KURIKULUM STANDARD SEKOLAH MENENGAH

SCIENCE
FORM 2

Writers
Jariah binti Khalib
Maznah binti Omar
Badariah binti Hamzah
Shamsulikram bin Abdul Hamid

Translators
Ram Kumari K. Raman
Yew Chian-Hauo
Sharon Chelvi Moorthy
Shirley Monica

Editors
Nadiatulaini binti Azenan
Kumutha Murugiah

Designer
Mohd Fauzi bin Mohamad Hassim

Illustrator
Wan Hamizan bin Wan Hussin

karangkraf network sdn. bhd.
2017

KEMENTERIAN
PENDIDIKAN
MALAYSIA

SERIAL BOOK NO. : 0076

KPM2017 ISBN 978-967-14472-7-7

First Published 2017

Published for Ministry of Education Malaysia by:
Karangkraf Network Sdn. Bhd.
Lot 2, Jalan Sepana 15/3,
Off Persiaran Selangor,
Seksyen 15,
40200 Shah Alam,
Selangor Darul Ehsan.
Telephone: 603-5101 3836
Fax: 603-5101 3685
Email: publishing@karangkrafnetwork.com.my
Website: www.karangkraf.com

Design and typesetting by:
Karangkraf Network Sdn. Bhd.

Font type: Minion Pro
Font size: 11 pt.

Printed by:
Ultimate Print Sdn. Bhd.
Lot 2, Jalan Sepana 15/3,
Off Persiaran Selangor,
Seksyen 15,
40200 Shah Alam,
Selangor Darul Ehsan.

ACKNOWLEDGEMENT

The publisher would like to thank the following organisations and individuals for their invaluable assistance and cooperation in the preparation of this book:

- Committee members of Quality Control, Textbook Division, Ministry of Education Malaysia
- Curriculum Development Division, Ministry of Education Malaysia
- Officers of the English Language Teaching Centre (ELTC), Teacher Education Division, Ministry of Education Malaysia
- Dato' Dr. Sheikh Muszaphar Shukor Al Masrie Sheikh Mustapha
- Datuk M. Magendran
- Datuk N. Mohanadas
- Datuk Dr. Mazlan Othman
- Universiti Perguruan Sultan Idris
- Nur Adlyka Ainul Annuar

Contents

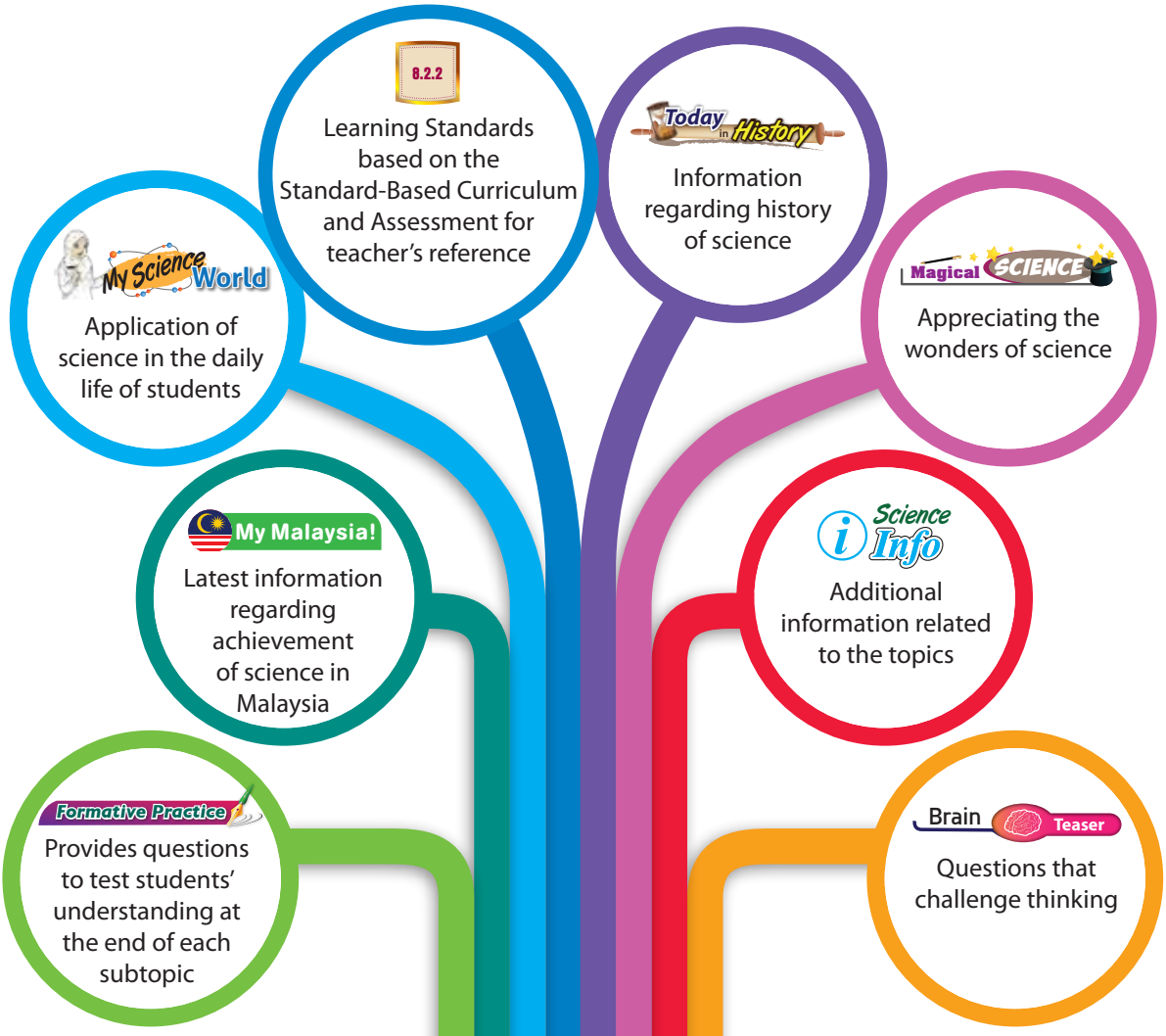
Theme 3: Energy and Sustainability of Life

Theme 4: Earth and Space Exploration

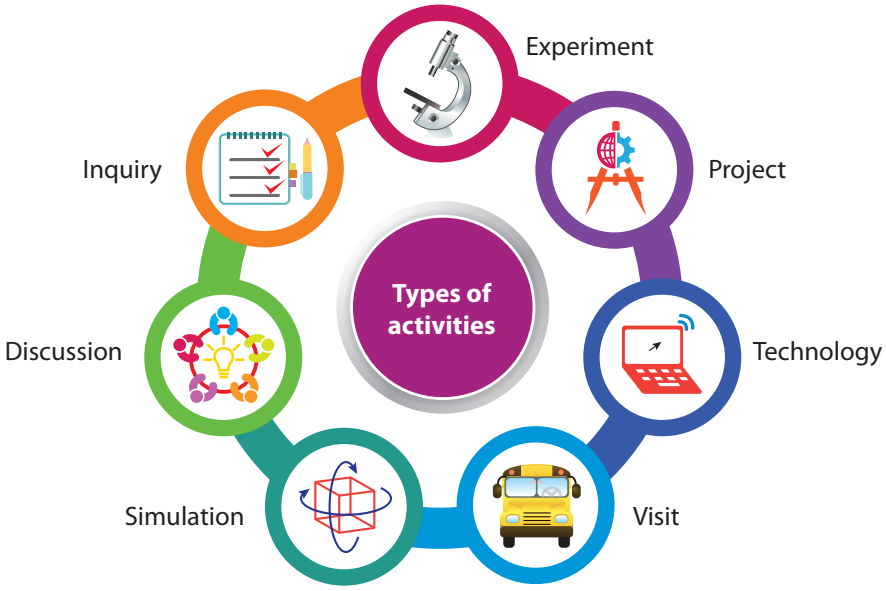
Introduction

The Science Form 2 textbook is written for Form 2 students based on the Standard-Based Curriculum and Assessment for Form 2 prepared by the Ministry of Education. 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. Additionally, STEM Teaching and Learning approach is incorporated through approaches such as inquiry, problem-solving and projects to elevate students' interest towards science and technology.

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

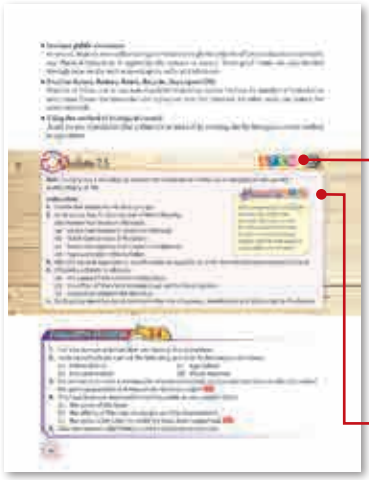


Various activities in this book:



New features in this book:

21st Century Skills
- Thinking & Problem-solving skills
- Interpersonal skills & Self-directed learning
- Information & communication skills



STEM (Science, Technology, Engineering and Mathematics)
As a teaching and learning approach which applies and integrates knowledge, skills and values of STEM through inquiry, problem-solving or projects in the context of daily life. This approach hopes to attract students' interest to pursue STEM education in school and enter the STEM workforce to tackle challenges and be competitive globally.

Career in STEM field (Science, Technology, Engineering and Mathematics)

Components at the end of a chapter:

1. **Summary**
   Summary of a chapter

2. **SELF-REFLECTION**
   Simple checklist of learning standards for students' reference

3. **Summative Practice**
   Questions to test students' understanding at the end of a chapter

4. **HOTS Mastery**
   Levels 5 and 6 HOTS questions

HOTS Questions
(Applying, analysing, evaluating, creating)

Digital components in this book:

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

Video — Video

Interactive quiz — Quiz

Additional information — Info

Guideline to scan AR for Three-dimensional Animations and Interactive Games

Step 1

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

Step 2

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

AR

or

App Store

Google Play

Step 3

Find the pages that have these icons.

Accompanied by audio

Three-dimensional animations

Interactive games

Step 4

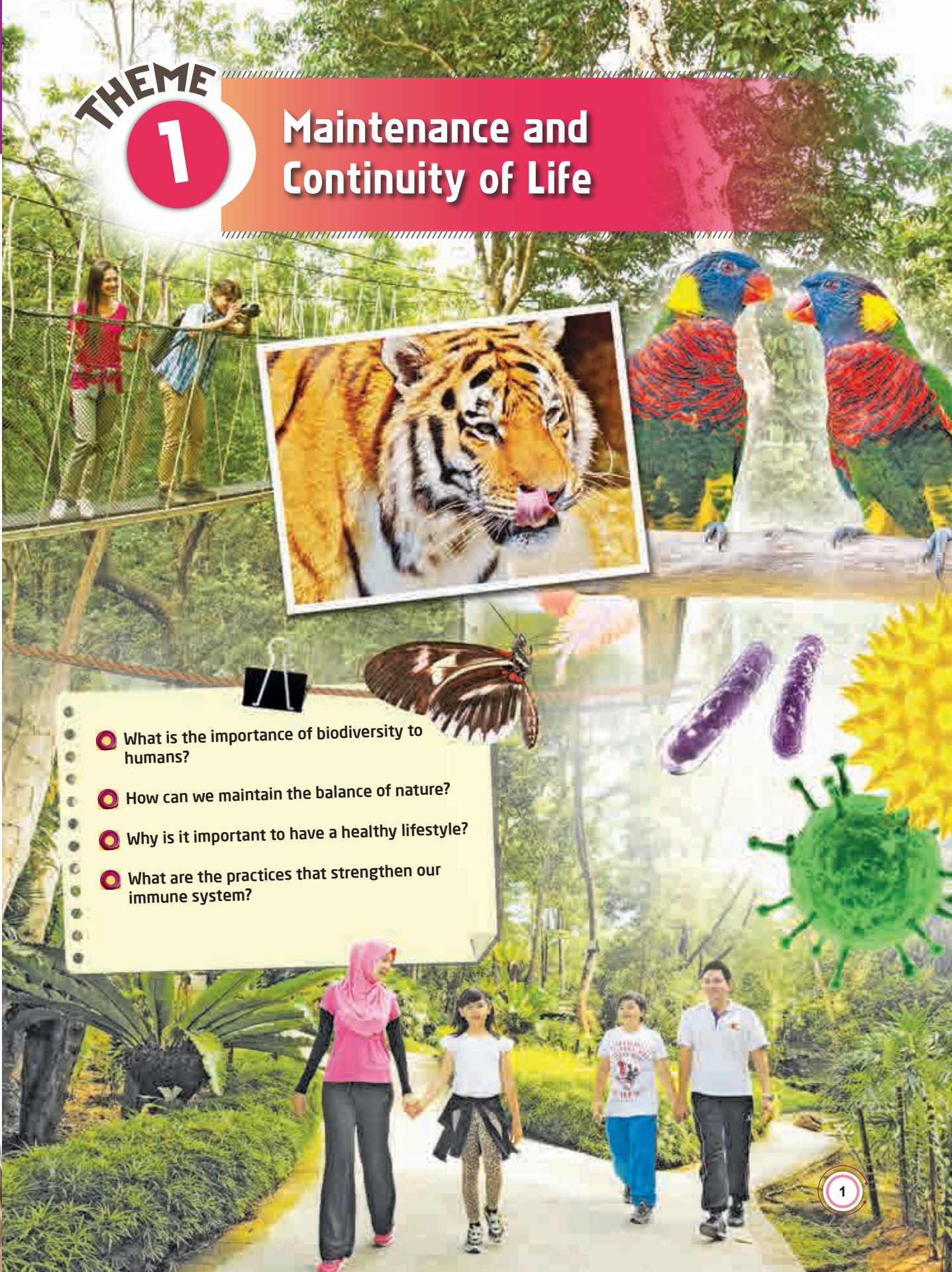
Scan the image on the page with your smartphone or tablet and enjoy the three-dimensional animations and interactive games.

Three-dimensional animations

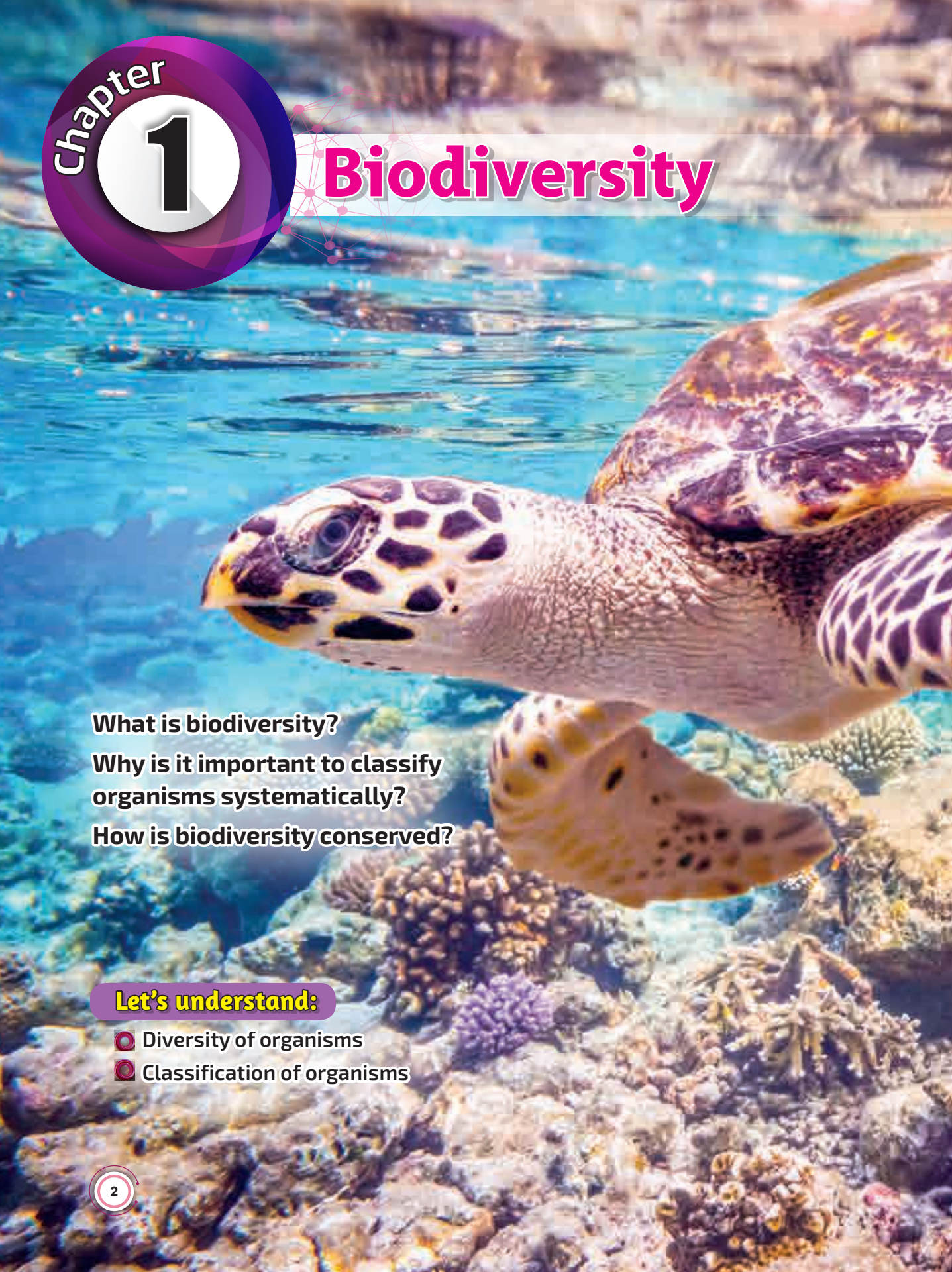
Interactive games

THEME 1

Maintenance and Continuity of Life



- What is the importance of biodiversity to humans?
- How can we maintain the balance of nature?
- Why is it important to have a healthy lifestyle?
- What are the practices that strengthen our immune system?



Chapter 1

Biodiversity

What is biodiversity?

Why is it important to classify organisms systematically?

How is biodiversity conserved?

Let's understand:

- Diversity of organisms
- Classification of organisms

SCIENCE BLOG

The Rafflesia in Malaysia

Malaysia is the habitat of the world's largest flower, the rafflesia (*Rafflesia* sp.). The rafflesia is a parasitic plant that feeds on its host.

The rafflesia gives off a rotting smell when in full bloom. This flower is also very unique because it does not have any leaves to carry out photosynthesis, nor does it have roots to absorb water and nutrients from the soil.

Keywords

- Biodiversity
- Vertebrate
- Invertebrate
- Mammal
- Bird
- Reptile
- Fish
- Amphibian
- Monocotyledon
- Dicotyledon

1.1 Diversity of Organisms

Did you know that our country, Malaysia, is one of the 12 **megabiodiversity** countries in the world? The **equatorial** climate of Malaysia makes it a very ideal habitat for a variety of organisms. Can you name the animals and plants shown in Photograph 1.1?

Photograph 1.1 *Diversity of animals and plants in Malaysia*

What is Biodiversity?

The diversity of organisms, whether microorganisms, animals or plants, is known as **biodiversity**. Biodiversity exists as a result of the diversity of **habitat** and **climate**. Different organisms have different characteristics which enable them to adapt and thrive independently in their respective habitats (Photograph 1.2).

Science Info

Biodiversity also covers diversity at the genetic level. Genetic diversity is the diversity within a species, based on variations in the genes of each microorganism, animal or plant.

Desert | Polar regions | Soil | Sea

Photograph 1.2 *Diverse organisms in different habitats*

The Importance of Biodiversity

Biodiversity is a priceless treasure and a legacy of nature which should be preserved. Can you list down some of the importance of biodiversity based on Photograph 1.3?

Today in History

The International Day for Biological Diversity is celebrated on the 22nd of May every year.

Sources of food

Animals and plants supply food to humans.

Balance in nature

Cycle of nutrients, pollination and interaction between organisms create balance in nature.

Recreational places

Areas that are rich in biodiversity can be developed as recreational places.

Medical

Herbs are widely used in the manufacture of medicines and cosmetics.

Raw materials for industries

Timber, bamboo and rattan are examples of forest products which are used to make musical instruments, furniture and to build buildings.

Education

Humans increase knowledge and create new technology through scientific research on microorganisms, animals and plants.

Photograph 1.3 *Importance of biodiversity*

Effective Biodiversity Management

It cannot be denied that we need raw materials such as timber for development. Nevertheless, deforestation activities need to be controlled to preserve our biodiversity from extinction (Photograph 1.4).

What methods can we use to maintain and conserve biodiversity? Biodiversity can be maintained and conserved by:

- banning the killing or trade of **endemic** and **endangered** animals and plants through the Wildlife Protection Act 1972,
- protecting the habitat through creating national parks, marine parks, forest reserves and wildlife sanctuaries,
- undertaking reproductive programmes such as seedling nurseries to help with reforestation and turtle hatcheries.

Photograph 1.4 *Deforestation activities cause animals to lose their habitat and food sources*

Science Info

An endemic species is a species that lives in clusters within a restricted habitat in a specific location. Examples of endemic plants and animals in Malaysia include the rafflesia, pitcher plant (*Nepenthes rajah*), leatherback turtle, Malayan tiger and the Borneo Pygmy elephant.

Activity 1.1

Aim: To conduct a discussion on effective biodiversity management.

Instruction

1. Work in groups.
2. Find information on:
   (a) factors that cause the extinction of animals and plants
   (b) ways to preserve and conserve animals and plants including endemic and endangered species
3. Present your group findings in class.

Science Info

The methods of biodiversity conservation can be classified as **in situ conservation** and **ex situ conservation**. In situ conservation, preserves the species within their natural habitat such as in national parks, permanent forest reserves and marine parks. Ex situ conservation, on the other hand, preserves the species outside of their natural habitat such as in zoos and botanical parks.

Info

Biodiversity
http://www.nre.gov.my

Formative Practice 1.1

1. What is biodiversity?
2. How does biodiversity contribute to the economy?
3. What is an endemic species? Give two ways to preserve and conserve endemic species.
4. Give examples of endangered species in Malaysia.

1.2 Classification of Organisms

The two main groups of organisms are animals and plants. Animals and plants can be classified further into smaller groups based on their common and different characteristics. Study Photograph 1.5. What are the similarities and differences between the two animals?

Photograph 1.5

Classification of Animals

Animals can be classified as **invertebrates** and **vertebrates**. Can you state the differences between these two groups of animals?

Invertebrates

Invertebrates are animals without a backbone. Figure 1.1 shows the classification of invertebrates.

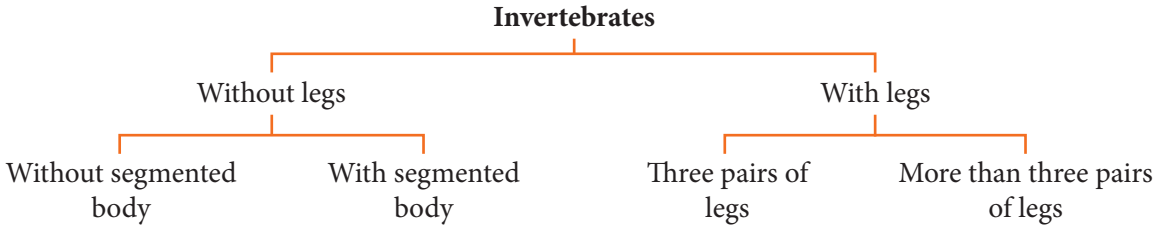


Figure 1.1 *Classification of invertebrates*

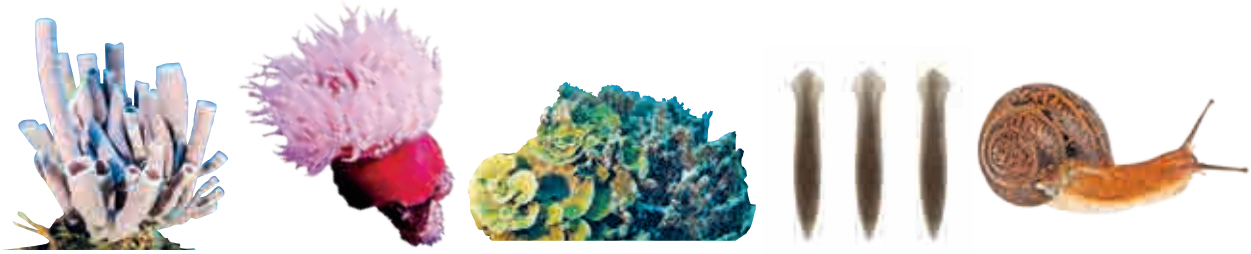
Science Info

Segmented body is the division of an animal's body into several segments.

Invertebrates Without Legs

1 Without segmented body

- There are invertebrates without legs and without segmented bodies.



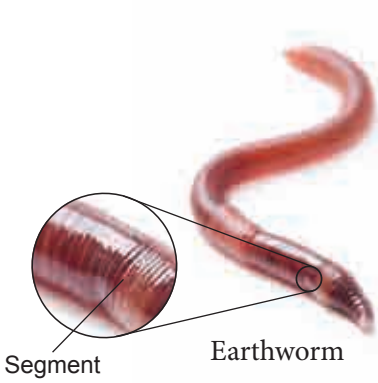
Sponge | Sea anemone | Corals | Planaria | Snail

Photograph 1.6 *Invertebrates without legs and without segmented bodies*

2 With segmented body

- Some invertebrates without legs have segmented bodies.

Tapeworm



Earthworm

Leech

Photograph 1.7 *Invertebrates without legs with segmented bodies*

Science Info

Insects are the largest group of animals. There are 950 000 species of insects.

Invertebrates With Legs

Characteristics of invertebrates with legs:

- have segmented bodies
- have hard outer shells (exoskeleton)

1 Three pairs of legs

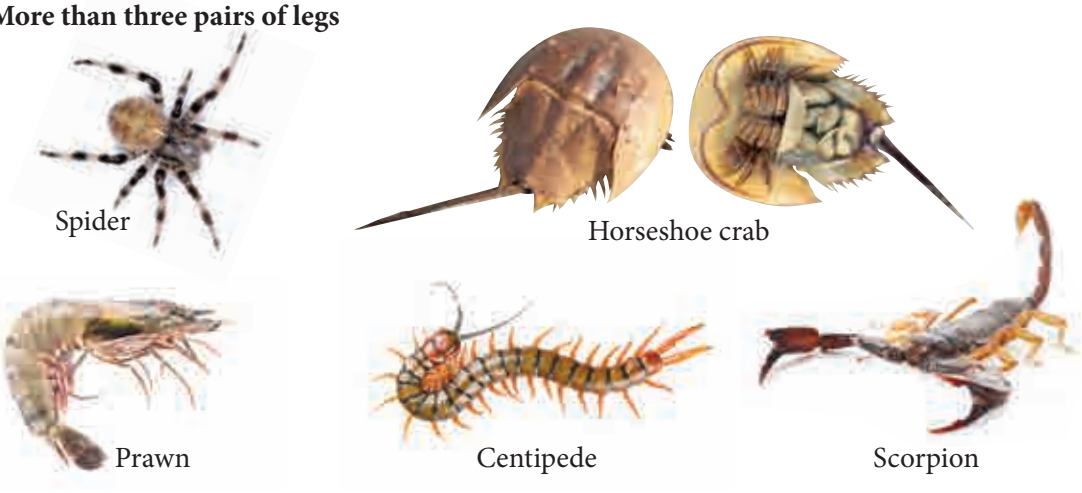
Ant

Butterfly

Cockroach

Photograph 1.8 *Invertebrates with three pairs of legs*

2 More than three pairs of legs



Photograph 1.9 *Invertebrates with more than three pairs of legs*

Vertebrates

Vertebrates are animals with a backbone (Figure 1.2).

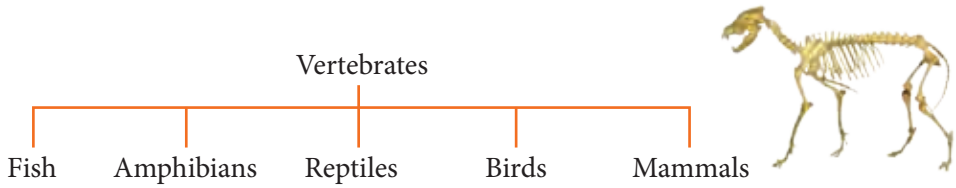


Figure 1.2 *Classification of vertebrates*

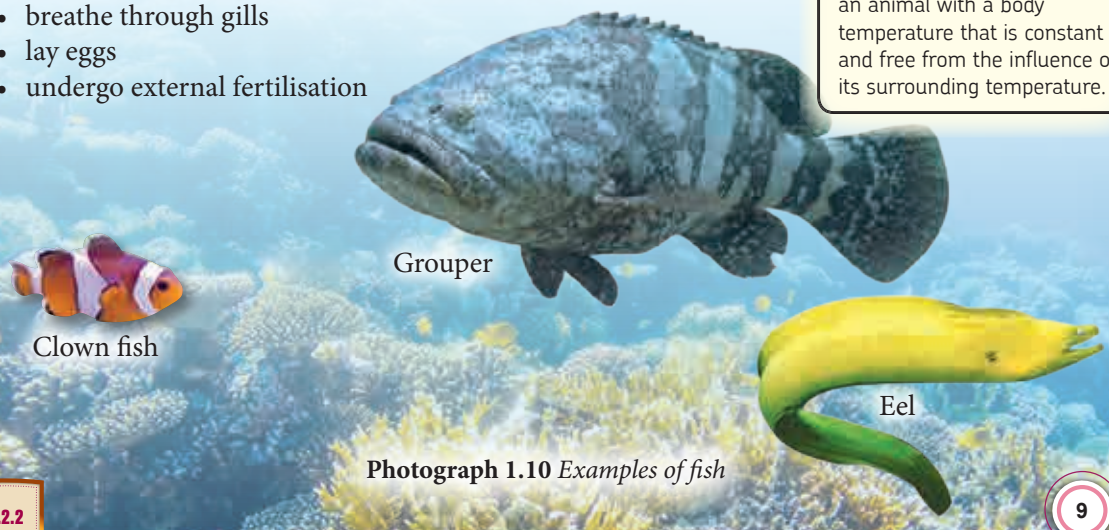
Fish

Fish are animals with the following common characteristics:

- poikilothermic
- covered in hard and slimy scales
- have fins and a tail
- breathe through gills
- lay eggs
- undergo external fertilisation

Science Info

A **poikilotherm** is an organism that has a body temperature that changes according to its surrounding temperature. A **homeotherm**, on the other hand, is an animal with a body temperature that is constant and free from the influence of its surrounding temperature.



Photograph 1.10 *Examples of fish*

Amphibians

Amphibians are animals with the following common characteristics:

- poikilothermic
- live on land and in water
- covered with moist skin
- young amphibians breathe through gills
- adult amphibians breathe using their lungs and moist skin
- produce jelly-like eggs (spawn) without a shell
- undergo external fertilisation

Salamander

Toad

Frog spawn

Tadpole

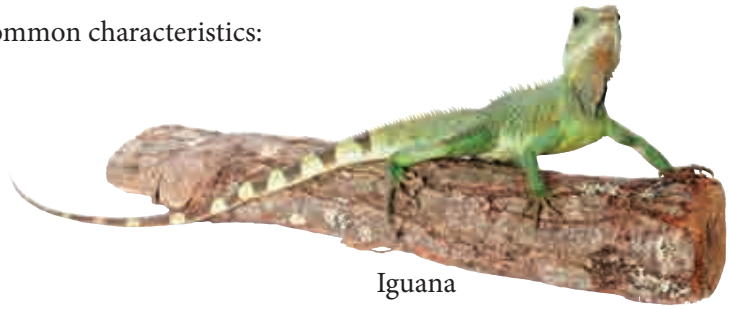
Frog

Photograph 1.11 *Examples of amphibians*

Reptiles

Reptiles are animals with the following common characteristics:

- poikilothermic
- produce eggs with a shell
- breathe through lungs
- have scales and hard skin
- undergo internal fertilisation



Iguana

Turtle

Snake

Crocodile

Photograph 1.12 *Examples of reptiles*

Birds

Birds are animals with the following common characteristics:

- homeothermic
- covered with feathers to maintain body temperature
- breathe through lungs
- have wings that help some birds to fly
- have a pair of scaly feet
- undergo internal fertilisation
- produce eggs with hard shell

Owl

Kingfisher

Duck

Photograph 1.13 *Examples of birds*

Science Info

The rhinoceros hornbill is a protected animal in Malaysia. It is the state bird of Sarawak.

SCAN IMAGE **Let's play**

My Malaysia!

Malaysia is a habitat for nearly 742 species of birds. At least 522 species are local species, 192 are migratory species and 52 are local species with migratory characteristics.

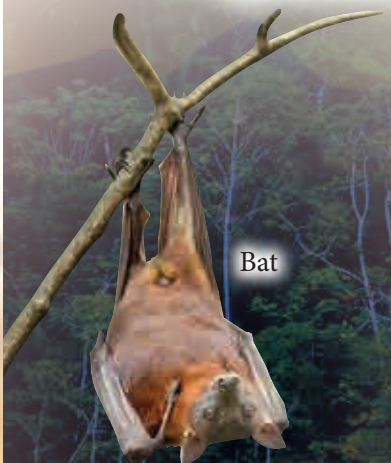
Mammals

Mammals are animals with the following common characteristics:

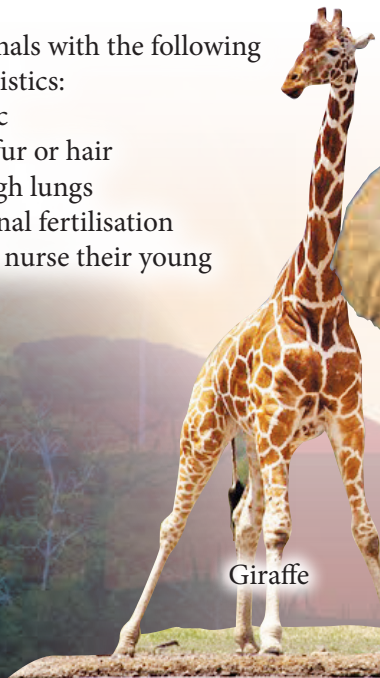
- homeothermic
- covered with fur or hair
- breathe through lungs
- undergo internal fertilisation
- give birth and nurse their young

Brain Teaser

What is the difference between fur and hair?



Bat



Giraffe

Elephant

Lion

Photograph 1.14 *Examples of mammals*

Classification of Plants

Plants are classified as **non-flowering** and **flowering** plants.

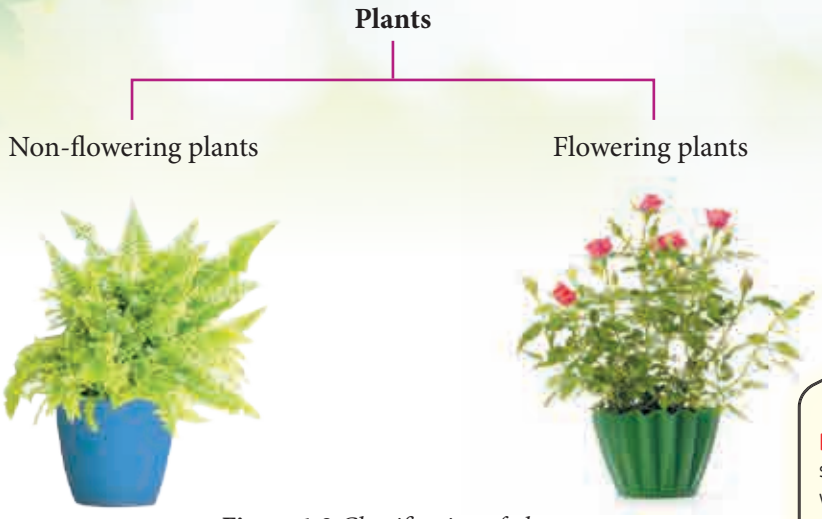


Figure 1.3 *Classification of plants*

Science Info

Non-vascular plants are simple and small plants without a vascular system.

Vascular plants have a vascular system within them that transport water and food throughout the plant. These plants also have true roots, stems and leaves.

Non-flowering Plants

Non-flowering plants consist of **moss**, **fern** and **conifer**. What are the common characteristics of each of these groups of plants?

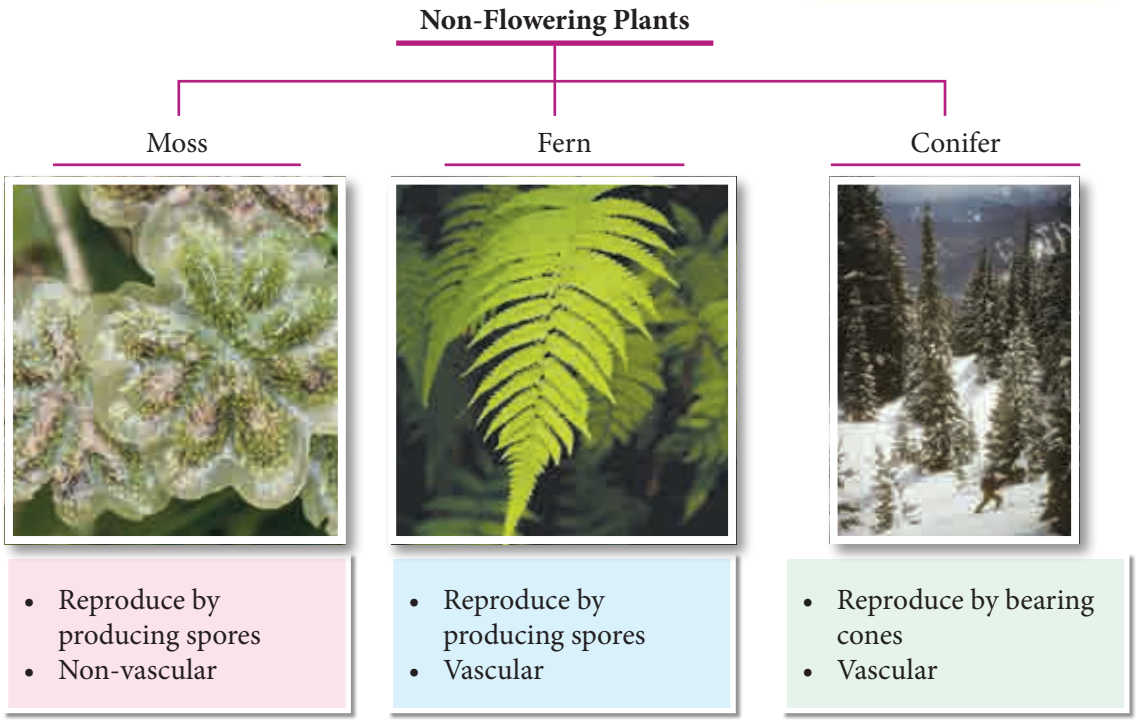


Figure 1.4 *Classification of non-flowering plants*

Flowering Plants

Flowering plants produce flowers which become fruits that contain seeds. Each seed has a **cotyledon**, which is stored food that is used by the seed to germinate. A seed which has one cotyledon is called a **monocotyledon**. A seed with a pair of **cotyledons** is called a **dicotyledon** (Figure 1.5).

Paddy plant | Orchid plant | Lotus plant | Sunflower plant

Photograph 1.15 *Examples of flowering plants*

Differences

Monocotyledons		Dicotyledons
One 	**Number of cotyledons**	Two 
Fibrous root	**Root**	Tap root
Leaves with parallel veins	**Leaf**	Leaves with network-like veins
Most have non-woody stem	**Stem**	Woody stem
Paddy and maize plants	**Example**	Tomato plant and durian tree

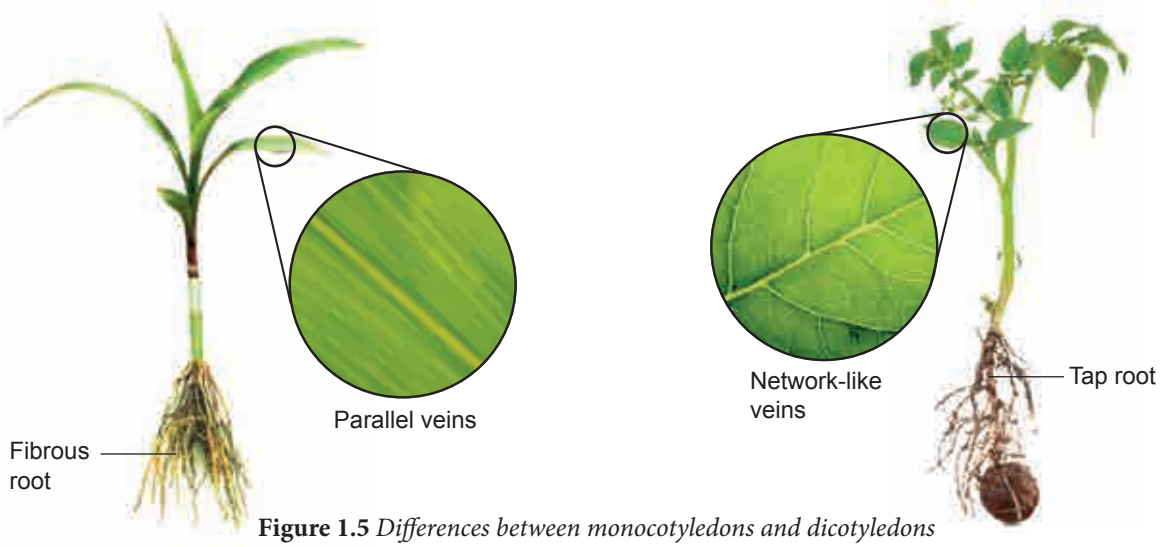


Figure 1.5 *Differences between monocotyledons and dicotyledons*

Activity 1.2

Aim: To identify the characteristics which differentiate major taxonomy groups.

Instruction

1. Work in groups.
2. Identify the differences between
   (a) plants, animals and fungi
   (b) fish, amphibians, reptiles, birds and mammals
3. Present the results using a multimedia presentation.

Constructing a Dichotomous Key

A **dichotomous key** is a method used by biologists to identify and classify organisms systematically based on similarities and differences. It is constructed of a series of couplets. Each couplet consist of two statements describing characteristics of a particular organism or group of organisms. Let's look at the example of a dichotomous key for animals (Figure 1.6) and plants (Figure 1.7).

Pomfret

Chicken

Lion

Frog

Snake

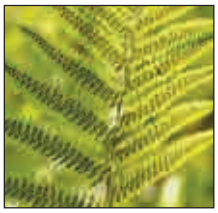
Dichotomous key

1. (a) Poikilothermic ..... go to 2
   (b) Homeothermic ..... go to 3
2. (a) Scaly skin ..... go to 4
   (b) Non-scaly skin ..... Frog
3. (a) Non-feathered ..... Lion
   (b) Feathered ..... Chicken
4. (a) Does not have fins ..... Snake
   (b) Has fins ..... Pomfret

Figure 1.6 *Example of a dichotomous key for animals*


Maize plant


Marchantia sp.


Fern


Gnetum sp.


Sunflower plant

Dichotomous key

1. (a) Non-flowering ..... go to 2
   (b) Flowering ..... go to 3
2. (a) Non-vascular ..... *Marchantia* sp.
   (b) Vascular ..... go to 4
3. (a) Monocotyledon ..... Maize plant
   (b) Dicotyledon ..... Sunflower plant
4. (a) Does not produce seeds ..... Fern
   (b) Produce seeds ..... *Gnetum* sp.

Figure 1.7 *Example of a dichotomous key for plants*

Activity 1.3

Aim: To construct a dichotomous key.

Instruction

1. Work in groups.
2. List down as many invertebrates found in your school compound.
3. Construct a dichotomous key for the invertebrates.
4. Present your group findings in class.

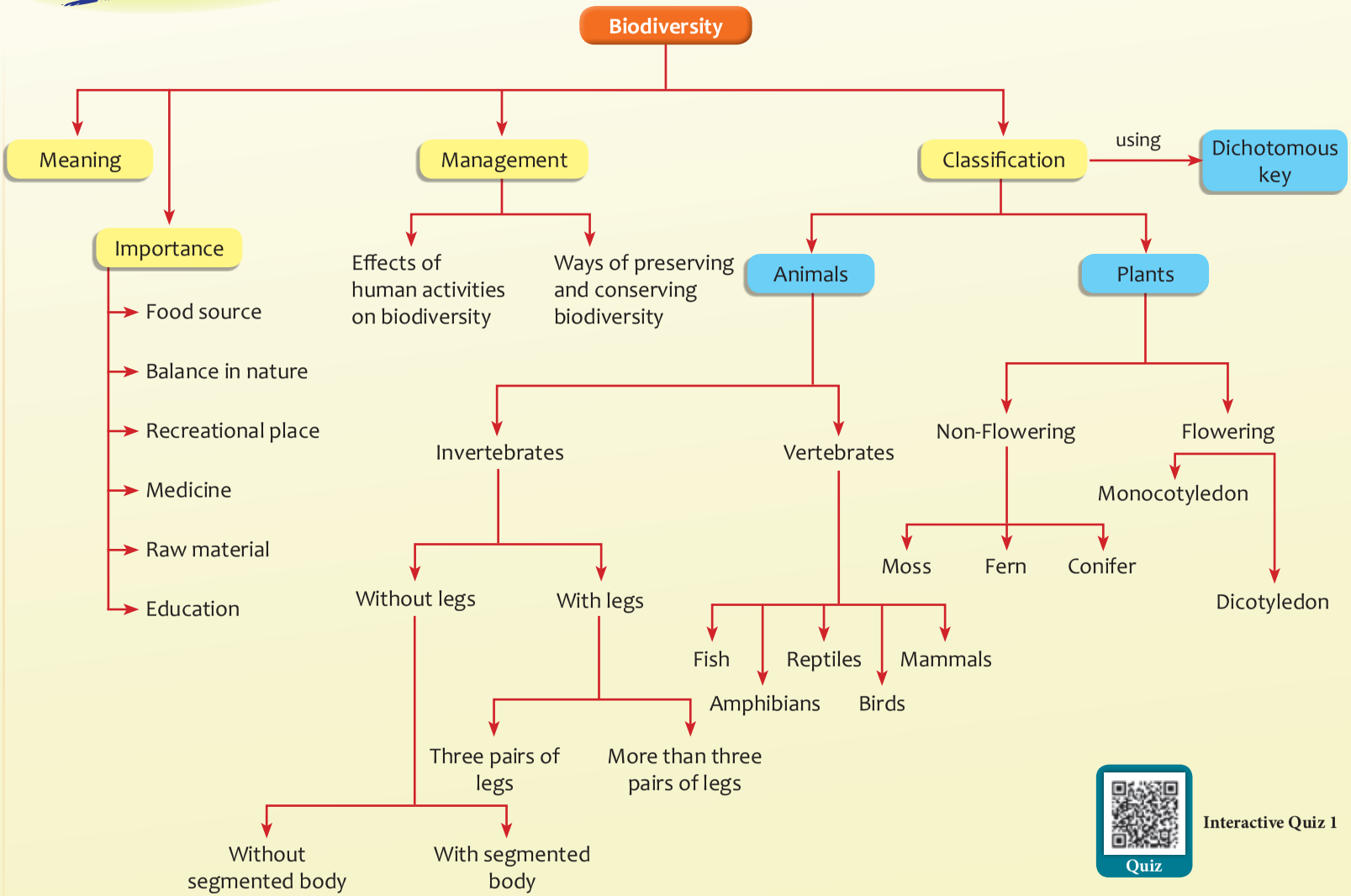
Formative Practice 1.2

1. Classify the following animals according to their common characteristics.

   tortoise, crocodile, eel, orang utan, dolphin, platypus, penguin, frog, duck, toad

2. The sunflower plant and paddy plant are flowering plants. State one similarity and three differences between the two plants.
3. Give two differences between monocotyledon and dicotyledon plants.

Summary



Quiz

Interactive Quiz 1

SELF-REFLECTION

After learning this chapter, you are able to:

1.1 Diversity of Organisms

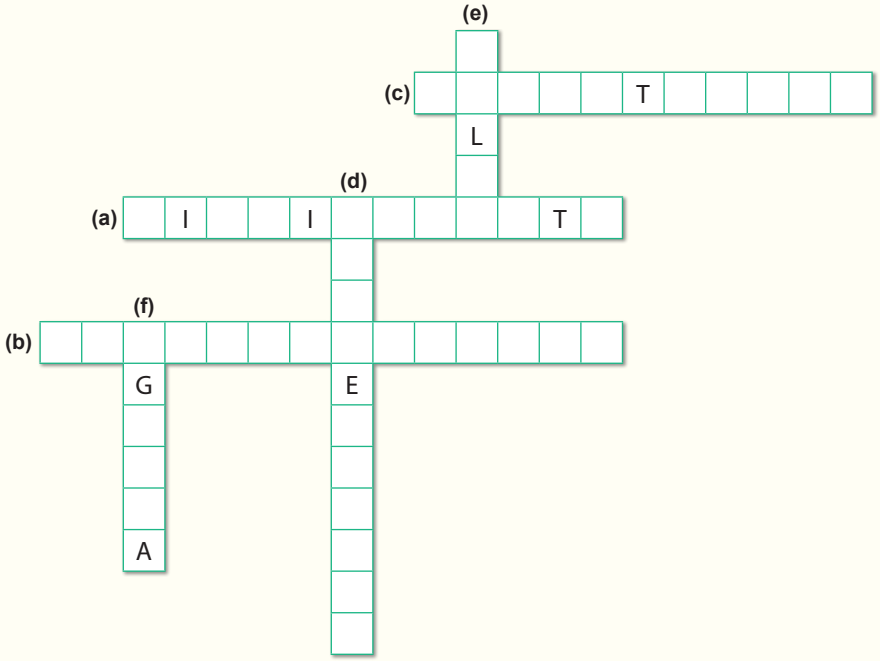
- ☐ Elaborate and communicate on biodiversity.
- ☐ Justify the needs of effective biodiversity management.

1.2 Classification of Organisms

- ☐ Differentiate organisms using a dichotomous key based on common characteristics.
- ☐ Characterise the major taxonomy groups.

Summative Practice 1

1. Complete the crossword puzzle below with the correct answers.



Across

(a) The diversity of organisms whether animals, plants or microorganisms is known as _____.

(b) Amphibians are _____ or cold-blooded.

(c) A _____ key is used by biologists to identify and classify organisms systematically.

Down

(d) _____ are animals which have backbones.

(e) Fish breathe through _____.

(f) An _____ is an example of a reptile.

2. Tick (✓) the true statement and cross (✗) the false statement.

(a) Biodiversity is the diversity of living and non-living organisms. ☐

(b) Biodiversity is very important for the continuity of human's existence. ☐

(c) Apart from classifying living things, a dichotomous key can also be used to classify non-living things. ☐

3. Liana and some of her friends collected the following five types of animals when they conducted a sampling activity in a forest.

Three pairs of legs

P

Three pairs of legs

Q

Three pairs of legs

R

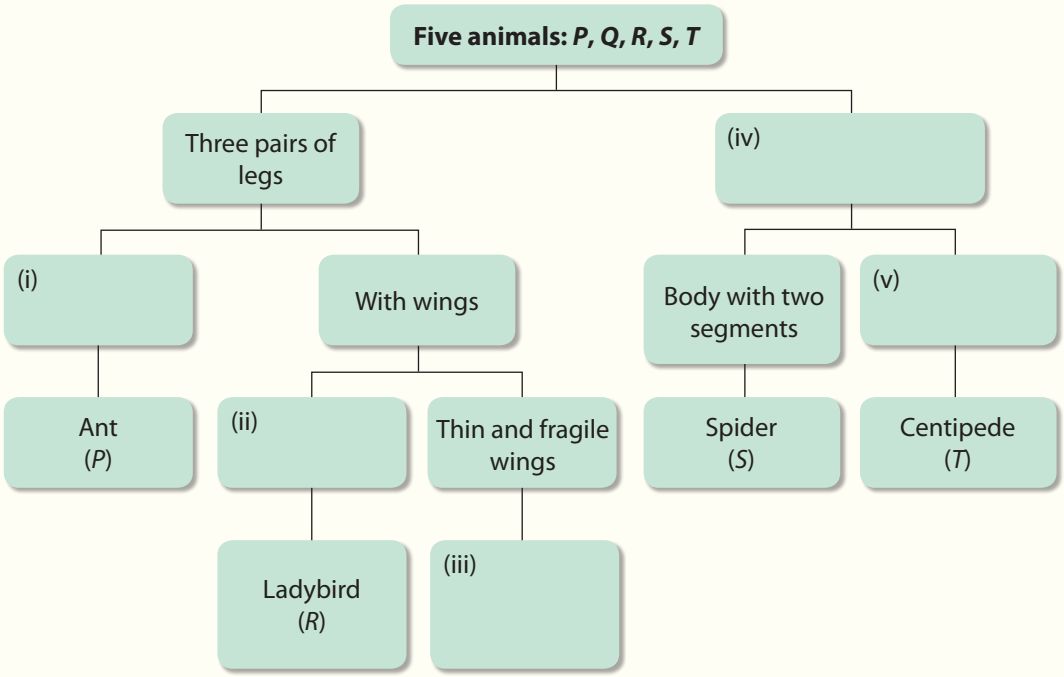
Four pairs of legs

S

More than four pairs of legs

T

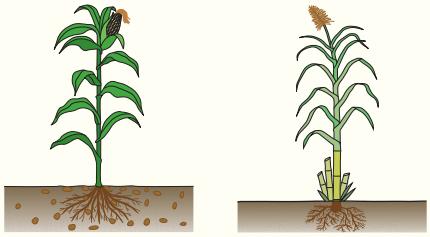
(a) Complete the following dichotomous key based on the physical characteristics of the animals collected by them.



(b) What are the similarities between animals *P*, *Q*, *R*, *S* and *T*?

(c) What are the differences between animals *P*, *S* and *T*?

4. Observe Figure 1.



Plant *A* Plant *B*

Figure 1

(a) Suggest two characteristics that can be used to classify plants.

(b) Give three similarities between plant *A* and plant *B*.

5. Sik Mei observed similarities between the three animals in Photograph 1. Sik Mei thinks that the three animals are in the same group. Is Sik Mei correct? Give your reasons.

Scorpion Jellyfish Crab

Photograph 1

6. List the differences between the animals in Photograph 2. Construct a dichotomous key to identify the animals.

Planaria Butterfly Earthworm

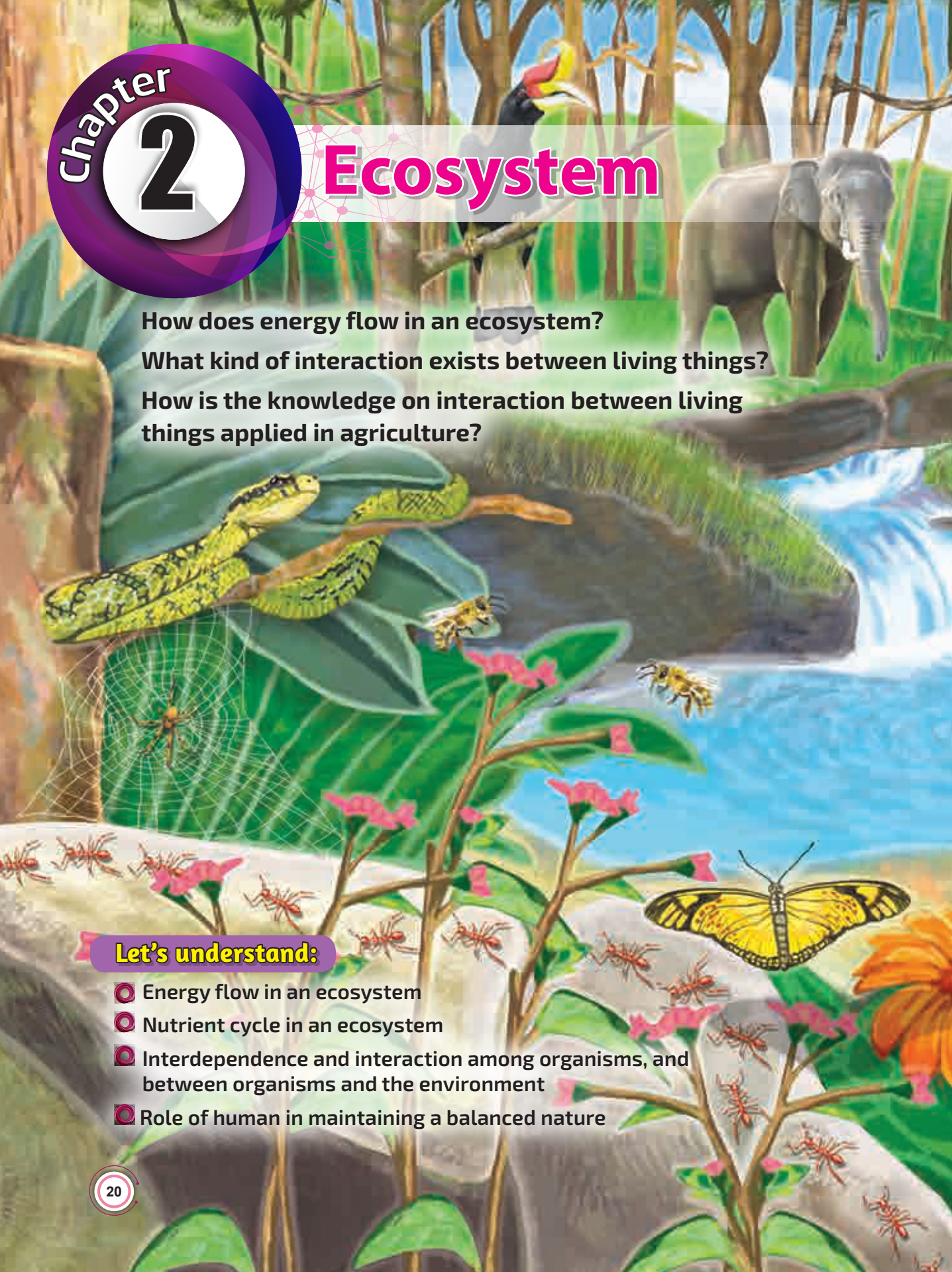
Photograph 2

HOTS Mastery 1

7. Deforestation is a huge threat on a global level. Nevertheless, it contributes to the development of a nation. Justify the needs for deforestation.

8. Photograph 3 shows a leatherback turtle, an endemic animal. Hunting this animal has serious consequences. Justify.

Photograph 3



Chapter 2

Ecosystem

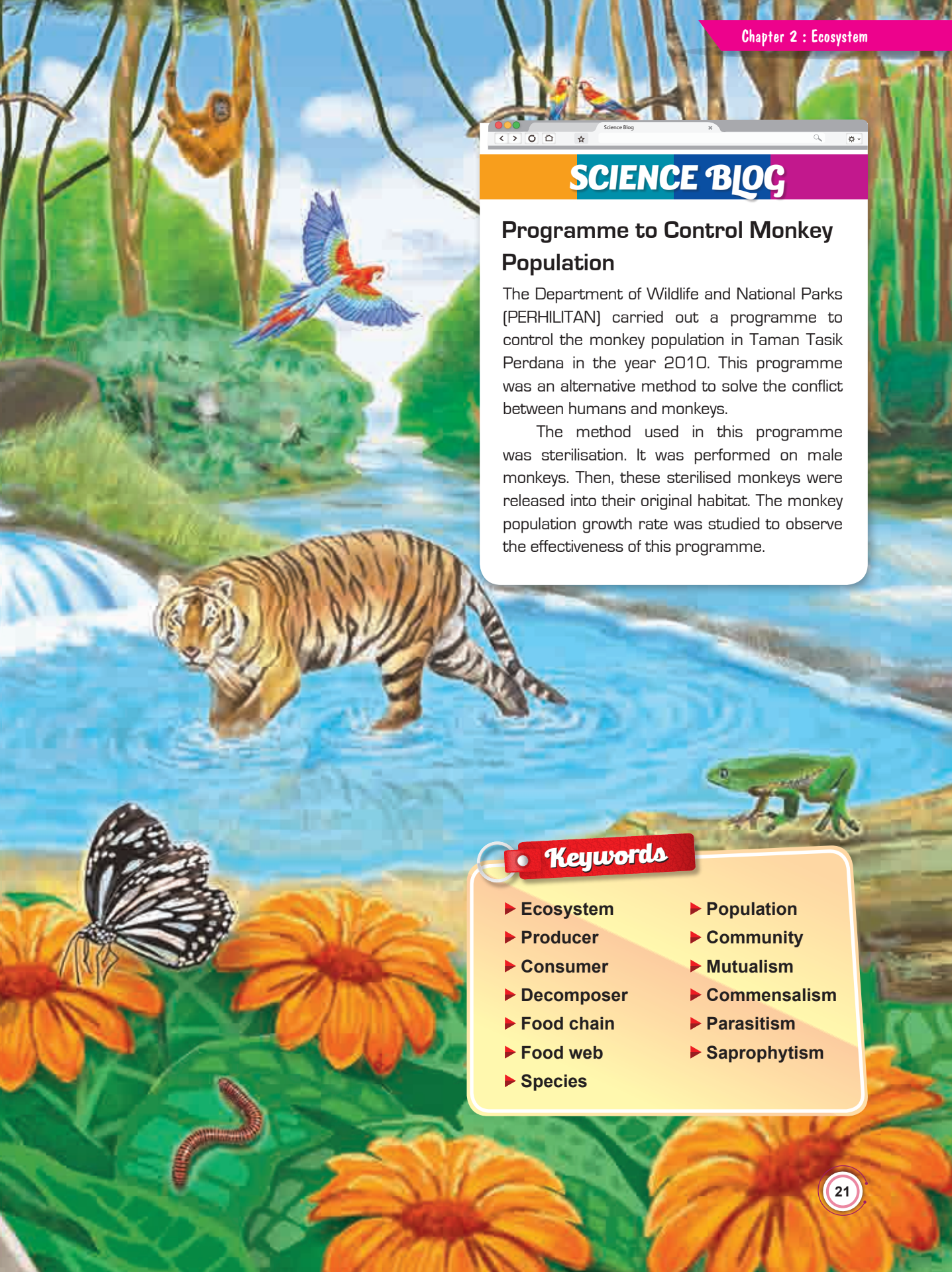
How does energy flow in an ecosystem?

What kind of interaction exists between living things?

How is the knowledge on interaction between living things applied in agriculture?

Let's understand:

- Energy flow in an ecosystem
- Nutrient cycle in an ecosystem
- Interdependence and interaction among organisms, and between organisms and the environment
- Role of human in maintaining a balanced nature



SCIENCE BLOG

Programme to Control Monkey Population

The Department of Wildlife and National Parks (PERHILITAN) carried out a programme to control the monkey population in Taman Tasik Perdana in the year 2010. This programme was an alternative method to solve the conflict between humans and monkeys.

The method used in this programme was sterilisation. It was performed on male monkeys. Then, these sterilised monkeys were released into their original habitat. The monkey population growth rate was studied to observe the effectiveness of this programme.

Keywords

- Ecosystem
- Producer
- Consumer
- Decomposer
- Food chain
- Food web
- Species
- Population
- Community
- Mutualism
- Commensalism
- Parasitism
- Saprophytism

2.1 Energy Flow in an Ecosystem

Do you know that the source of energy in all ecosystems originates from the Sun? Green plants convert **light energy** from the Sun into **chemical energy** through the process of photosynthesis. The chemical energy is transferred to primary consumers and then to secondary and tertiary consumers in the **food chain** and **food web**.

Producers, Consumers and Decomposers

In an ecosystem, organisms can be classified as **producers**, **consumers** and **decomposers**.

Producer

A **producer** is an organism that produces its own food through photosynthesis. Most plants are producers.

Primary consumer

A **consumer** is an organism that eats another organism. **Primary consumers** are **herbivores** and **omnivores** that eat producers. For example, caterpillars.

Caterpillar

Plant

Dead

Decomposer

A **decomposer** is an organism that breaks down dead animals and plants into simpler materials or nutrients. This interaction is known as **saprophytism**.

Brain Teaser

What are the materials that cannot be broken down by a decomposer?

Figure 2.1 *Examples of producer, consumer and decomposer in a forest ecosystem*

Secondary consumer

A **secondary consumer** is an **omnivore** and **carnivore** that eats the primary consumer. For example, the Himalayan bluetail, *Tarsiger rufilatus,* is an omnivore because it eats caterpillars and fruits. However, the kingfisher, *Alcedo atthis,* is a primary carnivore because it eats primary consumers such as snails, fish, tadpoles and shrimps.

Brain Teaser

Are human beings primary, secondary or tertiary consumers? Explain.

Info

Construct Food Chains
http://www.vtaide.com/png/foodchains.htm#create

SCAN IMAGE **Let's play**

Himalayan bluetail

Tertiary consumer

A **tertiary consumer** is a secondary carnivore that eats a secondary consumer. The size of a tertiary consumer is usually bigger than a primary or secondary consumer.

Fox

Mushroom

Science Info

Some examples of decomposers are mushrooms that grow on decaying wood, mould that grows on food as well as *E.coli* bacteria that break down food molecules in the large intestine of humans.

Food Chain

A **food chain** can be used to show the feeding relationship between organisms. Figure 2.2 shows an example of a food chain.

Cabbage (Producer) → Snail (Primary consumer) → Bird (Secondary consumer) → Fox (Tertiary consumer)

Figure 2.2 *Example of a food chain*

Food Web

The interconnection of a few food chains is called a **food web**. Figure 2.3 shows an example of a simple **food web** in a vegetable garden. Can you write four food chains that create the food web shown?

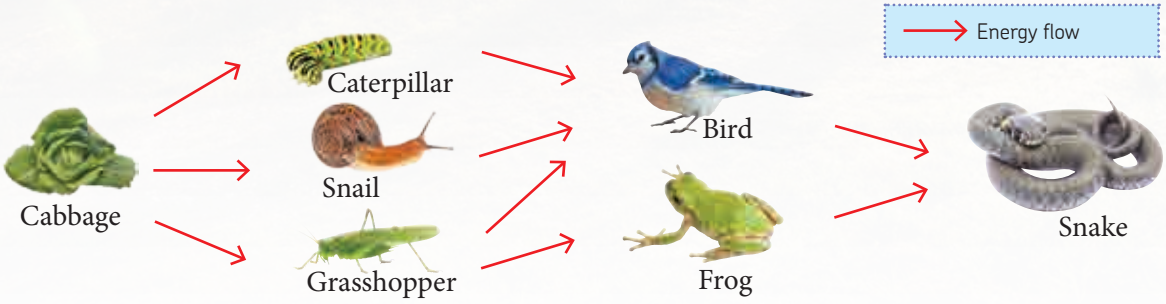


Figure 2.3 *Example of a food web*

Energy Flow in a Food Web

As seen in the food chain, energy is also transferred from one organism to another organism in the food web. In reality, some of the energy is lost because it is used by the organism to move and carry out the life process of respiration. Apart from this, energy is also lost in the form of heat energy or chemical energy through undigested food, or faeces.

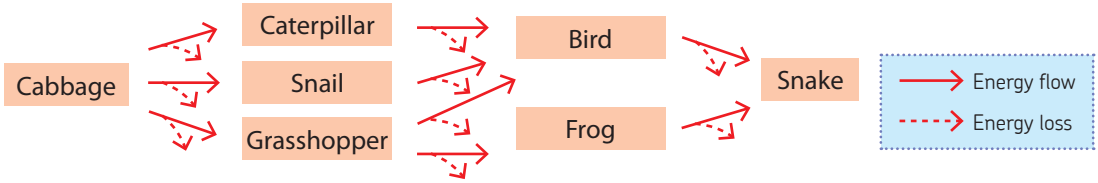


Figure 2.4 *Energy flow in a food web*

Activity 2.1

Aim: To construct a food web.

Instruction

1. Visit any ecosystem in your school compound or your housing area.
2. Construct as many food chains as possible from the plants and animals you find.
3. Interconnect the food chains to make a food web. Then, identify the producers, consumers and decomposers in the food web.
4. Discuss the energy flow in the food web.

Formative Practice 2.1

1. The following is an example of a food chain. Identify the producer, primary consumer, secondary consumer and tertiary consumer.

   Cabbage ⟶ Caterpillar ⟶ Chicken ⟶ Snake

2. Based on the following organisms:

   Paddy plant | Grasshopper | Sparrow | Owl | Rat | Caterpillar

   (a) construct a food web.
   (b) predict what will happen if the paddy plant dies because of a long drought.

2.2 Nutrient Cycle in an Ecosystem

The transfer of nutrients and energy is continuous in an ecosystem. Nutrients are obtained from a balanced ecosystem and used by living things. Then, the nutrients are returned to the environment to be used again. This cycle is called a **nutrient cycle**. Do you still remember the examples of nutrient cycles, such as the water cycle, carbon cycle and oxygen cycle that you learned in Form One? What is the role of living things in those cycles?

Water Cycle

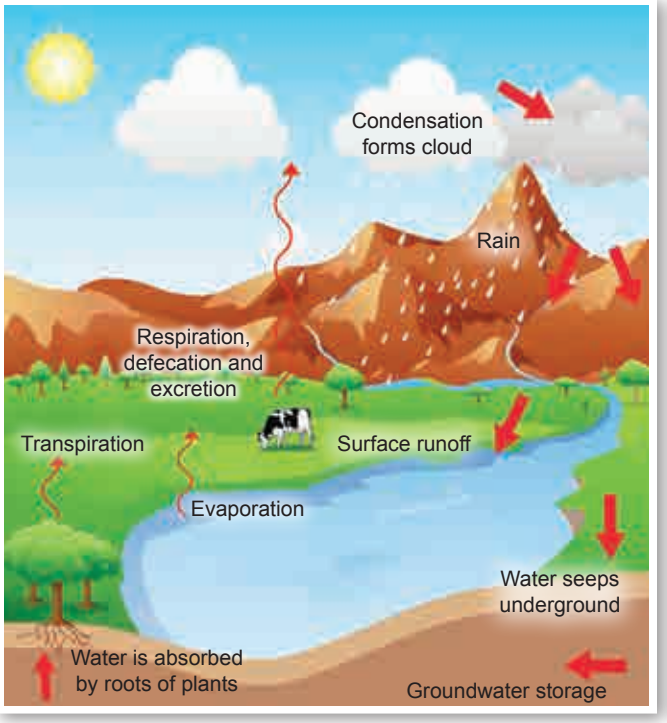


Figure 2.5 *Water cycle*

The role of living things in the water cycle

- Water is absorbed by roots of plants in the ground and released into the atmosphere through **transpiration**. Animals carry out respiration, defecation and excretion (sweating and urination). All of these **increase the water content** in the atmosphere.
- Roots of plants hold the soil tightly and make the structure of the soil more compact. This slows down the flow of water underground and **prevents soil erosion**.
- Leaves that fall from trees and cover the surface of the earth will reduce the rate of evaporation and **prevent the soil from becoming dry**.

Carbon Cycle and Oxygen Cycle

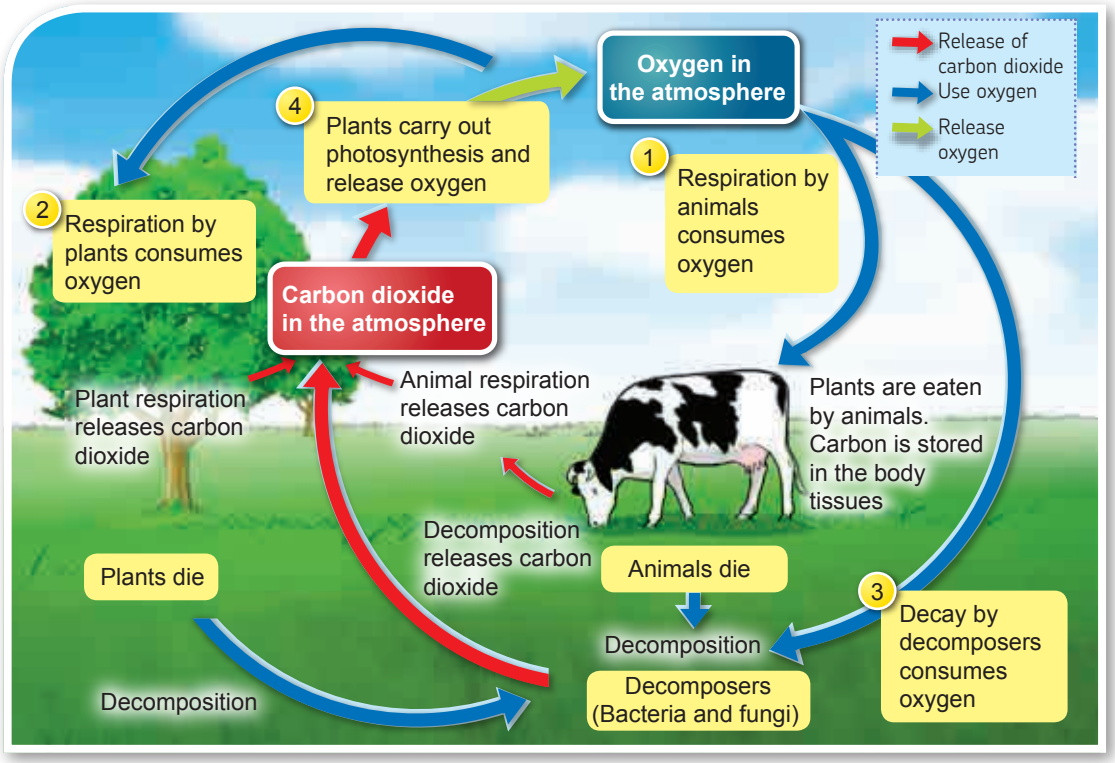


Figure 2.6 *Carbon and oxygen cycles are inter-connected*

The role of living things in the carbon cycle and oxygen cycle

1 2 Plants and animals carry out respiration which uses oxygen and releases carbon dioxide.

3 The decay of dead plants and animals by bacteria and fungi in the soil uses oxygen and releases carbon dioxide.

4 Green plants maintain the content of carbon dioxide and oxygen in the air through photosynthesis which absorbs carbon dioxide and releases oxygen.

Activity 2.2

21st Century

Aim: To create a multimedia presentation that connects the role of living things in the water cycle, oxygen cycle and carbon cycle.

Instruction

1. Work in groups.
2. Design a water cycle, a carbon cycle and an oxygen cycle using multimedia.
3. Predict the effects to the nutrient cycle if the water cycle, oxygen cycle or carbon cycle are affected.
4. Present the multimedia presentation in class.

Steps to Solve Problems when there is an Interference to the Nutrient Cycle

You have learned the role of plants in maintaining the balance of oxygen and carbon dioxide in the atmosphere. Nevertheless, human activities such as **unrestricted logging**, **burning of fossil fuels** and **overconsumption of water resources** for agricultural and domestic purposes have negatively affected the nutrient cycle. Can you think of steps to solve these problems?

Human activities that disrupt the nutrient cycle

Unrestricted logging

Burning of fossil fuels

Overconsumption of water resources

Steps to solve interference to the nutrient cycle

Create planned agricultural systems

Use public transport

Store rain water for daily use

Replant trees

Tighten laws

Photograph 2.1 *Human activities that disrupt the nutrient cycle and steps to solve the problem*

Formative Practice 2.2

1. Name three types of nutrient cycles.
2. Give two processes that change the state of matter in the water cycle.
3. Explain the role of organisms in the carbon cycle and oxygen cycle.
4. Suggest two steps to save water.

2.3 Interdependence and Interaction among Organisms, and between Organisms and the Environment

Before we study the interdependence and interaction among organisms, and between organisms and the environment, let us understand a few important terms first.

1 Habitat

A habitat is the **natural surroundings** or **home** of an organism.

2 Species

A species is a **group of organisms** that have common characteristics and can reproduce to breed offsprings.

3 Population

A population is a **group of organisms** of the **same species** that live in the same habitat.

4 Community

A community is a **few populations** of different organisms that live together in one habitat and have mutual interaction with one another.

Dragonfly

Species

A population of dragon flies

Pond community

5 Ecosystem

An ecosystem is a **few communities** that live together in one habitat and have mutual interaction with one another, including all the non-living components such as water, air and soil.

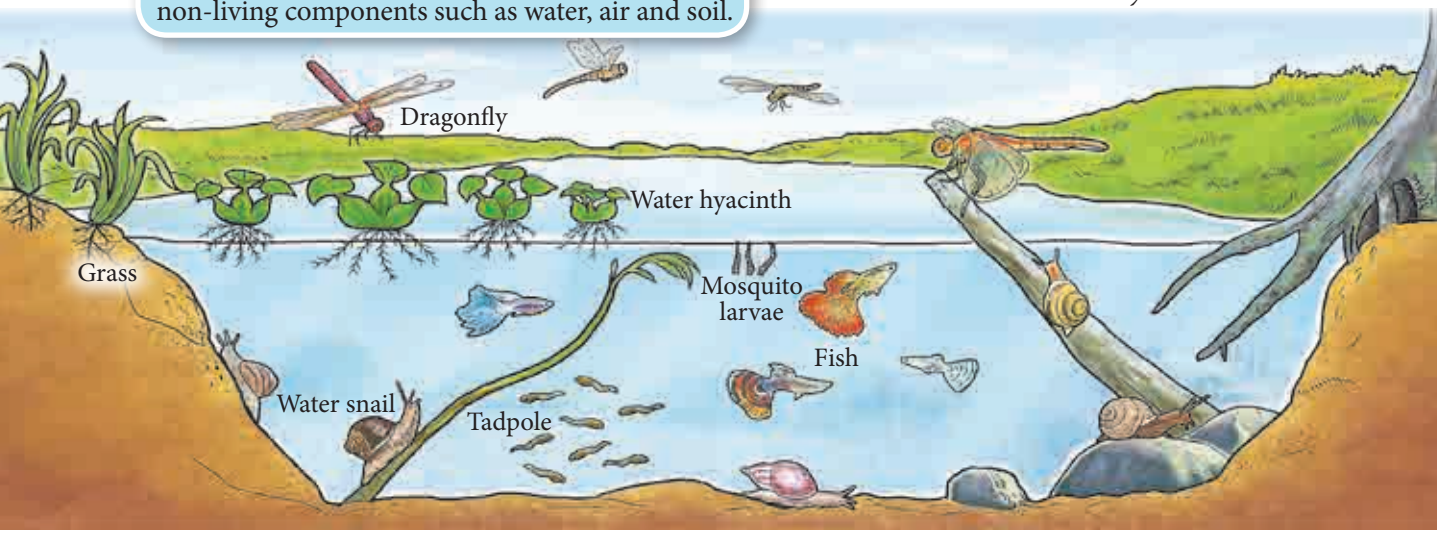


Figure 2.7 *Pond ecosystem*

A Balanced Ecosystem

Organisms in an ecosystem are interdependent on each other to ensure the survival of the species. These organisms are also interdependent on non-living components in the environment such as **water**, **light**, **air** and **soil**.

The interdependence that exists between organisms and their natural surroundings creates a **balanced** ecosystem. An ecosystem is said to be balanced if the living organisms and non-living components in the environment are in a state of harmony without any external interference. Imagine the state of a forest ecosystem if the trees were cut down. Would this ecosystem still be balanced?

Activity 2.3

STEM

Aim: To study the habitats, populations and communities in an ecosystem.

Instruction

1. Work in groups.
2. Find a natural ecosystem in your area.
3. Conduct an observation of that ecosystem.
4. Take photos and list the species, populations and communities of animals and plants that can be found in that ecosystem.
5. Prepare a folio of the information that you have obtained.

Career in STEM

A person who is an expert in the study of ecosytems is called an ecologist.

Questions

1. How do different populations obtain food?
2. How do living organisms interact with their surroundings?
3. What are the benefits that exist from the interaction of organisms and their surroundings?
4. Name an organism and predict what will happen if the population of that organism dies.

Most natural ecosystems are balanced if there is no external interference. Are man-made ecosystems such as aquariums also balanced?

Brain Teaser

Can you name a few other man-made ecosystems?

Photograph 2.2 *Example of a man-made ecosystem (aquarium)*

You have already learned that living organisms are interdependent on one another and also on non-living components to create a balanced ecosystem. What is the effect of these non-living components on the distribution of animals and plants? Let us carry out Experiment 2.1.

Experiment 2.1

Aim: To study the influence of temperature, light and humidity on the distribution of organisms.

A The effect of temperature on the distribution of organisms

Problem statement: What is the effect of temperature on the distribution of woodlice?

Hypothesis: Woodlice are more likely to gather in a place with medium temperature.

Variables:
(a) Constant variables: The number of woodlice, light and humidity
(b) Manipulated variable: Temperature
(c) Responding variable: Distribution of woodlice

Materials: Woodlice, hot water and room temperature water (26°C – 30°C)

Apparatus: Petri dish with partition, Petri dish lid, wire gauze, pliers and stopwatch

Procedure:
1. Pour 20 ml of hot water (50°C) into partition *P* of a Petri dish and 20 ml of room temperature water (26°C – 30°C) into partition *Q* of the same Petri dish.
2. Use a pair of pliers to make a wire gauze mould.
3. Place the wire gauze mould on the Petri dish.
4. Put 10 woodlice on the wire gauze above the Petri dish and cover with the lid (Figure 2.8).
5. Leave the apparatus in an open area in the laboratory for five minutes.
6. Record the number of woodlice found in each partition.

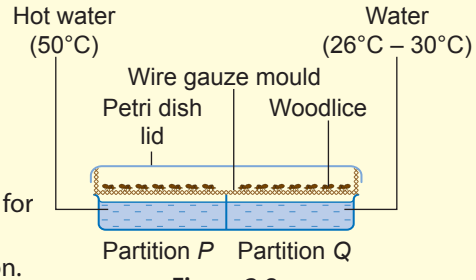


Figure 2.8

Conclusion:
Is the hypothesis accepted? Give your reasons.

B The effect of light on the distribution of organisms

Problem statement: What is the effect of light on the distribution of woodlice?

Hypothesis: Woodlice are more likely to gather in a dark place.

Variables:
(a) Constant variables: The number of woodlice, room temperature and humidity
(b) Manipulated variable: Light
(c) Responding variable: Distribution of woodlice

Material: Woodlice

Apparatus: Petri dish with partition, wire gauze mould, Petri dish lid, black cloth and stopwatch

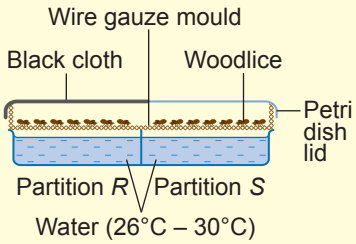


Figure 2.9

Procedure:
1. Pour 20 ml of room temperature water into partition *R* and *S* of a Petri dish with partition.
2. Use the wire gauze mould made in Experiment A.
3. Place the wire gauze mould on the Petri dish.
4. Put 10 woodlice on the wire gauze mould.
5. Cover the Petri dish lid of partition *R* with a black cloth (Figure 2.9).
6. Leave the apparatus in an open area in the laboratory for five minutes.
7. Record the number of woodlice found in each partition.

Conclusion:
Is the hypothesis accepted? Give your reasons.

C The effect of humidity on the distribution of organisms

Problem statement: What is the effect of humidity on the distribution of woodlice?

Hypothesis: Woodlice are more likely to gather in a damp place.

Variables:
(a) Constant variables: The number of woodlice, room temperature and light
(b) Manipulated variable: Humidity
(c) Responding variable: Distribution of woodlice

Material: Woodlice

Apparatus: Petri dish with partition, wire gauze mould, Petri dish lid, anhydrous calcium chloride and stopwatch

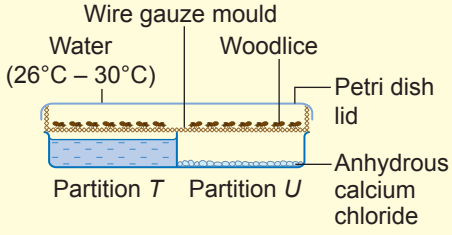


Figure 2.10

Procedure
1. Pour 20 ml of room temperature water (26°C – 30°C) into partition *T* of a Petri dish.
2. Place anhydrous calcium chloride into partition *U* of the same Petri dish.
3. Place the wire gauze mould on the Petri dish.
4. Put 10 woodlice on the wire gauze mould.
5. Cover the Petri dish with the lid (Figure 2.10).
6. Leave the apparatus in an open area in the laboratory for five minutes.
7. Record the number of woodlice found in each partition.

Conclusion:
Is the hypothesis accepted? Give your reasons.

Importance of Adaptation of Living Things to the Environment

Tropical areas receive high distribution of rainfall and sunlight throughout the year. Desert areas experience extreme hot and dry weather. Tundra areas experience long winters and short summers. How does wildlife adapt to the climate of their habitat in tropical, desert and tundra areas?

Photograph 2.3 *Tropical, desert and tundra areas*

Activity 2.4

21st Century

Aim: To carry out multimedia presentation on how animals and plants adapt to the climate of their habitats; in desert, tundra and tropics.

Instruction

1. Work in groups.
2. Each group represents one of the three different areas of habitats; desert, tundra and tropics.
3. Collect materials from a variety of media about the habitat.
4. Discuss the adaptation of animals and plants to the climate in their habitats.
5. Present your results using a multimedia presentation.

Interaction between Organisms

Interaction between organisms comprises **symbiosis**, **prey-predator** and **competition**.

Types of interaction between organisms

- Symbiosis
  - Mutualism
  - Commensalism
  - Parasitism
- Prey-predator
- Competition

Video

Video of Interaction between Organisms and Their Surroundings
http://www.bukutekskssm.my/Science/Video1.mp4

Figure 2.11 *Types of interaction between organisms*

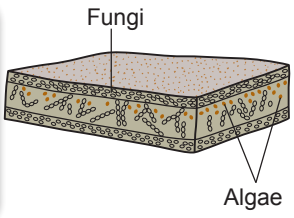
Symbiosis

Symbiosis happens when two or more organisms of different species live closely together and interact with one another. Symbiosis includes **mutualism**, **commensalism** and **parasitism**.

Mutualism

- An interaction that **benefits both organisms**. Photograph 2.4 shows a few examples of mutualism.

- The **sea anemone** protects the clown fish from predators and supplies food to it.
- The **clown fish** cleans the sea anemone and provides nutrients to the sea anemone in the form of waste.



Lichens are algae and fungi that live together.

- The **fungi** supply water and minerals to the algae.
- The **algae** carry out photosynthesis and supply food to the fungi.

Mynah

Buffalo

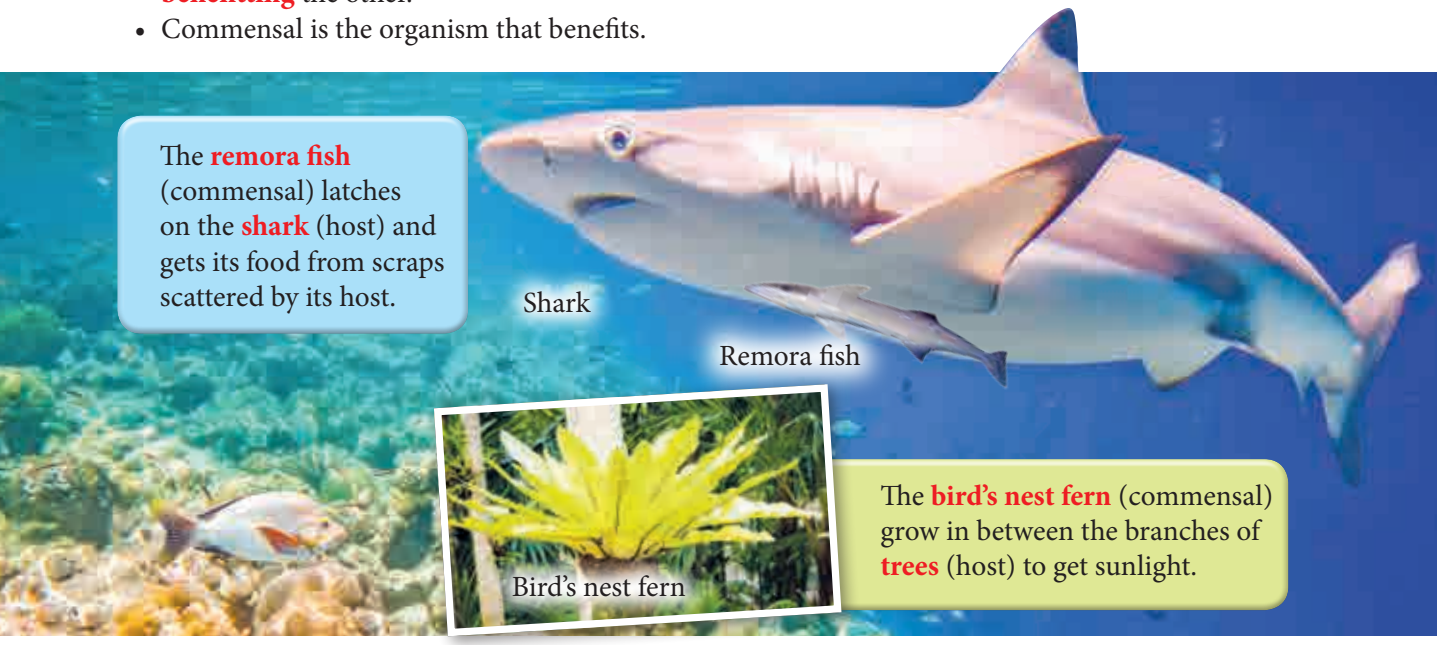
- The **mynah** gets food from the buffalo by eating the lice that stick to the body of the buffalo.
- The body of the buffalo is free of lice.

Photograph 2.4 *Examples of mutualism*

2.3.3

Commensalism

- The interaction between two organisms which only benefits **one organism without harming** or **benefitting** the other.
- Commensal is the organism that benefits.



Photograph 2.5 *Examples of commensalism*

Parasitism

- An interaction that benefits **one organism** only and **harms** the other.
- Parasite is the organism that benefits.
- Host is the organism that is harmed.

Photograph 2.6 *Examples of parasitism*

Prey-predator

- Involves one organism that **eats** another organism.
- Prey is the organism that is eaten by the predator.
- Predator is the organism that hunts another organism for food.

Photograph 2.7 *Examples of prey-predator*

Competition

- Competition happens when organisms in one habitat **compete** for **limited supply of basic needs** such as light, space, water, food and mates.

Competition to get food

Competition to get mate to reproduce

Photograph 2.8 *Examples of competition*

Biological Control

Biological control is a method that uses organisms that are natural predators, parasites or pathogens to reduce the number of pests in an area. Photograph 2.9 shows examples of biological control that are used in the agricultural sector in Malaysia.

Photograph 2.9 *Examples of biological control in Malaysia*

Biological control is **more environmental friendly** because it does not use pesticides or chemicals. Apart from this, this method is usually **cheaper** and **does not affect humans' health**. Nevertheless, this method has a few weaknesses such as:

- it **takes a long time** before any effect is seen.
- the **balance of the ecosystem** might be **disrupted** because a new species is introduced into that ecosystem.

Factors that Influence Population Size in an Ecosystem

How does population size change in an ecosystem? Among the factors that cause population size to change is **disease**, **the presence of predators**, **source of food** and **change of weather**.

Disease

The population of animals and plants decreases when a disease strikes. For example, avian flu in poultry-rearing areas and tobacco mosaic virus in tobacco crops.

Photograph 2.10 *Poultry affected by a disease*

Photograph 2.11 *Tobacco crops struck by a disease*

Presence of predators

The population size of a living organism is influenced by the population size of its predator. For example, the size of the zebra population in the savanna ecosystem decreases with the presence of its predators such as the lion.

Photograph 2.12 *Zebra being eaten by a lion*

Source of food

If a food source decreases, animals can be threatened by extinction. For example, panda depends on bamboo as its primary food source. Clearing of forests has caused the destruction of its food source and habitat.

In Malaysia, the crow population has increased due to the abundance of food scraps.

Photograph 2.13 *Panda*

Photograph 2.14 *Crow*

Change of weather

Droughts cause soil to become dry and infertile and increase the risk of forest fires. As a result, the population of plants and animals decreases.

Photograph 2.15 *Soil becomes dry and infertile*

Photograph 2.16 *Forest fires resulting from a long drought*

Changes in the Ecosystem

Changes in the ecosystem such as limited water supply, animal migration and decrease or increase in population size can upset the balance between populations.

Limited water supply

- Paddy is a plant that requires a lot of water.
- If there is a long drought season, this change in the ecosystem will **upset the balance between populations** in the paddy field.
- The food web will be affected because the population of the producer, which is paddy, decreases.

Photograph 2.17 *Insufficient water supply disrupts the ecosystem of a paddy field*

Migration

Photograph 2.18 *Cattle egret which migrates to Kuala Gula, Perak*

- The ecosystem can also change because of animal **migration**, moving from one place to another due to a change of season.
- For example, the **cattle egret** (*Bubulcus ibis*) migrates to Kuala Gula, Perak from September to April every year. As a result, the number of insects such as grasshoppers, crickets, spiders, flies and worms decreases as they are eaten by the egrets.

Photograph 2.19 *Overpopulation of beetles destroys crops*

Change in population size

- The **size of a population** can decrease or increase because of changes in another population.
- For example, the increase of pests such as beetles and caterpillars causes the population of plants to decrease.

Science Info

In 2015, the southern region of Russia was attacked by locusts which destroyed crops. Cornfields as wide as 800 hectares were destroyed in just a few hours.

Formative Practice 2.3

1. Fill in the boxes using the choice of answers given.

Habitat | Population | Ecosystem | Community

(a) A group of goats in a grass field.

(b) A small pond that has lotus plants, grass, a group of tadpoles, a few fish, ducks and frogs.

(c) A grass field that becomes the living place of a group of goats.

(d) A tropical rainforest where there are a variety of plants and animals that are interdependent on one another.

2. Based on the situation below, state the kind of interaction that happens between these living organisms.

Situation	Type of interaction
(a) Two roosters fight to get a mate to reproduce	
(b) A cucumber plant wraps around the branch of a papaya tree	
(c) A rafflesia flower grows on the branch of a live tree	

2.4 Role of Humans in Maintaining a Balanced Nature

Nature is threatened by destruction because of human activities. As such, humans are responsible for conserving and maintaining the balance of nature.

Table 2.1 *Effects of human activities on the environment*

Activity	Effects
Forest logging	• Extinction of flora and fauna species • Soil erosion • Greenhouse effect
Industrialisation	• Pollution of air, water and soil • Acid rain • Greenhouse effect
Agriculture	• Pollution of water due to overuse of pesticides and fertilisers • Soil loses minerals due to non-sustainable agriculture
Waste disposal	• Pollution of water and ground • Foul odour due to decaying organic waste matter • Flash floods

Steps to solve the effects of human activities on the environment

- **Enforce laws**
  The Forestry Department is always conducting law enforcement activities in all states. For example, carrying out patrols in the forest area, using helicopters and having road blocks to monitor the movement of timber-carrying lorries.

- **Increase public awareness**
  In schools, students are instilled with good values through Moral Education to appreciate the balance of nature. These good values are also instilled through mass media such as newspapers, radio and television.
- **Practise Refuse, Reduce, Reuse, Recycle, Repurpose (5R)**
  The practice of **refuse** (not to use non-recyclable materials), **reduce** (reduce the number of materials to use), **reuse** (reuse the materials), **recycle** (recycle materials) and **repurpose** (use the materials for other uses) can reduce the waste materials.
- **Use biological control**
  Avoid the use of pesticides that pollute the air and soil by carrying out biological control in agriculture.

Activity 2.5

STEM 21st Century

Aim: To carry out a role play to discuss the importance of humans to manage and ensure the sustainability of life.

Career in STEM

An environmental consultant cares for the environment from a science and technology aspect to make it sustainable.

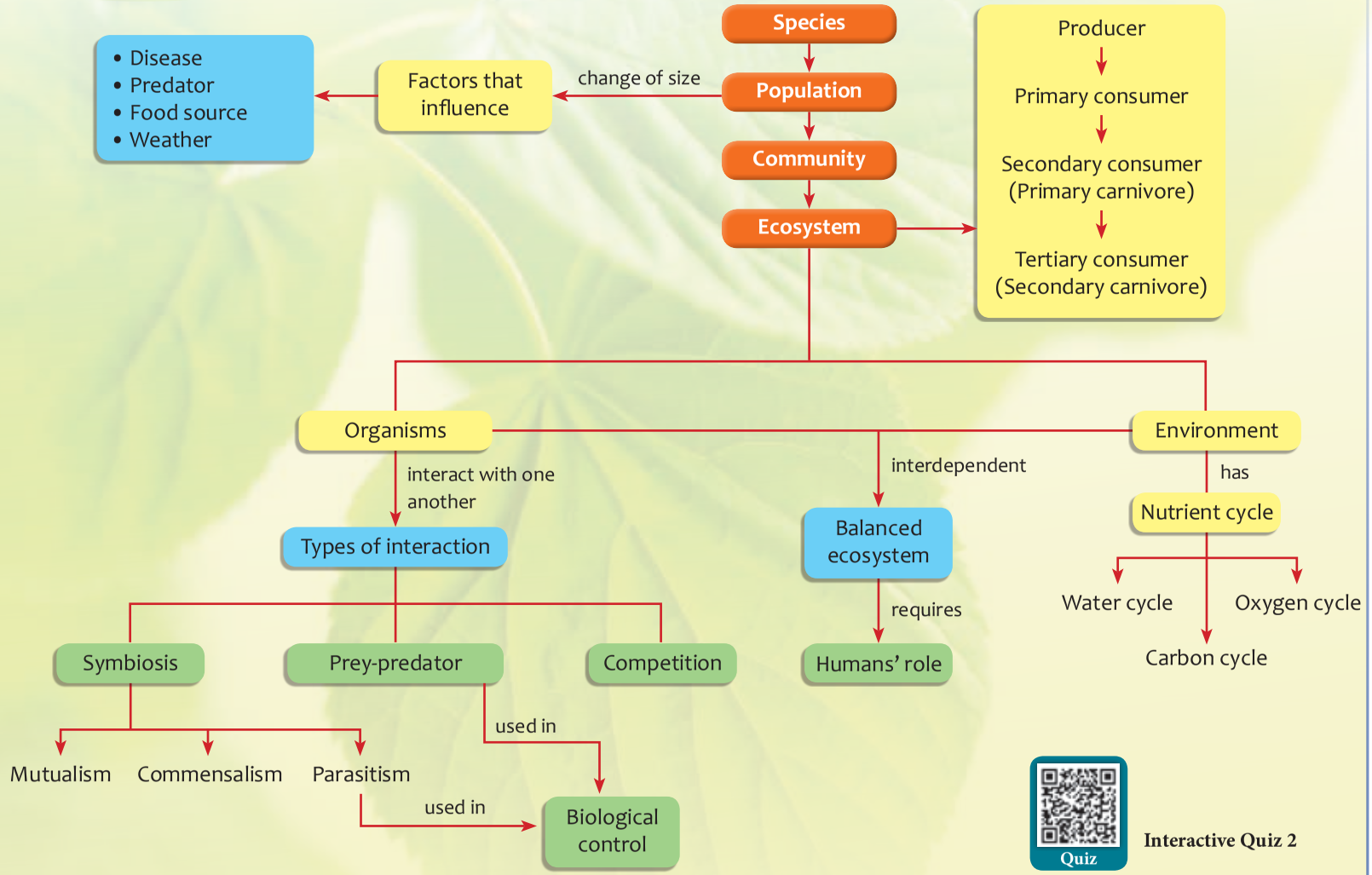
Instruction

1. Work in groups.
2. Each group has to choose one of the following environmental issues in Malaysia:
   (a) waste management system
   (b) flood dam project
   (c) forest management
   (d) haze
3. Identify several agencies or stakeholders and public to solve the selected environmental issue.
4. Organise a forum to discuss:
   (a) the cause of the environmental issue
   (b) the effect of the evironmental issue on the local community
   (c) solutions for the issue
5. Each group member must represent the roles of agencies, stakeholders and the public in the forum.

Formative Practice 2.4

1. List four human activities that can destroy the ecosystem.
2. State two effects for each of the following activities to the balance of nature.
   (a) Deforestation
   (b) Industrialisation
   (c) Agriculture
   (d) Waste disposal
3. Mr. Lim wants to start a sustainable oil palm plantation. In your opinion, how can Mr. Lim control the rat population that frequently destroys crops?
4. Haze happens more frequently in our country. State:
   (a) the cause of haze
   (b) the effects of haze on people and the environment
   (c) the steps to be taken to avoid haze from happening
5. Give two reasons why humans need a balanced ecosystem.

Summary



Quiz

Interactive Quiz 2

SELF-REFLECTION

After learning this chapter, you are able to:

2.1 Energy Flow in an Ecosystem

- ☐ Explain through examples; producer, consumer and decomposer.
- ☐ Interpreting food chains and food webs.

2.2 Nutrient Cycle in an Ecosystem

- ☐ Elaborate and communicate the role of living things in oxygen and carbon cycles in an ecosystem.
- ☐ Justify the role of organisms in water cycle in an ecosystem.
- ☐ Solve problems when there is an interference to the cycles due to human activities.

2.3 Interdependence and Interaction among Organisms, and between Organisms and the Environment

- ☐ Explain through examples interdependence among living things and the environment in maintaining a balanced ecosystem.
- ☐ Justify the importance of adaptation of living things to the environment.
- ☐ Communicate through examples the interaction between organisms and apply these interactions in daily life.
- ☐ Separate the factors that affect the size of population in an ecosystem.
- ☐ Predict how the changes in ecosystem affect resources and balance of population.

2.4 Role of Humans in Maintaining a Balanced Nature

- ☐ Justify and communicate why humans need a stable and productive ecosystem for the sustainability of life.

Summative Practice 2

1. Based on the food web in Figure 1, answer the following questions.

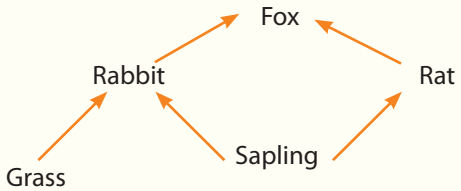


Figure 1

(a) Construct all the food chains from the food web in Figure 1.

(b) Why is grass categorised as a producer?

(c) If a flea lives on the body of a rabbit and sucks its blood, what type of interaction occurs between the flea and the rabbit?

(d) Predict what will happen if the population of fox in that area caught a disease.

2. City X is well-known as a rat-breeding area.

(a) State the effects of the high rat population on the inhabitants of City X.

(b) In your opinion, what is the cause of the high rat population in City X?

(c) Suggest two steps to solve the issue of rat-breeding that can be taken by:

(i) the authorities (ii) the inhabitants

3. Shikin and Azah have different opinions about producers and decomposers. Their opinions are as follows.

Shikin : Producers can still live without decomposers because producers can make their own food.
Azah : If there are no decomposers, producers cannot get enough nutrients. The producers could die.

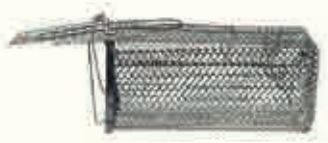
Give your view on Shikin and Azah's opinion.

4. Razak found that many of his chickens were eaten by Hawk-Eagles. Razak made a decision to shoot all the eagles. After a year, the rat population increased and ate all the chicken feed. This caused chickens to die. Explain the cause for the increase in the rat population and suggest a way Razak can prevent this from happening.

HOTS Mastery 2

5. An urban or city forest is an area that is planted with trees all around the city. Justify the idea of a city forest in terms of preserving a balanced ecosystem.

6. Photograph 1 shows a common rat trap sold in stores. This trap can only catch one rat at one time. Design a rat trap model that can catch more than one rat at one time. Sketch and explain your design.



Photograph 1

Chapter 3

Nutrition

What kind of food gives us energy?

How do the energy needs of one individual differ from another individual?

What happens to the food that we eat?

Let's understand:

- Classes of food
- Importance of a balanced diet
- Human digestive system
- Process of absorption and transportation of digested food and defecation

SCIENCE BLOG

Astronaut Food

Malaysia's first astronaut, Dato' Dr. Sheikh Muszaphar Shukor was flown to the International Space Station (ISS) on 10th October 2007.

In relation to that, Malaysian Agricultural Research and Development Institute (MARDI) was tasked with carrying out a research about food for astronauts while they were in space.

According to the research carried out, the salt content in food decreases in space. Therefore, the research was done numerous times until it produced appetising, delicious and nutritious food in space.

Then, the food produced was sent to Russia to undergo various tests before getting approval. The food prepared was stored in air-tight plastic containers and was frozen to avoid spoilage.

Keywords

- Carbohydrate
- Protein
- Fat
- Vitamin
- Mineral
- Fibre
- Balanced diet
- Digestion
- Absorption
- Oesophagus
- Small intestine
- Large intestine
- Rectum
- Anus
- Defecation

3.1 Classes of Food

What is your daily diet? Is it nutritious and energy-giving? Food not only supplies energy but also gives nutrients to maintain our health.

Nasi lemak Satay

Photograph 3.1 *Food is a basic need for humans*

Our food is divided into seven main classes; **carbohydrate**, **protein**, **fat**, **vitamin**, **mineral**, **fibre** and **water** (Figure 3.1). Each food class has a specific function. Can you identify the food classes that are shown in each food item in Photograph 3.1?

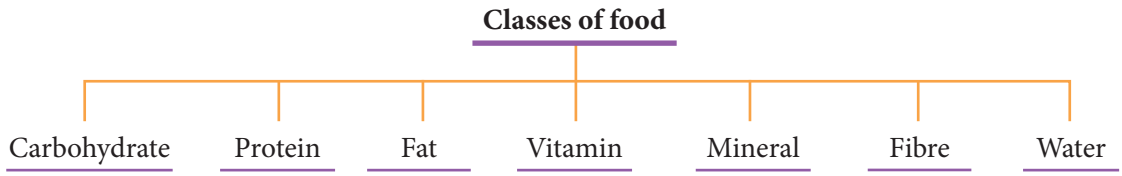


Figure 3.1 *Classes of food*

Carbohydrate

Carbohydrate is an organic compound that contains **carbon**, **hydrogen** and **oxygen**. Carbohydrate is a staple for humans because it **supplies a lot of energy**. Examples of carbohydrate are **starch**, **glycogen** and **cellulose**. Starch is the food stored in plants, whereas glycogen is the **food stored** in animals. Cellulose is the carbohydrate that **forms the cell walls** of plants.

Science Info

Some sources of carbohydrate, such as sugar supply energy quickly.

Photograph 3.2 *Sources of carbohydrate*

Protein

Protein is a food substance that contains **carbon**, **hydrogen**, **oxygen** and **nitrogen**. Proteins we eat are digested to the basic unit, that is, **amino acid**. Protein is required for **growth** and to **repair damaged tissues** in the body as well as to **replace dead cells**. Apart from that, protein is also used to **synthesise enzymes**, **hormones** and **antibodies**. Photograph 3.3 shows a few sources of protein.

Science Info

Kwashiorkor is a kind of disease caused by protein deficiency in human diet and it generally occurs in children aged between 1 and 3 years.

Photograph 3.3 *Sources of protein*

Fat

As in carbohydrate, **fat** contains **carbon**, **hydrogen** and **oxygen**. Fat is formed from **glycerol** and **fatty acid**.

Fat is a **high energy source** and **storage**. Each gramme of fat supplies two times the total energy supplied by carbohydrates. Fat **protects the organs** of the body such as the heart and kidneys. Apart from that, fat acts as a **transporter** for vitamin A, D, E and K. Excess fat in the body is stored under the skin as a **heat insulator** to regulate body temperature.

Science Info

Fat from animals contains higher cholesterol than fat from plants.

Butter

Coconut oil

Palm oil

Groundnuts

Photograph 3.4 *Sources of fat*

Vitamin

Vitamin is an organic compound that does not supply energy, but is needed by the body in small quantities to **maintain good health**. Vitamins can be classified as **water-soluble vitamins** and **fat-soluble vitamins** (Figure 3.2). We obtain vitamins from vegetables, fruits, milk and meat. Table 3.1 shows the types, sources, importance and effects of vitamin deficiency.

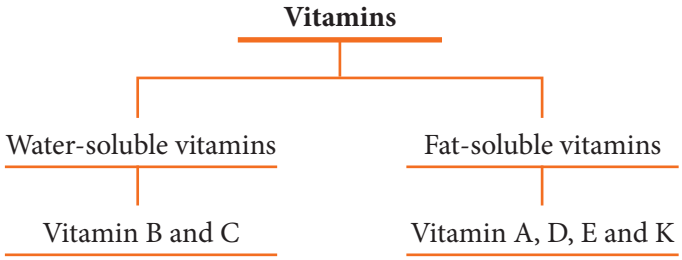


Figure 3.2 *Classification of vitamins*

Milk

Meat

Fruits

Vegetables

Photograph 3.5 *Sources of vitamins*

Table 3.1 *Type, source, importance and effects of vitamin deficiency*

Vitamin	Source	Importance	Effects of deficiency
A	milk, egg yolk, fish oil	• Helps with night vision • Maintains skin health	• night blindness • skin diseases
B	yeast, liver, eggs	• Maintains the functions of the nervous system • Formation of red blood cells	• Beri-beri • Anaemia
C	fruits, vegetables	• Fights diseases • Maintains the health of gums and mouth	• Scurvy (bleeding gums)
D	butter, eggs, fish oil, also produced through sun exposure	• Helps in the absorption of calcium • Strengthens tooth enamel • Maintains skin health	• Rickets • toothache • skin diseases
E	grains, green vegetables	• Maintains the functions of reproductive system	• sterility • foetus miscarriage
K	milk, egg yolk, fish oil	• Speeds up the blood-clotting process	• prolonged bleeding

Fibre

Fibre is a substance that cannot be broken down by the digestive system. Fibre comprises of **cellulose** that is found in the cell wall of plants.

Fibre is very important to **stimulate peristalsis**, that is, the movement caused by the constriction and relaxation of the muscles along the digestive tract such as oesophagus, small intestine and large intestine. This makes it easier for food to move along the digestive tract and prevents constipation.

High fibre bread

Vegetables

Grains

Photograph 3.6 *Sources of fibre*

Mineral

Mineral is a non-organic substance required by the body. Minerals do not supply energy, but are required in small quantities to regulate body processes to maintain health. Table 3.2 shows a variety of minerals, their importance and effects of deficiency.

Salt

Seafood

Photograph 3.7 *Sources of mineral*

Table 3.2 *Types, sources, importance and effects of mineral deficiency*

Mineral	Source	Importance	Effects of deficiency
Calcium	milk, anchovies, prawns, green vegetables	• Helps with blood-clotting • Strengthens bones and teeth	• Rickets • Osteoporosis
Sodium	salt, meat, eggs	• Maintains the functions of the nervous system	• muscle cramps
Iron	liver, meat	• Builds haemoglobin in the blood	• Anaemia
Iodine	seafood, fruits	• Helps with the funcions of thyroid gland	• Goiter
Phosphorus	cheese, meat, eggs, vegetables	• Strengthens bones and teeth • Forms nucleic acid in DNA and RNA	• Rickets • brittle teeth • cannot build DNA and RNA
Potassium	plants and animals	• Helps with muscle contraction • Maintains the functions of nervous system	• paralysis • muscle cramps

Water

Water is a compound that is very important to our body. Water contains elements of **hydrogen** and **oxygen**. Water acts as a **chemical solvent** and a **transportation medium** of nutrients and oxygen into the cells. It transports waste materials such as urea and salt out of the cells and **regulates body temperature** through evaporation of sweat.

Fruit juice

Watermelon

Photograph 3.8 *Sources of water*

Activity 3.1

Aim: To test for the presence of starch, glucose, protein and fat.

Materials: Iodine solution, 1% starch suspension, Benedict's solution, 10% glucose solution, Millon's reagent, albumen suspension, ethanol, cooking oil and distilled water

Apparatus: Test tube, dropper, beaker, Bunsen burner, wire gauze, tripod stand, test tube holder, stopper and test tube rack

A Iodine test for starch

Instruction

1. Pour 2 ml of starch suspension into a test tube.
2. Add two drops of iodine solution into the test tube (Figure 3.3).
3. Record your observations.

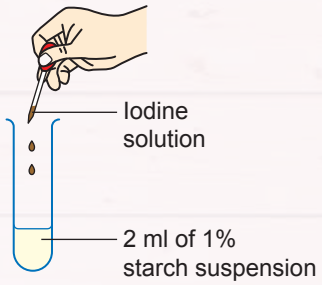


Figure 3.3

B Benedict's test for glucose

Instruction

1. Pour 2 ml of glucose solution into a test tube.
2. Add 2 ml of Benedict's solution into the test tube and shake it to mix the solutions.
3. Heat the test tube in a water bath for 5 minutes (Figure 3.4).
4. Record your observations.

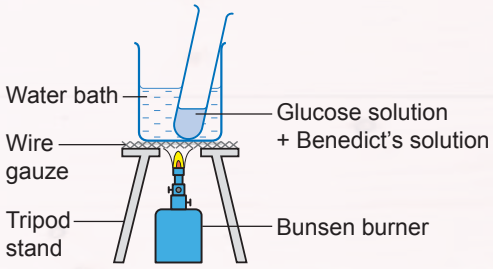


Figure 3.4

Science Info

Benedict's test is used to test the presence of reducing sugars. Examples of reducing sugars are glucose, maltose, galactose and fructose.

C Millon's test for protein

Instruction

1. Pour 5 ml of albumen suspension into a test tube.
2. Add two to three drops of Millon's reagent into the test tube (Figure 3.5 (a)). Then, shake the test tube to mix the solutions.
3. Heat the test tube in a water bath for 5 minutes (Figure 3.5 (b)).
4. Record your observations.

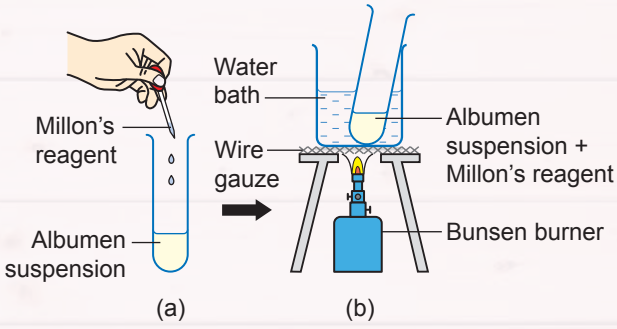


Figure 3.5

D Alcohol-emulsion test for fat

Instruction

1. Pour 3 ml of ethanol into a test tube.
2. Add 2 to 3 drops of cooking oil into the test tube (Figure 3.6 (a)). Then, close the test tube with a stopper.
3. Shake the test tube slowly and leave it in a test tube rack for 2 to 3 minutes.
4. Place 4 to 5 drops of the mixture from the test tube into another test tube filled with 20 ml of distilled water (Figure 3.6 (b)).
5. Close the test tube with the stopper and shake slowly. Leave the test tube in the test tube rack for 2 to 3 minutes.
6. Record your observations.

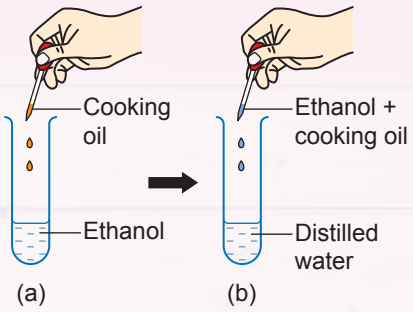


Figure 3.6

Safety Precaution

Ethanol is flammable. Please keep it away from fire.

Observation

Activity	Observation
A	
B	
C	
D	

Questions

1. Why is the heating in the Benedict's is test and Millon's test carried out in a water bath?
2. You are given a food sample in powder form. How do you determine the food class of the food sample?
3. What are the inferences you can make from each of the activity above?

Formative Practice 3.1

1. Name the food class based on the functions given.

Food class	Function
(a)	Regulates body temperature
(b)	Heals damaged body tissues
(c)	Required for energy
(d)	Protects from diseases

2. Name the diseases caused by deficiencies of the following vitamins.
   (a) Vitamin A (c) Vitamin C
   (b) Vitamin B (d) Vitamin D
3. State the effects to our health caused by deficiencies of the following minerals.
   (a) Iodine (b) Iron (c) Phosphorus

3.2 Importance of a Balanced Diet

What is meant by a balanced diet?

A **balanced diet** is a diet that contains all the food classes in the right quantities that are required by the body.

My Science World

Science Info

The "Healthy Plate" model has been prepared by the Ministry of Health Malaysia as a guide to practise a balanced diet.

Info

'Heathy Plate' Model
http://www.moh.gov.my/index.php/pages/view/84

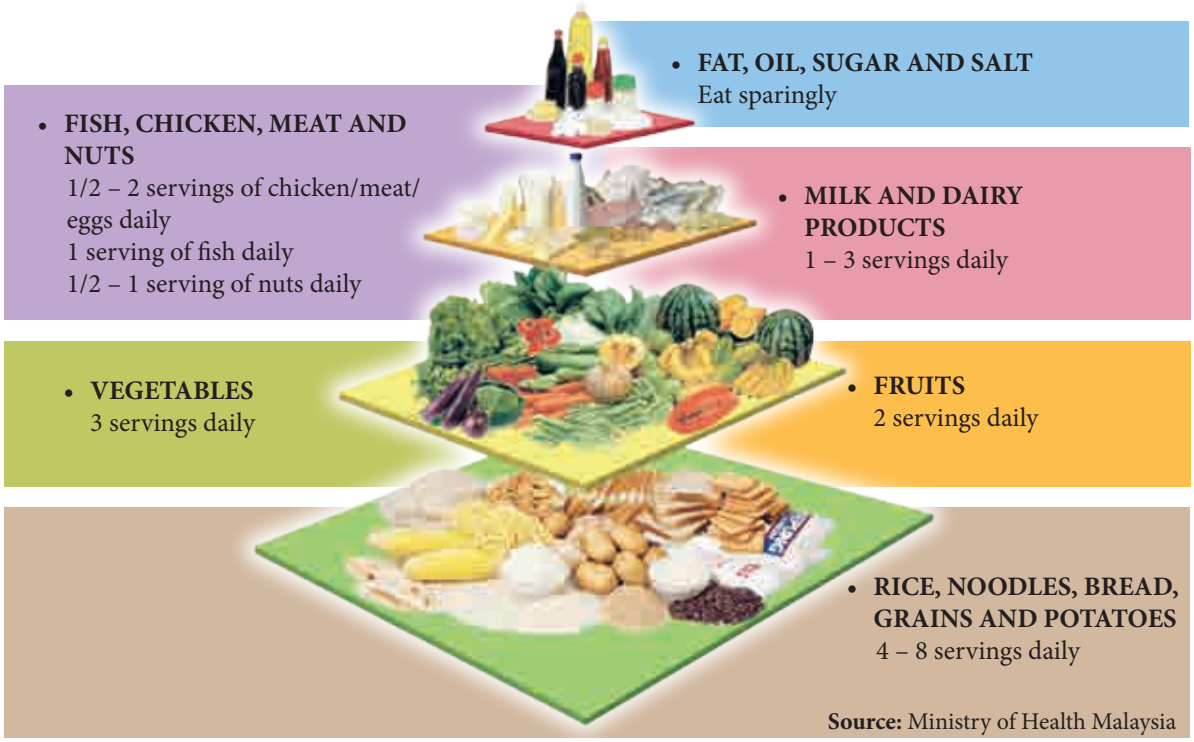


Figure 3.7 *Food pyramid*

Factors that Influence Calorific Requirement

Body size

A person with a large body frame needs to take a bigger portion of food because he or she needs to have more energy compared to someone with a smaller frame.

Age

Children and teenagers require more carbohydrates for energy and protein for growth because they are growing and are more active compared to adults.

Work

Farmers, labourers and fishermen require more energy because they do heavy work. Therefore, their diet requirements are higher compared to people who work in an office.

Gender

Generally, men are more muscular and they do more heavy activities. Therefore, they need bigger food portions than women.

State of health

People who are sick are weak. They require food suitable to their health condition.

Climate

People who live in cold climate countries lose heat quickly to their surroundings compared to people who live in hot climate countries. Therefore, they need more food to maintain their body temperature.

Figure 3.8 *Factors that influence a calorific requirement*

Calorific Value of Food

Food contains some basic classes, such as **carbohydrate**, **protein** and **fat**. All of these basic classes produce different quantities of energy when burned. The total amount of energy released when 1 g of food is burned completely in the body is called **energy value** or **calorific value**. This total energy is measured in units of **calorie (cal)** or **joule (J)**.

Table 3.3 *Energy value of fat, protein and carbohydrate*

Food class	Energy value	
	(kJ / g)	(kcal / g)
Fat	37	9
Protein	17	4
Carbohydrate	17	4

1 calorie (cal) = 4.2 joule (J)
1 kilocalorie (kcal) = 4.2 kilojoule (kJ)

You have learnt about the calorific value of food. Can you estimate the calorific value of the food in your daily meals? Let's do Activity 3.2.

Activity 3.2

STEM

Aim: To estimate the calorific value of food.

Instruction

1. List the breakfast menu of your friends in class.

   Example of a breakfast menu:

Fried rice

Banana

Milk

2. Estimate the calorific value for each of your classmates' menu items. You can scan the QR code given to know the calorific value of the food.

   Example of the calculation:

Food	Quantity	Calorific value (kcal)
Fried rice	1 plate (330 g)	640
Banana	2 pieces (120 g)	60 × 2 = 120
Milk	1 glass (250 ml)	130

   The total calorific value for the breakfast consumed is 890 kcal

3. Find out whose breakfast has the highest and lowest calorific values.

Info

Calorific Value of Food
http://www.moh.gov.my

Career in STEM

A dietitian gives advice in terms of evaluating the status of an individual's diet before recommending a suitable diet.

Activity 3.3

Aim: To collect information on calorific value of food.

Instruction

1. Work in groups.
2. Each group is required to collect 2 food labels that show the food calorific value (Figure 3.9).

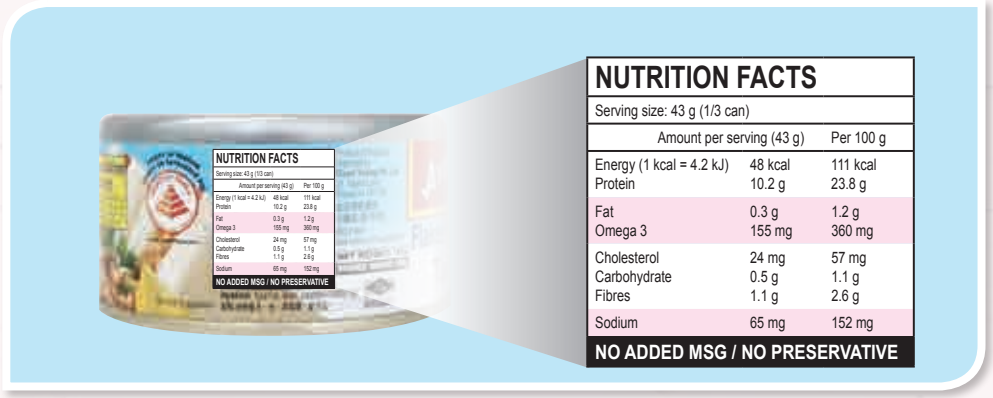


Figure 3.9

3. Fill in the calorific value of food found on the food labels in a table like the one below:

Food	Class of Food	Per 100 g	Calorific value (kJ)
Canned food	Carbohydrate		
	Protein		
	Fat		
	Carbohydrate		
	Protein		
	Fat		

4. Discuss the following things:
   (a) which food has the lowest and highest calorific values?
   (b) what other nutrients are printed on the food labels apart from carbohydrate, protein and fat?

Planning a Balanced Diet

Have you ever planned a balanced diet based on your calorie and nutrient requirements? As we have learnt, factors such as size of body frame, age, work, gender, health condition and climate influence the calorie and nutrient needs of a person.

Brain Teaser

If you are required to plan a menu for astronauts, what food would you recommend?

Activity 3.4

Aim: To plan a balanced meal for a day based on different factors.

Instruction

1. Work in groups.
2. Each group is required to prepare a menu for breakfast, lunch and dinner for one of the following individuals:
   - Individual A: a man who works as a bank officer
   - Individual B: a man who works as a construction worker
   - Individual C: a pregnant woman
   - Individual D: a school girl who is active in sports
3. Determine the quantity required for each food menu.
4. Total the calorific values consumed in one day.
5. Produce the planned menu according to your group's creativity.

Questions

1. What class of food appears the most in the food menus?
2. State the factors that were considered when planning the daily menu.
3. Which individual's meal has the highest calorific value?

The Importance of Maintaining Health

According to the research results of the National Health and Morbidity Survey (2016), the percentage of Malaysians with diabetes is 17.5%, high blood pressure is 30%, high cholesterol is 47%, obesity is 17% and overweight is 40%. This problem shows the improper diet and lifestyle of Malaysians. Activities to create awareness should be carried out more actively at school level.

Activity 3.5

Aim: To create awareness and emphasise the importance of maintaining a healthy body.

Instruction

1. Work in groups.
2. Collect information on:
   (a) heart diseases
   (b) high blood pressure
   (c) diabetes
   (d) skin cancer
   (e) lung cancer
3. Prepare a poster about the causes of these diseases and steps that can be taken to prevent them.
4. Put up the three best posters on the science notice board in your class.

We need to practise a healthy lifestyle such as eating food with less sugar, salt, oil and fat. Besides, we need to exercise and should not smoke to maintain our health and to reduce the risk of dangerous diseases.

The existence of various high-calorie foods has caused more people to be categorised as obese. Obesity is a problem that not only has a negative effect on the appearance of an individual, but also destroys health without considering age or background.

Science Info

The research results of the National Health and Morbidity Survey 2016 shows that only six percent of Malaysian adults eat enough fruits and vegetables. Thus, the Ministry of Health Malaysia launched the Eat Fruits and Vegetables Campaign.

Photograph 3.9 *Balanced diet can maintain health*

Science Info

Body Mass Index (BMI) is a formula that calculates body mass against height. We can evaluate our body mass index after calculating the BMI.

$$\text{Calculation of Body Mass Index (BMI)} = \frac{\text{Mass (kg)}}{\text{Height (m)} \times \text{Height (m)}}$$

Scan the QR code below for the Classification of Body Mass Index (BMI) for male and female students aged 9 – 17 years.

Info

Classifying BMI
jpnpahang.moe.gov.my

Activity 3.6

Aim: To study the obesity problem among school children and suggest ways to overcome it.

Instruction

1. Conduct a study on the obesity problem among students in your school.
2. You need to study:
   (a) the relationship between eating processed and junk food and the problem of obesity
   (b) ways to solve the problem at school level
3. Write the results of your study in the form of a folio.

Formative Practice 3.2

1. What is meant by a balanced diet?
2. State the factors that influence calorific requirement.
3. Compare the energy requirements of a 50-year-old woman and 50-year-old man.
4. Give the definition for calorific value of food.
5. Suraya is a long-distance runner. She has breakfast as shown in the photographs below before going for a practice session. What is the calorific value of the food consumed by Suraya? In your opinion, has Suraya taken a balanced meal?

A plate of nasi lemak (400 kcal)

A cup of cornflakes (160 kcal) and a cup of milk (130 kcal)

An apple (60 kcal)

6. Mr. Robert originates from Switzerland and now lives in Malaysia. Mr. Robert works as a diplomatic officer. He finds that his daily food requirements are less compared to when he was in Switzerland. Why?

3.3 Human Digestive System

What happens in our body after we eat? How is food like the watermelon in Photograph 3.10 digested? Let us learn about the process of food digestion.

Photograph 3.10

Food digestion is the process of breaking down food that is complex and large into molecules that are small, simple and soluble so that they can be absorbed by the cells of the body.

Digestion

Physical

- The process of breaking down food into smaller particles in the mouth with the help of teeth, tongue and saliva.
- Involves peristalsis.

Chemical

- The process of breaking down food from complex molecules into simple molecules with the help of enzymes.

Science Info

Enzyme is a substance in the body that speeds up chemical digestion.

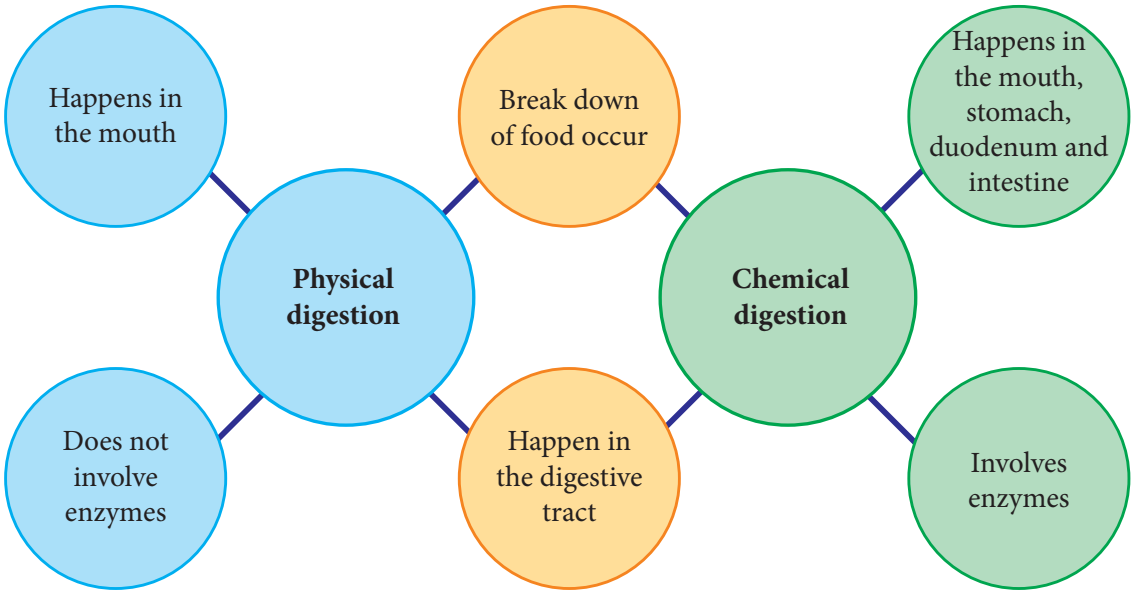


Figure 3.10 *Comparison between physical digestion and chemical digestion*

The Structure of the Human Digestive System

What are the organs that are involved in the human digestive system? The human digestive system comprises a tube that is called the digestive tract and a few other organs such as the liver, gall bladder and pancreas. The digestive tract is a long tube that begins in the mouth and ends at the anus.

Brain Teaser

If a digestive tract is 9 m long, how does the tract fit into a body that is 1.5 m in height?

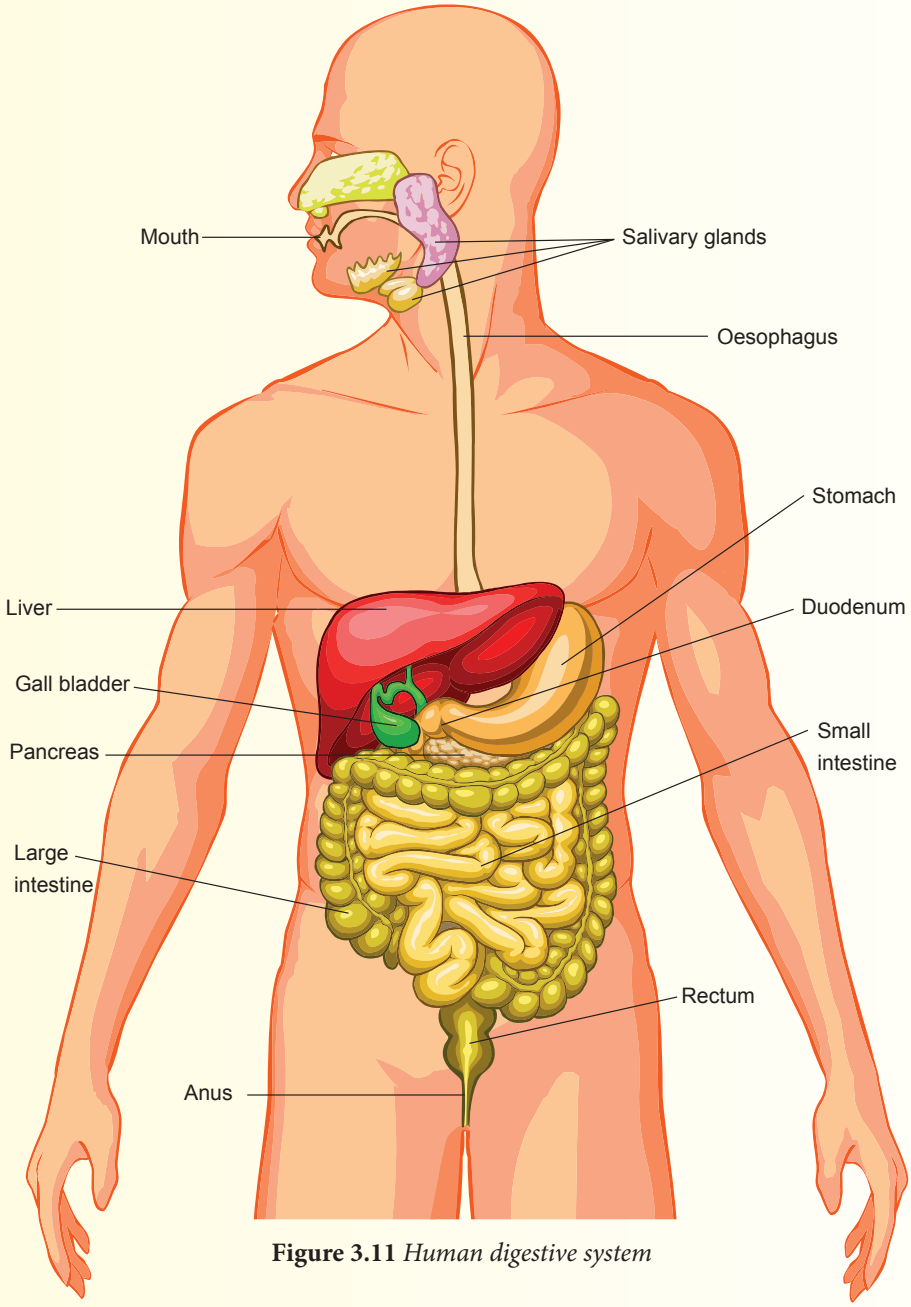


Figure 3.11 *Human digestive system*

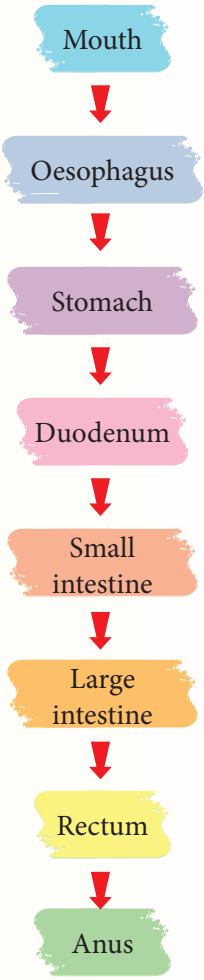


Figure 3.12 *The flow of food particles*

The Flow of Food in the Digestive Tract

What happens when food passes through each organ in the digestive tract?

1 Mouth

- Food is chewed by the teeth.
- Particles of food are softened by saliva.
- **Salivary amylase** in saliva breaks down **starch** into **maltose**.

Animation of Flow of Food

2 Oesophagus

- Food that enters the oesophagus is called **bolus**.
- The **process of peristalsis** at the wall of the oesophagus pushes the food into the stomach.

3 Stomach

- Walls of the stomach secrete **protease** and **hydrochloric acid**. Hydrochloric acid activates the protease and kills bacteria in the food that enters the stomach.
- Protease breaks down **protein** into **polypeptides**.
- Food that is semi-liquid is called **chyme**.

4 Duodenum

- Food enters the first part of the small intestine, that is, the duodenum.
- The liver produces bile that is stored in the gall bladder.
- The bile emulsifies fat into small droplets and neutralises the acid in the chyme.
- The pancreas produces pancreatic juice which contain enzymes amylase, protease and lipase.
- **Pancreatic amylase** digests **starch** into **maltose**.
- **Protease** digests **polypeptides** into **dipeptides**.
- **Lipase** digests **fat** into **fatty acids** and **glycerol**.

5 Small intestine

- The small intestine secretes enzymes maltase and protease.
- **Maltase** digests **maltose** into **glucose**.
- **Protease** digests **dipeptides** into **amino acids**.

6 Large intestine

- Undigested food will enter the large intestine.
- The process of water reabsorption happens in the large intestine.

7 Rectum

- Food that is undigested, known as faeces, enters the rectum and is stored here.

8 Anus

- Faeces are excreted from the body through the anus.

Figure 3.13 *Human digestive system*

Our body produces enzymes to quicken the food digestion. What are the examples of enzymes that are involved in digestion? What is the function of each of these enzymes? **Amylase**, **protease** and **lipase** are examples of enzymes in digestion. Enzymes are made up of protein. Without enzymes, the digestion process happens at a very slow rate.

Science Info

Some detergents contain enzymes. These enzymes help to remove stains such as blood and oil.

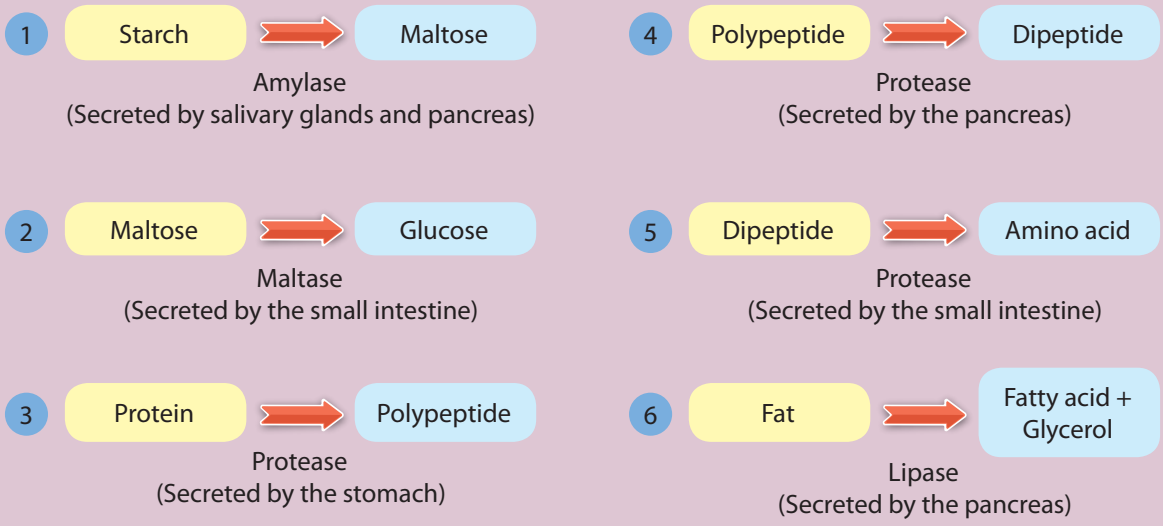


Figure 3.14 *Action of digestive enzymes*

Activity 3.7

Aim: To study the action of enzyme in saliva on starch.

Materials: 1% starch suspension, iodine solution, Benedict's solution and distilled water

Apparatus: Boiling tube, Bunsen burner, glass rod, wire gauze, 250 ml beaker, test tube, test tube holder, stopwatch, dropper, tripod stand, retort stand with clamp

Instruction

1. Rinse your mouth with distilled water and collect saliva in a small beaker. Use this in step 3.
2. Pour 10 ml of starch suspension into two boiling tubes, *P* and *Q*.
3. Add 4 ml of the saliva into boiling tube *Q*. Stir the mixture with a clean glass rod.
4. Take out 2 ml from each of the boiling tubes and carry out iodine test and Benedict's test.
5. Place boiling tubes *P* and *Q* in a water bath at 37°C and start the stopwatch (Figure 3.15).
6. After 30 minutes, take out 2 ml from each of the boiling tubes and carry out iodine test and Benedict's test.
7. Record your observations in a table.

Note: Students need to rinse their mouth first before starting the experiment.

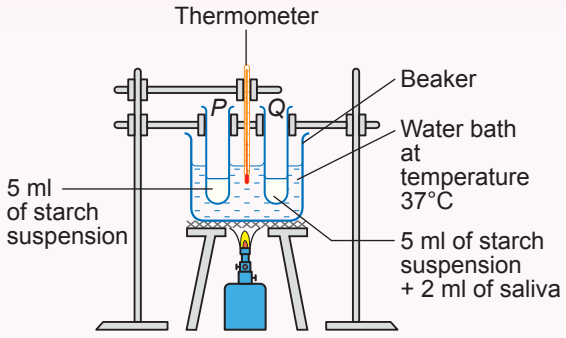


Figure 3.15

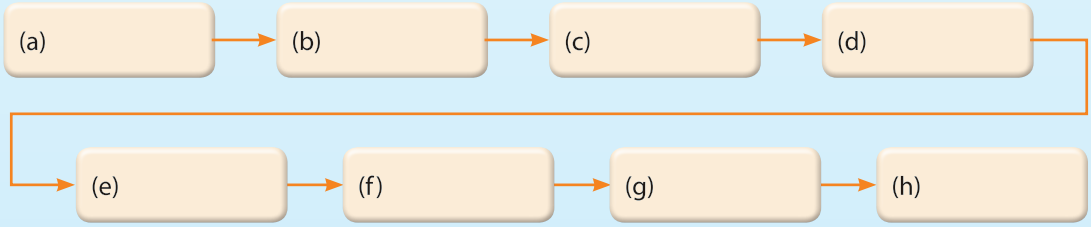
Boiling tube	Food test	Beginning of experiment	End of experiment
P	Iodine test		
	Benedict's test		
Q	Iodine test		
	Benedict's test		

Questions

1. Why does the temperature of the water bath need to be maintained at 37°C?
2. What happens to the starch in boiling tube *Q* at the end of the experiment?
3. What enzyme is found in our saliva?

Formative Practice 3.3

1. What is meant by digestion?
2. Complete the flow chart about the flow of food in the digestive tract.

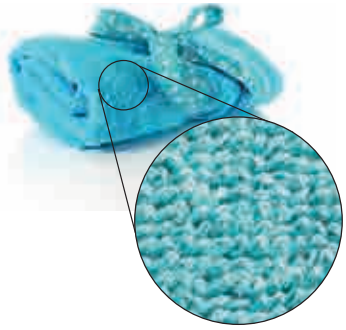


3. Name three digestive enzymes and state their function.
4. A man with a tumour in his pancreas had a surgery to remove his pancreas. Explain the effect on the process of digestion.

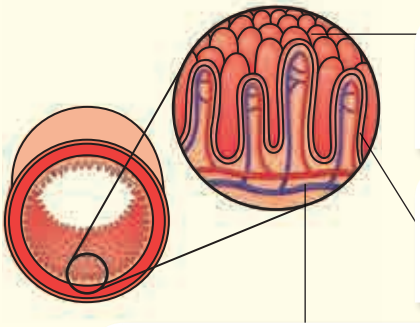
3.4 Process of Absorption and Transportation of Digested Food and Defecation

Observe the surface of the bath towel in Photograph 3.11. What can you see? Observe the thread projections on the surface of the towel. Like the towel, the wall of our small intestine has millions of fine projections called **villi.** This increases the surface area for the process of **absorption** of digested food.

Digested food which is made up of tiny molecules is easily absorbed into the blood circulatory system through the walls of the small intestine. These tiny molecules are then taken to every part of the body. Figure 3.16 shows the structure of a villus and the absorption of digested food in the small intestine.



Photograph 3.11 *Thread projections on a towel*

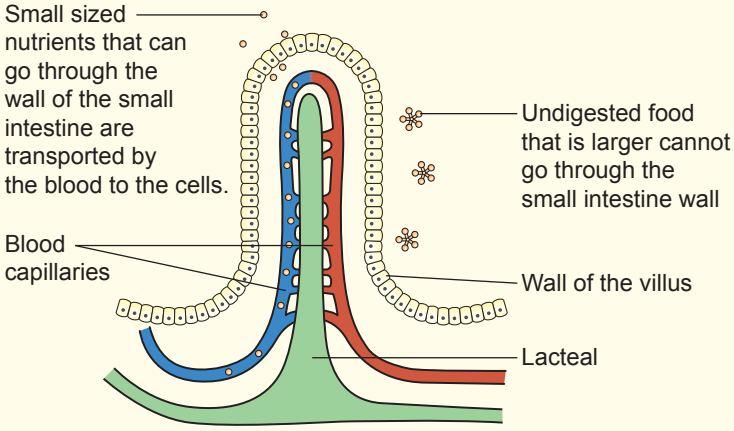


The surface of the small intestine has many folds to add to the surface area and increase the absorption rate of the products of digestion.

The wall of the villus is very thin. It is one-cell thick to increase the rate of absorption.

The function of the blood vessels in the small intestine is to transport nutrients to all parts of the body.

(a) Villi on the walls of the small intestine



(b) Absorption and transportation of the products of digestion

Figure 3.16 *Structure of villus and absorption of digested food in the small intestine*

Science Info

Villus - singular
Villi - plural

Brain Teaser

Why does our small intestine have more blood vessels than our stomach?

Science Info

Lacteal absorbs digested fat in the villi of the small intestine. The lacteal transfers it into the lymphatic system and then to the blood circulatory system.

Experiment 3.1

Aim: To study the absorption of glucose through a Visking tube.

Problem statement: Can glucose diffuse through a Visking tube?

Hypothesis: Glucose can diffuse through a Visking tube.

Variables:
(a) Constant variables: Type and size of Visking tube, temperature, time
(b) Manipulated variable: Content in the Visking tube
(c) Responding variable: Presence of glucose in the distilled water

Materials: 1% starch suspension, glucose solution, Visking tube, iodine solution, Benedict's solution and distilled water

Apparatus: Boiling tubes, beaker, test tubes, Bunsen burner, stopwatch, tripod stand, wire gauze and thread

Procedure:
1. Soak two Visking tubes in water to soften them.
2. Tie up one end of both Visking tubes using thread.
3. Pour 10 ml of starch suspension into one Visking tube and 10 ml of glucose solution into the other Visking tube.
4. Tie up the other end of both Visking tubes using thread.
5. Rinse both Visking tubes using distilled water until clean.
6. Set up the apparatus as shown in Figure 3.17.
7. Carry out Benedict's test and iodine test on the distilled water in boiling tubes *P* and *Q*.
8. Record your observations in the following table.
9. Leave the apparatus for 30 minutes. Then, repeat step 7.
10. Record your observations in the following table.

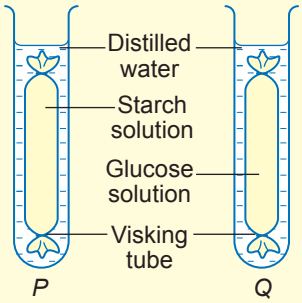


Figure 3.17

Observation:

Boiling tube	Food test	Observation	
		Beginning of experiment	End of experiment
P	Iodine test		
	Benedict's test		
Q	Iodine test		
	Benedict's test		

Questions
1. What is represented by the Visking tube and distilled water in the beaker?
2. State two precautionary steps that need to be taken when carrying out this experiment.
3. What inference can be made based on the observations of
   (a) boiling tube *P*?
   (b) boiling tube *Q*?
4. What conclusion can be made from this experiment?

Process of Transporting the Products of Digestion

Food that is digested and absorbed into a villus needs to reach the cells of the body. The molecules that are absorbed into the villus will undergo **assimilation**.

> **Assimilation** is a process of distributing the end products of digestion for the use of the cells in our body.

Our body uses the end products of digestion as follows:

- **Glucose** is used to produce energy.
- **Amino acid** is used to form component of cells.
- **Fatty acid** and **glycerol** combine to form fat which is used as heat insulator and to protect internal organs.

All these three systems below work together to ensure the digested food molecules reach the cells of the body.

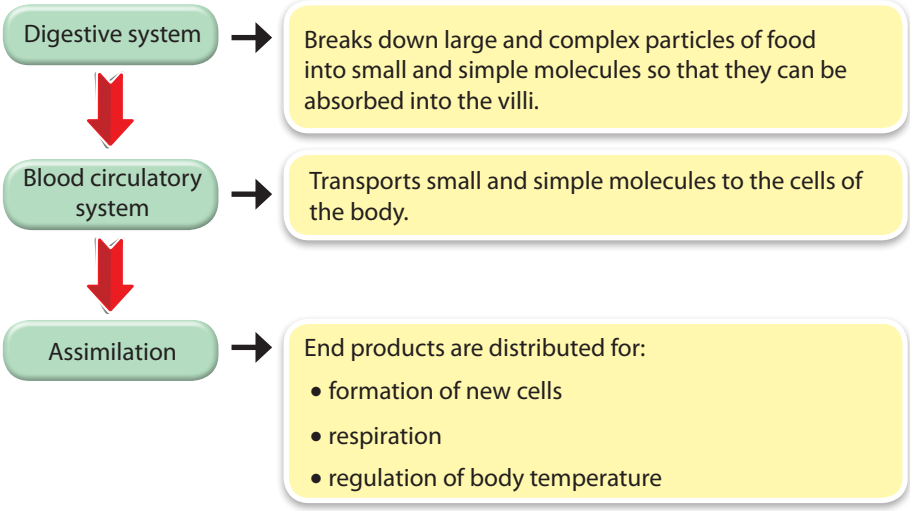


Figure 3.18 *Processes involved in the assimilation of digested food*

Activity 3.8

Aim: To explain the process of transporting products of digestion by the blood to the cells of the body.

Instruction

1. Work in groups.
2. Collect information from various sources on the process of transporting products of digestion by the blood to the cells of the body for assimilation.
3. Explain how the digestive system, blood circulatory system and respiratory system work together to fulfill the needs of our body.
4. Present the information obtained using a multimedia presentation.

Defecation

Undigested food and food that is not absorbed by the small intestine such as fibres, waste secretions of the digestive tract, dead cells and water will move into the large intestine. While moving through the large intestine, water and minerals are reabsorbed into the blood stream (Figure 3.19). This makes the unabsorbed and undigested food to become solid waste called **faeces**.

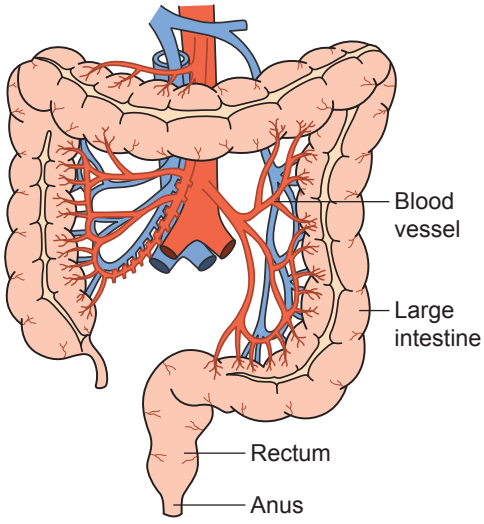


Figure 3.19

Faeces are stored temporarily in the **rectum** before being eliminated through the **anus**. The process of elimination of faeces from the body is called **defecation**.

Activity 3.9

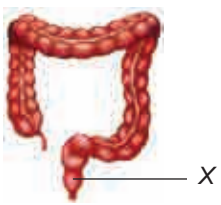
Aim: To create a multimedia presentation about transportation and reabsorption of water by the large intestine and the process of defecation.

Instruction

1. Get information from various sources on the:
   (a) importance of practising good eating habits to avoid constipation
   (b) implications to health if imbalanced diet is practised, especially with little or no fibres
2. Present the information using a multimedia presentation.

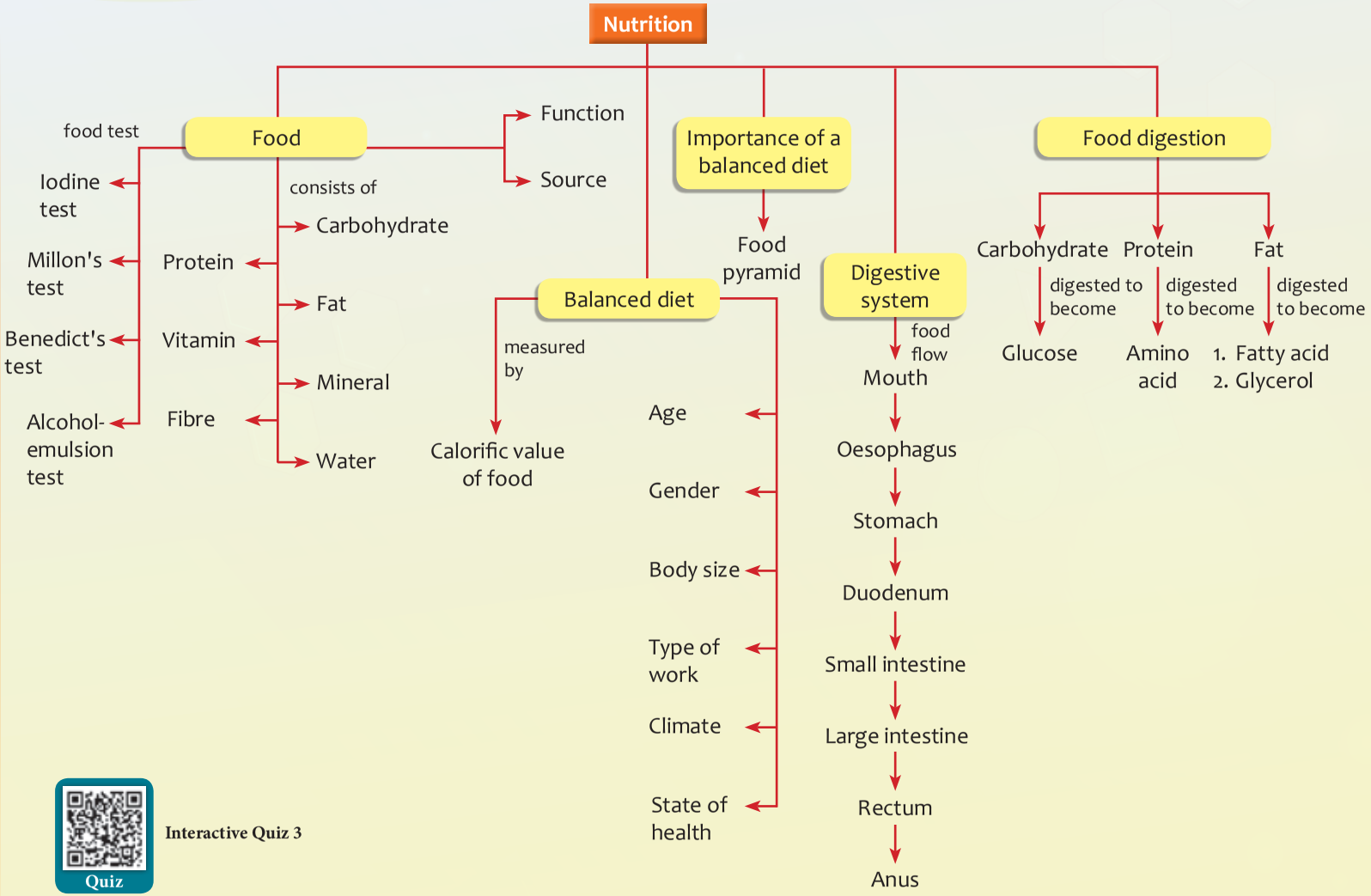
Formative Practice 3.4

1. The figure on the right shows the human large intestine.
   (a) Name *X* and state its function.
   (b) What is the movement that helps the movement of undigested food through the large intestine?
   (c) What is reabsorbed by the large intestine?



2. Kusairi does not like eating fruits and vegetables. What is the effect on his health?

Summary



Quiz

Interactive Quiz 3

SELF-REFLECTION

After learning this chapter, you are able to:

3.1 Classes of Food

- ☐ Elaborate and communicate on classes of food.
- ☐ Test the presence of starch, glucose, protein and fat in food.

3.2 Importance of a Balanced Diet

- ☐ Elaborate and communicate on a balanced diet.
- ☐ Estimate calories of food intake in a meal and plan a balanced diet.
- ☐ Conduct a research and justify the importance of a balanced diet, exercise and a healthy lifestyle in order to maintain a healthy body.

3.3 Human Digestive System

- ☐ Elaborate and communicate on digestion.

3.4 Process of Absorption and Transportation of Digested Food and Defecation

- ☐ Conduct an experiment to explain the absorption of the end products of digestion.
- ☐ Relate the function of digestive system, blood circulatory system and respiratory system.
- ☐ Elaborate and communicate on defecation.

Summative Practice 3

1. Figure 1 shows a food pyramid.

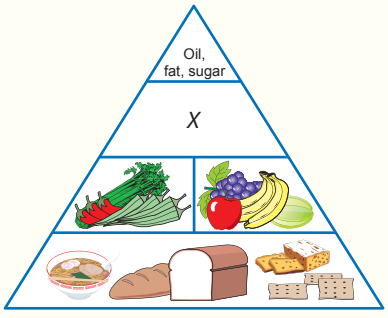


Figure 1

(a) Name three types of food in the space marked *X*.

(b) State the functions of that food.

(c) Amri is 15 years old and is obese. Amri has also been confirmed by the doctor as having diabetes.

(i) Suggest practices that Amri needs to cultivate to control his health.
(ii) Suggest a balanced breakfast menu that is suitable for Amri.
(iii) In your opinion, what is the cause of his health problems? Justify your opinion.

2. Nicole lives in the Arctic which has a temperature as low as –40°C.

(a) What class of food should Nicole consume continuously to adapt herself to the cold temperature?

(b) Give reasons for your answer in **2** (a).

3. Figure 2 shows the human digestive system.

(a) Identify parts *P* to *W*.

(b) Name the part where

(i) carbohydrate digestion begins
(ii) protein digestion begins
(iii) fat digestion begins

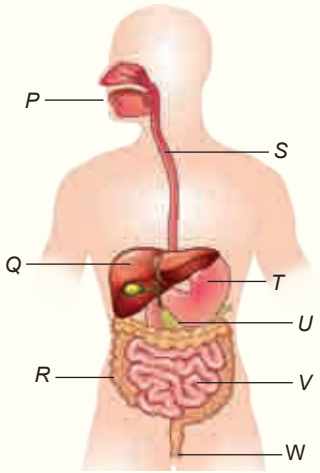


Figure 2

4. Amirah tested two types of food using iodine solution and Benedict's solution. Amirah's observations are as follows.

- Rice – changes colour to dark blue with the iodine test, remains blue with the Benedict's test
- Honey – remains brown with the iodine test, becomes a brick red precipitate with the Benedict's test

(a) Explain how Amirah conducts the Benedict's test.

(b) Create a table to show the results obtained by Amirah in both of the food tests.

(c) What is the conclusion that can be made by Amirah?

5. Pui Yee conducted an experiment about the effect of heat on amylase. Amylase breaks down starch to maltose.

- 2 ml of amylase solution is poured into two boiling tubes, *A* and *B*.
- Only the solution in boiling tube *A* is heated. Then, the solution is left to cool down to room temperature.
- 5 ml of starch suspension is added into boiling tubes *A* and *B*.
- After 10 minutes, Pui Yee carries out tests for the presence of maltose. Pui Yee finds that maltose is present in boiling tube *B* only.

(a) What is the manipulated variable in this experiment?

(b) State two constant variables in this experiment.

(c) Pui Yee concludes that high temperature destroys amylase. Is her conclusion correct? Justify your answer.

HOTS Mastery 3

6. Mr. Fuad and Mr. Razak live as neighbours in a village near the sea. Mr. Fuad is a fisherman while Mr. Razak teaches at a school in the village. Photograph 1 shows a set of breakfast for a healthy man.

Boiled egg | Sandwich | Tea | Watermelon

Photograph 1

(a) Study the set of food. State whether the set is more suitable for Mr. Fuad or Mr. Razak. Justify your answer.

(b) Suggest a breakfast set that is suitable for the individual that you did not choose in **6**(a).

7. Read the excerpt below and answer the questions that follow.

> A vegetarian does not eat meat, fish or chicken but only eats vegetables for personal reasons. Nevertheless, he can eat products that come from animals such as milk and cheese.

(a) In your opinion, is the vegetarian's diet healthy? Explain.

(b) The vegetarian wants to make a burger. Plan a balanced burger menu for him. Explain.

Chapter 4

Human Health

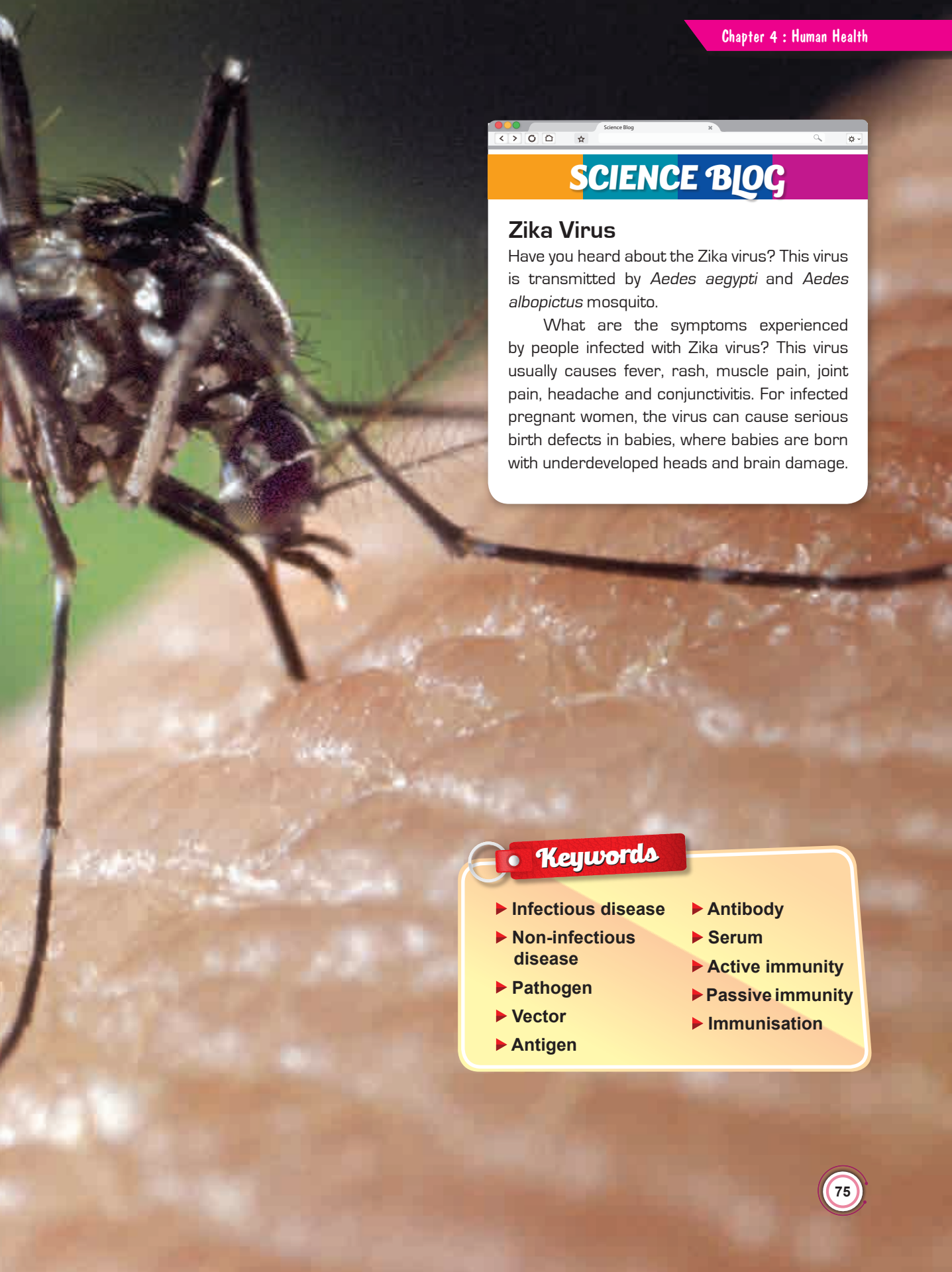
What are the differences between infectious and non-infectious diseases?

How do infectious diseases spread?

How are the microorganisms that enter the body killed?

Let's understand:

- Infectious and non-infectious diseases
- Body defence



SCIENCE BLOG

Zika Virus

Have you heard about the Zika virus? This virus is transmitted by *Aedes aegypti* and *Aedes albopictus* mosquito.

What are the symptoms experienced by people infected with Zika virus? This virus usually causes fever, rash, muscle pain, joint pain, headache and conjunctivitis. For infected pregnant women, the virus can cause serious birth defects in babies, where babies are born with underdeveloped heads and brain damage.

Keywords

- Infectious disease
- Non-infectious disease
- Pathogen
- Vector
- Antigen
- Antibody
- Serum
- Active immunity
- Passive immunity
- Immunisation

4.1 Infectious and Non-infectious Diseases

A disease is an abnormal condition of body or mind that causes discomfort, difficulty to function or stress to an individual. Diseases can be classified into two, namely **infectious diseases** and **non-infectious diseases**. What are the differences between these two types of diseases?

Infectious disease	Non-infectious disease
• Caused by infection of pathogens directly through mediums and vectors.	• Caused by genetic factor or lifestyle.
• Example: Tuberculosis, flu, ringworm, tinea, leptospirosis, dengue fever, malaria fever and Zika fever.	• Example: Cancer, hypertension, diabetes, asthma and cardiovascular diseases.
• A disease that can be transmitted from one individual to another.	• A disease that cannot be transmitted from one individual to another.

Figure 4.1 *Differences between infectious and non-infectious diseases*

How are Infectious Diseases Spread?

Infectious diseases are spread by **pathogens**, the organisms that cause diseases. All virus, some bacteria, protozoa, fungi and worms are pathogens.

Infectious diseases are spread by pathogens transmitted from an infected person (host) to another person through vectors and mediums such as water, air and contact. The host is a victim who is weak and easily infected. After getting infected, the host will show certain symptoms of the disease.

Science Info

Not all microorganisms are pathogens that are harmful to health. There are some bacteria acting on food residue in the large intestine to produce vitamin K and vitamin B12 which are absorbed by the body.

Airborne diseases

There are two ways airborne diseases are transmitted, through **droplet transmission** and **dust transmission**.

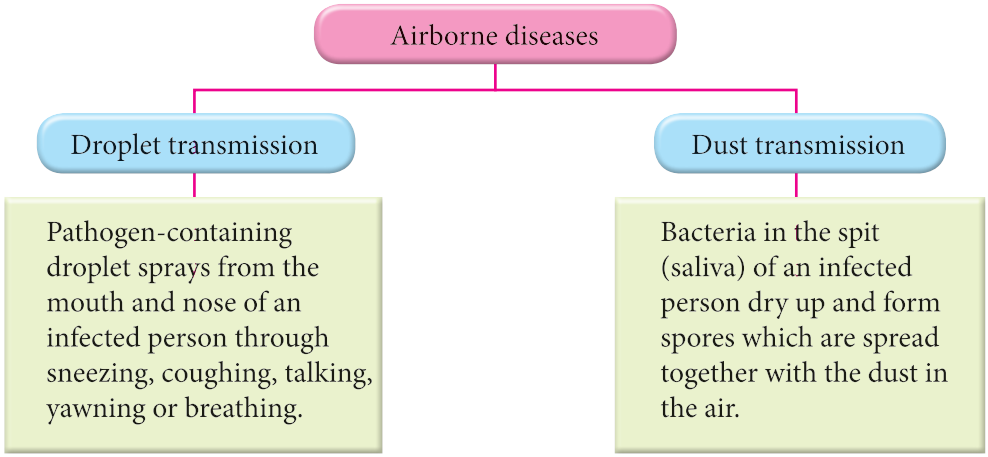


Figure 4.2 *Ways of transmission of airborne diseases*

Airborne diseases can be prevented by practising the following ways:

- ☑ cover the mouth and nose when sneezing, coughing or yawning
- ☑ do not spit everywhere
- ☑ avoid being in a crowded place
- ☑ ensure the living place gets enough light as ultraviolet rays can kill certain microorganisms in the air

Brain Teaser

Why does influenza spread more rapidly during cold weather?

4.1.2
4.1.3

Example of diseases that can be spread through air are tuberculosis, flu, Severe Acute Respiratory Syndrome (SARS), Influenza A (H1N1) and chicken pox.

Info **SARS**
http://www.infosihat.gov.my

Info **H1N1**
www.who.int

Waterborne diseases

Infection through water usually happens in areas with inadequate water supply and poor sanitation. For instance, when someone uses a toilet built over a river, faecal pathogens enter the river and pollute the river. A person can be infected by pathogens when he drinks the contaminated water.

Other than inadequate water supply and poor sanitation, floods can also spread infectious diseases.

Photograph 4.1 *Flood*

Among the diseases that are transmitted through water include cholera, typhoid and amoebic dysentery. Infection of diseases through water can be prevented by the following ways:

Info

Steps to Wash Hand Correctly
http://www.infosihat.gov.my

- add chlorine into swimming pools and water supply systems
- build toilets with good sanitation

- boil drinking water properly
- wash hands with soap after using the toilet

Photograph 4.2 *Steps to prevent waterborne diseases*

Infection of diseases through contact

Two examples of diseases that can be transmitted through contact are **ringworm** and **tinea**. Both are caused by **fungi**. Accidentally touching the infected skin or wearing the clothes of an infected person will cause infections to occur.

Diseases like **syphilis** and **gonorrhoea** can spread through sexual intercourse. Pathogens of these diseases are present in body fluids such as semen and vaginal fluid.

The HIV virus that causes AIDS can also be transmitted through sexual intercourse, blood as well as exposure to syringe-sharing among patients and among drug addicts.

Tinea

Ringworm

Photograph 4.3 *Diseases transmitted through contact*

Infection of diseases through vectors

Some pathogens are transmitted from one host to another new host through animals. Animals that transmit these pathogens are called **vectors.**

Brain Teaser

Construct a bridge map for vectors and their pathogens.

Table 4.1 *Vector and pathogen*

	Vector	Pathogen
1	 Cockroach	 *Salmonella typhi*
2	 Fly	 *Salmonella typhi*
3	 Aedes mosquito	 Dengue virus

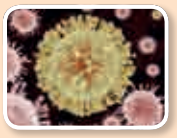
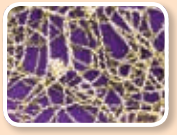
	Vector	Pathogen
4	 Aedes mosquito	 Zika virus
5	 Anopheles mosquito	 *Plasmodium malariae*
6	 Rat	 *Leptospira* sp. bacteria

Table 4.2 *Several types of diseases, symptoms, pathogens, vectors and ways of infection*

Disease	Symptoms	Pathogen	Vectors	Way of infection
Malaria	shivering, fever and sweating	*Plasmodium malariae*	female Anopheles mosquito	mosquito bite
Cholera	diarrhea and vomiting	*Vibrio cholerae* bacteria	fly	contaminated food and water
Dengue	joint pain, fever, headache and watery eyes	virus	Aedes mosquito	mosquito bite
Zika	fever, rashes, joint pain and conjunctivitis	virus	Aedes mosquito	mosquito bite
Typhoid	fever, intestinal bleeding and red rashes	*Salmonella typhi* bacteria	cockroach, fly	contaminated food and water
Leptospirosis	fever, headache and muscle pain	*Leptospira* sp. bacteria	rat	contaminated soil, food and water

How Do Vectors Spread Diseases?

Mosquitoes and flies are the two vectors that spread numerous infectious diseases. Let us see how these vectors spread diseases.

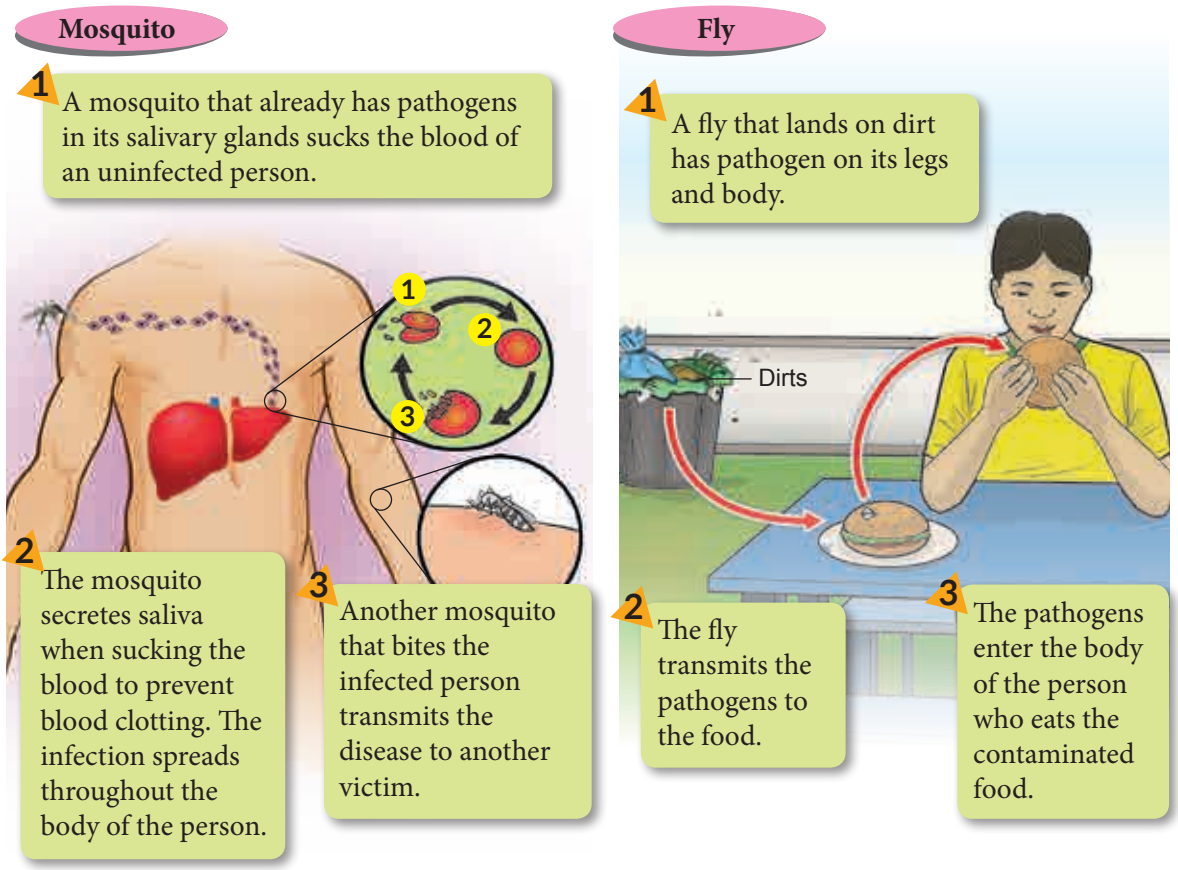


Figure 4.3 *Ways mosquitoes and flies spread diseases*

The Mechanism to Prevent the Spread of Infectious Diseases

How can infectious diseases be prevented from spreading? Prevention of infectious diseases involves three stages as shown in Table 4.3.

Table 4.3 *Three stages of prevention of infectious diseases*

Primary stage	Secondary stage	Tertiary stage
• Improving health ➟ Improving personal and family hygiene, cleanliness of living places and sanitation systems • Strengthening the body's defence system ➟ Getting vaccines and immunisation for babies, children, pregnant women, food premises operators, hajj pilgrims and travellers. • Frequent health check-ups • Maintaining a healthy lifestyle ➟ Inhaling clean air ➟ Eating a balanced diet	• Determining transmission of infections through active and passive case detection ➟ Giving early treatment to patients ➟ Separating patients from others Info: **Prevent Dengue before Its too Late** http://www.infosihat.gov.my/infosihat/media/video/D/index.php	• Controlling vector populations ➟ Destroying vector breeding and hiding places ➟ Fogging to kill vectors ➟ Enforcing laws by issuing compounds to owner of dirty food premises • Protecting hosts ➟ Using mosquito nets or mosquito coils ➟ Wearing thick clothes

Activity 4.1

Aim: To carry out a case study on diseases in Malaysia.

Info: **Ministry of Health Malaysia** http://www.moh.gov.my

Instruction

1. Work in groups.
2. Visit the website http://www.moh.gov.my.
3. Gather information on the statistics of infectious diseases from the website.
4. Discuss the following matters:
   (a) most common diseases in Malaysia
   (b) types of diseases transmitted, the causes and preventions
   (c) prediction of diseases progression based on the statistical graphs from Ministry of Health
   (d) suggestions to solve this problem
5. Present the outcomes using a multimedia presentation.

Formative Practice 4.1

1. What is meant by pathogen and vector?
2. Give one example of disease caused by
   (a) bacteria (b) virus (c) fungi
3. Give two examples of infectious diseases and two examples of non-infectious diseases.
4. State three ways infectious diseases are spread.

4.2 Body Defence

Pathogens enter the body through the respiratory system, digestive system, excretory system and skin. Pathogens need to be destroyed by the body. Do you know that our body has a strategy to defend itself against infections?

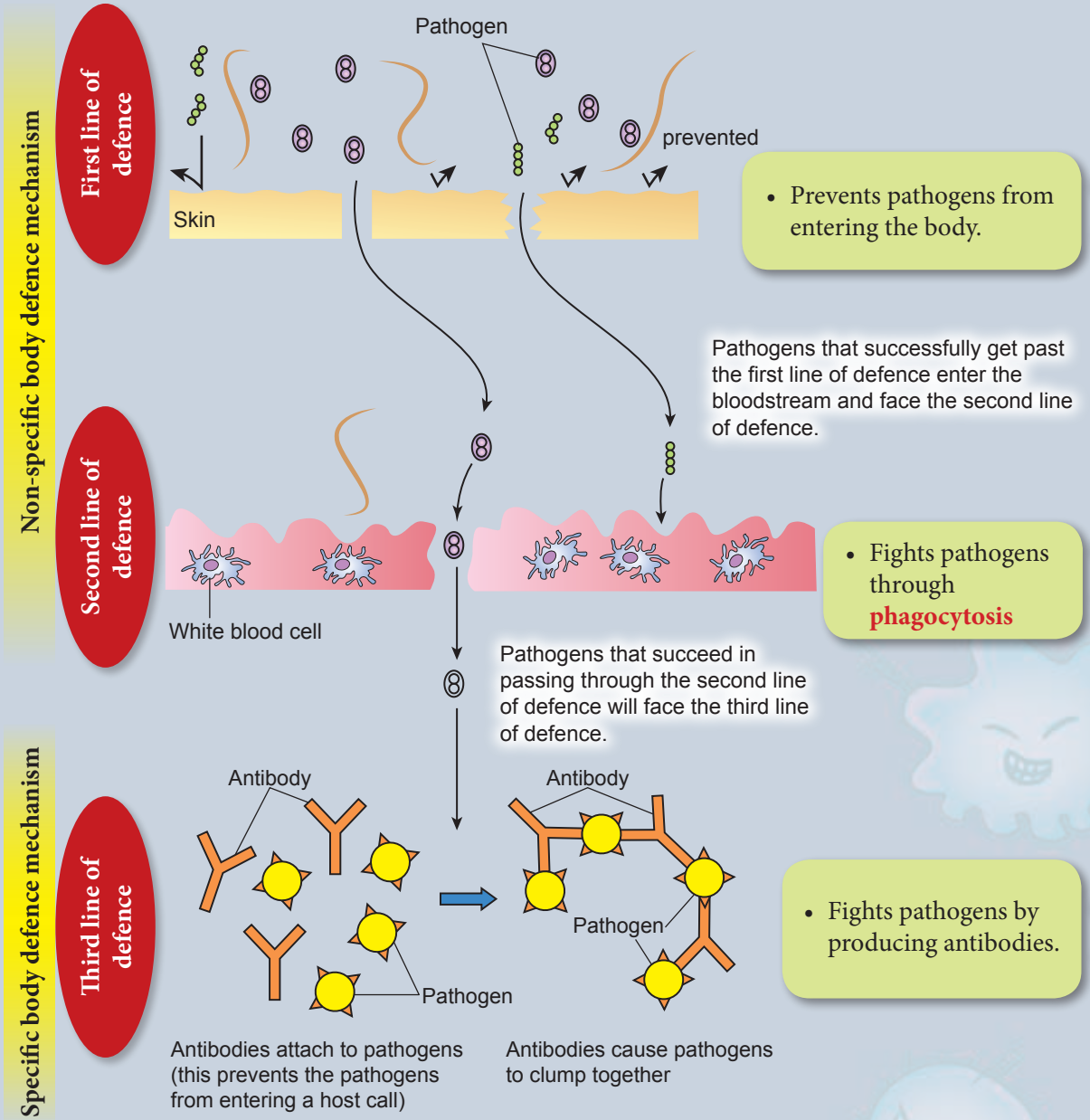


Figure 4.4 *Body defence mechanism*

4.2.1
4.2.2

First line of defence

Skin

- The human **skin** is made of a tough layer and is difficult to be penetrated by microorganisms.
- Microorganisms can only get into the body if there is a wound or if the skin is injured.
- **Sweat** and **sebum** secreted by the skin contain chemicals that can kill microorganisms.

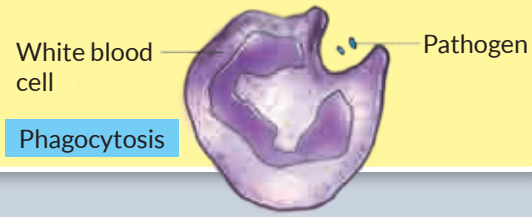
Mucous membrane

- **Mucous membrane** is a membrane that lines the **digestive tract** and **respiratory tract**.
- Microorganisms that enter the respiratory tract are filtered by nasal hairs and trapped by mucous lining the nasal cavity.
- Earwax, tears and vaginal secretions also function as an antiseptic that kills microorganisms.

Second line of defence

Phagocytosis

- White blood cells engulf and digest the pathogens using enzymes through **phagocytosis**.



Third line of defence

Body immune system

- Immunity is the ability of the body system to resist pathogens before it is infected.
- It involves the production of antibodies when pathogens enter the body.
- **Antibody** is a protein produced by white blood cells into the bloodstream in response to antigens.
- An **antigen** is a foreign substance that comes from outside the body and induces the production of antibodies. Examples of antigens are pathogens, toxin molecules and blood cells from other blood groups.

Activity 4.2

21st Century

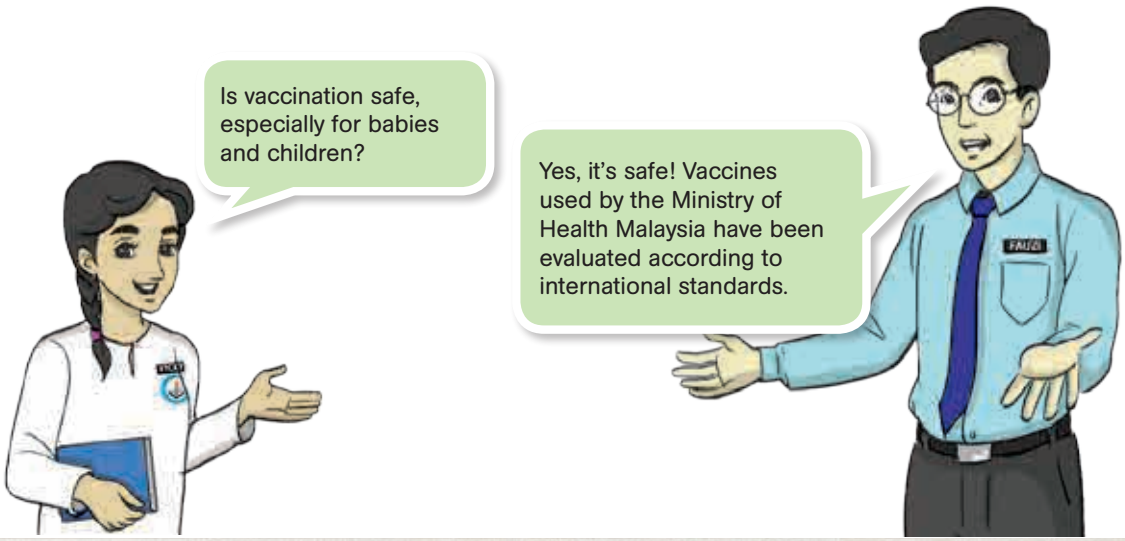
Aim: To create a multimedia presentation on how the body defence system fights against infections and promotes healing.

Instruction

1. Work in groups.
2. Gather information on:
   (a) body defence system fighting against infections
   (b) ways to promote healing from infections.
3. Present the outcomes using a multimedia presentation.

Importance of Immunisation

Immunisation is an effort to stimulate the body defence against infections in babies, children and adults by injecting vaccines.



A **vaccine** contains antigens obtained from a part or the whole structure of a weakened or dead virus or bacterium. Antigens stimulate the body's immune system, forming immunity against certain infections. Therefore, a baby needs to be injected with a few types of vaccines. Table 4.4 shows a vaccination schedule in Malaysia.

Info

Vaccines
http://www.infosihat.gov.my

Table 4.4 *Vaccination schedule in Malaysia*

IMMUNISATION	Age (Month)										(Year)		
	0	1	2	3	5	6	9	12	18	21	7	13	15
BCG	Dose 1												
Hepatitis B	Dose 1	Dose 2				Dose 3							
DTaP			Dose 1	Dose 2	Dose 3				Booster				
Hib			Dose 1	Dose 2	Dose 3				Booster				
Polio (IPV)			Dose 1	Dose 2	Dose 3				Booster				
Measles						Sabah only							
MMR							Dose 1	Dose 2					
MR											Dose 2		
DT											Booster		
HPV												Females only	
Tetanus													Booster
JE (Sarawak)							Dose 1			Dose 2			

Source: Ministry of Health Malaysia

Notes:

- Bacillus Calmette–Guérin (BCG) is a vaccine that gives protection against Tuberculosis.
- DTaP is the combination of Diphtheria, Tetanus and Pertussis.
- Hib is Haemophilus influenza type B.
- IPV is Inactivated Polio Vaccine that protects against Polio.
- MMR is the combination of Measles, Mumps and Rubella.
- MR is a booster dose to provide protection against Measles and Rubella.
- DT is a booster dose to protect against Diphtheria and Tetanus.
- HPV is Human Papillomavirus. This vaccine is given only for girls aged 13 years old. Dose 2 is given six months after dose 1.
- JE is vaccine against Japanese Encephalitis. This vaccine is only given in Sarawak.

Passive Immunity and Active Immunity

Immunity can be classified into two types, **passive immunity** and **active immunity**. Both immunities can be obtained **naturally** or **artificially**.

Science Info

Antibiotics that we consume are excreted from our body and the dose will become less. Thus, antibiotics should be taken at the prescribed dose and time so that the antibiotics are always at the optimum level.

Passive immunity: The body gains antibody from external sources

Natural

- Obtained when a baby receives antibody from breast milk or from the mother's blood that flows across the placenta.
- The immunity is temporary and short-lived, lasts for the first few months after the birth of the baby (Figure 4.5).

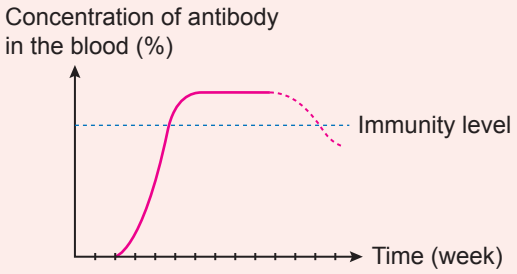


Figure 4.5 *Graph of passive natural immunity*

Artificial

- Obtained when an antiserum is injected into the patient's body.
- The antiserum fights against pathogens without interrupting the patient's immune system.
  - Antiserum is a clear liquid in the blood that contains antibodies to prevent diseases.
- The immunity is fast and temporary (Figure 4.6).

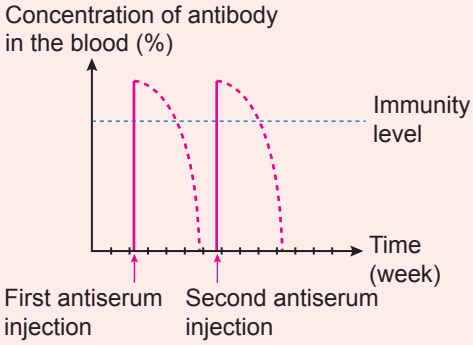


Figure 4.6 *Graph of passive artificial immunity*

Active immunity : The body produces its own antibodies when stimulated by antigens

Natural

- Occurs when a person recovers from an infection.
- The immunity lasts long after the infection (Figure 4.7).

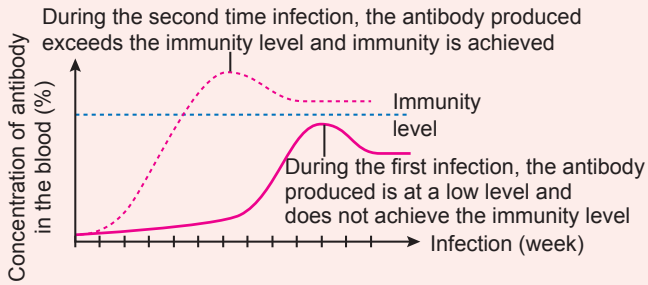


Figure 4.7 *Graph of active natural immunity*

Artificial

- Occurs when a vaccine that contains a dead or weakened pathogen is injected into the body, and the immune system responds by producing antibodies.
- The immunity lasts long after the infection (Figure 4.8).

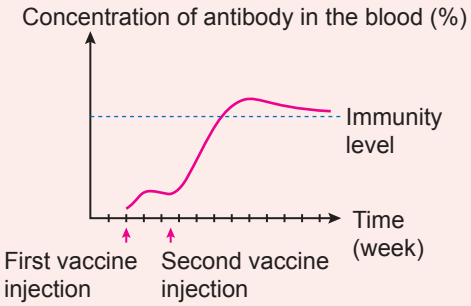


Figure 4.8 *Graph of active artificial immunity*

Strong Immune System

The human body is made up of various systems including the immune system. When there is an imbalance in the body or too much toxins, the immune system becomes weak. Some of the causes that weaken the immune system and the practices that strengthen the immune system are shown in Photograph 4.4.

Causes that weaken the immune system

Exposure to polluted air

Exposure to pesticides

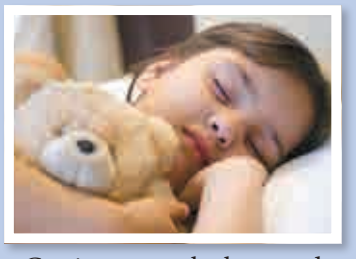
Stress

Excessive intake of sugar

Science Info

An allergy is the response of the body's immune system to allergen (cause of allergics) in the environment that is usually harmless for most people. Examples of allergens are mites, animal hair, dust, pollen, spores, food (seafood, milk and eggs), animal stings and some medicines.

Practices that strengthen the immune system



Getting enough sleep and rest

Exercising and inhaling fresh air

Not smoking and no exposure to cigarette smoke

Doing periodic health examination

Photograph 4.4 *Causes that weaken and practices that strengthen the immune system*

Activity 4.3

21st Century

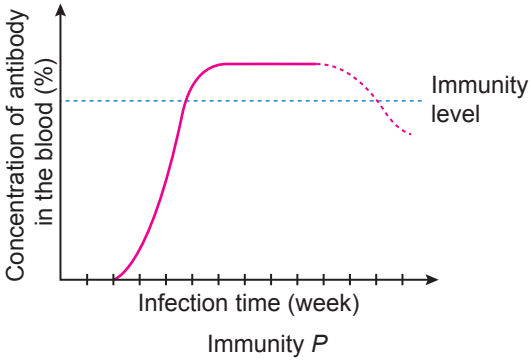
Aim: To gather information on the importance of immunisation and health level of individuals.

Instruction

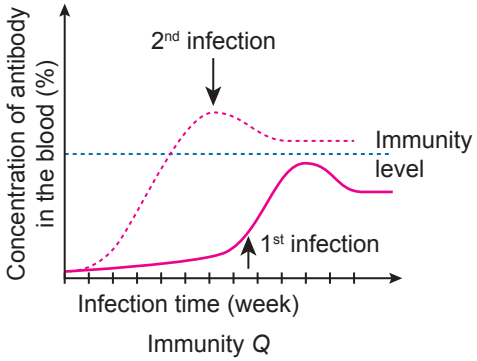
1. Work in groups.
2. Gather information on immunisation and the implications of the health level of individuals to the family, society, economy and nation.
3. Relate to the aspects of:
   (a) recurrence of controlled diseases such as leprosy, whooping cough and tuberculosis
   (b) increased costs of health care
   (c) affected quality of work
   (d) insurance coverage
   (e) quality of life
   (f) labour (migration)
4. Present the outcomes using a multimedia presentation.

Formative Practice 4.2

1. Name two strategies of human body defence system.
2. What is meant by antigen, antibody and immunity?
3. The graphs below show two types of immunity, *P* and *Q*.



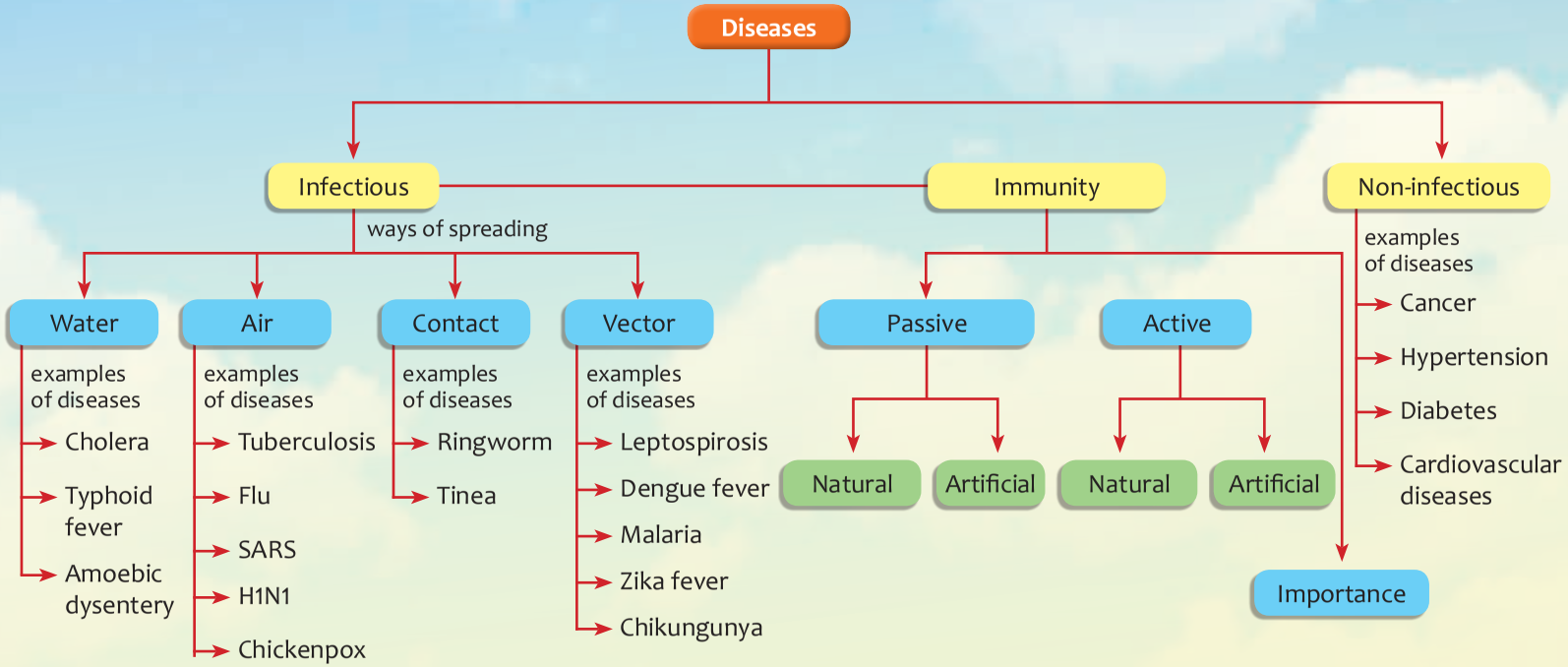
Immunity *P*



Immunity *Q*

   (a) Name immunity *P* and immunity *Q*.
   (b) Explain the similarities and differences between immunity *P* and immunity *Q*.
   (c) In your opinion, which immunity is better? Explain your answer.
4. Suggest two practices that weaken the immune system of a person.
5. Explain the reason why immunisation should be given to babies and children.

Summary



Quiz

Interactive Quiz 4

SELF-REFLECTION

After learning this chapter, you are able to:

4.1 Infectious and Non-infectious Diseases

- ☐ Differentiate and communicate infectious and non-infectious diseases.
- ☐ Explain how infectious diseases are spread.
- ☐ Separate the cause and spread of infectious diseases.
- ☐ Generate ideas on the mechanism to prevent the spread of infectious diseases.

4.2 Body Defence

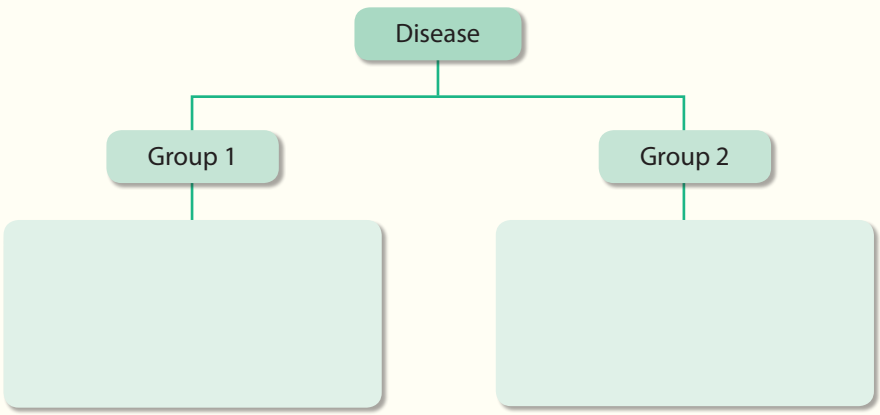
- ☐ Elaborate and communicate the function of body defence system.
- ☐ Define antigens, antibodies and immunity.
- ☐ Justify the importance of immunisation.
- ☐ Differentiate passive immunity and active immunity.
- ☐ Justify good practices towards strong immune system.
- ☐ Justify and communicate the importance of immunisation and health level of individuals to the family, social, economy and nation.

Summative Practice 4

1. The following are among the diseases recorded in Malaysia.

Diabetes	Flu	Chickenpox	Hypertension	Heart attack
Leptospirosis	Zika	Cholera	Cancer	Tinea

(a) Classify the diseases above into two groups based on their common characteristics.



(b) State the characteristic that you used to do the classification in **1**(a).

(c) Based on the list of diseases above, state a disease caused by each of the following factors.
(i) Fungi
(ii) Leptospira bacteria
(iii) Influenza virus
(iv) Unhealthy eating habits

(d) Which disease is included in the immunisation programme for babies and children?

2. Dengue haemorrhagic fever is a fatal infectious disease.

(a) Name the pathogen and vector for this disease.

(b) Give one other example of disease spread through the same vector of dengue haemorrhagic fever.

(c) Explain the way this disease is spread.

3. Photograph 1 shows a dustbin in a residential area. Predict the effects on the public if this situation prolongs. Give your reasons.

Photograph 1

4. Figure 1 shows the graph of concentration of antibody in the blood (%) over a period of 40 days. Based on the graph, answer the following questions.

(a) Explain the reaction of the body against the infection of virus A.

(b) How long does it take for the body to build antibodies to reach the immunity level after an infection?

(c) Give one reason why the antibody level drops after reaching the immunity level.

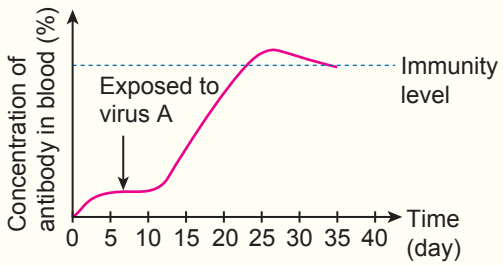


Figure 1

5. Humans are lucky to have two types of body defence mechanisms, specific defence mechanism and non-specific defence mechanism.

(a) Compare and contrast specific defence mechanism and non-specific defence mechanism.

(b) Describe the strategy of
(i) specific defence mechanism
(ii) non-specific defence mechanism

(c) Complete the table below by stating the type of immunity for each case.

Case	Type of immunity
(i) Amin is not infected with chickenpox anymore as he had been infected with the disease when he was 7 years old.	
(ii) Kelvin is not infected with hepatitis B as he has obtained immunisation against the disease.	
(iii) A baby gets antibodies from breast milk.	
(iv) A patient with a hacking cough is injected with the antibody taken from an individual immune to the disease.	

6. Assume you are a scientist. You are responsible to investigate a case of an infectious disease that has been spreading in a small town. The plague has caused three fatal cases and 10 more people have shown the symptoms of infection.

(a) What are the precautionary steps that should be taken before you carry out the laboratory test to investigate the cause of the plague?

(b) List down a few questions that you may ask the infected victims to help you in the investigation.

(c) What are the steps that you can suggest to the residents of the town to protect those who are not infected yet?

(d) The hospital has decided to impose quarantine on the infected people. Justify the hospital's decision.

HOTS Mastery 4

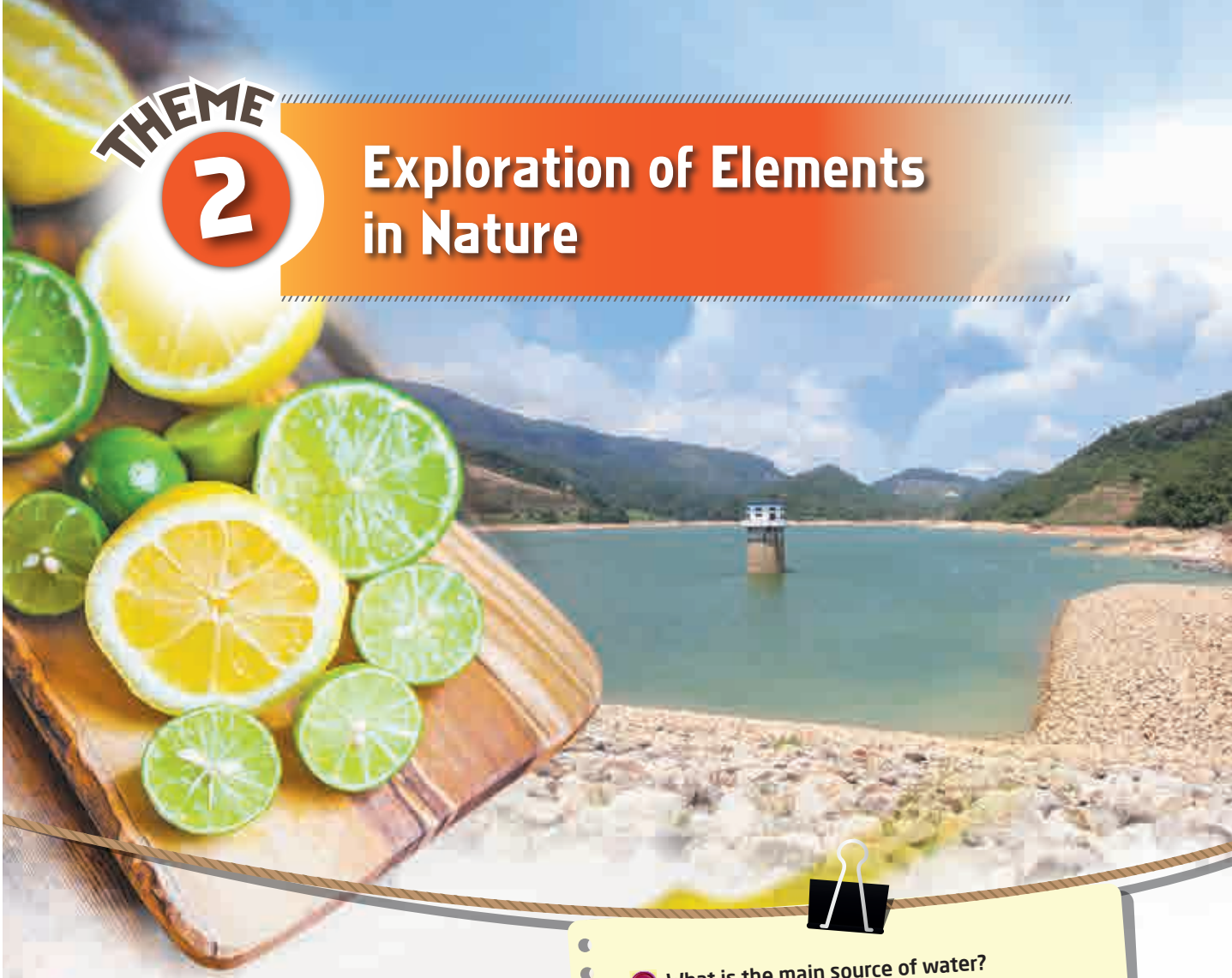
7. A farmer bought three hens and kept them in a chicken coop together with other 15 hens. After two days, the farmer found that the three new hens were infected with a disease. After few days, four more hens were infected with the disease. He called a veterinarian to help him. He told him about the three new hens and the change he made in the type of food for the hens a day before he found them sick.

(a) Suggest two inferences on the infected hens.

(b) If you were the veterinarian, how could you help the farmer to solve his problem? Explain the design of your test.

THEME 2

Exploration of Elements in Nature



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

Chapter 5

Water and Solution

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

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

What are the effects of water pollution on aquatic life?

How are saturated solutions formed?

Why is water known as a universal solvent?

Let's understand:

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

SCIENCE BLOG

Dead Sea

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

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

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

Keywords

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

5.1 Physical Characteristics of Water

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

- Boiling point = 100°C
- Freezing point = 0°C
- Colourless
- Density = 1 g cm^{-3}

Figure 5.1 *Physical characteristics of pure water*

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

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

Photograph 5.1 *Daddy longlegs on the surface of water*

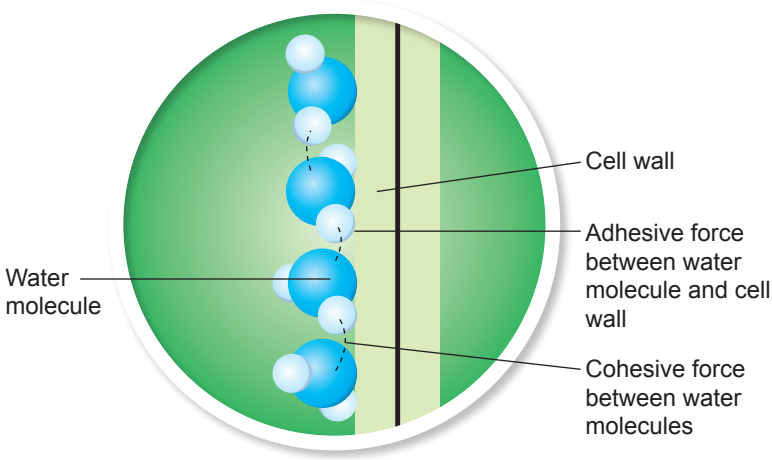


Figure 5.2 *Capillary action in plant*

Science Info

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

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

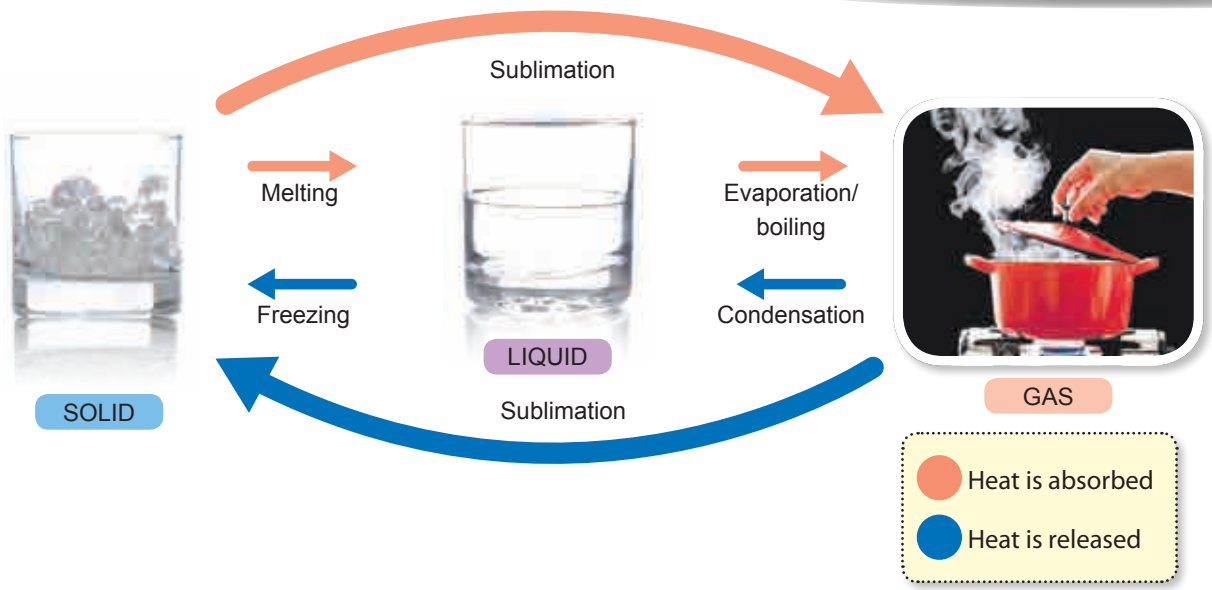


Figure 5.3 *Effects of absorption and release of heat on the state of water*

Activity 5.1

21st Century

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

Instruction

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

Composition of Water

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

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

Activity 5.2

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

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

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

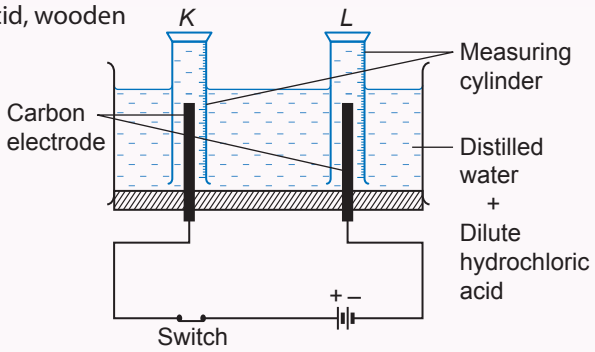


Figure 5.4

Instruction

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

Observation

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

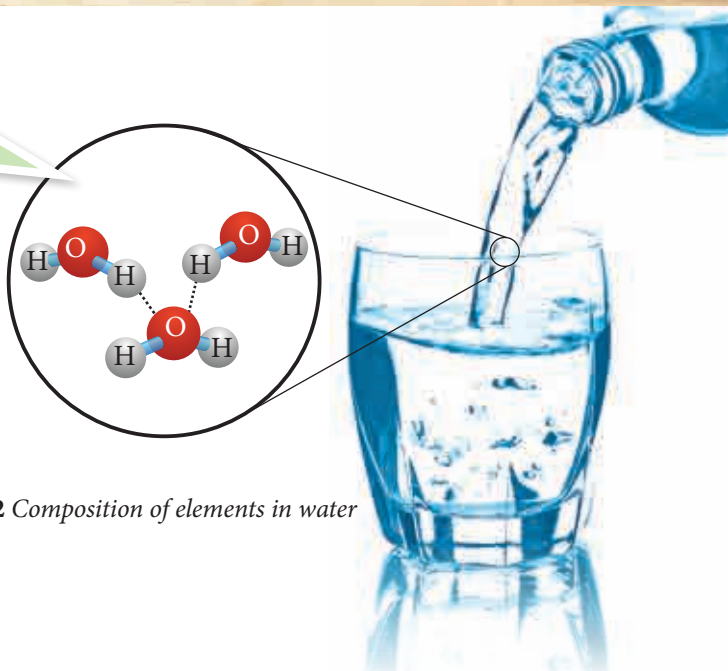
Questions

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

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

Science Info

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



Photograph 5.2 *Composition of elements in water*

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

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

(a) Water

(b) Chicken soup

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

Activity 5.3

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

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

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

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

Instruction

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

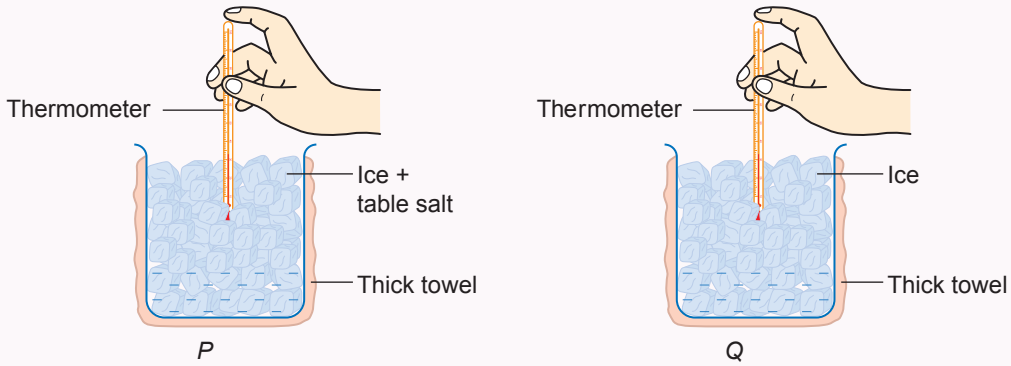


Figure 5.5

Observation

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

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

Instruction

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

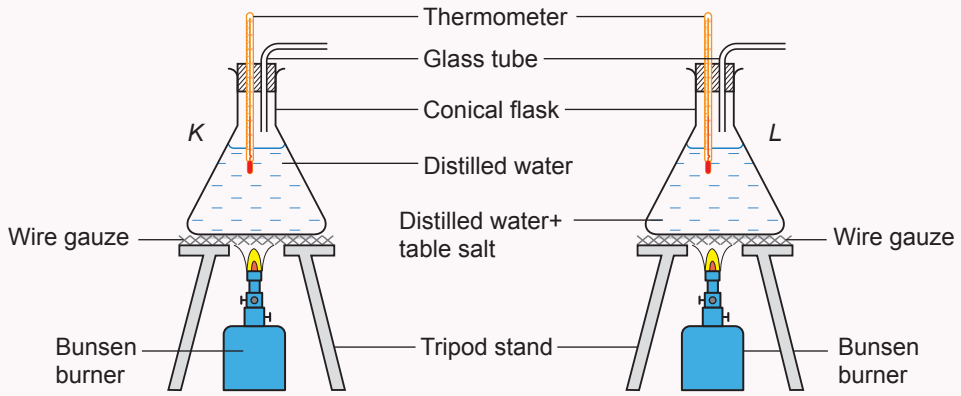


Figure 5.6

Observation

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

Questions

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

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

Evaporation of Water

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

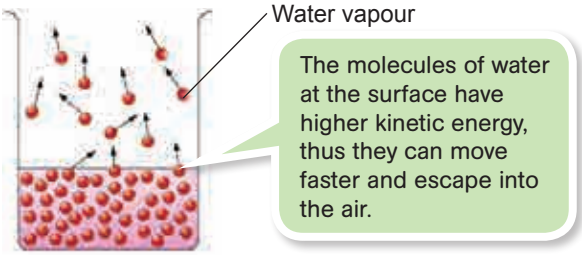


Figure 5.7 *The process of water evaporation*

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

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

Experiment 5.1

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

A Humidity

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

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

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

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

Apparatus: Bell jar and beaker

Procedure:

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

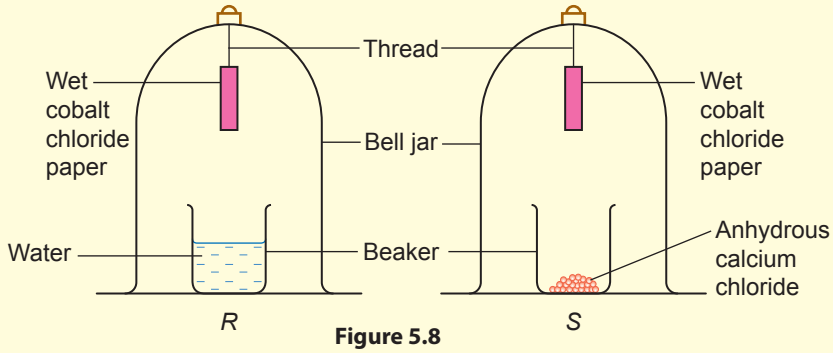


Figure 5.8

B Surrounding temperature

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

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

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

Materials: Anhydrous cobalt chloride papers and water

Apparatus: Filament lamp and white tile

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

Science Info

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

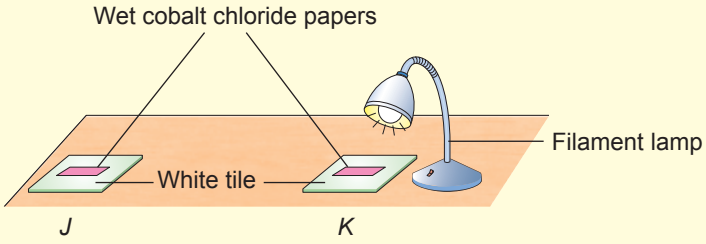


Figure 5.9

C Exposed surface area of water

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

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

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

Materials: Filter papers, water and thread

Apparatus: Retort stand with clamp

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

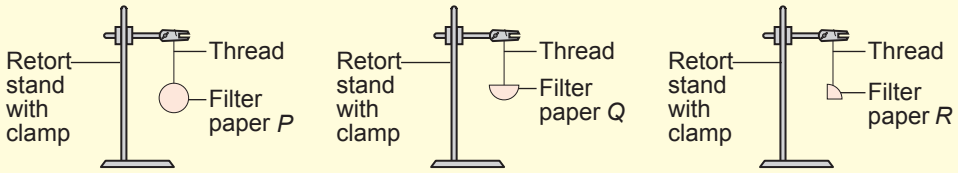


Figure 5.10

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

D Movement of air

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

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

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

Materials: Anhydrous cobalt chloride papers, cellophane tape and water

Apparatus: Microscope slides, fan and dropper

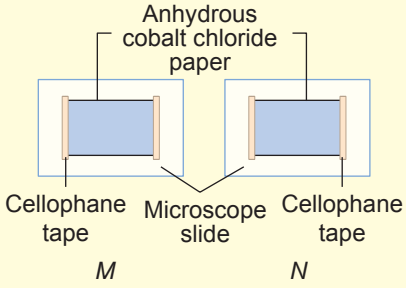


Figure 5.11

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

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

Questions

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

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

Brain Teaser

Why do we feel cold when we sweat?

Humidity

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

Surrounding temperature

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

Exposed surface area of water

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

Movement of air

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

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

Applications of Evaporation of Water in Daily Life

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

Sea salt is obtained from the evaporation of seawater.

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

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

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

Activity 5.4

21st Century

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

Instruction

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

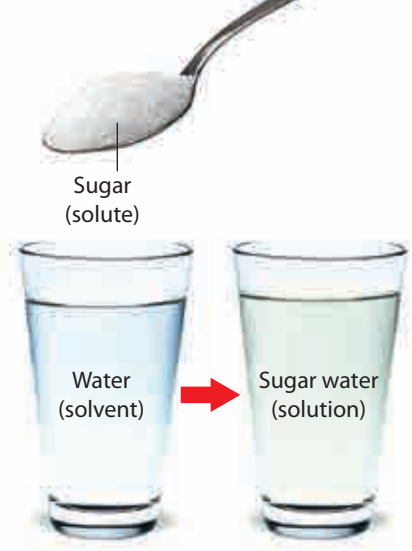
Formative Practice 5.1

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

5.2 Solution and Rate of Solubility

Solute, Solvent and Solution

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



Photograph 5.6
Formation of solution

Dilute Solution, Concentrated Solution and Saturated Solution

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

Activity 5.5

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

Materials: Distilled water and copper(II) sulphate crystal

Apparatus: Beaker, measuring cylinder, glass rod and spatula

Instruction

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

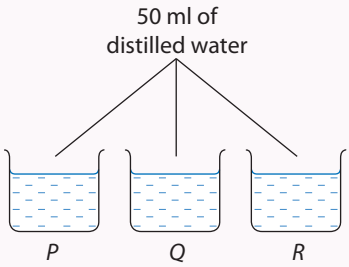


Figure 5.13

Observation

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

Questions

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

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

Table 5.1 *Comparison between different types of solutions*

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

Solution and Suspension

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

Figure 5.14 *River water is an example of suspension*

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

Activity 5.6

Aim: To distinguish between a solution and a suspension.

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

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

Instruction

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

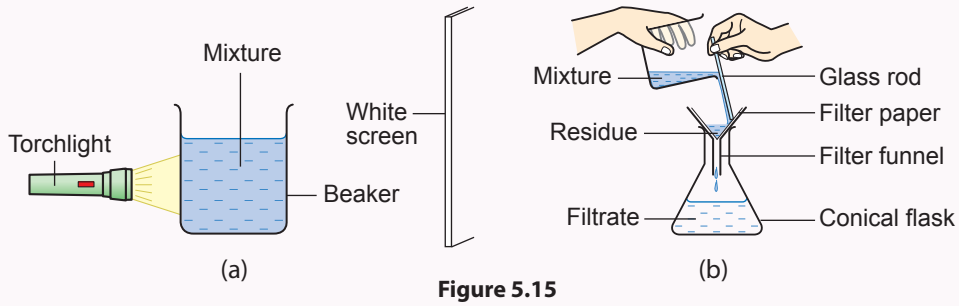


Figure 5.15

Questions

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

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

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

My Science World

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

Solubility

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

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

Rate of Solubility

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

Experiment 5.2

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

A Temperature of solvent

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

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

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

Materials: Distilled water and table salt

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

Procedure:

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

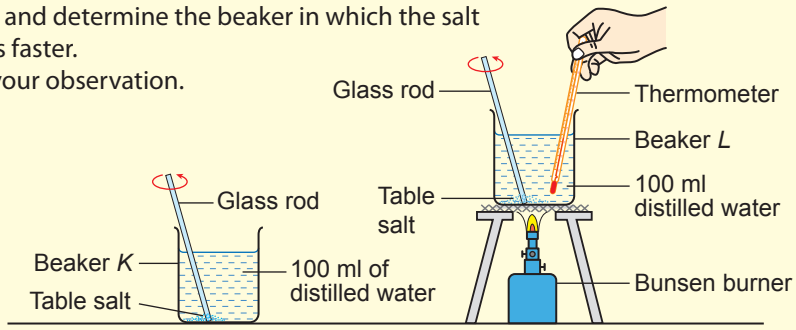


Figure 5.16

Conclusion:
Is the hypothesis accepted? Give your reason.

B Rate of stirring

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

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

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

Materials: Distilled water and table salt

Apparatus: Beaker, glass rod, measuring cylinder and spatula

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

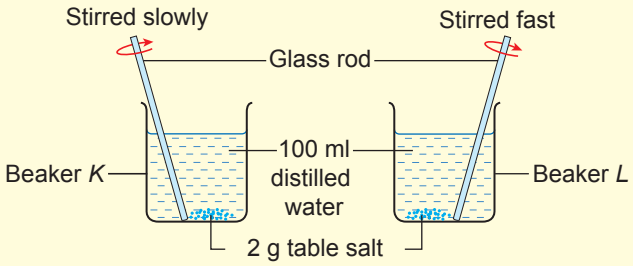


Figure 5.17

Conclusion:
Is the hypothesis accepted? Give your reason.

C Size of solute

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

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

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

Materials: Distilled water, fine sugar and sugar cubes

Apparatus: Beaker, measuring cylinder, glass rod and spatula

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

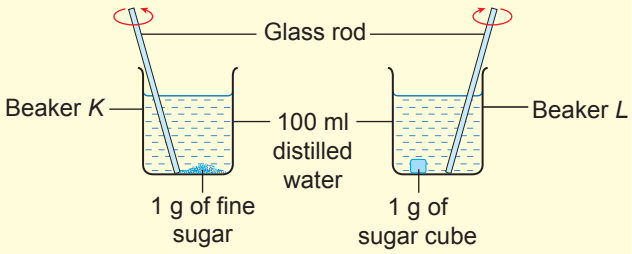


Figure 5.18

Conclusion:
Is the hypothesis accepted? Give your reason.

Summary:

Factor	Rate of solubility
Temperature	
Rate of stirring	
Size of solute	

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

Sugar dissolves faster in hot coffee when stirred.

Fine sugar dissolves faster compared to sugar cubes.

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

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

Photograph 5.7 *Factors affecting the rate of solubility*

Colloid

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

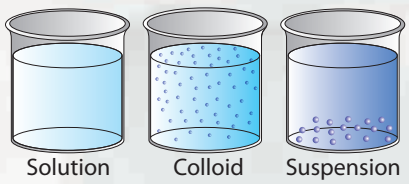


Figure 5.19

Foam – shaving cream

Emulsion – milk, mayonnaise

Photograph 5.8 *Examples of colloids in everyday life*

Water as a Universal Solvent

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

Fertilisers dissolve in water and are absorbed by the roots of plants.

Soft drinks are produced using water as a solvent.

Water dissolves detergents used in cleaning process.

Photograph 5.9 *Uses of water as a universal solvent*

Organic Solvents

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

Organic solvents

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

Figure 5.20 *Examples of organic solvents in everyday life*

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

Formative Practice 5.2

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

5.3 Water Purification and Water Supply

Water Purification Method

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

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

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

Activity 5.7

Aim: To study various water purification methods.

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

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

Instruction

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

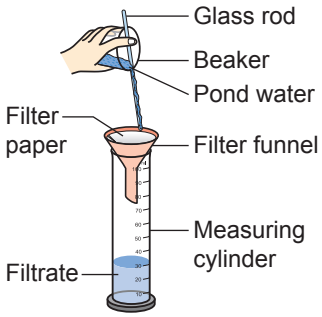


Figure 5.21(a)

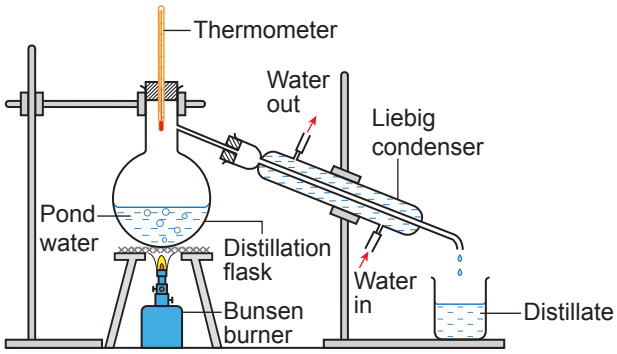


Figure 5.21(b)

Observation

Petri dish	Observation
A	
B	
C	
D	
E	

Questions

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

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

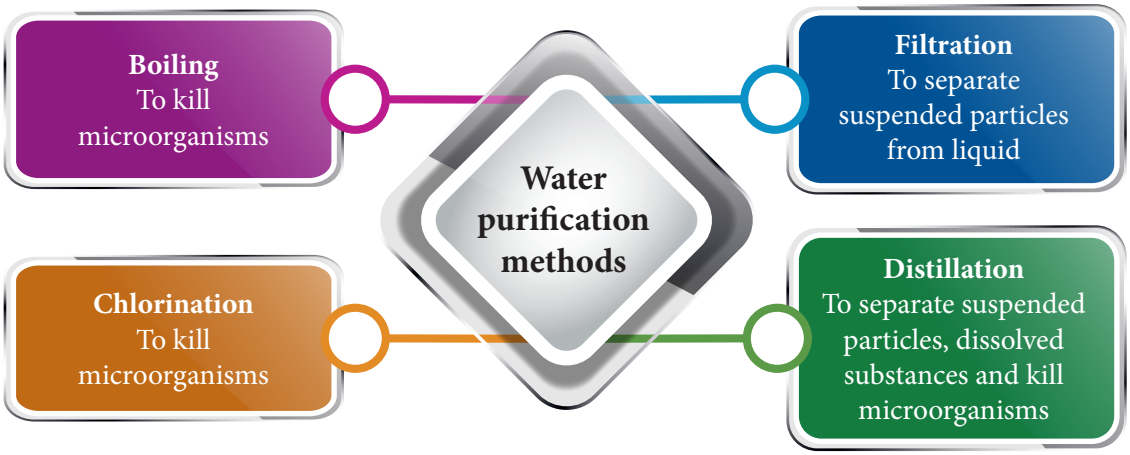


Figure 5.22 *Water purification methods*

Solving the Problems of Water Supply

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

Info

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

Activity 5.8

STEM

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

Instruction

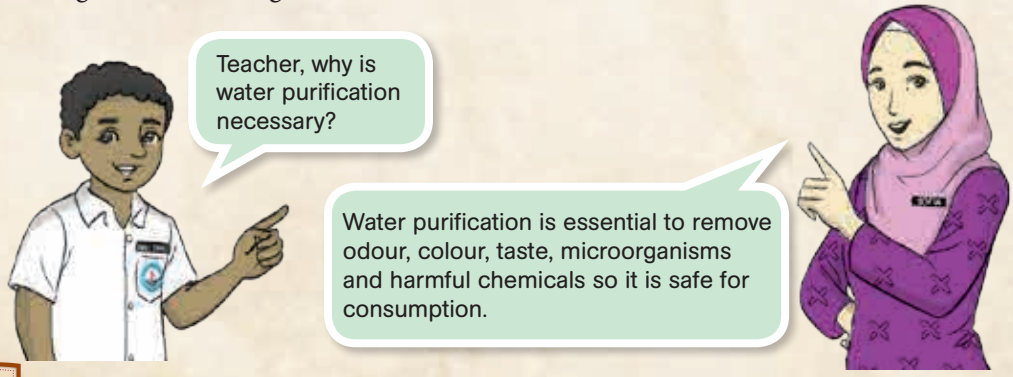
1. Work in groups.
2. Gather information on how the countries with water shortage find alternatives for water supply. The alternative methods include:
   (a) recycle of water
   (b) fog harvesting
   (c) water purification from seawater (reverse osmosis)
3. Present the outcomes using a multimedia presentation.

Career in STEM

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

Water Supply System

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



5.3.2

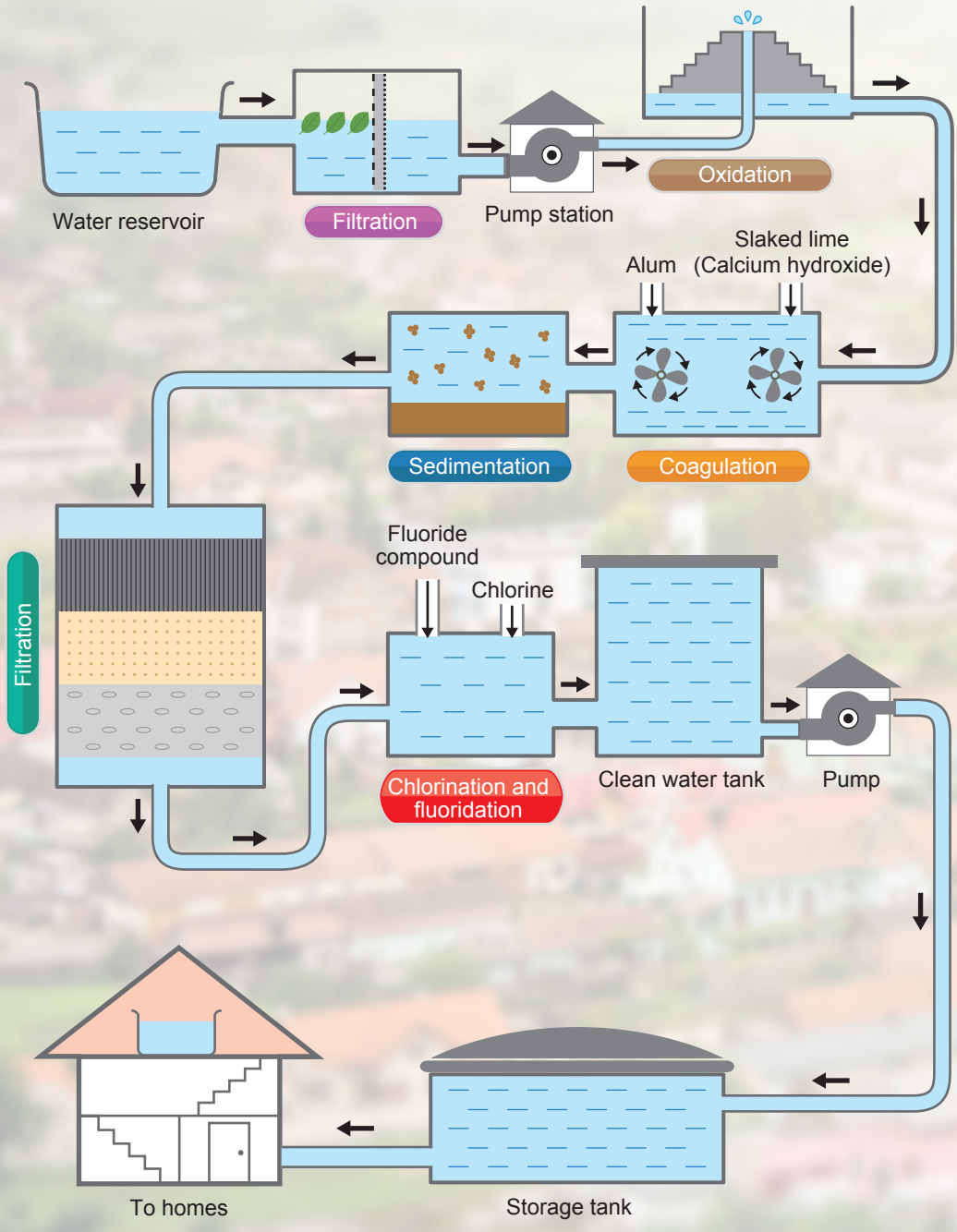


Figure 5.23 *The water supply system*

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

Figure 5.24 *Water purification process*

Activity 5.9

STEM 21st Century

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

Instruction

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

Water Sustainability

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

Photograph 5.10 *Water pollution*

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

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

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

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

Activity 5.10

Aim: To discuss water sustainability.

Instruction

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

Activity 5.11

STEM 21st Century

Aim: To carry out water audit activity.

Instruction

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

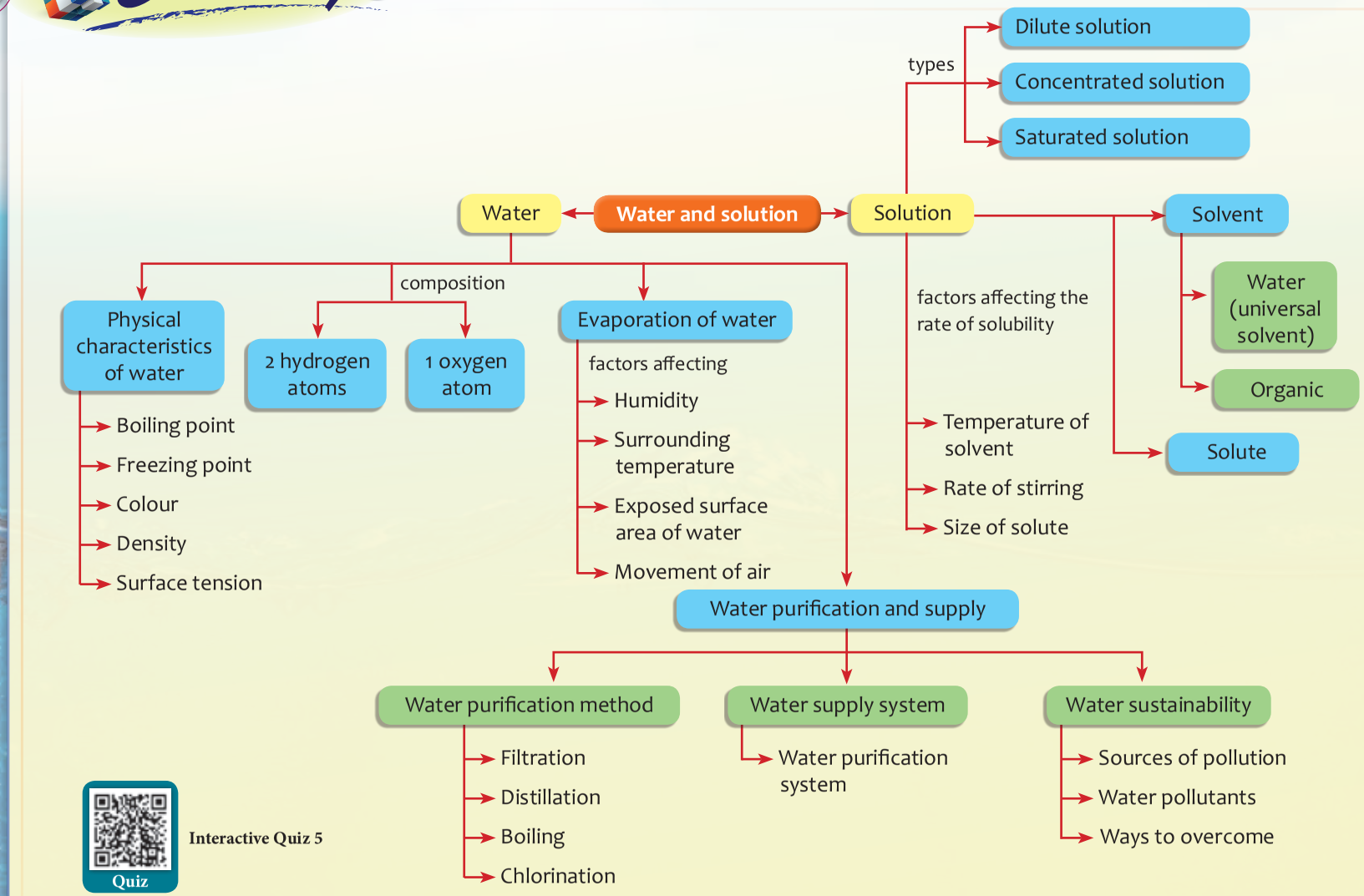
Formative Practice 5.3

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

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

5. Explain three ways to control water pollution.

Summary



Quiz

Interactive Quiz 5

SELF-REFLECTION

After learning this chapter, you are able to:

5.1 Physical Characteristics of Water

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

5.2 Solution and Rate of Solubility

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

5.3 Water Purification and Water Supply

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

Summative Practice 5

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

Photograph 1

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

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

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

3. Figure 1 shows the water evaporation process.

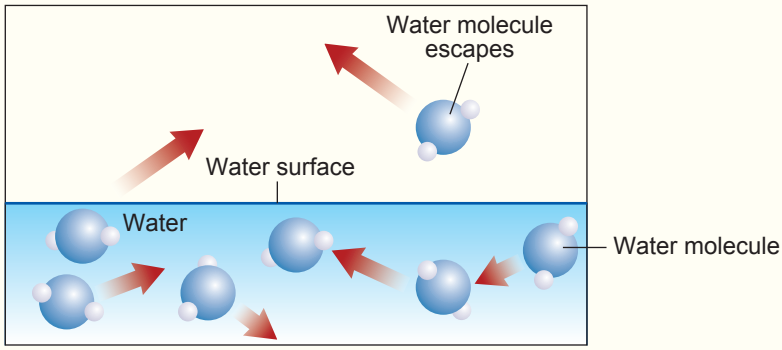
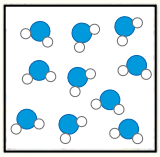


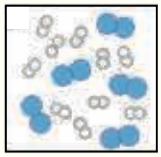
Figure 1

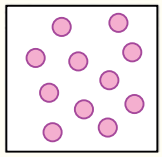
(a) Explain the process above using the Kinetic Theory of Matter.

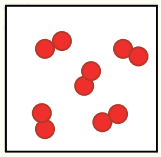
(b) State four factors that affect the water evaporation process. Explain two of them.

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

(i)  ☐

(ii)  ☐

(iii)  ☐

(iv)  ☐

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

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

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

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

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

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

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

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

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

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

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

(a) Which sample would become clear?

(b) Which sample would still contain suspended particles?

(c) Which sample would turn to pure water?

(d) In which sample would microorganisms be removed?

HOTS Mastery 5

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

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

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

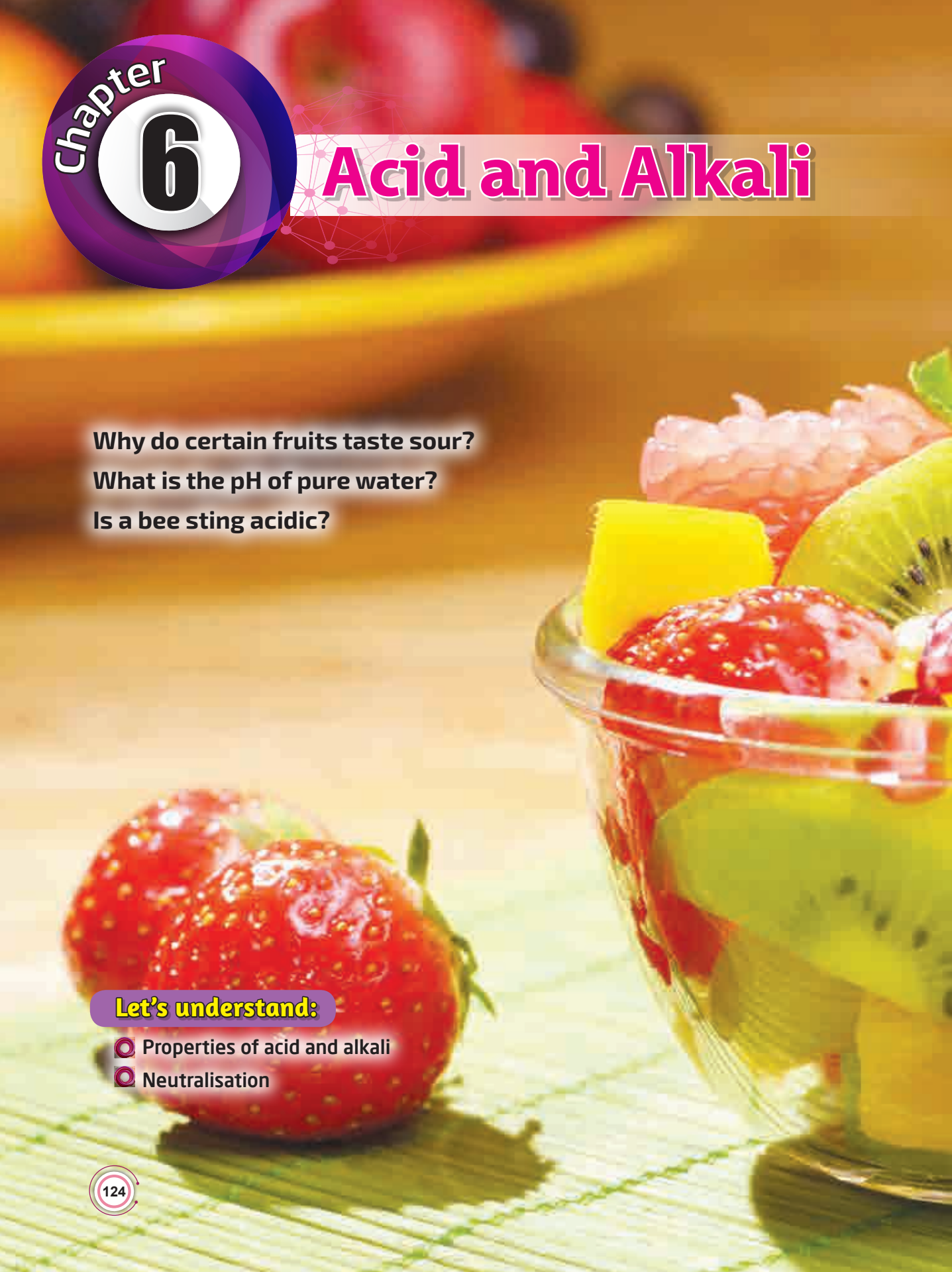
Chapter 6

Acid and Alkali

Why do certain fruits taste sour?

What is the pH of pure water?

Is a bee sting acidic?



Let's understand:

- Properties of acid and alkali
- Neutralisation

SCIENCE BLOG

The pH of Human Skin

The human skin acts as a natural barrier to fight infection by pathogens. The skin pH level plays an important role in fighting these infections.

Our skin has a thin protective layer known as acid mantle. This layer which is made of a combination of an oily substance (sebum) and sweat makes the skin acidic and protects the skin from the external environment.

Keywords

- Corrosiveness
- Blue litmus paper and red litmus paper
- pH value
- Neutralisation
- Universal indicator
- pH scale
- Phenolphthalein
- Titration

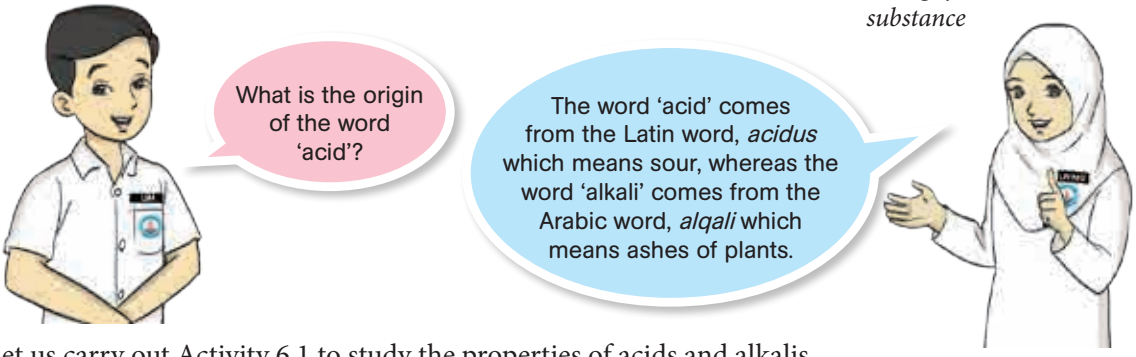
6.1 Properties of Acids and Alkalis

Try to recall the knowledge of acids and alkalis that you have learned in primary school. Acids and alkalis can be found in various substances used in our daily lives. What are the acidic and alkaline substances that you know?

Table 6.1 *Examples of acids and alkalis*

Acid	Alkali
Hydrochloric acid	Sodium hydroxide solution
Vinegar	Soap water

Photograph 6.1
Orange juice is an acidic substance



Let us carry out Activity 6.1 to study the properties of acids and alkalis.

Activity 6.1

Aim: To study the properties of acids and alkalis.

Materials: Dilute hydrochloric acid, concentrated hydrochloric acid, dilute sodium hydroxide solution, concentrated sodium hydroxide solution, lime juice, bitter gourd juice, magnesium ribbon, filter paper, sandpaper, blue litmus paper and red litmus paper, wooden splinter, matches, pH paper and pH chart

Apparatus: Test tube, dropper, Petri dish and white tile

Instruction

A pH value

1. Put 10 drops of dilute hydrochloric acid in a Petri dish.
2. Test the substance in the Petri dish with a piece of pH paper (Figure 6.1).
3. Determine the pH value by comparing the colour of the pH paper with a pH chart.
4. Record your observation.
5. Repeat steps 1 to 4 by replacing dilute hydrochloric acid with dilute sodium hydroxide solution.

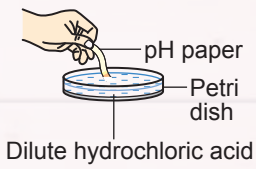


Figure 6.1

B Taste

1. Taste lime juice followed by bitter gourd juice. Gargle with water after tasting each substance.
2. Record your observations.

C Corrosiveness (Teacher's demonstration)

1. Put one drop of concentrated hydrochloric acid on a piece of filter paper placed on a white tile (Figure 6.2).
2. Record your observation.
3. Repeat steps 1 and 2 by replacing concentrated hydrochloric acid with concentrated sodium hydroxide solution.

Safety Precaution

- Carry out this activity in a fume chamber.
- Use the acid and alkali in small amounts.
- Wear safety goggles.

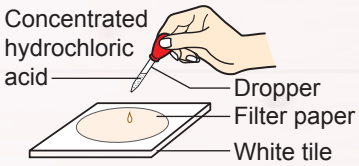


Figure 6.2

D Effect on blue litmus paper and red litmus paper

1. Place a blue litmus paper and a red litmus paper on a white tile.
2. Put one drop of dilute hydrochloric acid on both litmus papers and record your observations.
3. Repeat steps 1 and 2 by replacing dilute hydrochloric acid with dilute sodium hydroxide solution.

E Reaction with metals

1. Clean a magnesium ribbon with sandpaper.
2. Put the magnesium ribbon into a test tube filled with 5 ml of dilute hydrochloric acid.
3. Close the test tube with your thumb for one minute.
4. Remove your thumb and place a lighted wooden splinter at the mouth of the test tube (Figure 6.3).
5. Record your observation.
6. Repeat steps 1 to 5 by replacing dilute hydrochloric acid with dilute sodium hydroxide solution.

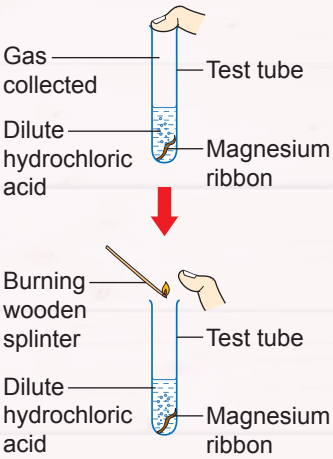


Figure 6.3

Observation

Activity \ Substance	Acidic	Alkaline
A		
B		
C		
D		
E		

Questions

1. What is the pH range of alkalis?
2. Give an inference for your observation in Activity E.
3. Why should the magnesium ribbon be cleaned with sandpaper before using it?
4. Predict the taste of vinegar and neem.
5. Give the operational definition of an acid and an alkali.

After carrying out Activity 6.1, can you identify the properties of acids and alkalis? Table 6.2 summarises the properties of an acid and an alkali.

Table 6.2 *Properties of an acid and an alkali*

Acid	Alkali
pH value less than 7	pH value more than 7
Tastes sour	Tastes bitter
Corrosive	Corrosive
Turns blue litmus paper red	Turns red litmus paper blue
Reacts with metals to produce hydrogen gas	Does not react with metals

The Role of Water in Showing the Properties of Acids and Alkalis

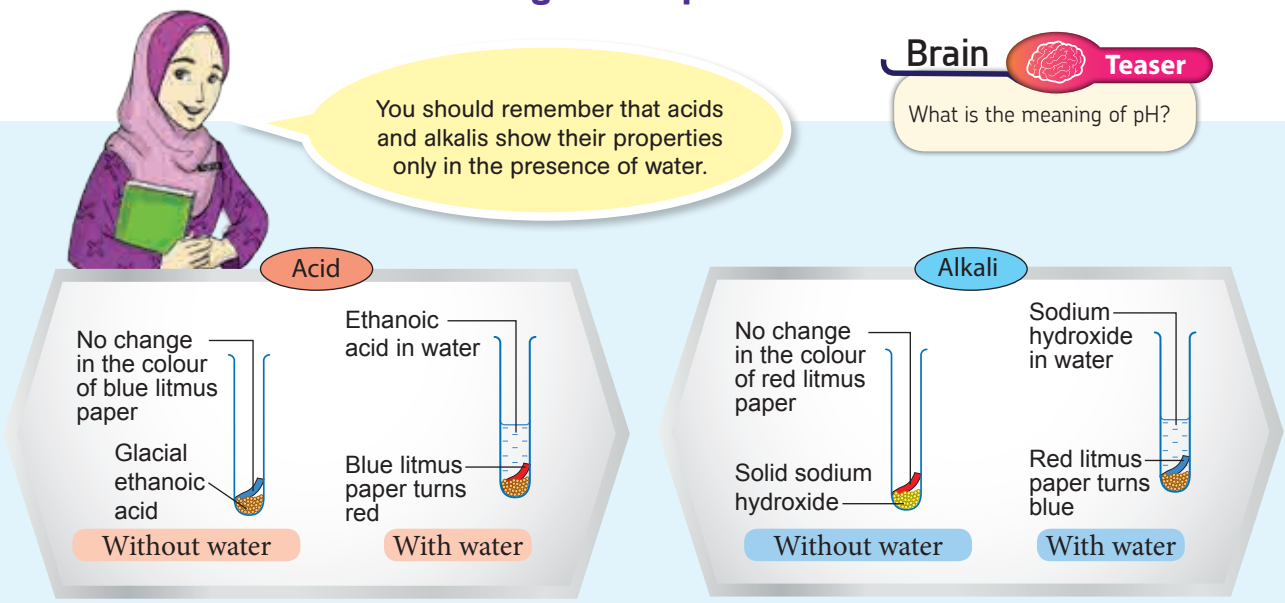


Figure 6.4 *Acids and alkalis show their properties in the presence of water*

Acidic and Alkaline Substances

Substances that contain acids are known as **acidic substances**, whereas substances that contain alkali are known as **alkaline substances**. Various foods in the kitchen can be classified into acidic and alkaline substances. For example, apples and coffee are acidic substances while baking soda is alkaline. Can you name another alkaline substance found in your kitchen?

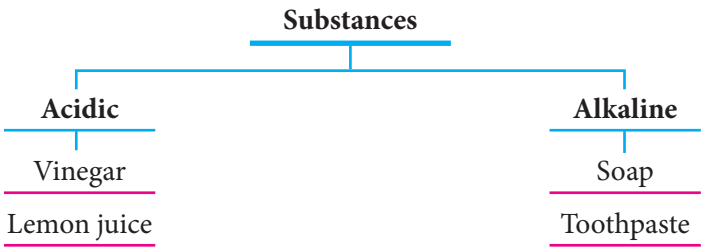


Figure 6.5 *Examples of acidic and alkaline substances*

The characteristic of different substances can be determined using a suitable **indicator**.

An indicator is a colouring or a mixture of different colourings that changes colour based on the substance tested. The colour change observed can be used to determine if a substance is neutral, acidic or alkaline.

Info

Indicator
http://www.bbc.co.uk/

Table 6.3 *Colour change of various indicators*

Indicator	Acid	Neutral	Alkali
Phenolphthalein	Colourless	Colourless	Pink
Universal indicator	Red	Green	Blue
Methyl orange	Red	Yellow	Yellow
Blue litmus paper	Red	Blue	Blue
Red litmus paper	Red	Red	Blue

Activity 6.2

Aim: To determine acidic and alkaline substances in daily life using various indicators.

Materials: Blue litmus paper, red litmus paper, universal indicator, methyl orange, phenolphthalein, fizzy drink, dishwashing liquid, distilled water, syrup and salt water

Apparatus: Dropper, test tube, measuring cylinder, pH meter and test tube rack

Note: *The colours of substances tested with the universal indicator should be compared with the pH chart.*

Instruction

1. Add 2 ml of a fizzy drink, dishwashing liquid, distilled water, syrup and salt water into separate test tubes, then place them in a test tube rack.
2. Test these substances with blue litmus paper and red litmus paper.
3. Record your observations in a table.
4. Repeat steps 1 to 3 by replacing the litmus papers with universal indicator, methyl orange, phenolphthalein and pH meter.

Observation

Substance	Indicator					Acid/ Alkali
	Blue litmus paper and red litmus paper	Universal indicator	Methyl orange	Phenolphthalein	pH meter	
Fizzy drink						
Dishwashing liquid						

Questions

1. What is the advantage of using universal indicator compared to litmus paper?
2. What is your inference on a substance that has a pH value of 7?

Strength of Acids and Alkalis

The **pH scale** is used to show the **strength** of acids or alkalis. The **range of pH value** is between 0 to 14. What is the relationship between the pH value and the strength of an acid and alkali?

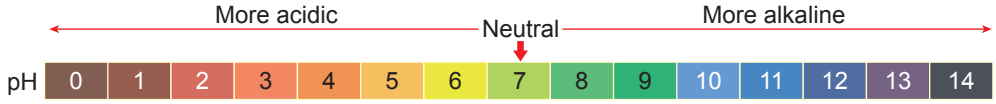


Figure 6.6 *The pH scale*

Activity 6.3

Aim: To study the relationship between the pH value and the strength of an acid and alkali.

Materials: pH paper, 0.1 M hydrochloric acid, sodium hydroxide solution, 0.1 M ethanoic acid, ammonia solution, pH chart and salt solution

Apparatus: Measuring cylinder, test tube and test tube rack

Note: *Make sure all the solutions used have the same concentration.*

Instruction

1. Pour 2 ml of hydrochloric acid into a test tube.
2. Test the substance in the test tube with a pH paper.
3. Observe the colour change of the pH paper and compare it with a pH chart to determine the pH value.
4. Record your observation in a table.
5. Repeat steps 1 to 4 by replacing hydrochloric acid with the other substances.

Observation

Substance	Hydrochloric acid	Sodium hydroxide solution	Ethanoic acid	Ammonia solution	Salt solution
pH value					

Questions

1. Relate the strength of acid to the pH value.
2. Identify the substance which is a:
   (a) strong acid (d) weak alkali
   (b) strong alkali (e) neutral solution
   (c) weak acid
3. Predict the pH value of rain water in an industrial area. Explain your answer.

After carrying out Activity 6.3, we can conclude that the lower the pH value, the stronger the acid; the higher the pH value, the stronger the alkali.

Uses of Acids and Alkalis in Daily Life

Acids and alkalis are widely used in our daily lives. For instance, we use vinegar which is acidic in cooking, and detergent which is alkaline for washing clothes. Besides, acids and alkalis are also used in various sectors such as the **agricultural**, **industrial** and **medical** sectors. For example, fertilisers used in agriculture are produced from the reaction between acidic and alkaline substances. Can you name the alkaline substance?

Brain Teaser

What will happen to crops if the acidity of soil increases?

Photograph 6.2 *Ammonia solution is used to produce fertilisers*

Let us carry out Activity 6.4 to find out the usage of acids and alkalis in daily life.

Activity 6.4

21st Century

Aim: To gather information on the usage of acids and alkalis in daily life.

Instruction:

1. Work in groups.
2. Gather information on the usage of acids and alkalis in daily life including agricultural and industrial sectors.
3. Present the finding using a mind map.

ACID

Tartaric acid

Tartaric acid

Fizzy drink

Carbonic acid

Car battery

Sulphuric acid

Pickle

Vinegar

ALKALI

Soap

Potassium hydroxide

Fertiliser

Ammonia

Antacid pills

Magnesium hydroxide

Detergent

Sodium hydroxide

Photograph 6.3 *Uses of acids and alkalis in daily life*

Formative Practice 6.1

1. Predict the arrangement of the following substances in decreasing order of pH value.

Orange juice | Bitter gourd juice | Hydrochloric acid | Mineral water

2. Explain the reason why the labels of acid and alkali bottles have the symbol as in the diagram below.

3. The colour of liquid *X* changes from green to red when universal indicator is added.
(a) Determine whether liquid *X* is acidic, neutral or alkaline.
(b) Predict the colour of liquid *X* if a few drops of methyl orange are added into it.

4. Arrange the following substances in increasing order of acid strength.

Pineapple juice: pH 4 | Fresh milk: pH 6 | Vinegar: pH 2

6.2 Neutralisation

What will happen if an acid is mixed with an alkali? The reaction between an acid and an alkali produces **salt** and **water**. This reaction is called **neutralisation**. During neutralisation, an acid loses its acidity while an alkali loses its alkalinity. The method used to carry out this reaction is called **titration**. The word equation for this neutralisation reaction is:

Acid + Alkali → Salt + Water

Different acids and alkalis produce different salts. For example:

Hydrochloric acid	+	Sodium hydroxide	→	Sodium chloride	+	water
Sulphuric acid	+	Potassium hydroxide	→	Potassium sulphate	+	water
Nitric acid	+	Sodium hydroxide	→	Sodium nitrate	+	water

Activity 6.5

Aim: To study the neutralisation reaction between hydrochloric acid and sodium hydroxide solution.

Materials: Phenolphthalein, 0.5 M hydrochloric acid and 0.5 M sodium hydroxide solution

Apparatus: Burette, pipette, conical flask, retort stand with clamp, white tile and filter funnel

Instruction

1. Fill 30 ml of hydrochloric acid into a burette using a filter funnel and record the initial reading of the burette.
2. Transfer 25 ml of sodium hydroxide solution into a conical flask using a pipette.
3. Add three drops of phenolphthalein into the conical flask. Set up the apparatus as shown in Figure 6.7.
4. Add the hydrochloric acid from the burette drop by drop into the conical flask while shaking the flask gently.
5. Stop adding the acid when the sodium hydroxide solution changes colour from pink to colourless.
6. Record the final reading of the burette.

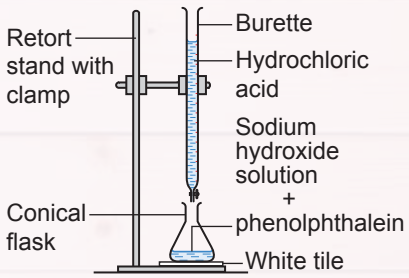


Figure 6.7

Observation

Initial reading of the burette (ml)	
Final reading of the burette (ml)	
Volume of hydrochloric acid used (ml)	

Questions

1. What is the volume of hydrochloric acid required to neutralise 25 ml of sodium hydroxide solution?
2. Write the word equation for the reaction between the acid and alkali in this activity.

Applications of Neutralisation in Daily Life

Neutralisation has many applications in our daily lives. Besides, it is also used in the agricultural and industrial sectors.

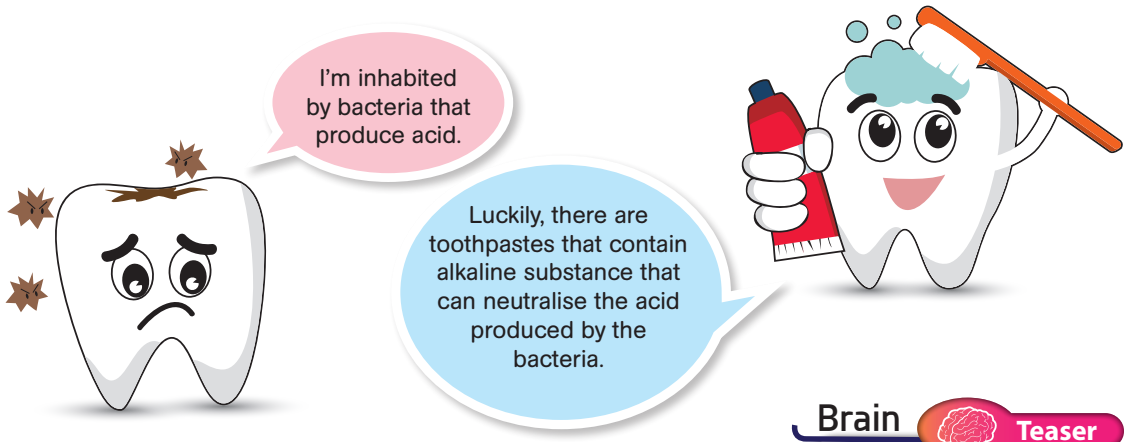


Figure 6.8 *Application of neutralisation of acid on dental care*

Brain Teaser

How can alkaline shampoo and acidic hair conditioner be combined into a 2 in 1 shampoo bottle?

Photograph 6.4 *Applications of neutralisation in self-care products*

Acidic soil can be treated by adding slaked lime which is alkaline in order for plants to grow well.

Fabric softeners are acidic, thus they reduce the pH level of fabrics which become alkaline after being washed with detergents.

Acidic waste substances from factories are treated with alkalis before being discharged into the river.

Photograph 6.5 *Applications of neutralisation in the agricultural and industrial sectors*

Formative Practice 6.2

1. (a) Complete the following equation.

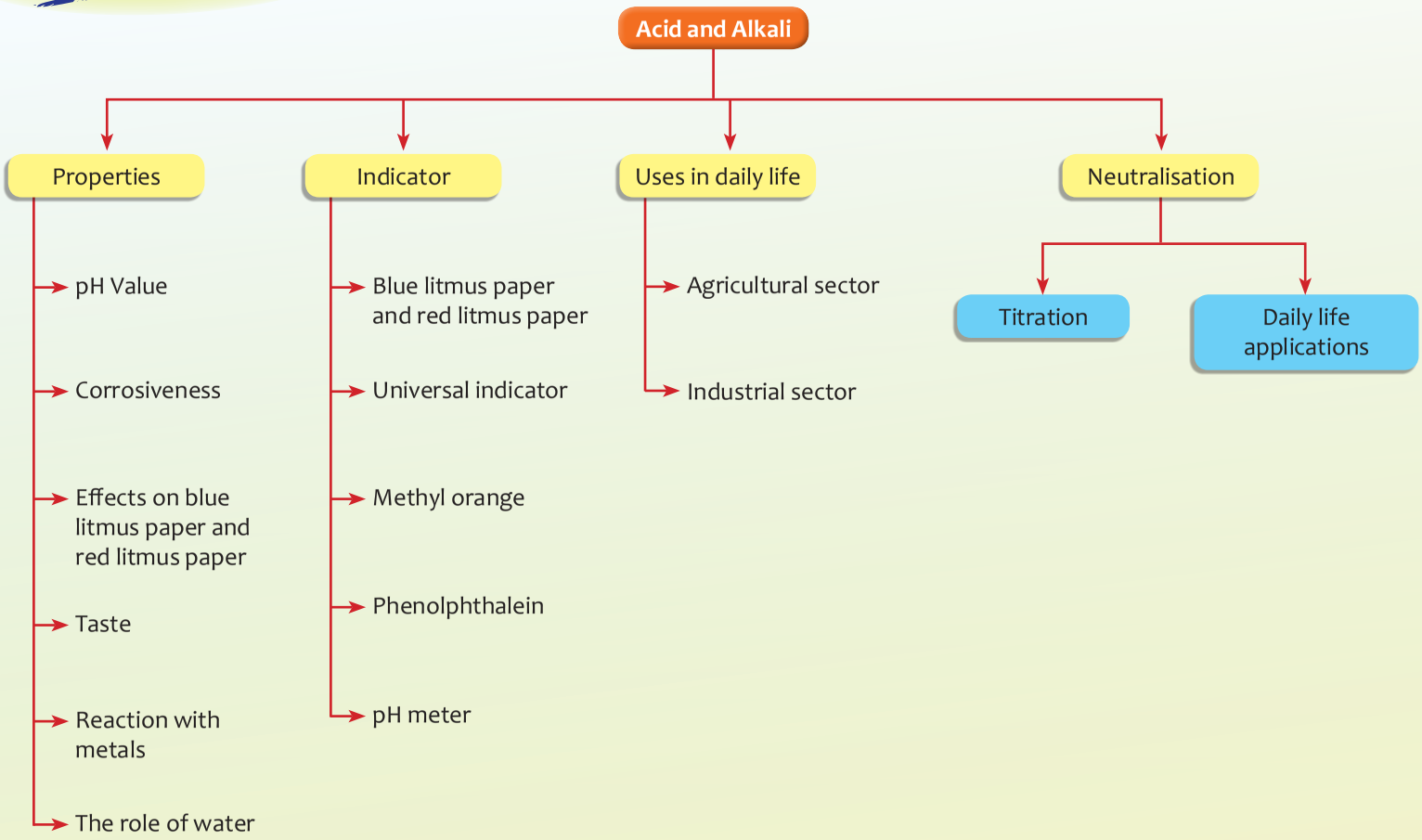
Acid + Alkali → ____ + ____

(b) If sulphuric acid and sodium hydroxide solution are added together, what would be the product?
Write down your answer in a word equation.

2. Explain how toothpaste works in cleaning teeth and preventing dental caries.

3. Is hair conditioner important? Explain your answer.

Summary



Quiz

Interactive Quiz 6

SELF-REFLECTION

After learning this chapter, you are be able to:

6.1 Properties of Acids and Alkalis

- ☐ Define operationally acid and alkali.
- ☐ Explain with examples of acidic and alkaline substances.
- ☐ Demonstrate the technique to determine the strength of acid and alkali based on pH value.
- ☐ Identify the uses of acids and alkalis in daily life.

6.2 Neutralisation

- ☐ Explain the neutralisation reaction.
- ☐ Explain with examples the applications of neutralisation reaction in daily life.

Summative Practice 6

1. The following is a list of several substances.

Malic acid	Formic acid	Potassium hydroxide solution

Based on the list above, answer the following questions.

(a) Which substance has the pH value of less than 7?

(b) State the substance found in

(i) fire ants

(ii) green apples

(c) Predict your observation if a magnesium ribbon is put in potassium hydroxide solution and tested with a lighted wooden splinter.

2. (a) Shida wants to carry out an activity to determine the pH value of ammonia gas. Based on your knowledge of acid and alkali, explain how Shida can determine the pH value of the ammonia gas.

(b) State one advantage of pH paper compared to litmus paper.

(c) Grace added two drops of phenolphthalein into colourless solution *M*. She found that the solution remained colourless.

(i) Is solution *M* acidic? Explain your answer.

(ii) Suggest another test that should be carried out to strengthen your answer in (i).

3. Figure 1 shows the reactions of blue litmus paper and red litmus paper when tested with three different solutions.

Figure 1

(a) Based on your observation, classify the solutions into two groups according to their common characteristics.

(b) State two other characteristics of each group that you stated in **3** (a).

(c) State one example of daily life substance that has the characteristic as
(i) solution *P*
(ii) solution *Q*

4. Amran was stung by a jellyfish when he was swimming in the sea with his friends. The part of his body stung by the jellyfish became red and swollen. The pain became worse when his friend applied soap and toothpaste on the affected area.

(a) Explain why Amran's pain became worse when applied with soap and toothpaste.

(b) Suggest a way to reduce Amran's pain.

HOTS Mastery 6

5. (a) Kiran was cleaning the fish she bought from the market. The fishy smell made her feel sick. Suggest one way to remove the fishy smell.

(b) How can you neutralise vinegar using sodium hydroxide solution? State the procedure for this activity.

6. A farmer found out that his agricultural land is not fertile. His son carried out simple tests on the soil sample to identify the cause. Table 1 shows the tests carried out and the observations obtained.

Table 1

Test	Observation
Soil sample + Baking soda + Water	Gas bubbles are observed
Soil sample + Vinegar	No gas bubbles are observed

(a) Based on the observation for both tests on the soil sample, what can be concluded?

(b) Relate your answer in **6** (a) with infertility of the soil.

(c) Suggest and explain one way to overcome the farmer's problem.

THEME 3

Energy and Sustainability of Life

- What is electricity and magnetism?
- What is force?
- How is force measured?
- What is the main source of energy on Earth?
- How do liquids react with heat?
- Why do different music instruments produce different sound?

Chapter 7

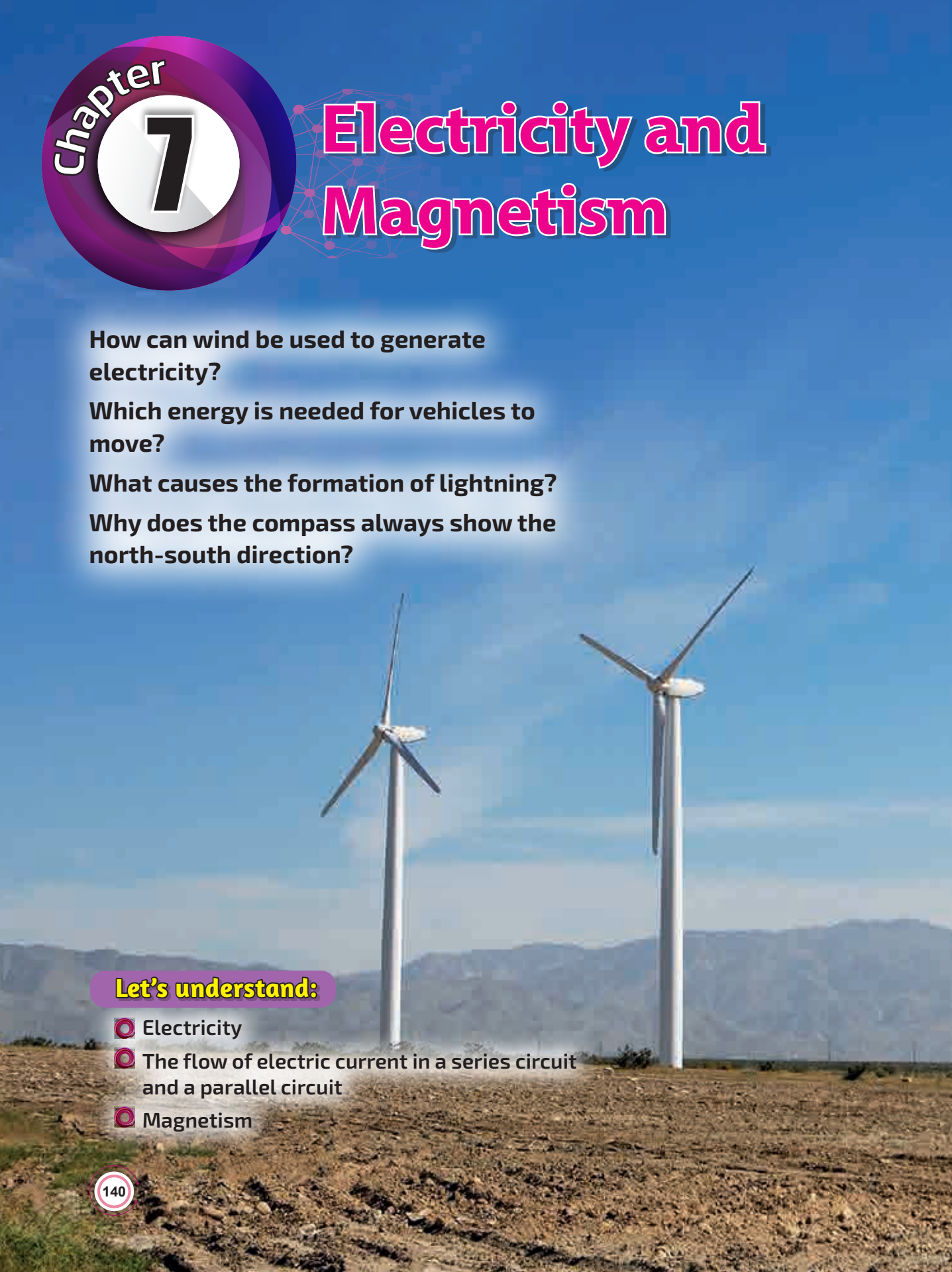
Electricity and Magnetism

How can wind be used to generate electricity?

Which energy is needed for vehicles to move?

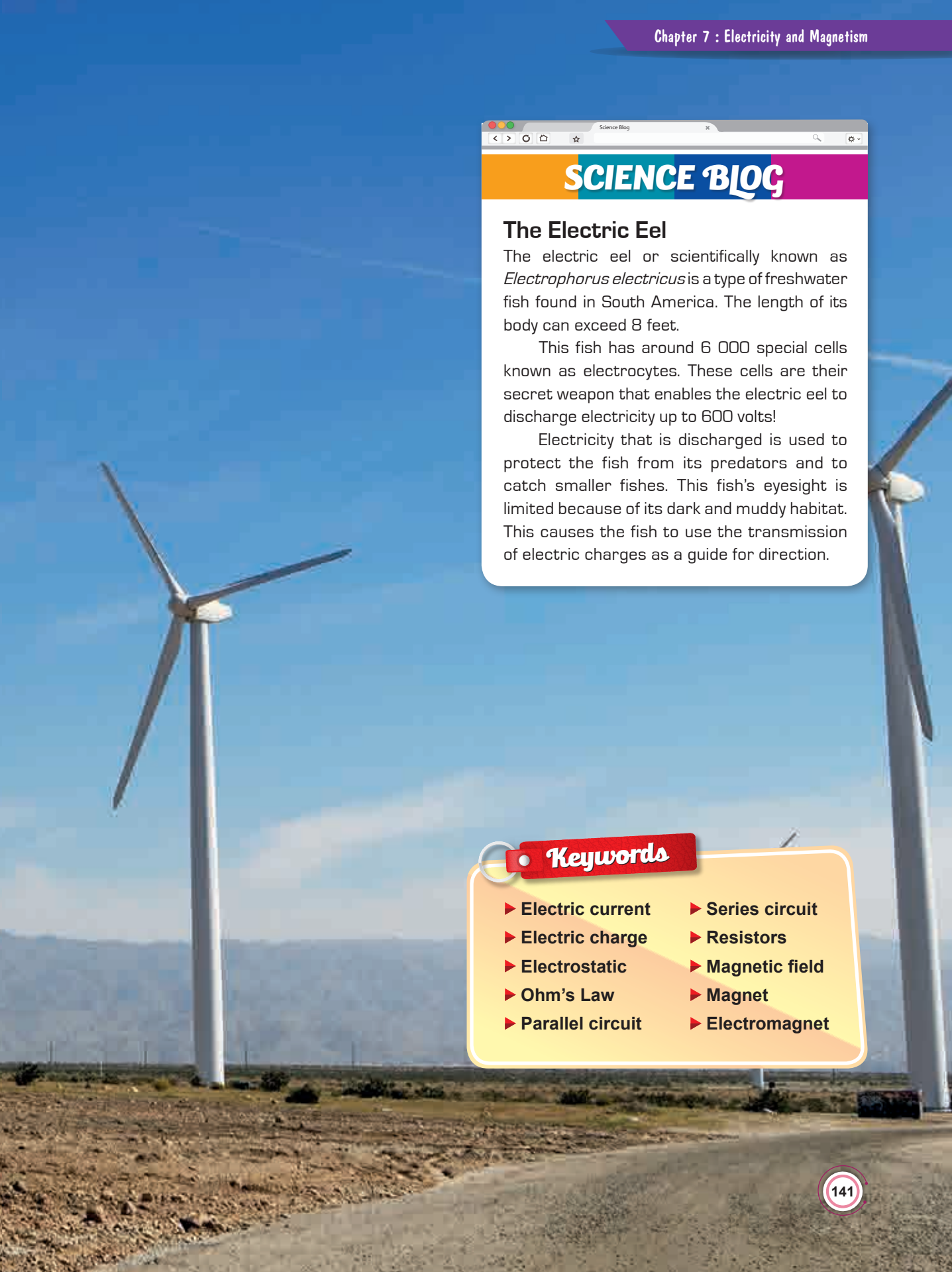
What causes the formation of lightning?

Why does the compass always show the north-south direction?



Let's understand:

- Electricity
- The flow of electric current in a series circuit and a parallel circuit
- Magnetism



SCIENCE BLOG

The Electric Eel

The electric eel or scientifically known as *Electrophorus electricus* is a type of freshwater fish found in South America. The length of its body can exceed 8 feet.

This fish has around 6 000 special cells known as electrocytes. These cells are their secret weapon that enables the electric eel to discharge electricity up to 600 volts!

Electricity that is discharged is used to protect the fish from its predators and to catch smaller fishes. This fish's eyesight is limited because of its dark and muddy habitat. This causes the fish to use the transmission of electric charges as a guide for direction.

Keywords

- Electric current
- Electric charge
- Electrostatic
- Ohm's Law
- Parallel circuit
- Series circuit
- Resistors
- Magnetic field
- Magnet
- Electromagnet

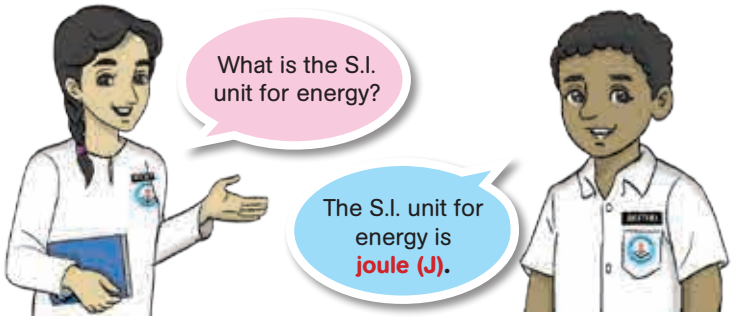
7.1 Electricity

Do you still remember the topic on electricity that you have learned during primary school? Various home appliances such as the washing machine, television, computer and others use electricity to function.

Energy

All living things need energy. A moving vehicle, a lighted bulb, and a sleeping cat use energy. What does energy mean? **Energy** means the ability to do **work**. Can you state a few daily activities that use energy?

Photograph 7.1 *Various uses and needs of energy*



Forms of Energy

Energy cannot be created nor destroyed but it can exist in **various forms**. Photograph 7.2 shows various forms of energy that exist around us. Can you give another example for each of the following types of energy?


Sound energy


Kinetic energy


Electrical energy


Gravitational potential energy


Elastic potential energy


Light energy


Nuclear energy


Heat energy


Chemical energy

Photograph 7.2 *Various forms of energy*

Sources of Energy

You have learned various forms of energy that exist. What are the sources used to generate energy? Figure 7.1 shows various sources of energy that exist around us.

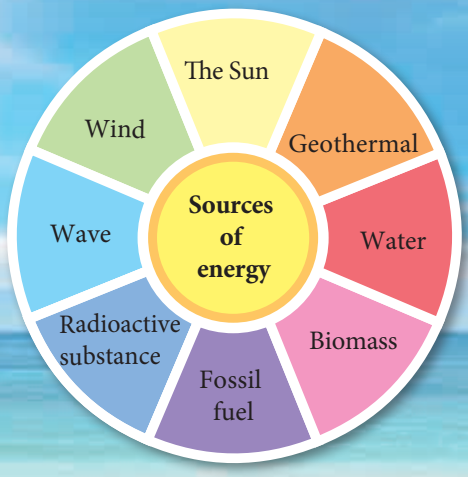


Figure 7.1 *Various sources of energy*

Brain Teaser

Does nuclear energy produce radioactive wastes?

Activity 7.1

21st Century

Aim : To discuss energy.

Instruction

1. Work in groups.
2. Discuss:
   (a) the importance of energy in our daily lives
   (b) forms of energy
   (c) sources of energy
3. Use various sources to gather these information.
4. Present your discussion in the form of a multimedia presentation.

Electrostatic Charges

Have you ever felt an electric shock when you touched a door knob? Why does this happen? It happens as a result of the transfer of electric charges between our body and the door knob that has static electric charges. These static charges are known as **electrostatic charges**. Let us carry out Activity 7.2 to show the existence of electrostatic charges on different types of materials.

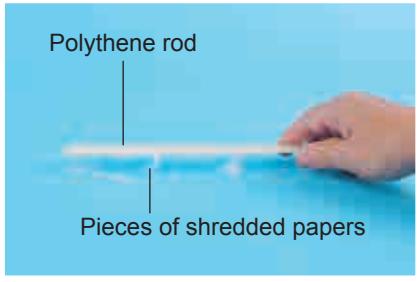
Activity 7.2

Aim: To test the existence of electrostatic charges on certain materials.

Note: *Make sure that all the apparatus are dry.*

Materials: Balloon, pieces of shredded paper and stream of running tap water

Apparatus: Polythene rod, cellulose acetate strip and woollen cloth



Photograph 7.3

Instruction

1. Rub a polythene rod with a woollen cloth.
2. Hold the rod close to pieces of shredded paper (Photograph 7.3) and record your observation.
3. Repeat step 1.
4. Hold the rod close to a small stream of running tap water and record your observation.
5. Repeat steps 1 to 4 using a cellulose acetate strip and a balloon to replace the polythene rod.

Questions

1. Give an inference for your observation.
2. What other methods can be used to test the existence of electrostatic charges on the balloon? Explain the steps taken.

Info

Tap Water and Electrostatic Charges
https://www.thoughtco.com/bend-water-with-static-electricity-604268

Based on your observation in Activity 7.2, how are the electrostatic charges between the objects produced? Electric charges consist of positive charges (proton) and negative charges (electron). The attraction and repulsion between the electric charges shown in Figure 7.2 are known as **electrostatic forces**.

When two different types of objects are rubbed together, only the electrons are transferred from one object to the other, whereas the protons do not move. The object that gains electrons will be negatively charged. The object that loses electrons will be positively charged. The object that has equal number of protons and electrons is known as neutral.

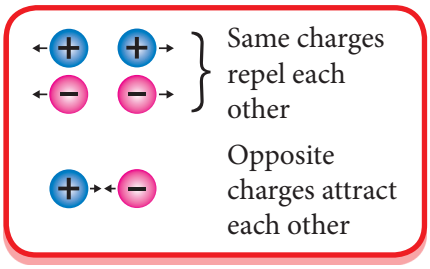
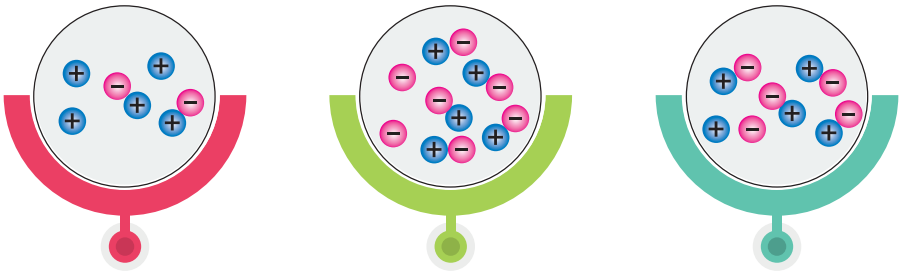


Figure 7.2 *Properties of electric charges*



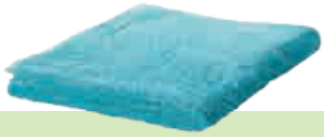
The number of protons is more than the electrons
Positively charged

The number of electrons is more than the protons
Negatively charged

The number of protons and electrons is equal
Neutral

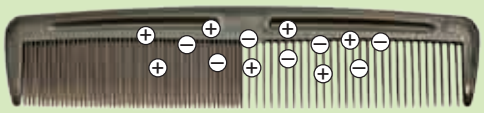
Figure 7.3 *The number of electrons on objects*

Look at Figure 7.4 to understand the effect of electrostatic charges on a plastic comb that has been rubbed with a piece of woollen cloth.

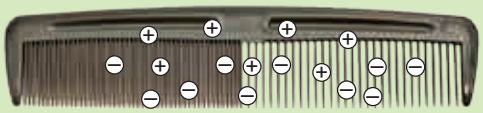


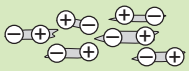
Before being rubbed with the woollen cloth

After being rubbed with the woollen cloth

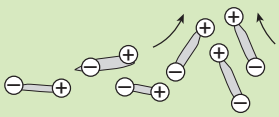


Neutral comb





Pieces of neutral shredded paper

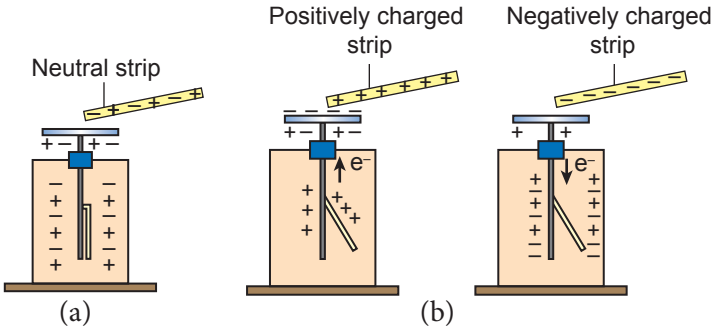


The comb rubbed with the woollen cloth will gain electrons from the woollen cloth and will be negatively charged. This enables the comb to attract the pieces of paper because of the force of attraction that exist between the positive charges on the pieces of paper and the negative charges on the comb.

Figure 7.4 *Effect of production of electrostatic charges*

Electroscope

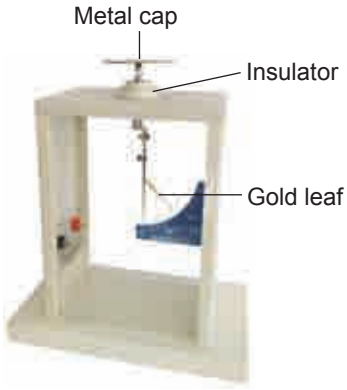
An electroscope is a device used to detect the **existence of electric charges** on an object.



The gold leaf does not diverge because the positive and negative charges are attracted to one another.

The gold leaf diverges because the same charges repel each other.

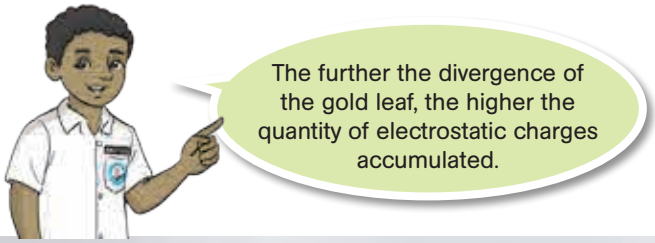
Figure 7.5 *How the electroscope works*



Photograph 7.4 *An electroscope*

Today in History

The first gold leaf electroscope was invented by a physicist, Abraham Bennet in 1787.



Examples of Electrostatic in Our Daily Life

The occurrence of lightning is one of the phenomena that is related to electrostatic charges. The friction between clouds and air causes the clouds to be charged with electric charges. Lightning is a result of the force of attraction that exists between the positive charges on the ground and the negative charges in the clouds.

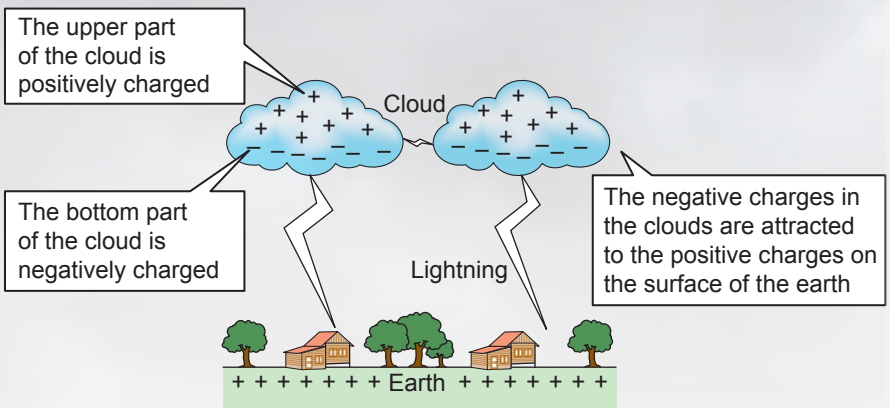


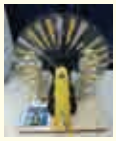
Figure 7.6 *Lightning*

Science Info

The lightning conductor is installed at buildings to provide a path for the electric charges to flow into the ground. This method protects the building from being struck by lightning.

Simulation of lightning can be carried out in the school laboratory by using a Van de Graaff generator or Wimhurst machine. Carry out Activity 7.3 to observe the simulation of lightning.

Science Info



Wimhurst machine is a device for generating high voltages.

Activity 7.3

21st Century

Aim: To carry out a simulation of lightning formation by using the Van de Graaff generator.

Apparatus: Van de Graaff generator

Instruction

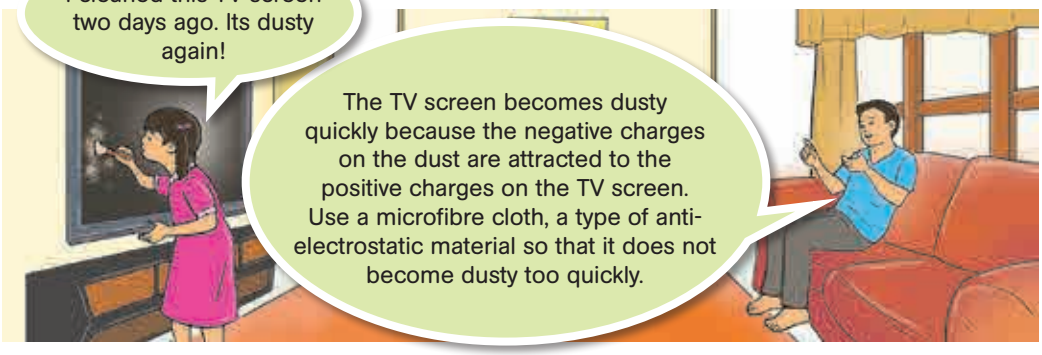
1. Switch on the Van de Graaff generator.
2. After a few minutes, move the metal sphere closer to the dome and record your observation.

Questions

1. What is your observation in this activity?
2. What will happen if the metal cap of an electroscope is brought closer to the dome of the Van de Graaff generator?

Photograph 7.5

Solving Daily Life Problems Involving Electrostatic



Activity 7.4

STEM 21st Century

Aim: To gather information and solve daily life problems involving electrostatic.

Instruction

1. Work in groups.
2. Gather information on the following problems that involves electrostatic. Discuss how to solve them.
   (a) The choice of fabric to be worn in hot weather
   (b) Safe shelters during a thunderstorm (use Faraday's cage concept)
3. Share your findings with the class.

Electric Current

Electrical appliances require electric charges to operate. Energy that is needed for the electric charges to flow can be generated from sources such as electrical generators, dry cells and solar cells. What is the relationship between electric charges and electric current?

Photograph 7.6 *Dry cells*

Activity 7.5

Aim: To study the relationship between electric charges and electric current.

Apparatus: Van de Graaff generator, galvanometer and connecting wire

Safety Precaution

Make sure all the apparatus are dry and neutral.

Instruction

1. Set up the apparatus as shown in Figure 7.7.
2. Switch on the Van de Graaff generator and observe the pointer on the galvanometer.

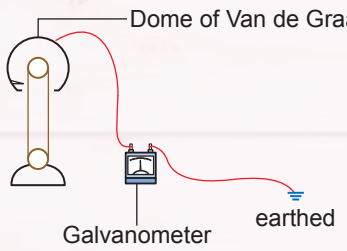


Figure 7.7

Science Info

A galvanometer is used to detect very small electric currents.

Questions

1. What happens to the galvanometer's pointer? Explain.
2. How do you show the existence of electric charges on the dome of the generator?
3. State the meaning of electric current.

The deflection of the galvanometer's pointer indicates the flow of the electric current. Electric current can be defined as the **rate of flow of electric charges** through a conductor.

Measuring the Quantity of Electricity

The flow of electric current can be measured by using an **ammeter**. You have learned in Form One that the S.I. unit for electric current is **ampere (A)**. The voltage is the potential difference between two points that can be measured in **volt (V)** by using a **voltmeter**.

Photograph 7.7 *Voltmeter*

Activity 7.6

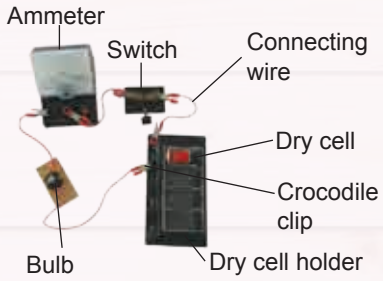
Aim: To measure the current and voltage by using a suitable measuring apparatus.

Apparatus: Ammeter, voltmeter, connecting wire, switch, dry cell, crocodile clip, bulb and dry cell holder

A Measuring current using an ammeter

Instruction

1. Connect the circuit as shown in Photograph 7.8 using one dry cell.
2. Turn on the switch and record the reading of the ammeter. Observe the brightness of the bulb.
3. Record your observations.
4. Repeat steps 1 to 3 using two dry cells.



Photograph 7.8

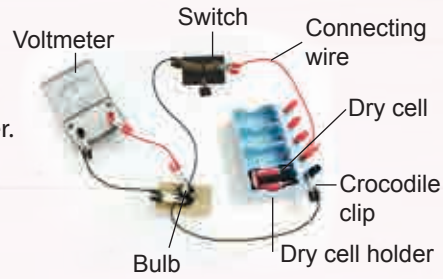
B Measuring the voltage using a voltmeter

Safety Precaution

The voltmeter must be connected parallel to the bulb in order to measure the voltage.

Instruction

1. Connect the circuit as shown in Photograph 7.9 using one dry cell.
2. Turn on the switch and record the reading of the voltmeter. Observe the brightness of the bulb.
3. Record your observations.
4. Repeat steps 1 to 3 using two dry cells.



Photograph 7.9

Observation

Activity	Number of dry cells	Reading of ammeter / A	Reading of voltmeter / V	Brightness of bulb
A	1			
	2			
B	1			
	2			

Questions

1. What is the relationship between the electrical current and the increase in the number of dry cells?
2. What is the relationship between the voltage and the increase in the number of dry cells?
3. Give an inference for the brightness of bulb in Activity A.
4. What is the relationship between the voltage, electric current and the brightness of the bulb?

Science Info

Multimeter can be used to measure current and voltage.

The Relationship between Current, Voltage and Resistance

The ability of a conductor to limit or resist the flow of electric current is known as **resistance**. The unit for measuring resistance is **ohm (Ω)**. A fixed resistor has resistance that cannot be adjusted whereas a variable resistor or rheostat has resistance that can be adjusted. Current, voltage and resistance are three electrical quantities that are closely related to one another in a circuit. The changes in magnitude of one of the electrical quantities will have an effect in the magnitude of the other quantities.

Let us carry out Experiment 7.1 to study the relationship between current, voltage and resistance.

Experiment 7.1

Aim: To study the effects of changes in resistance and voltage on electric current.

A The effect of changes in resistance on electric current

Problem statement: What is the effect of changes in resistance on electric current?

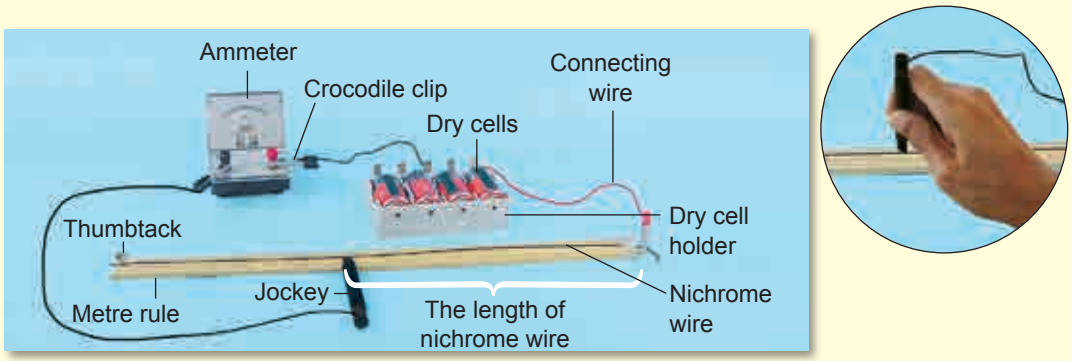
Hypothesis: The higher the resistance, the smaller the current flow.

Variables:
(a) Constant variable: Number of dry cells
(b) Manipulated variable: The length of the nichrome wire
(c) Responding variable: Reading of the ammeter

Material: Nichrome wire (60 cm)

Apparatus: Ammeter, metre rule, dry cell holder, dry cell, thumbtack, crocodile clip, jockey and connecting wire

Procedure:
1. Fix a nichrome wire to both ends of a metre rule.
2. Set up the apparatus as shown in Photograph 7.10.
3. Place the jockey where the length of the nichrome wire is 20 cm. Record the reading of the ammeter.
4. Repeat step 3 by increasing the length of the nichrome wire to 30 cm, 40 cm, 50 cm and 60 cm.
5. Record the ammeter readings in a table for each length of the nichrome wire used.
6. Plot a graph of current against the length of nichrome wire.



Photograph 7.10

Observation:

Length of nichrome wire (cm)	Reading of ammeter (A)
20	
30	

Conclusion:
Is the hypothesis accepted? Give your reasons.

Questions
1. What is the relationship between the length of the nichrome wire and resistance?
2. What is the relationship between the length of the nichrome wire and the current that flows in the circuit?
3. What is the relationship between resistance and electric current?

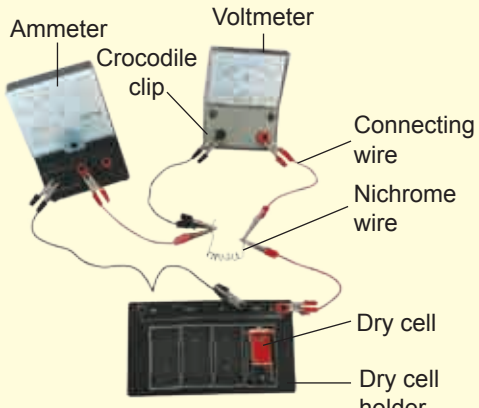
B The effect of changes in voltage on electric current

Problem statement: What is the effect of changes in voltage on current?

Hypothesis: The higher the voltage, the larger the current flow

Variables:
(a) Constant variable : Nichrome wire of 10 cm length
(b) Manipulated variable : Number of dry cells
(c) Responding variable : Reading of the ammeter

Apparatus: Ammeter, voltmeter, connecting wire, nichrome wire of 10 cm length, dry cell and crocodile clip



Photograph 7.11

Procedure:
1. Set up the circuit as shown in Photograph 7.11 using one dry cell.
2. Record the reading on the ammeter and voltmeter.
3. Record your observations in a table.
4. Repeat steps 1 to 3 using two, three and four dry cells.
5. Plot a graph of current against voltage.

Observation:

Number of dry cells	1	2	3	4
Reading of ammeter (A)				
Reading of voltmeter (V)				

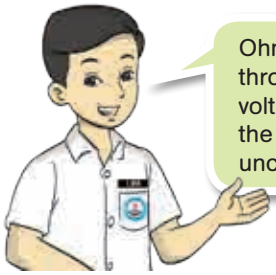
Conclusion:
Is the hypothesis accepted? Give your reasons.

Questions
1. What is the relationship between the number of dry cells and the reading of voltmeter?
2. What is the relationship between voltage and electric current?

Experiment 7.1 shows that the amount of current flowing through the circuit decreases as the resistance increases. Besides, we can also observe that when a higher voltage flows through the circuit, the amount of current flowing through the circuit also increases.

The relationship between the current, I, the voltage, V and the resistance, R is known as the **Ohm's Law**. The relationship among these three electrical quantities can be written as:

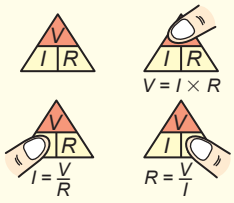
$$V = IR$$



Ohm's Law states that the electric current that flows through a conductor is directly proportional to the voltage across two ends of the conductor, provided the temperature and other physical situations remain unchanged.

Science Info

Ohm's Law Triangle can be used to memorise the Ohm's Law. Put your finger over the quantity that you are looking for. Then, multiply or divide the other two quantities that are given.



Formative Practice 7.1

1. State the forms of energy that exists in each of the following situations.
   (a) Boiling water
   (b) A chicken running
   (c) Compressed spring
2. As the clouds move, a lot of electric charges are accumulated by the clouds.
   Based on the statement above, explain the occurrence of lightning.
3. What is the resistance of a car light bulb that conducts 0.025 A current when connected to a 12 V car accumulator? Is the current in the bulb steady?

7.2 Flow of Electric Current in a Series Circuit and Parallel Circuit

Electric current requires a complete path which enables it to flow. This path is known as an **electric circuit**.

Electrical Circuit Components

A complete electric circuit is made up of various **electrical components** which are represented by symbols. These symbols are used to draw circuit diagrams.

Table 7.1 *Electrical components and their symbols*

Electrical component	Symbol
Switch	
Dry cell	
Voltmeter	V
Galvanometer	G
Ammeter	A

Electrical component	Symbol
Bulb	
Resistor	
Fuse	
Variable resistor	or

Series Circuit and Parallel Circuit

An electric circuit can be connected in series or parallel. A **series circuit** is made up of electrical components that are connected one after another where the current flows through in a single path (Figure 7.8). A **parallel circuit** is separated into several different paths of electrical circuit and each parallel path has electrical components (Figure 7.9).

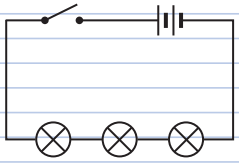


Figure 7.8 *Series circuit*

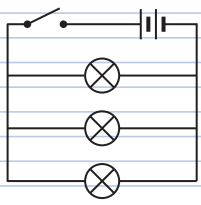


Figure 7.9 *Parallel circuit*

Current, Voltage and Resistance in a Series Circuit

Is the current that flows through each electrical component in a series circuit the same? Carry out Activity 7.7 to study the current, voltage and resistance in a series circuit.

Activity 7.7

Aim: To study current, voltage and resistance in a series circuit.

Apparatus: Dry cell holder, connecting wire, bulb (1.5 V), dry cell, switch, ammeter and voltmeter

Instruction

1. Set up a series circuit as shown in Figure 7.10 (a).
2. Turn on the switch and measure the current that flows through bulb *M*. Measure the current that flows through bulb *N* by placing the ammeter between *M* and *N* as shown in Figure 7.10 (b).
3. Measure the current that flows through bulb *M* and *N* by setting up the circuit as shown in Figure 7.10 (c).
4. Set up the voltmeter across bulb *M*, followed by bulb *N* as shown in Figure 7.10 (d) to measure the voltage reading across the bulb.
5. Set up the voltmeter as shown in Figure 7.10 (e) to measure the voltage across two bulbs.
6. Calculate the resistance for each bulb separately and also for both the bulbs using Ohm's Law.
7. Record all the readings in a table.

Questions

1. What is your conclusion on the current flow through the series circuit?
2. What will happen to the bulbs in the series circuit if one of the bulbs is removed?

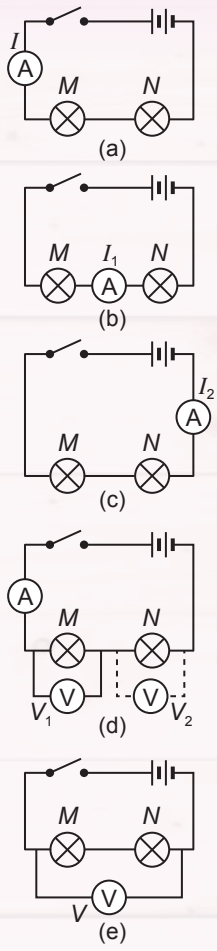


Figure 7.10

After carrying out Activity 7.7, you will notice that the current that flows through each bulb is the same but the voltage is the sum of the voltages across each bulb. Effective resistance, *R* is the total resistance across the components. We can conclude that:

Current, $I = I_1 = I_2$ | Voltage, $V = V_1 + V_2$ | Resistance, $R = R_1 + R_2$

Table 7.2 *Advantages and disadvantages of a series circuit*

Advantages	Disadvantages
• Every component in the circuit receives the same amount of current. • Every component is controlled by the same switch. • Increase in voltage supplies more electric current.	• When one of the electrical appliances is damaged, other electrical appliances cease to function. • Adding more electrical appliances increases resistance and decreases the flow of the current. • Each electrical appliance cannot be switched off individually.

Current, Voltage and Resistance in a Parallel Circuit

Current, voltage and resistance in a parallel circuit is different from a series circuit. Carry out Activity 7.8 to investigate the current, voltage and resistance in a parallel circuit.

Activity 7.8

Aim: To study current, voltage and resistance in a parallel circuit.

Apparatus: Dry cell holder, connecting wire, switch, bulb (1.5 V), dry cell, ammeter and voltmeter

Instruction

1. Set up a parallel circuit as shown in Figure 7.11 (a).
2. Turn on the switch and measure the current that flows through bulb *M*. Measure the current that flows through bulb *N* by changing the position of the ammeter.
3. Measure the electric current that flows through both the bulbs, *M* and *N* by setting up a circuit as shown in Figure 7.11 (b).
4. Fix the voltmeter across bulb *M* followed by bulb *N* as shown in Figure 7.11 (c) to measure the voltage across the bulbs.
5. Fix the voltmeter as shown in Figure 7.11 (d) to measure the voltage across two bulbs.
6. Calculate the resistance for each bulb separately and for both the bulbs using Ohm's Law.
7. Record all the readings in a table.

Questions

1. Is the value of voltage different for bulb *M* and *N*?
2. List out the advantages and disadvantages of a parallel circuit.

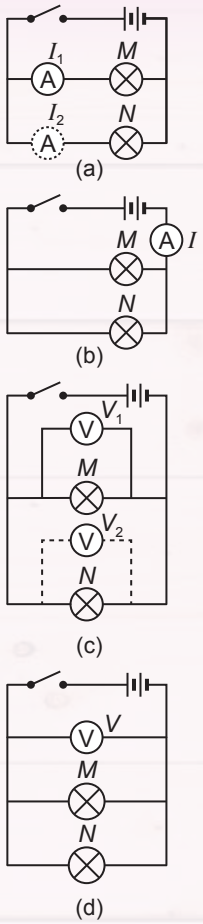


Figure 7.11

Voltage, V that flows across each resistor in a parallel circuit is the same as the voltage that flows across the dry cell. However, the current, I that flows in a parallel circuit is actually the total amount of current that flows through each resistor. Therefore, the current and the voltage can be concluded as:

Current, $I = I_1 + I_2$ Voltage, $V = V_1 = V_2$

Effective resistance, R can be calculated using the following formula: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

Table 7.3 *Advantages and disadvantages of a parallel circuit*

Advantages	Disadvantages
• Every electrical appliance can be switched on or off separately. • The increase in the number of electrical appliances does not affect the function of other appliances in the same circuit.	• The voltage for every electrical appliance cannot be adjusted because the voltage is the same as the source of voltage.

The electrical wiring system in our homes is connected in **parallel**. For example, all the lights at home are connected in parallel to ensure every light gets the same voltage from its main power supply. The current that flows from the main power supply to the circuit is controlled by a distribution panel (Photograph 7.12).

Photograph 7.12 *Distribution panel*

Numerical Problems Related to Current, Voltage and Resistance in Series Circuit and Parallel Circuit

1. Two resistors, R_1 and R_2 are connected in series in a circuit as shown in Figure 7.12. Calculate:
(a) the effective resistance, R
(b) the current, I in the circuit
(c) the voltage, V_1 and V_2

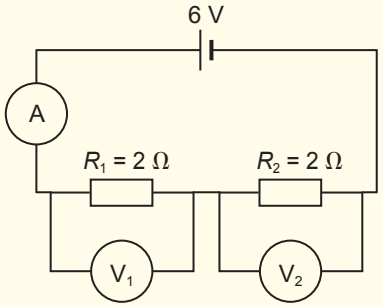


Figure 7.12

Solution:

(a) Effective resistance, R
$R = R_1 + R_2$
$R = 2\ \Omega + 2\ \Omega$
$R = 4\ \Omega$

(b) Current, I
$I = \frac{V}{R}$
$= \frac{6\ \text{V}}{4\ \Omega}$
$= 1.5\ \text{A}$

(c) $V_1 = IR_1$
$= 1.5\ \text{A} \times 2\ \Omega$
$= 3\ \text{V}$
$V_2 = IR_2$
$= 1.5\ \text{A} \times 2\ \Omega$
$= 3\ \text{V}$

2. Two resistors, R_1 and R_2 are connected in parallel in a circuit as shown in Figure 7.13. Calculate:
(a) the effective resistance, R
(b) the voltage, V
(c) the current, I in the circuit

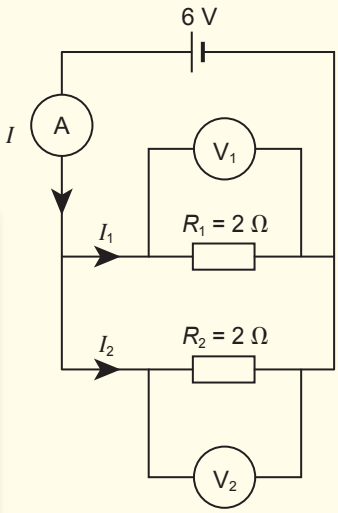


Figure 7.13

Solution:

(a) Effective resistance, R

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$\frac{1}{R} = \frac{1}{2\ \Omega} + \frac{1}{2\ \Omega}$$
$$\frac{1}{R} = 1\ \Omega$$
$$R = 1\ \Omega$$

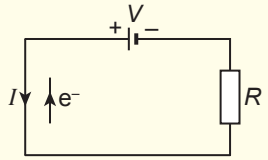
(b) Voltage, V
Voltage across each resistor in a parallel circuit is the same, that is 6 V.

(c) Current, I

$$I_1 = \frac{V_1}{R_1} = \frac{6\ \text{V}}{2\ \Omega} = 3\ \text{A} \qquad I_2 = \frac{V_2}{R_2} = \frac{6\ \text{V}}{2\ \Omega} = 3\ \text{A}$$

$$I = I_1 + I_2 = 3\ \text{A} + 3\ \text{A} = 6\ \text{A}$$

Science Info



- Direction of electron flow is from the negative terminal to the positive terminal of an electrical source.
- Direction of current flow is from the positive terminal to the negative terminal of an electrical source.

Formative Practice 7.2

1. Draw a parallel circuit using three bulbs, a dry cell, a switch and several connecting wires.

2. Based on Figure 1, calculate:
(a) the effective resistance
(b) the current in the circuit
(c) the voltage across each resistor

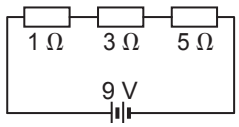


Figure 1

3. Based on Figure 2, calculate:
(a) the effective resistance
(b) the voltage
(c) the current flowing through each resistor

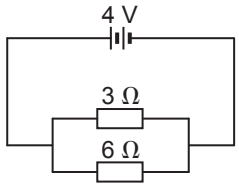


Figure 2

7.3 Magnetism

Do you know what causes button magnets to stick to a whiteboard? These button magnets have pieces of magnet attached to them to enable them to stick on a whiteboard surface (Photograph 7.13). Magnets exist naturally in the form of **lodestones**. However, man-made magnets, made of materials such as iron, steel, cobalt and nickel, are widely used in our everyday life.

Photograph 7.13 *Button magnets on whiteboard*

Properties of a Magnet

You might have already known one of the properties of a magnet, that it only attracts magnetic materials. Do magnets have other properties? Let us learn its properties (Figure 7.14).

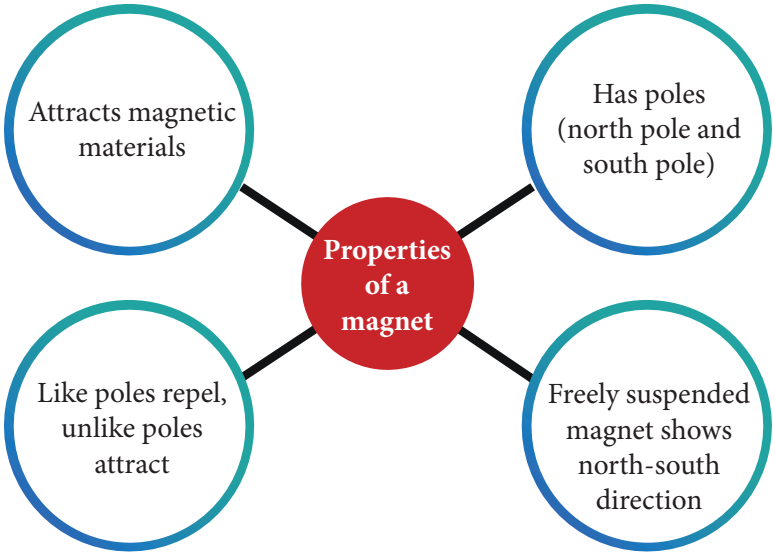


Figure 7.14 *Properties of a magnet*

Magnetic Field

Photograph 7.14 shows only steel balls that are closer to the magnet are attracted by the magnet. The area around the magnet with magnetic force is known as **magnetic field**.

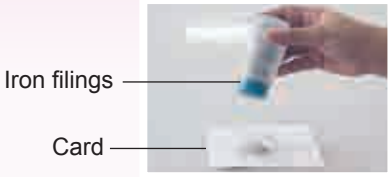
Photograph 7.14 *Magnet and steel balls*

Activity 7.9

Aim: To study the pattern of a magnetic field.

Materials: Iron filings and a piece of thin card

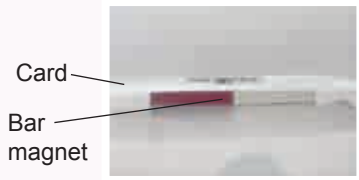
Apparatus: Bar magnet, horseshoe magnet, magnadur magnet, compass and drawing paper



Photograph 7.15

Instruction

1. Sprinkle some iron filings evenly on a thin piece of card. (Photograph 7.15).
2. Place the card on a piece of bar magnet (Photograph 7.16) and tap the card gently until a pattern is formed.
3. Draw the pattern that is formed.
4. Arrange four compasses and a bar magnet on the piece of drawing paper as shown in Figure 7.15.
5. Mark the direction of the compass needle on the pattern that you have already drawn in step 3.
6. Repeat steps 1 to 5 by replacing the bar magnet with a horseshoe magnet and magnadur magnet.



Photograph 7.16

Questions

1. Which part of the magnet can you see the most magnetic field lines?
2. What is the direction of the magnetic field lines?
3. What is the relationship between the magnetic field lines and the strength of the magnetic field?

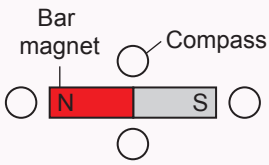


Figure 7.15

You have observed different patterns of magnetic field produced by the magnetic field lines. These magnetic field lines have several characteristics.

Brain Teaser

Does a magnet broken into two pieces still have two poles?

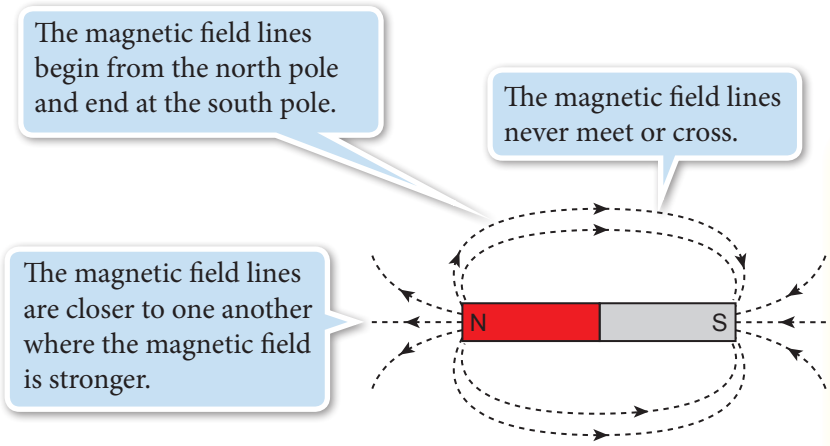
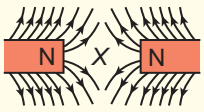


Figure 7.16 *Characteristics of magnetic field lines*

Science Info

A magnetic field between two like poles will produce a neutral region (*X*) which is free from the effect of any magnetic force.



Electromagnet

You have studied electric current in 7.1. Do you know that electric current has magnetic effects? An **electromagnet** is a type of magnet that has temporary magnetic effect when electric current flows through it. The electric bell is an object that uses electromagnet (Photograph 7.17).

Photograph 7.17
Electric bell

Activity 7.10

Aim: To study the pattern and direction of the magnetic field produced by the electric current that flows through different conductors.

Materials: Straight wire, coiled wire, thin cardboard, solenoid and iron filings

Apparatus: Compass, retort stand with clamp, power supply (D.C. 3 V), connecting wire and crocodile clip

Instruction

1. Set up the apparatus as shown in Figure 7.17.
2. Sprinkle some iron filings evenly on the white cardboard. Start the power supply and tap the cardboard gently until a magnetic field pattern is formed.
3. Stop the power supply and sketch the magnetic field pattern that has been formed.
4. Place four compasses around the straight wire as shown in Figure 7.18.
5. Restart the power supply and observe the direction of the needle of the compasses.
6. Stop the power supply. Mark the direction of the current flow and the direction of the magnetic field in the pattern you have drawn in step 3.
7. Reverse the direction of the current flow and observe the pattern and the direction of the magnetic field again.
8. Repeat steps 1 to 7 by replacing the straight wire with coiled wire and solenoid.

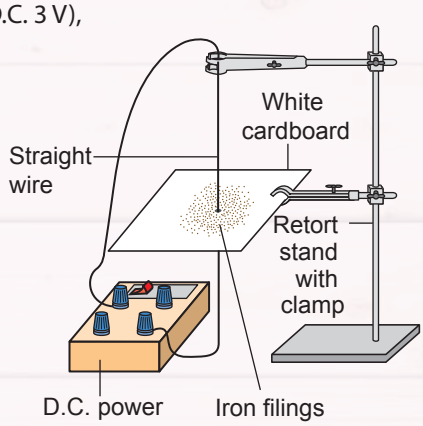


Figure 7.17

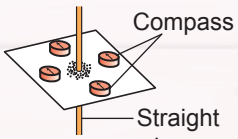


Figure 7.18

Questions

1. What is the purpose of using the iron filings and compass in this activity?
2. Are the magnetic field patterns for all three conductors similar?
3. What can you observe in the magnetic field when the direction of the electric current is reversed?

The **pattern of the magnetic field** depends on the **shape of the conductor** used. For example, the magnetic field lines produced by a straight wire and a coiled wire are concentric circles. Magnetic field lines are closer where the magnetic field is stronger. The strength of the magnetic field reduces as it moves away from the centre of the conductor. The pattern of the magnetic field produced is not affected by the direction of the current that flows through the conductor.

The **direction of the magnetic field** is determined by the direction of the electric current. The **right-hand grip rule** determines the direction of the magnetic field of the current flow in a straight wire (Figure 7.19).

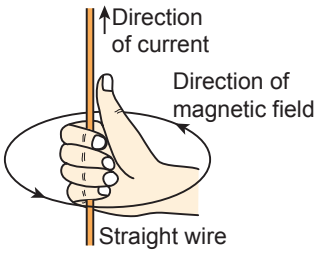


Figure 7.19 *Right-hand grip rule*

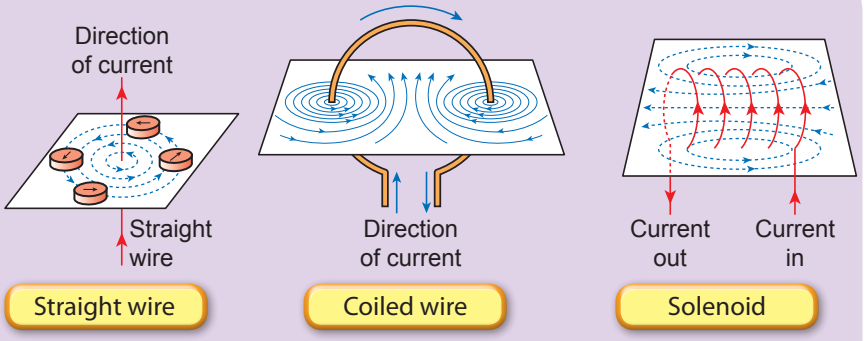
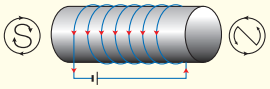


Figure 7.20 *Pattern and direction of magnetic fields produced by conductors*

Science Info

Solenoid polarity can be determined by observing the direction of the current flow. The current that flows in the anti-clockwise direction is the north pole, whereas the current that flows clockwise is the south pole.



Experiment 7.2

Aim: To study the factors that influence the strength of the magnetic field.

A The relationship between the current that flows and strength of the magnetic field

Problem statement: Does the current flow affect the strength of the magnetic field?

Hypothesis: The larger the current that flows through a conductor, the stronger the magnetic field.

Variable:
(a) Constant variable : The number of turns of the coil
(b) Manipulated variable: Current
(c) Responding variable : Number of pins attracted

Materials: Pin, iron rod and copper wire

Apparatus: D.C. power supply, ammeter, rheostat, Petri dish and retort stand with clamp

Procedure:
1. Set up the apparatus as shown in Figure 7.21 with 10 coils of copper wire around the iron rod.
2. Turn on the power supply and adjust the rheostat to obtain 0.5 A of current.
3. Replace the Petri dish containing pins with an empty Petri dish.
4. Turn off the power supply to let all the pins to fall back into the empty Petri dish.
5. Count the number of pins attracted by the iron rod.
6. Repeat steps 1 to 5 using 1.0 A, 1.5 A, 2.0 A and 2.5 A of current. Record your observations.

Conclusion:
Is the hypothesis accepted? Give your reasons.

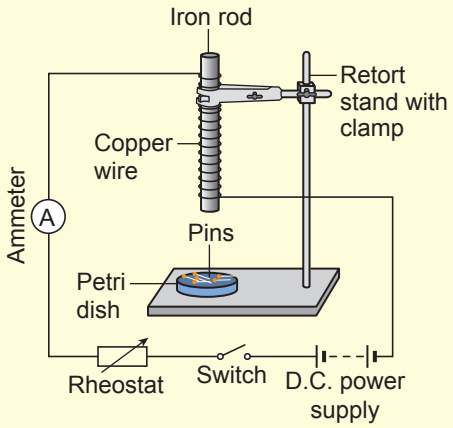


Figure 7.21

B **The relationship between the number of turns of a coil and the strength of the magnetic field**

Problem statement: Does the number of turns of a coil affect the magnetic field?

Hypothesis: The more the number of turns of a coil, the stronger the magnetic field.

Variables:
(a) Constant variable: Current
(b) Manipulated variable : Number of coils
(c) Responding variable : Number of pins attracted

Procedure:
1. Set up the apparatus as shown in Figure 7.21 with 10 coils of copper wire coiled around an iron rod.
2. Turn on the power supply.
3. Replace the Petri dish containing pins with an empty Petri dish.
4. Turn off the power supply so that all the pins drop back into the empty Petri dish.
5. Count the number of pins attracted by the iron rod.
6. Repeat steps 1 to 5 using 20, 30, 40 and 50 turns of copper wire on the iron rod.
7. Record your observations.

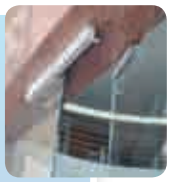
Conclusion:
Is the hypothesis accepted? Give your reasons.

Application of Magnets and Electromagnets in Daily Life

The needle of a compass uses a magnet to show the direction of the poles.

Credit cards and debit cards have an electromagnetic strip that stores information.

The magnetic lock on doors uses an electromagnet to lock the doors automatically.



Photograph 7.18 *Uses of magnets and electromagnets in daily life*

Formative Practice 7.3

1. What is a magnetic field?
2. Figure 1 shows an iron nail coiled with insulated copper wire connected to a dry cell of 1.5 V.
   (a) What happens when the switch is turned on?
   (b) Mark the direction of the current flow in the copper wire around the iron nail.
   (c) State the poles of the magnetic field at *P* and *Q*.
   (d) What happens to the strength of the magnetic field if another dry cell of 1.5 V is added?

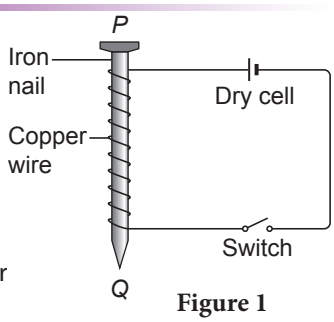
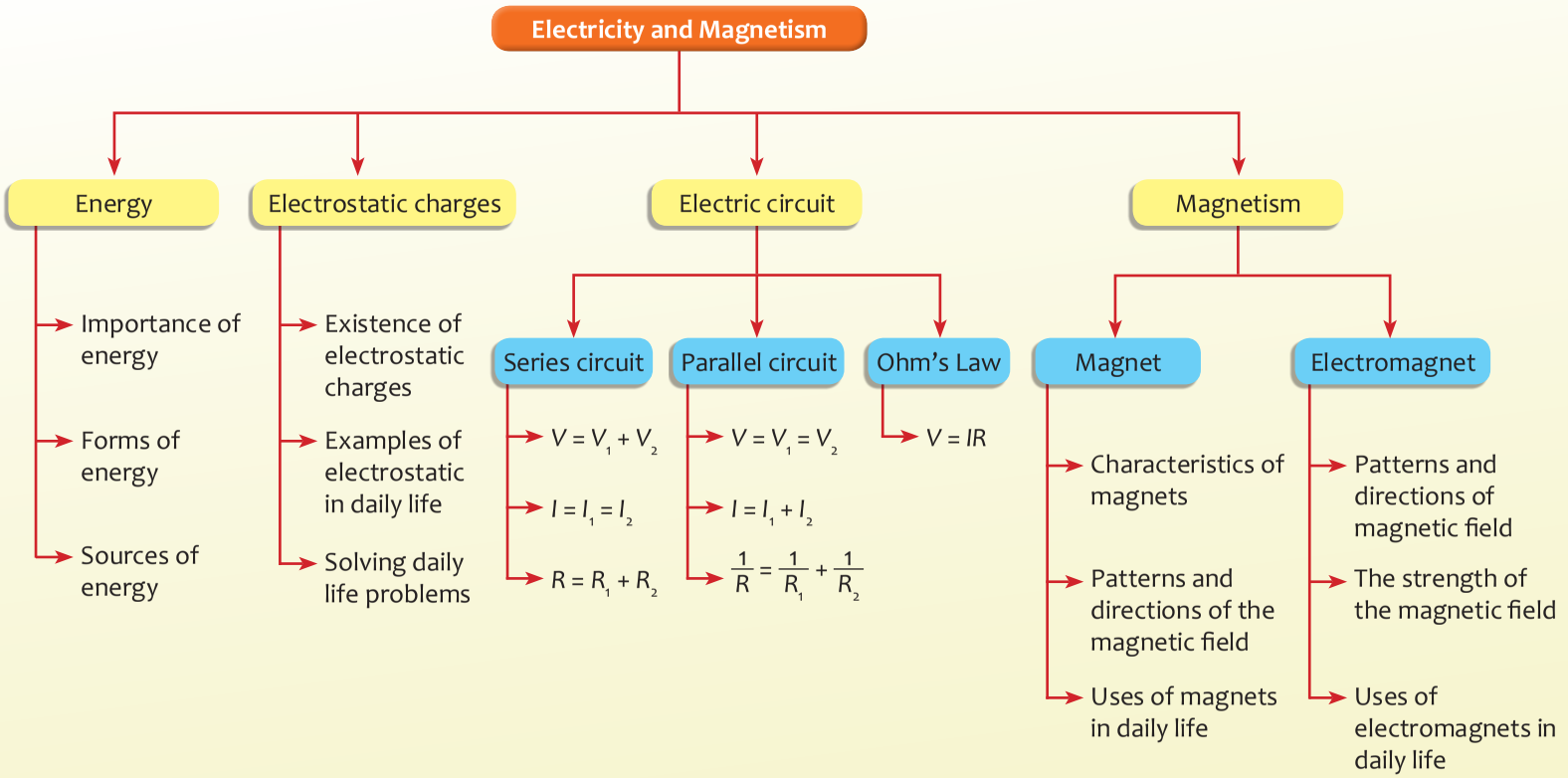


Figure 1

3. State **True** or **False** for the following statements.
   (a) If an object is attracted to magnet, the object is a magnetic material.
   (b) A straight wire produces magnetic field lines in the shape of concentric circles.

Summary



Quiz

Interactive Quiz 7

SELF-REFLECTION

After learning this chapter, you are able to:

7.1 Electricity

- ☐ Describe and communicate about energy.
- ☐ Explain and communicate the existence of electrostatic charges.
- ☐ Explain with examples electrostatic in daily life.
- ☐ Draw a conclusion that the flow of charges produces electric current.
- ☐ Characterise current, voltage and resistance, and their units.
- ☐ Draw a conclusion on the relationship between current, voltage and resistance.

7.2 The Flow of Electric Current in a Series Circuit and Parallel Circuit

- ☐ Elaborate and communicate about the flow of electric current in series circuit and parallel circuit.

7.3 Magnetism

- ☐ Draw a conclusion about the characteristics of a magnet.
- ☐ Describe and communicate about electromagnets.
- ☐ Carry out an experiment and communicate the uses of magnets and electromagnets in daily life.

Summative Practice 7

1. Tick (✓) the correct statement about electrostatic charges.

(a) Earthing causes positive charges to flow from the object to the ground. ☐

(b) Similar types of electric charges attract one another. ☐

(c) An electroscope is used to determine the presence of electrostatic charges. ☐

2. Imran's office floor is covered with a nylon carpet.

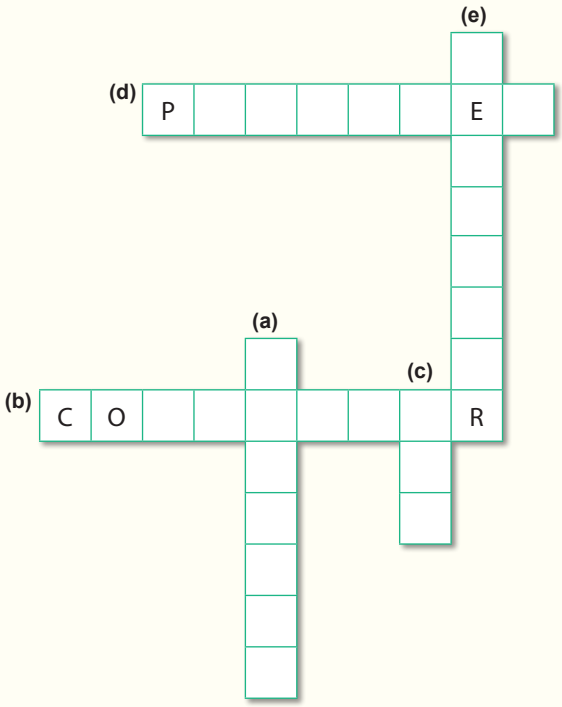
(a) What is the effect of electrostatic charges on Imran if he touches an iron chair? Explain your answer.

(b) Suggest a method to overcome the effect of the electrostatic charges mentioned in **2** (a).

3. (a) Why doesn't a Van de Graaff generator function properly in damp weather?

(b) Why is the shock from the Van de Graaff generator not as dangerous as the electric shock from a domestic power supply?

4. Complete the following crossword puzzle regarding electricity.



Across

(b) _____ allows the electric current to flow through it.

(d) A circuit connected in _____ has the same voltage across the bulb.

Down

(a) _____ is the quantity of electricity that is measured by the ammeter.

(c) The unit for resistance is _____

(e) _____ resists the electric current from flowing through a conductor.

5. What is the most suitable circuit to be used in a fire alarm system? Explain your answer.

6. Figure 1 shows a parallel electric circuit. Calculate the value of current A_1, A_2 and the voltage V_1, V_2 that is not stated.

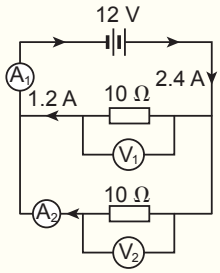


Figure 1

HOTS Mastery 7

7. Why does the copper coil in the electromagnet used in lifting scrap metals (Photograph 1) have many turns?

Photograph 1

Chapter 8

Force and Motion

All daily activities involve force. We need force to produce motion. What is the meaning of force?

What is the effect of force on daily activities?

Let's understand:

- Force
- Effects of force

SCIENCE BLOG

Force is All Around Us

Force is an important part of our lives. When you walk or run, chew food or lift objects, you are applying force. You cannot see force but you can feel its effect.

Have you ever taken part in football matches or tug-of-war? All these activities require a pulling or pushing force. When playing football, you kick the ball using a pushing force while in tug-of-war, both teams pull hard on opposite ends of the rope to win.

Keywords

- Force
- Direction
- Gravitational force
- Elastic force
- Buoyant force
- Frictional force
- Weight
- Moment of force
- Pressure

8.1 Force

What is force?

Force is a **pull** or a **push** upon an object.

Almost all daily activities involve force such as opening a can of food, pressing a switch and opening a door.

Force may exist in various forms such as gravitational force, weight, normal force, frictional force, elastic force and buoyant force.

Let us carry out Activity 8.1 to show the presence of different types of forces.

Photograph 8.1 *Force is used to open a can of food and press a switch*

Activity 8.1

Aim: To investigate the presence of different types of forces.

Materials: Ball, wooden block, sandpaper and water

Apparatus: Spring, retort stand with clamp, 50 g weight, beaker and metre rule

A

Instruction

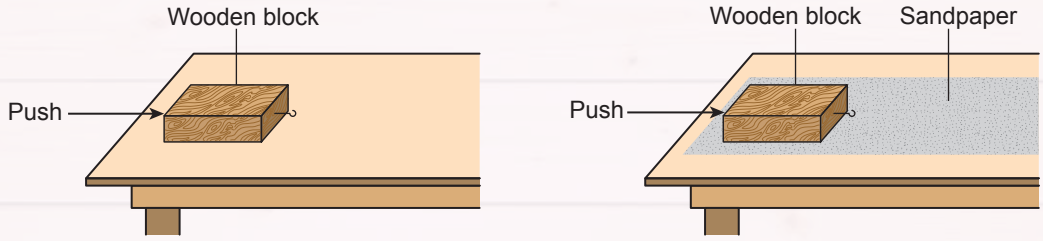
1. Throw a ball up in the air (Figure 8.1).
2. Observe whether the ball keeps going up or falls down.

Figure 8.1

B

Instruction

1. Place a wooden block on a table. Why does the wooden block remain in its position?
2. Then, push the wooden block (Figure 8.2 (a)).
3. Repeat step 2 by pushing the same wooden block on a sandpaper (Figure 8.2 (b)).
4. Compare the difficulty of pushing the wooden block on the table and on the sandpaper.



(a) Push the wooden block on a table (b) Push the wooden block on a sandpaper

Figure 8.2

C

Instruction

1. Hang a spring on a retort stand.
2. Hang a 50 g weight at the end of the spring (Figure 8.3).
3. Observe the change in the length of the spring.
4. Remove the weight and observe the change in the length of the spring.

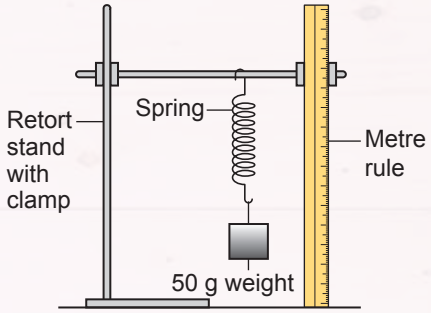


Figure 8.3

D

Instruction

1. Place a wooden block on the surface of the water in a beaker (Figure 8.4).
2. Press the wooden block to the bottom of the beaker and release it.
3. Observe what happens to the wooden block.

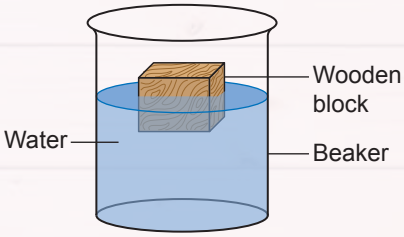
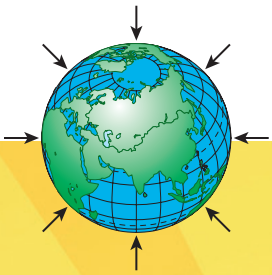


Figure 8.4

Questions

1. Identify the forces involved in Activities A, B, C and D.
2. What is the type of force acting on stationary objects?
3. What is the type of force that resists the motion of objects?

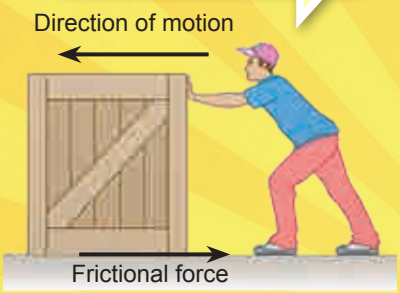
Types of Forces



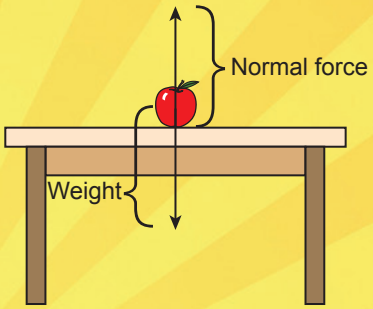
Gravitational force is the force that points towards the centre of the Earth. This force causes all objects that are thrown upwards to fall back to Earth.

Frictional force is the force that resists movement between two surfaces that are in contact with each other.

Frictional force acts in the opposite direction of motion.



Normal force is the force produced when an object is in contact with a surface.



Types of forces

Buoyant force is the thrust force acting on an object that is floating on the surface of a fluid.

The **weight** of an object is defined as the gravitational force acting on it.

Elastic force exists when a material is stretched or compressed.

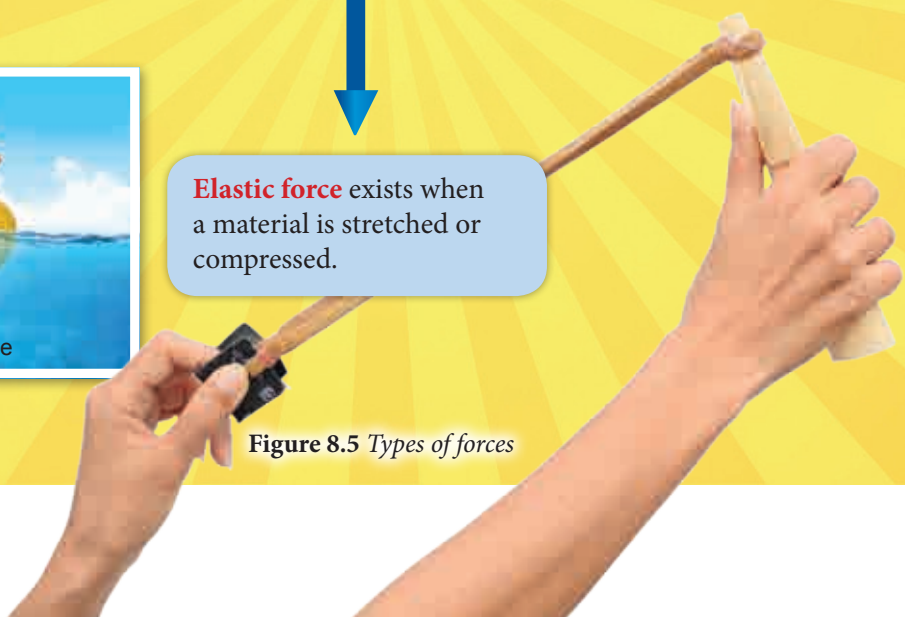
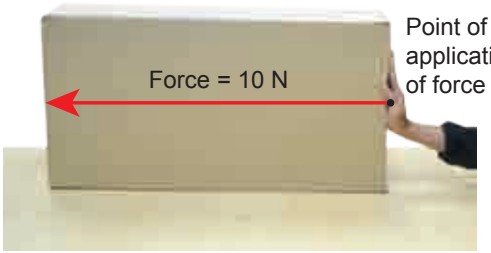


Figure 8.5 *Types of forces*

Characteristics of Force

Force is a vector quantity that has **magnitude** and **direction**. Magnitude is the quantity or value of a measurement.



Photograph 8.2 *Force acting on a box that is pushed*

Photograph 8.2 shows a pushing force with a magnitude of 10 N acting on a box. The direction of the force is as shown by the arrow and the **point of application** of the force is the hand that exerts the pushing force onto the box.

Figure 8.6 shows a hammer being used to remove a nail from the surface of a table. The force acting on the hammer has a magnitude of 15 N and its direction is as shown by the arrow. The **point of application** of force is at the head of the hammer, which is the area where the applied force is concentrated.

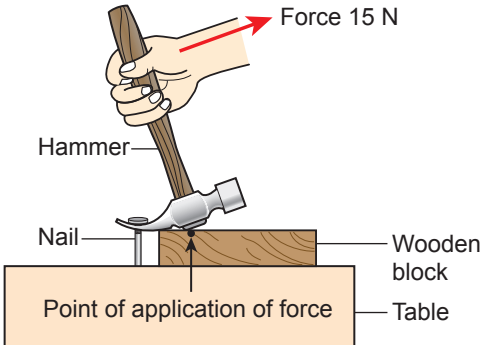
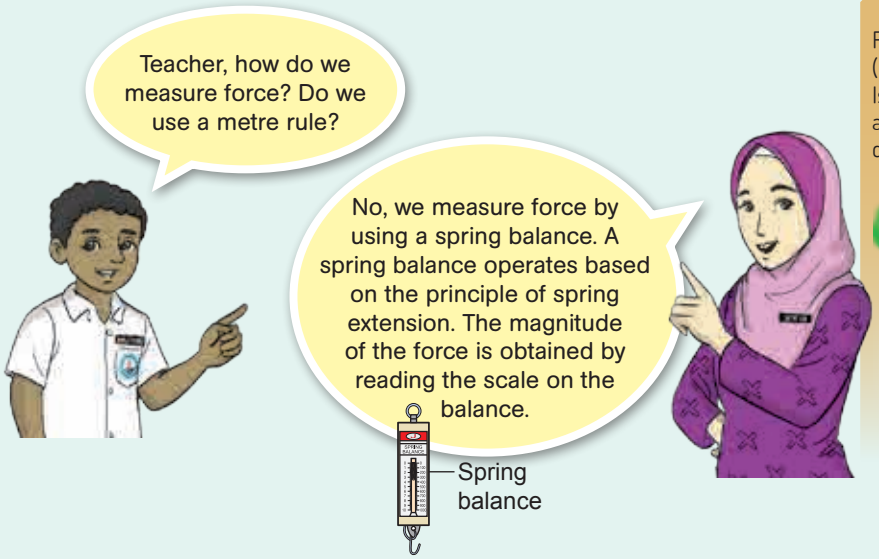


Figure 8.6 *Force acting when removing a nail using a hammer*

Measurement of Force



Today in History

Force is measured in newton (N), which is named after Sir Issac Newton, the scientist and mathematician who discovered gravitational force.

Unit of Force

The S.I. unit of force is **newton (N)**. The weight of an object is the gravitational force acting on the object. On Earth, an object with a mass of 100 g has a weight of 1 N. Therefore, an object with a mass of 1 kg has a weight of 10 N.

1 kg → 10 N

Activity 8.2

Aim: To measure force.

Materials: Weight (50 g), string, sandpaper and wooden block

Apparatus: Retort stand with clamp and spring balance

Instruction

A **Weight of object**

1. Hang a 50 g weight at the end of a spring balance (Photograph 8.3).
2. Record the reading of the spring balance.
3. Add up to five weights and record the reading of the spring balance.

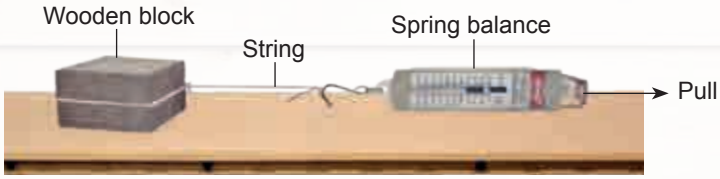
Photograph 8.3

Questions

1. What is the physical quantity measured by the spring balance?
2. What is the unit of the physical quantity for your answer in question **1**?
3. What happens to the reading of the spring balance when the number of weights is increased? Explain your answer.

B **Frictional force**

1. Set up the apparatus as shown in Photograph 8.4.
2. Pull the spring balance until the wooden block starts to move and record the reading of the spring balance.
3. Repeat this activity by pulling the wooden block on a sandpaper.



Photograph 8.4

Questions

1. The wooden block moves only when enough pulling force acts on it. What type of force is resisting the movement of the wooden block?
2. State the difference in the reading of the spring balance when the wooden block is pulled on the table and when it is pulled on the sandpaper. What is the force involved that causes the difference between the readings of the two spring balances?

Action-Reaction Pair

Observe the objects in Photograph 8.5. Why do these objects remain stationary? What are the forces acting on these objects?

Photograph 8.5 *Car, book and apple in a stationary state*

Newton's Third Law states that for every action force, there is a reaction force of the **same magnitude** but in the **opposite direction**.

There are three different situations to explain this concept.

Situation 1 An object that remains on a table

A book that remains still on a table experiences gravitational force known as **weight**. At the same time, a reaction force called **normal force** will exist in the opposite direction. The book remains still on the table because the magnitude of the weight (**action force**) is the same as the normal force (**reaction force**) (Figure 8.7).

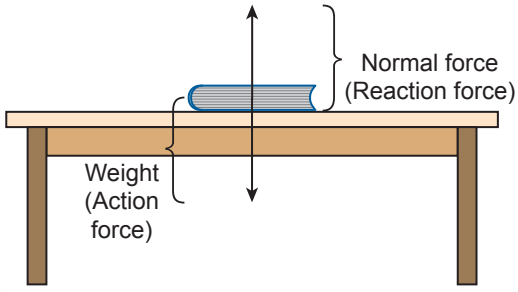


Figure 8.7 *Book that remains on a table*

Situation 2 An object that floats on water

A wooden block that floats on water experiences a gravitational force known as **weight**. At the same time, a reaction force called **buoyant force** will exist in the opposite direction. Objects can float on water because the magnitude of the weight (action force) is the same as the buoyant force (reaction force)(Figure 8.8).

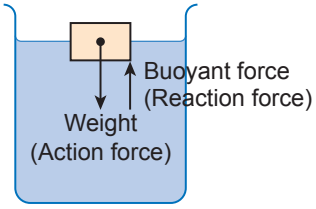


Figure 8.8 *Wooden block that floats on water*

Situation 3

Two trolleys in contact with each other and launched with a spring mechanism will move at same distance but in the opposite direction.

When two trolleys are pushed towards each other as in Figure 8.9 (a), the first trolley with the spring will exert an elastic force on the second trolley (action force) and at the same time, the second trolley will exert an elastic force of the same magnitude but in the opposite direction (reaction force).

When the two trolleys that were initially touching each other are launched as in Figure 8.9 (b), they will move at the same distance but in the opposite direction.

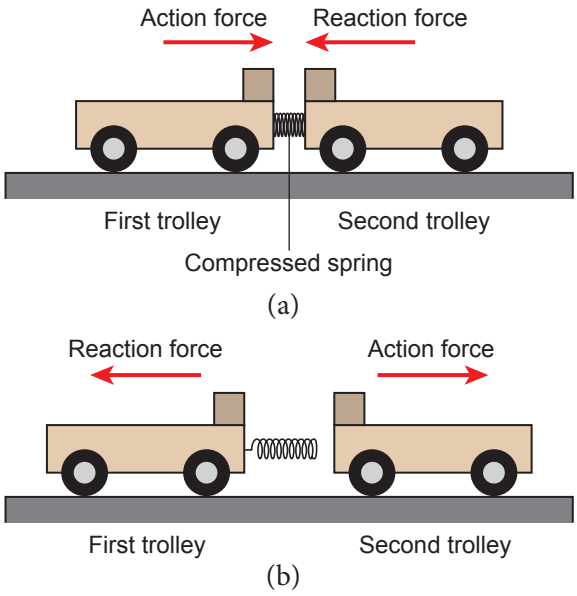


Figure 8.9 *Two trolleys pushed close together with compressed spring*

Formative Practice 8.1

1. Name the force acting in each of the following situations (Photograph 1).

(a) Bungee jumper jumping

(b) Bicycle moving on rough surface

(c) Hot air balloon floating in the air

Photograph 1

2. Photograph 2 shows a man pushing a car. Show the direction of the pushing force and point of application of force on the photograph.

Photograph 2

3. Photograph 3 shows a football being kicked by a player.
(a) Name the forces involved in this situation.
(b) Show the direction of the forces on the photograph.

Photograph 3

8.2 Effects of Force

Force cannot be seen but its effects can be felt. When a force acts on an object, the force can change the **shape**, **size** and **motion** of the object.

Let us carry out Activity 8.3 to study the effects of force on an object.

Activity 8.3

Aim: To study the effects of force.

Materials: Toy car and plasticine

Apparatus: Table

Instruction

1. Clear the table of your group.

2. (a) Place a toy car at one end of the table as shown in Figure 8.10.

(b) Push the toy car using a force of small magnitude. Observe what happens to the stationary toy car.

(c) Increase the pushing force and observe the change in the speed of the toy car.

(d) Push the toy car again and ask another student to block the movement of the toy car using his hands. Observe what happens to the movement of the toy car.

(e) Push the toy car again. Ask another student to push the toy car from the side. Observe what happens to the movement of the toy car.

3. Hold a piece of plasticine. Squeeze the plasticine and observe the shape and size of the plasticine.

4. Record all the observations obtained.

5. Make a conclusion about the effects of force observed.

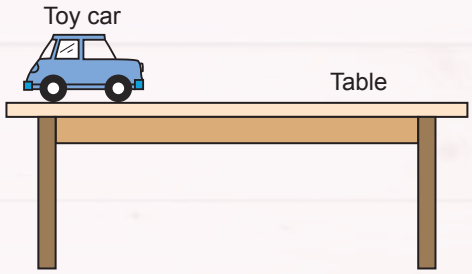


Figure 8.10

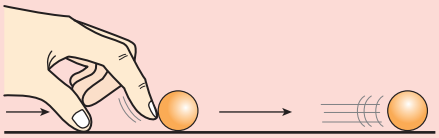
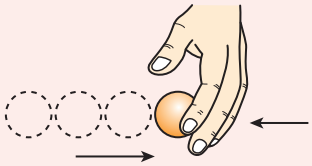
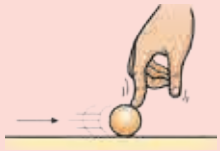
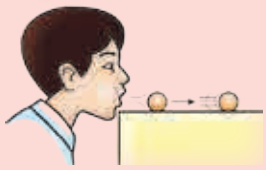
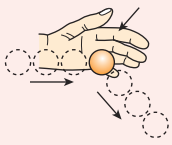
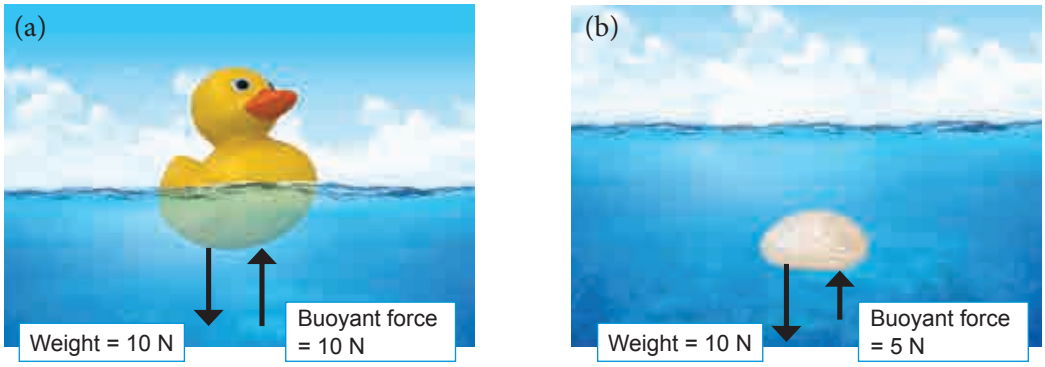
Effects of force	Situation 1 (Table tennis ball)	Situation 2 (Football)
Moving a stationary object	 • When a stationary object is pushed, the object moves	
Stopping a moving object	 • When force is applied in the opposite direction, the object will stop moving	
Changing the speed of an object that is in motion	• Force from the opposite direction slows down an object  • Force from the same direction speeds up an object 	
Changing the direction of motion of an object	 • Force from the side changes the direction of motion of an object	
Changing the shape and size of an object	 • Force can change the shape and size of an object	

Figure 8.11 *Effects of force*

Buoyant Force

An object will float if the buoyant force acting on it is enough to support its weight, that is buoyant force equals to the weight of the object. For example, the rubber duck below has a weight of 10 N. The reaction force, which is the buoyant force, acts with the same magnitude (10 N) but in the opposite direction (Photograph 8.6 (a)).



Photograph 8.6 *Condition of rubber duck and stone in water*

Conversely, an object will **submerge** if the buoyant force acting on it is not enough to support its weight, that is buoyant force is less than the weight of the object (Photograph 8.6 (b)).

Buoyant force = Actual weight – apparent weight

Let us carry out Activity 8.4 to determine the buoyant force of an object in water.

Science Info

Actual weight: Weight of an object in the air.

Apparent weight: Weight of an object immersed in fluid.

Activity 8.4

Aim: To determine buoyant force.

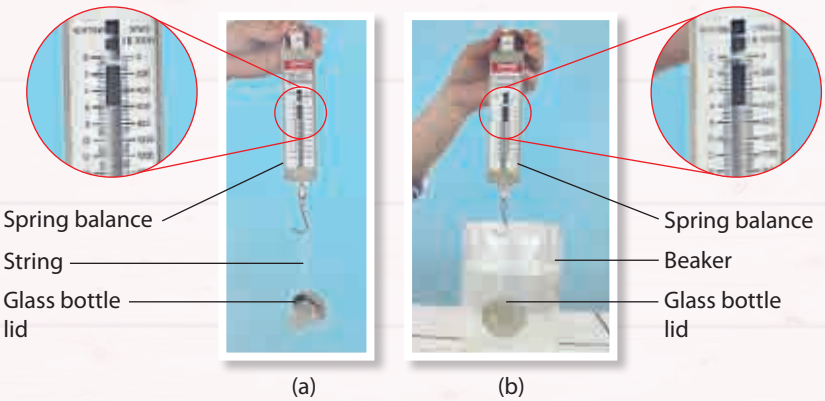
Materials: Glass bottle lid, rubber stopper, squash ball, plasticine and string

Apparatus: 250 ml beaker and spring balance

Instruction

1. Hang a glass bottle lid at the end of a spring balance as shown in Photograph 8.7 (a).
2. Record the actual weight of the glass bottle lid, W_1.
3. Fill 250 ml of water into a beaker.
4. Put the bottle lid into the water as in Photograph 8.7 (b).
5. Record the apparent weight of the bottle lid, W_2.
6. Calculate the buoyant force, F.
7. Repeat steps 1 to 6 using a rubber stopper, squash ball and plasticine.

8. Put the bottle lid, rubber stopper, squash ball and plasticine into the water. Observe whether they submerge or float.
9. Record your observation in the table below.



Photograph 8.7

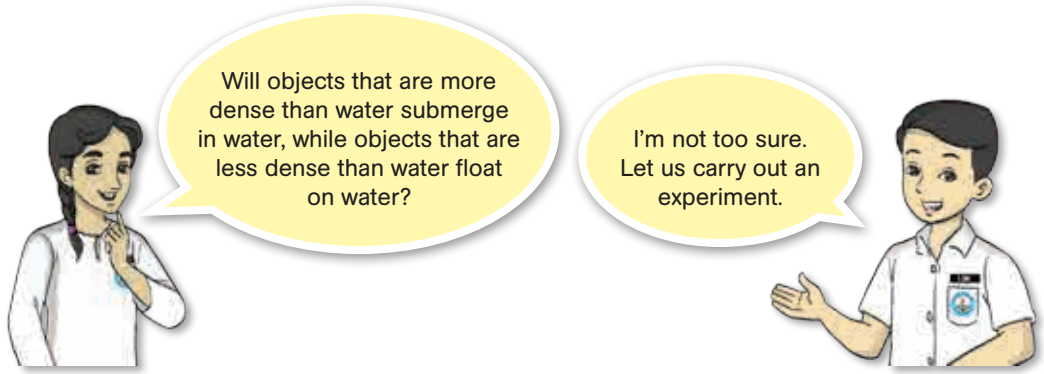
	Glass bottle lid	Rubber stopper	Squash ball	Plasticine
Actual weight, W_1 (N)				
Apparent weight, W_2 (N)				
Buoyant force, F (N)				
Submerge / float				

Question

1. What is the relationship between the buoyant force of an object and the condition of the object?

Density and Buoyant Effect

Different materials have different densities. The position of an object in a fluid depends on the density of the object, whether it is more or less than the density of the fluid.



Experiment 8.1

STEM

Aim: To study the effect of density on the position of an object in water.

Problem statement: Will an object that is more dense than water submerge or float in water?

Hypothesis: An object that is more dense than water will submerge, while an object that is less dense than water will float.

Variables:
(a) Constant variable: Volume of blocks
(b) Manipulated variable: Density of blocks
(c) Responding variable: Position of blocks in water

Materials: Copper block, aluminium block, cork block and wooden block of the same size

Apparatus: Weighing scale, glass basin and metre rule

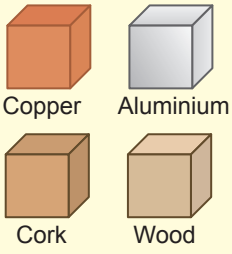


Figure 8.12 *Four blocks with the same size*

Procedure:
1. Weigh the mass of each block.
2. Calculate the volume of each block.
3. Calculate the density of each block using the following formula:

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

4. Record the mass, volume and density in the table below.

	Copper	Aluminium	Cork	Wood
Mass (g)				
Volume (cm^3)				
Density (g/cm^3)				

5. Put the four blocks into a glass basin filled with water. Observe the block that floats or submerges in water.

Conclusion:
Is the hypothesis accepted? Give your reasons.

Questions
1. Water has a density of 1.0 g cm^{-3}. Which block is more dense than water?
2. State whether the block that is more dense than water floats or submerges in water.

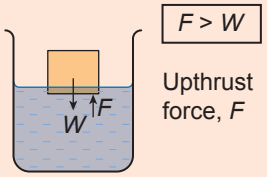


Figure 8.13 *Object floats*

When an object that is less dense than a liquid is pushed into the liquid, the buoyant force (upthrust force, F) is more than weight (W). It pushes the object up to the surface of the liquid. The object will **float** (Figure 8.13).

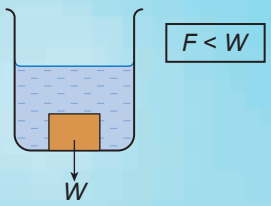


Figure 8.14 *Object submerges*

Conversely, when an object is more dense than the liquid, the buoyant force (upthrust force, F) is less than the weight of the object (W). It causes the object to submerge to the bottom of the liquid (Figure 8.14).

Table 8.1

Material	Density at 0 °C and 1 atmospheric pressure	
	g cm^{-3}	kg m^{-3}
Cork	0.24	240
Water	1.0	1 000
Glycerine	1.26	1 260
Iron	7.9	7 900
Lead	11.3	11 300
Mercury	13.6	13 600
Gold	19.3	19 300

Table 8.1 shows the densities of a few materials. Based on this table, cork floats on water because it is less dense than water. Glycerine, iron, lead, mercury and gold submerge in water because they are more dense than water.

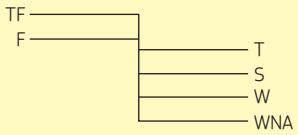


Figure 8.15 *Plimsoll line*

TF = Tropical freshwater
F = Freshwater
T = Tropical zone
S = Summer
W = Winter
WNA = Winter North Atlantic

Cargo ships are marked with Plimsoll lines for safety purposes. Due to the differences in temperature and concentration of salt, the density of sea water is different in different parts of the world. Plimsoll lines will help to determine the safe level for a ship to stay afloat.

Photograph 8.8 *Cargo ship*

Lever

We use various types of tools at home and in school every day. These tools help us perform tasks easily based on the lever principle. What is a lever? A **lever** is a bar that rotates on a fixed point. A lever is made up of three parts as shown in Figure 8.16.

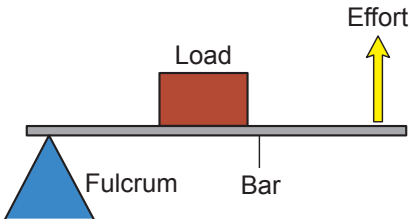


Figure 8.16 *Parts of a lever*

Effort : Force applied on the bar
Load : Object to be moved
Fulcrum : Fixed support point

A lever is a **simple machine**. What is the purpose of a lever?

A lever allows us to do work easily.

Opening a can lid with a spoon

Opening a bottle cap with a bottle opener

Photograph 8.9 *Examples of levers used to make work easier*

A lever allows us to use minimal force to do work.

Lifting a heavy load

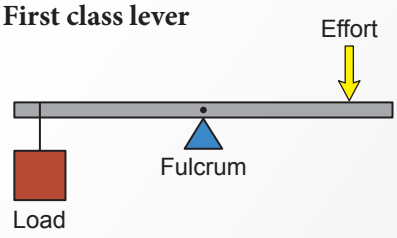
Removing a nail

Photograph 8.10 *Examples of levers using minimal force*

Classification of Levers

Levers are classified into three types, first class, second class and third class, depending on the position of the effort, fulcrum and load.

First class lever



Fulcrum is between load and effort.

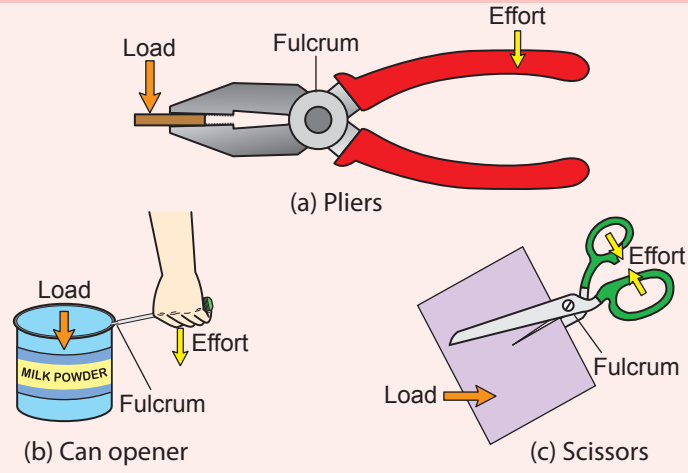
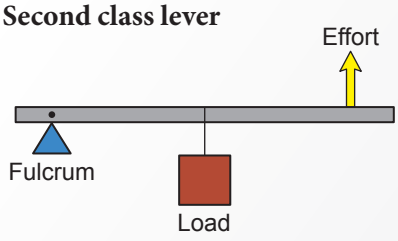


Figure 8.17 *Examples of first class lever*

Second class lever



Load is between fulcrum and effort.

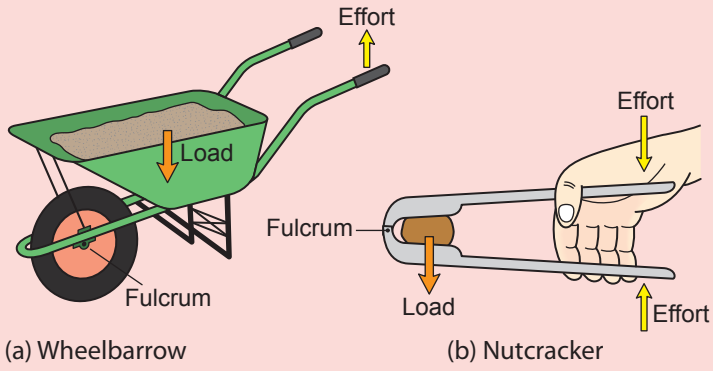
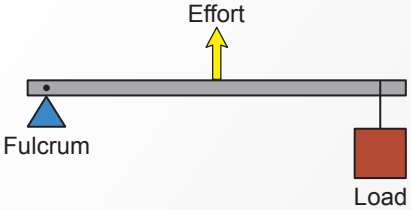


Figure 8.18 *Examples of second class lever*

Third class lever



Effort is between fulcrum and load.

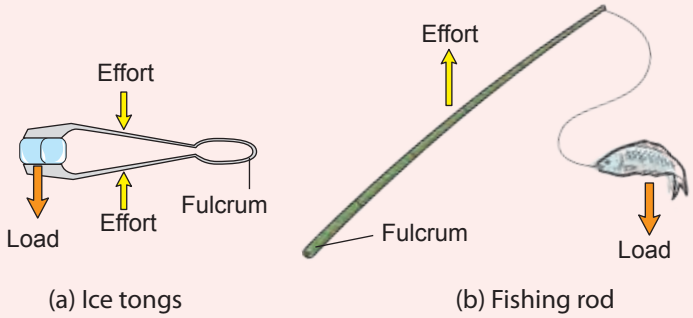


Figure 8.19 *Examples of third class lever*

The tree map below is a summary of the classification of levers.

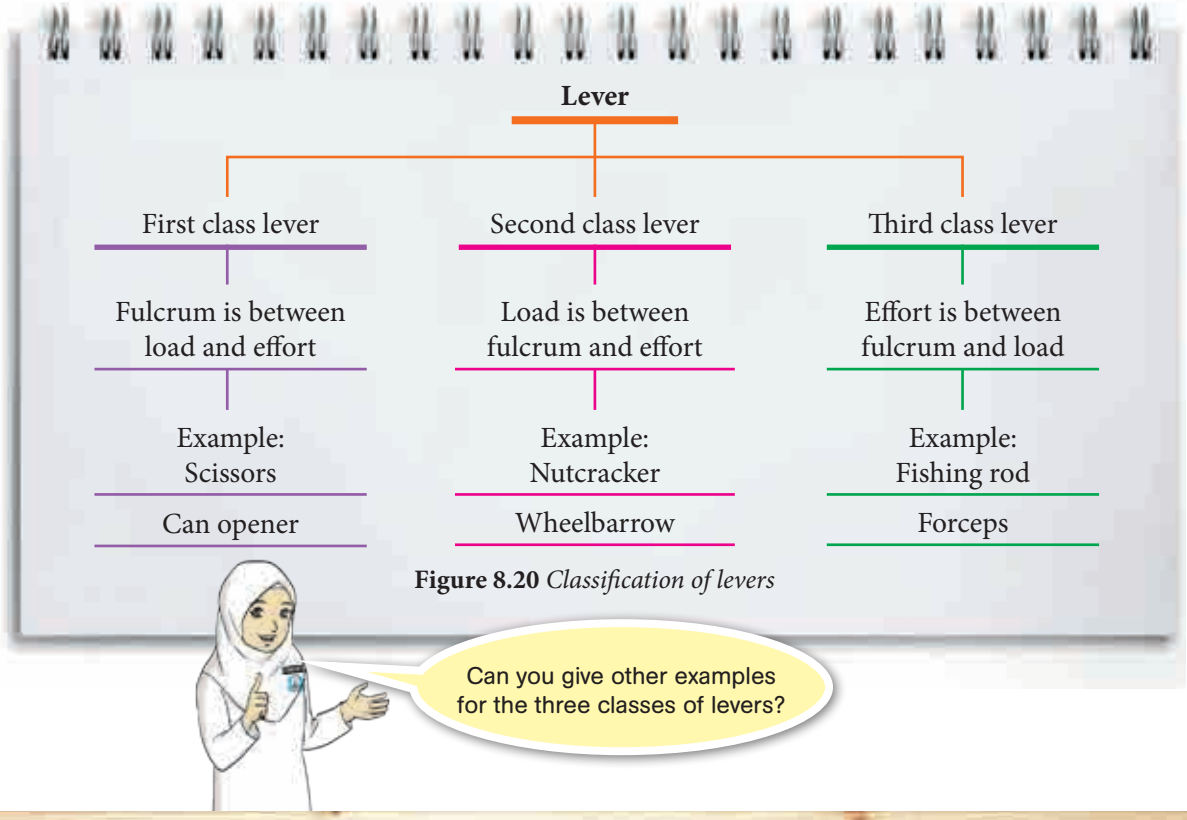


Figure 8.20 *Classification of levers*

Activity 8.5

Aim: To discuss the various examples of levers in daily life according to their classes.

Instruction

1. Work in groups.
2. Every group has to find information regarding tools used in daily life and classify the tools into three classes of levers.
3. Label the position of load, effort and fulcrum on every tool.
4. Present your group discussion in class.

The Moment of Force

A force acting on an object can rotate the object at a fixed point (pivot or fulcrum). The turning effect produced is called the **moment of force**.

- The moment of force allows us to do work easily.
- The moment of force depends on the force applied and the **perpendicular distance** of the fulcrum to the force.

8.2.3
8.2.4

Examples of moment of force are like using a spanner to tighten a nut and the act of opening a door as shown in Figure 8.21.

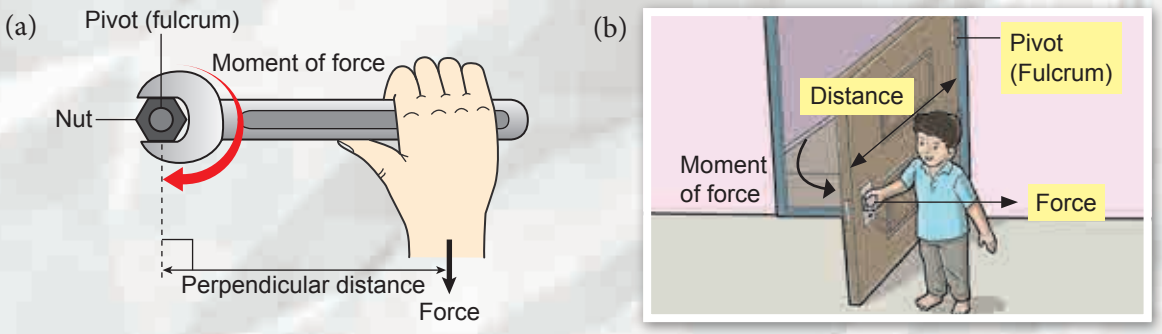


Figure 8.21 *Moment of force in daily life*

Method to calculate moment of force:

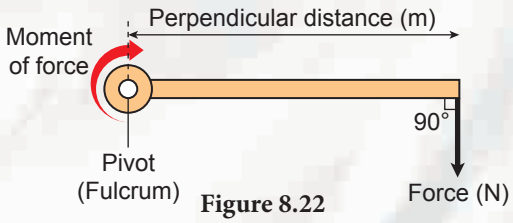


Figure 8.22

Moment of force = Force (N) × Perpendicular distance from the pivot to the force (m)

Unit for moment of force is **newton metre (N m)**.

Example 1:

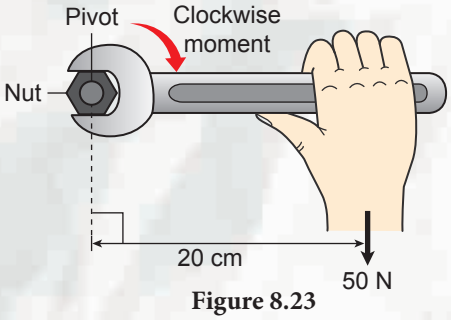


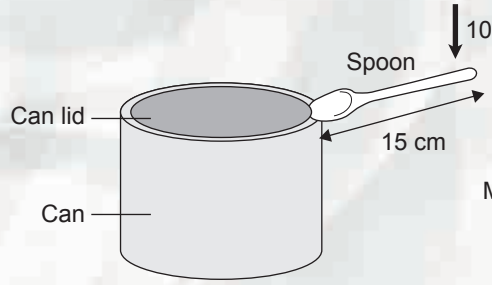
Figure 8.23

Moment of force = Force (N) x Perpendicular distance from the pivot to the force (m)
= 50 N x 0.2 m
= 10 N m

Moment of force has two directions, either clockwise or anticlockwise. It is found that the direction of moment of force to tighten the nut is clockwise. What is the direction of moment of force to loosen the nut?

Example 2:

The force used to open the lid of a can is 10 N using a spoon of length 15 cm. Calculate the moment of force



Moment of force = 10 N x 0.15 m
= 1.5 N m

Figure 8.24

Activity 8.6

Aim: To study the relationship between moment of force, effort and perpendicular distance from pivot to force.

Materials: Nut and screw

Apparatus: Spanner

Instruction

1. Prepare an item that is fitted with a nut and screw.
2. Hold a spanner in position *X* as shown in Figure 8.25 and tighten the nut. Then, hold the spanner in position *Y* as shown in Figure 8.26 and tighten the nut. Which position requires more effort? Which position results in greater moment of force?

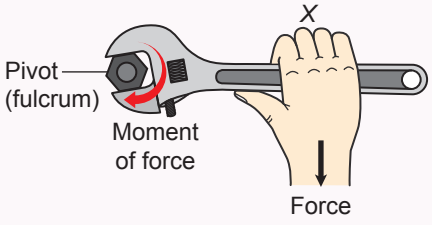


Figure 8.25 *Tightening nut from position X*

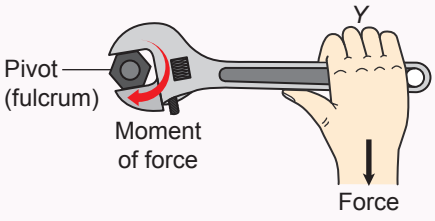


Figure 8.26 *Tightening nut from position Y*

Moment of force will increase if the:

- magnitude of force increases, by applying a greater force
- perpendicular distance from pivot to effort increases

(a) **Figure 8.27** (b)

Figure 8.27 shows a spanner used to tighten the nuts. Figure 8.27 (a) shows a 10 N force applied at a distance of 0.2 m from the turning point and in Figure 8.27 (b), force is applied at a distance of 0.1 m.

In Figure 8.27 (a), moment of force = 10 N× 0.2 m
= 2 N m

In Figure 8.27 (b), moment of force = 10 N× 0.1 m
= 1 N m

In conclusion, a greater moment of force is produced when force is applied at a greater distance from the turning point.

Observe Figure 8.28. The weight of the load produces a clockwise moment. The applied effort produces an anticlockwise moment to balance the lever horizontally. Therefore, the product of the magnitude of effort and the perpendicular distance from the pivot (fulcrum) is the same as the moment required to balance the lever.

Load (N) × Distance of load from fulcrum (m) = Effort (N) × Distance of effort from fulcrum (m)

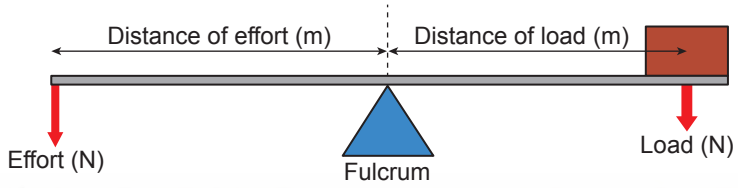


Figure 8.28 *Principle of moments of lever*

The formula above can be used to solve daily life problems involving levers as in the following.

Example 1

Figure 8.29 shows two children sitting on a see-saw. What is the distance of Jia Yin from the fulcrum so that the see-saw is balanced?

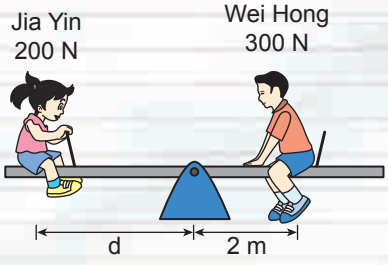


Figure 8.29

Solution:

Load × Distance of load from fulcrum = Effort × Distance of effort from fulcrum

$200\ N \times d = 300\ N \times 2\ m$

$d = \frac{300\ N \times 2\ m}{200\ N}$

$d = 3\ m$

Jia Yin has to sit 3 m away from the fulcrum.

Example 2

Figure 8.30 shows a man trying to move a boulder weighing 100 kg using a small stone as a fulcrum. The distance between the boulder and the small stone is 0.5 m and the distance between the man and the small stone is 2 m.
Calculate the effort required by the man to move the boulder.
(Gravitational force = 10 N kg^{-1})

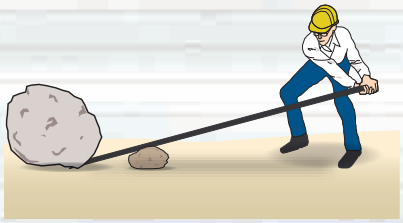


Figure 8.30

Solution:

Load = 100 kg × 10

= 1000 N

Load × Distance of load from fulcrum = Effort × Distance of effort from fulcrum

1000 N x 0.5 m = Effort x 2 m

$\text{Effort} = \frac{1000\ N \times 0.5\ m}{2\ m}$

= 250 N

Pressure

You have learned that force is a push or a pull applied on an object. But sometimes a large force cannot push or pull a small object. Why?

Observe Photograph 8.11 below.

(a) Press a thumbtack into a plank

(b) Press a coin into a plank

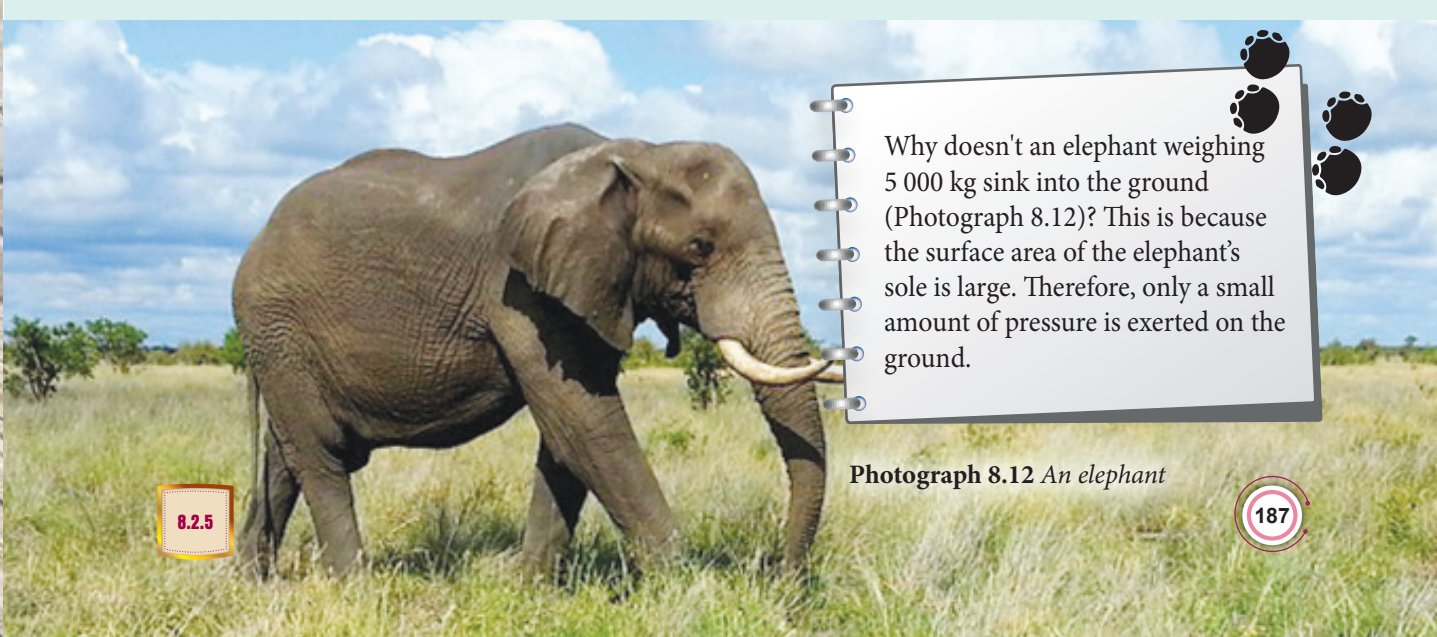
Photograph 8.11

You can press a thumbtack into a plank but you cannot press a coin into a plank even though the same force is applied. Do you know why?

The examples above show that the effects of force acting on a surface depend on the **surface area** on which the force is applied. Force applied on a smaller surface area will result in a larger pressure. Conversely, the same force applied on a larger surface area will result in a smaller pressure. **Pressure** is defined as force per unit area (direction of force is perpendicular to the surface area).

$$\text{Pressure} = \frac{\text{Force (N)}}{\text{Surface area (m}^2\text{)}}$$

The S.I. unit for pressure is pascal (Pa).
1 Pa equals 1 newton per square metre (N m^{-2}).



Why doesn't an elephant weighing 5 000 kg sink into the ground (Photograph 8.12)? This is because the surface area of the elephant's sole is large. Therefore, only a small amount of pressure is exerted on the ground.

Photograph 8.12 *An elephant*

8.2.5

Let us carry out Experiment 8.2 to study the effects of surface area on pressure produced by the same force.

Experiment 8.2

Aim: To study the relationship between surface area and pressure.

Problem statement: What is the effect of surface area on pressure produced by the same force?

Hypothesis: The larger the surface area, the lower the pressure exerted.

Variables:
(a) Constant variable: Metal blocks of the same mass
(b) Manipulated variable: Surface area
(c) Responding variable: Depth of dent

Materials: Metal block and plasticine

Apparatus: Retort stand with clamp, metre rule and thread

Procedure:
1. Prepare two metal blocks of the same mass.
2. Hang the two blocks as shown in Figure 8.31.
3. Place a piece of plasticine under the two metal blocks.
4. Release metal block *P* and measure the depth of the dent produced using a metre rule.
5. Repeat step 4 using metal block *Q*.

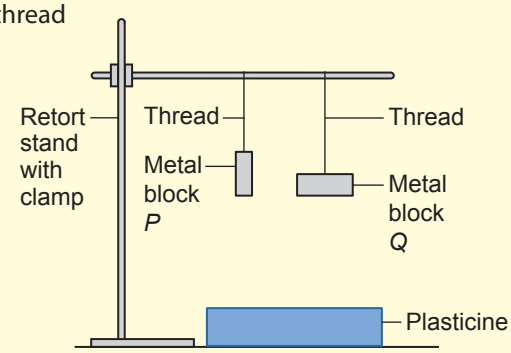


Figure 8.31

Result:

Metal block	*P*	*Q*
Depth of dent produced (cm)		

Conclusion:
Is the hypothesis accepted? Give your reasons.

Questions
1. What is the change in depth of the dent produced when the surface area upon which the force is applied increases?
2. What is the relationship between surface area and pressure?
3. State an inference based on the observation.
4. State the operational definition of pressure.

Application of Pressure in Daily Life

(a) Why are the metal blades of skating boots thin?

(b) Why is the blade of an axe thin?

(c) Why do tractors have big and wide wheels?

(d) What is the purpose of studs on the sole of football boots?

Photograph 8.13 *Examples of application of pressure in daily life*

Activity 8.7

21st Century

Aim: To discuss the application of pressure in daily life.

Instruction

1. Work in groups.
2. Discuss the application of pressure in daily life.
3. Present your group discussion using a multimedia presentation.

Gas Pressure

You would have surely played with balloons. Do you know why balloons expand when they are blown? Why do the balloons deflate when air is released from the balloons (Figure 8.32)?

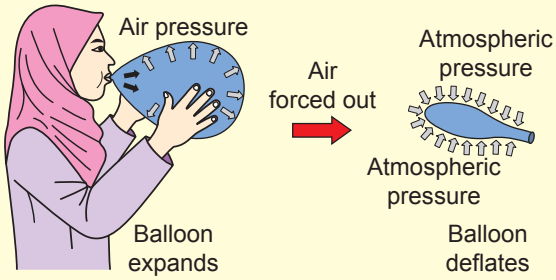


Figure 8.32 *Air pressure causes the balloon to expand and deflate*

The kinetic theory of gas states that air molecules always move about freely and collide with the walls of its container. The frequency of collision between the air molecules and the walls of the container will produce a force that pushes against the walls (Figure 8.33). This force is called **air pressure**.

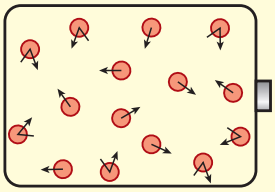


Figure 8.33

Let us carry out Activity 8.8 to show that air exerts pressure.

Activity 8.8

Aim: To show that air exerts pressure.

Instruction

1. Fill a glass with water until it is full.
2. Cover the mouth of the glass with a card.
3. Hold the card and turn the glass upside down quickly.
4. Remove your hand slowly. Observe if the water flows out (Figure 8.34).

Question

Why doesn't the water flow out when the hand that presses the card is removed?

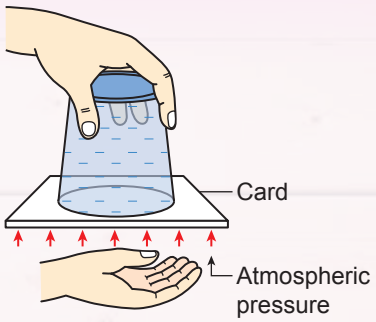


Figure 8.34

Why do balloons burst when they are left under the Sun (Photograph 8.14)? Is it due to factors affecting air pressure? Let us carry out Activity 8.9 to study these factors.

Photograph 8.14 *Balloons left under the Sun*

Activity 8.9

Aim: To study the factors that affect gas pressure.

Material: Water

Apparatus: Bourdon gauge, 250 ml beaker, Bunsen burner, tripod stand, retort stand with clamp, wire gauze, wooden block, thermometer, rubber tube, stirrer, round-bottom flask and syringe

A Volume

Instruction

1. Set up the apparatus as shown in Figure 8.35.
2. Push the piston into the syringe. Observe the change in the reading of the Bourdon gauge.
3. Pull the piston out of the syringe. Observe the change in the reading of the Bourdon gauge.
4. Record your observations.

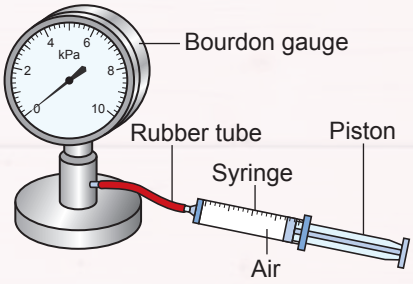


Figure 8.35

Question

What is the relationship between the volume of air and air pressure in the syringe?

B Temperature

Instruction

1. Set up the apparatus as shown in Figure 8.36.
2. Heat up the water in the beaker slowly. Observe the change in the reading of the thermometer and the Bourdon gauge.
3. Record your observations.

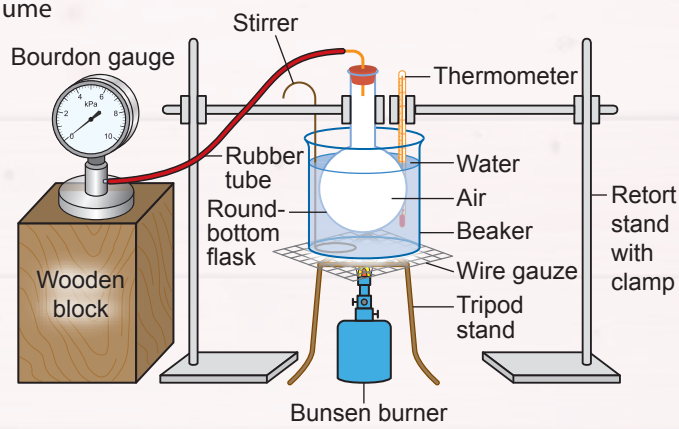


Figure 8.36

Question

What is the relationship between change in temperature and air pressure?

Factors that affect air pressure
- ☑ Volume
- ☑ Temperature

Volume

When a closed container is compressed, the volume in the container is reduced (Figure 8.37). This causes the air particles to **collide more frequently** with the walls of the container and air pressure in the container increases.

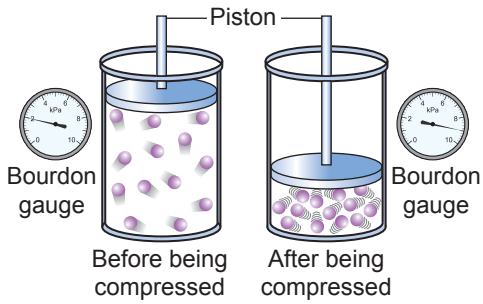


Figure 8.37 *Relationship between volume and air pressure*

Temperature

When the air temperature in a closed container increases, the air particles move faster. This causes the air particles to collide with the walls of the container more frequently and with a greater force (Figure 8.38). Therefore, the air pressure in the container increases.

Info

Relationship between Temperature and Air Pressure
http://www.passmyexams.co.uk/GCSE/physics/pressure-temperature-relationship-of-gas-pressure-law.html

The lower the temperature, the slower the movement of air particles	The higher the temperature, the faster the movement of air particles.

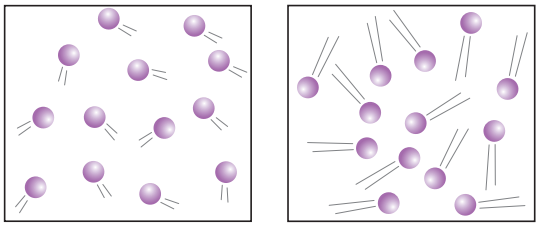


Figure 8.38 *Relationship between temperature and air pressure*

Atmospheric Pressure

When a drink is sucked out of its packet, the packet will compress (Photograph 8.15). What causes the packet to compress? When the drink is sucked out, the drink inside the packet becomes a partial vacuum and the air pressure inside decreases. Therefore, the higher air pressure outside will press onto the packet and compress it. The air pressure outside is called the **atmospheric pressure**. Atmospheric pressure is the pressure exerted by the atmosphere on the surface of the Earth and all objects on the Earth.

Photograph 8.15 *A packet of drink is compressed*

Application of the Concept of Air Pressure in Daily Life

The concept of air pressure allows us to use various tools to carry out daily activities easily. Let us study a few tools that function based on the concept of air pressure in Activity 8.10.

Activity 8.10

Aim: To show the existence of atmospheric pressure in daily life.

Materials: Water and shredded paper

Apparatus: Plunger, Magdeburg hemisphere, straw, syringe, vacuum cleaner, beaker, drinking glass, rubber tube, tiles and basin

Instruction

1. Wet the rim of a plunger with water. Press the plunger against a piece of tile so that air in the plunger is displaced (Figure 8.39). Try to pull the handle of the plunger. Can you detach the plunger from the tile? How is this situation related to atmospheric pressure?

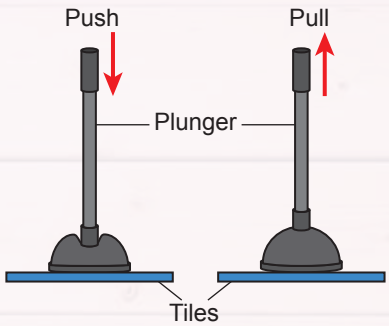


Figure 8.39

8.2.6
8.2.7

2. Attach two Magdeburg hemispheres together and turn the screws to remove the air inside. Try to pull and separate the two hemispheres (Figure 8.40). Can you do it? Explain this phenomenon.

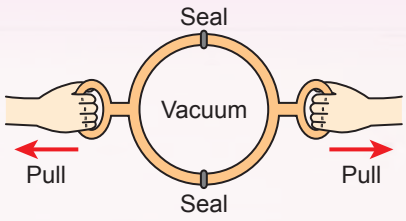


Figure 8.40

3. Fill a beaker with water and put in a drinking straw. Close the upper end of the straw (Figure 8.41). Lift up the straw. Observe what happens to the water in the straw. Explain your answer.

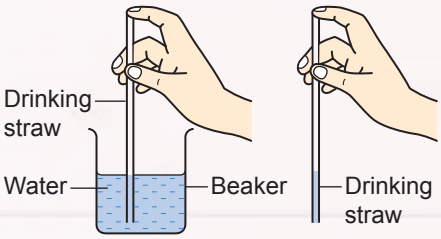


Figure 8.41

4. Arrange the apparatus as shown in Figure 8.42. Fill a rubber tube with water. Close both ends of the rubber tube. Then, place one end of the rubber tube in the water and the other end at a lower point outside the basin. Observe what happens to the water in the basin. What happens if both ends of the tube are at the same level?

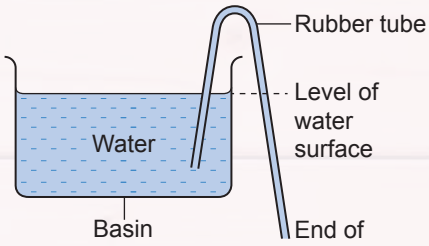


Figure 8.42

5. Insert a syringe into a glass of water (Figure 8.43). Pull the piston upwards. Observe what happens.

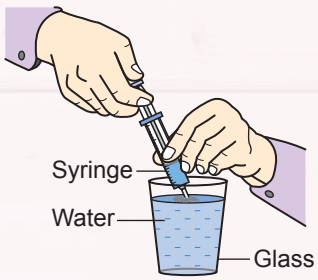


Figure 8.43

6. Scatter shredded papers on the floor. Then, use a vacuum cleaner to suck all the shredded papers (Figure 8.44). Observe what happens. How does the vacuum cleaner function?

Figure 8.44

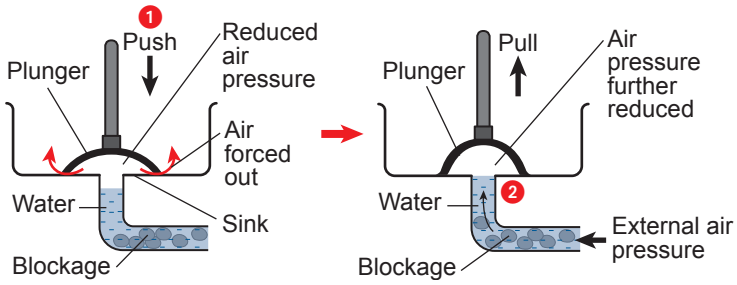
Explain all the observations above using labelled figures to show the action of atmospheric pressure.

Note:
Students need to use the terms air pressure and atmospheric pressure correctly.

Application of the Concept of Air Pressure in Daily Life

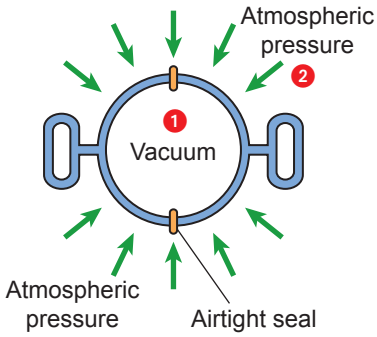
Plunger

1. When the plunger is pressed against the sink, the air inside it will be forced out and creates an area of low pressure.
2. The high pressure in the pipe pushes out the blockage stuck inside the sink when the plunger is pulled up.



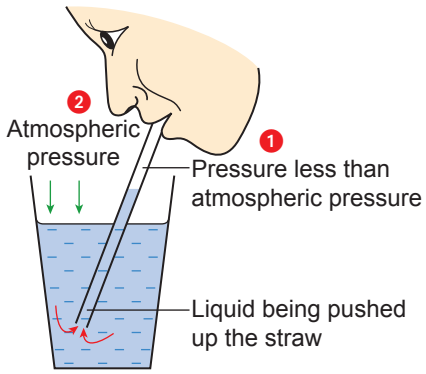
Magdeburg Hemisphere

1. When the air in the hemisphere is pumped out so that the space in the hemisphere becomes a vacuum, the pressure in the hemisphere is zero.
2. The two hemispheres cannot be separated because the atmospheric pressure outside will exert a very strong force on the hemispheres.



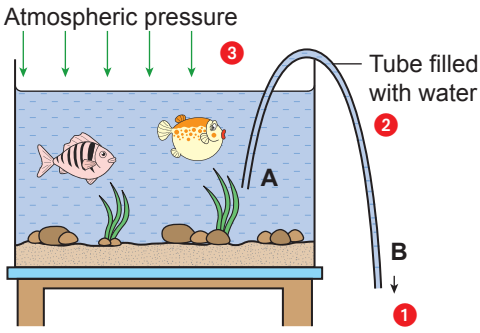
Straw

1. When air in the straw is sucked, the pressure inside the straw is reduced.
2. The higher air pressure outside (atmospheric pressure) will push the drink into the straw and finally into the mouth.



Syphon

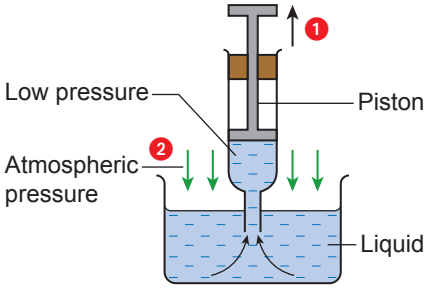
1. The end of tube B is placed lower than the end of tube A, causing water to flow out from it.
2. Water in the tube flows out and creates an area of low pressure in the tube.
3. Atmospheric pressure pushes the water into the tube, so the water flows out continuously.



Application of the Concept of Air Pressure in Daily Life

Syringe

1. When the piston is pulled up, the volume of air in the cylinder increases. This causes a low air pressure in the cylinder.
2. The higher air pressure outside (atmospheric pressure) will push the liquid into the syringe.



Vacuum cleaner

1. When the switch is turned on, the fan in the vacuum cleaner will push air out of the vacuum cleaner. This causes the air pressure in the vacuum cleaner to drop.
2. The higher atmospheric pressure outside will push the air and dust into the vacuum cleaner.

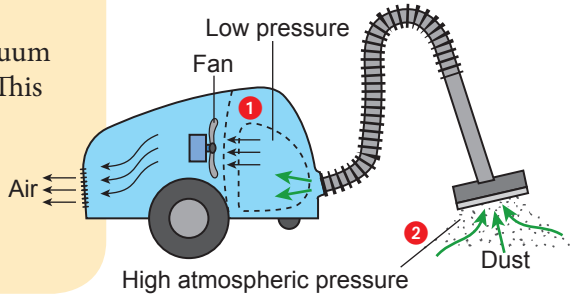
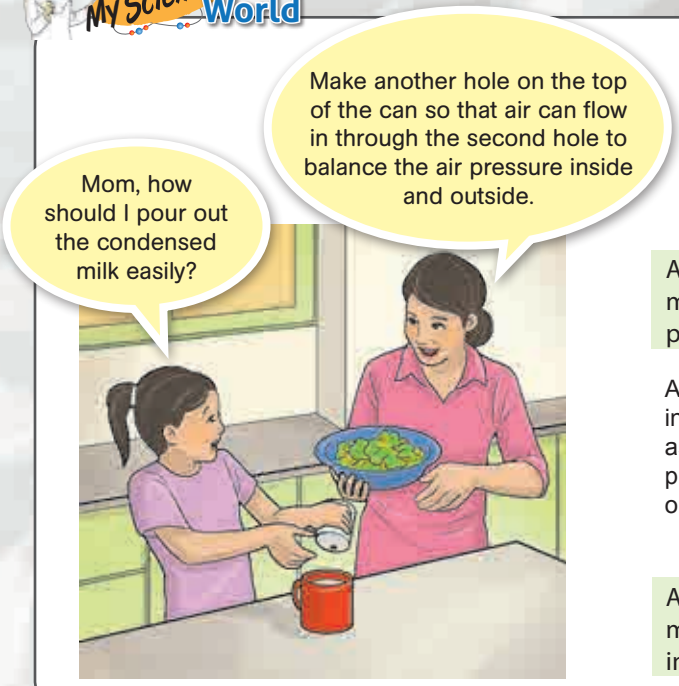
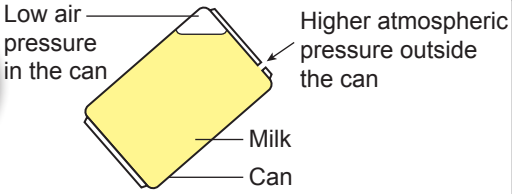


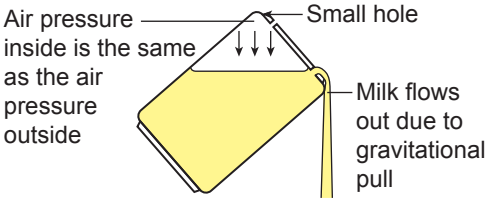
Figure 8.45 *Examples of application of air pressure in daily life*

My Science World





A can of condensed milk with one hole – milk does not flow out easily due to high pressure outside the can.



A can of condensed milk with two holes – milk flows out easily because air pressure inside and outside the can is equal.

Relationship between Altitude and Atmospheric Pressure

Do you know that atmospheric pressure depends on altitude? Atmospheric pressure decreases as altitude increases. This is due to gravitational attraction. Air molecules closer to the surface of the Earth are pulled together by the gravitational attraction causing a rise in pressure. At higher altitudes, air molecules are less affected by the gravitational attraction, so air becomes less heavy and expands easily. This causes a low atmospheric pressure at high altitude (Figure 8.46).

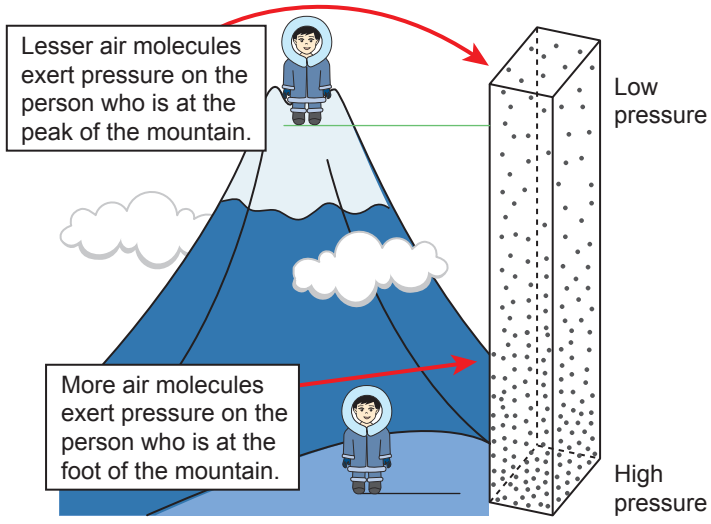


Figure 8.46 *Atmospheric pressure at different altitudes*

My Malaysia!

With the '*Malaysia Boleh*' spirit, two Malaysians, Datuk M. Magendran and Datuk N. Mohanadas became the first two Malaysians to conquer Mount Everest on 23rd May 1997. The peak of Mount Everest has an area of very low atmospheric pressure.

Scan the QR codes below for more information regarding the relationship between altitude and atmospheric pressure.

Info

Altitude Calculator, Atmospheric Pressure and Analysis
http://www.mide.com/pages/air-pressure-at-altitude-calculator

Info

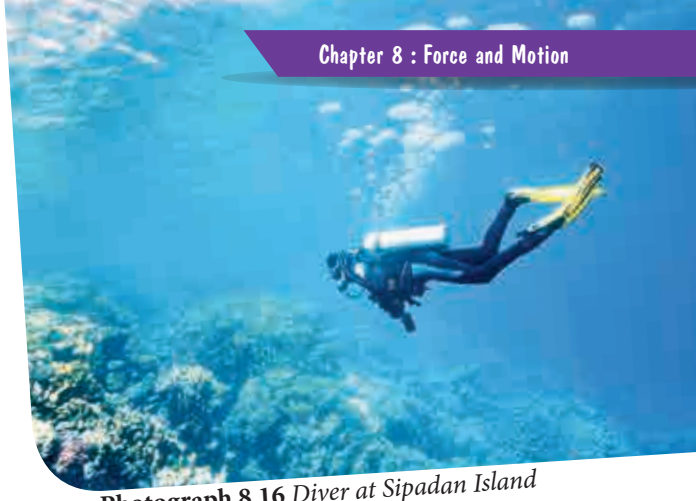
Data Analysis Regarding Relationship between Altitude and Atmospheric Pressure
http://www.windows2universe.org/earth/Atmosphere/pressure_vs_altitude.html

Info

Interactive Lab – Interactive Activity and Quiz
http://sunshine.chpc.utah.edu/Labs/OurAtmosphere/atm_measure2.html

Effects of Depth on Liquid Pressure

When a diver is diving in the sea, his body will experience pressure (Photograph 8.16). The weight of the sea water acting on the body of the diver causes the pressure. What will the diver experience if he dives deeper into the sea? Let us carry out Activity 8.11 to find out the answer.



Photograph 8.16 *Diver at Sipadan Island*

Activity 8.11

Aim: To study the effect of depth on pressure in liquids.

Material: Water

Apparatus: 50 cm rubber tube, basin and 1 000 ml measuring cylinder

Instruction

1. Fill a measuring cylinder to the maximum volume and turn it upside down as shown in Figure 8.47.
2. Put one end of a rubber tube into the measuring cylinder.
3. Blow air into the other end of the rubber tube. Observe the change in size of the air bubbles rising from the bottom to the water surface.

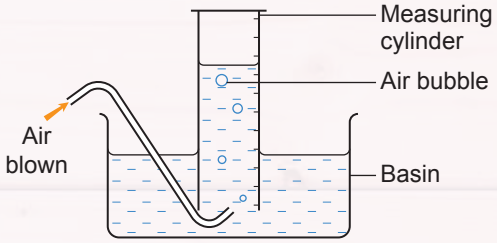


Figure 8.47

Questions

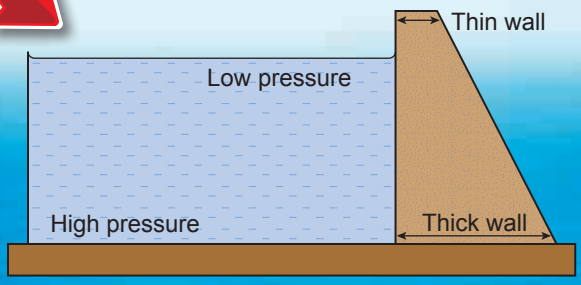
1. Compare the size of the air bubbles at the bottom of the basin and at the water surface.
2. State the relationship between volume of air bubbles and its depth in the water.
3. Explain this phenomenon in relation to pressure in liquids.

Based on the results of Activity 8.11, the size of the air bubbles becomes larger as the air bubbles rise to the surface. This is caused by the decreasing liquid pressure as depth of liquid decreases. Scan the QR code below for additional information regarding the effects of depth on liquid pressure.

Info

Effects of Depth on Liquid Pressure
http://oceanservice.noaa.gov/facts/pressure.html

Effects of Depth on Liquid Pressure in Daily Life



The walls of a dam are designed to be thicker at the base in order to withstand the high water pressure at the base of the dam.

A diver wears a special suit in order to withstand high water pressure.

The body of a submarine is made of strong material so that it will not be crushed by high water pressure.

Photograph 8.17 *Examples of effects of depth on liquid pressure*

Magical SCIENCE

STEM

It's fun to try!
Try carrying out the experiment shown in the video below to observe the effects of depth on liquid pressure.

Video

Video of Pressure in Liquids
http://bukutekskssm.my/Science/Video2.mp4

Career in STEM

Mechanical engineers carry out research on dam designs, industrial plants, machines and many other things. They need knowledge of physics, such as the concept of water pressure when building dams.

Water from the bottom hole shoots out further than water from the upper hole due to pressure in liquid.

Formative Practice 8.2

1. Figure 1 shows a lever system in equilibrium. Calculate the weight of X.

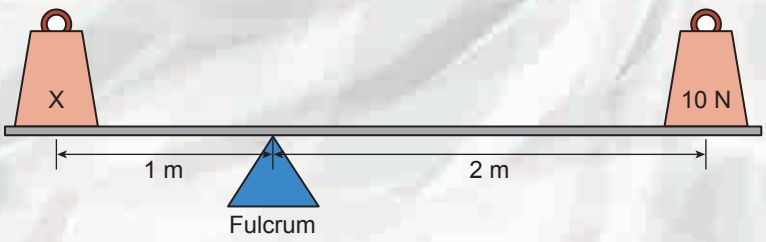


Figure 1

2. Figure 2 shows a cuboid with a weight of 5 N.
(a) Which surface will exert the greatest pressure?
(b) Calculate the pressure exerted by each surface.

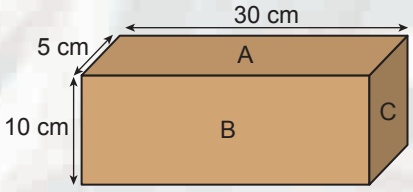


Figure 2

3. A balloon filled with helium gas will rise upwards when released and float at a certain height.
(a) Why does the balloon rise upwards?
(b) Explain the change in the size of the balloon as it rises higher.
(c) Show the forces acting on the balloon when it is floating with the help of a diagram.

Summary

Force and Motion

Force

- Types of forces
  - Gravitational force
  - Weight
  - Normal force
  - Elastic force
  - Buoyant force
  - Frictional force
- Characteristics of force
  - Force has magnitude
  - Force has direction
  - Force has point of application
- Measuring force in S.I. unit using spring balance
  - Weight of object
  - Frictional force
- For every force acting there is a reaction force of the same magnitude but in the opposite direction
  - Object that remains on the table
  - Object that floats on water
  - Two trolleys in contact with each other are released using spring mechanism

Quiz

Interactive Quiz 8

Effects of Force

- Effects of force
  - Moves stationary objects
  - Changes the velocity of objects
  - Stops moving objects
  - Changes direction of motion of objects
  - Changes shape and size of objects
- Difference in densities and effects of buoyancy on daily life
- Lever system
  - Effort
  - Fulcrum
  - Load
- Moment of force
- Pressure and its application in daily life
- Gas pressure and kinetic theory of gas
- Atmospheric pressure and the effects of altitude on atmospheric pressure
- Effects of depth on liquid pressure

SELF-REFLECTION

After learning this chapter, you are able to:

8.1 Force

- ☐ Describe and communicate about force.
- ☐ Explain that force has magnitude, direction and point of application.
- ☐ Measure force in S.I. unit.
- ☐ Explain with examples that every action force has an equal (same magnitude) reaction force but in the opposite direction.

8.2 Effects of Force

- ☐ Describe and communicate the effects of force.
- ☐ Explain and communicate the relationship between the differences in density and the effects of buoyancy in daily life.
- ☐ Classify and solve problems involving levers based on the position of fulcrum, load and effort.
- ☐ Explain and communicate about moment of force.
- ☐ Carry out experiment and communicate about pressure and its application in daily life.
- ☐ Elaborate and communicate about gas pressure based on the kinetic theory of gas.
- ☐ Explain and communicate the existence of atmospheric pressure and the effects of altitude on atmospheric pressure.
- ☐ Explain the effects of depth on liquid pressure.

Summative Practice 8

1. Identify the following types of forces.

(a)

(b)

Photograph 1

2. State the device used to measure force and the S.I. unit of force.

Measuring device: _____

S.I. unit: _____

3. Label the action force and the reaction force acting on the object in Photograph 2 below.

Photograph 2

4. Tick (✓) the activity that involves atmospheric pressure.

Inhaling air into lungs ☐

Opening a door ☐

Hanging a picture on the wall using a nail ☐

Drinking water from a straw ☐

5. Figure 1 shows a nail being removed from a plank using a hammer. If a force of 5 N is required to remove the nail, what is the moment of force required to pull the hammer in the direction shown in Figure 1?

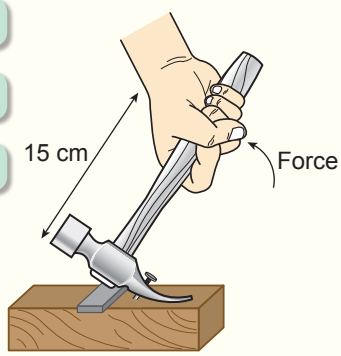


Figure 1

6. Figure 2 shows a car that has a weight of 1 000 N. The area of contact of each tyre with the road is 0.1 m^2. Calculate

(a) the total pressure exerted by the car on the road.

(b) the pressure exerted by each tyre on the road.

Figure 2

7. A piece of stone has a weight of 20 N in the air and 15 N when fully submerged in water.

(a) Determine the difference in the weight of the stone in the air and in water.

(b) Determine the upthrust force on the stone.

(c) Explain why the stone sinks in water.

8. Su Ling wants to use a straw to drink from a glass but she could not suck the water. She finds a small hole on the straw (Figure 3). Suggest a method to overcome the problem.

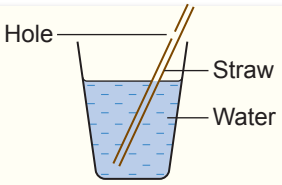


Figure 3

9. Mei Foong is invited to an event held at a field. The field has a soft ground. She has two pairs of shoes as shown in Figure 4. Suggest the most suitable pair of shoes to be worn by Mei Foong to attend the event. Give your reasons.

Figure 4

10. Azman wants to transfer liquid from beaker *B* to beaker *A* (Figure 5). He has tried a few times but failed. What is the problem? Modify the set up so that the liquid can be transferred from beaker *B* to beaker *A*.

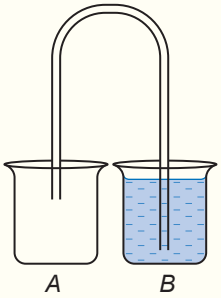


Figure 5

HOTS Mastery 8

11. Wan and Nurul sat on a see-saw (Figure 6). The see-saw is imbalanced because Wan's mass is 45 kg while Nurul's mass is only 30 kg. Suggest how Nurul can balance the see-saw.

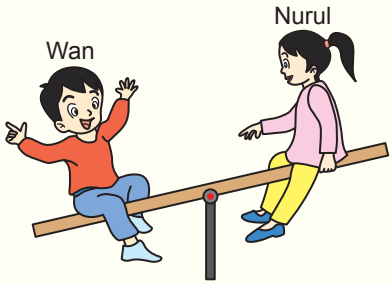


Figure 6

12. Mr. Tan pushes a wheelbarrow on a muddy road (Figure 7). He finds it very difficult to push the wheelbarrow. Suggest one modification that can be made to reduce the pressure exerted on the road. Explain your answer.

Figure 7

Chapter 9

Heat

Why are tall buildings fixed with shiny glass panels?

Why does a thick glass break when it is filled with hot water?

How do thermometers work?

Why is a bonfire lit on a cold night?

How does heat affect gas?

Let's understand:

- Relationship between temperature and heat
- Heat flow and thermal equilibrium
- Principle of expansion and contraction of matter
- Relationship between types of surface of object, and heat absorption and emission

SCIENCE BLOG

Infrared Cameras Hardly Detect Polar Bears

An infrared camera is an equipment used to detect heat emitted by the body and processes it to be shown as a thermal image. This equipment is often used to detect the location of animals or its habitat which is difficult to be seen with the naked eyes.

However, researchers find it difficult to detect polar bears using this equipment. Polar bears, which live in cold climates trap heat beneath its layers of fat and furs so well that it is almost undetectable by the infrared camera.

Keywords

- Heat
- Temperature
- Conduction
- Convection
- Radiation
- Heat conductor
- Heat insulator
- Expansion
- Contraction
- Land breeze
- Sea breeze
- Mercury

9.1 Relationship between Temperature and Heat

Try to recall the knowledge of heat and temperature that you have learned in primary school. Heat is obtained from various sources such as the Sun, electrical appliances and burning of fuel. **Heat** is a form of **energy**. Heat flows from a hotter region to a colder region.

What does temperature mean? **Temperature** is a measure of the degree of hotness or coldness of an object. Temperature increases in a hot environment and decreases in a cold environment (Photograph 9.1). Temperature is measured by using a **thermometer**.

When water is heated, its temperature increases.

When ice cubes are placed around bottles of juice, the temperature in the bottles decreases.

Photograph 9.1 *Temperature changes according to its surroundings*

Although heat and temperature are interrelated, both are not the same. Table 9.1 shows the differences between heat and temperature.

Table 9.1 *The differences between heat and temperature*

Heat	Temperature
A form of energy	The degree of hotness or coldness of an object
Measured in joule (J)	Measured in degrees Celsius (°C) or kelvin (K)
The amount of heat depends on the type of material, quantity of material and temperature	Temperature depends on the degree of movement of the particles in a matter.

Formative Practice 9.1

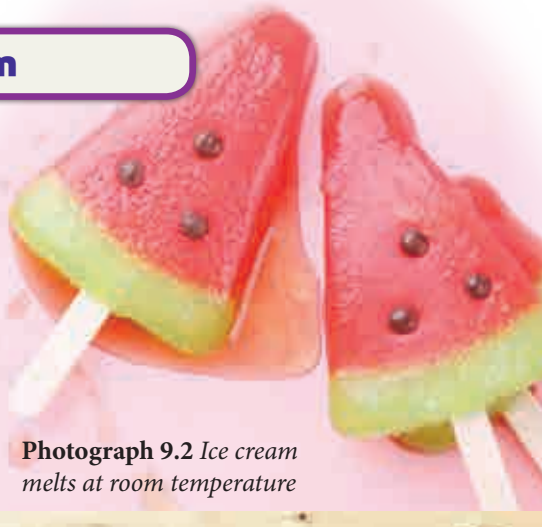
1. State the S.I. unit of heat.
2. Is the sense of touch a reliable method to determine if a person has fever? Give an explanation for your answer.
3. Tick (✓) the correct statement about heat and temperature.
   (a) When water is boiled in two beakers filled with 100 ml and 200 ml of water respectively, the temperature of the water is the same. ☐
   (b) The smaller the mass of water, the longer the time taken for the water to boil. ☐

9.2 Heat Flow and Thermal Equilibrium

Heat Flow

Heat flows from a **hot** object to a **cold** object. Ice cream left at room temperature absorbs heat and melts. What would happen to a hot kettle if it is left at room temperature?

Heat flow happens in three different ways, which are through **conduction**, **convection** and **radiation**. Let us carry out Activity 9.1 to understand these three ways of heat flow.



Photograph 9.2 *Ice cream melts at room temperature*

Activity 9.1

Aim: To show heat is transferred by conduction, convection and radiation.

Materials: Candle wax, water, matches, candle, incense stick, potassium permanganate crystal and thumbtacks

Apparatus: Copper rod, beaker, wire gauze, bell jar, bulb, T-shaped cardboard, thermometer, tripod stand, retort stand with clamp and Bunsen burner

A Conduction

1. Stick three thumbtacks on a copper rod using candle wax and set up the apparatus as shown in Figure 9.1.
2. Heat the end of the copper rod and observe the sequence in which the thumbtacks fall off.

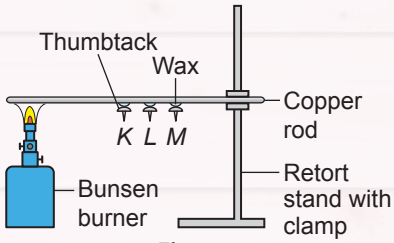


Figure 9.1

B Convection

(i) Convection in liquid

Safety Precaution

Make sure the potassium permanganate crystal sinks completely to the bottom of the beaker before it is heated up.

1. Fill a beaker with water and set up the apparatus as shown in Figure 9.2.
2. Heat the beaker slowly and observe the direction in which the potassium permanganate crystal moves inside the beaker.

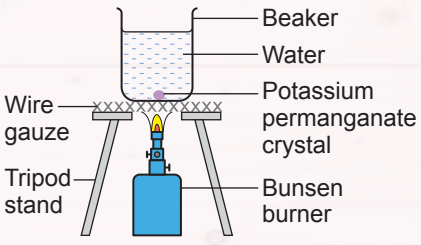


Figure 9.2

(ii) Convection in gas

1. Light a candle and place it inside a beaker on one side and place the T-shaped cardboard in the middle of the beaker (Figure 9.3).
2. Bring a glowing incense stick close to the mouth of the beaker on the opposite side of the candle.
3. Observe the movement of smoke in the beaker.

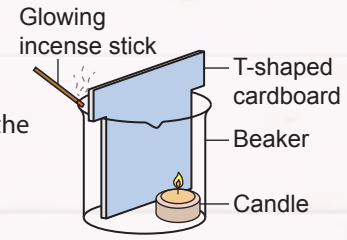


Figure 9.3

C Radiation

1. Set up the apparatus as shown in Figure 9.4.
2. Fix the vacuum pump to the bell jar and remove the air from the jar.
3. Place your palms on the sides of the bell jar to feel the heat.
4. Switch on the bulb. After 10 minutes, place your palms on the sides of the bell jar to feel the heat.

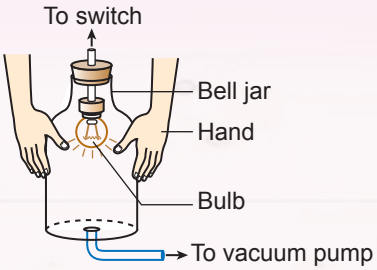


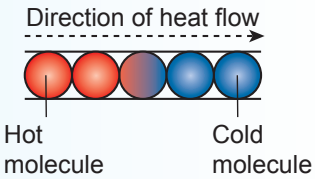
Figure 9.4

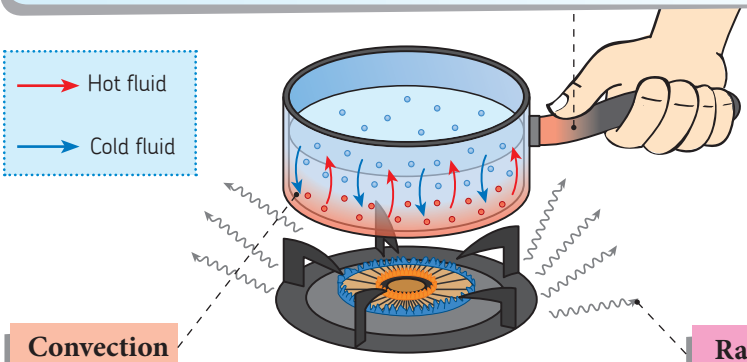
Questions

1. Give an inference for your observation in Activity A.
2. Draw the direction of the convection current in liquid.
3. What is the use of the incense stick in Activity B?
4. State other ways to detect surface heat of the bell jar in Activity C.

Conduction

- The process of heat transfer from hotter regions to colder regions through a **solid medium**.
- The particles that receive heat energy will **vibrate** and **collide** with one another more frequently and transfer the heat to the whole medium.





Brain Teaser

Why does a carpet feel warmer than marble tiles when we step on them?

Convection

- Heat is transferred by the **movement of fluid** (liquid and gas) from hotter regions to colder regions.
- The part of the fluid that receives heat will expand, become less dense and rise.
- The colder and more dense fluid moves downwards.
- The circulating stream that rises and falls continuously is known as **convection current**.

Radiation

- The process of transferring heat **without** any **medium**.
- Heat can propagate through an **empty space** or **vacuum**.
- The types of surface, temperature and total surface area of an object will influence the rate of heat flow.

Heat Flow in Natural Phenomena

Can you identify the method of heat flow from the Sun to the Earth? Heat energy from the Sun is transferred to the Earth through radiation. It is the only method that can propagate through an empty space (Figure 9.5). Energy that is radiated from the Sun penetrates the atmosphere before being absorbed by land and water. The warming of the Earth by the Sun causes changes in climate and the occurrence of natural phenomena such as sea breeze, land breeze, thunderstorms and so on.

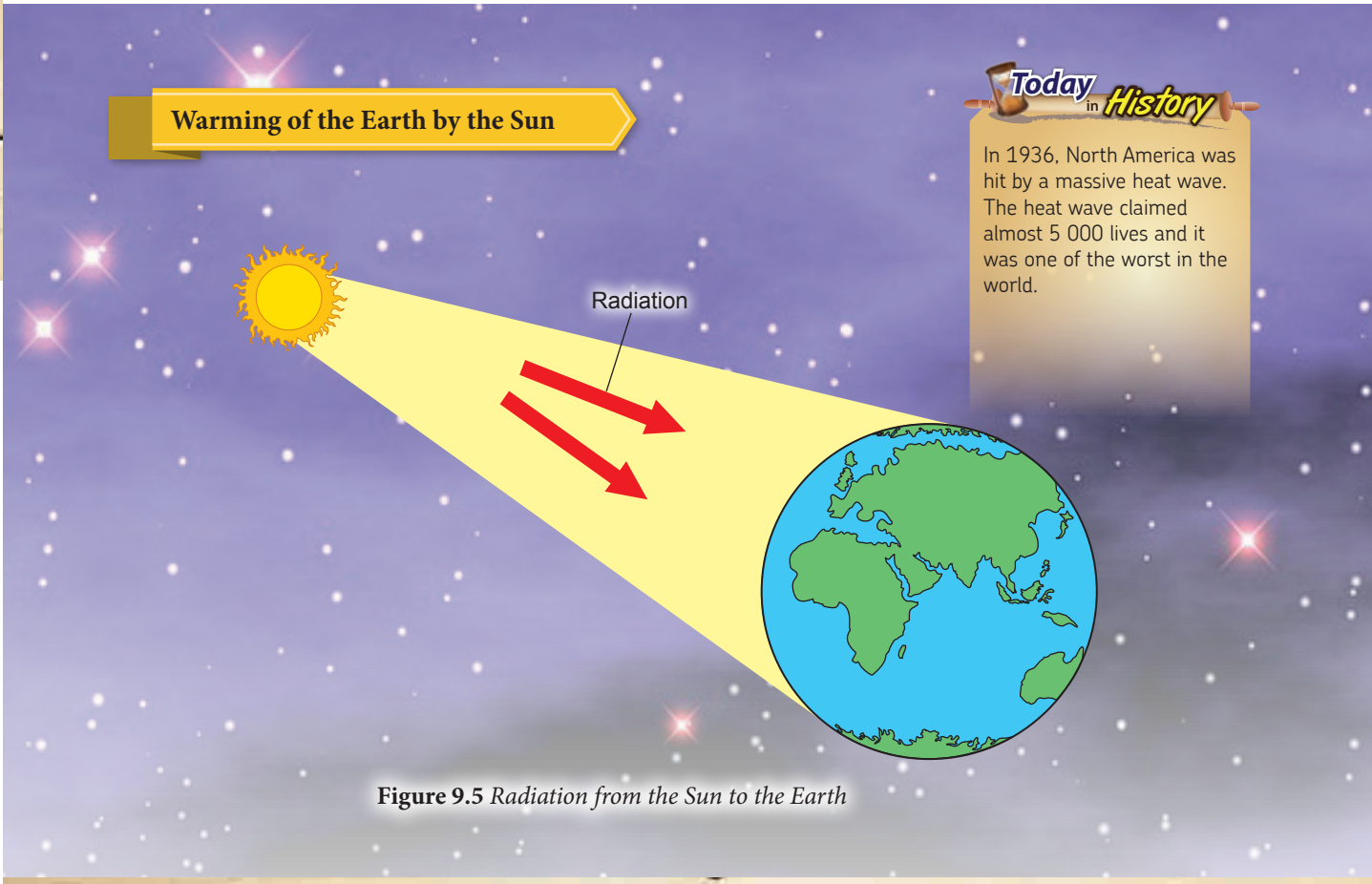


Figure 9.5 *Radiation from the Sun to the Earth*

Today in History

In 1936, North America was hit by a massive heat wave. The heat wave claimed almost 5 000 lives and it was one of the worst in the world.

Activity 9.2

21st Century

Aim: To discuss heat flow in natural phenomena.

Instruction

1. Work in groups.
2. Gather information on heat flow that can be observed in natural phenomena such as land breeze, sea breeze and warming of the Earth by the Sun.
3. Present your discussion.

9.2.2

Sea breeze

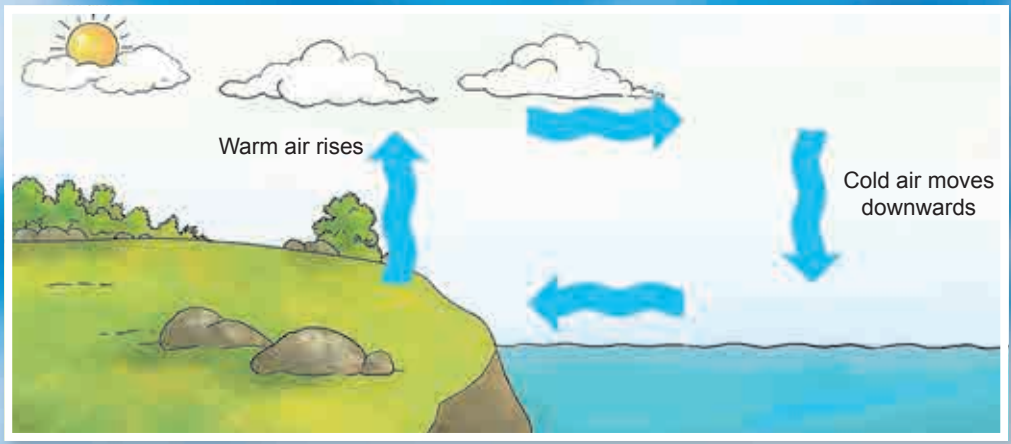


Figure 9.6 *Sea breeze*

The **formation of land breeze** and **sea breeze** are examples of a natural **convection process**. During the day, the Sun heats up the land faster than the sea. Warm air on land expands, becomes less dense and rises because it is lighter. The cold air from the surface of the sea that is more dense is drawn in to replace the warm air on land. This results in sea breeze (Figure 9.6).

Land breeze

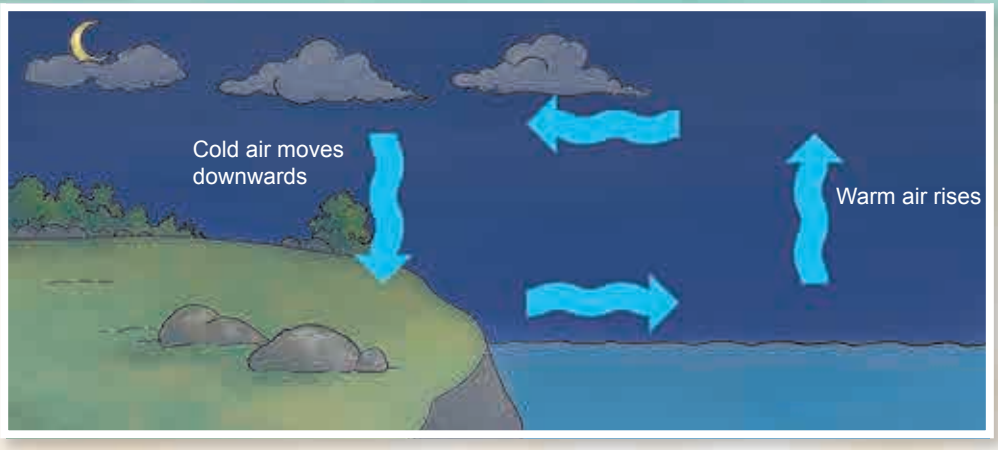


Figure 9.7 *Land breeze*

At night, the land cools faster than the sea. The air above the sea which is warmer becomes less dense and rises. The cold and more dense air from land begins to move to the sea resulting in land breeze (Figure 9.7).

Heat Conductors and Heat Insulators

Materials that allow heat flow are known as heat conductors.

The base of an iron is made of metal to enable it to **conduct heat** so that clothes can be ironed quickly.

The bottom of a pan is made of **metal** that **allows heat to flow** quickly to the food.

Mercury in thermometers is a **good heat conductor**. It can detect change in temperature very quickly.

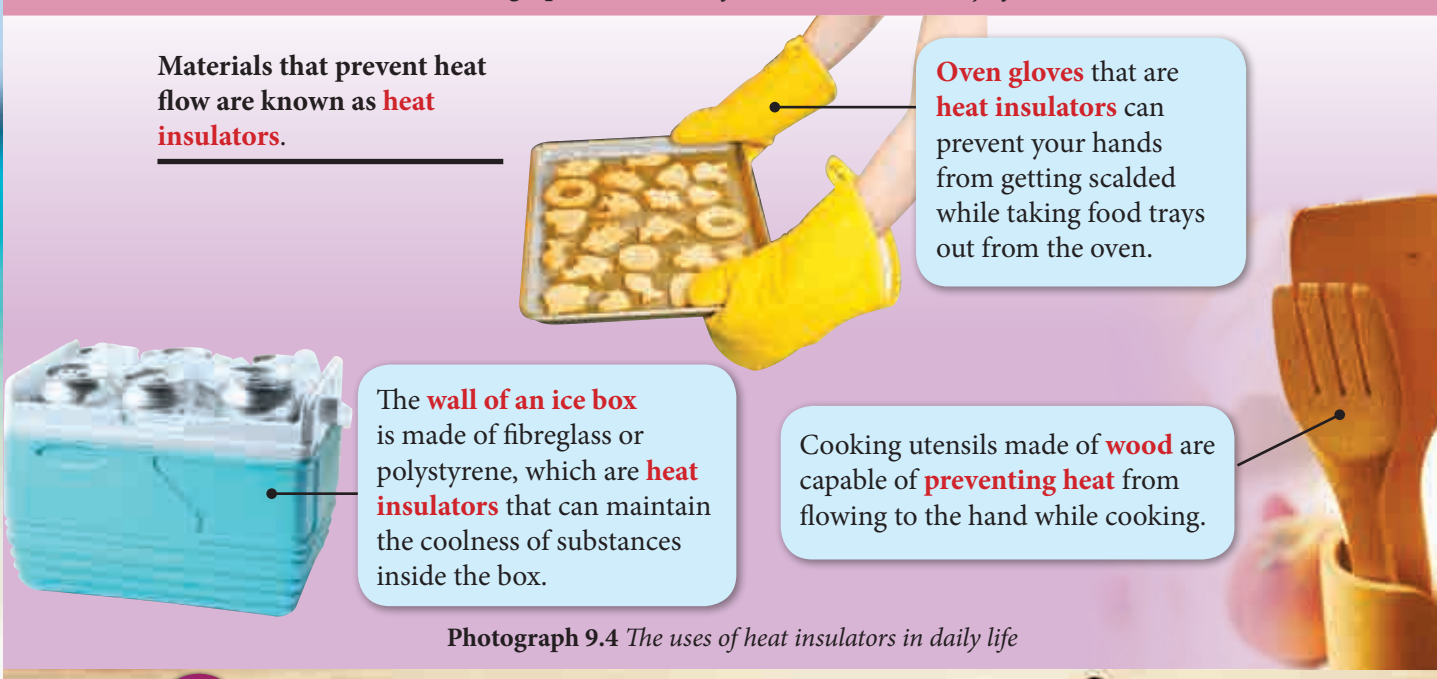
Photograph 9.3 *The uses of heat conductors in daily life*

Materials that prevent heat flow are known as heat insulators.

Oven gloves that are **heat insulators** can prevent your hands from getting scalded while taking food trays out from the oven.

The **wall of an ice box** is made of fibreglass or polystyrene, which are **heat insulators** that can maintain the coolness of substances inside the box.

Cooking utensils made of **wood** are capable of **preventing heat** from flowing to the hand while cooking.



Photograph 9.4 *The uses of heat insulators in daily life*

Activity 9.3

21st Century

Aim: To discuss the uses of various heat conductors and heat insulators in daily life.

Instruction

1. Work in groups.
2. Gather information and photographs related to various uses of heat conductors and heat insulators in daily life.
3. Present your discussion using a mind map.

Experiment 9.1

Aim: To study the uses of different materials as heat insulators.

Problem statement: Which is a good heat insulator, cotton, felt or aluminium foil?

Hypothesis: Cotton and felt are good heat insulators.

Variables:
(a) Constant variable: Volume of water in the flat-bottom flasks
(b) Manipulated variable: Types of insulators
(c) Responding variable: Final temperature

Materials: Cotton, felt, aluminium foil and boiling water

Apparatus: Flat-bottom flask, rubber stopper, thermometer and stopwatch

Procedure:
1. Prepare four flat-bottom flasks as shown in Figure 9.8.
2. Record the initial temperature of each flask.
3. Record the final temperature of each flask after 10 minutes.

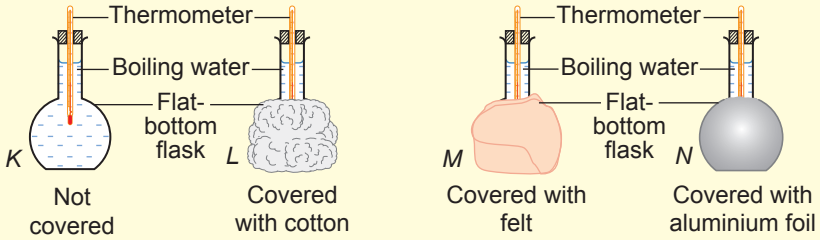


Figure 9.8

Observation:

Flat-bottom flask	*K*	*L*	*M*	*N*
Initial temperature (°C)				
Final temperature (°C)				
Difference in temperature (°C)				

Conclusion:
Is the hypothesis accepted? Give your reasons.

Questions
1. State an inference for the observation made for flask *N*.
2. What is the use of flask *K*?

Thermal Equilibrium

Two objects which are in **thermal contact** can exchange heat energy between them. The heat energy is transferred from the object with a higher temperature to the object with a lower temperature. When there is no net transfer of heat energy between the objects, the objects are said to be in **thermal equilibrium**. Two objects that are in thermal equilibrium have the same temperature.

Formative Practice 9.2

1. Why is the heating coil in an electric kettle placed at the bottom of the kettle?
2. The chicken that we roast in an oven is usually wrapped in an aluminium foil. Why?
3. Why is a polystyrene container used to store ice cubes?
4. Amirah uses a thick blanket for sleeping during cold weather. What is the function of the blanket? Explain your answer.

9.3 Principle of Expansion and Contraction of Matter

Expansion and Contraction of Matter

You have learned the three states of matter in Form One. Do you know the effect of changes in temperature towards matter? Let us carry out Activity 9.4 to study the effect of heat on the states of matter.

Activity 9.4

Aim: To show that heat can cause solid, liquid and gas to expand and contract.

A Solid

Apparatus: Bunsen burner, gauge and metal bar

Safety Precaution

Be careful when handling a hot metal bar.

Instruction

1. Try to fit the metal bar into the gauge (Figure 9.9).
2. Heat the end of the metal bar using a Bunsen burner for five minutes.
3. Try to fit the hot metal bar into the gauge. Record your observation.
4. Let the metal bar to cool and try to fit it into the gauge again. Record your observation.

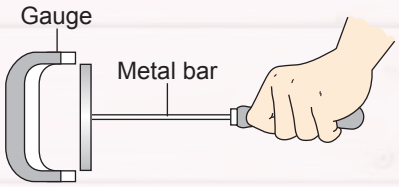


Figure 9.9

B Liquid

Materials: Coloured water, ice cubes and hot water

Apparatus: Conical flask, basin, rubber stopper and glass tube

Instruction

1. Set up the apparatus as shown in Figure 9.10 and mark the coloured water level in the glass tube at the beginning of the experiment.
2. Place the conical flask into a basin of hot water and observe the coloured water level.
3. Repeat steps 1 and 2 by replacing the hot water with ice cubes and record your observations.

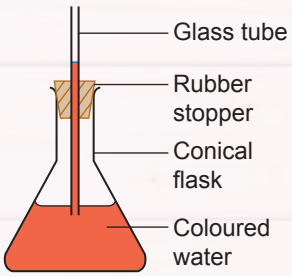


Figure 9.10

C Gas

Materials: Hot water, ice cubes and balloon

Apparatus: Conical flask and basin

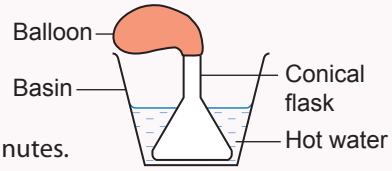


Figure 9.11

Instruction

1. Set up the apparatus as shown in Figure 9.11.
2. Observe and record the condition of the balloon after three minutes.
3. Repeat steps 1 and 2. Replace the hot water with ice cubes.

Questions

1. Give an inference for your observation in Activity A.
2. Why is coloured water used in Activity B?
3. What causes the physical changes to the balloon in Activity C?

The particles in a solid vibrate at a fixed position. When the solid is heated, the particles vibrate faster and move further apart from one another. This causes the volume of the solid to increase because the **solid expands**. Conversely, when the solid is cooled, the particles vibrate slower and move closer to one another. This causes the volume of the solid to decrease because the **solid contracts**.

The particles in liquid and gas move freely. When the liquid and the gas are heated, the particles move faster and randomly. The distance between the particles also increases. This causes the volume of the liquid and the gas to increase because the **liquid** and the **gas expand**. Conversely, when the liquid and gas are cooled, the particles move slower and closer to one another. This causes the volume of the liquid and the gas to decrease because the **liquid** and the **gas contract**.

The Uses of Expansion and Contraction of Matter in Daily Life

(a)

Photograph 9.5

Mercury in a thermometer is a heat conductor that can expand and contract (Photograph 9.5).

(b)

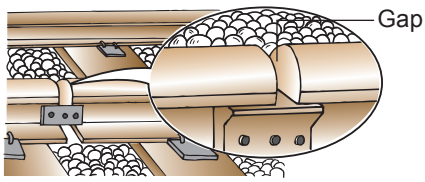


Figure 9.12

Railway tracks have small gaps between their rails to enable them to expand in hot weather. Without these gaps, the tracks will buckle and overlap (Figure 9.12).

(c)

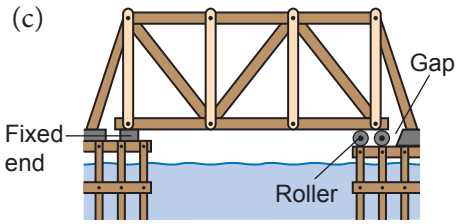


Figure 9.13

Steel bridges are built with rollers and a gap on one end. This allows the bridges to expand in hot weather (Figure 9.13).

(d) A bimetallic strip is usually used in devices that depend on temperature regulation. The strip is made from two different types of metal strips that can expand and contract at different rates. The fire alarm system shown in Figure 9.14 is designed with a circuit which is incomplete at room temperature.

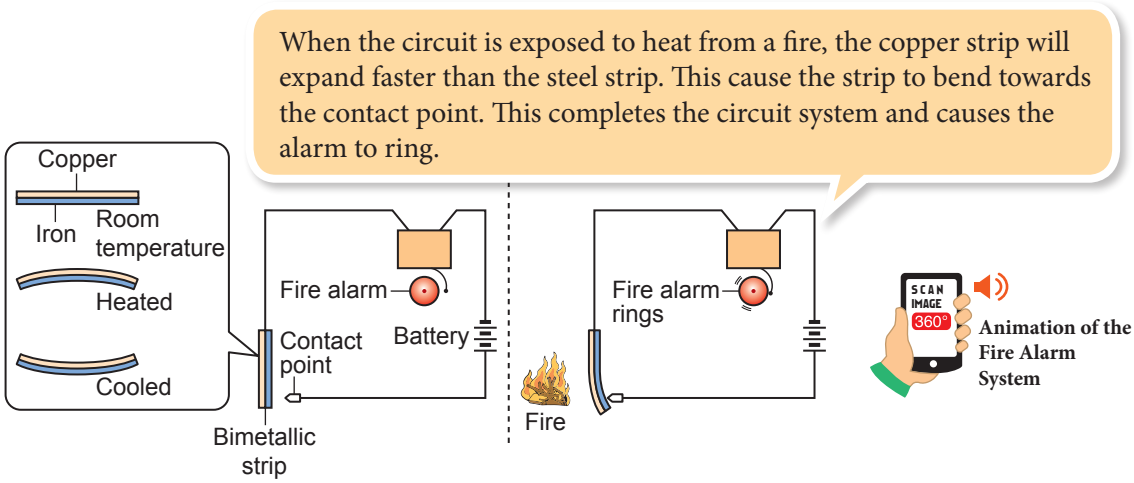
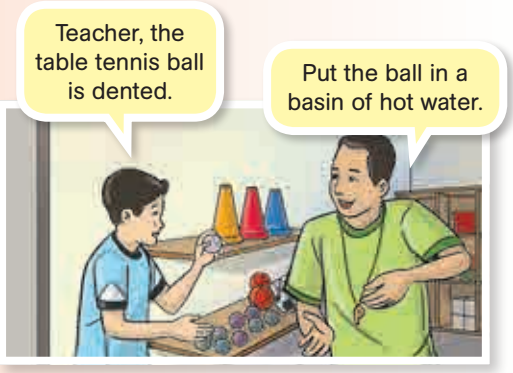


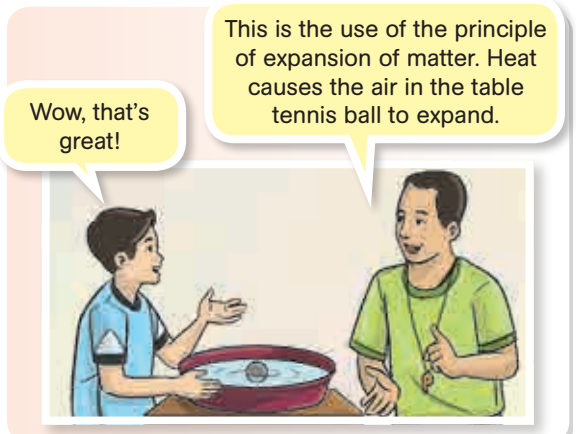
Figure 9.14 *Model of a fire alarm system*

The Uses of the Principle of Expansion and Contraction of Matter to Solve Simple Problems

Situation 1

Situation 2





Formative Practice 9.3

1. What happens to the volume of water when it is heated?
2. Explain briefly why electric transmission cables on poles are hung loosely.
3. Will the expansion and contraction of matter be harmful to the structure of buildings? Give your opinion.

9.4 Relationship between Types of Surface of Object, and Heat Absorption and Emission

Absorption and Radiation of Heat

Have you ever wondered why fuel tanks are painted in bright colours such as white or silver? This is because bright colours do not absorb a lot of heat, therefore the evaporation of fuel is reduced. The ability of an object to absorb or radiate heat depends on the **type and colour of its surface**.

Photograph 9.6 *Fuel tank truck*

Experiment 9.2

Aim: To study how a dark object absorbs and radiates heat better than a white object.

Problem statement: Do dark objects absorb and radiate heat better than white objects?

Hypothesis: Dark objects absorb and radiate heat better than white objects.

A Good heat absorber

Variables:
(a) Constant variable: Distance from the heat source
(b) Manipulated variable: Colour of surface
(c) Responding variable: Increase in temperature

Materials: Black paint and white paint

Apparatus: Bunsen burner, thermometer, empty milk can, iron plate, wire gauze, tripod stand and wooden block

Video

Video of Good Absorber and Radiator of Heat
http://bukutekskssm.my/Science/Video3.mp4

9.4.1
9.4.2

Procedure:

1. Prepare two empty milk cans, one painted in white and the other in black. Then label the cans as *J* and *K*.
2. Set up the apparatus as shown in Figure 9.15 by placing both cans as close as possible to the Bunsen burner.
3. Record the initial temperature of the air inside each can and light up the Bunsen burner.
4. Observe and record the final temperature of each can after 10 minutes.

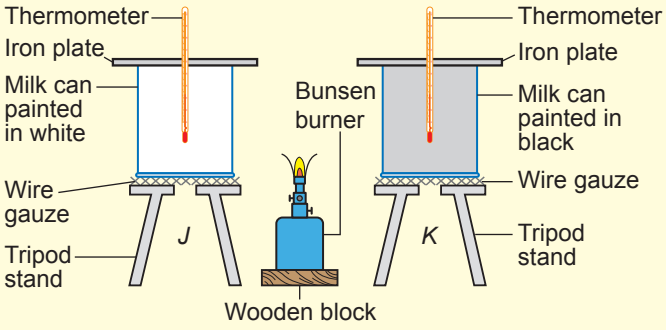


Figure 9.15

Observation:

Can	Temperature (°C)		Increase in temperature (°C)
	Initial	Final	
J			
K			

Conclusion:
Is the hypothesis accepted? Give your reasons.

Questions

1. Which can absorbs heat better?
2. What inference can you make from this activity?

B Good heat radiator

Variables:
(a) Constant variable: Volume of hot water
(b) Manipulated variable: Colour of surface
(c) Responding variable: Decrease in temperature

Materials: Black paint, white paint and hot water

Apparatus: Thermometer, empty milk can, iron plate and wooden block

Procedure:

1. Prepare two empty milk cans, one painted in white and the other in black. Then label the cans as *J* and *K*.
2. Fill both cans with hot water as shown in Figure 9.16.
3. Record the initial temperature of the water inside each can.
4. Observe and record the final temperature of each can after 10 minutes.

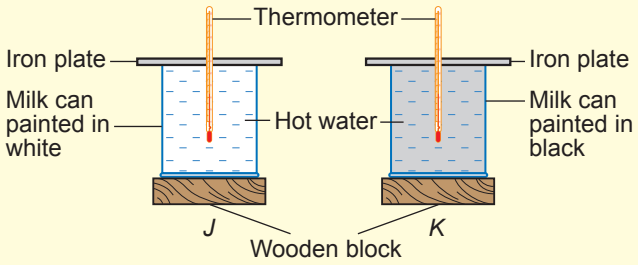


Figure 9.16

Observation:

Can	Temperature (°C)		Decrease in temperature (°C)
	Initial	Final	
J			
K			

Conclusion:
Is the hypothesis accepted? Give your reasons.

Questions
1. Which can radiates heat better?
2. What inference can you make from this activity?
3. What method of heat flow causes the cans to lose heat?
4. Design an experiment to study whether a dull or shiny object absorbs and radiates heat better.

When an object absorbs heat, its temperature increases. However, when an object radiates heat, its temperature decreases. **Dark and dull** surfaces are **better heat absorbers and radiators** compared to **white and shiny** surfaces.

Heat Concept in Daily Life

The **Green Building Concept** is an idea developed to reduce the effects of rapid development on the environment and our health. The features of green buildings are listed below:

- ☑ has high energy efficiency through the usage of solar energy or renewable energy.
- ☑ has good water flow system, air circulation and lighting.
- ☑ uses recycled materials.

Activity 9.5

STEM 21st Century

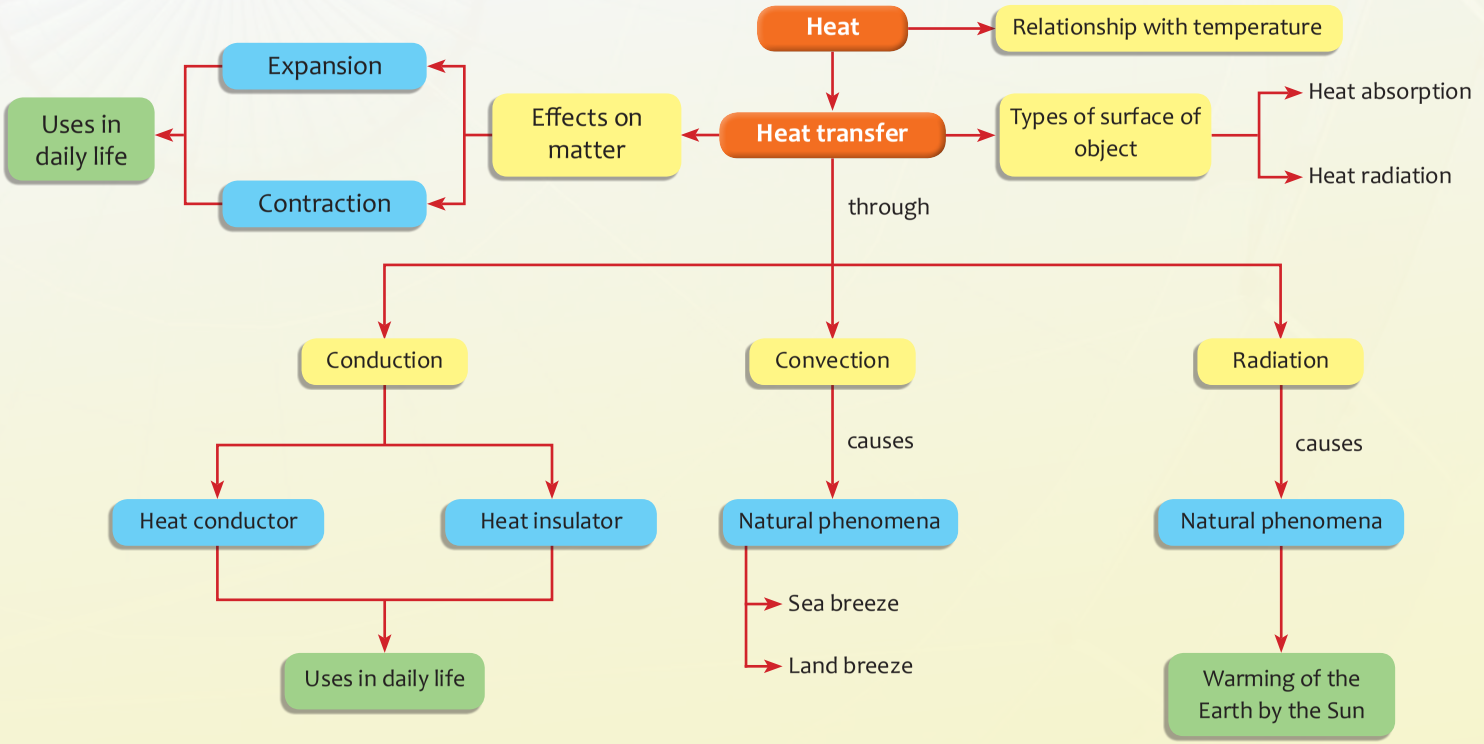
Project based learning
Design a Green Home where energy used for cooling the house or vice versa can be reduced. You can design or innovate in a local or global context.

Info
Green Building Concept
https://www.gbcsa.org.za/about/about-green-building/

Formative Practice 9.4

1. What is the benefit of wearing bright coloured clothing in hot weather?
2. What is the feature of the wall of a thermos flask that allows it to maintain the temperature of hot water for a long time?
3. State two good heat absorbers and radiators that can be used in our daily life.

Summary



Quiz

Interactive Quiz 9

SELF-REFLECTION

After learning this chapter, you are able to:

9.1 Relationship between Temperature and Heat

- ☐ Make a comparison between heat and temperature.

9.2 Heat Flow and Thermal Equilibrium

- ☐ Explain how heat flows from a hot region to a cold region.
- ☐ Explain and communicate about heat flow in natural phenomena.
- ☐ Communicate about heat conductors and heat insulators and their uses in daily life.

9.3 Principle of Expansion and Contraction of Matter

- ☐ Explain how heat can cause the expansion and contraction in solid, liquid and gas.
- ☐ Communicate about the various uses of expansion and contraction of matter in daily life.

9.4 Relationship between Types of Surface of Object, and Heat Absorption and Emission

- ☐ Demonstrate how dark, dull objects absorb heat better than white, shiny objects.
- ☐ Demonstrate how dark, dull objects radiate heat better than white, shiny objects.
- ☐ Conceptualise and design using the heat concept in daily life.

Summative Practice 9

1. Figure 1 shows a car at a parking lot exposed to sunlight. The windscreen of the car cracks the moment the air conditioner is turned on.

Figure 1

(a) Explain the phenomenon shown in Figure 1.

(b) Suggest and explain a precautionary step that should be taken to prevent this incident.

2.

Keep away from heat or fire!

The warning above is seen on a can of insecticide. Discuss what might happen if the empty can of insecticide is thrown into a rubbish dump.

3. How can you prove that heat transfer by radiation does not need a medium? Give a brief explanation.

4. (a) What causes convection current?
(b) Which heat transfer method is the fastest? Explain your answer.

HOTS Mastery 9

5. Cold weather on a rainy day causes Dayah to have difficulty in sleeping. She uses one thick blanket but still feels cold. Suggest a design of a blanket that can solve this problem (use the heat-trapping concept).

6. Figure 2 shows the apparatus of an experiment to study transmission of heat.

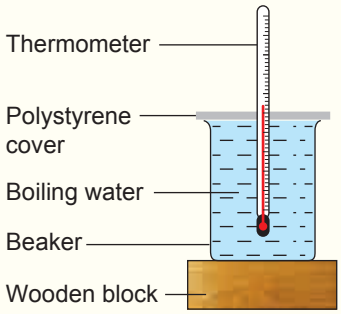


Figure 2

After the apparatus is left for 10 minutes, the reading of the thermometer was at 60°C. Suggest and explain modifications that need to be made to the arrangement of the apparatus so that the temperature of water reaches room temperature quickly.

Chapter 10

Sound Waves

Can sound waves propagate to the bottom of the sea?

How do our ears respond to sound?

What is echo?

What is the limitation of a human's hearing?

Let's understand:

- Characteristics of sound waves
- Loudness and pitch of sound
- Phenomena and applications of reflection of sound waves

SCIENCE BLOG

Lightning and Thunder

Lightning is a phenomenon caused by huge discharge of static electricity in the sky. The static electricity passes through the air and causes the air particles to vibrate. The vibrations are heard as thunder. Have you noticed that we see the flash of lightning before hearing the rumble of thunder?

In reality, lightning and thunder occur at the same time but the different speeds of propagation of light and sound through the air cause the delay.

The light from the lightning travels to our eyes much quicker than the sound from the thunder. Therefore, the flash is seen before the rumble is heard.

Keywords

- Vibration
- Medium
- Wave
- Amplitude
- Frequency
- Echo
- Pitch
- Ultrasound
- Limit of hearing
- Sonar

10.1 Characteristics of Sound Waves

Our surroundings are filled with a variety of sounds. Sound is a form of energy caused by **vibration**. For example, the musical instruments in Photograph 10.1 produce sound through vibration. Touch the front of your throat with your fingertips while speaking. Can you feel the vibration of your vocal cords?

Photograph 10.1 *Musical instruments*

Let us carry out Activity 10.1 to study the characteristics of sound waves.

Activity 10.1

Aim: To study the characteristics of sound waves.

A Propagation

(i) Requires a medium to propagate

Apparatus: Bell jar, polystyrene sheet, alarm clock and vacuum pump

Instruction

1. Set up the apparatus as shown in Figure 10.1.
2. Activate the alarm clock and listen to the sound produced.
3. Then, turn on the vacuum pump to suck the air out.
4. Record your observation.

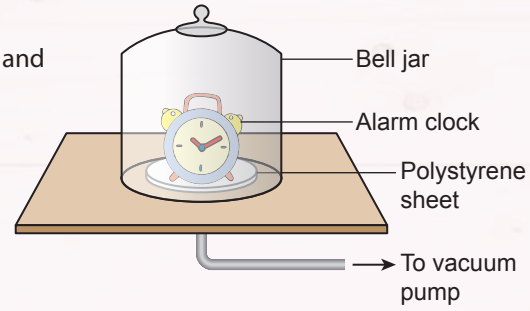


Figure 10.1

(ii) Propagate at different speeds in different medium

Materials: Water and flour

Apparatus: Plastic container and alarm clock

Safety Precaution

Ensure the water and flour are fully filled into the containers so that there is no trapped air.

Instruction

1. Prepare three plastic containers that are filled with air, water and flour respectively.
2. Place the empty plastic container (filled with air) tightly onto the table and place your ear onto the container (Figure 10.2).
3. Ask your friend to activate the alarm clock at the end of the table and listen to the sound produced.
4. Repeat steps 2 and 3 using the containers filled with water and flour. Compare the loudness of the sound produced.

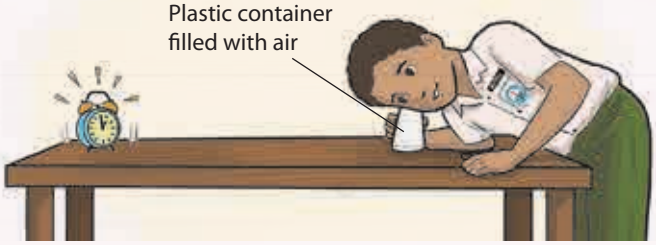


Figure 10.2

Questions

1. What is observed when the vacuum pump is turned on? Give an inference for your observation.
2. Arrange the containers filled with air, water and flour in order of increasing loudness.

B Sound can be reflected and absorbed

Apparatus: Cardboard tube, analogue stopwatch, plasticine, wooden plank, metal sheet, softwood and towel

Instruction

1. Set up the apparatus as shown in Figure 10.3 and make sure there is a distance of about 5 cm between the wooden plank and the end of the cardboard tubes.
2. Move tube *Q* until you can hear the ticking stopwatch clearly.
3. Without moving tubes *P* and *Q*, replace the wooden plank with a metal sheet followed by a towel. Compare the loudness of the ticking of the stopwatch.
4. Record all your observations.

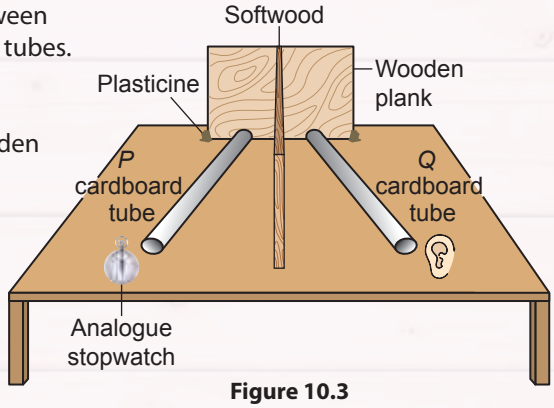


Figure 10.3

Questions

1. Based on your observation, which surface is a
   (a) good absorber of sound?
   (b) good reflector of sound?
2. Predict whether a glass sheet is a good absorber or reflector of sound.

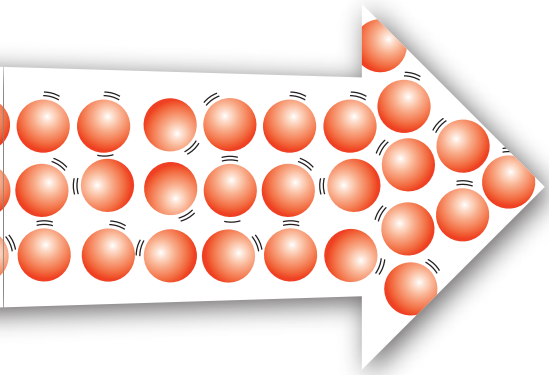
Transfer of Sound

Sound **requires a medium to propagate**. Sound can propagate through a **liquid**, **solid** and **gas**, but not through vacuum. For example, when a bell is rung, the metal surface of the bell will vibrate. Air molecules near the surface will also vibrate and collide with the air molecules nearby. This vibration is transferred from one molecule to another molecule beside it in the form of **waves**. In this way, the bell produces sound that can be heard by the ears of the listener (Figure 10.4).

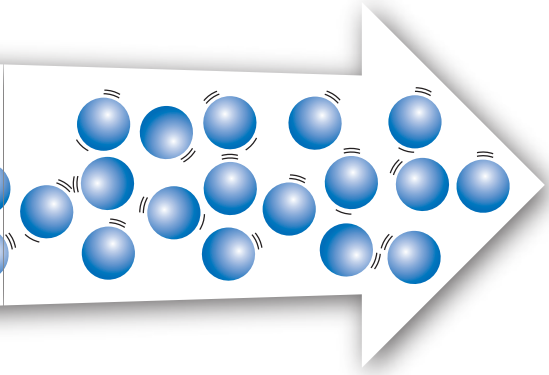
Figure 10.4 *Transfer of sound from bell to the ears of the listener*

Figure 10.5 *Sound propagates at different speeds in different media*

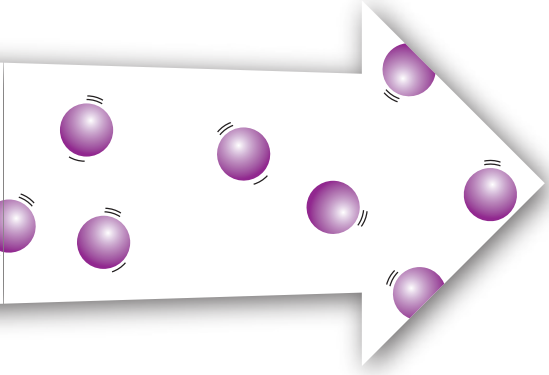
Photograph 10.2 *Sound of the aircraft engines can be heard because sound can propagate through air*



Sound is transferred **very rapidly** in solids. When the particles at one end of the solid start to vibrate, the vibration causes the nearby particles to also vibrate as the particles of solids are arranged very closely together.



The loose arrangement of particles in liquid causes sound vibrations to be transferred **less rapidly** compared to solids.



Sound waves propagate **very slowly** in gases because the arrangement of gas particles which are far apart from each other causes a delay in transfer of vibration.

Reflection and Absorption of Sound

Sound can be reflected and absorbed when it hits the surface of an object. These characteristics are the same as the characteristics of light that you have learned in Form One. The amount of sound reflected or absorbed depends on the surface of the object.

Marble tiles

Wall

Hard and **smooth** surfaces are good sound reflectors. (Photograph 10.3)

Photograph 10.3 *Examples of good sound reflectors*

Carpet

Softboard

Soft and **rough** surfaces are good sound absorbers (Photograph 10.4)

Photograph 10.4 *Examples of good sound absorbers*

Formative Practice 10.1

1. State four sources of vibration that produce sound.
2. Tick (✓) the correct statement regarding sound waves.

   (a) Sound waves can only be reflected. ☐

   (b) Astronauts can hear sounds more clearly in the space than on Earth. ☐

   (c) Sound waves require a medium to propagate. ☐
3. The walls of cinema halls are usually covered with layers of thin softboards. What is the purpose of these boards?

10.2 Loudness and Pitch of Sound

Our ears can differentiate the sounds that are heard because sounds have different strengths and pitches. **The strength or loudness of sound** produced depends on the amplitude of the sound wave (Photograph 10.5), whereas **pitch of sound** depends on the frequency of the sound produced (Photograph 10.6). Frequency is measured in the unit of **hertz (Hz)**.

Photograph 10.5 *The way we press the piano keys determines the strength of the sound produced*

The mooing of a cow is a low frequency sound.

The squeaking of a rat is a high frequency sound.

Photograph 10.6 *Animals produce sounds with different frequencies*

What is the effect of amplitude and frequency on the loudness and pitch of sound respectively? Let us carry out Activity 10.2 to investigate these effects.

Activity 10.2

Aim: To study the effect of amplitude on the loudness and the effect of frequency on the pitch of sound.

Apparatus: Cathode Ray Oscilloscope (C.R.O.), audio signal generator, loudspeaker and connecting wire

Instruction

1. Arrange the apparatus as shown in Figure 10.6.
2. Adjust the audio signal generator and C.R.O. until sound is produced and the waveform can be observed on the screen of the C.R.O.
3. Fix the frequency of the audio signal generator and gradually increase the output power.
4. Listen to the sound produced and observe the waveform on the screen of the C.R.O. Record your observation.
5. Then, fix the output power of the audio signal generator and gradually increase the frequency.
6. Listen to the sound produced and observe the waveform on the screen of the C.R.O. Record your observation.

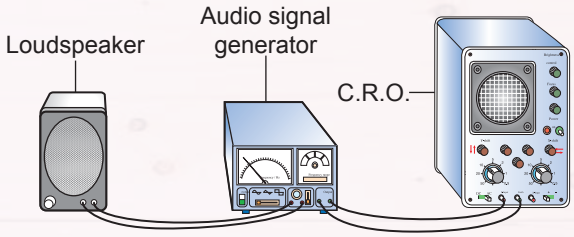


Figure 10.6

10.2.1
10.2.2
10.2.3

Observation

Adjustment done on audio signal generator		Change in the waveform on C.R.O.		Change in the sound produced by the loudspeaker
Output power	Frequency	Amplitude	Frequency	
Increased	Fixed			
Fixed	Increased			

Questions

1. What are the conclusions that can be made regarding the effect of
   (a) amplitude on loudness?
   (b) frequency on the pitch of sound?
2. Explain the relationship between the increase in amplitude and the changes in the sound produced with reference to vibration energy.
3. If an object produces vibration at a high amplitude and frequency, what will happen to the sound produced?

Based on Activity 10.2, we can summarise the relationship between, loudness and amplitude; pitch of a sound and frequency as shown in Figure 10.7.

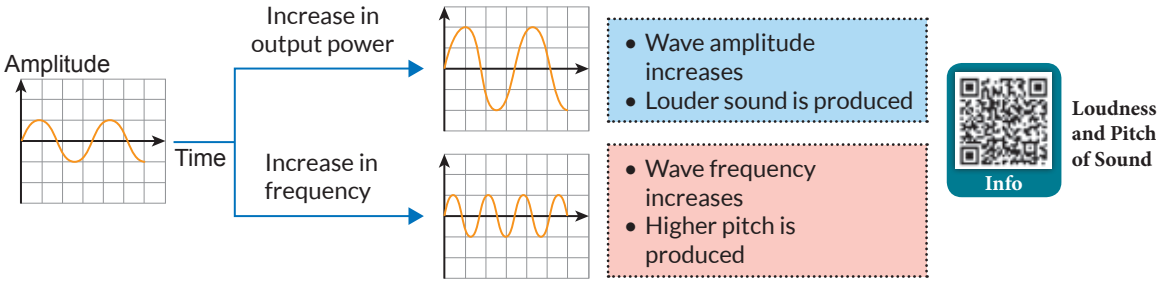


Figure 10.7 *Display on screen of C.R.O. when output power and frequency are changed*

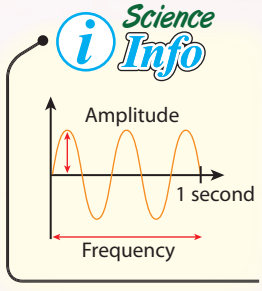
Activity 10.3

21st Century

Aim: To search for information regarding the strength and pitch of musical instruments.

Instruction

1. Work in groups.
2. Gather information regarding the following musical instruments:
   (i) piano
   (ii) recorder
   (iii) guitar
   (iv) drum
3. Gather the following information:
   (a) audio recordings
   (b) waveform of every sound produced by the musical instruments
   (c) comparison between the waveforms of each musical instrument
4. Present your discussion in the form of a multimedia presentation.



Doppler Effect

The **Doppler effect** is the **apparent change in frequency** caused by the relative movement of sound source, the relative movement of the observer or both. Figure 10.8 explains the Doppler effect.

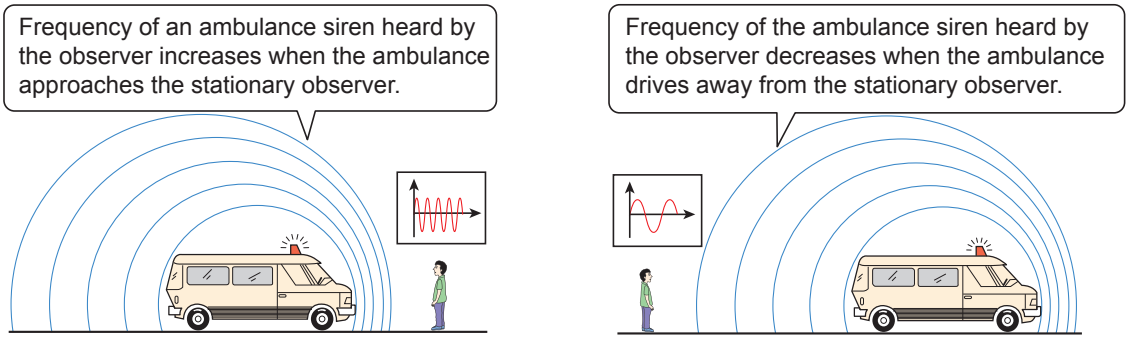


Figure 10.8 *The Doppler effect*

Activity 10.4

21st Century

Aim: To study the Doppler effect of sound using an air horn.

Apparatus: Air horn

Instruction

1. You are required to stand in the middle of the assembly area.
2. Ask your friend to sound an air horn while running past you.
3. Record the pitch of the sound of the air horn during and after your friend has run past you.

Questions

1. What happens to the pitch of the sound when the air horn is sounded while passing by the observer?
2. State the relationship between the frequency of sound and the distance of the sound source from the observer.
3. Does the person who carries the sound source also feel the change in the pitch of the sound? Give a reason.

Formative Practice 10.2

1. State one difference in the characteristics of the vibration of the voice box of men and women.
2. If a musician plays a soft note, what is the characteristic that has been changed?

   (a) Loudness

   (b) Pitch of sound

3. Figure 1 shows several waveforms formed in one second. Which waveform has the lowest frequency?

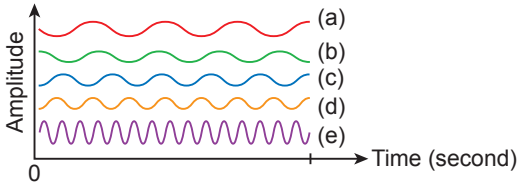


Figure 1

10.3 Phenomenon and Application of Reflection of Sound Waves

Reflection of sound waves is one of the characteristics of sound waves that you have learned in 10.1. This characteristic produces a phenomenon known as echo. Apart from that, reflection of sound waves is also used in various devices and sectors.

Phenomenon of Reflection of Sound Waves

An echo is produced when sound waves are **reflected** from a hard surface to the listener. The reflected echo sounds the same as the original sound but takes some time to reach the listener's ears. An echo can be heard in places like enclosed halls, empty rooms, caves, tunnels and gorges. Observe Figure 10.9 to understand the phenomenon of echo.

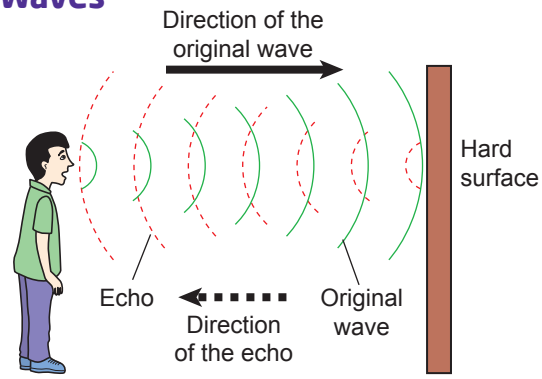


Figure 10.9 *Echo formed in an empty room*

Application of Reflection of Sound Waves

The reflection of different sound waves can be produced when sound waves hit different surfaces. The recorded reflections will provide a variety of information and images that can be used in different sectors.

Ultrasound is a type of sound wave with a frequency of more than 20 000 Hz. An ultrasound cannot be heard by humans but can be heard by animals such as bats that use it for navigation (Figure 10.10). A sound reflection technology known as **sonar** is used in the shipping industry to detect underwater objects. This technology is also used in other sectors such as medical and fisheries. Scan the QR code below to learn more about sonar and its uses in the medical sector.

Figure 10.10

Info

Sonar
http://www.dosits.org.tutorials/technology/sonar/

Video

Sonogram Video
http://bukuteksksm.my/Science/Video4.mp4

Activity 10.5

21st Century

Aim: To gather information regarding different applications of the reflection of ultrasound.

Instruction

1. Work in groups.
2. Gather information regarding different applications of the reflection of ultrasound in
   (a) shipping sector
   (b) fishery sector
   (c) medical sector
   (d) estimation of distance by bats
3. Present your discussion in the form of a multimedia presentation.

Limitations of Hearing

The frequency of sound that can be detected by humans is within the range of 20 Hz to 20 000 Hz. This range becomes narrower as we age because our ears lose their sensitivity to sound frequencies.

On the other hand, animals have their own limit of hearing. Bats, dolphins and dogs are examples of animals that have a higher range of hearing than humans.

The limited sense of hearing in humans makes us unable to hear soft sounds and sounds from a distance. Therefore, we need to use special devices to overcome these limitations (Photograph 10.7).

Science Info

Animal	Hearing range (Hz)
Bats	2 000 – 110 000
Dogs	67 – 45 000
Dolphins	40 – 100 000
Elephants	16 – 12 000
Horses	55 – 33 500

Stethoscopes help doctors listen to a patient's heartbeat.

A megaphone amplifies the voice so that it can be heard from a distance.

Hearing aids can amplify sound entering the ear.

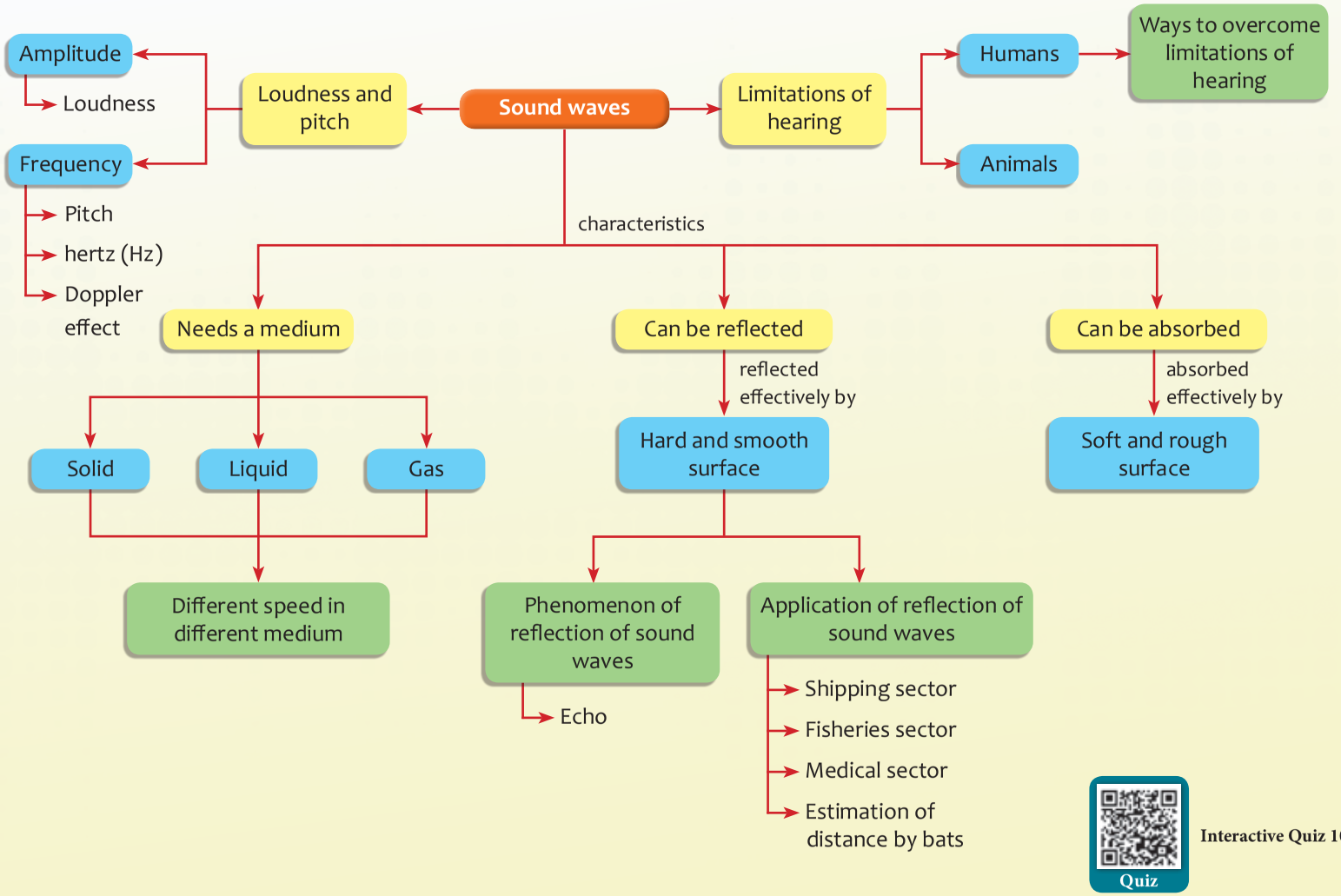
Photograph 10.7 *Devices to overcome human limitations of hearing*

Formative Practice 10.3

1. Does the distance of a sound source from the reflecting surface have any effect on the echo produced? Give your opinion.
2. Why is echo heard repeatedly in a cave?
3. State two uses of ultrasound.

10.3.3
10.3.4

Summary



Quiz

Interactive Quiz 10

SELF-REFLECTION

After learning this chapter, you are able to:

10.1 Characteristics of Sound Waves

- ☐ Communicate the basic characteristics of sound waves.

10.2 Loudness and Pitch of Sound

- ☐ Explain frequency and its unit, and amplitude of vibration.
- ☐ Relate frequency to pitch.
- ☐ Relate amplitude to loudness.
- ☐ Explain with examples loudness and pitch using musical instruments.
- ☐ Doppler effect.

10.3 Phenomena and Application of Reflection of Sound Waves

- ☐ Explain with example the phenomena related to reflection of sound waves such as echo.
- ☐ Explain with example the applications of reflection of sound waves.
- ☐ Elaborate and communicate the limitations of hearing for humans and animals.
- ☐ Explain with examples ways to overcome human limitations of hearing.

Summative Practice 10

1. Figure 1 shows Aiman trying to communicate with Sam at a distance of 10 metres.

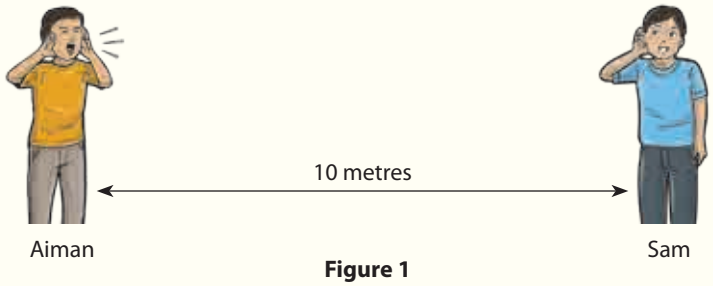


Figure 1

Suggest a method so that Sam can hear Aiman's voice more clearly.

2. Figure 2 shows the original waveform of a sound signal on a C.R.O. screen. Draw the resulting waveform when the following adjustments are made to the sound signal.

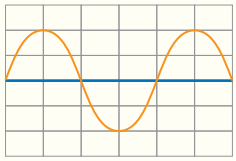


Figure 2

(a) Output power is reduced

(b) Frequency is increased

3. The speed of sound waves will change when travelling through different media. State the relationship between the speed of sound and temperature of air. Explain your answer.

4. Mr. Azli moved into a new house that has no furniture. He found that echo is produced when he speaks. The effect of echo becomes lesser when furniture is brought into the house.

(a) How is echo produced?

(b) Why does the effect of echo reduce when there is furniture in the house?

5. Figure 3 shows ultrasound waves being used to scan the condition of a foetus in the womb.

(a) Explain how ultrasound can be used to produce the image of the foetus in the womb.

(b) Give two advantages of using ultrasound compared to X-ray.

(c) Give two other uses of ultrasound waves.

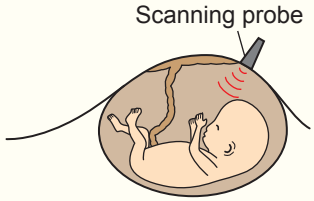


Figure 3

6. What are the changes that can be observed if

(a) a guitar string is tightened?

(b) a guitar string is plucked harder?

HOTS Mastery 10

7. You have been assigned to design a recording studio. Explain the modifications to the studio that should be done so that sound recordings of good quality are produced.

8. Astronauts communicate with each other in space using radio frequency communication equipment. Suggest and explain another way for astronauts to communicate with each other.

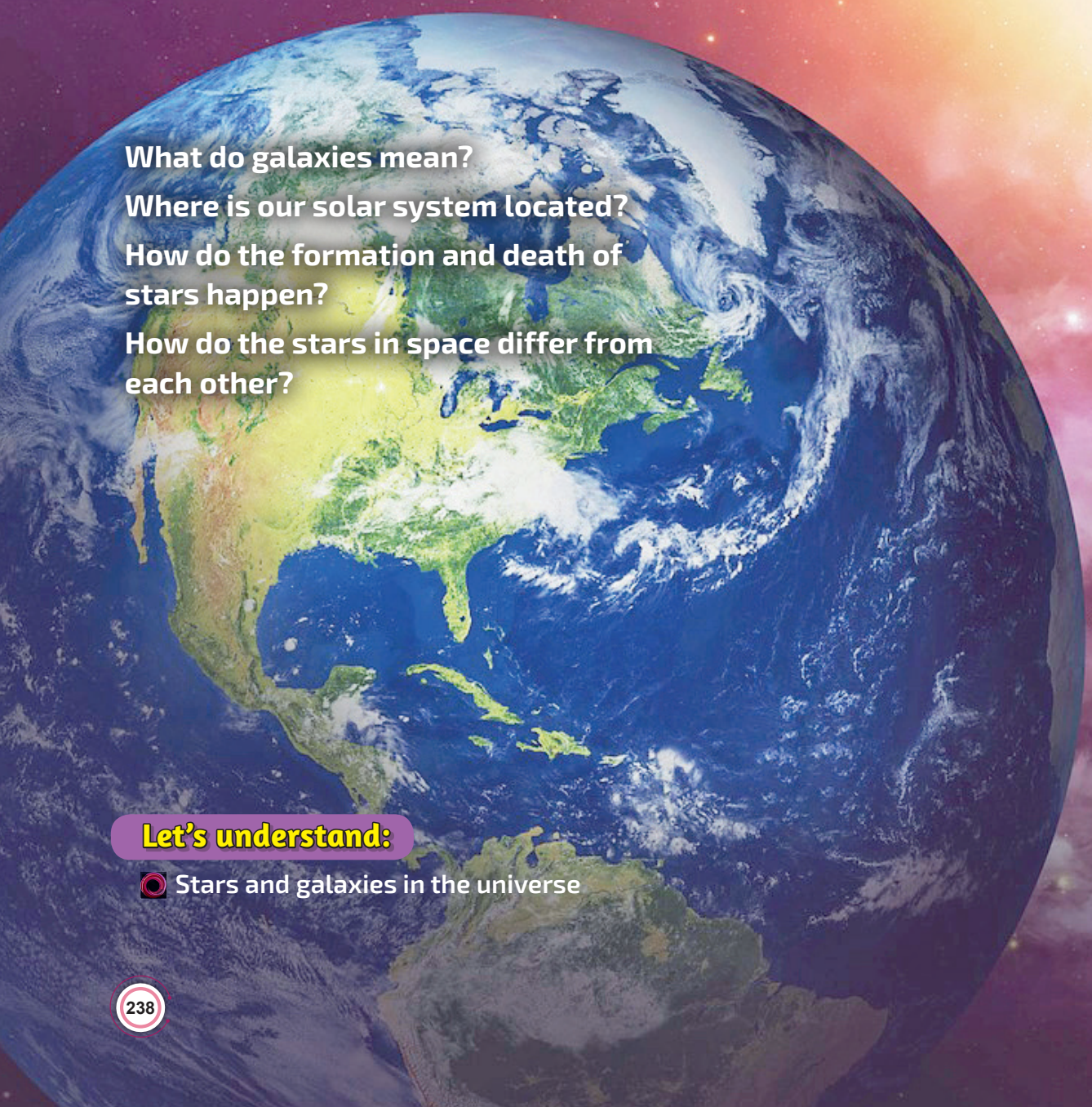
THEME 4

Earth and Space Exploration

- How do humans explore the Earth and the outer space?
- What are the technologies used by humans to explore the Earth and the outer space?
- Are there any other planets in the solar system capable of supporting life?
- What would happen to the Earth if it is hit by a meteoroid, asteroid or comet?

Chapter 11

Stars and Galaxies in the Universe



What do galaxies mean?

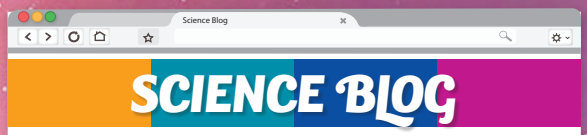
Where is our solar system located?

How do the formation and death of stars happen?

How do the stars in space differ from each other?

Let's understand:

- Stars and galaxies in the universe



SCIENCE BLOG

Supernova Explosions

Do you know about Supernova? Supernovae are giant explosions of massive stars. Every explosion produces 100 times more amount of light energy than the Sun.

The last supernova happened about 400 years ago but it was only detected in 1987. This supernova was visible to the naked eye for several weeks.

Keywords

- Galaxy
- The Milky Way
- Nebula
- Stars
- Solar system

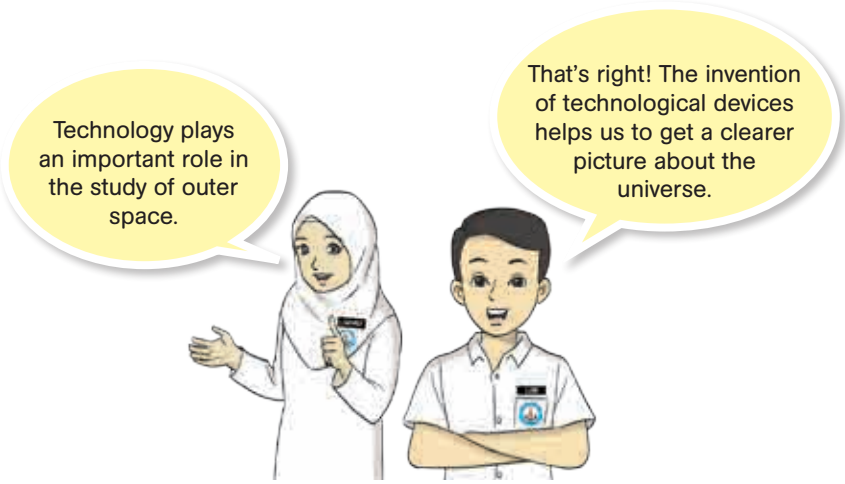
11.1 Stars and Galaxies in the Universe

The universe consists of every existing thing around us. Do you know that there are many objects in space which you may have never seen or known of their existence? The study of astronomy has raised our awareness of the beauty and vastness of God's creation of the universe.

My Malaysia!

Dato' Dr. Sheikh Muszaphar Shukor was the first Malaysian to venture into outer space on the 10th of October 2007.

Photograph 11.1 *The Earth*



Science Info

- The Hubble space telescope was launched on the 24th of April 1990.
- This telescope is so powerful that it could see a coin from 725 km away!

Galaxies

There are millions of galaxies in the universe. What do galaxies mean? A **galaxy** is a set of bodies consisting of millions of stars with gas and dust particles. Galaxies come in many forms, such as **spiral galaxies**, **elliptical galaxies** and **irregular galaxies** (Photograph 11.2). Our solar system is situated in the **Milky Way galaxy** (Photograph 11.3).

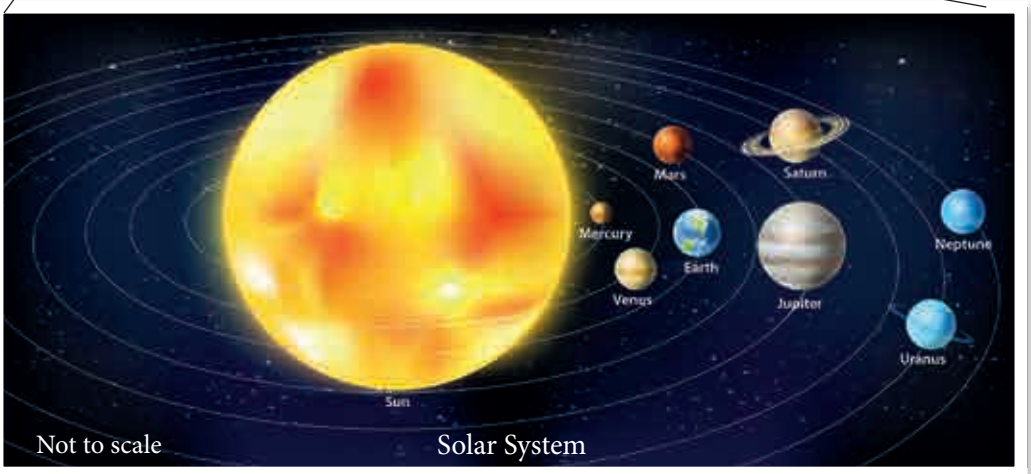
Types of galaxies

Spiral	Elliptical	Irregular
		
Examples: Andromeda and The Milky Way	Examples: Ursa Major and Messier 87	Examples: Small Magellanic Cloud and Large Magellanic Cloud

Photograph 11.2 *Types of galaxies*

THE MILKY WAY

- The Milky Way is a medium large spiral galaxy.
- Our solar system is located at the edge of one of the spiral arms of the Milky Way.
- The Milky Way consists of approximately 200 billion stars and the Sun is one of it.



Photograph 11.3 *The location of our solar system within the Milky Way galaxy*

Stars

How do the birth and death of stars happen? Let us study the life cycle of stars.

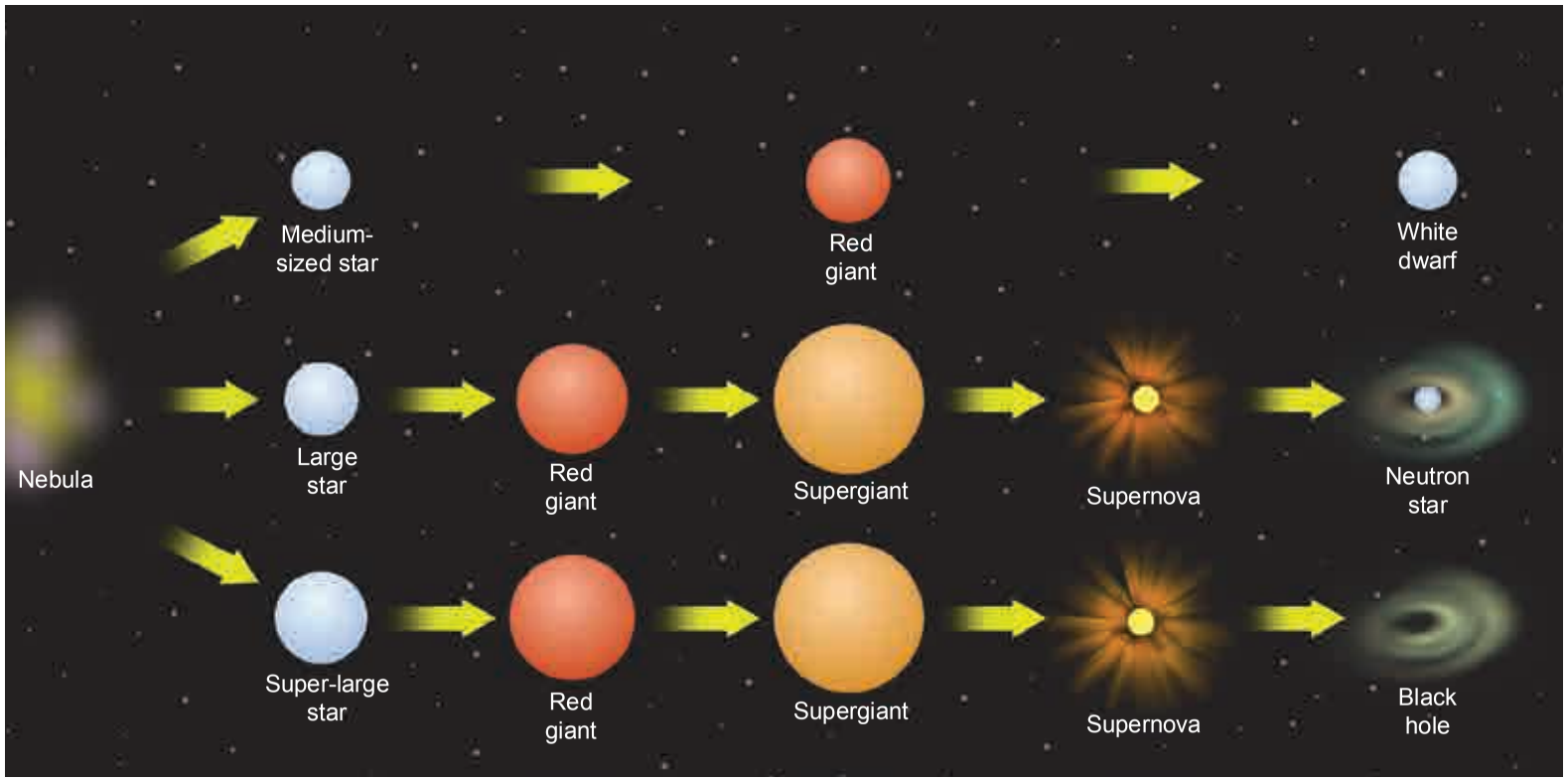


Figure 11.1 *The life cycle of a star*

Birth of Stars

Stars are formed from **nebulae**. Nebulae are large clouds consisting of dust particles and gases such as hydrogen and helium.

- The gases and dust particles in a nebula are pulled by a **strong gravitational force** which causes it to form a globe.
- The strong gravitational force causes the globe of gas to shrink and compress until it becomes very dense and forms a **core**.
- The core **shrinks** and becomes **dense** due to the increasing strength of the gravitational force.
- When the temperature and pressure in the core become too high, a nuclear reaction will take place. **Hydrogen gas** turns into helium. A huge amount of heat energy and light is released.
- The core will shine and a **star** is formed.
- The star that is formed is known as a protostar.
- This new star continues to expand and becomes either an **average star** like the Sun or a **massive star**.

Death of Stars

In a star, a lot of heat is generated which will heat up the outermost layer of the star. As a result, hydrogen within this layer starts to burn. This causes the star to expand. During this stage, the star appears red in colour and is called a **red giant**.

If the red giant is not massive, a white dwarf is formed. However, if the red giant is big enough, it contracts so quickly that a big explosion called a **supernova** occurs. A supernova is extremely bright. It can be seen in daylight. As a result of the explosion, a **neutron star** is formed if the original star is a large star. If the original star is a super-large star, a **black hole** is formed. It is called a black hole because light in it cannot escape. Any matter that enters it cannot escape too.

My Malaysia!

In early 2017, Nur Adlyka Ainul Annuar made Malaysia proud by being one of the world's astronomers who successfully proved the existence of a supermassive black hole that is hidden within the cosmic universe circle.

Brain Teaser

Predict the effects if the Sun runs out of hydrogen in its core.

Relative Size Comparison between the Earth and the Universe

The universe is beautiful and unique. There are millions of galaxies in the universe. The Milky Way is one of the many galaxies in the universe. In the Milky Way, there is a solar system which consists of eight planets that orbit the Sun, and this includes the Earth where we live in.

The Earth is smaller than a speck of dust in the universe. Can you imagine how vast this universe created by God is? We can never see the end of it. We should be thankful for the beauty of this universe which is a symbol of God's supremacy.

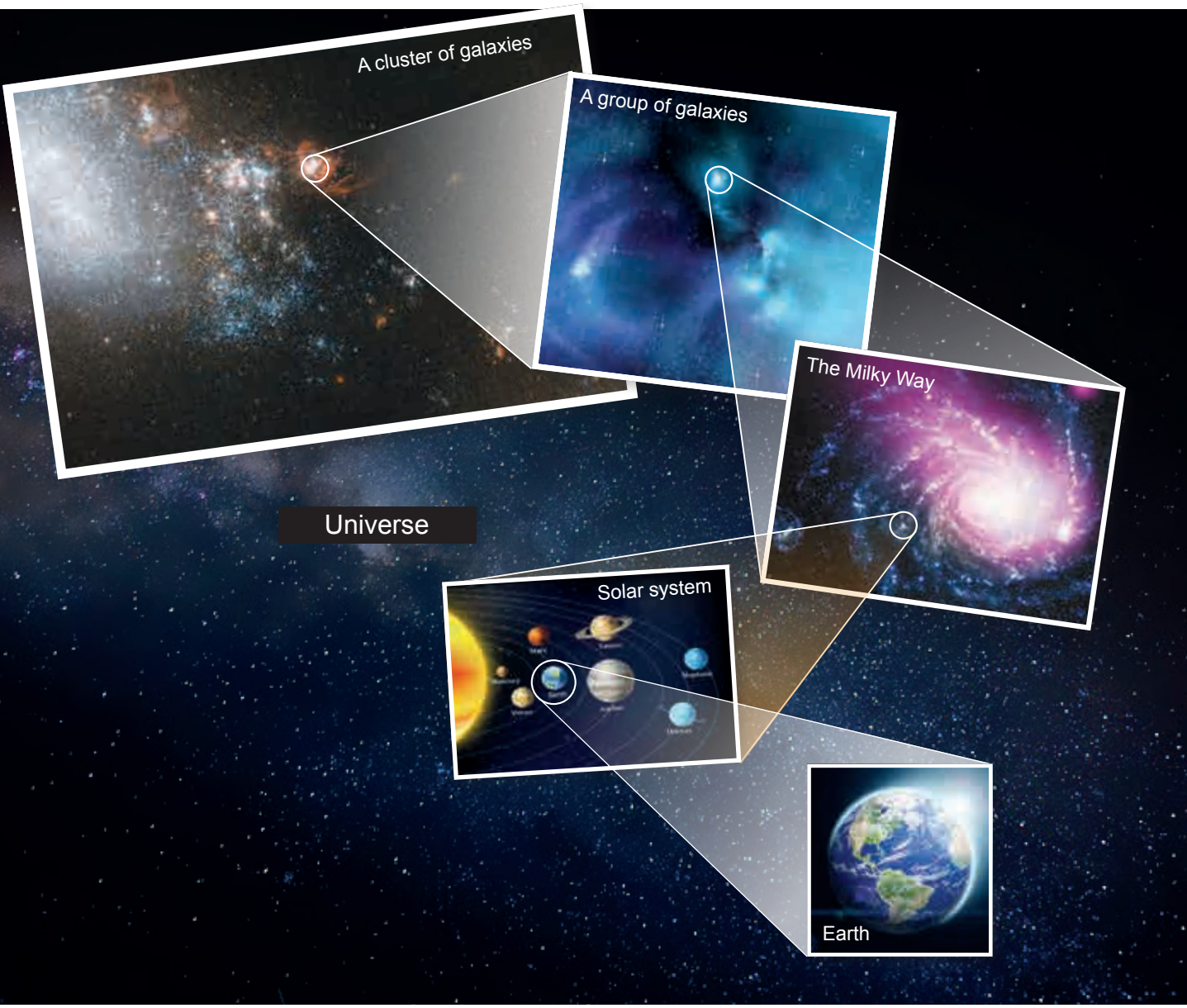


Figure 11.2 *Comparison of relative sizes of the Earth, the solar system, the Milky Way, galaxies and the universe*

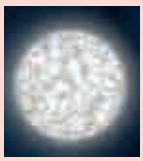
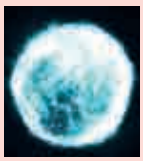
Characteristics of Stars

Have you ever observed the stars in the sky at night? If you look closely, some stars appear bright while some appear dim. These stars can be classified based on the following characteristics.

Figure 11.3 *Characteristics to classify stars*

Generally, stars have colours that correspond to its surface temperature which ranges from a lower to higher temperature. Table 11.1 shows the classification of stars based on **colour** and **temperature**.

Table 11.1 *Classification of stars based on colour and temperature*

Colour	 Red	 Orange	 Yellow	 Yellowish-white	 White	 Bluish-white	 Blue
Temperature (K)	<3 500	3 500 – 5 000	5 000 – 6 000	6 000 – 7 500	7 500 – 11 000	11 000 – 25 000	>25 000

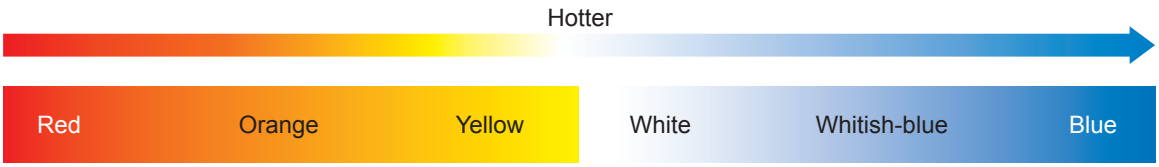


Figure 11.4 *Temperatures of stars for comparison*

Stars have different **sizes**; the really big ones are called supergiant stars, big stars are called giant stars while the really small ones are called dwarf stars (Figure 11.5). The **brightness** of a star depends on its size, **distance** and surface temperature. The brightest stars in the sky are **Sirius** and **Rigel**.

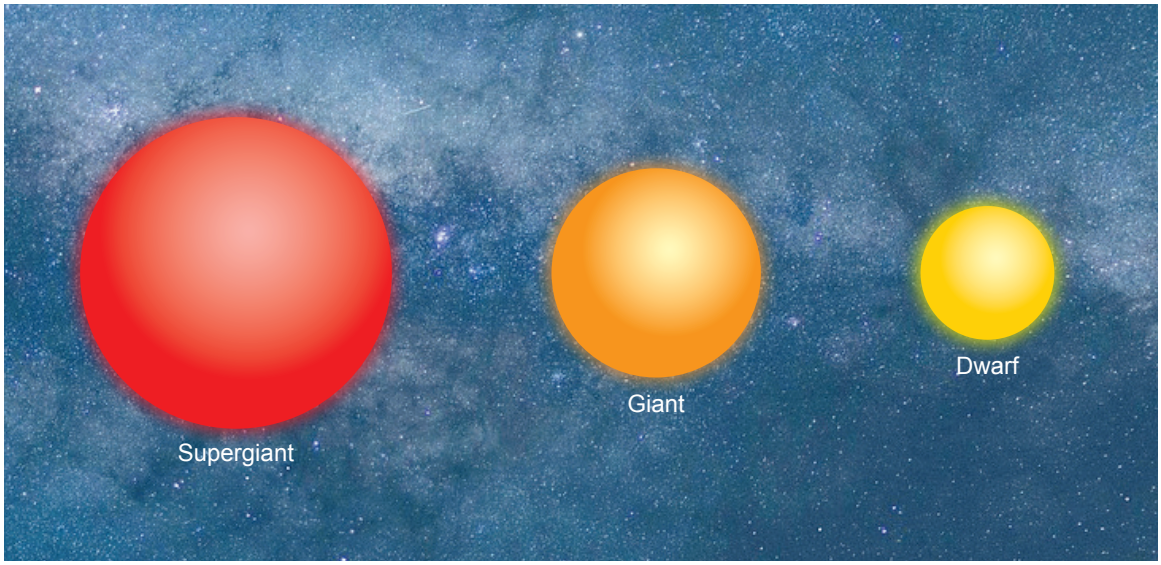


Figure 11.5 *Sizes of stars*

Activity 11.1

21st Century

Aim: To gather information on the characteristics of stars.

Instruction

1. Work in groups.
2. Surf the following websites by scanning the QR codes given.

(a) Info
Skychart
http://astronomynow.com/uk-sky-chart/

(b) Info
Stellarium
http://www.stellarium.org/

3. Gather information on the similarities and differences between stars.
4. Present the information gathered.

Activity 11.2

Aim: To observe objects in the sky at night and at daytime.

Instruction

1. You are required to participate in a trip organised by your teacher to the Observatory Station or the National Planetarium.
2. Collect information about:
   (a) the characteristics of stars
   (b) the birth and death of stars
   (c) types of galaxies
3. Note everything down in your science journal.

Photograph 11.4 *National Planetarium, Kuala Lumpur*

My Malaysia!

The National Planetarium was officially opened in 1994 as a space science education facility for the public. The design of this facility is very unique, as it is a combination of Islamic architecture and astronomy.

Photograph 11.5 *Melaka Planetarium Adventure Science Centre*

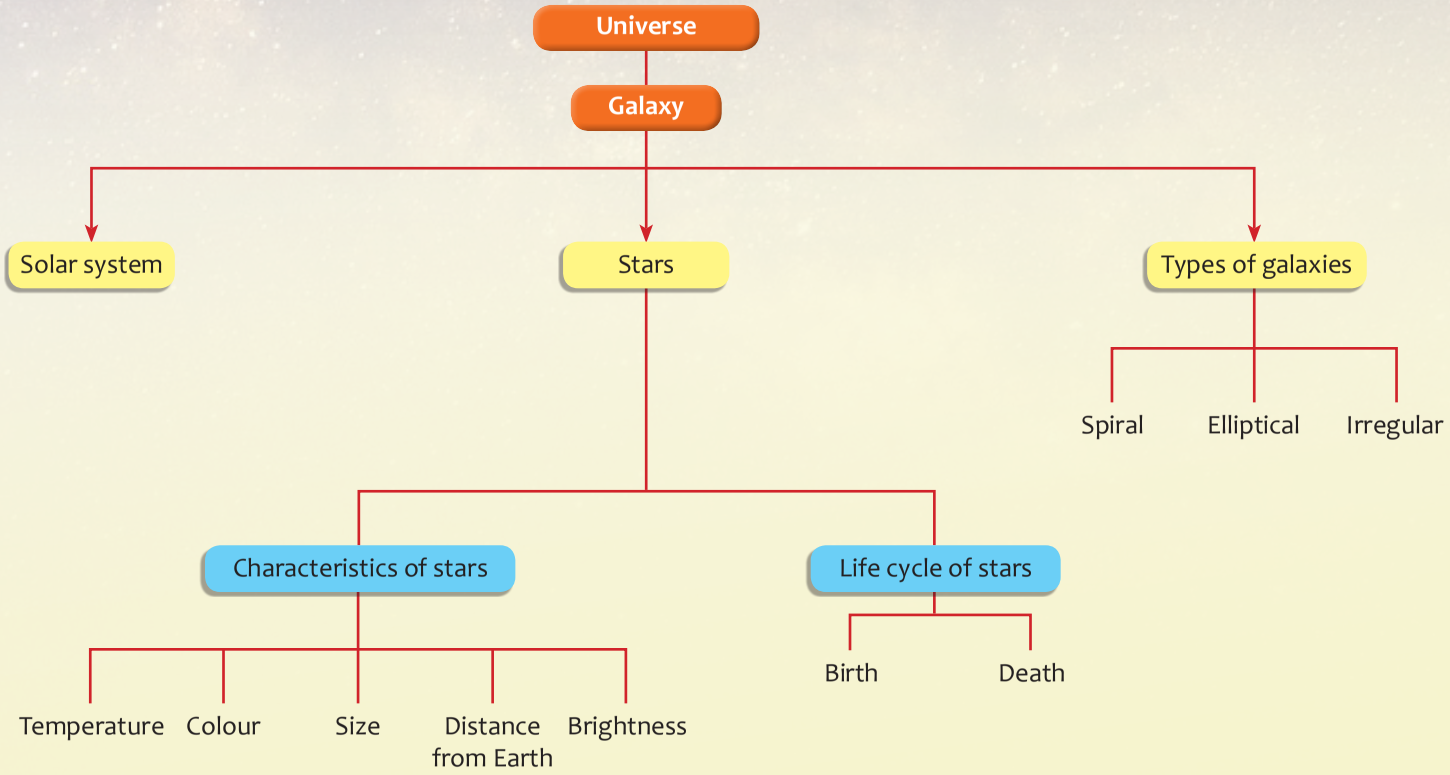
Info

National Planetarium
http://www.planetariumnegara.gov.my

Formative Practice 11.1

1. What does a galaxy mean?
2. Describe the birth of a star.
3. Predict the effects that will happen to the solar system when the Sun dies.
4. What are the characteristics to classify stars?
5. Based on observation on Earth, how can the temperature of a star be determined?

Summary



Quiz

Interactive Quiz 11

SELF-REFLECTION

After learning this chapter, you are able to:

11.1 Stars and galaxies in the universe

- ☐ Communicate the characteristics of objects in space.
- ☐ Compare and contrast the characteristics of stars (including the Sun) and relate them to the observation of stars on Earth.

Summative Practice 11

1. Photograph 1 shows an object that is located in a galaxy.

Photograph 1

(a) Name the object.

(b) What is the surface temperature range of this object?

(c) This object has its own light. How does this happen?

2. The Sun is a star, not a planet.

(a) Do you agree with this statement? Explain your answer.

(b) Why does the Sun appear bigger and brighter as compared to other stars in the universe?

3. A group of astronauts would like to carry out a mission to the Andromeda galaxy which is near the Milky Way galaxy, using a spaceship. In your opinion, would this mission be successful? Explain your answer.

HOTS Mastery 11

4. If an astronomer designs a vehicle that can go to the Sun, what characteristics should this vehicle have to enable it to transport astronauts?

Chapter 12

Solar System

What are the planets in the solar system?

What would happen if the Earth stops rotating?

Are there other planets that can support life the way the Earth can?

Let's Understand:

- Solar system

Science Blog

The discovery of a new planet

In early 2016, astronomers found a new planet in our solar system. Astronomers refer to this planet as the 9th planet that could have a mass about 10 times that of the Earth. However, this discovery is still in its research stage. Please visit the following website for additional information.

Info

The Discovery of a New Planet
https://solarsystem.nasa.gov/planets/planetx

Keywords

- Solar system
- Astronomical unit
- Light years
- Amplitude
- Planets
- Ecological footprint

12.1 Solar System

You have studied the solar system and planets in the solar system in primary school. Scan the following AR to see a 3D animation of the solar system.

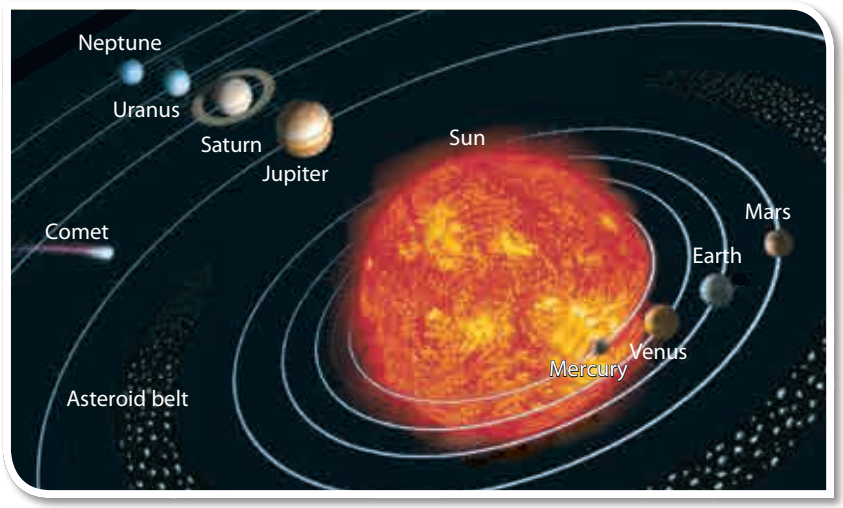


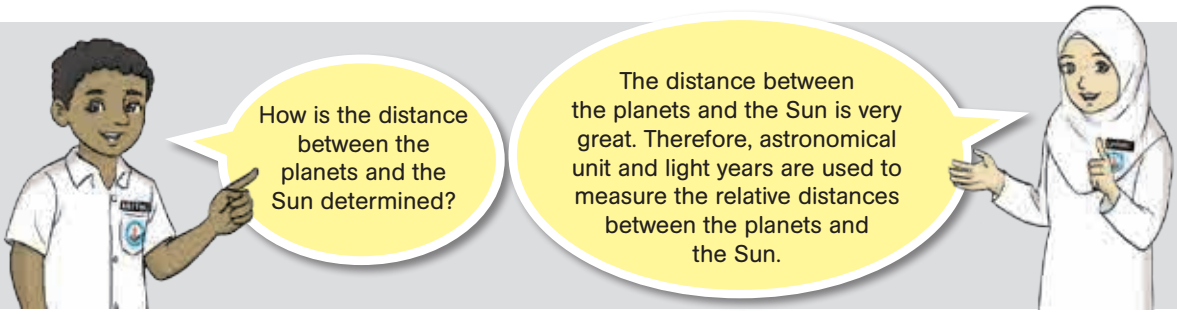
Figure 12.1 *Solar system (Not to scale)*

Science Info

In 2006, Pluto was no longer recognised as a planet in the solar system. Instead it is known as a dwarf planet.

SCAN IMAGE 360°

Animation of the Solar System



Comparison of Planet Distances in the Solar System from the Sun

- **Astronomical Unit (A.U.)**
  Astronomical unit (A.U.) is the average distance between the Earth and the Sun, which is approximately 93 million miles or 150 million kilometres (Figure 12.2).

$$1 \text{ A.U.} = 1.5 \times 10^8 \text{ km}$$

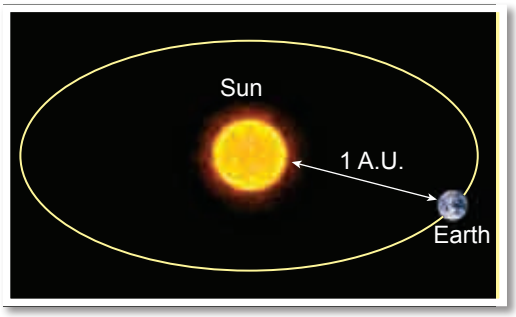


Figure 12.2 *Distance of the Earth from the Sun*

- **Light Years (ly)**
  Light years refers to the distance travelled by light in one year. Light moves at a velocity of 300 000 km every second. Therefore, light can move as far as 9.5×10^{12} km in a year.

$$1 \text{ light year} = 9.5 \times 10^{12} \text{ km}$$

Converting Units between Astronomical Unit, Light Years and Kilometres

To convert units between astronomical unit (A.U.) and km:

$$\text{Distance in A.U.} = \frac{\text{Distance in km}}{1.5 \times 10^8 \text{ km}}$$

To convert units between light years (ly) and km:

$$\text{Distance in ly} = \frac{\text{Distance in km}}{9.5 \times 10^{12} \text{ km}}$$

Example 1: Determine the distance of the Earth from the Sun in A.U. and ly.

Solution:

Distance of Earth from Sun in km $= 1.5 \times 10^8$ km

Distance of Earth from Sun in A.U. $= \dfrac{1.5 \times 10^8 \text{ km}}{1.5 \times 10^8 \text{ km}}$

$= 1.0$ A.U.

Distance of Earth from Sun in ly $= \dfrac{1.5 \times 10^8 \text{ km}}{9.5 \times 10^{12} \text{ km}}$

$= 1.58 \times 10^{-5}$ ly

Example 2: Saturn is the 6th planet in the solar system which is 1.43×10^9 km from the Sun.

(a) Calculate its distance in A.U.

(b) Calculate its distance in ly.

Solution:

(a) Distance $= 1.43 \times 10^9$ km

Distance in A.U. $= \dfrac{1.43 \times 10^9 \text{ km}}{1.5 \times 10^8 \text{ km}}$

$= 9.5$ A.U.

(b) Distance $= 1.43 \times 10^9$ km

Distance in ly $= \dfrac{1.43 \times 10^9 \text{ km}}{9.5 \times 10^{12} \text{ km}}$

$= 1.51 \times 10^{-4}$ ly

Activity 12.1

Aim: Calculate the distance between the planets and the Sun in A.U. and ly.

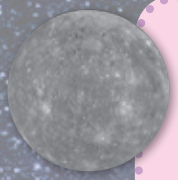
Instruction

Complete the table below.

Table 12.1 *Distance of planets from the Sun in A.U. and ly*

Planet	Distance from Sun (km)	Distance from Sun (A.U.)	Distance from Sun (ly)
Mercury	5.79×10^7	0.39	
Venus	1.08×10^8	0.72	
Earth	1.50×10^8	1.0	1.58×10^{-5}
Mars	2.28×10^8		
Jupiter	7.78×10^8		
Saturn	1.43×10^9	9.5	1.51×10^{-4}
Uranus	2.87×10^9		
Neptune	4.5×10^9	30	

Planets in the Solar System



Mercury

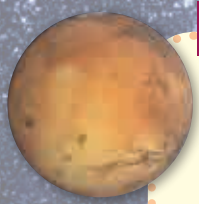
- The closest planet to the Sun, approximately 57.9 million kilometres.
- It is the smallest planet in the solar system. The diameter of Mercury is 40% smaller than the diameter of the Earth, and 40% bigger than the moon. In fact, it is smaller than Jupiter's moon, Ganymede; and Saturn's moon, Titan.
- The surface of Mercury is similar to the surface of the moon, with asteroid craters and cliffs which are tens of kilometres high. However, because of the absence of atmosphere, light cannot be scattered. As a result, the sky appears dark in outer space.

Venus

- The second closest planet to the Sun.
- Venus is known as the 'greenhouse' planet because of the high content of carbon dioxide in its atmosphere.
- Venus also rotates from east to west, which differs from the Earth and other planets which rotate from west to east. This means that on Venus, the Sun rises from the west.
- The size and age of Venus is the same as the Earth, but its climate is far more challenging, with a temperature of approximately 460°C.

Earth

- The third planet from the Sun.
- The only place in the universe that is inhabited by living things.
- Earth has a layer of air known as the atmosphere, which protects the surface of the Earth from solar wind, harmful ultraviolet rays and radiation from outer space.
- More than 71% of the Earth is covered in water and 29% land.



Mars

- The fourth planet from the Sun and is also known as the 'Red Planet'.
- Mars has two moons, Phobos and Demos.
- Mars has a surface area that is only 25% that of the Earth and its mass is 10% that of the Earth.
- If observed from Earth, the atmosphere of Mars can be divided into two different areas. The brighter area is covered in dust and reddish sand, while the poles contain frozen water and carbon dioxide.

Jupiter

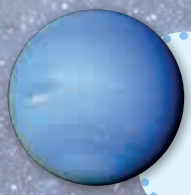
- The fifth planet from the Sun and also the largest planet of all eight planets in the solar system.
- Its mass is almost 320 times that of the Earth, and is twice the amount of all the planets in the solar system.
- Jupiter is said to be the protector of the Earth, as it is able to deflect huge objects from hitting Earth with its strong gravity.

Saturn

- The sixth planet from the Sun and the second largest planet in the solar system.
- Saturn is classified as a 'giant gas' planet.
- It has a ring system which mostly comprises of ice with a small amount of rocky material and dust.
- To date, 62 moons have been found to orbit this planet. The size of Titan, Saturn's biggest moon (after Ganymede) is bigger than Mercury.

Uranus

- The seventh planet from the Sun.
- The first elements in the interior of Uranus are ice and rock. Uranus is the third biggest planet in the solar system. Astronomers often refer to it as a 'giant gas' planet.
- Uranus has a ring system similar to Saturn, but it is thinner and darker.
- It has many moons.
- Uranus is a unique planet because its axis of rotation is tilted, almost parallel to its orbit around the Sun.
- Uranus takes 84 years (time on Earth) to orbit the Sun.



Neptune

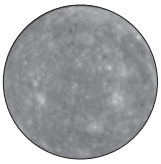
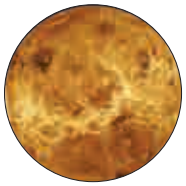
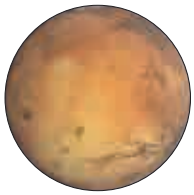
- The eighth planet from the Sun.
- Also classified as a 'giant gas' planet.
- Takes almost 165 years (time on Earth) to orbit the Sun.

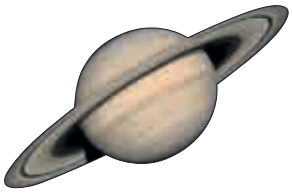
Photograph 12.1 *Planets in the solar system*

Video

Video of the Solar system
http://bukutekskssm.my/Science/Video6.mp4

Table 12.2 *General characteristics of planets in the solar system*

Planet	Mercury	Venus	Earth	Mars
				
Distance from Sun (million km)	57.9	108.2	149.6	227.9
Relative mass (x Earth)	0.055	0.815	1	0.107
Diameter (km)	4 879	12 104	12 756	6 794
Density (g cm^{-3})	5.4	5.2	5.5	3.9
Gravitational pull (m s^{-2})	3.7	8.87	9.8	3.71
Average surface temperature (°C)	167	457	14	–55
Time taken to orbit Sun (time on Earth)	88 days	224.7 days	365 days	687 days
Time taken for one complete rotation on its axis (time on Earth)	59 days	243 days	24 hours	25 hours
Velocity of rotation on axis (km/h)	10.89	6.52	1 674.4	868.2
Number of natural satellites or moons	0	0	1	2
Main atmospheric content	None (no atmosphere)	96.5% carbon dioxide; 3.4% nitrogen; 0.1% argon, helium, sulphur dioxide, water vapour	78% nitrogen; 21% oxygen; 0.97% inert gases and other substances; 0.03% carbon dioxide	96% carbon dioxide; 1.9% nitrogen; 1.9% argon; 0.2% oxygen, carbon monoxide
Condition of planet's surface	No colour, craters covered in fine dust, has plains, mountains and valleys	Orange, sandy and rocky, has big plains, volcanoes and wide craters.	More than 71% of its surface is water and 29% land (plains, mountains and volcanoes)	Red, sandy and rocky, has big plains, volcanoes and wide craters

Jupiter	Saturn	Uranus	Neptune
			
778.3	1 429	2 871	4 504
317.8	95.159	14.536	17.147
142 984	120 536	51 118	49 528
1.3	0.7	1.27	1.6
24.79	10.44	8.69	11.15
−153	−185	−214	−225
11.9 years	29.5 years	84 years	164.8 years
10 hours	11 hours	17 hours	16 hours
45 300	35 500	9 320	9 660
67	62	27	14
89.6% hydrogen; 10.1% helium; 0.3% methane, ammonia, ethane, water	96% hydrogen; 3% helium; 0.4% methane, ammonia, ethane, water	83.3% hydrogen; 15.5% helium; 2.4% methane	80% hydrogen; 19% helium; 0.1% methane, ethane
No hard surface. Only covered in gas.	No hard surface. Only covered in gas.	No hard surface. Only covered in gas.	No hard surface. Only covered in gas.

Activity 12.2

21st Century

Aim: To plan a vacation to explore outer space

Instruction

1. Work in groups.
2. Choose a planet as a holiday destination.
3. Collect the features of the planet and create a tourism poster or advertisement brochure to attract the interest of other classmates to visit that planet.
4. Present the product.

Relationship between Temperature of a Planet and the Sun

Theoretically, planets that are closer to the Sun would receive more heat from it as compared to planets which are further from the Sun. However, the situation in reality is rather complex. Let us refer to the table below to understand better.

Table 12.3 *Distance of planet from the Sun and the surface temperature of each planet*

Planet	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Distance from the Sun (million km)	57.9	108.2	149.6	227.9	778.3	1 427	2 871	4 497
Surface temperature (°C)	−173 to 427	462	−89.2 to 56.7	−143 to 35	−108	−139	−197.2	−201

For planets that do not have an atmosphere

Mercury : sunlight that directly reaches its surface will cause the area that faces the Sun to be extremely hot, **more than 427°C**. The darker area is extremely cold, and its temperatures can drop to **−173°C**.

For planets that have an atmosphere

(a) Earth : has clouds that reflect sunlight back into outer space but the atmosphere traps some of the heat, which causes the greenhouse effect.

(b) Venus : has thick clouds that can reflect sunlight back into outer space, but the atmospheric layers consist of mostly carbon dioxide which causes the greenhouse effect. Therefore, more heat is trapped and the surface temperature can reach up to **462°C**.

(c) Mars : although it has an atmosphere, the surface pressure is extremely low compared to that of the Earth (less than $\frac{1}{100}$ of Earth's pressure), causing minimal effect on the surface temperature. The surface temperature fluctuates between **−143°C** to **35°C**.

For giant planets

Jupiter, Saturn, Uranus and Neptune – the surface of these planets are covered in gas. These planets receive very little sunlight, therefore their surface temperatures are extremely low.

The Relationship between Density and Gravitational Pull of the Planets

The gravity on the surface of a planet depends on its mass and density.

Table 12.4 *Relative mass, diameter, density and gravity of the planets*

Planet	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Relative mass (x Earth)	0.055	0.815	1	0.107	317.8	95.159	14.536	17.147
Diameter (km)	4 879	12 104	12 756	6 794	142 984	120 536	51 118	49 528
Density ($g\ cm^{-3}$)	5.4	5.2	5.5	3.9	1.3	0.7	1.27	1.6
Gravity ($m\ s^{-2}$)	3.7	8.87	9.8	3.71	24.79	10.44	8.69	11.15

The gravity of the Earth

The gravity of the Earth is **9.8 m s^{-2}**. This means that if we release an object from a certain height, the object will fall at an acceleration of 9.8 metres per second per second.

- The gravity of Mercury and Mars is lower than the Earth because their masses are lower than the Earth.
- The gravity of Venus is almost the same as the Earth's because its mass is almost the same as the mass of the Earth.
- The gravity of Jupiter is much higher compared to the Earth because its mass is extremely high although it has a low density.
- Although Saturn, Uranus and Neptune have very high mass, their gravity is not as high as the gravity of the Earth because these 'giant gas' planets have low density.

The Relationship between Distance, Time and Speed

Table 12.5 *Distance from the Sun and time taken for each planet to orbit the Sun*

Planet	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Distance from Sun (million km)	57.9	108.2	149.6	227.9	778.3	1 427	2 871	4 497
Time taken to orbit the Sun (time on Earth)	88 days	224.7 days	365 days	687 days	11.9 years	29.5 years	84 years	164.8 years

The further a planet is from the Sun, the more time it needs to orbit the Sun.

For example, Mercury is the closest planet to the Sun. It takes only 88 days to orbit the Sun. Neptune is the furthest planet from the Sun and it takes 164.8 years to complete its orbit around the Sun.

Rotational direction of the planets

All planets in the solar system rotate on their axis at different angles (Figure 12.3). All these planets rotate from **west to east** except Venus and Uranus. Venus rotates from **east to west** while Uranus rotates on its side. Why do these two planets have different rotational direction as compared to the other planets?

My Science World

The Earth rotates from west to east, and therefore we see the Sun rising in the east and setting in the west.

Figure 12.3 *Rotational angle and direction of the planets in the solar system*

Hypothetical Situation related to the Solar System

What happens if the rotation of the Earth slows down or stops completely?

We know that the rotation of the Earth on its axis is the reason for several phenomena such as day and night, tides and many more.

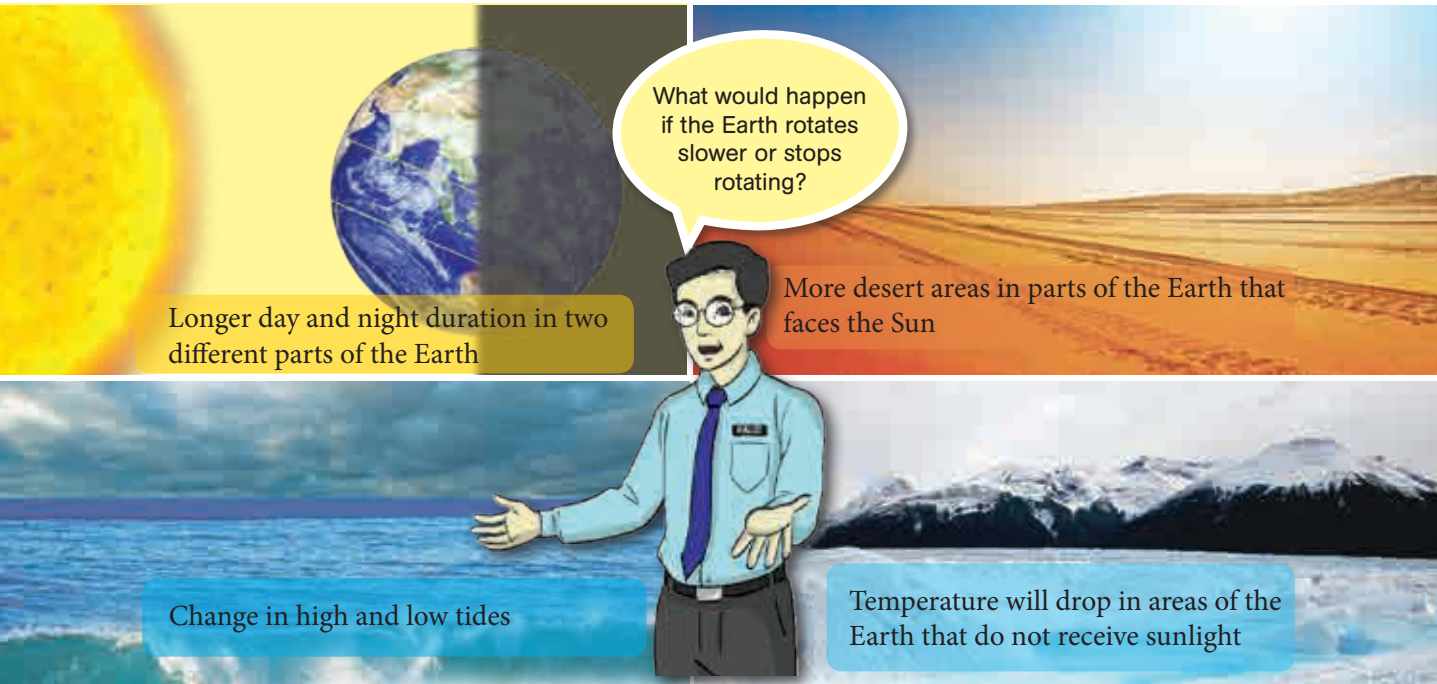


Figure 12.4 *Effects that take place if the Earth rotates slower or stops rotating*

12.1.3
12.1.4

What are natural satellites?

Natural satellites are objects that move around planets on their own orbit. The moon is the only natural satellite of the Earth (Figure 12.5).

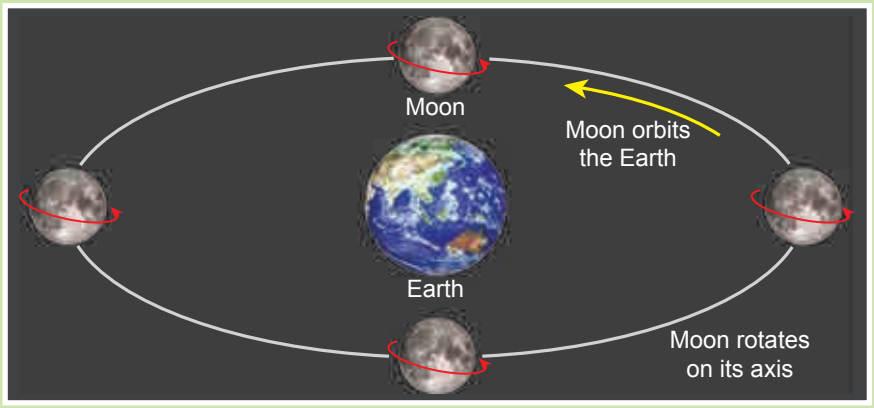
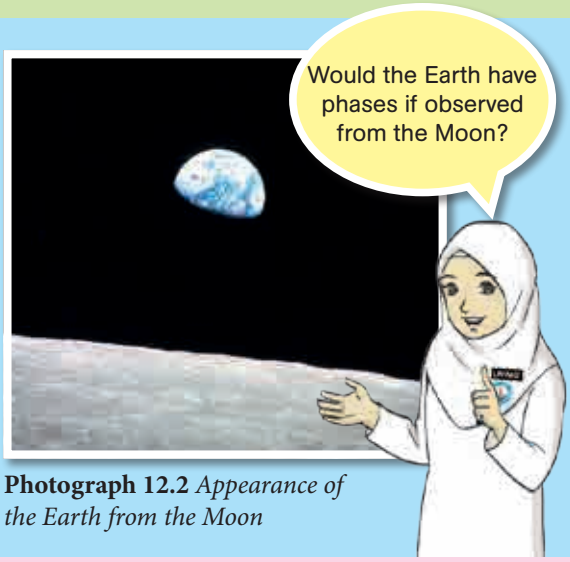


Figure 12.5 *The Earth orbits the Sun, while the Moon orbits the Earth*

How would the condition and appearance of the Earth be from the Moon?

Just like the Earth, the Moon also rotates on its own axis. At the same time, the Moon also moves around the Earth on its orbit. The duration taken for the Moon to rotate on its axis and orbit the Earth is about the same, which is 27 days. Therefore, the same surface of the Moon would be facing the Earth at all times. The Earth is four times bigger than the Moon. How would the Earth appear from the Moon?



Photograph 12.2 *Appearance of the Earth from the Moon*

The Earth as a Planet for Living Things

Figure 12.6 *The Earth*

The Earth is the only planet that has life. The Earth can support life because of a few factors such as the presence of water, minerals, its temperature and atmospheric content. Discuss the characteristics of the Earth as a planet most suitable for life. Are there other planets that are suitable for life if the resources on the Earth are fully exhausted or the Earth is destroyed by natural disasters and pollution? What is the role of each individual to preserve the Earth?

21st Century

12.1.3
12.1.4

Figure 12.7 *Characteristics of the Earth as the most suitable planet for life*

My Malaysia!

Datuk Dr. Mazlan Othman is well known in the field of research and development of astronomy in Malaysia. She has not only received recognition at national level but is also admired in the international arena.

Activity 12.3

STEM 21st Century

Aim: To look for new ideas of the possibility of other planets to replace the Earth if the natural resources on the Earth are depleted.

Instruction

1. Work in groups.
2. Use your creativity or imagination to think about the possibility of a planet to support life if the natural resources on the Earth are depleted. Collect information from the Internet or the library.
3. Present ideas using a multimedia presentation.

Career in STEM

Astronomers are scientists who study objects in outer space such as planets, stars and galaxies. They are looking at the possibilities of other planets to replace the Earth.

Love Our Earth

Human life relies heavily on resources from water and earth, including to get food, manufacturing materials and to generate energy. The increase in human population has caused rapid exploration of the seas and land. Are the Earth's natural resources able to sustain the increasing needs and wants of humans?

- **Ecological footprint** is the measure of the ability of water and land to provide the basic needs of humans (food, water, shelter and others) as well as the ability of the Earth to absorb all human wastes and reproduce resources after they have been used by humans.
- Ecological footprint is the ratio measurement for six areas, which are **carbon dioxide waste treatment areas**, **construction areas**, **forests**, **agricultural areas**, **farming areas** and **fishing areas** using the shape of a human foot.
- If the ecological footprint exceeds the ability of the Earth to renew its resources, the Earth will be depleted of all its resources.
- Ecological footprint is different between countries.

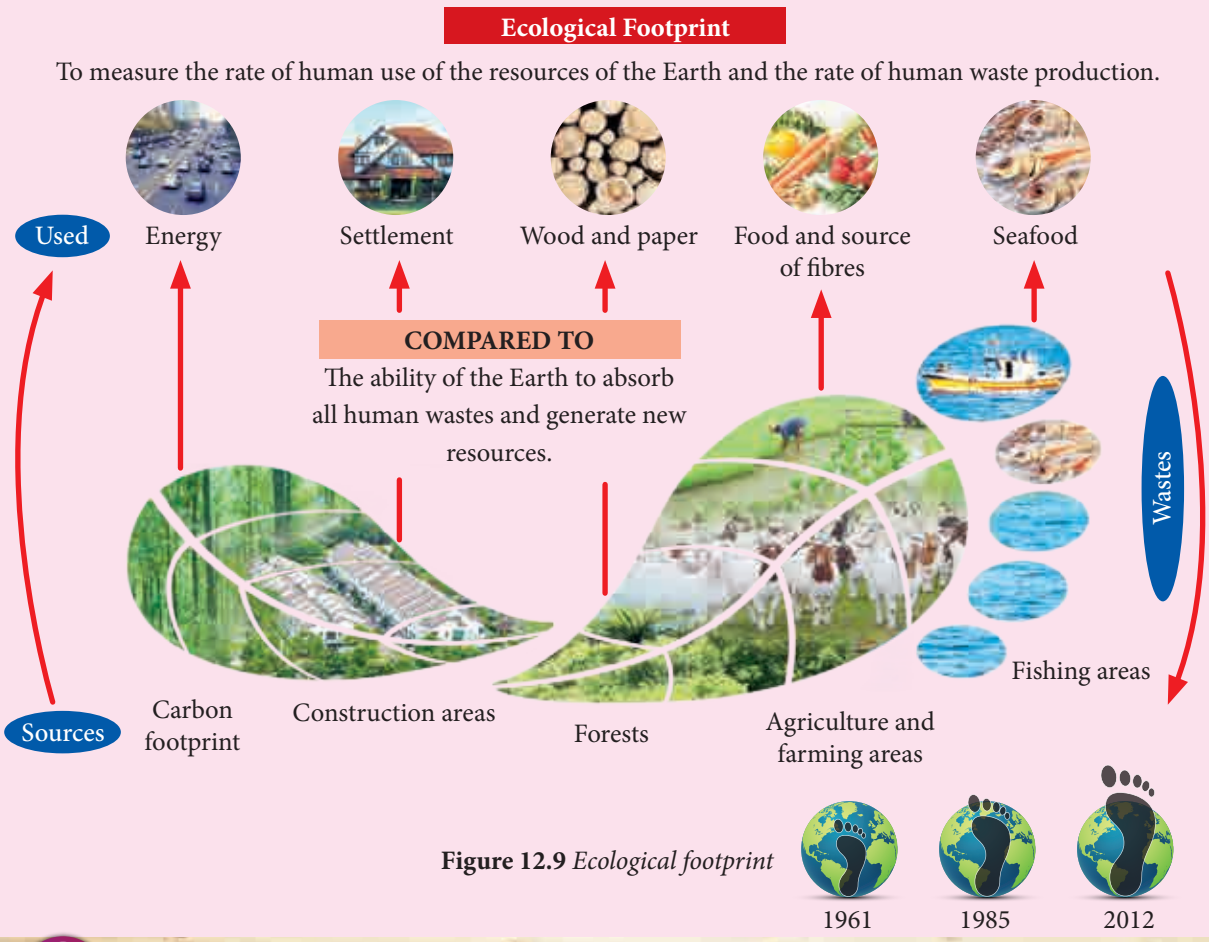


Figure 12.9 *Ecological footprint*

Activity 12.4

Aim: To discuss the steps and importance of reducing our ecological footprint.

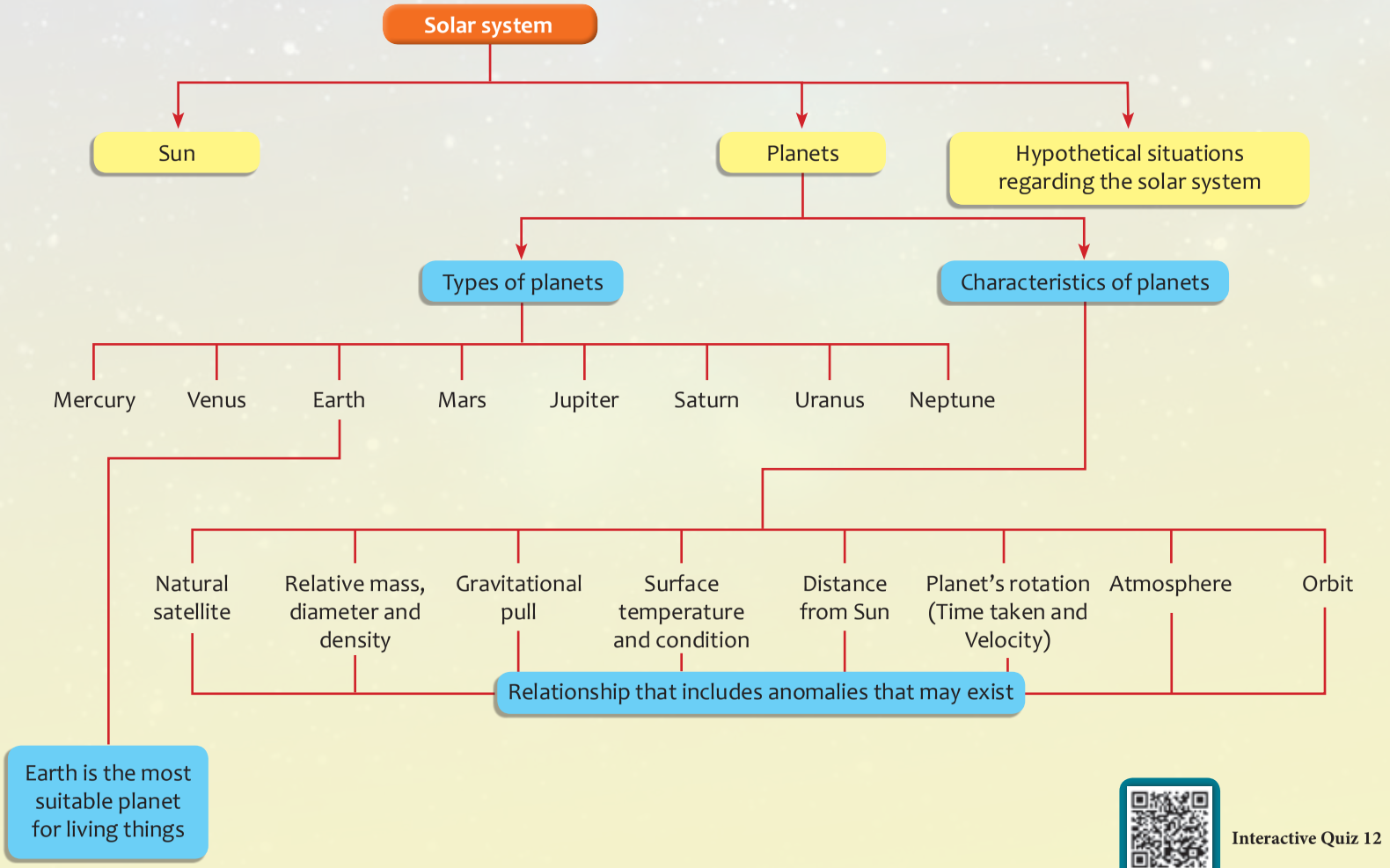
Instruction

1. Work in groups.
2. Each group is assigned with collecting information on ecological footprint.
3. Discuss:
   (a) the steps we can take as consumers to reduce our ecological footprint
   (b) the importance of reducing our ecological footprint.
4. Present the results in the form of a multimedia presentation.

Formative Practice 12.1

1. Why are A.U. and ly used to determine the distance between planets and the Sun in the solar system?
2. Which planet is closest to the Sun?
3. What is the relationship between the surface temperature of a planet and its distance from the Sun?

Summary



Quiz

Interactive Quiz 12

SELF-REFLECTION

After learning this chapter, you are able to:

12.1 Solar System

- ☐ Compare the distance between the Sun and the planets in the solar system using astronomical unit (A.U.) and light years (ly).
- ☐ Construct a table to compare and contrast the planets in the solar system and the Earth.
- ☐ Explore the possible relationship based on the characteristics of the planets and explain the relationship including anomalies that may arise.
- ☐ Reasoning and making analogies in hypothetical situations related to the solar system.
- ☐ Justify why the Earth is the most ideal planet for life based on data collected.

Summative Practice 12

1. Figure 1 shows the solar system.

(a) State the number of planets that are in the solar system.

(b) State the planet that is the nearest to and furthest from the Sun.

(c) Why does Mercury orbit the Sun faster than the Earth?

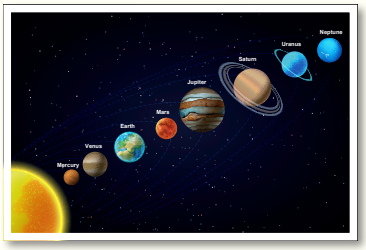


Figure 1

2. Figure 2 shows phenomena that happen on the Earth.

Sun rises in the East

Sun sets in the West

Figure 2

(a) Which characteristic of the Earth causes such phenomena?

(b) Venus has a different rotational direction compared to the Earth. Predict the phenomena of the sun rising and setting that can be seen on Venus.

(c) Predict two possibilities that might take place if the Earth stops rotating.

3. A star is 4.37 light years away from the Sun.

(a) Calculate its distance in km.

(b) Calculate its distance in A.U.

4. The natural resources of the Earth such as wood and fossil fuels are decreasing.

One way to overcome this issue is to recycle materials. Design a new product that uses waste materials.

5. The information below shows the distance of planet *P*, *Q* and *R* in the solar system from the Sun.

P: 108.2 million km
Q: 2 871 million km
R: 778.3 million km

(a) Based on the information above, which planet is the hottest and the coldest? Give reasons for your answers.

(b) Which planet takes the longest time to orbit the Sun? Give reasons for your answers.

HOTS Mastery 12

6. (a) Venus is considered as a twin planet to the Earth because its size, volume and density are similar to that of the Earth. Why doesn't this planet have any living things compared to the Earth?

(b) Two students were having a conversation about Mercury and Venus.

Aisyah : Mercury is the closest to the Earth, and therefore is the hottest planet in the solar system.
Pei Lui : No. Venus is the hottest planet in the solar system.

In your opinion, who is correct? Give reasons for your answers.

7. Europa is a natural satellite of Jupiter (Figure 3) which is very unique as there is a possibility of seawater below the surface of the ice. In your opinion, why do scientists have an assumption that there is life on Europa?

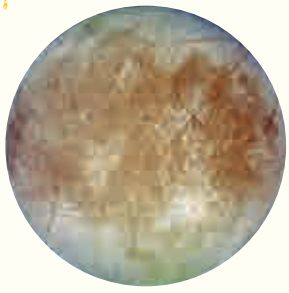


Figure 3

Chapter 13

Meteoroid, Asteroid, Comet

What are the differences between meteoroid, asteroid and comet?

What will happen to the Earth when it is hit by a meteoroid, asteroid or comet?

Let's understand:

- Other objects in the solar system such as meteoroids, asteroids and comets

Science Blog

SCIENCE BLOG

The Largest Meteorite in the World

What is a meteorite? A meteorite is a shooting star that has fallen to the Earth. To date, the Hoba Meteorite has been recorded as the largest meteorite in the world. This meteorite is believed to have fallen to the Earth approximately 80 000 years ago.

The Hoba Meteorite was discovered near Grootfontein, Namibia in 1920 by a farmer while he was ploughing his land.

Uniquely, the impact of this meteorite did not create a crater around the site. Scientists believe the flat shape of the object may be responsible for its low velocity at impact.

Keywords

- Meteoroid
- Meteor
- Meteorite
- Asteroid
- Comet

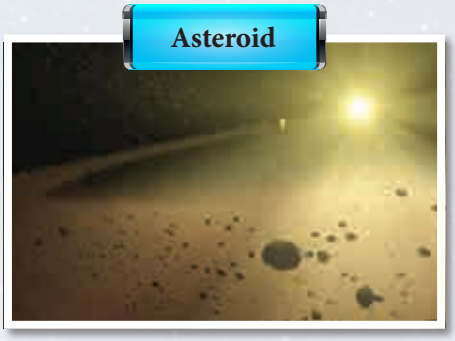
13.1 Other Objects in the Solar System, such as Meteoroids, Asteroids and Comets

Besides the galaxy, stars and planets studied in Chapters 11 and 12, there are other objects present in our solar system. These objects are meteoroids, asteroids and comets. Let us discuss the characteristics of these three objects.

Meteoroid

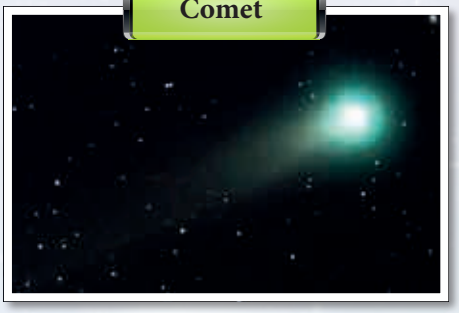
A **meteoroid** is a floating piece of stone and metal that moves in space.

Asteroid



An **asteroid** is a large metal and rocky body that travels around the Sun in its own orbit.

Comet



A **comet** is a small body made up of a mixture of ice, gas and frozen dust. It travels around the Sun in its own orbit.

Figure 13.1 *Characteristics of meteoroids, asteroids and comets*

Characteristics of a meteoroid

- Appears in various sizes, which is from 10 μm to 1 m.
- Made up of **stones** and **metals** such as iron and nickel.
- Originates from fragments of asteroids and comets.
- Its surface temperature in outer space is about **0°C**.
- Travels at varying speed. The fastest meteoroid travels at 42 km s^{-1}.

Characteristics of an asteroid

Photograph 13.1 *The asteroid belt between the orbits of Mars and Jupiter*

- Size starts from 1 m to 1 000 km.
- Made up of **stones** and **metals** such as iron and nickel.
- Has a cold surface temperature, approximately **–73°C**.
- Travels around the Sun at an average speed of **25 km s^{-1}**.
- Asteroids form an **asteroid belt** between the orbits of **Mars** and **Jupiter** (Photograph 13.1).
- Large asteroids such as Ceres, Pallas, Juno and Vesta have diameters of a few kilometres to 1 000 kilometres.
- Asteroids are also known as small planets.

Characteristics of a comet

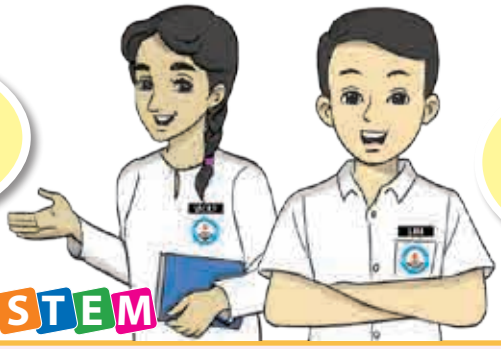
- Consists of two main parts, a **head** and a **tail**.
- The length of the tail of a comet can reach up to 150 000 000 km. The size of the head can reach up to 250 000 km.
- Comprises **gas** and **water** that freeze into **ice**, **dust** and **rocky** particles.
- Travels around the Sun in its own **elliptical orbit**.
- Travels at an average speed range of **10 km s^{-1}** to **70 km s^{-1}**.

Science Info

The first direct collision of a comet with objects in the solar system occurred in 1994, between the Shoemaker-Levy 9 comet and Jupiter.

Magical SCIENCE

The Halley Comet was recently seen passing the Earth in 1986 and is expected to pass the Earth again in 2061.



Can you differentiate between a meteoroid, asteroid and comet?

There are many differences in terms of size, structure and shape. Let's carry out Activity 13.1.

Activity 13.1 STEM

Aim: To prepare a multimedia presentation on meteoroids, asteroids and comets.

Instruction

1. Work in groups.
2. Collect information from the Internet, print media and electronic media about meteoroids, asteroids and comets.
3. Discuss the following:
   (a) the similarities and differences between meteoroids, asteroids and comet.
   (b) predict what will happen to the Earth if it is hit by a meteoroid, asteroid and comet.
4. Present your discussion using a multimedia presentation.

Career in STEM

A petrologist, career in one of the fields of geology, studies the origin, composition, structure and changes in rocks. The study includes objects that reach the Earth, such as meteorites and asteroids.

Movement of Meteoroids, Asteroids and Comets

Asteroids and comets move through their own orbit around the Sun. Meteoroids move freely in space and are influenced by the gravitational pull of planets, the moon and other objects around it. Due to the smaller size and mass of meteoroids, they are easily influenced by smaller gravitational pulls. How do the movement of meteoroids, asteroids and comets affect the Earth?

Movement of a meteoroid

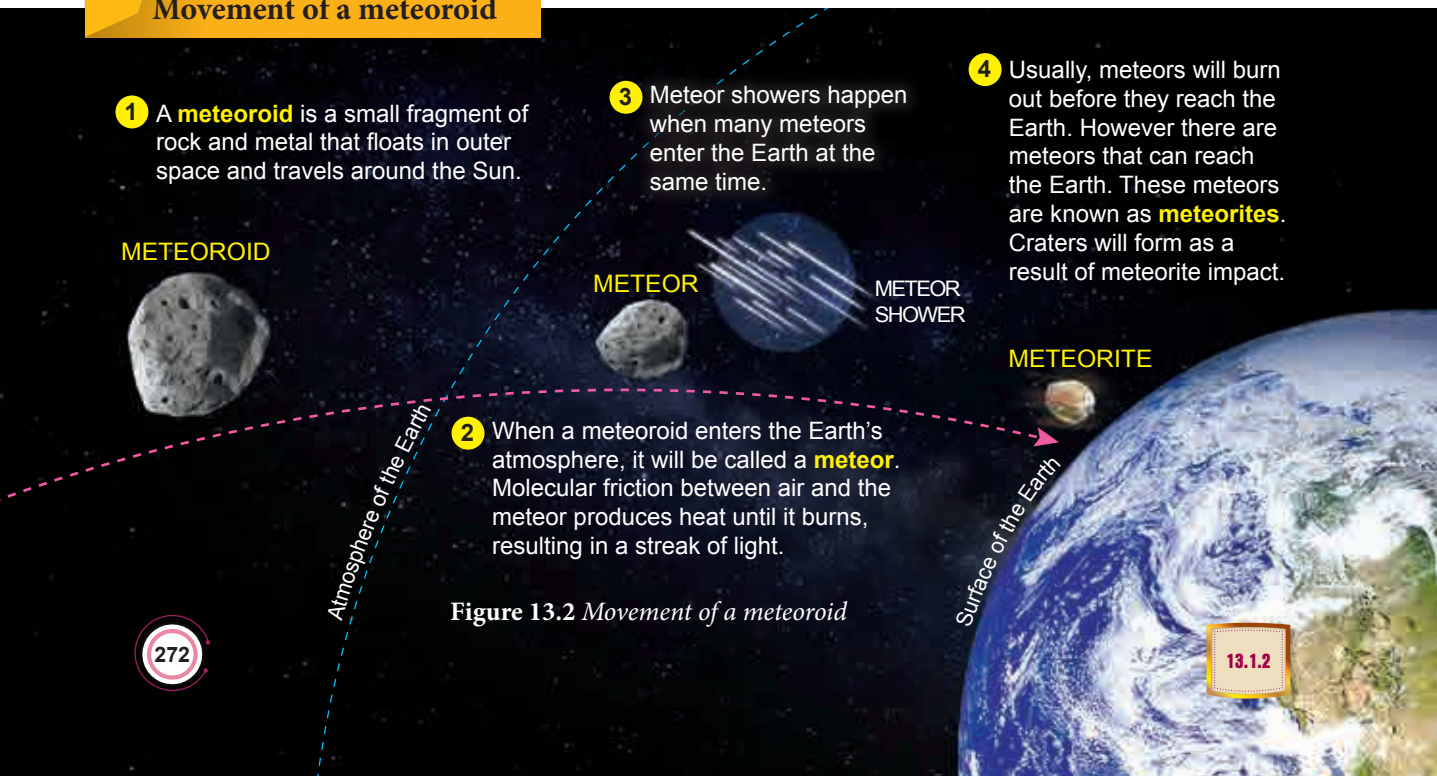
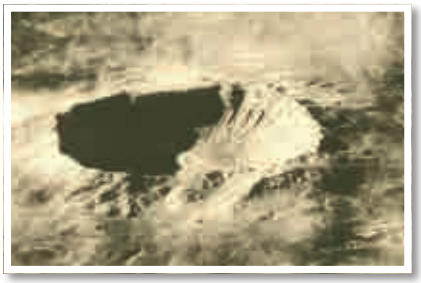


Figure 13.2 *Movement of a meteoroid*

Science Info

A huge crater was formed due to a meteorite impact approximately 50 000 years ago in Arizona, United States. Its diameter is approximately 1.2 km.

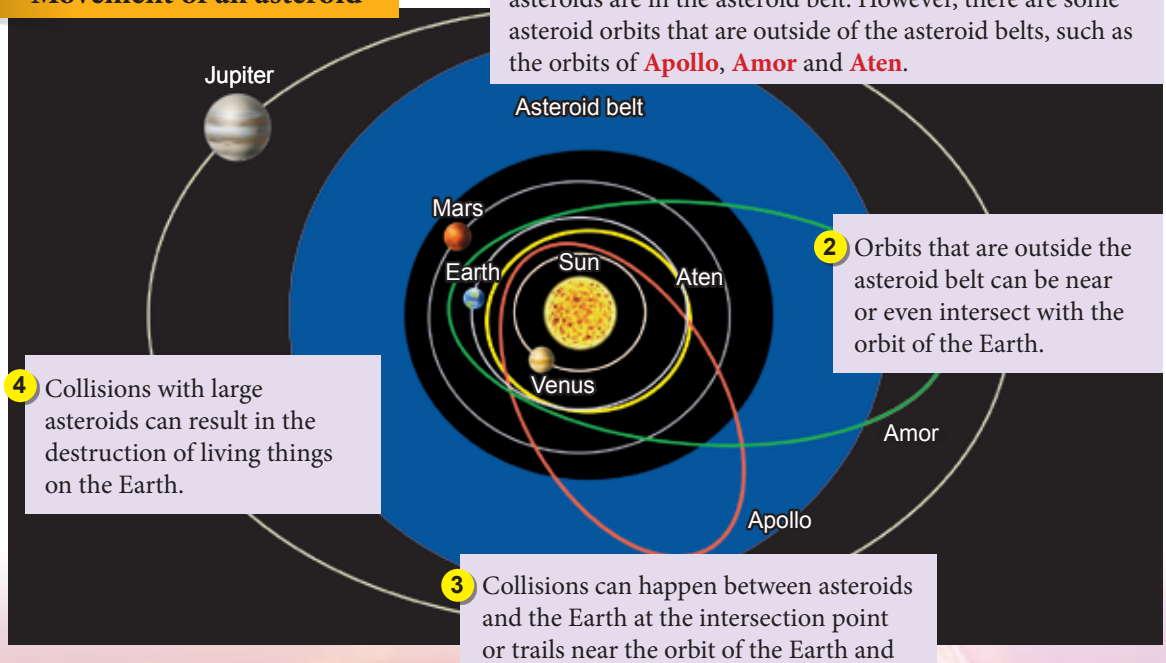


Photograph 13.2 *The meteorite crater in Arizona, United States (Photo source: NASA)*

Brain Teaser

What causes the moon to be hit by meteoroids more frequently as compared to the Earth and resulting in craters on its surface?

Movement of an asteroid



1. Asteroids move at an average speed of 25 km s^{-1}. Most asteroids are in the asteroid belt. However, there are some asteroid orbits that are outside of the asteroid belts, such as the orbits of **Apollo**, **Amor** and **Aten**.
2. Orbits that are outside the asteroid belt can be near or even intersect with the orbit of the Earth.
3. Collisions can happen between asteroids and the Earth at the intersection point or trails near the orbit of the Earth and orbit of the asteroids.
4. Collisions with large asteroids can result in the destruction of living things on the Earth.

Figure 13.3 *Movement of an asteroid*

Science Info

Paleontologists believe that the extinction of dinosaurs was caused by the collision of a 10 km sized asteroid with the surface of the Earth.

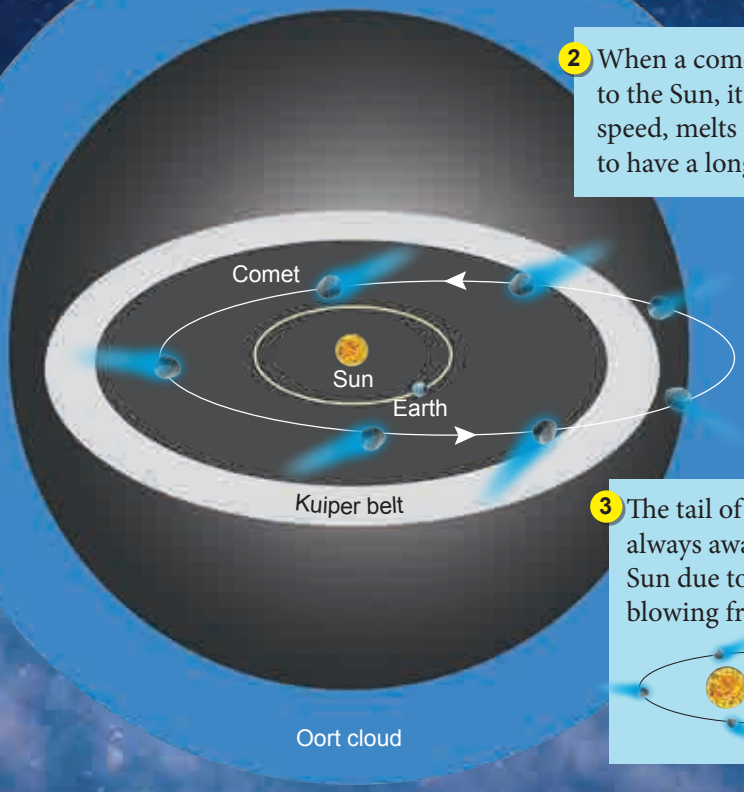
Photograph 13.3 *Asteroids are said to be one of the factors that contributed to the extinction of dinosaurs*

Movement of a comet

1 A comet moves at a speed range of 10 to 70 km s^{-1}. Most comets are from the **Kuiper belt** and the **Oort cloud**.

2 When a comet gets closer to the Sun, it increases in speed, melts and appears to have a long tail.

5 A comet that is out of its orbit has a risk of colliding with the Earth at high speed.



4 Strong gravitational pull of outer planets causes the comet to easily slip out of its orbit.

3 The tail of a comet is always away from the Sun due to solar wind blowing from the Sun.

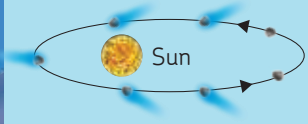


Figure 13.4 *Movement of a comet*

Activity 13.2

Aim: To observe meteors.

Instruction

1. Visit the National Planetarium.
2. Observe meteors using a space pod, which is a spaceship simulator that gives the impression just like you are in outer space.
3. Visit the following website to watch videos about movement of meteoroids.

Video

Video of Meteor Shower
http://bukutekskssm.my/Science/Video7.mp4

Protecting the Earth from Asteroid Impacts

Scientists are always monitoring asteroids in space to ensure that the orbits of the asteroids are at a safe distance from the orbit of the Earth. Warnings will be issued if there is a risk of an asteroid colliding with the Earth. Asteroids that approach the Earth may be destroyed or have its course changed.

Photograph 13.4 *An asteroid approaching the Earth*

Brain Teaser

What are some problems that scientists may face in their effort to destroy or deflect the direction of an asteroid that comes close to the Earth?

My Malaysia!

The National Space Agency (ANGKASA) is responsible to drive and monitor the development of space science in Malaysia.

SCAN IMAGE 360°

Animation on Asteroid Impact

Info

Near-Earth Object Programme
http://neo.jpl.nasa.gov

Activity 13.3

Aim: To collect information and prepare a multimedia presentation about the phenomenon of the collision of asteroids and other objects with the Earth.

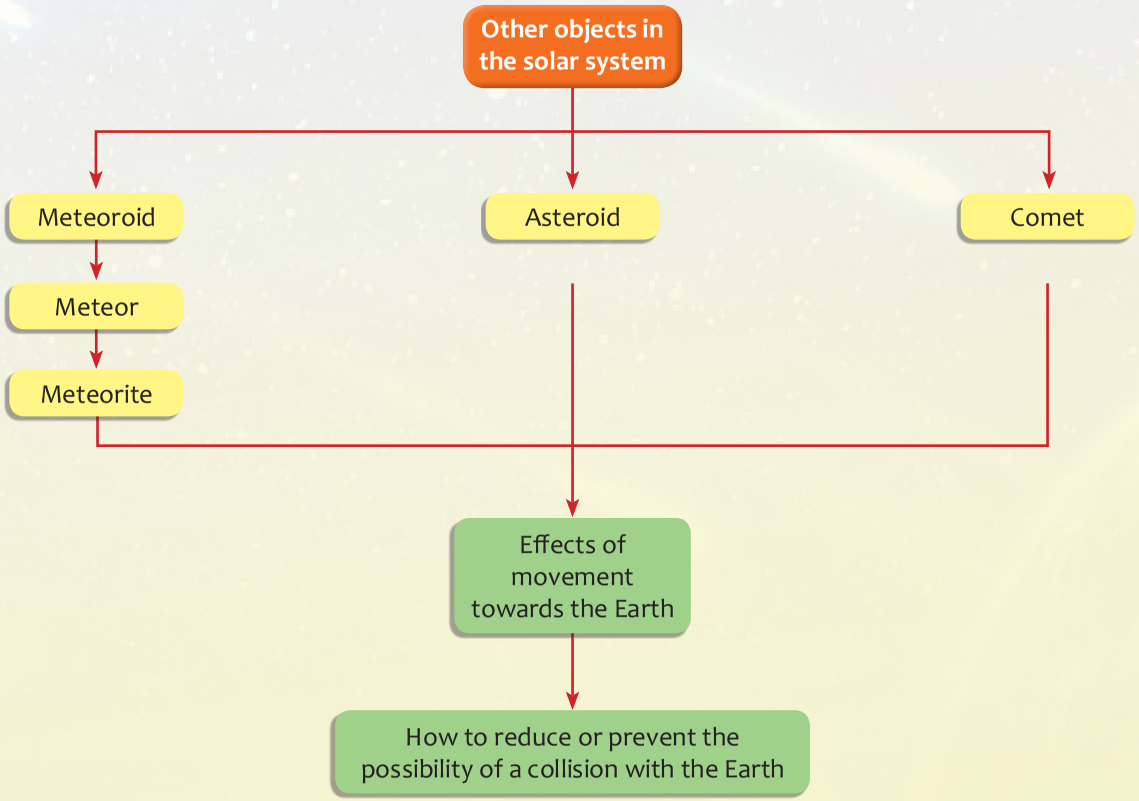
Instruction

1. Work in groups.
2. Collect information on the phenomenon of the collision of asteroids and other objects with the Earth.
3. Present your discussion using a multimedia presentation.

Formative Practice 13.1

1. Explain the stages and names of a meteoroid as it enters the atmosphere of the Earth.
2. How does the collision between an asteroid and the Earth happen? Explain your answer.
3. Why does the tail of a comet always face away from the Sun?

Summary



Quiz

Interactive Quiz 13

SELF-REFLECTION

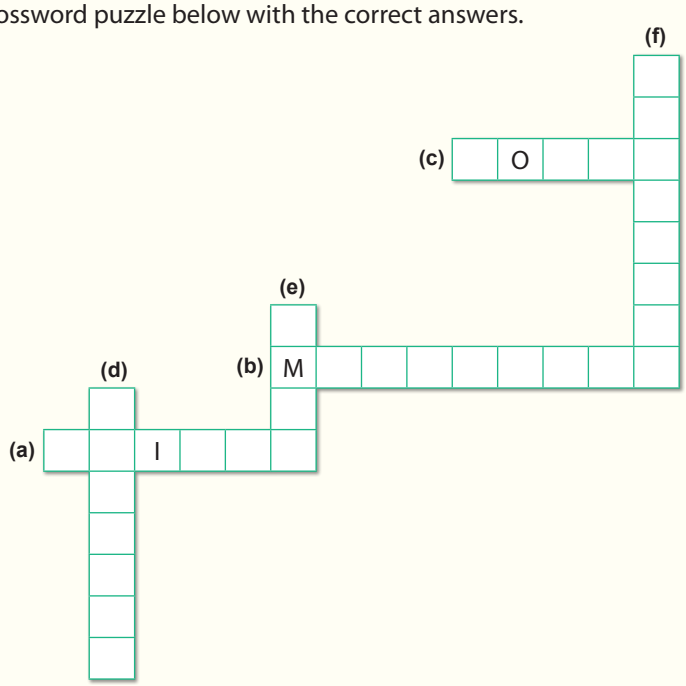
After learning this chapter, you are able to:

13.1 Other objects in the Solar System, such as Meteoroids, Asteroids and Comets

- ☐ Communicate on other objects in the solar system, such as meteoroids, asteroids and comets.
- ☐ Discuss the movement of meteoroids, asteroids and comets and their effects on the Earth based on data.
- ☐ Generate ideas on how to reduce or prevent the possibility of asteroids colliding with the Earth.

Summative Practice 13

1. Complete the crossword puzzle below with the correct answers.



Across

(a) Most comets originate from this belt.

(b) This object originates from asteroids and comets.

(c) This object is made up mostly of gas and water that freezes into ice

Down

(d) Planet that is close to the asteroid belt.

(e) One of the asteroid orbits that is outside the asteroid belt.

(f) This object is also known as a small planet.

2. Between a meteor and a meteorite, which would you most likely find in a museum? Give one reason for your answer.

3. Nicol saw a shower of light crossing the sky while she was looking at the stars. Then this shower of light disappeared. What object did Nicol see? Explain your answer.

4. Asteroids are among the objects in the solar system.

   (a) Predict the effects on the Earth if a large asteroid enters the atmosphere of the Earth.

   (b) How do we avoid a large asteroid from entering the Earth? Explain your answer.

   (c) One of the theories of the extinction of dinosaurs is that it was due to a large asteroid impact 65 million years ago.

   (i) Suggest a way that the asteroid may have caused the death of dinosaurs.

   (ii) Some scientists disagree with this theory because of the discovery of evidence that states there were a few dinosaur species that became extinct 20 million years before the impact of this asteroid. Justify these scientists' opinion.

5. In your opinion, can an asteroid become a planet within 100 million years? Why?

6. Why are meteors more dangerous to astronauts in space as compared to humans on the Earth? Explain your answer.

HOTS Mastery 13

7. A few astronauts would like to go to Saturn in a spaceship. They are taking precautionary measures due to the risk of colliding with an asteroid. In your opinion, where can this collision happen?

8. In your opinion, will the Earth be pushed out of its orbit by large chunks of asteroids? Why?

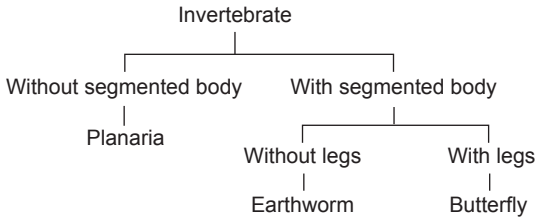
ANSWERS

ONLY SELECTED ANSWERS ARE PROVIDED HERE

Chapter 1

Summative Practice 1

1. (a) Biodiversity (d) Vertebrates
   (b) Poikilothermic (e) Gills
   (c) Dichotomous (f) Iguana
2. (a) ✗ (b) ✓ (c) ✓
3. (a) (i) Without wings
   (ii) Thick, hard wings
   (iii) Dragonfly (*Q*)
   (iv) More than three pairs of legs
   (v) Body with many segments
   (b) Have legs
   (c) Animal *P* has three pairs of legs, animal *S* has four pairs of legs whereas animal *T* has more than four pairs of legs.
4. (a) Root, leaf, stem, number of cotyledons
   (b) (i) Leaves with parallel veins
   (ii) Fibrous root
   (iii) Both have non-woody stem
5. Correct. The animals are invertebrates because all three have no backbone.
6. Differences:
   (i) Segmented body, not segmented
   (ii) Has legs, no legs
   Dichotomous key:



Chapter 2

Summative Practice 2

1. (a) Sapling → Rat → Fox
   Sapling → Rabbit → Fox
   Grass → Rabbit → Fox
   (b) Because grass can make its own food
   (c) Parasitism
   (d) The number of rabbits and rats will increase
   The number of grass and saplings will decrease
2. (a) Outbreak of diseases
   (b) Disposal of rubbish, especially food scraps in an unsystematic way
   (c) (i) Scheduled collection of garbage/ fines
   (ii) Organise community clean-up events and cleaning campaigns. Take care of the cleanliness of the house environment and business premises.
3. Azah is correct. Without decomposers, nutrients such as phosphorus and nitrogen will remain in the dead body of organisms and cannot be used by plants. Plants become infertile and may eventually die without enough nutrients.
4. The rat population increased because its predator, the eagles, had been shot. Razak needs to breed owls at his farm as a biological control to destroy the rats.

Chapter 3

Summative Practice 3

1. (a) Eggs, meat, soy bean, chicken, fish
   (Any other answers are accepted)
   (b) For growth// To build cells and body tissues
   (c) (i) Practise healthy intake of food// Exercise// Drink more plain water
   (ii) Bread, chocolate milk and half-boiled eggs
   (Any other answers are accepted)
   (iii) Amri probably had too much snacks and carbonated drinks. Snacks have high content of fat. Carbonated drinks contain a lot of sugar. Excessive fat can cause obesity and excessive sugar can cause diabetes.
2. (a) Consume a diet that is high in fat.
   (b) To keep her warm. Excess fat will be stored under the skin as heat insulator.
3. (a) *P*: Mouth
   Q: Liver
   R: Large intestine
   S: Oesophagus
   T: Stomach
   U: Duodenum
   V: Small intestine
   W: Anus
   (b) (i) Mouth
   (ii) Stomach
   (iii) Duodenum
4. (a) (i) Food sample is placed into a boiling tube
   (ii) 2 ml of Benedict's solution is added
   (iii) The mixture is heated using a water bath
   (iv) A change of colour is observed.

(b)

Food	Test	Observation
Rice	Iodine	
	Benedict	
Honey	Iodine	
	Benedict	

(c) Rice contains starch. Honey contains reducing sugars

5. (a) Temperature of amylase

(b) Volume of amylase and volume of starch suspension

(c) Yes. When heated, Benedict's solution does not form a brick red precipitate in boiling tube A. This shows that there is no reducing sugar present. The high temperature destroys amylase. Starch cannot be broken down into maltose.

Chapter 4

Summative Practice 4

1. (a) Group 1: Diabetes, hypertension, heart attack, cancer
Group 2: Flu, chickenpox, Leptospirosis, Zika, cholera, tinea

(b) Non-infectious diseases and infectious diseases

(c) (i) Tinea
(ii) Leptospirosis
(iii) Flu
(iv) Diabetes// hypertension// heart attack

(d) Chickenpox

2. (a) Dengue virus, Aedes mosquito

(b) Zika// Chikungunya

(c) Dengue haemorrhagic fever spreads when an Aedes mosquito bites and sucks the blood of a patient who has dengue virus. The mosquito will transmit the virus to another individual that it bites.

3. Besides producing unpleasant smell, the exposed garbage will attract cockroaches, flies and rats. These animals can be the vectors for diseases such as cholera, typhoid and leptospirosis.

4. (a) The body reacts to fight viral infection by producing antibodies in the blood to kill the virus.

(b) 16 to 17 days after the infection.

(c) The virus is killed and the body gets immunity against the disease.

5. (a) Similarity: Both mechanisms function to prevent infection of diseases.
Difference: Specific defence mechanism attacks certain pathogens whereas non-specific defence mechanism attacks all pathogens.

(b) (i) Pathogens are destroyed by antibodies produced by white blood cells.
(ii) The entrance of pathogens is prevented by the skin and mucous membranes, whereas pathogens that have successfully entered the body are destroyed through phagocytosis.

(c) (i) Active natural immunity
(ii) Active artificial immunity
(iii) Passive natural immunity
(iv) Passive artificial immunity

6. (a) Sever the transmission of infection by detecting the cases actively and passively such as giving initial treatment to the patients and separating the patients from others.

(b) (i) What activities did you do within the two weeks before the infection?
(ii) Did you go into the forest or swim in the waterfall before getting sick?
(Any other answers are accepted)

(c) (i) Avoid meeting the patients
(ii) Take precautionary steps when meeting the patients like wearing a face mask to cover the nose and mouth.
(iii) Improve personal hygiene, and cleanliness of house and environment.
(iv) Take vector control measures.
(Any other answers are accepted)

(d) Quarantine the patients is a wise step to prevent the public from meeting the patients. This is because transmission of bacteria or viruses can occur through air, water, vectors and also through contact.

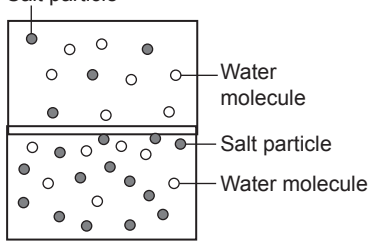
Chapter 5

Summative Practice 5

1. Water has a strong surface tension due to the cohesive force between the molecules of water at the surface. Johan should have dived into the water by keeping his hands together straight to the front, and both legs together straight to the back. This can reduce the effect of surface tension of water on him.

2. (a) (i) Salt particle

(ii)



(b) Yes. Heat can increase the rate of movement of salt particles. Hence, the salt particles can move faster to fill the spaces between the water molecules.

3. (a) The water particles at the surface of water vibrate faster upon gaining heat energy from the surrounding and escape from the water surface.

(b) Humidity, movement of air, surrounding temperature and exposed surface area.
– The higher the humidity, the lower the rate

of evaporation of water.
– The higher the surrounding temperature, the higher the rate of evaporation of water.
– The faster the movement of air, the higher the rate of evaporation of water.
– The wider the surface area exposed, the higher the rate of evaporation of water.
(Choose any two answers)

(c) (i)

4. Colloid: (a) (c) (f)
Suspension: (b) (e)
Solution: (d) (g)

5. Alcohol

6. (a) *N*, *K*, *M*, *L*

(b) Alum – To coagulate suspended particles in water
Slaked lime – To reduce the acidity of water
Chlorine - To kill the microorganisms in water.
(Choose any two answers)

(c) Alum is added to coagulate suspended particles in water. Slaked lime is added to reduce the acidity of water.

(d) Suspended particles mix with the water and the water becomes cloudy.

7. (a) Sample *C*

(b) Sample *B* and *D*

(c) Sample *C*

(d) Sample *B*, *C* and *D*

Chapter 6

Summative Practice 6

1. (a) Formic acid, malic acid

(b) (i) Formic acid
(ii) Malic acid

(c) No changes

2. (a) Flow the ammonia gas into water. Test the solution with a suitable indicator. Record the pH of the solution.

(b) pH paper can determine the pH value of a substance tested. Litmus paper cannot determine the pH value of a substance tested.

(c) (i) Yes. Phenolphthalein remains colourless in acidic and neutral conditions and turns pink in alkaline condition.

(ii) Put red and blue litmus papers into solution *M*. If the colour of blue litmus paper changes to red, solution *M* is acidic. If the colour of red litmus paper does not change colour, solution *M* is acidic.
(Any other answers are accepted)

3. (a) Acidic: *P* and *R*
Alkaline: *Q*

(b) *P*, *R*
– Tastes sour
– pH value less than 7

Q
– Tastes bitter
– pH value more than 7

(c) i) *P* – Vinegar// Lime juice
ii) *Q* – Shampoo// Soap// Detergent
(Any other answers are accepted)

4. (a) Jellyfish's sting venom is alkaline, therefore soap and toothpaste which are alkaline cannot neutralise the venom, but will increase the pain caused by the venom.

(b) Apply pineapple juice/ vinegar/ acidic substance to neutralise the alkaline venom.

Chapter 7

Summative Practice 7

1. (c)

2. (a) Imran will feel a mild electric shock caused by the electricity discharged from his body.

(b) By wearing shoes with rubber soles.

3. (a) The large amount of water vapour formed in the air during damp weather prevents the gathering of charges on an object.

(b) The current from the Van de Graaff generator is less compared to the domestic electric power supply.

4. (a) – Current (d) – Parallel
(b) – Conductor (e) – Resistor
(c) – Ohm

5. Parallel circuit. So, the alarm can be switched on by a heat detecting switch from any different locations in the same building.

6. $A_1 = 2.4$ A
$A_2 = 1.2$ A
$V_1 = V_2 = 12$ V

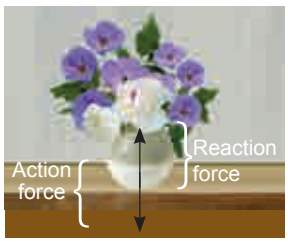
Chapter 8

Summative Practice 8

1. (a) Elastic force

(b) Gravitational force

2. Measuring device: Spring balance
S.I. unit: newton (N)



4. Inhaling air into lungs and drinking water from a straw

5. 0.75 N m

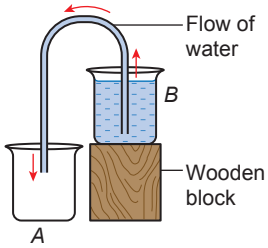
6. (a) 2 500 N m^{-2}
Total pressure by car

$$= \frac{1\,000}{4(0.1)} = 2\,500 \text{ N m}^{-2}$$

(b) Pressure exerted by each tyre

$= \frac{2\,500}{4} = 625 \text{ N m}^{-2}$

7. (a) 5 N
   (b) 5 N
   (c) Weight of stone is greater than the upthrust force.
8. Close the hole with her finger to prevent atmospheric pressure from entering the straw so that water will rise when sucked.
9. Shoe *Q* because it has bigger surface area which will decrease the pressure exerted on the field. The shoe will not sink into the soft ground.
10. The tube is not filled with water and the end of tube in beaker A is higher than in beaker B.
    Modification:
    1. Make the position of beaker B higher.
    2. Fill the tube with water until full.



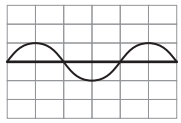
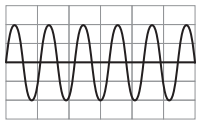
Chapter 9

Summative Practice 9

1. (a) The windscreen of the car cracked because a sudden change in the temperature causes a non-uniform contraction of the layer of the windscreen.
   (b) Wind down the windows of the car before turning on the air conditioner to allow the hot air from inside the car to escape first.
2. High heat caused by hot weather or burning of rubbish would increase the pressure inside the can and cause it to explode.
3. Switch on a bulb inside a vacuum flask. After a few minutes the flask will become hot. This proves that heat can transfer without a medium through radiation.
4. (a) The convection current is caused by the change in the density of fluid particles. The hot fluid particles will expand, become lighter, then rise. Whereas, the cold fluid particles become more dense and move downwards. The continuous flow of this fluid causes convection.
   (b) Radiation is the fastest heat transfer method because it does not need any medium for propagation.

Chapter 10

Summative Practice 10

1. Use two polystyrene cups connected with a string.
   – The polystyrene cups trap sound waves.
   – The string will help to transfer the sound waves.
2. (a)  (b) 

   3. Sound will propagate faster in air of higher temperature because transfer of sound energy can occur faster due to the higher kinetic energy of air molecules.
4. (a) Sound is reflected by a hard surface, such as the wall.
   (b) Furniture will absorb some sounds and reduce the effect of reflection.
5. (a) – Ultrasound waves are transmitted by a scanner probe that is moved across the belly of a pregnant mother.
   – The ultrasound waves are reflected when it hits the foetus in the womb.
   – Information from the reflection will be shown as an image on the monitor screen.
   (b) Advantages of ultrasound:
   – Not harmful to the foetus in the womb.
   – Can be done more often or repeatedly.
   – Painless
   – Does not use radiation
   – Results can be obtained immediately
   (c) – To determine the depth of sea.
   – To locate schools of fish in the sea.
   – To detect cracks inside engines
   – To clean jewellery
   (Any other answers are accepted)
6. (a) Pitch of sound increases because tighter guitar string produces higher frequency of vibration.
   (b) Strength of sound increases because amplitude of vibration increases.

Chapter 11

Summative Practice 11

1. (a) A star
   (b) 6 000 K to 7 500 K
   (c) When the temperature and pressure at the core become too high, a nuclear reaction will take place. Hydrogen gas is converted into helium. A lot of heat and light energy will be released.
2. (a) Yes, the Sun emits its own light.
   (b) This is because the Sun is the closest star to Earth.
3. In my opinion, the mission would not be successful because the diameter of a galaxy such as the Milky Way can reach up to hundreds of light years. In addition the distance between the Milky Way

galaxy and the Andromeda galaxy can also reach up to thousands of light years. Therefore, taking into consideration the factor of human age that can only reach approximately 100 years, an astronaut would not be able to stay alive and make it to the Andromeda Galaxy.
(Any other answers are accepted)

Chapter 12

Summative Practice 12

1. (a) Eight planets
(b) The planet that is closest to the Sun is Mercury and the planet that is furthest from the Sun is Neptune.
(c) Mercury is the closest planet to the Sun. The closer the planet is to the Sun, the faster the planet orbits the Sun.

2. (a) The Earth rotates from west to east.
(b) On Venus, the Sun rises in the west and sets in the east.
(c) If the Earth stops rotating,
– longer days occur on the surface that faces the Sun while longer nights occur on the surface that is away from the Sun.
– the area of the Earth that faces the Sun will experience dry seasons.

3. (a) Distance = 4.37 ly
Distance in km
= Distance in ly × 9.5×10^{12} km
= $4.37 \times 9.5 \times 10^{12}$
= 4.15×10^{13} km
(b) Distance = 4.15×10^{13} km

$$\text{Distance in A.U.} = \frac{4.15 \times 10^{13} \text{ km}}{1.5 \times 10^{8} \text{ km}}$$

$$= 2.76 \times 10^{5} \text{ A.U.}$$

4. (Student's answer. All products may be accepted if it uses recyclable materials).

5. (a) The hottest planet is planet *P*, the coldest planet is planet *Q*. This is because planet *P* is the closest to the Sun while planet *Q* is the furthest from the Sun.
(b) Planet *Q*. The further a planet is from the Sun, the more time it needs to travel around the Sun in one orbit.

Chapter 13

Summative Practice 13

1. (a) Jupiter (d) Kuiper
(b) Amor (e) Meteoroid
(c) Asteroid (f) Comet

2. Meteorite. A meteorite is a rock that hits the surface of the Earth. A meteor would not reach the Earth as it would have burned out before it reaches the Earth.

3. Meteor. A meteor shower happens when many meteors enter the Earth at the same time.

4. (a) If a large asteroid less than 10 km in size enters the atmosphere, the species at the area of impact and about 100 kilometres around the area will be destroyed. However, if the asteroid is 10km or bigger in size, the entire species on the Earth will face extinction (as what happened to the dinosaurs.).
(b) (i) It can be avoided by changing the course of the asteroid or breaking it into smaller rock fragments.
(ii) A spaceship can be used to attach explosives to the asteroid or shoot it with bombs that have strong explosive powers before it reaches Earth.
(c) (i) The asteroid impact 65 million years ago destroyed living things and caused a change in temperature. The temperature in one area reduced drastically while the temperature in another area increased drastically, causing the death of dinosaurs.
(ii) This opinion is acceptable. This is because scientists have their own opinion and theory about events that happened millions of years ago.
If there are any signs or evidence, a theory can be debated and scientists can study it again.

5. Yes, it can. This is because some asteroids have their own gravity while some don't. For an asteroid that has its own gravity, its mass has the ability to continue expanding and attracting other asteroids nearby to combine. When the asteroid becomes too large, this asteroid can become a planet.

6. Meteors in space are larger in size and have higher speeds. When they reach the Earth, their size and speeds reduce due to the friction with the atmosphere. Therefore, the effects of collision will be worse in space as compared to the Earth.

Full answers for teachers, please scan QR Code

Glossary

Air pressure	Force exerted by collision of gas molecules against a surface.
Ammeter	A device used to measure current.
Amplitude	The maximum displacement of wave measured from its equilibrium position.
Antibody	A protein produced by white blood cells (lymphocyte) into the bloodstream as a response to antigens.
Atmospheric pressure	Pressure exerted by the atmosphere on the surface of the Earth.
Balanced diet	A diet that contains all the food classes that our body require, served in the right proportion.
Bimetallic strip	A strip made of two different metals which are joined together along their length and expand at different rate when heated.
Biodiversity	A variety of organisms such as microorganisms, animals and plants in an ecosystem.
Biological control	The control of a pest by introducing another organism which is the natural predator to the pest.
Black hole	A region of space created by the explosion of supernova that has an intense gravitational pull.
Boiling point of water	Temperature at which water turns into water vapour, which is at 100°C.
Bourdon gauge	A device used to measure air pressure.
Chlorination	A process of adding chlorine to water to kill microorganisms.
Community	Several different population of organisms coexisting in a habitat and interacting with each other.
Concentrated solution	A solution that contains a lot of dissolved solute.
Dichotomous keys	A tool used by biologists to identify and classify organisms systematically according to their similarities and differences.
Digestion	A process of breaking down complex food substances into simpler molecules that can be absorbed by body cells.
Dilute solution	A solution that contains a little amount of dissolved solute.
Echo	Sound waves that are reflected from a hard surface.
Ecosystem	Several communities of organisms living in the same habitat that interact with each other and their non-living components such as water, air and soil.
Electric circuit	A path that consists of electrical components that are connected by connecting wires to allow electricity to pass through it.

Electrolysis	A process by which compounds are decomposed into their constituent elements when electricity is passed through the compounds.
Electron	A subatomic particle with negative charge found in atoms.
Electroscope	A device used to detect the existence of electrical charges and to identify the type of charges.
Filtration	A process of separating suspended solid particles.
Force	A push or pull that is exerted on an object.
Freezing point of water	Temperature at which water turns into ice, which is at 0°C.
Frequency	The number of complete wave cycles that occur in one second.
Fulcrum	A fixed turning point in a lever which is also known as a pivot.
Habitat	An environment or a natural home of an organism.
Heat	A form of energy that flows from hotter regions to colder regions.
Heat conductor	A material that allows heat to flow through it easily.
Heat insulator	A material that does not allow heat to flow through it.
Immunity	The ability of our body to fight a pathogen infection.
Invertebrates	Animals without a backbone.
Kinetic theory of gas	Gases are made up of tiny particles that move randomly.
Lever	A simple machine which consists of three parts; load, effort and fulcrum.
Magnetic field	A region around a magnet that has a magnetic force.
Magnitude	The value of a measured quantity.
Moment of force	The product of the force and the perpendicular distance from the pivot to the force.
Nebula	A cloud of hydrogen gas and dust.
Neutralisation	A chemical reaction between an acid and an alkali which forms salt and water.
Nutrition	The process of obtaining and using nutrients from food necessary for growth and development of the body.
Orbit	A pathway of a celestial object around other objects in space due to their gravitational force.
Organic solvent	A carbon-based solvent such as benzene, petrol, kerosene and alcohol.
pH scale	A scale that has a range between 0 to 14 and is used to measure the strength of acids and alkalis.
Planet	A celestial object moving in an elliptical orbit around the Sun or a star.
Population	A group of organism of the same species living in the same habitat.
Protein	A class of food that is essential for cellular growth and repairing of tissues.
Saturated solution	A solution that contains the maximum amount of dissolved solute.

Solar system	A system in the Milky Way galaxy that consists of eight planets and their moons travelling in independent orbits around the Sun.
Solubility	The maximum amount of solute that can dissolve in 100 g of solvent at a given temperature.
Solute	A substance that dissolves in a solvent.
Solution	A mixture that is formed when one or more solutes dissolve in a solvent.
Solvent	A substance that dissolves a solute.
Species	A group of organisms that has similar characteristics and is capable of interbreeding and producing fertile offsprings.
Symbiosis	Interaction between two or more different species living together in close proximity.
Syphon	A tube or pipe used to transfer liquid from one container at a higher position to another container at a lower position using the concept of air pressure.
Temperature	The degree of hotness or coldness of a substance.
Ultrasound	Sound waves with frequency more than 20 000 Hz.
Universal solvent	A solvent that can dissolve most substances (water).
Universe	A space consisting of galaxies, stars, planets and particles.
Vertebrates	Animals with a backbone such as fish, amphibians, reptiles, birds and mammals.
Vitamin	A class of food that is essential and required in small quantities by the body to maintain health.
Voltmeter	A device used to measure voltage.
Water evaporation	A process by which water changes into water vapour at any temperature.

Bibliography

Clarke, J., Levesley, M., Pimbert, M., Johnson, P., Baggley, S., & Gray, S. (2002). *Exploring Science 7*. Edinburgh Gate: Pearson Longman.

Edwards, M.A., Gardner, S., Hayes, J., Howell, J., Mascetti, B., Myers, J., Parsons, R., Steven, M., Waller, L., & Williams, A. (2007). *GCSE Physics*. United Kingdom: Coordination Group Publications Ltd.

Fong, J., Hoh, Y.K., Tho, L.H., & Tho, M.Y. (2008). *Lower Secondary Volume B: Interactive Science for Inquiring Minds. Singapore*: Panpac Education Private Limited.

Garton, A., & Williamson, K., (2005). *Science for Life Year 7*. South Yarra: Macmillan Education Australia Pty Ltd.

Garton, A., & Williamson, K., (2005). *Science for Life Year 8*. South Yarra: Macmillan Education Australia Pty Ltd.

Goh, H.C., Gui, E.H., & Tan, K.S. (2014). *Science Around Us, Module 1 Gadgets Work Wonders (I)*. Singapore: Star Publishing Pte Ltd.

Goh, H.C., Gui, E.H., & Tan, K.S. (2014). *Science Around Us, Module 2 Gadgets Work Wonders (I)*. Singapore: Star Publishing Pte Ltd.

Goh, H.C., Gui, E.H., & Tan, K.S. (2014). *Science Around Us, Module 3 Gadgets Work Wonders (I)*. Singapore: Star Publishing Pte Ltd.

Ho, P.L. (2009). *International Lower Secondary Science 1*. Singapore: Marshall Cavendish Education.

Ho, P.L. (2009). *International Lower Secondary Science 2*. Singapore: Marshall Cavendish Education.

Johnson, P. (2006). *21st Century Science, Science GCSE Foundation*. Edinburgh Gate: Pearson Longman.

Lee, C., Lam, E., Fong, J., Lam, P. K., & Loo, P.L. (2014). *Lower Secondary Science: Volume A : Matters* (2nd ed.). Singapore: Marshall Cavendish Education.

Lee, C., Lam, E., Fong, J., Lam, P. K., & Loo, P.L. (2014). *Lower Secondary Science: Volume B : Matters* (2nd ed.). Singapore: Marshall Cavendish Education.

Lofts, G., & Evergreen, M. J. (2000). *Science Quest 1*. Australia: John Wiley & Sons Australia Ltd.

Loo, K.W., & Loo, W.Y. (2007). *Physics Insights 'O'Level* (2nd ed.). Singapore: Pearson Education South Asia.

Yip, P. (2003). *Biology for Tomorrow*. Hong Kong: Manhattan Press (H.K.) Ltd.

Index