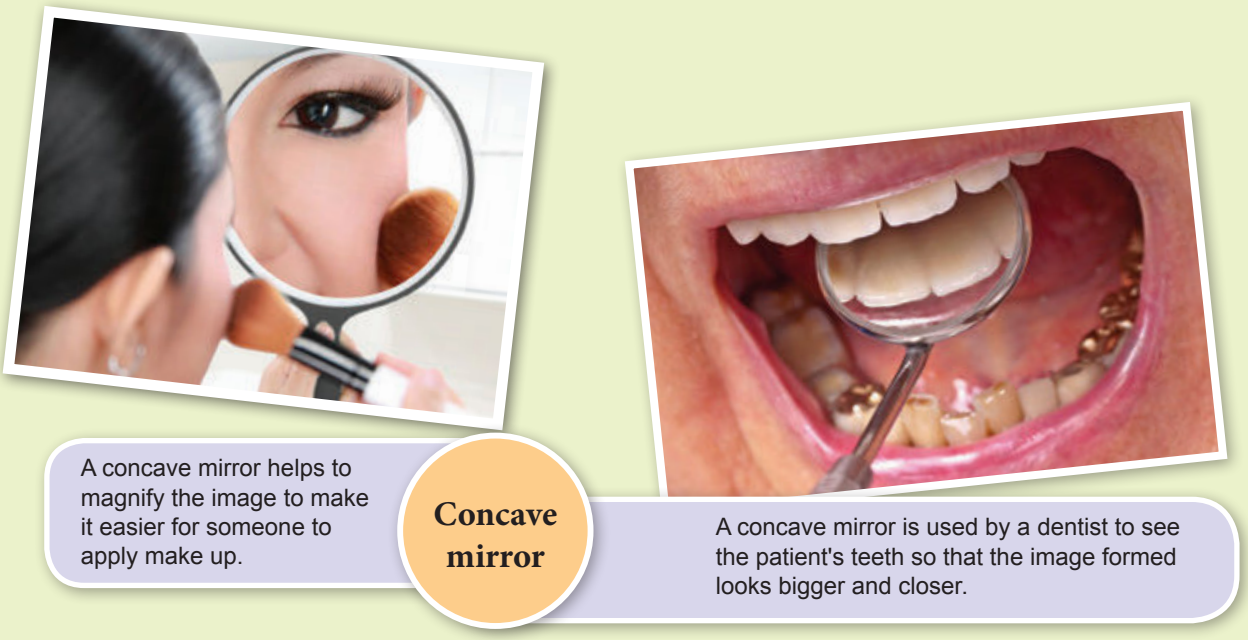


Figure 8.5 *Reflection of light*

Usage of Plane Mirror, Concave Mirror and Convex Mirror

Do you know that the plane mirror, concave mirror and convex mirror are widely used?

Photograph 8.2(a) *Usage of plane mirrors*



Photograph 8.2(b) *Usage of concave mirrors*

Convex mirror

A convex mirror is used as a safety feature at dangerous corner of a road.

Convex mirrors at the supermarket can help a shopkeeper to see every corner of the supermarket to prevent theft.

Photograph 8.2(c) *Usage of convex mirrors*

Convex mirrors and concave mirrors
http://www.animations.physics.unsw.edu.au/jw/light/mirrors-and-images.htm

Activity 8.3

21st Century ICS

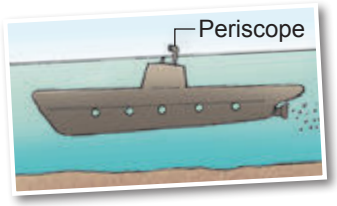
Aim: To discuss the usage of plane mirrors, concave mirrors and convex mirrors

Instruction

1. Work in groups.
2. Discuss the usage of plane mirrors, concave mirrors and convex mirrors.
3. Present your discussion using multimedia presentation.

Optical Instruments that Apply the Concept of Reflection of Light

Optical instruments are invented by scientists based on the concept of light reflection to enhance the ability of human senses. We should be grateful for these inventions and appreciate them.



Submarine

Periscope

Periscope is an instrument used in submarines to observe the sea surface. Periscope works by using the concept of reflection of light. Light from the sea surface is hit through the top mirror and is reflected. The light is then reflected again at the second mirror, right into the eye of the observer in the submarine. Let us create a simple periscope in Activity 8.4.

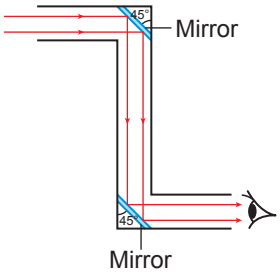


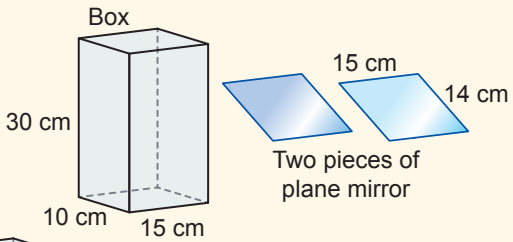
Figure 8.6 *A periscope*

Activity 8.4

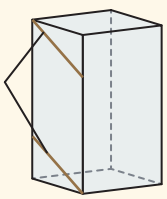
Aim: To create a simple periscope

Materials and apparatus: Two plane mirrors, box, knife.

Instruction

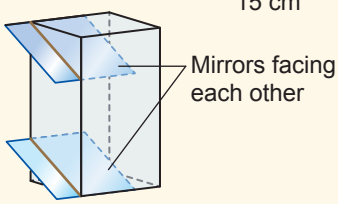


1



Cut the side of the upper and lower box to fit the width of the mirror.

2

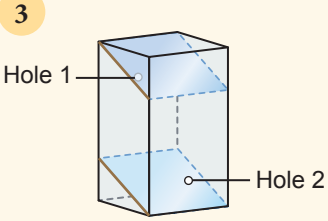


Place the mirrors facing each other.

PRECAUTION

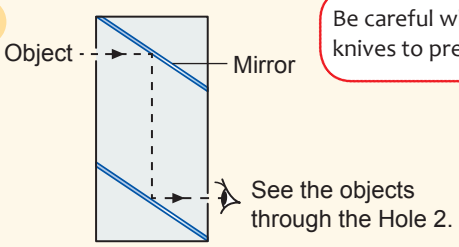
Be careful when using knives to prevent injuries.

3



Make two holes exactly opposite each mirror.

4



Place the object to be viewed in front of Hole 1.

Figure 8.7 *Steps to create a periscope*

Kaleidoscope

Kaleidoscope is a toy made using plane mirrors. With this toy, you can create various amazing patterns. These patterns are obtained due to the repeated reflection of the image of the objects inside the kaleidoscope. Therefore, the number of images seen is more than the number of objects. Let's carry out Activity 8.5 to build a kaleidoscope.

Activity 8.5

Aim: To build a kaleidoscope

Materials and apparatus: One kitchen towel roll, three pieces of mirror cards, colourful beads, two pieces of plastic discs, scissors, glue, cellophane tape, colourful paper for decoration, round black cardboard.

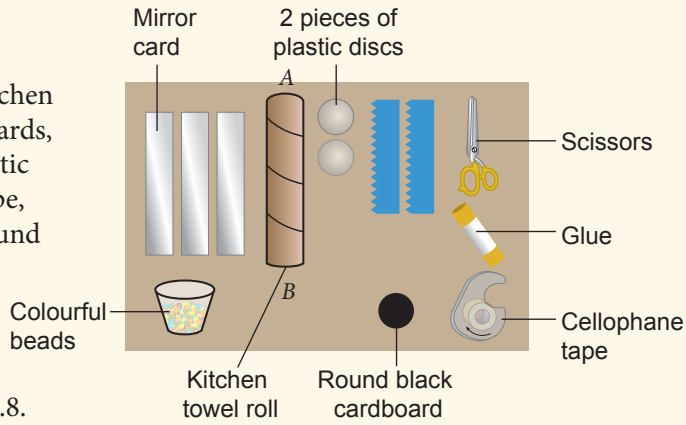


Figure 8.8

Instruction

1. Prepare the materials and apparatus as shown in Figure 8.8.
2. Prepare three pieces of mirror cards. Each one is 4.3 cm in width and 21 cm in length.
3. Stick the three pieces of the mirror cards with cellophane tape to make a triangle prism. Make sure the shiny surface is facing inward.
4. Push the triangle prism into the empty roll (Figure 8.9(a)).
5. Cut two pieces of round plastic discs with a diameter of 5.3 cm respectively.
6. Attach the first plastic disc on one end of the roll, *A* (Figure 8.9(b)). Push the first plastic disc into the roll until it touches the triangle prism.

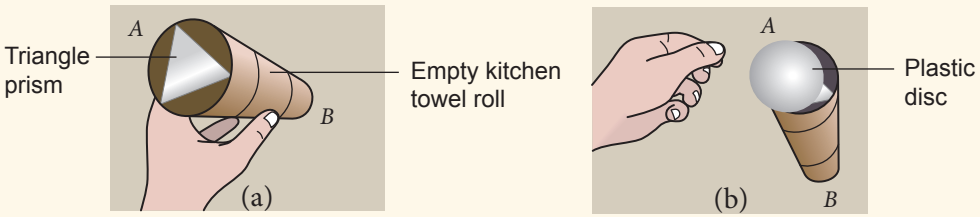


Figure 8.9

7. Add colourful beads on the surface of the first plastic disc (Figure 8.10(a)). Attach the second plastic disc to cover the colourful beads (Figure 8.10(b)).

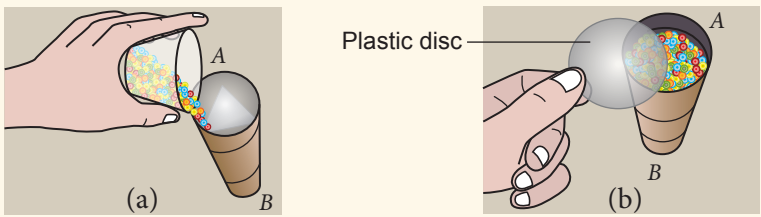


Figure 8.10

8. At the other end of the kitchen towel roll, *B*, attach a round black cardboard which has a diameter of 5.3 cm and make a hole on it (Figure 8.11).
9. Decorate the kitchen towel roll with colourful papers according to your creativity.
10. Look at the pattern of the colourful beads formed through the hole.

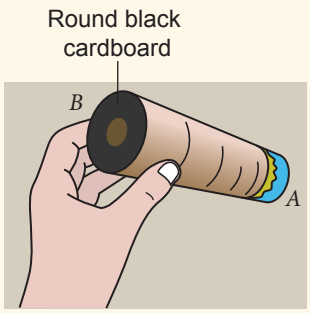
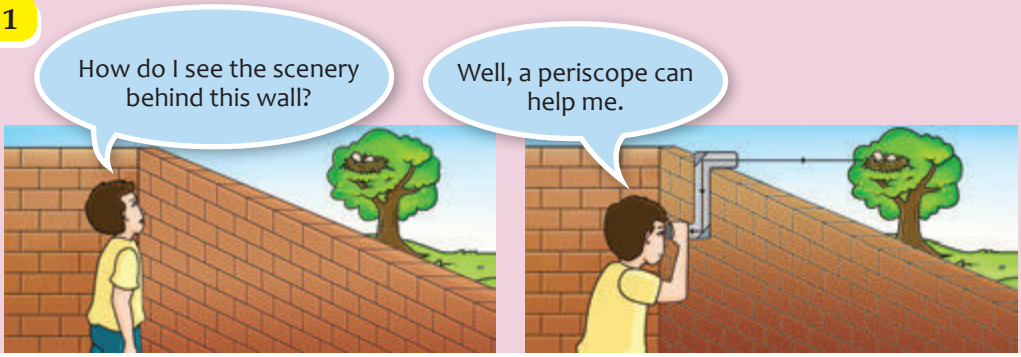


Figure 8.11

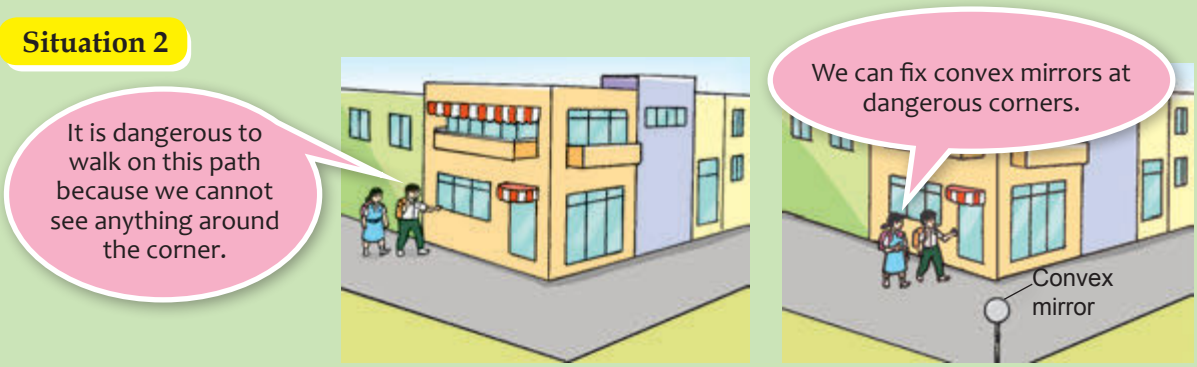
Science in Life

21 Century CPS

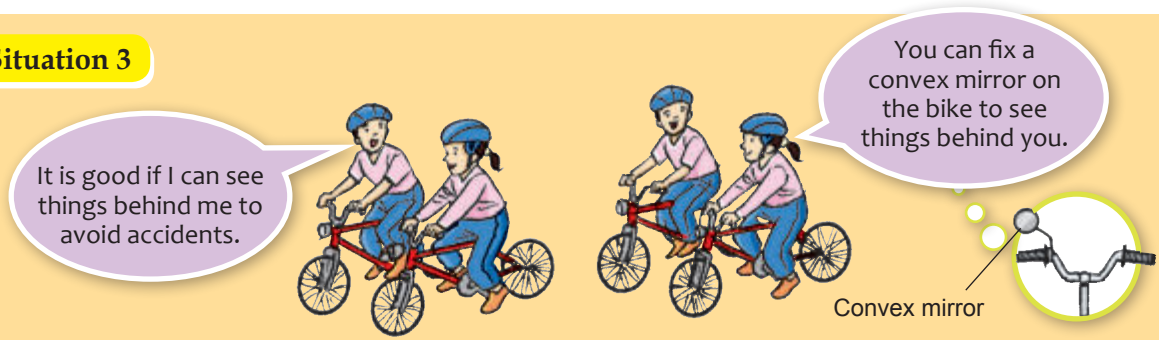
Situation 1



Situation 2



Situation 3



Formative Practice 8.1

1. The picture shows a man standing in front of a mirror. What type of mirror is it? State the characteristic of the image formed.
2. What is the function of plane mirrors in a periscope?
3. Why do we need plane mirrors in a lift?

8.2 Properties of Light

Let's learn

- Communicate about the properties of light.

What are the properties of light? Why do we see lightning before we hear thunder?

Albert Einstein

The speed of light is 3.0×10^8 m s^{-1}. Light travels much faster than sound, so we see the lightning before we hear the thunder.

Photograph 8.3 *A lightning*

Light travels in straight lines. We can see the movement of light in a light show (Photograph 8.4).

Photograph 8.4 *A light show*

Have you ever wondered how shadows are formed?

1. Sunlight travels in straight lines.
2. Umbrella is an opaque object, therefore the sunlight cannot pass through it.
3. When light is blocked by an opaque object, a shadow is formed behind the opaque object.

Photograph 8.5 *Formation of shadows*

Do you know that your shadow will become short in the afternoon and long in the evening?

Another property of light is that it can be dispersed by water droplets in the sky to form a rainbow as in Photograph 8.6.

Photograph 8.6 *A rainbow*

History Corner

Photograph 8.7 *The Sundial*

The Sundial was used in ancient times to determine the time during the day. The sundial used the concept that shadows are formed when the sunlight is blocked by objects.

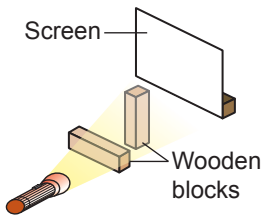
Science Exploration

Did you know that shadow puppets use the concept that shadows are formed when light is blocked?

Photograph 8.8 *Shadow puppets*

Formative Practice 8.2

1. Hisyam's shadow is the shortest in the _____ when the Sun is _____ his head.
2. The diagram shows two opaque objects blocking the light from a torchlight.
   Draw the shape of the shadow that will be formed on the screen.



8.3 Reflection of Light

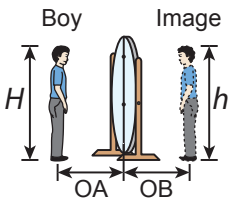
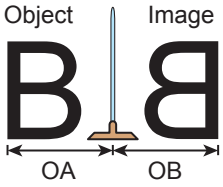
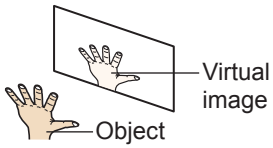
Let's learn

- State the characteristics of the image formed by a plane mirror.
- Communicate about the Law of Reflection.
- Draw ray diagrams to show the reflection of light
- Solve problems in daily life with the application of reflection of light.

You have learned how an image is formed in a plane mirror using the concept of reflection. Do you still remember the characteristics of the image? What are the other characteristics of the image formed by a plane mirror?

Table 8.1 shows the characteristics of the image formed by a plane mirror.

Table 8.1 *Characteristics of the image formed by a plane mirror*

(a) Upright 	(b) Object size, H = Image size, h (c) Object distance, OA = image distance, OB 
(d) Laterally inverted 	(e) Virtual 

I Can Remember!

The image formed by a plane mirror is:
- upright
- laterally inverted
- same size as the object
- virtual
- of the same distance as the object distance

Law of Reflection

When a beam of light is directed onto a piece of a plane mirror at a certain angle (**angle of incidence, *i***), the light ray will be reflected to a certain angle (**angle of reflection, *r***). What is the relationship between the angle of incidence and angle of reflection? Carry out Experiment 8.1.

Experiment 8.1

Problem statement: What is the relationship between the angle of incidence, i and angle of reflection, r?

Hypothesis: The angle of incidence, i is the same as the angle of reflection, r.

Aim: To determine the relationship between the angle of incidence, i and angle of reflection, r

Variables

Manipulated variable: Angle of incidence, i
Responding variable: Angle of reflection, r
Constant variable**:** The size of slit

Materials and Apparatus: Plane mirror, ray box, power supply, white paper, protractor.

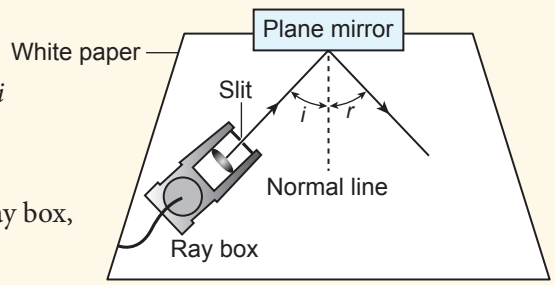


Figure 8.12

Procedure

1. Carry out this activity in the dark.
2. Arrange a ray box and a plane mirror on a sheet of white paper.
3. Direct the light beam towards the plane mirror at an angle i = 10°.
4. Measure the angle of reflection, r.
5. Repeat steps 3 and 4 with angle of incidence, i = 20°, 30°, 40° and 50°.

6. Record your results in a table.

Results

Angle of incidence, i (°)	Angle of reflection, r (°)
10	
20	

Conclusion

Is the hypothesis accepted?

What is the relationship between the angle of incidence, i and angle of reflection, r?

Light reflected obeys the Law of Reflection:

a. The incident ray, the reflected ray, and the normal line all lie on the same plane.
b. The angle of incidence, i is equal to the angle of reflection, r.

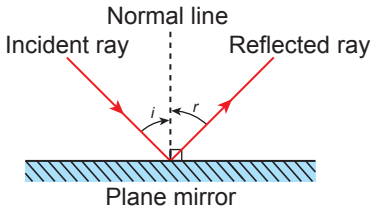


Figure 8.13 *Reflection of light*

I Can Remember!

The angle of incidence, i is equal to the angle of reflection, r.

$i = r$

Science Exploration

Applications of Reflection of Light

Photograph 8.10 *Applications of reflection of light*

Photograph 8.9
An ambulance

Have you ever wondered why the word "ambulance" is written in an inverted manner? How is the image formed when the drivers of other vehicles look into their rear view mirror? Think about it.

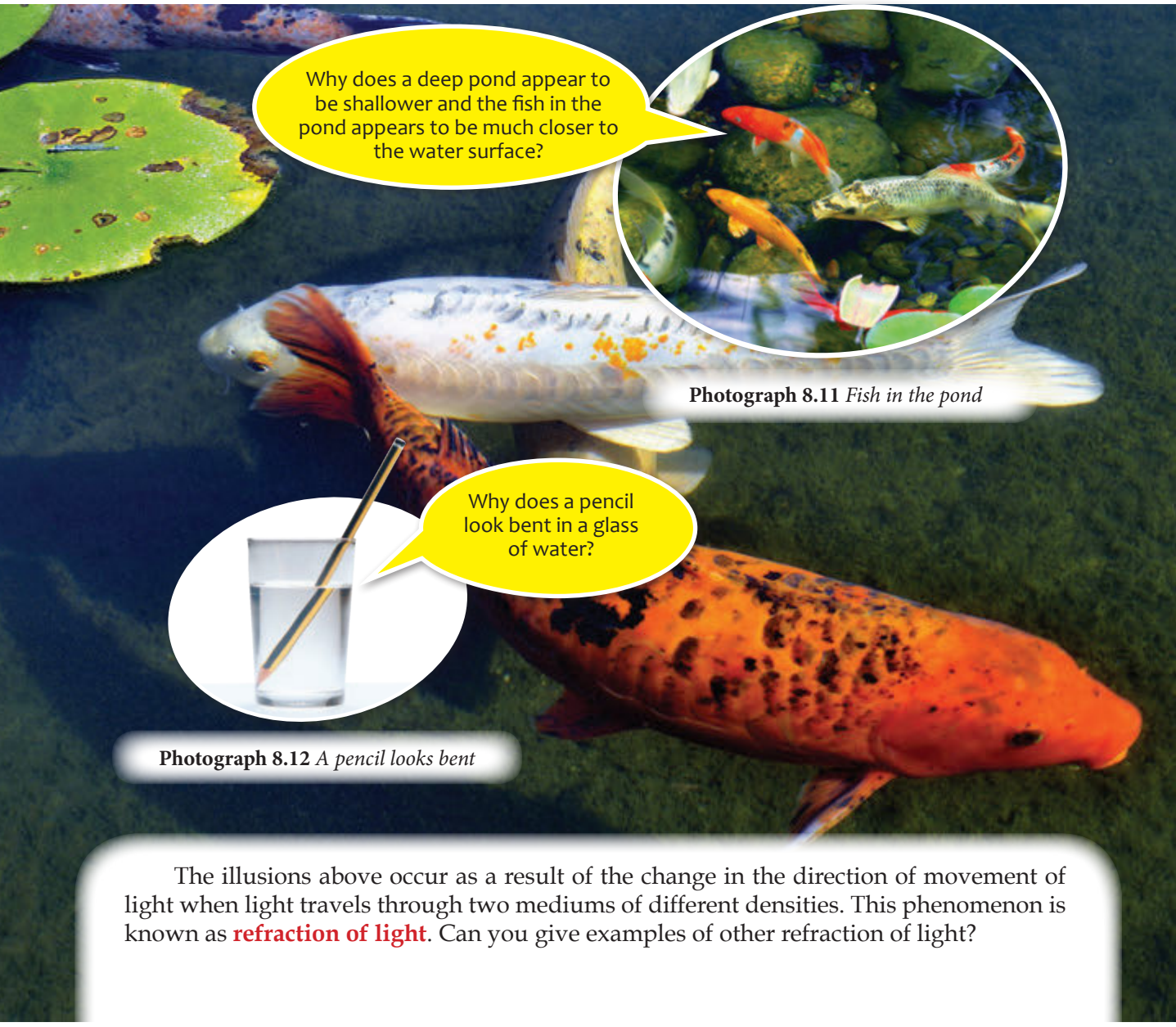
Formative Practice 8.3

1. Explain the Law of Reflection with the help of a light reflection ray diagram.
2. Complete the statement below.
   The image formed by a plane mirror is _____, _____, _____ and the image distance is _____ with the object distance.

8.4 Refraction of Light

Let's learn

- Generalise that refraction occurs when light moves through medium of different densities.
- Draw ray diagrams to show refraction of light when light propagate from one medium to another medium of a different density.
- Generalise the relationship between the angle of incidence, *i* and angle of refraction, *r*, when light travels from a medium of low density to a medium of high density.
- Justify the applications of refraction of light in daily life.



Photograph 8.11 *Fish in the pond*

Photograph 8.12 *A pencil looks bent*

The illusions above occur as a result of the change in the direction of movement of light when light travels through two mediums of different densities. This phenomenon is known as **refraction of light**. Can you give examples of other refraction of light?

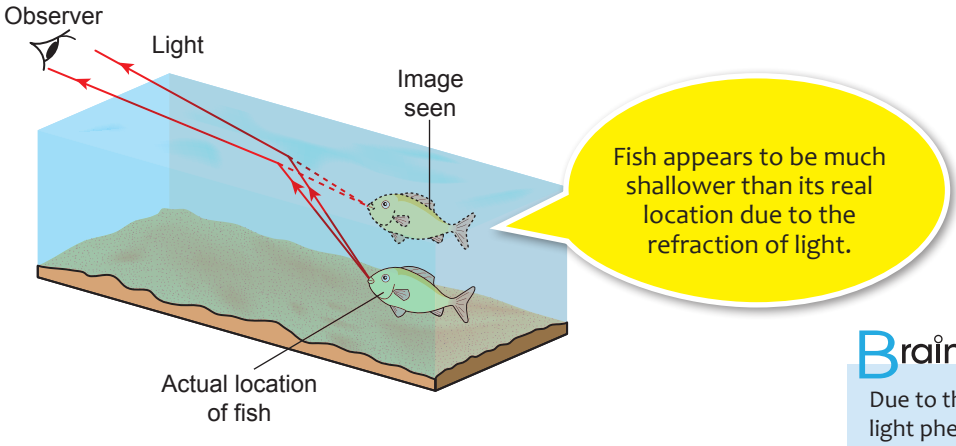
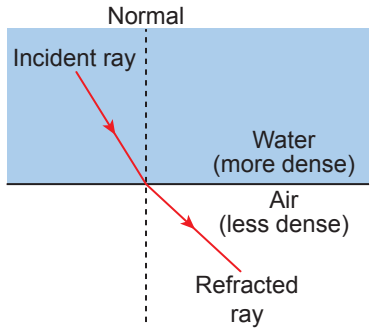


Figure 8.14 *Fish in an aquarium*

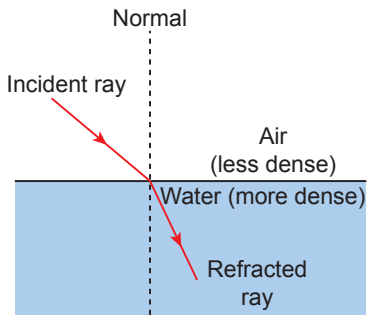
Brain Teaser

Due to the refraction of light phenomenon, how do you catch fish in a river?

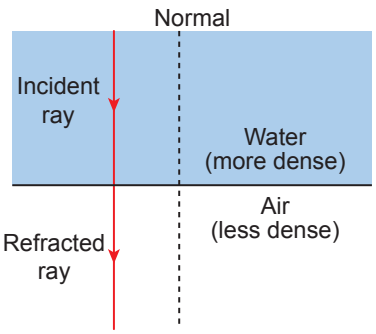
Figure 8.15 shows the refraction of light when light rays pass through mediums of different densities.



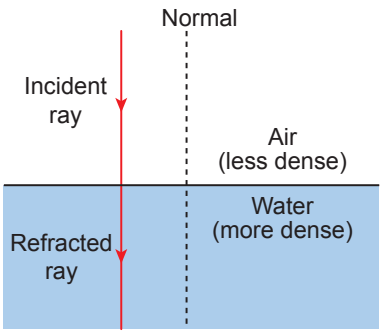
The light ray is refracted away from the normal when the incident ray moves from a more dense medium to a less dense medium.



The light ray is refracted towards the normal when the incident ray moves from a less dense medium to a more dense medium.



The light ray is not refracted when the incident ray is parallel to the normal and moves from a more dense medium to a less dense medium.



The light ray is not refracted when the incident ray is parallel to the normal and moves from a less dense medium to a more dense medium.

Figure 8.15 *Ray diagrams to show refraction of light*

Experiment 8.2

Problem statement
What is the relationship between the angle of incidence, *i* and angle of refraction, *r* when light travels from a less dense medium to a more dense medium?

Hypothesis: The greater the angle of incidence, *i*, the bigger the angle of refraction, *r*.

Aim: To determine the relationship between angle of incidence, *i* and angle of refraction, *r* when light travels from a less dense medium (air) to a more dense medium (glass block)

Variables
Manipulated variable: The angle of incidence, *i*
Responding variable: The angle of refraction, *r*
Constant variable: The size of the slit, the shape of glass block

Materials and apparatus: Glass block, ray box with single slit plate, plastic ruler, power supply, white paper, protractor.

Procedure
1. Carry out this experiment in the dark.
2. Place a glass block on a white paper and trace its outline.
3. Direct a single incident ray onto the block, mark its path and draw its incident ray with a ruler.
4. Mark the path of the ray emerging from the block and draw the ray with a ruler.
5. Remove te block, connect the entry and exit points to show the path of the ray inside the block.
6. Draw a normal line at the entry point.
7. Measure the angle of incidence, *i* and the angle of refraction, *r* using a protractor.
8. Repeat steps 3 to 7 for different angles of incidence.
9. Record your results in a table.

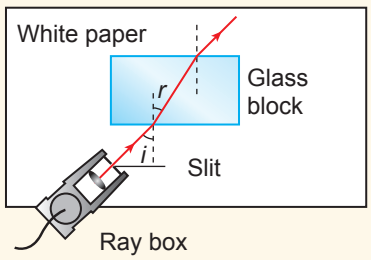


Figure 8.16

Results

Angle of incidence, *i* (°)	Angle of refraction, *r* (°)

Discussion
1. Plot a graph of *i* against *r*.
2. Based on the graph of the angle of incidence, *i* against the angle of refraction, *r*, what is the relationship between the angle *i* with the angle *r*?

Conclusion
Can the hypothesis be accepted?

Question
What happen to the light ray when it travels from a
(a) less dense medium to a more dense medium?
(b) more dense medium to a less dense medium?

We can see many examples of the effects of light refraction in our daily life. Let us carry out Activity 8.6 to discover even more light refraction phenomena.

Activity 8.6

Aim: To investigate the phenomenon of refraction of light

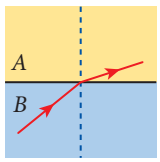
Instruction

1. Work in groups.
2. Use resources such as the library, Internet, and others to collect information regarding the following phenomena.
   - A spoon looks bent in water
   - The bottom of a pool appears to be shallower
3. Present the outcomes of your research in class.

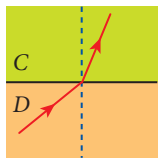
Formative Practice 8.4

1. Why does the bottom of a deep swimming pool appear shallower?
2. Light rays refract at a certain angle in two different cases as below. Differentiate the density of the two mediums for both the cases below.

Case 1:



Case 2:



8.5 Dispersion of Light

Let's learn

- Communicate about the dispersion of light.
- Explain the dispersion of light in daily life with examples.

Do you know why the components of colour in a rainbow can be seen when light passes through a glass prism (Figure 8.17)?

White light consists of seven components of colour. Each component of colour travels at a different speed in a medium. For example, red light has the highest speed, so red light is refracted the least. However, violet light has the lowest speed, so violet light is refracted the most.

1 When a white light ray is directed to a prism, the white light will be separated into its components of colour. This is because the different colours in the white light bend towards the normal at different angles when entering the prism.

Brain Teaser

What will happen if a second inverted prism is placed behind the first prism?

21st Century CPS

2 When the different colours leave the glass prism, they are refracted away from the normal. The different colours are dispersed in an order that is known as a **spectrum**. The spectrum of white light consists of red, orange, yellow, green, blue, indigo and violet colour.

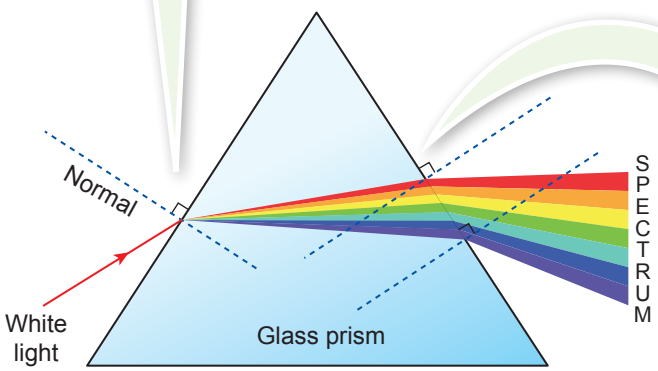


Figure 8.17 *Dispersion of white light by a glass prism*

When sunlight enters rain droplets in the sky, the white light will be refracted and dispersed into seven different colours to form a **rainbow**.

Figure 8.18 *The formation of rainbow*

Activity 8.7

Aim: To study the dispersion of light passing through a glass prism and the formation of rainbow

Materials and Apparatus: Glass prism, white screen, ray box, a plane mirror, water, torch light, a piece of white paper, a basin, cellophane tape, a round black cardboard.

Instruction

I Dispersion of light by a glass prism

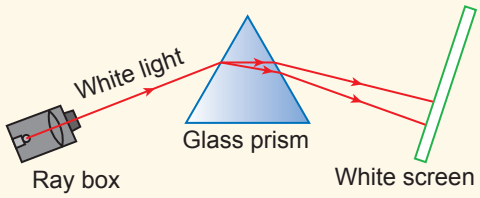


Figure 8.19

1. Carry out this activity in the dark.
2. Direct a narrow light ray from a ray box towards a glass prism (Figure 8.19). Adjust the glass prism slowly until a sharp colour spectrum is formed on a white screen.
3. Identify the colours formed on the white screen.
4. Observe the order of colours on the white screen.
5. Record your observation.

II Formation of a Rainbow

1. Fill a basin half-full with water.
2. Place a piece of mirror in the water with an incline on the side of the basin. Secure the mirror using a cellophane tape.
3. Make a small hole on a piece of round black cardboard. Then, attach the cardboard to the front of a torch light.
4. Shine the torch light towards the mirror (Figure 8.20).
5. Hold a white paper beside the mirror. Adjust the direction of the torch light until you see a rainbow on the paper.

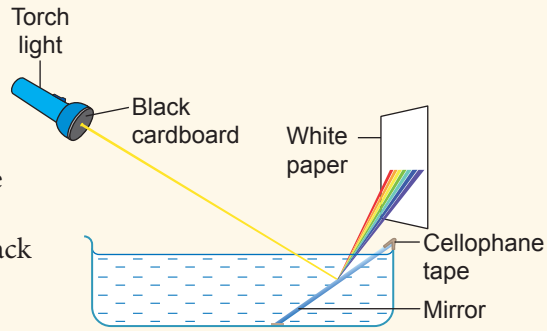
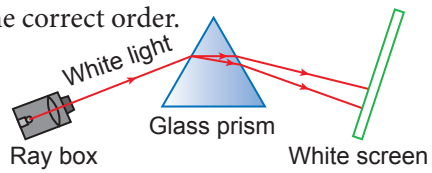


Figure 8.20

Formative Practice 8.5

1. List the seven colours formed on the screen below in the correct order.
2. State the colour component that is refracted the most and refracted the least in the phenomenon above. Relate the phenomenon with the speed of each colour component.



8.6 Scattering of Light

Let's learn

- Communicate about scattering of light.
- Explain scattering of light in daily life with examples.

Why does the sky appear blue at midday and reddish in the evening?

Photograph 8.13 *The phenomena of scattering of light*

The two natural phenomena are caused by the **scattering of light**. Scattering of light occurs when light is reflected in all directions by clouds or particles in the air.

During midday

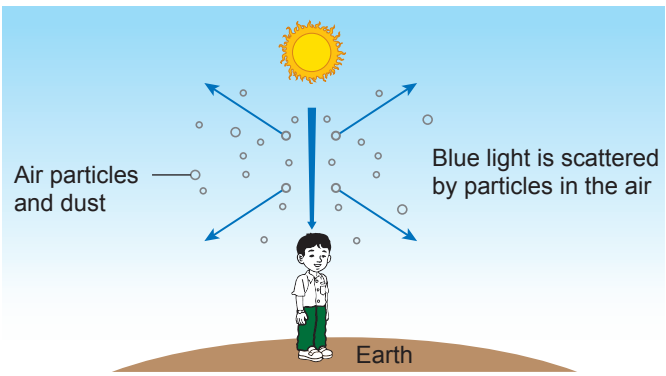


Figure 8.21 *Scattering of light during midday*

During midday, **blue light** is scattered the most in all directions by the tiny particles in the atmosphere. Therefore, the sky looks blue during midday.

During sunset

During sunset, the sun is at the horizon. Red and orange light are less scattered and will go through the atmosphere to reach your eyes. Other coloured lights such as blue light are scattered away. Therefore, the sky looks reddish during sunset.

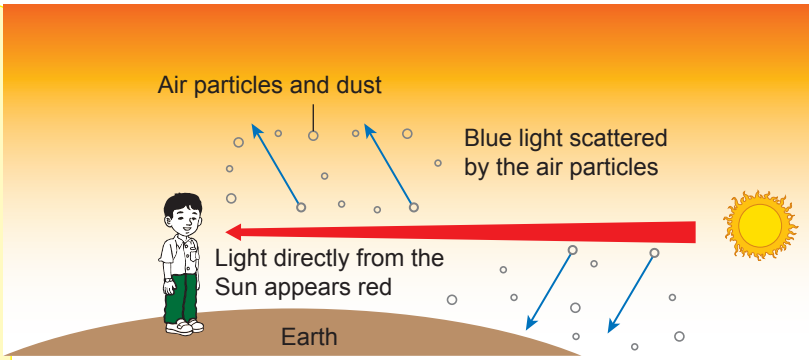


Figure 8.22 *Scattering of light during sunset*

Activity 8.8

Aim: To study the scattering of light

Materials and apparatus: Milk powder, 1000 ml glass beaker, ray box, white screen.

Instruction

1. Carry out this activity in the dark.
2. Set up the apparatus as shown in Figure 8.23.
3. Turn on the ray box.
4. Add a few tablespoons of milk powder into the water. Stir the water until you can see a beam of light that shines through the mixture.
5. See the light beam from the side of the beaker. Then, look at the white screen as shown in Figure 8.23.
6. Add more milk powder and observe the colour change of the white light beam at the side of the beaker and on the white screen.
7. Record your observation.

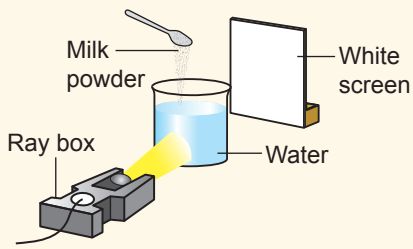


Figure 8.23

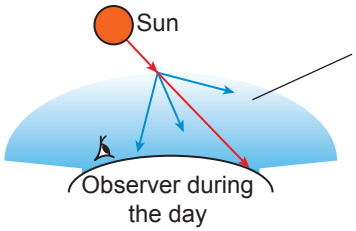
Questions:

1. What is the function of adding milk powder into the water?
2. What is the difference between the beam of light as seen from the side of the beaker and the beam of light on the screen? Explain your answer.

Formative Practice 8.6

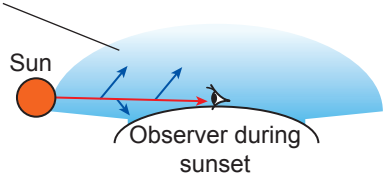
1. Why does scattering of light occur?
2. Fill the blanks with the correct words.

(a)



Blue colour is scattered _____ compared to red colour.

(b)



Red colour is scattered _____ compared to blue colour.

8.7 Addition and Subtraction of Light

Let's learn

- Identify primary colours.
- Identify the addition of primary colours to produce secondary colours.
- Communicate about subtraction of light.
- Record the colours formed on the screen when light passes through colour filters.
- Differentiate the addition and subtraction of light.
- Explain addition and subtraction of light in daily life with examples.

Coloured lights can be categorised into two types, namely **primary colour** and **secondary colour**. The primary colour is the basic colour that cannot be produced through colour mixing. Red, blue and green are primary colours.

The Addition of Light

What is the colour produced when two primary colours are mixed? Colours produced from the mixing of two colours are known as secondary colours. Cyan, yellow and magenta are secondary colours. White colour is produced when all the three primary colours are mixed together (Figure 8.24).

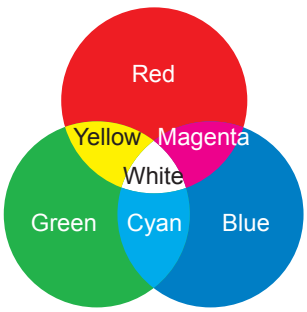


Figure 8.24 *The addition of light*

What is the method to produce secondary colours? Let us carry out Activity 8.9 to produce secondary colours using colour filters.

The addition of light
http://www.physicsclassroom.com/class/light/Lesson-2/Color-Addition

I Can Remember!

Formula for colour addition

Primary colour	+ Primary colour	= Secondary colour
Red (R)	Blue (B)	Magenta (Mag)
Red (R)	Green (G)	Yellow (Y)
Blue (B)	Green (G)	Cyan (C)
Red + Blue + Green = White		

Activity 8.9

Aim: To study the addition of primary colours to produce secondary colours

Materials and apparatus: Primary colour filters, three ray boxes, white screen.

Instruction

1. Carry out this activity in a dark room.
2. Prepare three ray boxes with red, blue and green filters each fixed in front of them.
3. Direct the red ray and green ray to overlap on a white screen as shown in Figure 8.25. What is the colour that you observe where the rays overlap?

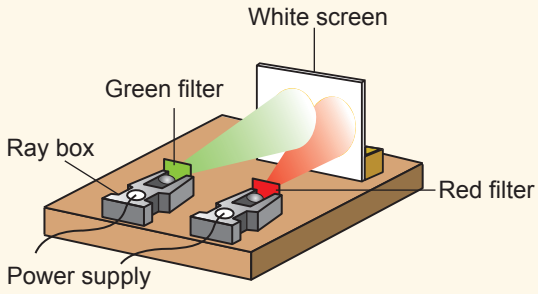


Figure 8.25

4. Repeat step 3 using green and blue rays, followed by red and blue rays. Observe the colours formed.

The Subtraction of Light

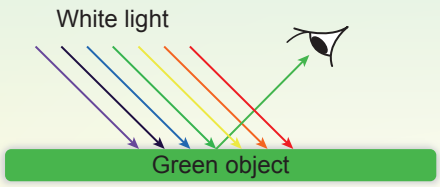
How do we see the colour of opaque objects? Why do we see banana as yellow, strawberry as red and leaf as green? The light which has the same colour as the colour of the opaque objects will be reflected directly into our eyes, while the light of other colours will be absorbed by the objects. This phenomenon is known as **subtraction of light**.

Photograph 8.14 *Colour of fruits*

The Principle of Light Subtraction

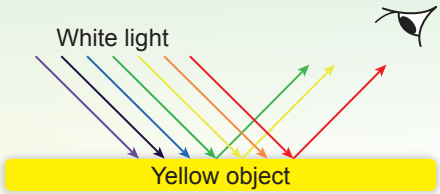
The colour of opaque objects depends on the colour of the light reflected into our eyes.

Objects with **primary colours** (red, blue or green) will only reflect the light which has the same colours as them.



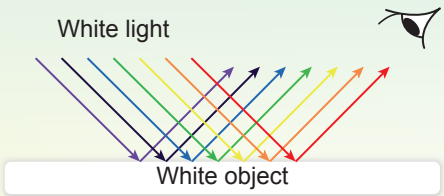
A green object only reflects green light. Other coloured lights will be absorbed. Therefore, the object appears green.

Objects with **secondary colours** (yellow, magenta or cyan) reflect the light of the same colour and also the light of primary colours which form the secondary colour.



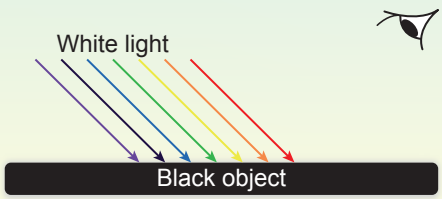
A yellow object reflects yellow, red and green colours. The overlap of red and green lights causes the object to appear yellow.

White objects appear white in white light because the white objects **reflect all colours in white light**.



White objects reflect all colours in white light. All coloured lights overlap to produce white light again.

Black objects appear black because they **absorb all colours in white light**.

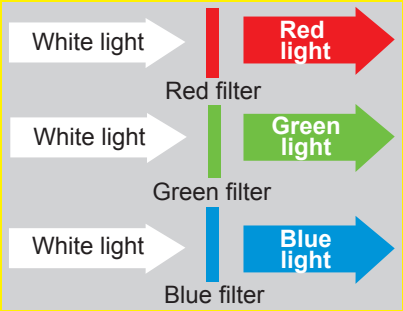


Black objects absorb all colours in white light. No coloured lights are reflected. Therefore, the objects appear black.

Usually, colour filters are used to understand the principle of subtraction. There are two types of colour filters:

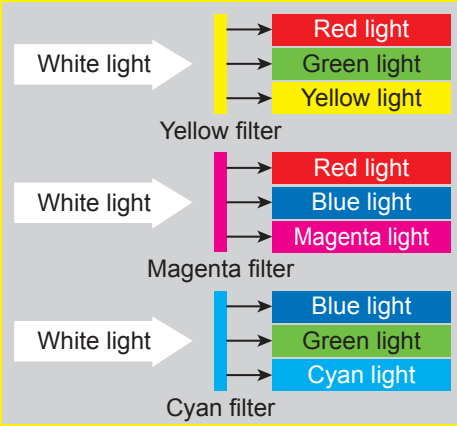
Primary colour filters

- Allow only the light of the same colour to pass through, light of other colours are absorbed.



Secondary colour filters

- Allow only the light of the same colour and the light of primary colours which form the secondary colour to pass through. Light of other colours are absorbed.



Let us study the subtraction of light when light is absorbed or subtracted by colour filters in Activity 8.10.

Brain Teaser

What will happen if a second colour filter is placed at the back of the first colour filter?

21 Century ICS

Activity 8.10

Aim: To study subtraction of light

Materials and apparatus: Primary colour filters, secondary colour filters, ray box, white screen.

Instruction

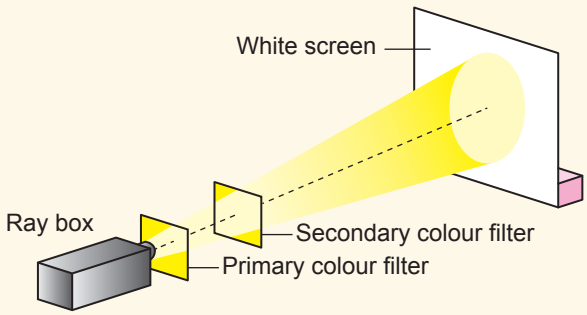


Figure 8.26

1. Carry out this activity in a dark room.
2. Direct a white light beam towards a white screen.
3. Place a primary colour filter of red and secondary colour filter of yellow in front of the ray box (Figure 8.26). What can you observe on the white screen?
4. Repeat step 3 by replacing the secondary colour filter of yellow with a magenta and cyan filter.
5. Record your results in the table below.
6. Repeat steps 3 to 5 by replacing the primary colour filter of red with green and blue filters.

Primary colour filter	Secondary colour filter	Colour of light on the screen
Red	Yellow	
	Magenta	
	Cyan	
Green	Yellow	
	Magenta	
	Cyan	
Blue	Yellow	
	Magenta	
	Cyan	

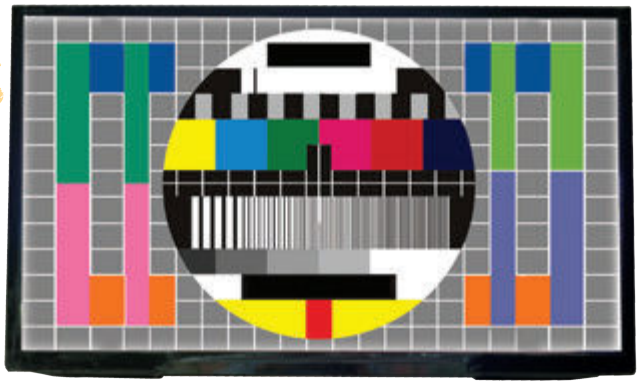
Difference between Addition and Subtraction of Light

After learning about addition and subtraction of light, what is the difference between them?

Addition and subtraction of light are two different principles of light. The addition of light is the mixing of primary colour lights to produce secondary colour lights. However, subtraction of light occurs when an opaque object reflects the light of same colour and absorbs the light of other colours.

Examples of Addition and Subtraction of Light

Example 1 Colour television



Photograph 8.15 *A colour television*

Example 2 Coloured lights on stage

Photograph 8.16 *Coloured lights play a role on the stage during a performance*

Example 3 Coloured lights in a stadium

Photograph 8.17 *Coloured lights in a stadium*

Example 4 Coloured lights at KLCC

Photograph 8.18 *Coloured lights in the fountain in front of KLCC*

Activity 8.11

21st Century ICS

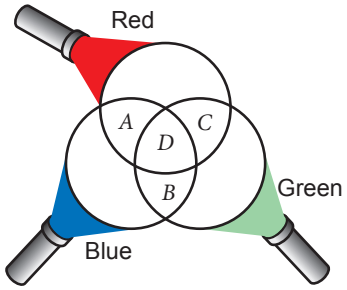
Aim: To gather the information regarding examples of addition and subtraction of light

Instruction

1. Work in groups.
2. Each group has to find information regarding examples of addition and subtraction of light.
3. Present your findings using multimedia presentation.

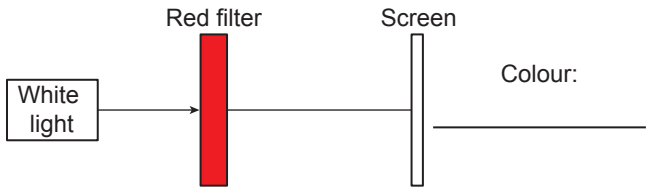
Formative Practice 8.7

1. Three torchlights are switched on as in the diagram below. What are the colours formed in *A*, *B*, *C* and *D*?

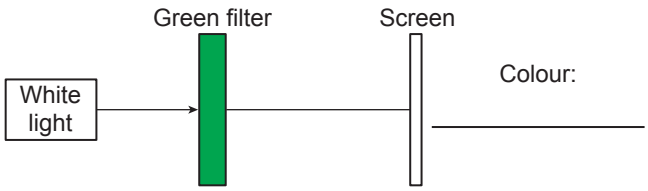


2. State the colours of the light formed on the screen in the diagrams below.

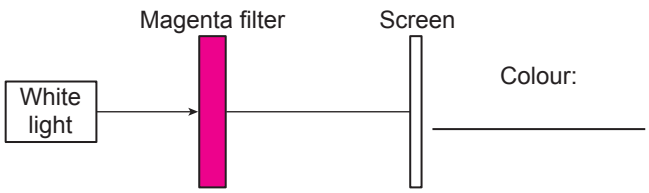
(a)



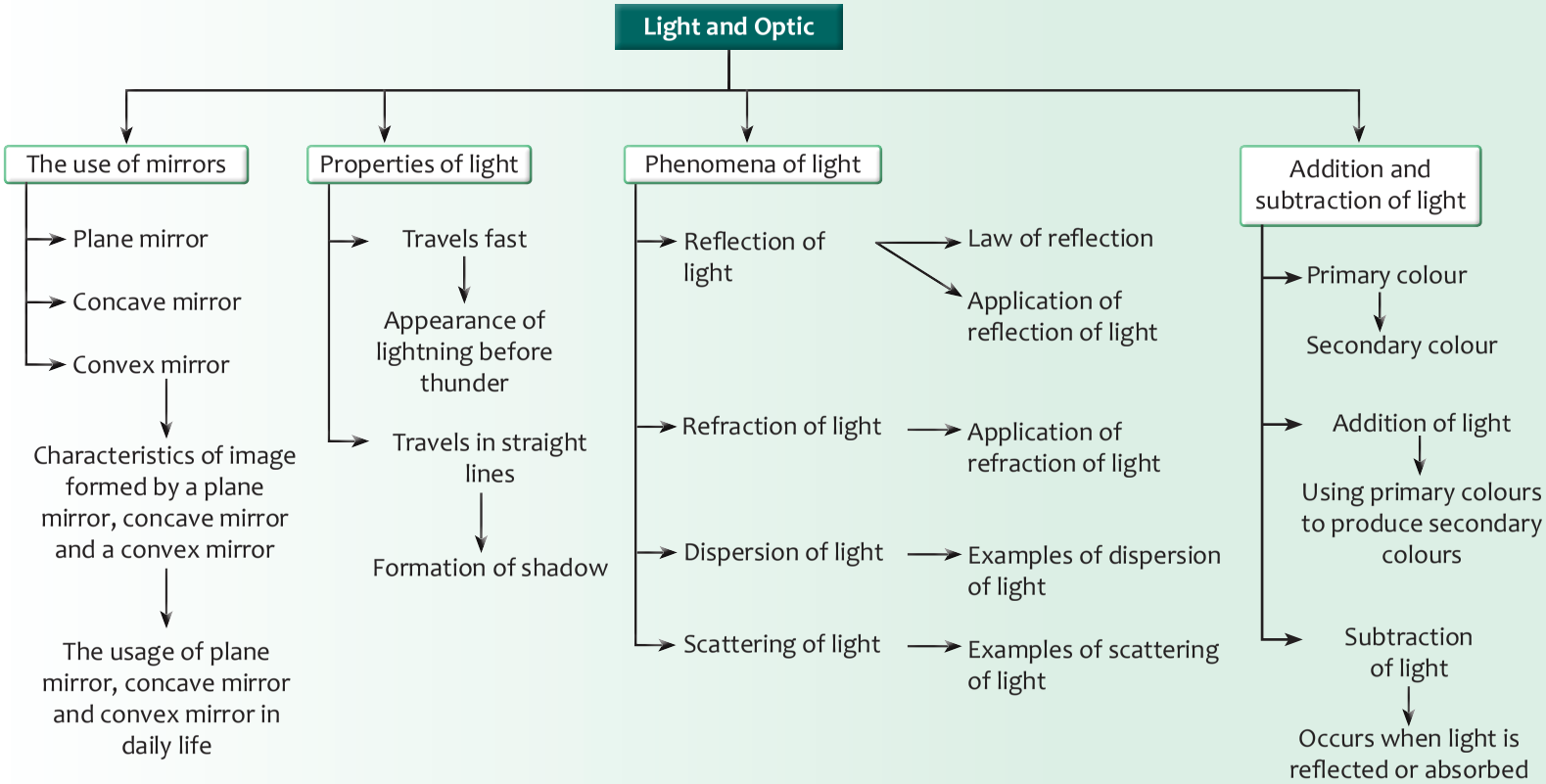
(b)



(c)



Concept Map


Light and Optic
The use of mirrors
Plane mirror
Concave mirror
Convex mirror
Characteristics of image formed by a plane mirror, concave mirror and a convex mirror
The usage of plane mirror, concave mirror and convex mirror in daily life
Properties of light
Travels fast
Appearance of lightning before thunder
Travels in straight lines
Formation of shadow
Phenomena of light
Reflection of light
Law of reflection
Application of reflection of light
Refraction of light
Application of refraction of light
Dispersion of light
Examples of dispersion of light
Scattering of light
Examples of scattering of light
Addition and subtraction of light
Primary colour
Secondary colour
Addition of light
Using primary colours to produce secondary colours
Subtraction of light
Occurs when light is reflected or absorbed

SELF-REFLECTION

After learning the chapter, you are able to:

8.1 The Use of Mirrors

- ☐ Differentiate between a real image and a virtual image.
- ☐ Communicate about the characteristics of image formed by a plane mirror, concave mirror and convex mirror.
- ☐ State that the object distance is equal to the image distance in a plane mirror.
- ☐ Use the plane mirror to apply the concept of reflection of light.
- ☐ Justify the application of concave mirrors and convex mirrors in daily life.
- ☐ Construct an optical instrument to appreciate the use of these optical instruments to enhance the ability of the human senses.
- ☐ Solve problems in daily life involving the application of plane mirrors, concave mirrors and convex mirrors.

8.2 Properties of Light

- ☐ Communicate about the properties of light.

8.3 Reflection of Light

- ☐ State the characteristics of the image formed by a plane mirror.
- ☐ Communicate about the Law of Reflection.
- ☐ Draw ray diagrams to show the reflection of light.
- ☐ Solve problems in daily life with the application of reflection of light.

8.4 Refraction of Light

- ☐ Generalise that refraction occurs when light moves through medium of different densities.
- ☐ Draw ray diagrams to show refraction of light when light propagate from one medium to another medium of a different density.
- ☐ Generalise the relationship between the angle of incidence, i and angle of refraction, r, when light travels from a medium of low density to a medium of high density.
- ☐ Justify the applications of refraction of light in daily life.

8.5 Dispersion of Light

- ☐ Communicate about the dispersion of light.
- ☐ Explain the dispersion of light in daily life with examples.

8.6 Scattering of Light

- ☐ Communicate about scattering of light.
- ☐ Explain scattering of light in daily life with examples.

8.7 Addition and Subtraction of Light

- ☐ Identify primary colours.
- ☐ Identify the addition of primary colours to produce secondary colours.
- ☐ Communicate about subtraction of light.

- Record the colours formed on the screen when light passes through colour filters.
- Differentiate the addition and subtraction of light.
- Explain addition and subtraction of light in daily life with examples.

Summative Practice 8

1. What are the differences between a real image and a virtual image?

2. Circle the correct refracted light ray.

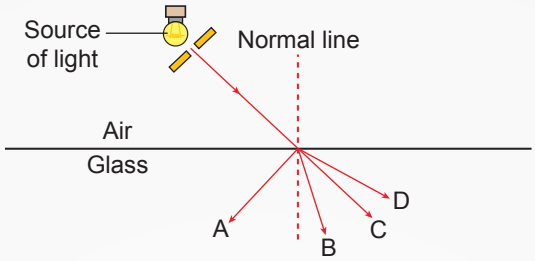


Figure 1

3. Which observer will see the sunlight as reddish?

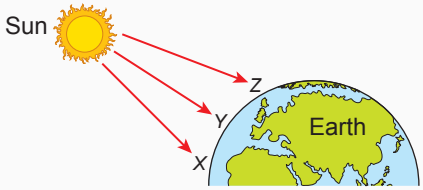


Figure 2

4. Write the colour produced when the following colour lights are mixed.

(a) Red light + Blue light → _____

(b) Red light + Green light → _____

(c) Blue light + Green light → _____

(d) Red light + Blue light + Green light → _____

5. A periscope is built using two plane mirrors. State the characteristics of the image that can be seen by the observer.

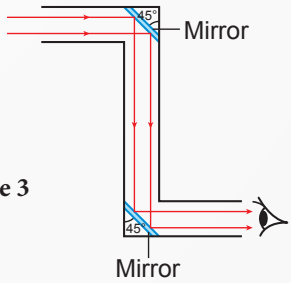


Figure 3

6. The following statement explains the side mirror of a car:

Objects in the mirror appear closer than the actual distance.

What is the type and function of the side mirror of the car as shown in Photograph 1?

Photograph 1

7. Draw a ray diagram to show why the feet of the boy appears short in Figure 4.

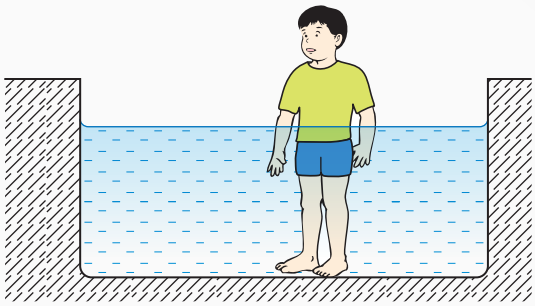
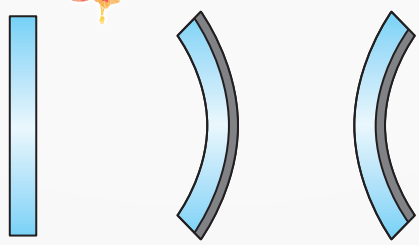


Figure 4

8. Kavita saw a rainbow at a fountain in a park. What is the phenomenon that has occurred?

Photograph 2

9. Akmal wants to fix mirrors in every corner of his shop so that he can view every corner to ensure that his things are not stolen. He is given three mirrors as below. Which mirror should Akmal choose? Give a reason.



P *Q* *R*

Figure 5

10. A man wants to see what is behind a wall as in Figure 6. Suggest an instrument to help the man to see what is behind the wall. Draw the instrument.

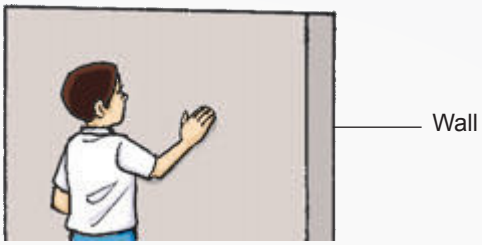


Figure 6

The Next Challenge . . .

11. Khairul is learning how to spear a fish in a river. Even though he has tried many times, he is still unable to do so. Based on the diagram below, what phenomenon has occurred? How can you help Khairul to spear the fish? Explain.

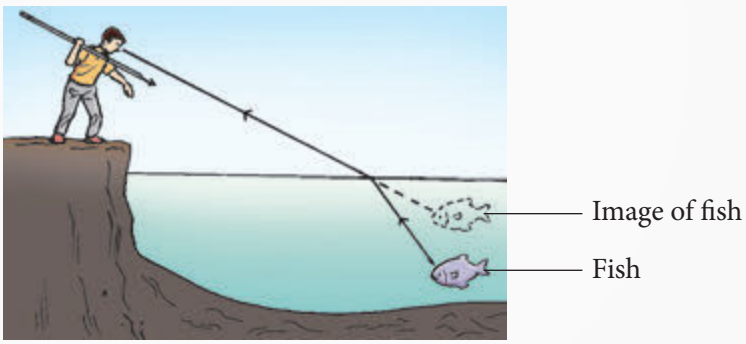


Figure 7

12. An adventurer has lost his way in a jungle. He lost his watch. Suggest an instrument that can help him to estimate time accurately. Explain the property of light used in creating the instrument. Draw the instrument.

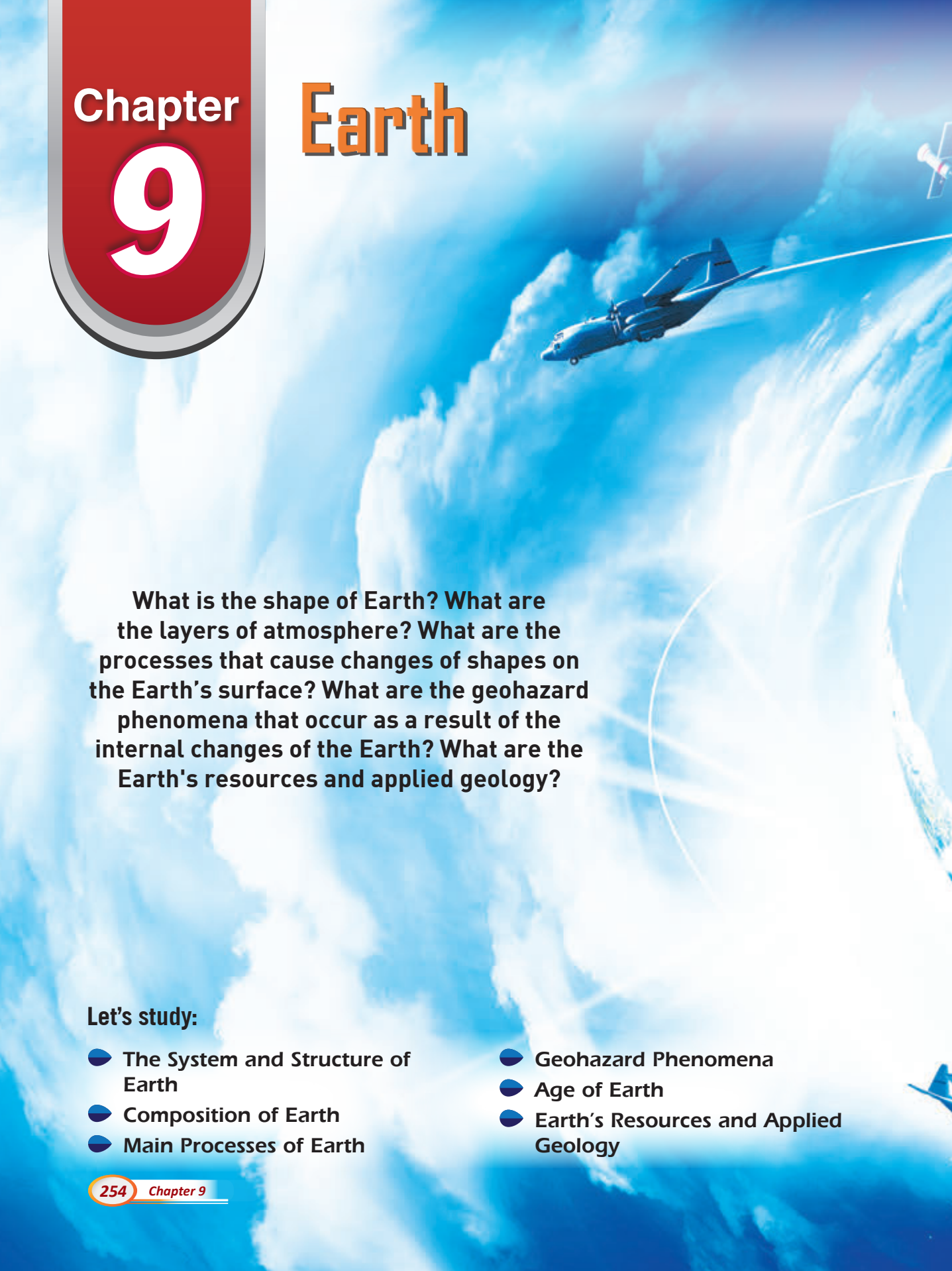
THEME 5

Exploration of Earth and Space

The Earth supplies us with useful fossil materials. For example, fossil fuel is very useful in transportation and in our everyday life. What are fossil materials?

Chapter 9

Earth



What is the shape of Earth? What are the layers of atmosphere? What are the processes that cause changes of shapes on the Earth's surface? What are the geohazard phenomena that occur as a result of the internal changes of the Earth? What are the Earth's resources and applied geology?

Let's study:

- The System and Structure of Earth
- Composition of Earth
- Main Processes of Earth
- Geohazard Phenomena
- Age of Earth
- Earth's Resources and Applied Geology

SCIENCE BULLETIN

IS EARTH SPHERICAL OR FLAT?

Earth is spherical though it looks flat when we look at the horizon. The hypothesis that states that Earth is spherical in shape was proven by Ferdinand Magellan who set sail from Spain in September 1519. He appointed a Malay man from Malacca named Panglima Awang or "Henry the Black" as his translator. Even though Magellan was killed in the Philippines in 1521, his and his crew's voyage had proved that Earth is spherical in shape.

KEYWORDS

- Atmosphere
- Hydrosphere
- Biosphere
- Geosphere
- Ozone depletion
- Igneous rock
- Metamorphic rock
- Sedimentary rock
- Exogenic process
- Endogenic process
- Geohazards
- Geological time scale
- Fossil
- Surface water
- Underground water
- Minerals
- Hydrothermal

9.1 The System and Structure of the Earth

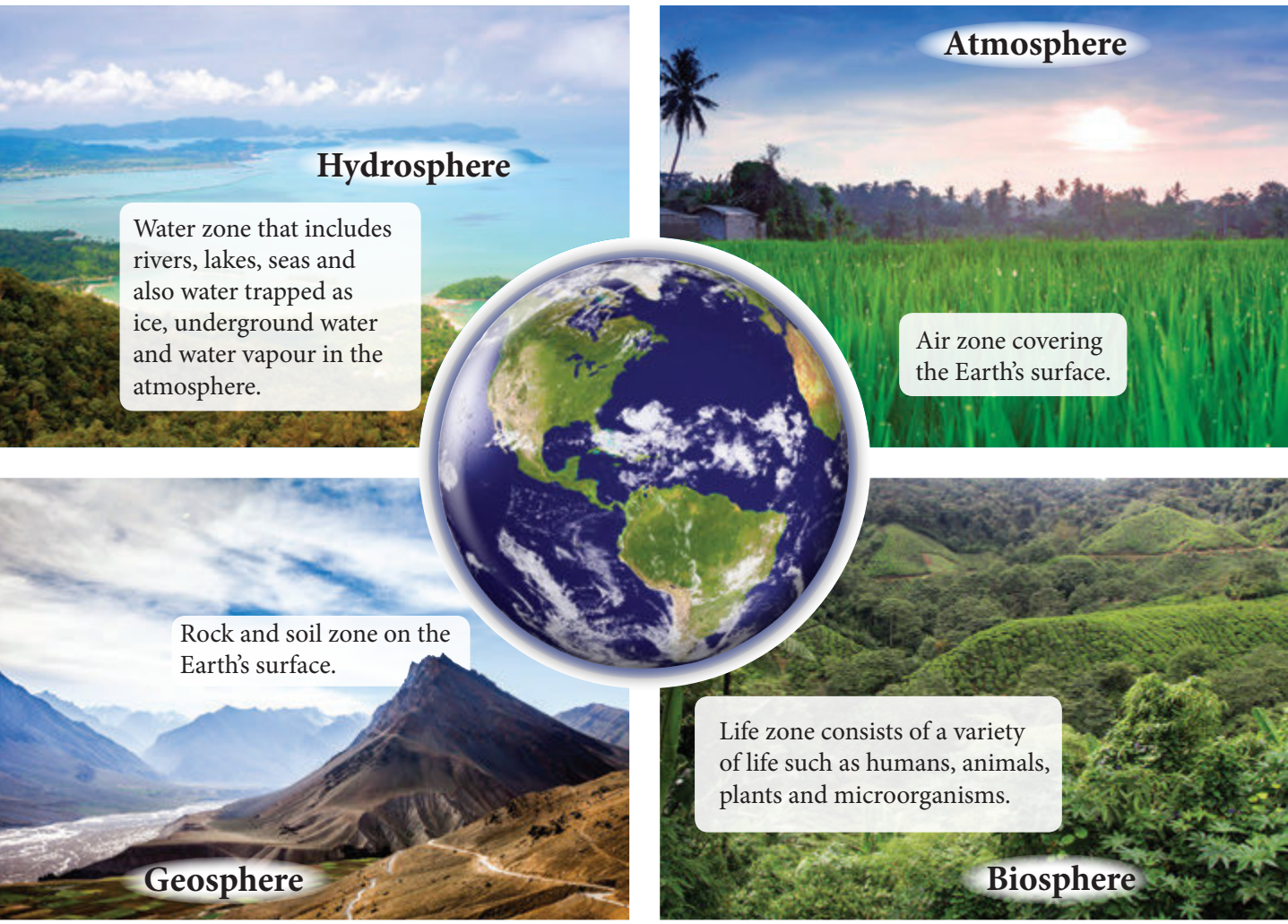
Let's learn

- Communicate about the system of the Earth.
- Explain the differences of the Earth's layers based on its composition and physical characteristics.
- Realise that Earth is the only place that can sustain life based on its physical characteristics.

Have you ever thought about the structure of the Earth? What are the layers of air above the Earth? How is water on Earth such as oceans, rivers, clouds and lakes distributed? What are the Earth's layers and its composition? Why is Earth suitable for living things?

The Earth system consists of four main components which are interconnected, namely **atmosphere**, **biosphere**, **hydrosphere** and **geosphere**.

Video on atmosphere's structure and composition of air



Photograph 9.1 *The Earth system consists of four main components*

Atmospheric Stratification

Earth's atmosphere consists of five layers, each with its respective roles.

Figure 9.1 *Atmospheric stratification*

What do you feel when a climbing mountain? Will you feel cold and have difficulties in breathing?

From troposphere to stratosphere, the altitude increases. The higher the altitude, the lower the air pressure. The temperature also becomes lower when altitude increases.

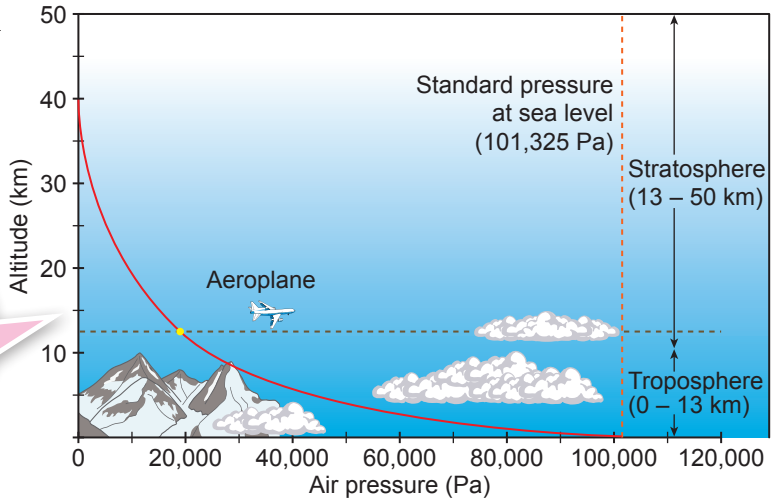
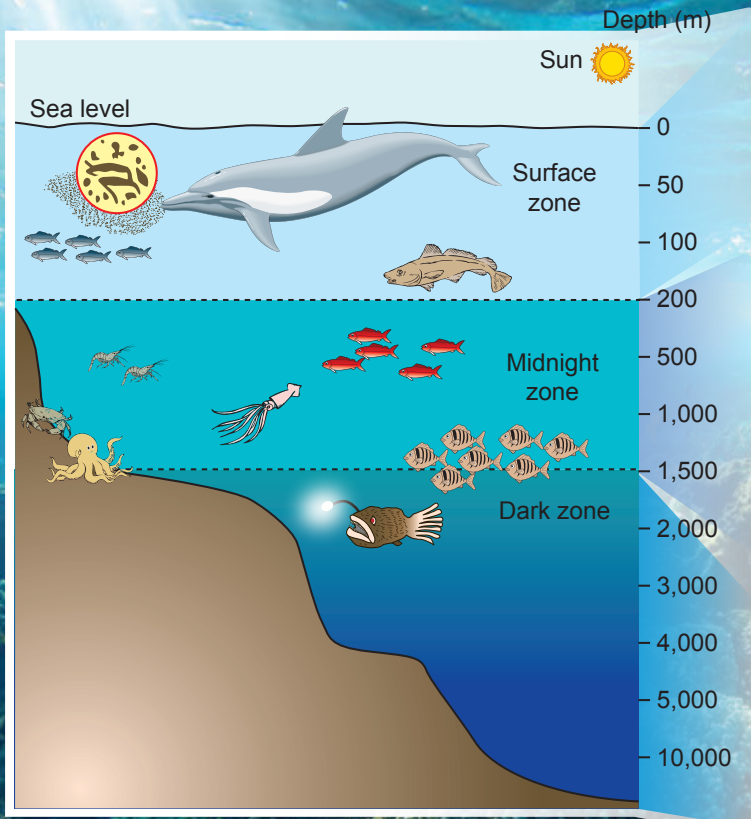


Figure 9.2 *Relationship between air pressure and altitude*

Ocean Stratification

The ocean can also be divided into different zones, from a zone where light can penetrate to a zone where light cannot penetrate (dark zone) (Figure 9.3).



Surface zone
In this zone, the water is very shallow and light can penetrate. This makes the zone suitable as a habitat for plants.

Midnight zone
This zone has little or no light. It is difficult for plants to live at this depth but this level of depth becomes the habitat for large marine animals, such as giant squids and various species of whales.

Dark zone
This zone is very deep and no light can reach it. Therefore, most animals in this zone have shimmering bodies or are able to glow in the dark.

Figure 9.3 *Ocean stratification*

Distribution of Water on Earth

The ocean contains a lot of water. Where does this water come from? Seawater is evaporated by sunlight and is taken to the mainland by clouds before it falls back as rain water. The water in the rivers then flow into the ocean. The **water cycle** process is continuous. Therefore, it is said that the total amount of water contained in Earth, on Earth's surface and in Earth's atmosphere is always constant.

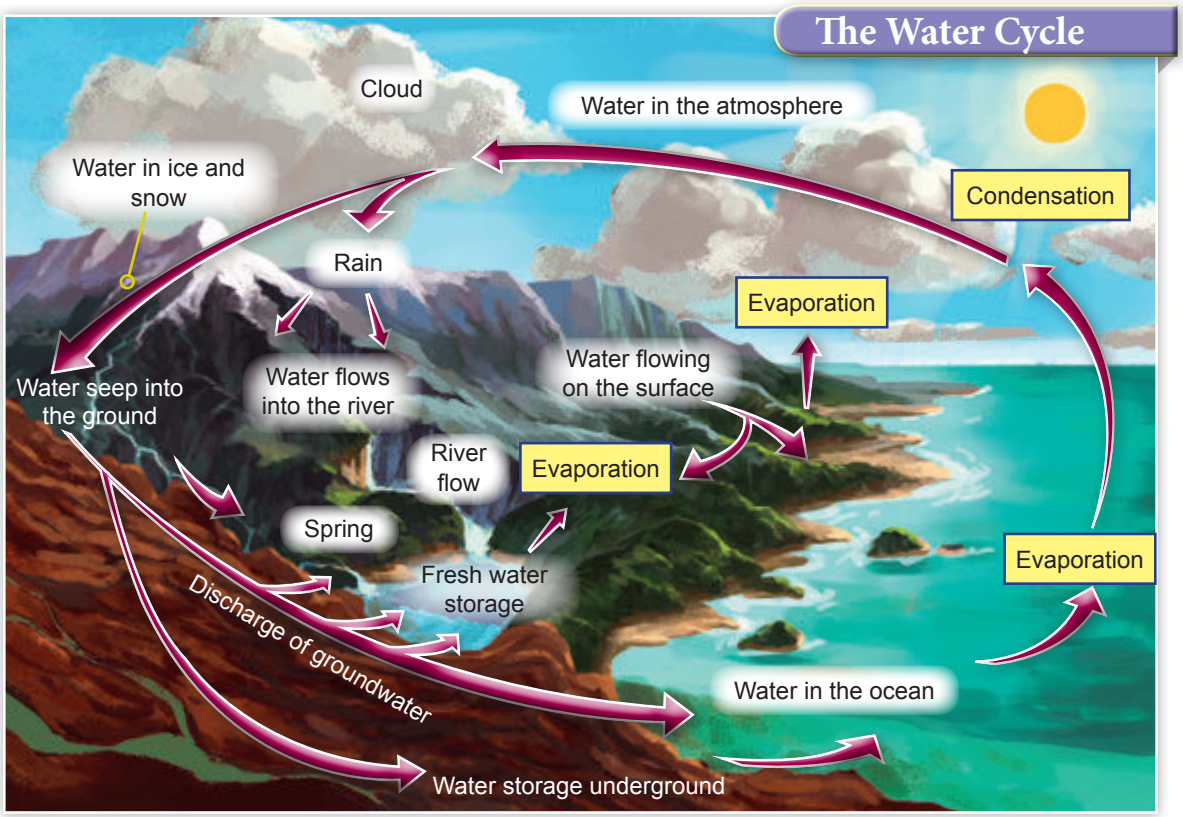


Figure 9.4 *The water cycle*

Activity 9.1

21st Century ICS

Aim: To prepare a multimedia presentation on atmospheric stratification and ocean stratification

Instruction

1. Work in groups.
2. Each group is required to do a presentation regarding one of the topics below:
   - Atmospheric stratification and its role
   - Ocean stratification and the distribution of animals in it
   - Ozone depletion
   - Distribution of water on Earth

Earth's Layers

Earth can be divided into three main layers according to its physical properties, namely **crust**, **mantle** and **core**. The mantle consists of the lithosphere, asthenosphere and mesosphere. Lithosphere covers the crust and the top part of the mantle.

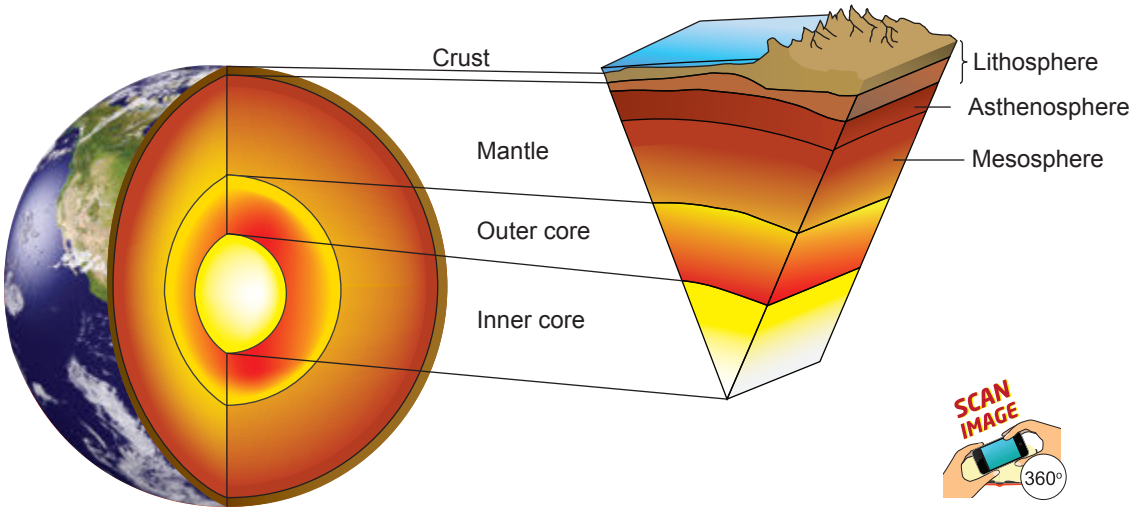


Figure 9.5 *The Earth's main layers*

Activity 9.2

Aim: To create a model of Earth

Instruction

1. Work in groups.
2. Design a model of Earth containing four layers using clay.
3. Present your model in class.

Activity 9.3

Aim: To discuss the differences in Earth's layers based on its composition and physical characteristics

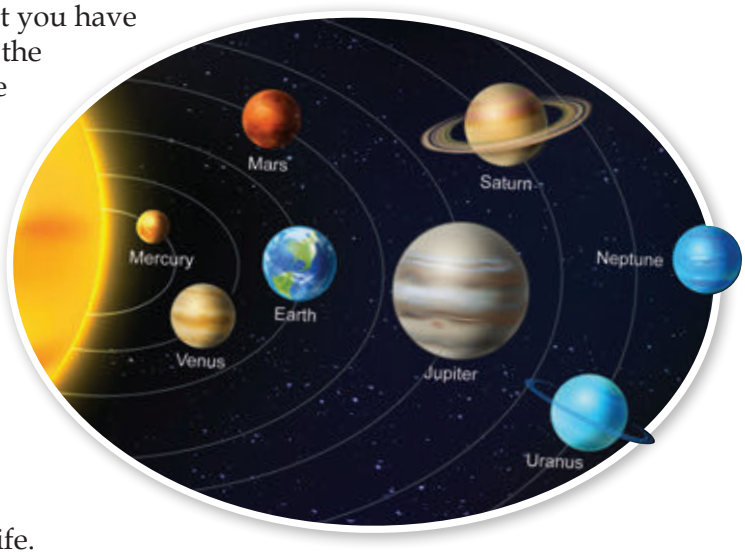
Instruction

1. Work in groups.
2. Gather information about the composition and physical characteristics of each of the Earth's layers.
3. Present your findings using a multimedia presentation.

Earth is the Only Home for Living Organisms

Recall the topic of Solar System that you have learned in primary school. Earth is the third planet from the Sun and is the only planet suitable for life in our Solar System (Photograph 9.2).

One of the unique characteristics of Earth that makes it suitable for all life is the Earth's temperature, which is not too hot or too cold compared to other planets. This is due to the Earth's position, which is not too near or too far from the Sun. Besides, the presence of water and oxygen on Earth also allows Earth to host all life. Therefore, love our Earth by taking good care of the environment!



Photograph 9.2

Future Studies

Scientists are searching for another habitable planet for all life so that we can move to that planet in future.

Formative Practice 9.1

1. Earth consist of four main spheres which are _____, _____, _____ and _____.
2. A fish catches its prey using light. In which zone of the ocean can this fish be found? Why?

9.2 Composition of the Earth

Let's learn

- Explain the type and characteristic of rocks.
- Communicate on how to differentiate the process of rock formation.

Earth's crust is formed from various types of rocks, which differ in colour, structure, texture and the way it is formed. Generally, the rocks can be categorised into three groups, namely igneous rocks, sedimentary rocks and metamorphic rocks. Each type of rock forms differently and takes thousands of years to form. All rocks contain materials known as **minerals**.

Types and Characteristics of Rocks

Table 9.1 shows the types of rocks and their characteristics.

Table 9.1 *Types of rocks and their characteristics*

Igneous rock	Sedimentary rock	Metamorphic rock
		
Formed from the process of cooling and freezing of magma or lava that flows out of the mantle.	Formed by compression of deposited materials carried by the rivers, glaciers and wind.	Formed when igneous rocks or sedimentary rocks are exposed to very high pressure and temperature.
Contains various minerals.	Consists of many layers which are sometimes hollow and contain fossils.	Usually harder than the original rocks that formed them.

The Process of Rock Formation

How are igneous rocks, sedimentary rocks and metamorphic rocks formed? The process of rock formation can be explained using the rock cycle as shown in Figure 9.6.

Video on classification of rocks

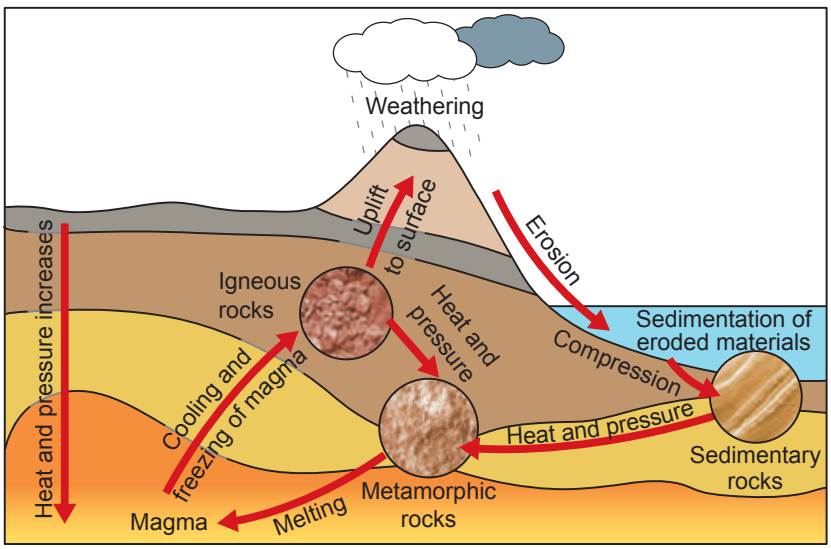


Figure 9.6 *The rock cycle*

Formative Practice 9.2

1. How are sedimentary rocks, igneous rocks and metamorphic rocks formed? Explain.
2. Why are fossils not found in igneous rocks?
3. Why are metamorphic rocks harder than igneous rocks and sedimentary rocks?

9.3 Main Processes of the Earth

Let's learn

- Explain the different Earth processes that affect the changes on Earth.
- Communicate about exogenic and endogenic processes.

What are Earth's processes that cause changes on Earth's surface? How do the changes take place? Earth's surface is formed by two processes, namely **exogenic process** and **endogenic process**.

Exogenic Process

- Process that occurs on Earth's surface.
- Examples: Weathering, erosion, mass and land depletion, transport and sedimentation.

Weathering
It is a process of rock fragmentation and decomposition or decay due to changes in temperature, rainwater, frosting and microorganisms.

Erosion
It is a process of eroding of the Earth's surface by moving agents such as water, wind and waves.

Exogenic processes

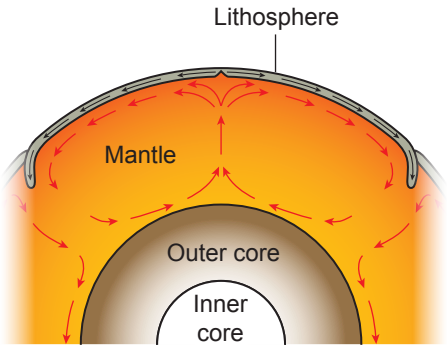
Mass and land depletion
They involve soil movement from the top of a slope to below as a result of gravitational force.

Transport and sedimentation
Weathered or corroded materials are moved by agents such as running water, wind, waves and glaciers. The materials will be sedimented when the velocity of the agents decreases.

Figure 9.7 *Exogenic processes*

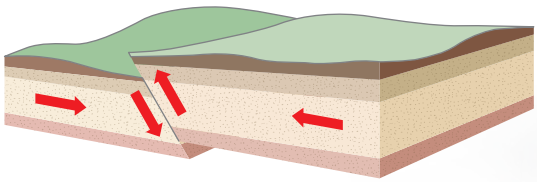
Endogenic Process

- Process that is caused by forces from within the Earth.
- Forms and changes the Earth's surface.
- Examples: Mantle convection process, magma activity and Earth's crust movement (Plate Tectonics).



Mantle convection process
The high temperature in the mantle and the core of Earth produces convection currents in the asthenosphere layer. These currents are able to move Earth's crust.

Earth's crust movement (Plate Tectonics)
According to the theory of Plate Tectonics, the Earth's crust is divided into several pieces of plates. These plates constantly move resulting in collision and divergence which produce various landforms on Earth and continental drifts.



Divergence of Earth's crust

Endogenic processes

Magma activity
Volcano is a vent on the Earth's crust that allows molten and hot magma to flow out through it in a strong eruption. The erupted materials accumulate around the slope of the vent and form volcanic cones.

Figure 9.8 *Endogenic processes*

Formative Practice 9.3

1. What are exogenic and endogenic processes?
2. What are the agents causing erosion?
3. What is Plate Tectonics theory?
4. Explain mantle convection process.

9.4 Geohazard Phenomena

Let's learn

- Communicate about geohazards.
- Generate ideas on the importance of science and technology to prepare for geohazards.
- Realise that environmental disasters affect human livelihood.

After learning the exogenic and endogenic processes in subtopic 9.3, do you know the consequences of the endogenic process? The consequences of the endogenic process are occurrence of **geohazards** such as earthquake, landslide, tsunami and volcanism. Can you identify each of these geohazards?

Volcanism

Global warming

Tsunami

Earthquake

Landslide

Sinkhole

Video on preparing for earthquakes

Photograph 9.3 *Geohazards*

Quicksand is a geohazard that usually occurs in wetlands while acid rain is a geohazard that usually occurs in the industrial area.

Quicksand

Acid rain

Figure 9.9 *Quicksand and acid rain*

Activity 9.4

Aim: To gather information about geohazards

Instruction

1. Work in groups.
2. Gather information on how these geohazards happen.
   (a) Earthquake (d) Tsunami (g) Quicksand
   (b) Landslide (e) Global warming (h) Sinkhole
   (c) Volcanism (f) Acid rain
3. Present your findings using a multimedia presentation.

Science and Technology Used to Prepare for Geohazards

Advances in science and technology allow the invention of devices that could provide early warnings on occurrence of landslide and tsunami.

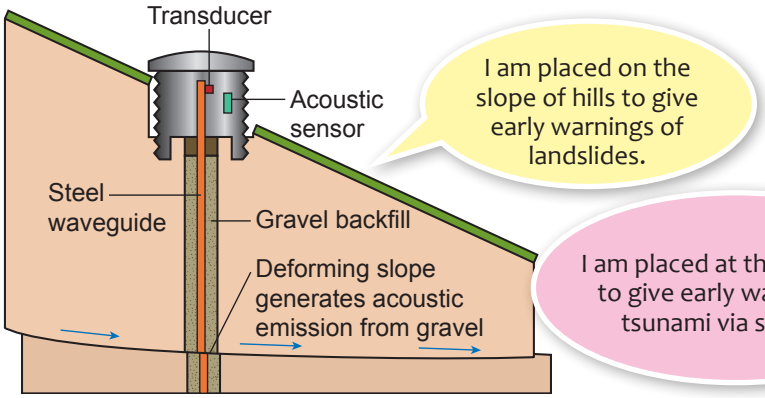


Figure 9.10 *The device to detect landslides*

Photograph 9.4 *The device to detect tsunami in Malaysia*

Can you think of other inventions used to predict or provide early warnings of geohazards?

The Impact of Geohazards

Geohazards such as tsunami and earthquake can cause loss of life, diseases, starvation and damage to properties. We should sympathise with and assist victims of environmental disasters.

43 Malaysians killed by tsunami waves

KUALA LUMPUR 26 December - Many people were killed, including 43 Malaysians who were hit by huge waves by the earthquake in northern Sumatra today; the most powerful in the world in the last 40 years. Many homes and possessions have been destroyed by the tsunami.

(Extracted and adapted from Utusan Melayu, December 27, 2004)

Earthquake on Mount Kinabalu

KOTA KINABALU: As a result of the earthquake, 19 people were killed.

(Extracted and adapted from Mstar, June 23, 2015)

Occurrence of mudslide

CAMERON HIGHLANDS – The installation method of plastic protective rain structure by farmers is one of the factors which trigger the occurence of mudslide.

(Extracted and adapted from Kosmo, March 4, 2016)

Visit the following websites to get more information about tsunami, volcano eruption, mud flood and the collapse of Highland Towers.

Tsunami
http://www.tsunami.noaa.gov/

Volcano eruption
http://www.euronews/tag/volcano-eruption

A mud flood in Cameron Highlands
http://www.beritasemasa.com.my/gambar-banjir-lumpur-di-cameron-highland

Collapse of Highland Towers
https://en.wikipedia.org/wiki/Highland_Towers_collapse

Formative Practice 9.4

1. List three examples of geohazards.
2. What are the impacts of geohazards to humans?
3. State two devices invented by scientists to predict occurrences of geohazards.

9.5 Age of Earth

Let's learn

- Communicate about geological time scale of the Earth.
- Explain the method to determine the age of the Earth.
- Communicate about fossils.
- Reason about the importance of fossils in the advancement of contemporary science.

The age of Earth is estimated to be 4.5 billion years based on meteorites obtained. Earth has gone through various stages of periods, which have changed or shaped the Earth's landscape. Geologists define a long period of time as an era. Each era is divided into several periods.

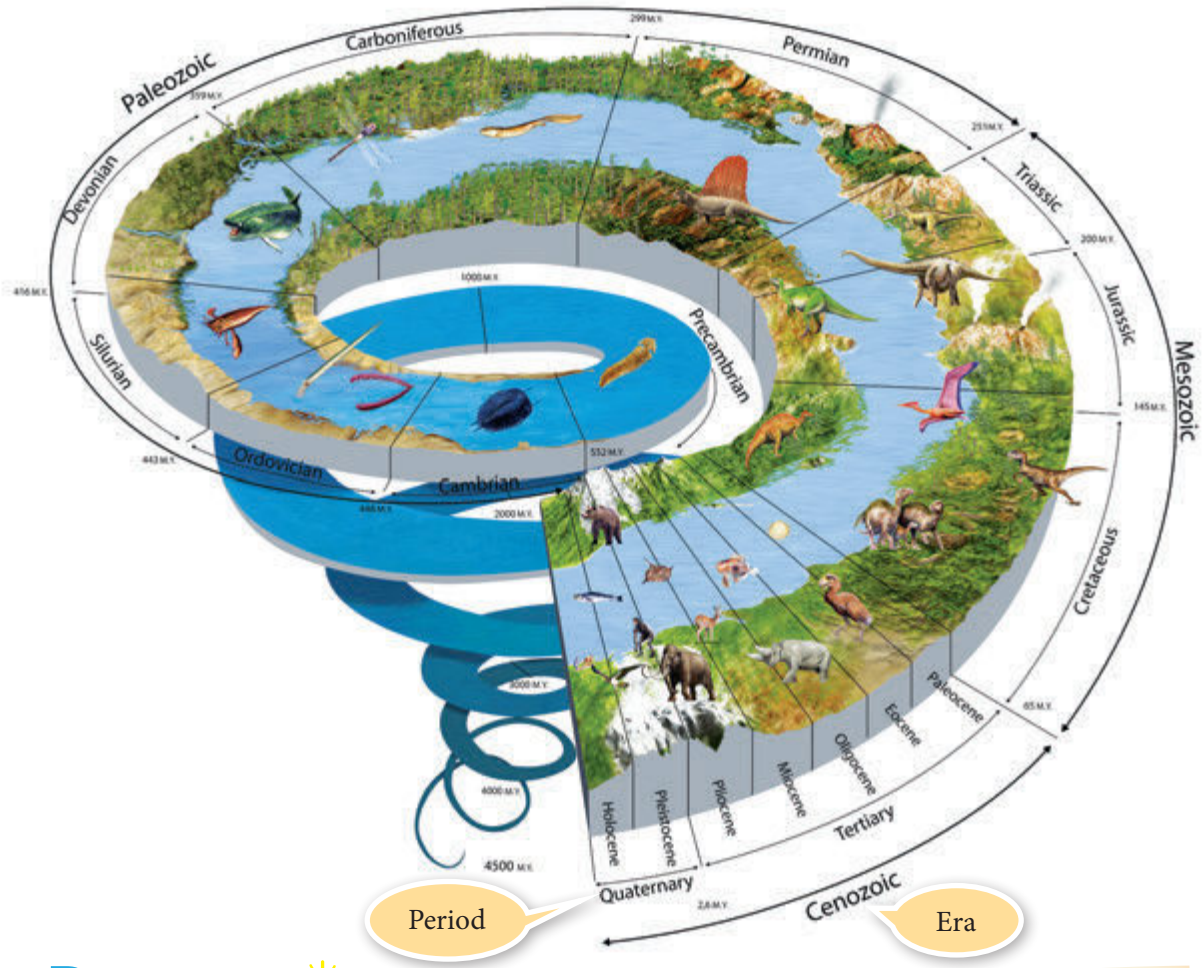


Figure 9.11 *Geological time scale*

Brain Teaser

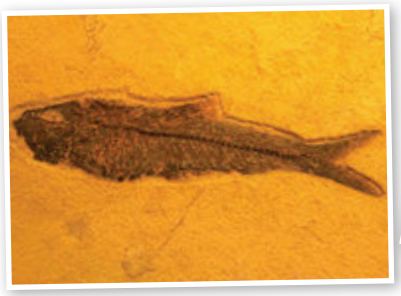
What era are we living in?

Note

M.Y. refers to million years.

Fossil

Fossils are Earth's materials such as plants, animals and insects which have been submerged and buried for a very long period of time.



History Corner

The word 'fossil' originates from the Latin word 'fossilis', which means 'obtained from digging'.

Figure 9.12 *Examples of fossils*

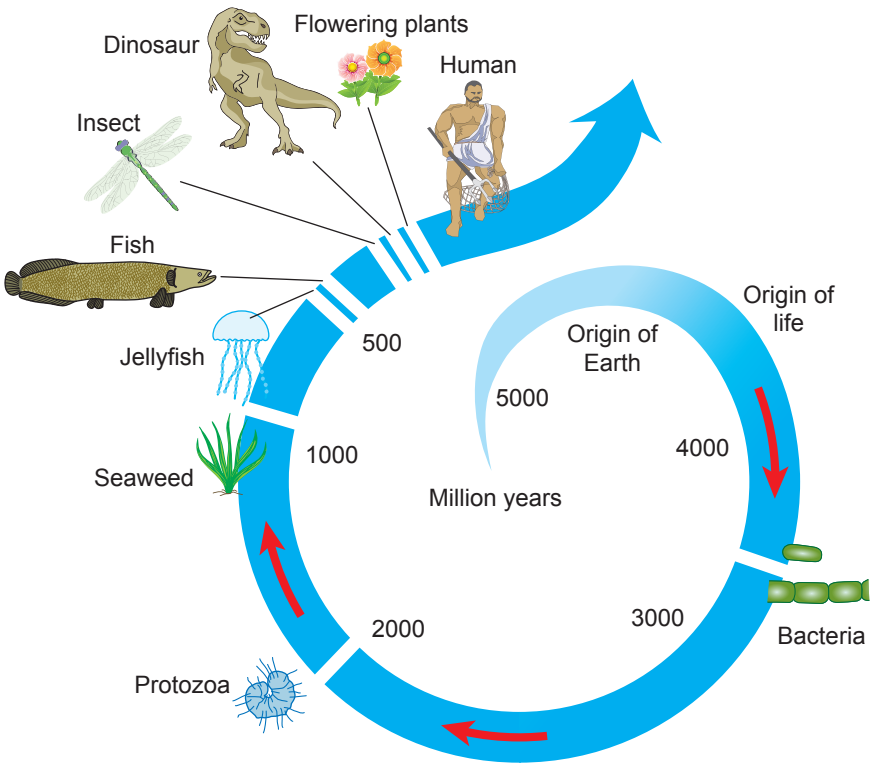


Figure 9.13 *Various organisms on Earth since 5000 million years ago*

The importance of fossils to current scientific development:

- Fossil records can provide information about how animals and plants species on Earth have evolved over millions of years.
- Fossil records can also provide information about species that have gone extinct.

Formative Practice 9.5

1. When did fish first appear on Earth?
2. Between insects and flowering plants, which appeared on Earth first?
3. When did seaweeds first appear on Earth?

9.6 Earth's Resources and Applied Geology

Let's learn

- Explain surface water and its risks.
- Explain the importance of underground water and its risks.
- Communicate about economic minerals.
- Explain the formation of petroleum and coal.
- Communicate about the hydrothermal process.
- Solve problems about the negative effects of unplanned human activities on all living things on Earth.

Surface Water and Underground Water

What is surface water?

Surface water is found on the surface of Earth. Examples of surface water include seas, ponds and rivers.

Surface water can be polluted by waste materials from industrial and housing areas. Excessive fertilisers and pesticides from agricultural areas also pollute river water.

Photograph 9.5 *Surface water*

Do you know that there is water under the ground known as underground water?

Yes, I do. Underground water or aquifer fills up the empty spaces between soil particles and the layers of permeable rocks.

Leaching of chemical fertilisers and pesticides in agriculture exposes underground water to the risk of pollution. Chemicals from industrial and domestic waste in landfills carry the risk of polluting underground water.

Photograph 9.6 *Underground water*

Brain Teaser

Do surface water and underground water interconnect?

21 Century ICS

Economic Minerals

Economic minerals in the Earth consist of metallic minerals, non-metallic minerals and rare earth minerals. Examples of metallic minerals are iron ore, tin and gold while examples of non-metallic minerals are coal and petroleum.

Rare earth minerals consist of one or more than one of 17 rare earth elements found inside Earth's crust. Even though almost all rare earth minerals can be found in abundance, it is however not easy to separate them as they exist together with other rare earth elements. Because of the rare minerals' unique properties, they are very important in modern technology. They are used in computers, DVDs, communication devices, television and others. Therefore, technology based on rare earth minerals is very important to the development of the economy of the country and world in general.

Petroleum and coal are used as fuel. How are they formed?

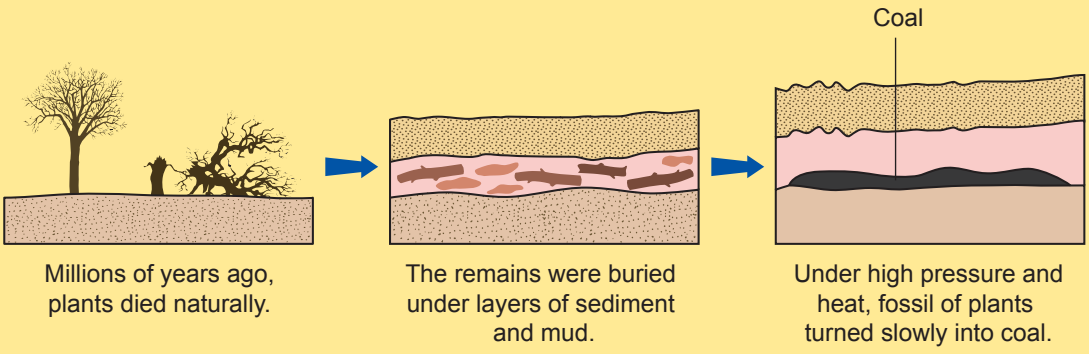


Figure 9.14 *The formation of coal*

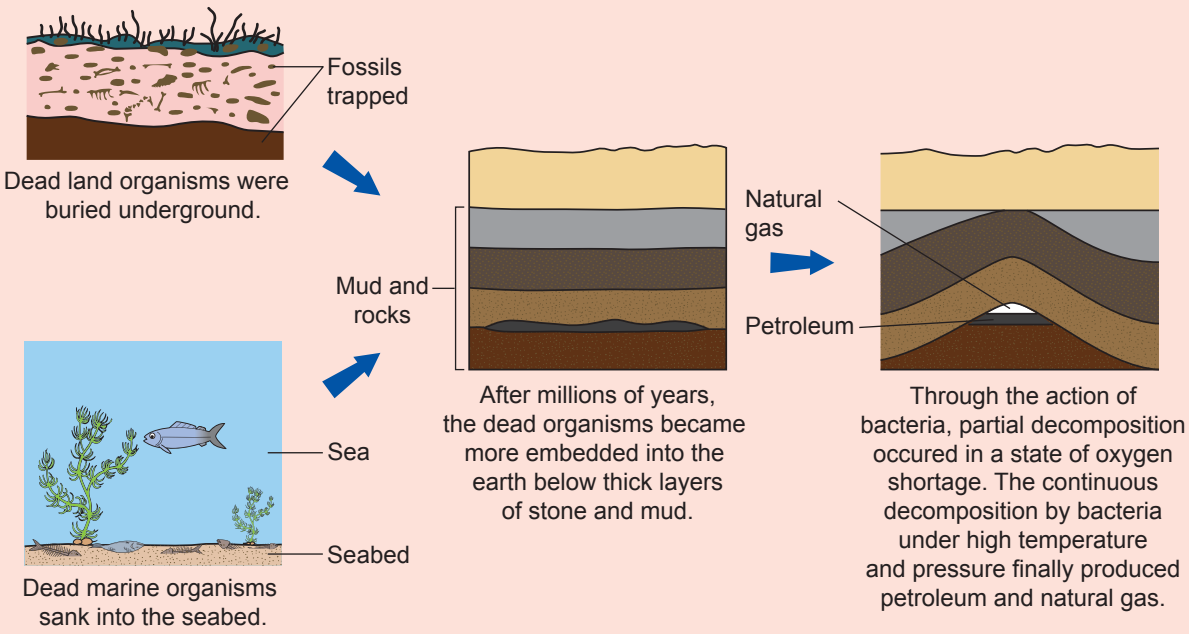


Figure 9.15 *The formation of petroleum and natural gas*

Hydrothermal Process

Have you even been to a hot spring? Do you know why the water is hot? The water is heated naturally by the heat from the Earth. This is known as hydrothermal process. What are the advantages of the hydrothermal process in economic prospects?

Photograph 9.7 *Hot spring in Sungai Klah, Perak*

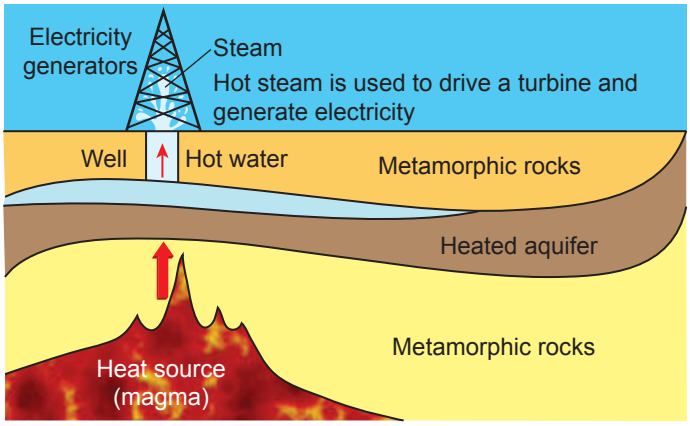


Figure 9.16 *Formation of a hot spring and generation of electricity through the hydrothermal process*

The Negative Effects of Unplanned Human Activities

Human activities that are not well-planned may cause negative effects to all living things. Think of ways to solve them.

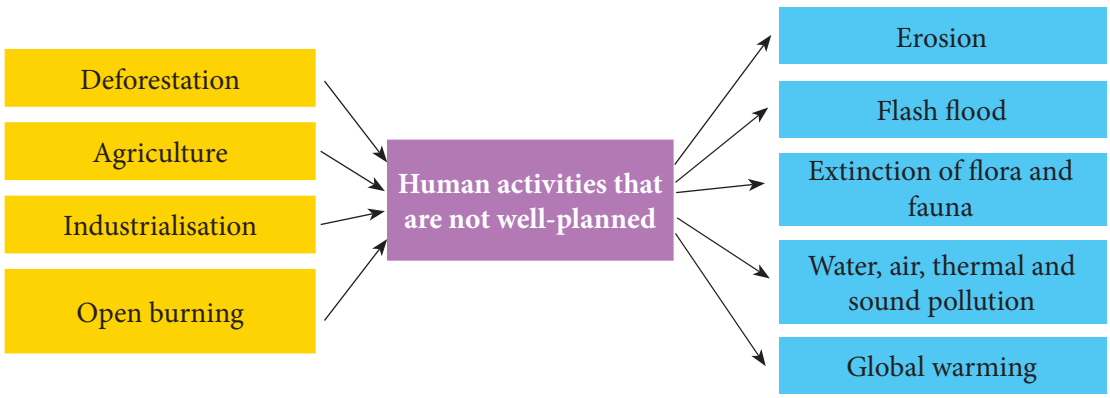


Figure 9.17 *Human activities that are not well-planned*

Activity 9.5

Aim: To debate how exploitation of Earth's resources may cause adverse effects on living things

Instruction

1. Work in groups.
2. The motion of the debate is 'Exploitation of Earth's resources may cause adverse effects on living things'.
3. Each group is required to present their arguments.

Formative Practice 9.6

21st Century ICS

1. What are the effects of deforestation?
2. Minerals mined from Earth are required for continuous economical development of a country. However, mineral supply is limited. Suggest ways to ensure the continuous supply of minerals.

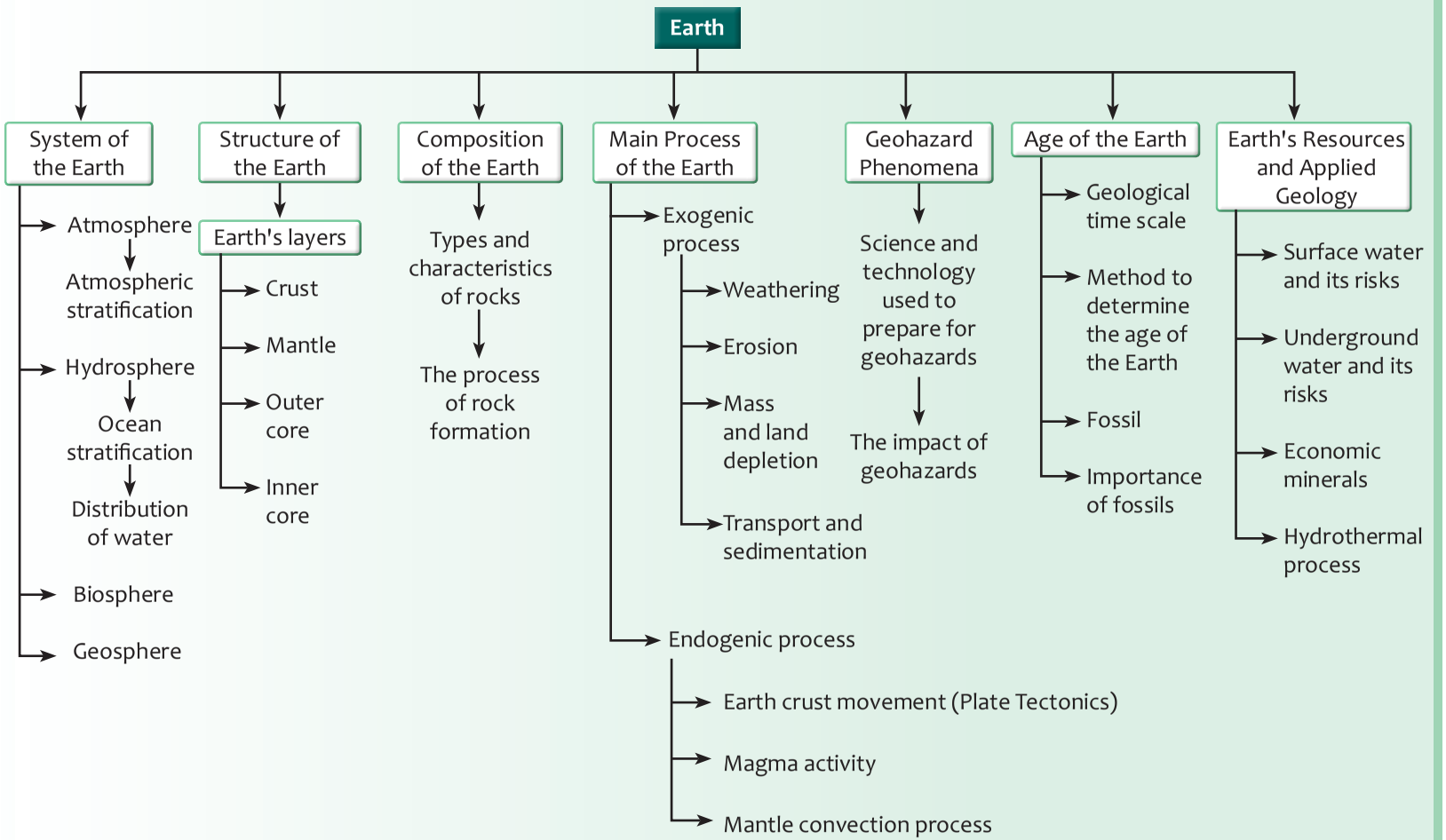
My Malaysia

The discovery of dinosaur fossils for the first time in Malaysia by a geologist from the University of Malaya shook our nation. The fossils were found in the Endau Rompin Forest, Pahang which is among the oldest jungles in the world. Can you identify the type of dinosaur shown below?
Do you want to be a geologist to find more fossils?

Visit the following website for more information.

The discovery of dinosaur fossils in Malaysia
http://www.sciencedaily.com/releases/2014/02/140224204737.htm

Concept Map


Earth
System of the Earth
Atmosphere
Atmospheric stratification
Hydrosphere
Ocean stratification
Distribution of water
Biosphere
Geosphere
Structure of the Earth
Earth's layers
Crust
Mantle
Outer core
Inner core
Composition of the Earth
Types and characteristics of rocks
The process of rock formation
Main Process of the Earth
Exogenic process
Weathering
Erosion
Mass and land depletion
Transport and sedimentation
Endogenic process
Earth crust movement (Plate Tectonics)
Magma activity
Mantle convection process
Geohazard Phenomena
Science and technology used to prepare for geohazards
The impact of geohazards
Age of the Earth
Geological time scale
Method to determine the age of the Earth
Fossil
Importance of fossils
Earth's Resources and Applied Geology
Surface water and its risks
Underground water and its risks
Economic minerals
Hydrothermal process

SELF-REFLECTION

After learning this chapter, you are able to:

9.1 The System and Structure of the Earth

- ☐ Communicate about the system of the Earth.
- ☐ Explain differences of the Earth's layers based on its composition and physical characteristics.
- ☐ Realise that Earth is the only place that can sustain life based on its physical characteristics.

9.2 Composition of the Earth

- ☐ Explain type and characteristic of rocks.
- ☐ Communicate on how to differentiate the process of rock formation.

9.3 Main Processes of the Earth

- ☐ Explain the different Earth processes that affect the changes on Earth
- ☐ Communicate about exogenic and endogenic processes.

9.4 Geohazard Phenomena

- ☐ Communicate about geohazards.
- ☐ Generate ideas on the importance of science and technology to prepare for geohazards.
- ☐ Realise that environmental disasters affect human livelihood.

9.5 Age of the Earth

- ☐ Communicate about geological time scale of the Earth.
- ☐ Explain the method to determine the age of the Earth.
- ☐ Communicate about fossils.
- ☐ Reason about the importance of fossils in the advancement of contemporary science.

9.6 Earth's Resources and Applied Geology

- ☐ Explain surface water and its risks.
- ☐ Explain the importance of underground water and its risks.
- ☐ Communicate about economic minerals.
- ☐ Explain the formation of petroleum and coal.
- ☐ Communicate about the hydrothermal process.

Summative Practice 9

1. Figure 1 shows the various layers of the Earth. Label each layer with the correct name.

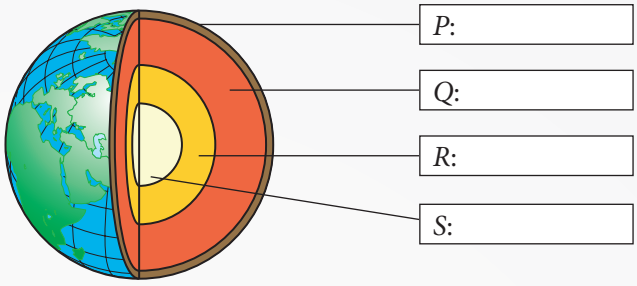


Figure 1

2. Weather phenomena such as rain, cloud, earthquake and storm form inside the Earth's atmosphere. In which atmospheric layer do the phenomena occur?

3. Figure 2 shows the atmospheric layers.
   (a) In which layer does aurora occur?
   (b) State two living organisms that can be found in layer *P*.

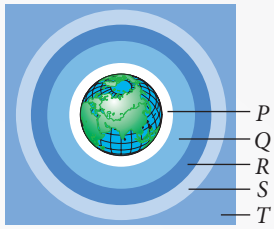


Figure 2

4. What are the factors that influence the formation of metamorphic rocks?

5. Figure 3 shows flow of lava from a volcano. What rocks could form in *P*?

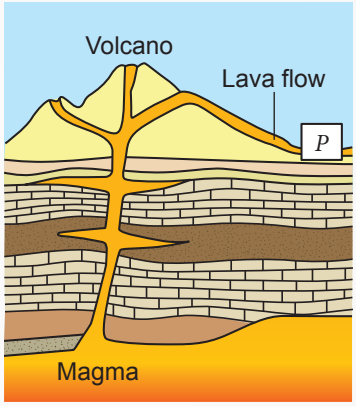


Figure 3

6. Salina found a type of rock by the mouth of a river. The characteristics of the rock were recorded as below.

   - Hollow
   - Layered
   - Contains dry fossil

   What type of rock is it?

7. Uncle Yatim is a farmer. His son always advises him not to spray pesticides excessively. Why?

Figure 4

8. The statement below shows a human activity.

   Deforestation of mangrove forests for timber creates negative consequences.

   In your opinion, what negative consequences may arise due to the deforestation of mangrove forests?

9. The statement below refers to one of the characteristics on the surface of Earth.

> Water distribution on Earth is constant.

In your opinion, is the statement true? Discuss.

10. Earthquakes are recorded using sensitive seismographs that detect movements or vibrations. Invent a simple seismograph device for detecting vibration on Earth's surface using marker, metal rod, spring, weight, cardboard paper and other easily obtainable objects. Drop heavy objects close to the device built to create your own "quake".

The Next Challenge . . .

11. The statement below shows a newspaper cutting regarding an issue that happened in Malaysia.

Bauxite pollution in Kuantan

KUANTAN – Kuantan residents complain about the bauxite pollution in the vicinity of Bukit Goh, Gebeng and Kuantan Port which can cause health risks. Uncontrolled bauxite mining activity has dirtied the main road. The air is polluted by bauxite dust. The river is also polluted by bauxite mining. Bauxite is red soil rich in aluminum.

Bauxite

(Extracted and adapted from Astro Awani, 5 July 2015)

In your opinion, what are the negative consequences due to uncontrolled bauxite mining in Kuantan?

12. Cameron Highlands always faces landslides. Suggest a suitable device that could detect the possibilities of a landslide.

ANSWERS

ONLY SELECTED ANSWERS ARE PROVIDED HERE

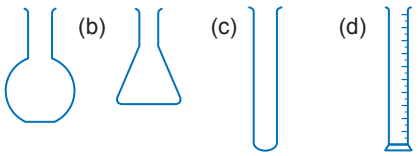
Chapter 1

Formative Practice 1.1

1. Growth of a baby, the occurrence of day and night
2. (a) observation, experiments
   (b) biology
3. Biology- Botanist, Chemistry- Pharmacist, Physics- Astronaut

Formative Practice 1.2

1. (a) (b) (c) (d)



2. (a) (i) Poisonous/toxic
   (ii) Irritant
   (iii) Flammable
   (iv) Explosive
   (v) Corrosive
   (b) Mercury and chlorine
3. Inform his teacher. If possible, turn off the electrical supply. With the teacher's help, use a suitable fire extinguisher to extinguish the fire. If he is not sure, he should leave the laboratory immediately.

Formative Practice 1.3

1. Length – metre, m; Mass – kilogram, kg; Time – second, s; Temperature – kelvin, K; Electric current – ampere, A
2. (a) 13 cm (b) 0.018 kg (c) 4000000 μm
   (d) 24 kg (e) 6 mA

Formative Practice 1.4

1. (a) 6.28 mm (b) 4.56 mm
2. 24 cm^2
3. Value shows the mass of Chong

Formative Practice 1.5

1. A = 2 g cm^{-3}, B = 2 g cm^{-3}, C = 2 g cm^{-3}
2. Liquid R, the most dense liquid will sink to the bottom

Formative Practice 1.6

1. Inference is the reason or cause for the observation of a phenomenon.
2. Manipulated variable = surface area of the container
   Constant variable = the initial volume of water in the container, surrounding temperature and period of the experiment
   Responding variable = The quantity of water after 30 minutes

Formative Practice 1.7

1. Be honest and precise in recording and approving data and have a positive attitude
2. Be responsible towards health, safety and environment

Summative Practice 1

1. Corrosive material
2. $V \rightarrow R \rightarrow P \rightarrow T \rightarrow Q \rightarrow W \rightarrow U \rightarrow S$
3. 0.1 kg
4. (a) Lever balance
   (b) Vernier calipers
6. 34 squares x 1 cm^2 = 34 cm^2. Area of both wings = 34 cm^2

Chapter 2

Formative Practice 2.1

1. (a) platelets, blood circulatory
   (b) Lungs, kidneys and skin
2. Palisade cell - Absorbs sunlight for photosynthesis
   Epidermis cell - Reduces water loss
   Root hair cell - Absorbs water from soil
   Guard cell - Controls the opening and closing of stoma
3. Cell wall

Formative Practice 2.2

1. Photosynthesis. To produce glucose and oxygen
2. Glucose, cell respiration

Summative Practice 2

1. P = cytoplasm, Q = nucleus, R = mitochondria
2. Kidney, lung
3. (a) ovum (b) red blood cell
   (c) nerve cell
4. Plant cells have cell wall, chloroplast, vacuole and fixed shape.

Chapter 3

Formative Practice 3.1

1. Homeostasis is the process of maintenance of the internal environment in an organism.
2. Temperature regulation and water regulation

Summative Practice 3

1. Through transpiration that helps plants to absorb and transport water and minerals from the soil to all parts of the plant to replace water loss to the surroundings from the leaves. Water lost to the

surroundings through evaporation is able to help the plant cool itself down during hot weather.

2. Blood vessels constrict to reduce heat released to the surroundings. Hair stands erect to trap heat from being lost to the surroundings.
   Less sweating to reduce heat loss through evaporation. Skeletal muscles contract and relax actively causing our body to shiver and increase the body temperature. At the same time, certain hormones are secreted to increase the body's metabolism.
3. Blood vessels dilate to enable more blood to flow near the surface of the skin to release more heat to the surroundings.
4. Enables enzymes to function optimally at 37°C to regulate all chemical reactions inside living cells.

Chapter 4

Formative Practice 4.1

1.

Sexual Reproduction	Asexual Reproduction
• Involves reproductive cells	• Does not involve reproductive cells
• Occurs in humans, animals (high level) and flowering plants	• Occurs in simple organisms (*Amoeba*, *Paramecium*, *Hydra*) and plants (onion, ginger, potato)
• Involves two parents	• Involves one parent

2. (a) Onion; bulb
   (b) Yam; stem
   (c) Ginger; stem
   (d) Lallang; stem
   (e) Potato; stem
   (f) *Bryophyllum;* leaf.
3. Reproduction is important to ensure the survival of species.

Formative Practice 4.2

1. To produce offsprings.
2. Function of urethra: To discharge sperms (and urine) from the body
   Penis: Transfers sperms into the vagina during copulation
   Scrotum: Holds and protects the testes
3. Function of Fallopian tube: The place where fertilisation between sperm and ovum occurs
   Function of vagina: Receives sperms and it is the birth channel through which a baby is born
   Function of uterus: Place where the embryo develops and grows
4. The early stage in which the reproductive system becomes mature and produces reproductive cells.

Formative Practice 4.3

1. **(i) Menstruation phase (Day 1-5)**
   The uterine lining breaks down as menstruation begins and is discharged together with blood, unfertilised ovum and mucus.
   (ii) Repair phase (Day 6-11)
   Uterine lining starts to rebuild and thickens. Blood vessels in uterine lining are formed and ready to receive the implantation of fertilised ovum.
   (iii) Ovulation phase (Day 12-17)
   An ovum is released from the ovary on the 14th day of the menstrual cycle (ovulation). The uterine lining continues to thicken. Fertilisation is likely to occur if sperms are present.
   (iv) Premenstrual phase (Day 18-28)
   The uterine lining continues to thicken and becomes richly supplied with blood vessels. Implantation of an embryo is ready if fertilisation occurs. The menstrual cycle will repeat if fertilisation does not occur.
2. A woman begins to get menstruation between 10-12 years old, for 5-7 days.
3. Ovulation is the process of matured ovum being released from the ovary and it occurs in the ovary.

Formative Practice 4.4

1. No.
2. After fertilisation, zygote divides itself into a ball of cells called embryo. Embryo that is implanted on the uterine lining continues to develop into foetus and eventually becomes a baby.
3. Zygote → Embryo → Foetus → Baby
4. **Function of amnion**: A sac-like membrane which contains fluid
   Function of placenta: Place where exchange of oxygen and carbon dioxide, supply of nutrients and removal of waste materials through the mother's blood and the foetus occur.
   Function of umbilical cord: Tube which connects the foetus to the placenta.

Formative Practice 4.5

1. A pregnant woman needs more nutrients because the baby inside her uterus needs nutrients to grow healthily.
2. Baby absorbs calcium from the mother for the growth of its own teeth and bones.

Formative Practice 4.6

1. Factors of male sterility:
   (i) Low quality of sperm
   (ii) Low sperm count
   (iii) Testes cannot produce sperm
   (iv) Impotent
   Factors of female sterility:
   (i) Ovaries cannot produce ovum
   (ii) Blockage in the Fallopian tubes
   (iii) Abnormal uterus
   (iv) Tumour in the uterus
2. (a) Hormone injection and surgery
   (b) Treatment using IVF method
3. (a) Vasectomy: Sperm ducts are cut and the two ends are then tied to prevent the sperms from being transported to the urethra.

(b) Ligation: Both Fallopian tubes are cut and the two ends are then tied to prevent the ovum from meeting the sperms.

4. Test tube baby is a baby that is formed using the IVF method. The sperm and ovum are fertilised in a glass dish. Then, the fertilised embryo is put inside the uterus to develop.

Formative Practice 4.7

1. Attracts insects for pollination
2. Sepal: usually green in colour and protects flower during the bud stage.
   Petal: usually colourful to attract insects and animals.
4. (a) Function of stigma: receives pollen grains (male gametes)
   (b) Function of style: connects stigma to ovary
   (c) Function of anther: produces male gametes
5.

Wind	Insects
• Light pollen grains	• Sticky pollen grains
• White and dull	• Bright coloured
• Number of pollen grains is high	• Number of pollen grains is low

Summative Practice 4

1. (a) Amniotic fluid
   (b) Acts as a cushion to absorb concussion and prevents foetus from injuries.
   (c) Placenta. The foetus obtains food and oxygen from the placenta through the umbilical cord.
   (d) When foetus is completely formed, the body will rotate until the head is engaged to the cervix. The cervix expands to enable the baby's head to go through the vagina. The uterine muscle wall contracts strongly, bursts the amnion and amniotic fluid is released. Strong contraction of the uterus pushes out the baby.

Chapter 5

Formative Practice 5.1

1. Matter: Book, pencil, pen, glass and beaker (Any other answers are accepted)
2. Has mass and occupies space
3. Yes, because all living things have mass and occupy space
5.

Physical properties	Chemical Properties
• Depend on the type of material it is made of.	• Depend on the reaction that occurs upon the substances.

Formative Practice 5.2

1. (a) (i) Bubble: Gas
   (ii) Water: Liquid
   (iii) Water weed: Solid
   (iv) Aquarium: Solid
   (v) Fish: Solid
   (b) Solid: book, glass, cloth
   Liquid: oil, petrol, milk
   Gas: air, carbon dioxide and oxygen
   (Any answers are accepted)
   (c)

State of matter	Arrangement	Movement
Solid	Close and packed	Vibrate and rotate at its position
Liquid	Close but not in orderly manner	Move freely, glide and collide with each other
Gas	Far apart from each other	Move randomly, freely and collide with each other very fast

2. Food smell spreads through diffusion of the smell particles into the air particles.
3. Particles in matter always move and collide with one another
4. Temperature does not change because heat is used to overcome the force of attraction between the particles and thus, no change in temperature.

Summative Practice 5

1. (a) Coffee: liquid
   Stones: solid
   Air in the balloon: gas
   (b) Coffee and stones
   (c) The particles only vibrate in the stone and rotate at its position while air particles move randomly and collide with one another with high kinetic energy.
4. (a) The air particles are compressed nearer to each other.
   (b) Tan's action is correct as it can cause the tyre to expand during hot weather and explode it.
   (c) The air inside the tyre contracts when it is cold because heat is released and this will cause the particles of the gas to move nearer to one another and flatten the tyre.

Chapter 6

Formative Practice 6.1

1. Proton, electron and neutron
2. The number of electrons in an atom is equal to the number of protons. Thus, an atom is neutral.
3. An element is made of only one type of atom while a compound consists of two or more elements that are combined chemically.
4. An atom is the smallest particle of an element while a molecule is a combination of two or more atoms.
5. Elements are arranged according to the proton number.

6.

Metal	Non-metal
Magnesium	Carbon
Aluminium	Iodine
Copper	Chlorine
Gold	Neon
Iron	Argon
Mercury	-

Formative Practice 6.2

1. Mixture is a substance that consists of two or more elements or compounds combined physically.
2.

Type of mixture	Separation method
Paper clips and glass fragments	Filtration
Water and ethanol	Distillation
Three types of water soluble ink	Chromatography
Soil and water	Using magnet
Oil and water	Sedimentation
Coffee powder and water	Floatation

Formative Practice 6.3

1. Compound is a substance consisting of two or more elements combined chemically
2. Sugar, salt, water, marble, building blocks
3. Electrolysis
4.

Mixture	Characteristics	Compound
No	Formation of new substance	Yes
No	Chemical bond	Yes
No heat changes	Heat changes during formation	Yes
Physical method	Separation method	Chemical method
Same	Properties compared to its original properties	Different

Summative Practice 6

1. (a) (a), (b), (e), (f), (g), (h), (m), (n), (p)
   (b) (c), (i), (j), (o)
   (c) (d), (k), (l)

Chapter 7

Formative Practice 7.1

1. Nitrogen 78%, oxygen 21%, carbon dioxide 0.03%, inert gases and others 0.97%
3. Carbon dioxide is used by plants for photosynthesis.
4. Greenhouse effect and global warming

Formative Practice 7.2

1. Combustion is the reaction when a substance is heated with oxygen and releases heat and light energy
2. The presence of oxygen, heat and fuel
3. Fire blanket is a special blanket made of fire-resistant substances. This blanket covers the fire and prevents oxygen from seeping below the blanket which will eventually extinguish the fire.
4. (a) Always be aware of electrical appliances used.
   (b) keep matches and lighters in a safe place.
   (c) Keep away flammable substances from fire.
   (d) Do not throw cigarette butts when they are still burning.
   (e) Do not plug in too many appliances to a single electrical source.
   (f) Install fire alarm at home.
5. Potassium and sodium metals are flammable when exposed to the air

Formative Practice 7.3

1. Smoke and dust
3. (a) Humans can stay healthy.
   (b) Reduce the cost of repairing damaged buildings by acid rain.
   (c) Earth's climate will be better.
4. Rubbish can cause the increase of microorganisms in the air.
6. (a) ✓
   (b) ✓
   (c)
   (d) ✓
   (e)

Summative Practice 7

1. (a) *P*: Nitrogen
   Q: Oxygen
   R: Inert gases
   S: Carbon dioxide
   (b) (i) Needed to produce nitric acid and ammonia
   (ii) Helps in animal and plant growth
   (c) The temperature increases as gas *S* traps heat.
   (d) (i) Air components can be separated physically.
   (ii) Each gas still shows its original properties when separated.
2. (a) Carbon dioxide
   (b) Argon
   (c) Atmosphere
   (d) Oxygen
3. (a) Green plants are the only living things that can absorb and reduce carbon dioxide in the atmosphere through photosynthesis. When a lot of trees are cut down, carbon

dioxide which is released through respiration, combustion and decomposition will increase the percentage of carbon dioxide in the atmosphere.

(b) Fossil fuel burning/ burning of forests

(c) Greenhouse effect and global warming

4. (a) Combustion is the reaction when a substance reacts with oxygen chemically and produces heat and light energy.

(b) Heat, oxygen and fuel

(c) (i) Ensure the electrical wiring is according to the right specification

(ii) Use dry powder fire extinguisher

(d) (i) Install smoke detectors and fire alarm at home

(ii) Do not plug too many appliances on a single electrical source.

(iii) Always be aware of the electrical appliances used.

5. (a) Haze

(b) Causes breathing difficulties and cough

Chapter 8

Formative Practice 8.1

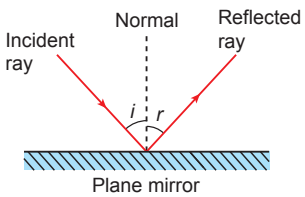
1. Convex mirror, the man looks slim
2. To reflect light so that the image can be formed in the eyes
3. To make the small space look spacious and comfortable. The mirrors are security measures too as a person could see all around him.

Formative Practice 8.2

1. afternoon, above
2. 

Formative Practice 8.3

1. According to the law of reflection, angle of incidence, *i*, is equal to angle of reflection, *r*.



2. Upright, same size with the object, virtual, same, (also laterally inverted)

Formative Practice 8.4

1. When light rays from the bottom of the swimming pool leave the water, they are refracted. This makes the image of the bottom of the swimming pool to look shallower compared to its real depth.
2. *A*: Less dense

   B: More dense

   C: More dense

   D: Less dense

Formative Practice 8.5

1. Red, orange, yellow, green, blue, indigo, violet
2. Red light is refracted the least because it is the fastest. Meanwhile, violet light is refracted the most because it is the slowest.

Formative Practice 8.6

1. Scattering of light occurs because light rays are blocked and reflected to all directions by the clouds or particles in the air.
2. more, less

Formative Practice 8.7

1. A = Magenta, B= Cyan, C= Yellow, D = White
2. (a) red

   (b) green

   (c) magenta

Summative Practice 8

1. A real image can be formed on a screen while a virtual image cannot be formed on a screen.
2. B
3. X and Z
4. (a) Magenta, (b) Yellow, (c) Cyan , (d) White

Chapter 9

Formative Practice 9.1

1. hydrosphere, biosphere, geosphere, and atmosphere.

Formative Practice 9.2

1. Igneous rocks are formed when magma from volcano eruptions cools when it rises to the surface. Sedimentary rocks are formed from various rock fragmentation processes such as weathering and erosion. It is then carried by the river to the sea and deposited there. Metamorphic rocks are the rocks formed when pressure and heat acts on igneous and sedimentary rocks.
2. Igneous rocks are formed from cooled magma. Magma has a high temperature and no living things can live in it. Therefore, there are no fossils found in igneous rocks.
3. Metamorphic rocks are harder than other rocks because they are formed from high pressure and temperature.

Formative Practice 9.3

1. Exogenic process – a process that occurs on Earth's surface
   Endogenic process – a process that is caused from within the Earth
2. Water, wind and waves
3. Earth's crust is divided into several plates. These plates always move due to collision and divergence that produce various landforms and continental drifts.
4. Mantle convection process happens when the high temperature inside the mantle and Earth's core produce convection flow in the asthenosphere that is able to move Earth's crust.

Formative Practice 9.4

1. Landslide, tsunami, earthquake
2. Destruction of properties, loss of life, diseases, famine.
3. Seismograph to detect earthquake, radar to detect tsunami.

Formative Practice 9.5

1. 500 million years ago
2. Insects
3. 1000 million years ago

Formative Practice 9.6

1. Deforestation can cause lack of oxygen production and carbon dioxide content in the air to increase. This will cause global warming as carbon dioxide is a greenhouse gas that can trap the heat from the Sun. Lack of oxygen content will also reduce oxygen for respiration. Deforestation can also cause soil erosion.
2. Recycle, use mineral materials wisely.

Summative Practice 9

1. *P*: Crust , *Q*: Mantle, *R*: Outer core, *S*: Inner core
2. Troposphere
3. (a) *S*
   (b) Birds and insects
4. Mineral composition of original rocks, pressure and temperature, tectonic process and hot chemical fluid

Full answers for teacher, please scan QR code.

GLOSSARY

Atom	The smallest particle of an element that can take part in a chemical reaction
Accuracy	The closest degree of a measured value to an actual value
Area	The size of a surface
Air pollution	The situation involving the introduction of any chemicals, particulate matter, or biological materials that can cause harm, discomfort to humans or other living organisms and damage to the environment when released into the atmosphere
Binary fission	The division of a parent cell into two daughter cells
Budding	The process of forming buds in an organism
Consistency	The ability to give the same reading when the measurement is repeated
Carbon cycle	A cycle that maintains the carbon dioxide content in the air by taking carbon dioxide from the air and returns it back into the air continuously
Cell	The basic unit of living things
Cell respiration	Process of oxidising glucose in the cells of organisms to produce energy.
Combustion	Reaction that occurs when a substance reacts with oxygen chemically and releases heat energy
Cross-pollination	Transfer of pollen grains from anther to stigma involving two parent plants of the same species
Compound	A substance consisting two or more elements joined chemically
Density	The mass per unit volume
Diffusion	Process in which particles of a matter move from an area of high concentration to an area of low concentration
Electrolysis	The decomposition of a compound to its elements when an electric current flows through it
Erosion	A diminution process on the earth's surface due to the action of moving agents such as flowing water, wind and waves

External fertilisation	Process where the nucleus of a male gamete fuses with the female gamete outside the body of the female
Exogenic process	The process that occurs on the Earth's surface
Endogenic process	The process that is caused by forces from within the Earth
Element	A substance that consists of one type of particle only
Fire extinguisher	Fire protection device used to extinguish fire or control small fires, often used in emergency situations
Homeostasis	The regulation of internal environment in an organism, such as temperature level, water, pH, blood pressure and so on, so that it remains at a balanced and stable condition
Igneous rock	Rock formed from the cooling and freezing process of magma or lava that flows out from the mantle
Infertility	Inability to produce offspring/ conceive baby
Internal fertilisation	Process where the nucleus of a male gamete fuses with the nucleus of a female gamete in the body of the female
Light subtraction	Coloured light which is the same as the colour of an opaque object will be reflected to our eyes while the other colours are absorbed
Light scattering	Rays of light reflected in all directions by clouds or particles in the air
Metamorphic rock	Rock formed when igneous or sedimentary rocks are exposed to very high pressure and temperature
Mixture	A substance consisting of two or more elements or compounds combined physically
Menstruation	The breakdown of the lining of the uterine wall and discharge of blood through the vagina
Matter	Any substance that has mass and occupies space
Mass	The quantity of matter contained in an object
Menstrual cycle	A series of changes that occurs in the lining of the uterine wall and ovaries
Multicellular organism	An organism that consist of more than one cell
Oxygen cycle	A cycle that involves taking oxygen from the air and returning it to the air continuously
Organ	A group of different tissues joined together to perform a specific function

Puberty	The period during which adolescents reach sexual maturity and become capable of reproduction
Physical quantities	The physical properties that can be calculated and measured
Parallax error	The error due to the position of the eyes which are not perpendicular to the scale reading when taking measurements
Primary colours	Basic colours that cannot be produced by mixing colours
Real image	The image formed on a screen
Reproduction	Process to produce new individuals by living organisms
Refraction of light	The change of light direction or the bending of light when it passes through two mediums of different densities
Regenerative	The ability of specific fragment of organisms to grow and develop into a new complete individual
Respiration	Gas exchange that occurs between the organism and its environment
Science	A discipline that involves the observation and the systematic experiment towards the nature of a phenomenon
Scientific method	Systematic method used to solve a problem in science
Sedimentary rock	Rock formed by compression of sedimented materials carried by rivers, glaciers and wind
Sensitivity	The ability to detect small changes of the quantity to be measured
Spore formation	Process of producing spores in the sporangium
Systematic errors	The error caused by measuring instruments that are less accurate or zero error that occurs in the measuring instrument
System	A group of organs joined together to perform a specific function
Stoma	Tiny pore on a leaf that controls the entry of air into the leaf
Secondary colours	Colours produced when two primary colours are mixed together
Tissue	A group of cells joined together to perform a specific function
Unicellular organism	An organism that consists of only one cell
Virtual image	An image that cannot be formed on a screen
Vegetative reproduction	Production of new plants from vegetative parts of a parent plant and does not the flower
Weathering	A process of fragmentation and decomposition or decay of rocks due to changes in temperature, rain, frost action and microorganisms

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Dengan ini **SAYA BERJANJI** akan menjaga buku ini dengan baik dan bertanggungjawab atas kehilangannya serta mengembalikannya kepada pihak sekolah pada tarikh yang ditetapkan

Skim Pinjaman Buku Teks

Sekolah _____

Tahun	Tingkatan	Nama Penerima	Tarikh Terima

Nombor Perolehan: _____

Tarikh Penerimaan: _____

BUKU INI TIDAK BOLEH DIJUAL