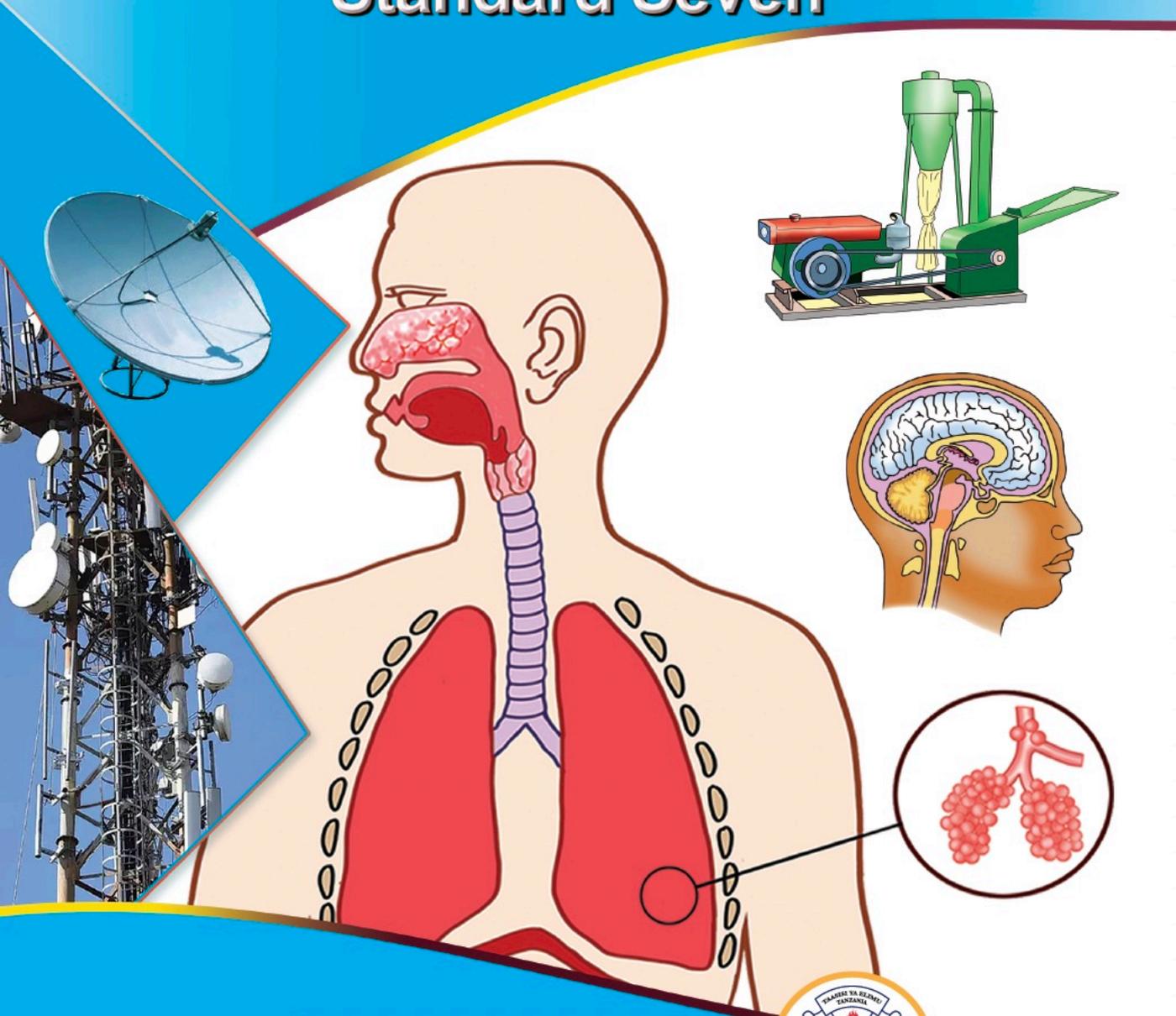


# Science and Technology

## Pupil's Book Standard Seven



Tanzania Institute of Education



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# Science and Technology

## Pupil's Book Standard Seven

THE UNITED REPUBLIC OF TANZANIA  
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SCIENCE AND TECHNOLOGY

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Commissioner for Education

Tanzania Institute of Education

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Dr Aneth A. Komba  
Director General  
Tanzania Institute of Education

## Introduction

This is the fifth book in a series of five textbooks on Science and Technology for Primary Schools from Standard Three to Seven. The book is prepared according to the 2020 Science and Technology Syllabus for Primary Schools issued by the Ministry of Education, Science and Technology. This book consists of 10 chapters which are Safety signs in the environment, Electrical energy, Floating and sinking, Antenna, Complex machines, Scientific experiments, Waste disposal, Body health, Nervous system, and Human respiratory system. The book includes descriptions, illustrations, activities and experiments that enhance learning. The book contains exercises and activities that are intended to test your understanding in each chapter. You should do all the activities, exercises and experiments provided. This will enable you to develop the intended competencies.

## Safety signs in the environment

### Introduction

*In Standard Six, you learnt about environmental cleanliness. In this chapter, you will learn about the concept of safety signs in the environment, interpretation of safety signs and uses of safety signs in the environment. The competencies developed will enable you to take appropriate precautions in ensuring your safety and that of others.*

### The concept of safety signs



#### Think

1. Safety signs available in your environment
2. Places where the safety signs are positioned
3. The meaning and importance of safety signs

In our environment, there are signs or symbols that give signals or warning. These are known as safety signs. Safety signs provide information about dangers in items or the environment. Likewise, safety signs provide instructions that can lead to the protection of living and non-living organisms in the environment. Some safety signs are presented with texts to facilitate interpretation. However, most of the signs and symbols have no texts. Users in the relevant areas are supposed to understand the meaning of the signs. Safety signs are used in all countries, and they are placed on items such as bottles containing medicines or chemicals. They are also placed on vehicles and vessels such as buses, airplanes, ships, boats and fuel tankers. Similarly, they are placed on buildings to indicate slippery floors and exit during emergencies. They are also placed on items with chemicals or

potential hazards. In addition, these safety signs are placed on transformers and electric poles with high voltage. Safety signs are important because they help us to take appropriate precautions when using such items and equipment. They also warn us against risky environments, such as playing or passing across high voltage cables.

### Types of safety signs

There are four major types of safety signs, which are

- (a) prohibition,
- (b) warning,
- (c) mandatory, and
- (d) emergency.

Each type of the safety signs is presented in a specific shape and colour. The shapes and colours of the signs are governed by the international safety regulations as shown in Table 1.

**Table 1:** Types of safety signs, their colours, instructions, and characteristics

S/N.	Types of safety signs	Colour	Instructions	Characteristics	Example
1.	Prohibition	Red	(a) Danger (b) Stop (c) Turn off or shutdown (d) Vacate (e) No entry for unauthorised person	Red circle or quadrilateral (rectangular or square), black image on a white background and red border. Some of these signs have a red diagonal line through them.	
2.	Warning	Yellow	(a) Be careful (b) Take precaution (c) Danger nearby	Triangular, a black image on a yellow background and a black border	

S/N.	Types of safety signs	Colour	Instructions	Characteristics	Example
3.	Mandatory	Blue	Insisting specific behaviour or actions	Circular, a white image on a blue background	
4.	Emergency	Green	(a) Emergency exit door (b) Emergency exit (c) First aid or rescue facilities	Rectangular or square, white image or text on a green background or green image or text on a white background	

**Note:** Some of the safety signs are presented using different colours depending on the degree of potential effects in case the precaution is not taken. For example, danger signs may have red, orange or yellow colours. The red colour indicates major effects followed by orange and yellow colours. The danger sign is used in places that can cause severe injuries or death in case precautions are not taken. A danger sign with a red background and white text is used to indicate environmental hazards which can cause major effects.

### The interpretation of safety signs

Safety signs offer precautions to users. It is important to recognise these signs and their meanings. This will help to avoid the possible dangers or accidents which may occur by ignoring the given precautions. Table 2 shows some of the safety signs.

**Table 2: Interpretation of some safety signs**

S/N.	Safety sign and interpretation	Items or places where the safety signs are displayed	Effects for not taking the required precautions
1.	 No entry	Unauthorised access, such as in the laboratory	One can get health-related effects in case he/she enters or passes through the restricted areas.

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S/N.	Safety sign and interpretation	Items or places where the safety signs are displayed	Effects for not taking the required precautions
2.	 No smoking	In smoking prohibited areas such as in filling stations, airplanes, restaurants, schools and other public places	Fire can erupt, and it can cause health-related problems to a non-smoker who is close to the smoker.
3.	 Do not eat or drink	Areas where eating or drinking is not allowed, such as in a laboratory	Health-related issues can occur to a person.
4.	 Fragile	On packages which carry fragile items, such as glass utensils	Items can break and result into loss.
5.	 Unsafe water	On water taps with unsafe water that is not suitable for drinking, washing, or cooking	Health problems may occur to a person.
6.	 Explosive	On explosive items such as herbicides, paints, solvents, and chemicals used in the laboratory	They can explode and cause injury to a person.

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S/N.	Safety sign and interpretation	Items or places where the safety signs are displayed	Effects for not taking the required precautions
7.	 Corrosive	On items which contain corrosives such as bottles containing concentrated acids and car batteries, which can cause eroding or burning	Can cause large body wounds, burn, or destroy various things, such as clothes and furniture
8.	 Flammable	On items that contain flammable chemicals which catch fire easily such as spirits, pesticides, colour-removing agents, polishes, petrol, and diesel	Can cause fire accidents
9.	 Toxic or poison or danger	On items containing toxic chemicals, such as toilet cleaning detergents, chemicals for livestock dipping trough (acaricides), and pesticides: This sign is also placed on transformers and electric poles with high voltage	Can cause death in case one touches the items with that sign or the contents enter the body through drinking or inhaling
10.	 Health hazard	On items with chemicals or drugs that cause harm or health effects. Examples of chemicals include pesticides, glue, paint, and petroleum products	They can cause serious long term health effects.

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S/N.	Safety sign and interpretation	Items or places where the safety signs are displayed	Effects for not taking the required precautions
11.	 High voltage	On electric poles and stations with high voltage	A person can get an electric shock, and death may occur.
12.	 Strong radiation	Posted where radioactive materials are handled or where radiation-producing equipment is used, such as an X-ray room	Can cause dangerous effects such as skin damage, blindness and various types of cancers
13.	 Biohazard	On materials containing biohazards, for example dangerous diseases causing microorganisms: These include containers for biohazard sample storage and waste disposal	Can cause disease infections
14.	 Slippery floor	On slippery or wet floor	A person may slip, fall down, and get injured.

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S/N.	Safety sign and interpretation	Items or places where the safety signs are displayed	Effects for not taking the required precautions
15.	 Danger	In dangerous places, such as areas with ongoing roadworks	Accidents can occur.
16.	 Hand wash station	Hand-washing facilities as in hospitals and restaurants	Can result into diseases and infection
17.	 Eye protection required	Areas that require eye protection, such as areas with strong radiation	A person can be affected in the eyes.
18.	 Eye and face protection required	Areas or materials such as explosive chemicals that can affect the face and eyes	Effects can occur in the eyes and face.
19.	 Exit door	On exit doors, particularly on emergency doors as in hospital buildings	Accidents can occur.

**Activity: Drawing safety signs**

**Materials:** manila papers, marker pens, pencils and coloured pencils

**Procedure**

1. Visit places having safety signs and study the signs.
2. Draw the signs on manila paper.

**Questions**

- (a) Which of the items or equipment that you saw had safety signs?
- (b) What are the safety signs you saw on the items or in the different places that you visited?
- (c) What are the possible effects a person can get if he or she does not follow the instructions of the signs?

**Exercise 1**

**Answer the following questions:**

1. Give the meaning of safety signs.
2. Why are there different safety signs in the environment?
3. Why are texts included in some safety signs?
4. Use Table 3 to write the appropriate interpretations of the indicated safety signs.

**Table 3: Safety signs and interpretation**

S/N.	Safety sign	Interpretation
(a)		
(b)		

(c)		
(d)		
(e)		
(f)		

## Uses of safety signs in the environment

Safety signs are used in different places and on items available in our environment. The following are some of the uses of safety signs:

### Indicating danger

There are items or places marked with safety signs to caution people against the possible dangers in case they do not take precautions. For example, some safety signs indicate the risks of X-ray radiation, explosive chemicals, and a high voltage transmission line. These signs require a person to take precautions as he or she approaches such environments.

### Prevention of diseases

Safety signs are used to indicate ways in which a person can be protected from diseases or health effects by adhering to the given safety signs. For

example, safety signs on biohazardous items such as waste dustbins in hospitals warn us against touching. This sign protects one from the diseases caused by biohazards.

### Prevention of accidents

Some safety signs can help to prevent accidents. For example, a fuel tanker has a warning sign for highly flammable materials. Therefore, this sign is used to prevent possible fire accident.

### Warning and instructions

Some safety signs alert and provide instructions on how to use items or do something carefully. For example, easily broken items are marked with instructions such as “handle with care” to help carry them safely. Some chemicals such as insecticides or herbicides are marked as dangerous or toxic. The signs on those chemicals require the user to wear protective equipment to use them safely. Such protective items include gloves, goggles, special clothing or overalls, boots and helmets. The flammable safety sign is placed on bottles containing pesticides and perfumes. Therefore, it is advised to stay away from fire sources when using such items.

### Exercise 2

Answer all questions in Sections A and B.

#### Section A

Choose the most correct answer and write its letter in the box provided.

- The types of safety signs are \_\_\_\_\_.
  - prohibition, warning, mandatory, and emergency signs
  - emergency, personal, and danger signs
  - mandatory, prohibition, and entry signs
  - hospital, warning, road, and aerial signs
- What is the colour used for mandatory signs?
  - Yellow
  - Red
  - Blue
  - Green

3. What does the following sign represent?



- (a) Toxic
- (b) Flammable
- (c) Corrosive
- (d) Harmful

4. One of the following words is not displayed on pesticide containers:

- (a) Flammable
- (b) Toxic or danger
- (c) Unsafe water
- (d) Irritant

5. What precaution should you take to protect your eyes when using dangerous items?

- (a) Wear a mask
- (b) Use a face cloth
- (c) Wear a hat
- (d) Wear goggles

### Section B

- 6. List four uses of safety signs.
- 7. List five items or equipment with danger or toxic signs.
- 8. Explain five precautions that you will take when using drugs or chemicals having a toxic sign.
- 9. Explain the importance of safety signs.
- 10. Explain the possible effects which can occur when using chemicals with the irritant sign.

### Vocabulary

Explosive	a substance that is able or likely to cause an explosion
Pesticide	a substance or chemical used to control or kill organisms that affect plants, animals, or products
X-ray radiation	an electromagnetic radiation of high energy and very short wavelength which is able to pass through materials that are opaque to light

## Chapter Two

### Electrical energy

#### Introduction

*In Standard Four, you learnt how to generate electricity from waterfalls, the sun, wind and fuel. In Standard Six, you learnt how to generate electricity from biogas. In this chapter, you will learn how water waves, water currents, and geothermal energy are used to generate electricity. You will also learn about the quality of renewable energy over non-renewable energy. The competencies developed will enable you compare ways of generating electricity from water waves, water currents, and geothermal energy.*

#### The concept of electrical energy



#### Think

Primary sources of energy for generating electricity

Electrical energy is generated from primary sources such as natural gas, biogas, wind, geothermal energy, coal, and water waves. Electrical energy is also called an energy carrier. This is because it can be converted into other forms of energy, such as mechanical energy, heat energy, and light energy.

#### The concept of water waves

When the surface of still water is disturbed by a force or something dropped from above, a change in the vertical motion of the water molecules around that surface occurs. The directly affected water molecules oscillate up and down at the same position. This motion affects neighbouring molecules. Thus, the water surface appears to have an undulating motion. It also appears to move away horizontally from the source of the disturbance. In reality, water molecules do not move horizontally, but it is the water wave energy that moves.

**Activity:** To observe how water waves occur

**Materials:** basin, water, and a small stone

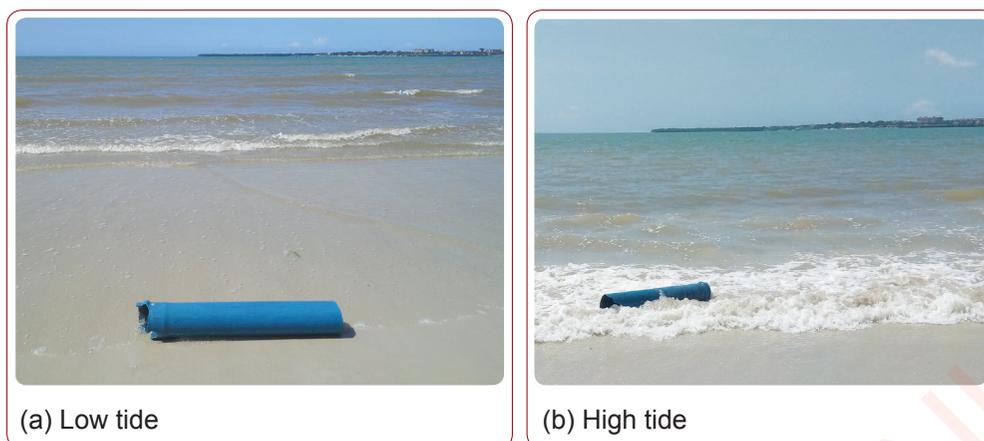
**Procedure**

1. Take a basin and fill water to three-quarters.
2. Drop a small stone on the surface of water as shown in Figure 1. What happens to the water?



**Figure 1:** A pupil creating water waves

Water waves in the ocean, sea, lake or dam are caused by wind. These occur due to the friction between the wind and the surface of the water. The magnitude of the produced waves depends on the wind speed. Water waves are also caused by the rise or fall of water level in the ocean. This is caused by the gravitational attractive force between the earth and the moon. This force causes water to move away or closer to the shoreline. The movement of water away or closer to the shoreline is known as ocean tides. The movement away from the shoreline is called a low tide and the movement closer to the shoreline is called a high tide as shown in Figure 2 (a) and (b).



**Figure 2:** *Low and high tides*

Besides producing large waves, tides also produce water currents. Both water waves and water currents produce mechanical energy that is driven from the forces exerted by water. Therefore, this energy can be used to generate electricity.

### **Generating electricity from water waves**

Water waves caused by wind or the gravitational attraction between the earth and the moon can be used to generate electricity. A special floating plant is used to generate such electricity. The water wave energy is used to drive the plant, which produces electricity.

The closer the ocean waves are to the shoreline, the greater the amount of wave energy is produced within a small area. Therefore, the plant is placed in an area where water waves are large as they approach the shoreline. As with a power-generating plant from a waterfall, this plant has turbines and generators. The turbines are rotated by the air above the surface of water as the water oscillates every time a wave passes. The turbine rotation runs the electric generator as shown in Figure 3 (a) and (b).

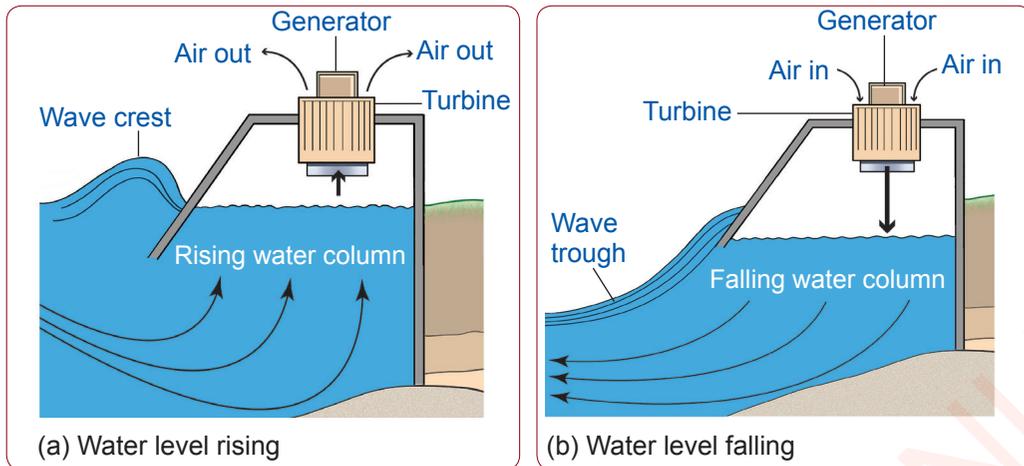


Figure 3: Electric generation from ocean waves

### Generating electricity using water currents

Water currents caused by ocean tides can generate electric energy. The energy is generated by a specialized plant whose principle for the generation of electricity is shown in Figure 4. Basically, this plant is similar to the one that generates electricity from a waterfall.

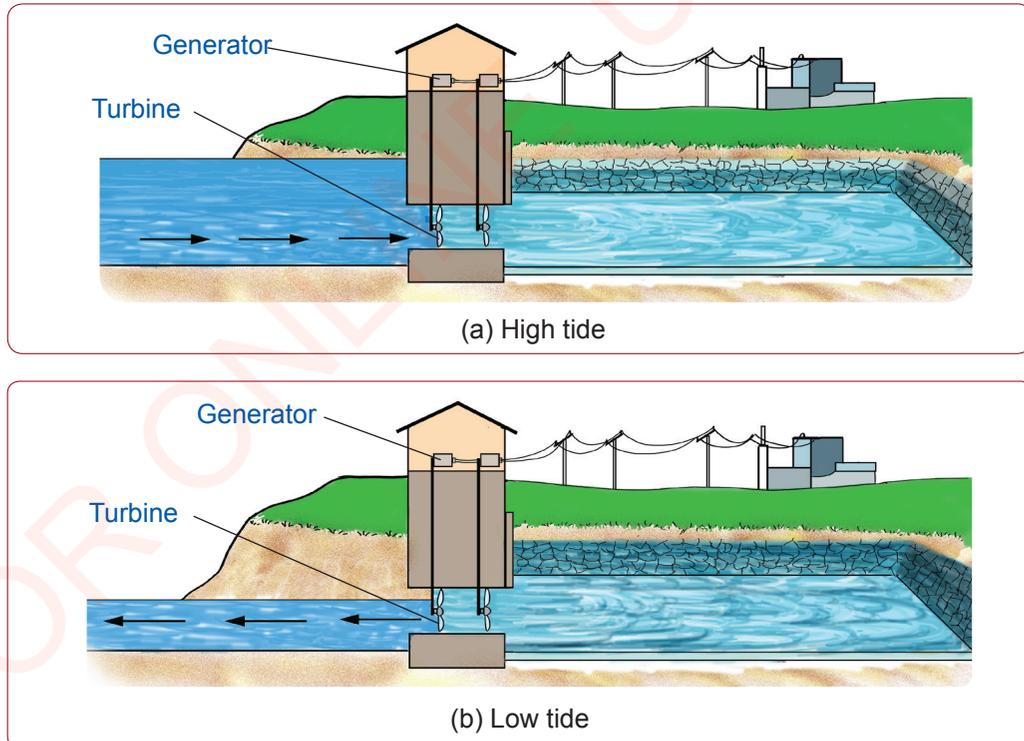


Figure 4: Tidal power plant

As the arrows in Figure 4 (a) show, during a high tide, water flows out of the ocean and passes through the turbines before entering the dam. During a low tide, the water that entered the dam flows back to the ocean as the arrows in Figure 4 (b) show. The water continues to rotate the turbines driving the generator that produces electricity. High and low tides generate electricity using water currents.

### **Advantages of generating electricity from water waves and currents**

- (a) The electricity generated from ocean currents is always available provided there is a large water reserving dam.
- (b) The electricity generated from water waves and currents is renewable. This is because the tides are due to the natural forces, which are always available.
- (c) The electricity produced from water waves and currents is environmentally friendly. This is because its generation does not produce harmful gases to living organisms.

### **Disadvantages of generating electricity from water waves and currents**

- (a) This method of generating electricity is not used in most countries. This is because the initial costs associated with the manufacturing and installation of the plant are high.
- (b) Living organisms in the ocean can be affected if they are not prevented from entering the turbine area by wire mesh.

#### **Exercise 1**

#### **Answer the following questions:**

1. Explain the sources of water waves.
2. List the main components of a power plant that generates electricity from ocean water waves.
3. Describe how to generate electricity from water waves.
4. Describe how to generate electricity from water currents.

## The concept of geothermal energy

Geothermal energy comes from hot magma in the underground rocks. Sometimes, magma can flow as lava through cracks in rocks, causing a volcano. However, large amounts of magma remain in the underground rocks. Thus, the rocks and groundwater near the magma area heat up. In some places, water jets out to the earth's surface as vapour and hot spring. The steam and hot water in the rocks are the sources of geothermal energy that can be used to generate electricity. Geothermal energy is another source of renewable energy.

## Generating electricity from geothermal energy

Geothermal energy can be converted into electricity using a special electric generating plant. The plant consists of a turbine which is rotated by high-pressure steam. The steam is pumped out from underground rocks as shown in Figure 5.

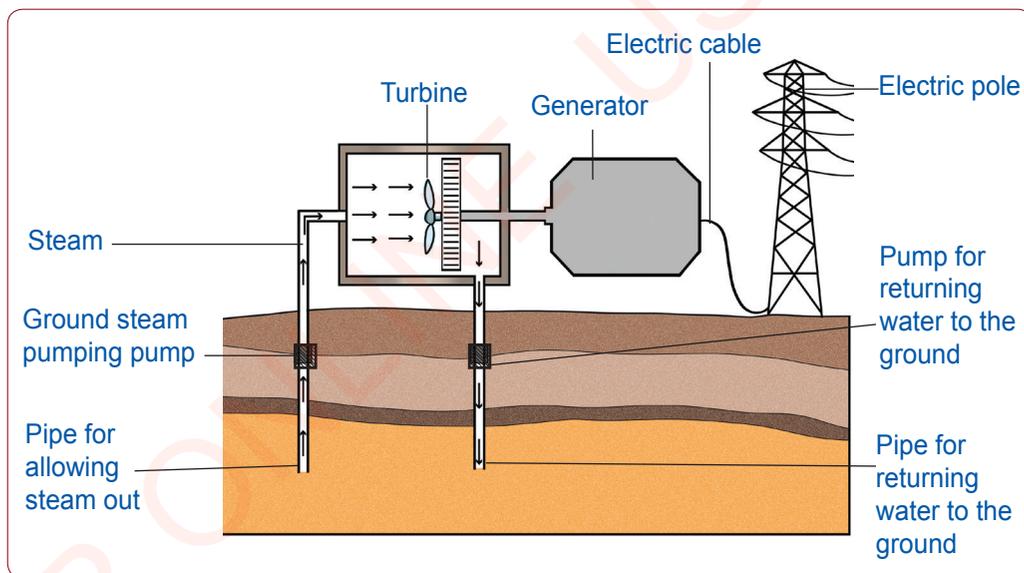


Figure 5: Geothermal power plant for producing electricity

The steam used to run the turbine cools, changes into liquid, and then returns back to the earth via a pump. The turbine is connected to the generator that produces electricity. This electricity is distributed using electric cables and poles.

### Exercise 2

**Answer the following questions:**

1. Explain the source of geothermal energy.
2. Why is geothermal energy renewable?
3. Describe how geothermal energy is used to generate electricity.

#### **Advantages of generating electricity from geothermal energy**

- (a) Geothermal electricity is renewable, and it cannot be depleted as its sources are sustainable.
- (b) The running costs of electrical plants are low.

#### **Disadvantages of generating electricity from geothermal energy**

- (a) The initial costs of manufacturing and installing electrical plants are high.
- (b) Geothermal sources are found only in some areas. Hence, only few countries can benefit from it.

#### **Quality of renewable energy**

Renewable energy is a better source of energy than non-renewable energy. This energy is ideal as it comes from natural sustainable sources. For example, hydropower from waterfalls or water stored in dams is cheaper due to the presence of sufficient water sources. Electrical energy from water waves can be used at any time in countries with coastlines like Tanzania.

#### **Disadvantages of renewable energy**

Although renewable energy is better than non-renewable energy, it has the following disadvantages:

- (a) Renewable energy involves large capital cost.
- (b) Renewable energy depends on the presence and type of a primary source. For example, wind power depends on the presence of high speed wind to generate electricity. Similarly, energy from waterfalls depends on the availability of sufficient water.

### Exercise 3

Answer all questions in Sections A, B and C.

#### Section A

Fill in the blanks.

1. The sources of renewable energy are \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
2. The sources of electricity derived from water are \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
3. A power plant that does not use a turbine is \_\_\_\_\_.

#### Section B

Write **TRUE** for a correct statement and **FALSE** for an incorrect statement in the space provided.

4. Electrical energy is generated using oil and biogas only. \_\_\_\_\_
5. Renewable energy resources are derived from natural processes.  
\_\_\_\_\_
6. Water waves, waterfalls, and geothermal energy are some of the sources for generating electricity. \_\_\_\_\_
7. Manufacturing and installation costs of renewable energy plants are low. \_\_\_\_\_
8. Electrical energy from wind does not depend on the presence of high speed wind. \_\_\_\_\_

#### Section C

9. List two advantages of renewable energy.
10. Using examples, differentiate between renewable and non-renewable energies.
11. Differentiate between solar-generated electric energy and geothermal-generated electric energy.
12. Renewable energy is called sustainable energy. Explain.
13. Which source is easier to generate electricity in your environment? Why?
14. Explain the advantages of the electrical energy generated by ocean waves.

#### Vocabulary

Geothermal	the heat in the underground rocks
Lava	magma that reaches the earth's surface through rock cracks
Magma	hot liquid or molten rock within the earth's surface
Undulating motion	up-and-down movement like the motion of waves
Wave crest	the highest point the wave rises
Wave trough	the lowest point the wave falls

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## Chapter Three

### Floating and sinking

#### Introduction

*In Standard Three, you learnt about matter and its properties. You also learnt about floatation of matter in the air. In this chapter, you will learn about the characteristics of objects which float on or sink in water. You will also learn about the law of floatation and its application in marine transportation. In addition, you will make models of objects which float and objects which sink in water. The competencies developed will enable you to apply the law of floatation in constructing models of vessels used in water transport.*

#### Objects which float on or sink in water



##### Think

1. Objects which float on water
2. Objects which sink in water

There are various objects in our living environment. These objects differ in mass and volume. Some of these objects float and others sink in water. Objects like balloons, balls, leaves and canoes float on water. In contrast, objects like stones, glass, tiles, wax, and some metallic objects sink in water.

#### Characteristics of objects which float on or sink in water



##### Think

Reasons for objects to float on or sink in water

Floating or sinking of objects in water depends on the following:

### (a) Density of the object

Different objects have different densities. For example, a piece of metal rod has a different density from that of wood. The density of the piece of metal rod is greater than that of the piece of wood. Likewise, the metal rod has a greater density than water. On the other hand, a piece of wood is less dense than water. When these objects are placed on water, the metal rod will sink in water whereas the piece of wood will float. Moreover, immiscible liquids such as water and kerosene have different densities. When they are poured in a container, the less dense liquid will float on the more dense liquid. In this case, kerosene will float on water because kerosene is less dense than water.

*Density is the mass of an object per unit volume.*

**Formula**

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

The SI unit of mass is kilogram (kg), and that of volume is cubic metres (m<sup>3</sup>). Therefore, the SI unit of density is kilogram per cubic metres (kg/m<sup>3</sup>). Another SI unit of density is gram per cubic centimetres (g/cm<sup>3</sup>).

#### Example 1

Find the density of an object with a mass of 640 grams and volume of 800 cubic centimetres.

#### Solution

*Given:*

$$\text{Mass} = 640 \text{ g}$$

$$\text{Volume} = 800 \text{ cm}^3$$

*Required:* Density of an object.

#### Formula

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

$$\text{Density} = \frac{640 \text{ g}}{800 \text{ cm}^3}$$

$$\text{Density} = 0.8 \frac{\text{g}}{\text{cm}^3}$$

The density of the object is **0.8 g/cm<sup>3</sup>**.

### Example 2

Find the density of an object having a mass of 1 000 kilograms and volume of 100 cubic metres.

#### Solution

Given:

Mass = 1 000 kg

Volume = 100 m<sup>3</sup>

*Required:* Density of an object.

#### Formula

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

$$\text{Density} = \frac{1\,000 \text{ kg}}{100 \text{ m}^3}$$

$$\text{Density} = 10 \frac{\text{kg}}{\text{m}^3}$$

The density of the object is **10 kg/m<sup>3</sup>**.

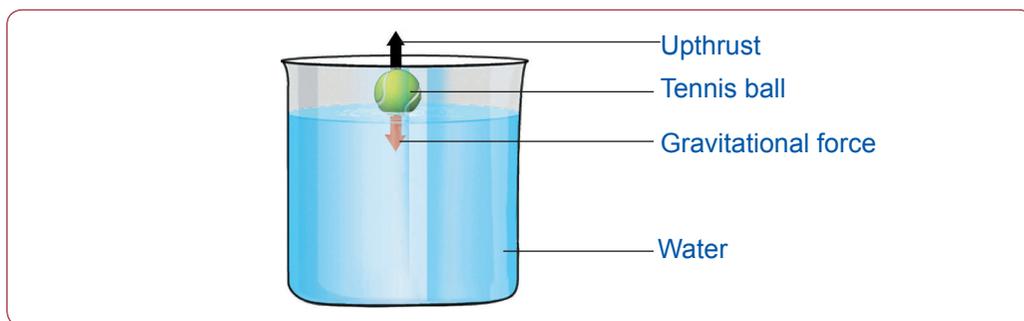
The density of water is one gram per cubic centimetres; that is, 1 g/cm<sup>3</sup> or 1 000 kg/m<sup>3</sup>. If the density of an object is greater than that of water, the object will sink in water. Objects which float on water are less dense than water. For example, a ship is large and heavy, but it floats on water because its average density is less than that of water.

#### (b) Shape of the object

Hollowed objects are filled with air. Hence their average densities are less than water. These objects float on water because their masses are smaller than solid objects, which are not hollowed. Examples of hollowed objects include ships, canoes, balls, empty gallons and boats.

#### (c) Relationship between the upthrust force and the gravitational force

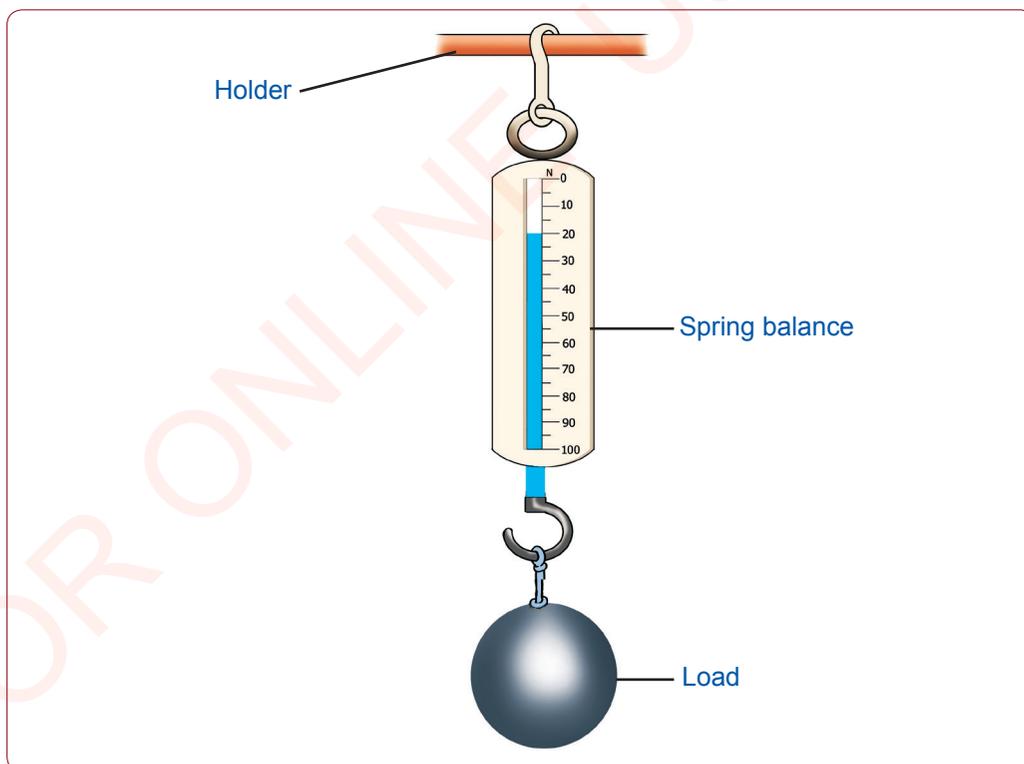
The tennis ball floats because the upthrust force exerted by water is greater or equal to the gravitational force as shown in Figure 1. If the upthrust force is less than the gravitational force, the object sinks. For example, when a coin is placed on water, it sinks because the upthrust force is less than the gravitational force.



**Figure 1:** The relationship between the upthrust and gravitational forces

In Figure 1, the upthrust force acts in the opposite direction to the gravitational force. The gravitational force is a natural force originating from the earth's gravity towards its center. Upthrust is associated with the mass of water displaced by a floating or sinking object.

The gravitational force is also called weight. The SI unit of the gravitational force is newton, abbreviated by N. This force is measured using a spring balance as shown in Figure 2.



**Figure 2:** Measuring weight using a spring balance

The gravitational force is a product of mass ( $m$ ) and acceleration due to gravity ( $g$ ). The SI unit of the acceleration due to gravity is metre per second squared ( $m/s^2$ ). Mass is the quantity of matter in an object. Its SI unit is kilogram ( $kg$ ). The gravitational force or weight is represented by  $W$ . The SI unit of weight is newton ( $N$ ), which is equivalent to ( $kgm/s^2$ ). Therefore,

$$\text{Weight} = \text{Mass} \times \text{Acceleration due to gravity}$$

or 
$$W = m \times g$$

### Example

Find the weight of a substance with the mass of 10 kilograms and the acceleration due to gravity of 10 metres per second squared.

#### Solution

Given:

$$m = 10 \text{ kg}$$

$$g = 10 \text{ m/s}^2$$

Required: Weight ( $W$ ).

#### Formula

$$\text{Weight} = \text{Mass} \times \text{Acceleration due to gravity}$$

$$W = m \times g$$

$$W = 10 \text{ kg} \times 10 \text{ m/s}^2$$

$$W = 100 \text{ kgm/s}^2$$

$$W = 100 \text{ N}$$

Therefore, the weight of the object is **100 N**.

#### Note:

1. If the gravitational force is greater than the upthrust force, the object sinks.
2. If the gravitational force is less than the upthrust force, the object will be pushed vertically upwards.
3. If the gravitational force is equal to the upthrust force, the object floats.

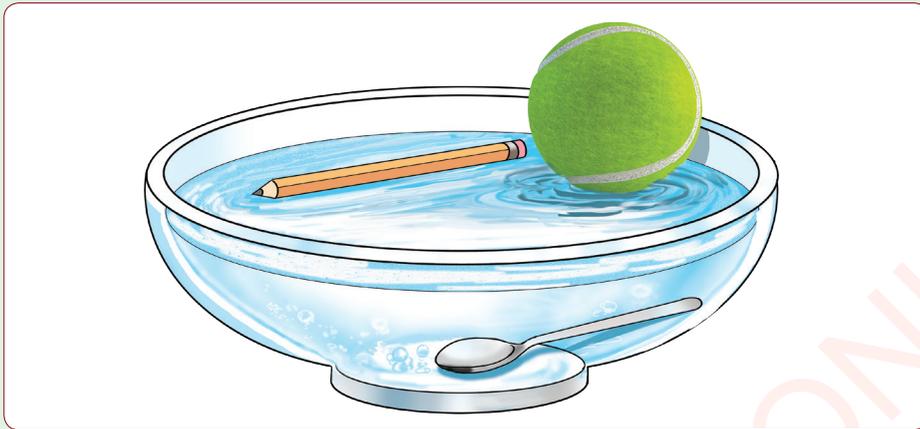
#### Activity 1: To identify objects which float on and those which sink in water

**Materials:** nail, eraser, leaf, sharpener, metal spoon, plastic spoon, stone, pencil, small pieces of paper, feather, tennis ball, and a dish or a bucket or a bowl, and water

#### Procedure

1. Take a dish, a bucket, or a bowl; then, pour enough water into it as shown in Figure 3.

- Put one object after another into the bowl with water as shown in Figure 3.



**Figure 3:** Objects which float on water and objects which sink in water

- Observe the objects you have placed on water. Which objects float on water and which objects sink in water?
- After observation, record your results in Table 1. Write “floats” for the object that floats and “sinks” for the object that sinks in water.
- For each result, explain why the object floated or sank in the water.

**Table 1:** Objects which float on or sink in water

Object	Results	Explanation
Leaf		
Nail		
Eraser		
Sharpener		
Metal spoon		
Plastic spoon		
Stone		
Pencil		
Feather		
Small pieces of paper		

### Exercise 1

Answer all questions in Sections A and B.

#### Section A

1. Fill in the column by writing “floats” or “sinks” on placing the object in water.

**Table 2:** *Objects which float on or sink in water*

S/N	Object	Results
(a)	Razor blade placed vertically	
(b)	Stainless plate	
(c)	Porcelain cup	
(d)	“Sufuria”	
(e)	Dhow	
(f)	Pencil	

#### Section B

2. Define density.
3. Explain why a ship floats on water while a needle sinks in water.
4. Write two characteristics of the objects that float on water.

### Archimedes’ principle

It is easier to pull a submerged object. For example, it is easier to pull a bucket of water tied to a rope when drawing water from a deep well. Pulling starts to become harder as soon as part of the bucket is in the air. Figure 4 shows the relationship between upthrust and the increase in water level when an object is submerged in water. This relationship was discovered by a Greek scientist, named Archimedes, who lived from 288 to 212 BC. For example, the weight of a stone in the air is 40 N, but, when immersed in water, it weighs 20 N. Also, when the stone is sunk in water, the water volume increases from 20 mL to 40 mL. The loss in weight of the stone is equal to the weight of the increased volume of water. Archimedes’ principle states, *When an object is partially or totally immersed in a fluid, it experiences an upthrust which is equal to the weight of the fluid displaced by the object.*

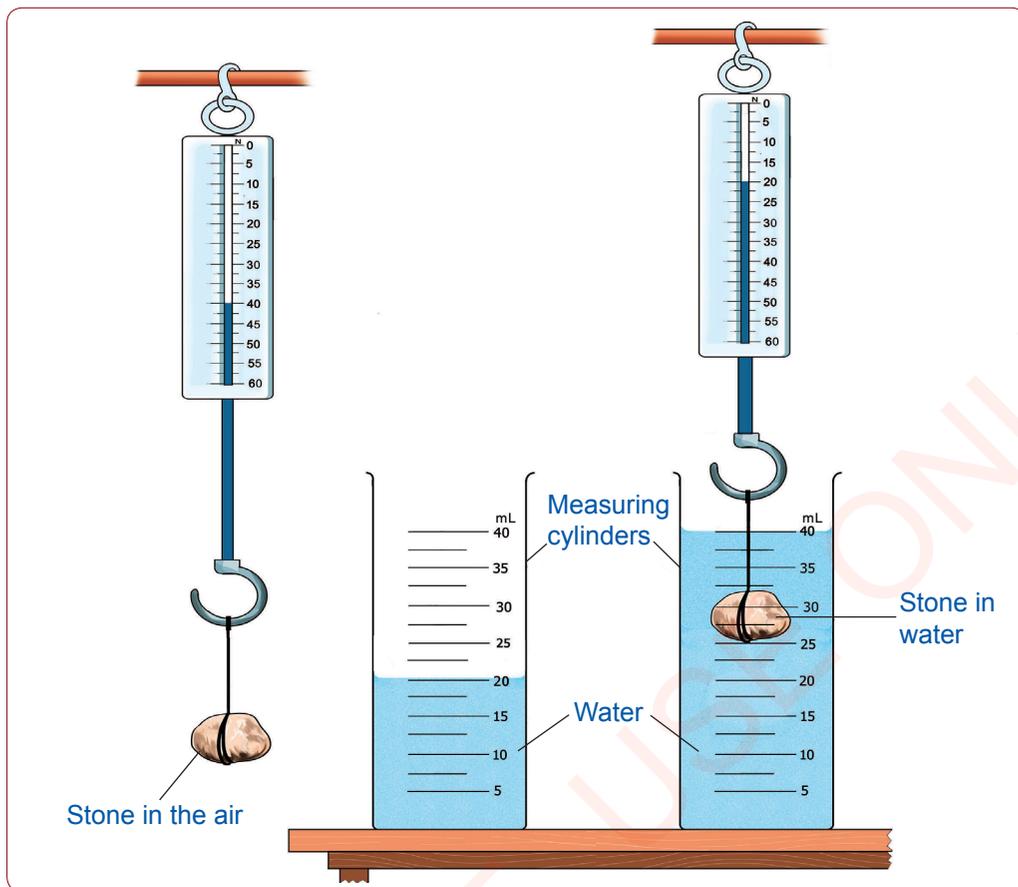


Figure 4: The weight of stone in the air and in water

### Example

A stone weighs 100 newtons in the air. If the stone is immersed in a fluid, it weighs 80 newtons. Find the upthrust force acting on the stone.

### Solution

Given:

Weight of the stone in the air = 100 N

Weight of the stone in the fluid = 80 N

### Formula

Upthrust = Weight of the stone in the air – Weight of the stone in the fluid

Upthrust = 100 N – 80 N

Upthrust = 20 N

Therefore, the upthrust is **20 N**.

### Experiment 1: Verification of Archimedes' principle

**Aim:** Verifying Archimedes' principle

**Materials:** spring balance, stone, Eureka Can full of water, thread, knife and an empty plastic bottle

#### Procedure

1. Cut the top part of an empty plastic bottle and tie the thread to the upper section of the remaining part. Then, use a spring balance to measure its weight. Write its weight in your exercise book.
2. Using the spring balance, measure the weight of the stone in the air as shown in Figure 5 (a). Write its weight in your exercise book.
3. Place a cut plastic bottle tied with thread under the spout of the Eureka Can.
4. Immerse the stone suspended from the spring balance into the Eureka Can filled with water as shown in Figure 5 (b). Write down its weight in your exercise book.
5. Take the cut plastic bottle with the displaced water as shown in Figure 5 (c). Measure and record its weight in your exercise book.

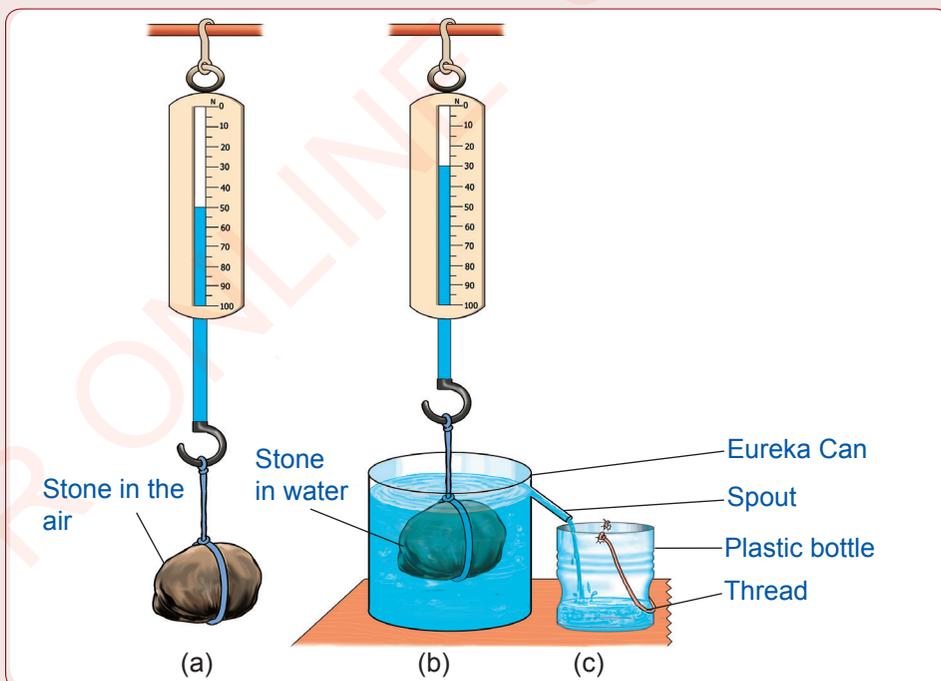


Figure 5: Verification of Archimedes' principle

### Results

The weight of the stone in the air in Figure 5 (a) is \_\_\_\_\_ newtons.

The weight of the stone immersed in water in Figure 5 (b) is \_\_\_\_\_ newtons.

The weight of the displaced water in Figure 5 (c) is \_\_\_\_\_ newtons.

The upthrust force is \_\_\_\_\_ newtons.

### Conclusion

When an object floats or sinks in water, it displaces an amount of water whose weight equals the weight lost by the object. The loss in weight of the object is equal to the upthrust force. When an object floats or sinks in the fluid, the weight of the displaced fluid is equal to the upthrust force.

## The law of floatation

The magnitude of the upthrust force depends on the volume of the submerged part of the floating object. Therefore, if an object is floating, with part of its body submerged, the depth of the submerged part does not affect upthrust. The upthrust force on the object is equal to the weight of the fluid displaced by the object. For an object to float, the upthrust force must be equal to the gravitational force. If the gravitational force is greater than the upthrust force, the object sinks.

The law of floatation states, *A floating body displaces its own weight of the fluid in which it floats.*

### Experiment 2: Verification of the law of floatation

**Aim:** To prove that a floating body displaces fluid of equal weight to that of the floating body

**Materials:** spring balance, four wooden blocks of different weights, Eureka Can, empty plastic bottle, thread, knife and water

#### Procedure:

1. Cut the top part of the bottle and tie the thread to the upper section of the remaining part. Then, measure its weight using a spring balance as shown in Figure 6 (a). Record its weight in Table 3.

2. Tie each piece of wood using thread and measure its weight as shown in Figure 6 (b). Record its weight in Table 3.
3. Fill the Eureka Can with water and place the cut plastic bottle tied with thread under the spout of the Eureka Can as shown in Figure 6 (c).
4. Immerse the first piece of wooden block into the Eureka Can.
5. Measure the weight of the cut plastic bottle with displaced water and record its weight in Table 3.
6. Pour out the displaced water from the cut plastic bottle and refill the Eureka Can with water.
7. Repeat steps 4 up to 6 for each piece of wooden block.
8. Use the weight of the empty cut bottle to find the weight of the displaced water for each piece of wooden block. Record their weights in Table 3.

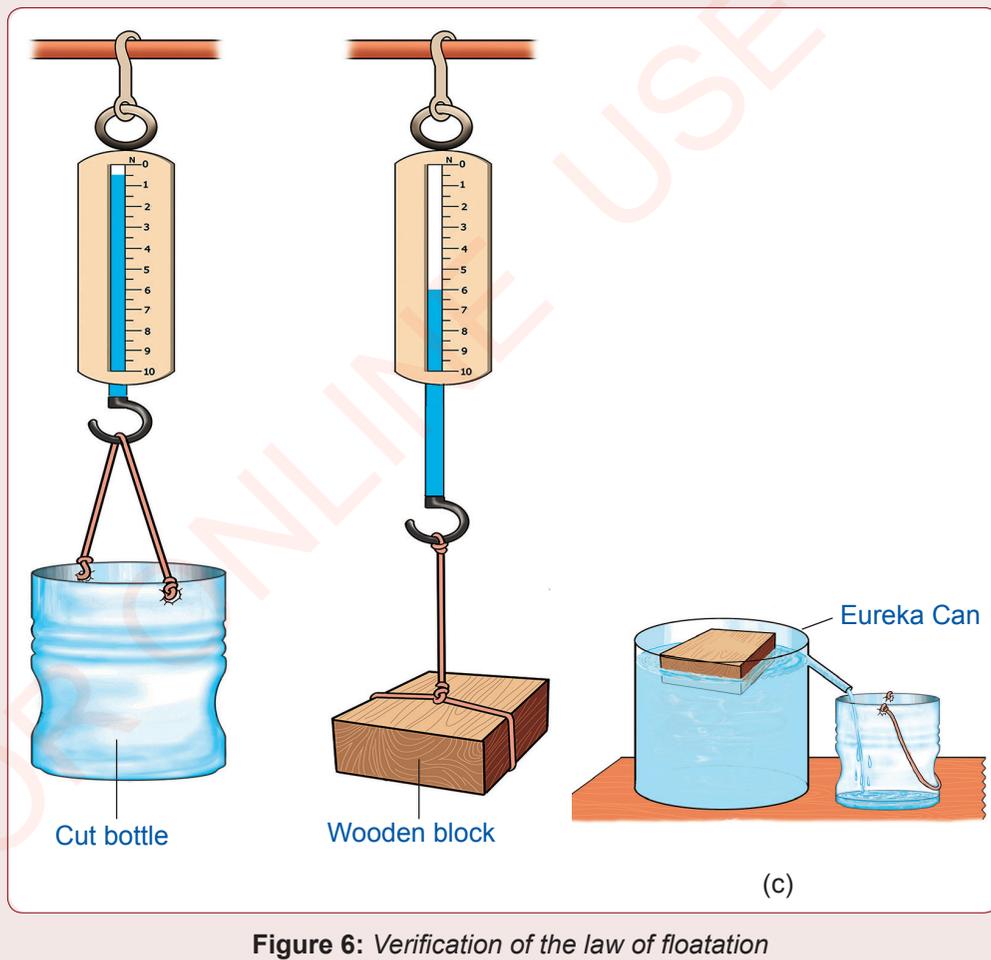


Figure 6: Verification of the law of floatation

**Table 3:** Verification of the law of floatation

Piece of wooden block	Weight of cut plastic bottle	Weight of wooden block	Weight of cut plastic bottle with displaced water	Weight of displaced water
1.				
2.				
3.				
4.				

### Results

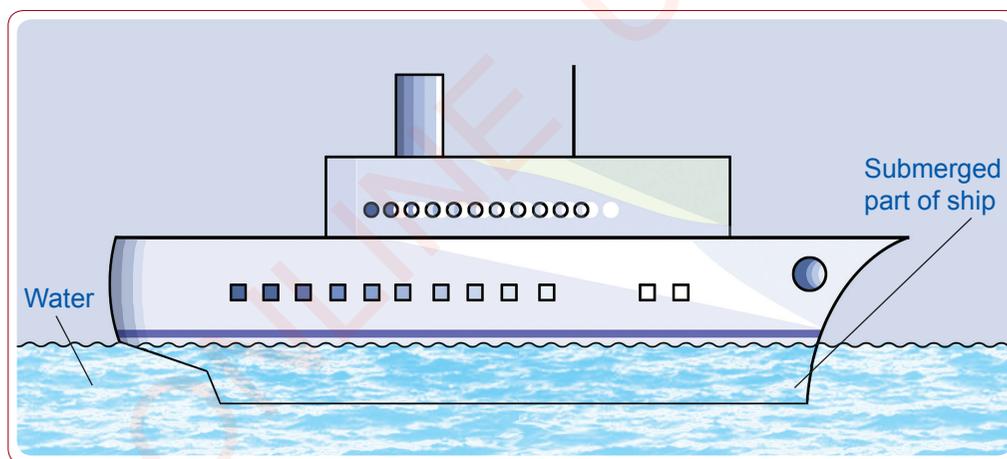
What is the relationship between the weight of the wooden block and the weight of displaced water?

### Conclusion

Write the conclusion of this experiment.

### Application of the law of floatation in water transport

- (a) The law of floatation is used in constructing water transport vessels. For example, a ship is heavy, but it does not sink in water. The reason is that the weight of the water displaced by the ship is equal to the weight of the ship, which is partially submerged as shown in Figure 7.



**Figure 7:** Ship floating on water

Other examples of water transport vessels are submarines. Submarines are different from ships because they can sink in or float on water. They can do so because they have tanks which can be filled with water or air. If a submarine is required to sink, the tanks are filled with water. This causes the submarine to have a greater density than that of water. Therefore, it sinks. When the submarine

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has totally submerged, the water in the tanks can be replaced with air. Thus, its density becomes less than that of water. Therefore, the submarine floats.

- (b) Ships that conduct research on waves in deep water can move horizontally or vertically. This is made possible by filling water in the ship's tanks when the ship is required to sink and removing water when the ship is required to float.

**Activity 2: Constructing a model of a canoe, boat or ship**

**Materials:** plastic bottles, a plastic gallon, wood or metal, straws, a rope, manila paper or box, sticks or small nails, hammer, glue and pictures of canoe, boat, and ship

**Procedure**

1. Choose a type of the model that you will construct.
2. Draw a picture of the model that you will construct.
3. Identify materials you will use to construct your model.
4. Cut pieces of materials according to the model diagram and its dimensions and connect them using glue, rope or small nails.
5. Submit your model and place it in the Science and Technology learning corner.

**Exercise 2**

**Answer all questions in Sections A and B.**

**Section A**

Choose the most correct answer and write its letter in the box provided.

1. What causes an object to float or sink?  
(a) Length of the object   
(b) Width of the object  
(c) Density of the object  
(d) Height of the object
2. If the density of an object is less than that of water, what will happen if you drop the object into water?  
(a) It will sink.  
(b) It will float.   
(c) It will sink and float.  
(d) It will sink or float.

3. The density of an object is mass per unit \_\_\_\_\_.  
(a) weight  
(b) height  
(c) depth  
(d) volume
4. The submarine sinks in the sea if its density is \_\_\_\_\_.  
(a) less than that of water  
(b) greater than that of water  
(c) equal to that of water  
(d) greater or less than that of water

### Section B

5. Why do objects float on or sink in water?
6. What is the relationship between the weight of an object floating on a fluid and upthrust?
7. State Archimedes' principle.
8. Explain how the law of floatation is used in constructing a ship.
9. What is the relationship between the weight of a floating piece of wooden block and the weight of the water displaced when the piece of wooden block is immersed in water?
10. Find the density of an object having a mass of 180 kg and a volume of 90 cubic metres.
11. The density of a substance is 80 kilograms per cubic metres. If its mass is 240 kilograms, calculate its volume.

### Vocabulary

Fluid	a substance which can flow easily
Gravitational force	is the force of attraction that exist between any two masses
Immiscible liquids	liquids which do not mix e.g. water and kerosene
SI unit	is a scientific method of expressing magnitude or quantity of phenomena
Submarine	a watercraft that is capable of propelling itself beneath the water as well as on the water surface
Sufuria	a flat based, deep sided, lipped cooking pot or container
Upthrust	is the upward force exerted by a fluid which enables the object to float

## Chapter Four

### Antenna

#### Introduction

*In Standard Four, you learnt how to use and take care of a radio and television. Likewise, in Standard Six, you learnt about the concept of the Internet, which is among the communication networks. In this chapter, you will learn about the concept of the antenna as a device used in communication. You will also learn about the types of antennas, quality and uses of antennas. Similarly, you will learn about the materials used in the fabrication of antennas. The competencies developed will enable you to design, fabricate, and choose the right antenna.*

#### The concept of antenna



#### Discuss with your fellow:

1. The meaning of antenna
2. The importance of antennas in communication

Radio and television receive communication signals from a device which captures those signals from broadcasting stations. Also, ships and aeroplanes receive communication signals throughout the journey. This communication takes place through electromagnetic waves. Communication signals are wirelessly transmitted. The reception and transmission of these signals is done by a device called an antenna.

#### The meaning of the antenna

The antenna is a device that receives and transmits electromagnetic waves to communication devices such as radios, cell phones, and televisions. For example, when a radio reporter broadcasts, the sound waves are converted into electrical signals. The electrical signals are then carried to

the transmitting antenna installed at the broadcast station. The antenna converts electrical signals to electromagnetic waves and transmits them through the air. These waves are received by the antenna installed on the user's radio. The radio antenna then converts electromagnetic waves into electrical signals in an electric circuit connected to this antenna. The waves are received and converted into sound waves that the radio listener listens to.

Antennas are also mounted on telecommunication system towers as shown in Figure 1 (a). These antennas receive and transmit electromagnetic waves to mobile phones. In addition, air and water transportation vessels are installed with antennas for communication. The captain or pilot uses a voice recorder to deliver a message that is converted into electrical signals. The electrical signals are then conveyed to the transmitting antenna installed on the aeroplane or ship for transmission. The antenna converts the electric signals into electromagnetic waves and transmits them to the other antenna installed on radar. Radar is a system used to detect and track the movement of objects such as aircraft and ships. See Figure 1 (b).



**Figure 1 (a):** Telecommunication system tower

*Source: Tanzania Telecommunications Corporation, TTCL*



**Figure 1 (b):** Radar system

*Source: www.habarileo.co.tz*

Some antennas are capable of both receiving and transmitting waves. Other antennas are capable of either receiving or transmitting waves. Examples of antennas that are capable of receiving and transmitting waves are those used on mobile phone and telecommunication towers. Receiving antennas are similar to those used on radios and televisions. Also, transmitting antennas are similar to those used at radio and television broadcasting stations.

### The importance of antennas

Communication devices that are not connected using cables need antennas to communicate. Therefore, antennas enable wireless communication, such as mobile phone communication. Antennas are used in various devices such as in wireless transmitting and receiving communication, mobile phone, satellite, radar, and wireless internet communication devices.

#### Exercise 1

**Answer the following questions:**

1. Explain the meaning of an antenna.
2. Explain the importance of antennas in communication.
3. Name three devices which use antennas.
4. How will the knowledge of antennas help you in your life?
5. Which devices use antennas that are capable of both transmitting and receiving electromagnetic waves?

### Types of Antennas

Different types of antennas are grouped based on their structures. Those groups are as follows:

- (a) Wire antennas,
- (b) Aperture antennas,
- (c) Array antennas,
- (d) Reflector antennas, and
- (e) Microstrip antennas.

## Wire antennas

Antennas in this group are mainly fabricated of wires. Wire antennas come in different shapes and sizes, such as circular, square or rectangular. These antennas are in different shapes because wires can be folded and shaped depending on the needs or appearance. Examples of wire antennas are dipole antennas, loop antennas and monopole antennas. In this section, you will only learn about loop antennas.

**Loop antennas:** These antennas are available in different shapes such as circular, oval, rectangular or square as shown in Figures 2 (a) and 2 (b).



Figure 2 (a): Square loop antenna



Figure 2 (b): Circular loop antenna

Loop antennas are mainly used for receiving radio waves. The efficiency of these antennas depends on the loop's circumference. Therefore, loop antennas with large circumference have higher efficiency than small ones. Loop antennas can capture waves from any direction because they do not need to be placed at a fixed position. Thus, loop antennas are not much affected by environmental noise.

## Advantages of using loop antennas

Loop antennas have the following advantages:

- (i) They do not receive unwanted signals; therefore, they are free from electromagnetic signal interference;
- (ii) They have a simple and stable structure;
- (iii) No need to search the direction of the radio wave;
- (iv) They are suitable for portable devices;
- (v) They are available in different sizes and shapes; and
- (vi) They can be fabricated at low cost.

### Disadvantages of using loop antennas

Loop antennas have the following disadvantages:

- (i) Small loop antennas are mostly used in short range transmission, and they are less efficient than the larger loop ones and
  - (ii) Antennas with a small loop cause electrical energy loss as heat.
- Therefore, large loop antennas are more preferred over the small ones.

### Aperture antennas

This group includes antennas such as waveguide antennas, slot antennas, and horn antennas. The waveguide antenna is a pipe-shaped antenna with a wide opening on one side and a narrow opening at the other end. The slot antenna looks like a metallic piece with a hole at the centre. In this part, you will only learn about horn antennas.

**Horn antennas:** These antennas have a wide opening at the beginning and a narrow opening at the end to capture and guide waves. They are used to collect and transmit radio waves from a waveguide. Horn antennas can have square, rectangular or circular surfaces as shown in Figures 3 (a) and 3 (b).

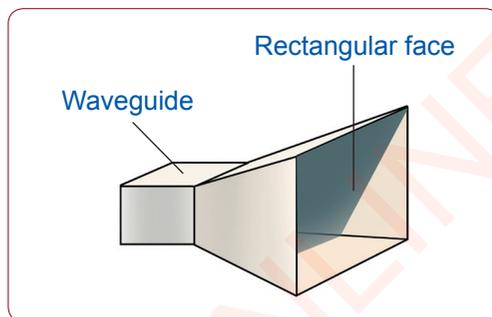


Figure 3 (a): Pyramidal horn

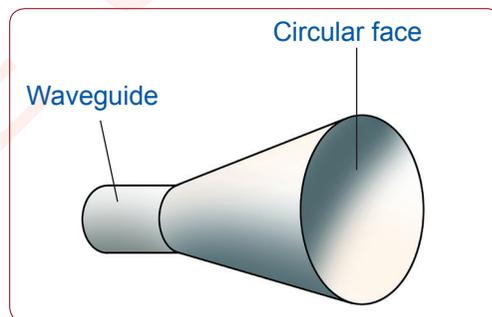


Figure 3 (b): Conical horn

### Advantages of using horn antennas

Horn antennas have the following advantages:

- (i) They are simple to fabricate;
- (ii) They direct the waves efficiently and effectively; and
- (iii) They produce straight waves, thus travelling long distances.

### Disadvantage of using horn antennas

They cannot receive many signal waves especially weak signals.

## Array antennas

Array antennas are a combination of multiple antennas that work together as a single antenna. The Yagi-Uda antenna is a well-known and popular antenna in this group.

**The Yagi-Uda antenna:** This name comes from Japanese inventors Hidetsugu Yagi and Shintaro Uda. The Yagi-Uda antenna is often called the Yagi antenna. It is made of the following materials: director elements, a feeder, dry pole, a boom, a reflector and a cable for transmitting waves to communication devices such as televisions as shown in Figure 4. The Yagi-Uda antenna is mainly used for receiving television and radio waves since they require many waves. Yagi-Uda antenna also receives signals which are in analog format.

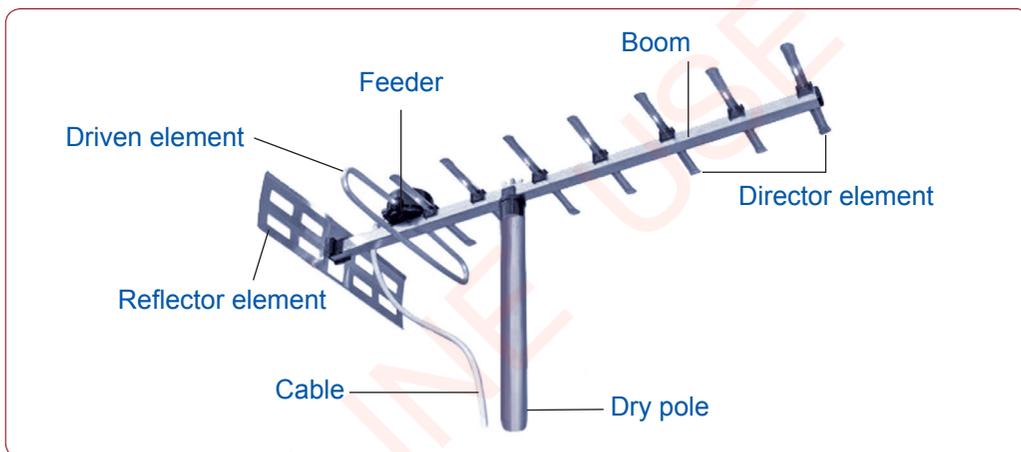


Figure 4: The Yagi-Uda antenna

### Advantages of using the Yagi-Uda antenna

The Yagi-Uda antenna has the following advantages:

- (i) It has high efficiency even when signals are weak;
- (ii) It receives reasonably good un-directional signals;
- (iii) It is easy to maintain and repair;
- (iv) It consumes a small amount of electrical energy;
- (v) It covers a wide range of frequencies; and
- (vi) It is cheap to handle and maintain.

### Disadvantages of using the Yagi-Uda antenna

The disadvantages of using the Yagi-Uda antenna are as follows:

- (i) It is easily affected by interferences from the flow of electric current;
- (ii) It is easily affected by weather; and
- (iii) It needs a large number of connected elements to be efficient.

### Reflector antennas

Reflector antennas have a curved surface for reflecting waves. Based on their structures, these antennas are likened to the human ear. Reflector antennas are used to transmit and receive electromagnetic waves more efficiently. They are often used to receive and transmit waves for television and satellites. Examples of these antennas are the parabolic reflector antenna, known as the dish; corner antenna and plasma antenna. In this section, you will learn about the parabolic reflector antenna or the dish.

**Parabolic reflector antenna or dish:** This antenna has a curved surface to direct and capture waves. Also, this antenna is known as a dish or a bowl antenna because it looks like a dish as shown in Figure 5. Large antennas of this type are built together with horn feed and disk attachment to increase their efficiency.

The quality of the parabolic reflector antenna depends on the size of the dish. Large dish antennas are more efficient than small ones. These antennas are most popular and widely used to receive and transmit radio waves in the air. For example, a dish receives signals from satellites, rockets, and aeroplanes. Similarly, dishes are used to receive weather forecasting information signals at the meteorological station.



Figure 5: Parabolic reflector antenna

### Advantages of using parabolic reflector antennas

Parabolic reflector antennas have the following advantages:

- (i) They can be efficiently used to transmit and receive signals over long distances;
- (ii) They can be made in different ways depending on use; and
- (iii) The production cost is relatively low considering its good efficiency.

### Disadvantages of using parabolic reflector antennas

The following are the disadvantages of using parabolic reflector antennas:

- (i) They need a horn feed to operate properly;
- (ii) The horn feed reduces a certain amount of signals from the main antenna;
- (iii) The process of fabricating a parabolic reflector antenna is complex;
- (iv) Some signals from a horn feed may interfere with the signals from the main dish; and
- (v) It is difficult to align the horn feed and the main antenna during its installation.

### Microstrip antennas

A microstrip antenna is a type of antenna that is light and flat. This antenna is fabricated of two flat metals, which are small and large flat metals. A small flat metal called a patch is placed on top. A large flat metal called ground plane is placed down as a base. The ground plane and the patch are separated by a substrate as shown in Figure 6.

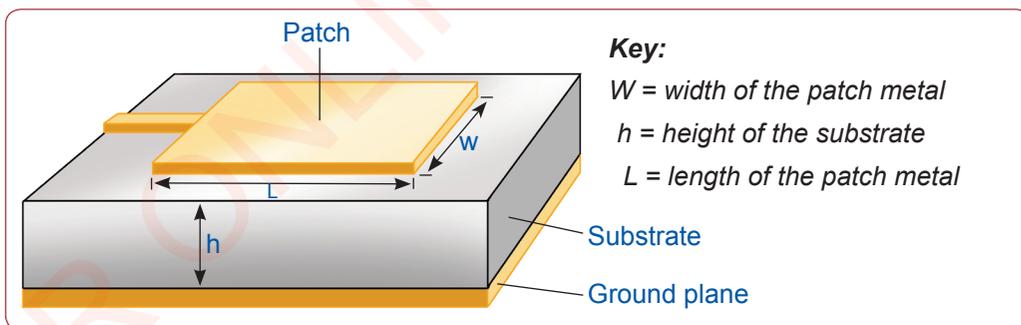
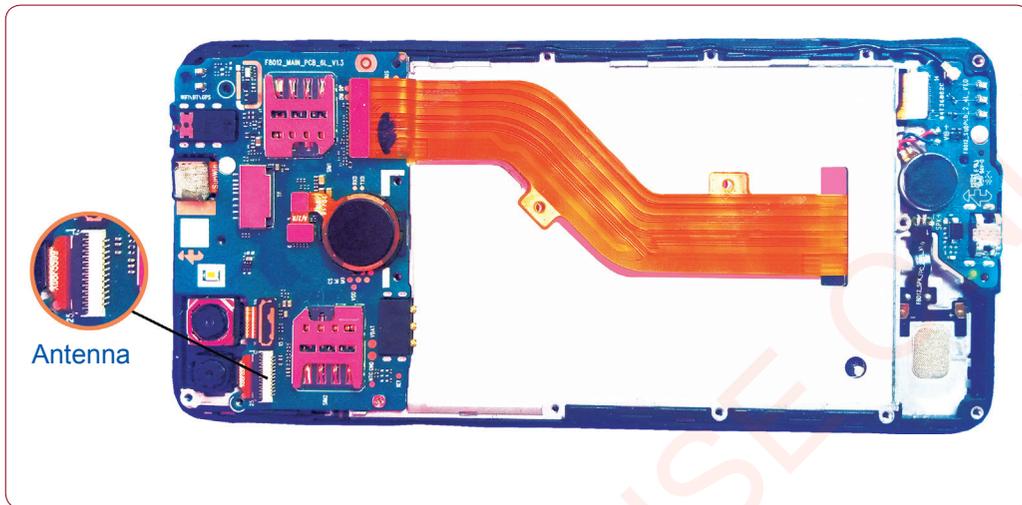


Figure 6: The structure of the microstrip antenna

The ability to receive and process electromagnetic waves depends on the distance between the patch and ground plane metals. The greater the distance, the better the performance and vice versa. However, a

moderate distance is required to eliminate the possibility of having a big device that uses this antenna. Microstrip antennas are used in wireless devices such as mobile phones, satellites, the Global Positioning System (GPS) and aeroplanes. Such devices require small and light antennas as shown in Figure 7.



**Figure 7:** A microstrip antenna on the mobile phone

### **Advantages of using microstrip antennas**

Microstrip antennas have the following advantages:

- (i) They are light and portable;
- (ii) They do not require mesh support to increase their efficiency; and
- (iii) They can work in parallel waves operation.

### **Disadvantages of using microstrip antennas**

Microstrip antennas have the following disadvantages:

- (i) They require complex systems to operate efficiently; and
- (ii) They require high care when mounting on the device.

#### **Activity 1:** *Observing the antennas which are found in your surroundings*

Study the antennas that can be found around the school or home areas. Then, identify the uses of each device.

## Exercise 2

**Answer the following questions:**

1. Name four types of antennas based on their structure.
2. Distinguish between the loop antenna and the parabolic reflector antenna.
3. Explain with examples the use of microstrip antennas, parabolic reflector antennas and Yagi-Uda antennas.
4. Name three challenges of using parabolic reflector antennas.

### Quality of antenna

Various characteristics determine the quality of antennas. These include the shape of the antenna, transmitting frequencies and efficiency, depending on the use.

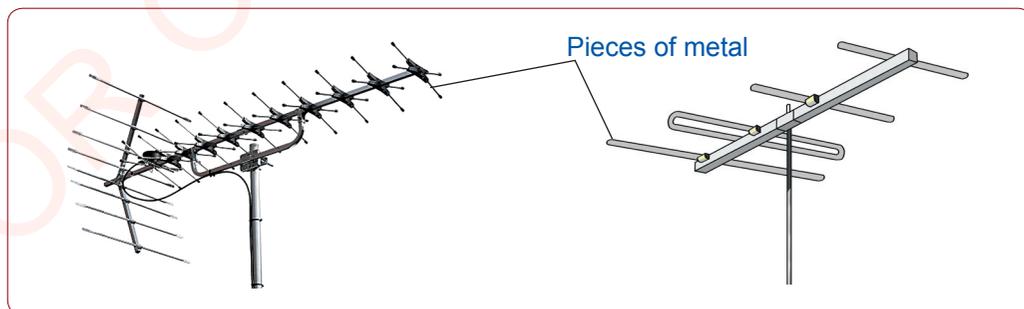
#### (a) The shape of the antenna

The antenna's shape significantly contributes to its quality.

**Parabolic reflector antennas:** The best parabolic reflector antenna is the one that has a smooth surface, an edge made of iron ore and a similar surface edge throughout the dish. If the dish is made of woven cables or aluminium, it should have a small hole to reduce the loss of waves.

**Wire antennas:** The quality of these antennas, especially loop antennas, depends on the size of its loop. An antenna with a larger circumference is better than the one with a smaller circumference.

**Array antennas:** The quality of the array antenna especially the Yagi-Uda antenna, depends on the length of its boom. That length provides an opportunity to have many pieces of metal forming it. These pieces give these antennas the ability to capture even weak signals. See Figure 8.



**Figure 8:** A pair of Yagi-Uda antennas showing the difference in the length of boom

### **(b) The transmitting frequencies**

The quality of the antenna can also be measured based on the frequency of the waves. The unit for measuring frequency is Hertz (Hz). For example, both horn and Yagi-Uda antennas can receive and transmit high frequency waves with more than one gigahertz (GHz) equal to  $10^9$  Hz or one billion Hz. However, horn antennas are more efficient because they transmit straight waves in longer distances while Yagi-Uda waves spread. The Yagi-Uda antenna is more efficient than the loop antenna because it can capture even the weakest signals. Thus, it is preferred to transmit and receive “FM” radio waves and long-distance television broadcasts between 88.1 to 108.1 MHz.

### **(c) Antenna efficiency**

The choice of the antenna depends on its efficiency and the task it performs, such as transmitting and receiving waves. Considering this criterion, the horn antenna is better than other antennas because it can transmit and receive waves from a distance. However, this antenna cannot receive many waves, especially weak ones. The ability to receive waves is enhanced by connecting the horn antenna with the parabolic reflector antenna. These antennas are mostly used in satellite communications, weather forecasting, and space observations.

## **Fabrication of antennas**

Antenna fabrication involves the following steps:

### **(a) Identify the use of the antenna**

Antennas are made depending on their use. They can be designed to receive waves, transmit waves, or both. For example, the antenna for receiving radio waves is different from the radar antenna.

### **(b) Select the type of the antenna**

After identifying its use, you can select the most suitable type of the antenna. The choice also depends on the efficiency and position to put the antenna.

### **(c) Antenna design**

This is a stage in which an antennas sketch is designed. The antenna sketch guides you through fabricating the antenna. When designing an antenna, such as the Yagi-Uda antenna, you should know that it has two

main parts. Those parts are the element and the boom. The elements are of three types: reflector, driven element, and directors. The reflector is behind the antenna, followed by the driven element and then the directors. The director element is installed in front of the driven element to get the direction of the broadcasting station. The driven element is the part where the dipoles are often folded. The feeder receives waves and transmits them to the television or radio via wire. These elements help each other to capture electromagnetic waves. The antenna's boom is directed to the source of the waves as shown in Figure 4.

#### (d) Selecting materials

Antenna fabricating materials should be capable of conducting electricity and resisting rust. They should also be durable. Thus, antennas are made using metals such as copper, aluminium, and stainless steel.

Copper is preferred when fabricating antennas because it allows the flow of electricity more easily. However, most antennas are not made of copper because of its high cost and weight. Aluminium is mostly suitable for fabricating antennas because it is light and rust resistant. Thin stainless steel wires are also suitable for fabricating antennas due to their high strength. Stainless steel wires are mostly used to create mobile whip antennas where strength and flexibility are needed due to the motion of the vehicle. These wires are not used in fabricating normal antennas used in homes due to their poor ability of conducting electricity.

#### (e) Making an antenna

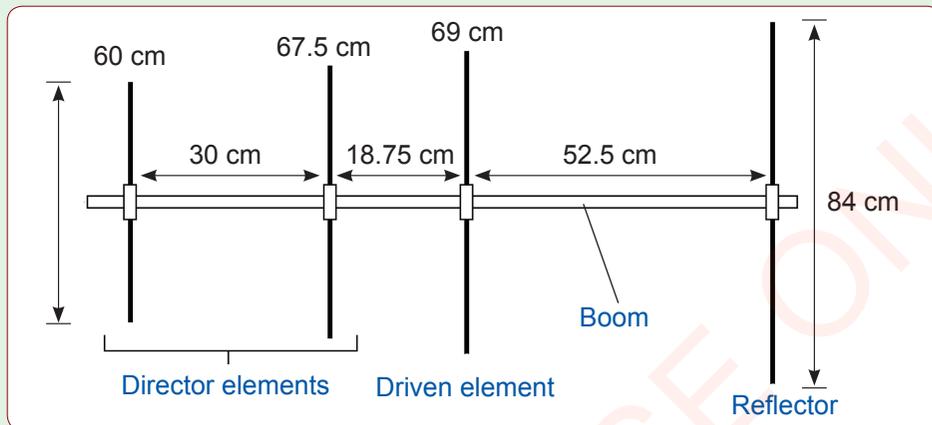
After you have a sketch and all the required materials for your antenna, you can make your antenna. Follow the next activity to create the Yagi-Uda antenna by studying Figure 9.

#### Activity 2: Making an antenna using materials available in the surrounding

**Materials:** wire, a piece of board or bamboo, straight dry poles, screws, glue, pegs and the pieces of aluminium or devices with the characteristics mentioned in the material selection section, as well as the device to receive communications such as a radio or television

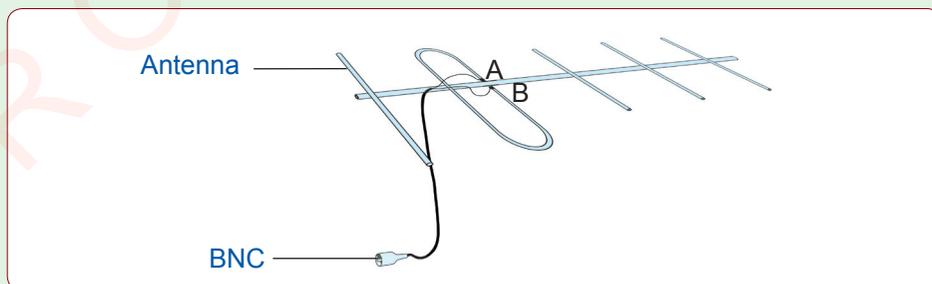
**Steps:**

1. Cut four pieces of aluminium based on the dimensions shown in Figure 9.
2. Tie the pieces of aluminium to the boom by leaving spaces between the pieces based on the dimensions shown in the antenna diagram.



**Figure 9:** Measurement for making the Yagi-Uda antenna

3. From the materials you have, take two insulated wires. If you have a large cable with three wires inside, remove the outer plastic. Do not peel the plastic of the inner wire. Use two wires with a plastic cover. Insert the wires in the space between the reflector and the driven element and glue them together. Make sure the wires reach the driven element for connecting.
4. Connect the wires to the driven element at Points A and B as shown in Figure 10. Connect the other end of the wire to the “Bayonet Neill Concelman” (BNC) connector which is connected to a communication device such as a television.



**Figure 10:** The Yagi-Uda antenna

5. After completing Step 4, drill a 10 mm hole in the antenna's boom. Connect the boom to the straight dry pole using a 10 mm bolt as shown in Figure 11. At this point, your Yagi-Uda antenna will be ready for use.

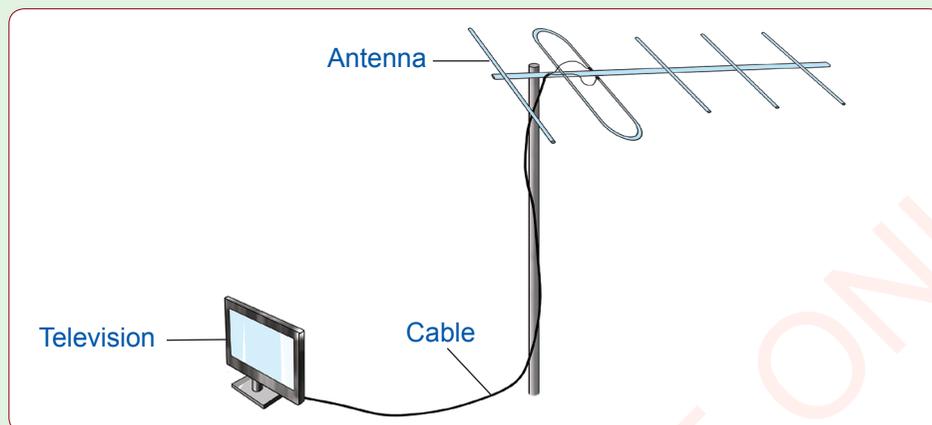


Figure 11: The appearance of an antenna connected to a television

### Exercise 3

Answer the following questions:

1. Name three characteristics of the materials used to make the antenna.
2. Why is aluminium used more than copper in fabricating antennas?
3. Why are the director elements fixed at the front part of the Yagi-Uda antenna?

### Uses of antennas

Antennas are used in various communication systems. Some of the uses of antennas are

- (a) capturing and transmitting electromagnetic waves, such as television broadcasting, radio communications, radar, and space communications;
- (b) providing underwater communication or through the ground at short range frequencies;
- (c) transmitting and receiving communication waves on ships, aeroplanes, satellites, cell phones, rockets, radios, televisions, radar and radio calls;
- (d) capturing weather forecast indicators; and
- (e) enabling a global location reporting system.

**Exercise 4**

**Answer all questions in Sections A and B.**

**Section A**

Choose the most correct answer and write its letter in the box provided.

- Which of the following is the best antenna for capturing weather forecasting signals?  
(a) Microstrip antenna  
(b) Yagi-Uda antenna  
(c) Parabolic reflector antenna  
(d) Loop antenna
- Which of the following antennas can effectively protect itself from noise?  
(a) Microstrip antenna  
(b) Yagi-Uda antenna  
(c) Parabolic reflector antenna  
(d) Loop antenna
- Which of the following is correct about wireless communication devices?  
(a) May communicate without antennas  
(b) Cannot communicate without antennas  
(c) Can communicate with un-directional antennas  
(d) Cannot communicate without a loop antenna
- The microstrip antenna is commonly used on one of the following pairs of devices:  
(a) satellites and dishes  
(b) radio receivers and ships  
(c) cell phones and aeroplanes  
(d) televisions and mobile phones
- Which of the following are the two main components of the Yagi-Uda antenna?  
(a) Antenna's elements and director elements  
(b) Antenna's boom and director elements  
(c) Antenna's elements and antenna's boom  
(d) The reflector element and the director element
- Which of the following materials is effective for antennas due to its ability to conduct electricity?  
(a) Copper  
(b) Stainless steel  
(c) Aluminium  
(d) Wood

### Section B

7. Name four communication devices that use antennas.
8. Where can antennas be used apart from radio broadcasting stations and marine or air transport vessels?
9. Which type of antennas is used on mobile phones?
10. List the types of antennas that can be used on a television.
11. Explain three advantages of using the parabolic reflector antenna.

### Vocabulary

Circuit	a connection of components that can conduct electric current
Communications device	any type of device capable of transmitting data, instructions, and information between a sending device and a receiving device
Communication system	a model describing a communication exchange between two stations, transmitter and receiver
Electromagnetic wave	waves that are created as a result of vibrations between an electric field and a magnetic field
Element	is a metallic conductor connected to the boom
Meteorological station	a station where regular observations of atmospheric conditions are made
Radar	a device for detecting the presence, direction, distance, and speed of aircraft, ship, and other objects, by sending out pulses of radio waves which are reflected off the object back to the source
Radio wave	an electromagnetic wave having a wavelength between 1 millimeter and 30,000 meters, or a frequency between 10 kilohertz and 300,000 megahertz
Signal	an electrical or electromagnetic current that is used for carrying data from one device to another
Sound wave	mechanical wave that results from the back and forth vibration of the particles of the medium through which the sound wave is moving
Waves	disturbance that travels through a medium, transporting energy from one location to another location without transporting matter

## Complex machines

### Introduction

*In Standard Six, you learnt about the meaning, types, and applications of pulleys. You also learnt about the meaning and importance of complex machines. In addition, you learnt about work in science and its applications. In this chapter, you will learn about the structure of complex machines such as mortise locks, sewing machines, bicycles, grain milling machines, and juice-making machines. You will also learn about the uses and maintenance of complex machines. The competencies developed will help you to use complex machines to simplify work. In addition, you will be able to maintain them properly so that they last longer.*

### Structure of complex machines



#### Think

Importance of complex machines in daily uses

Complex machines are made up of two or more simple machines. These machines simplify work by reducing the amount of force applied and by changing the direction of the force applied. Therefore, two or more simple machines which form a complex machine are designed to work together. Examples of complex machines are mortise locks, sewing machines, bicycles, grain milling machines, and juice making machines.

### Mortise lock

The mortise lock is an example of a complex machine, with a key to lock and unlock the door. The mortise lock is a complex machine because it is made up of two or more simple machines. There are different types of mortise locks depending on the need. All mortise locks function similarly.

### The structure of the mortise lock

The mortise lock is made up of two main parts: the outer part and the inner part. The outer part is made up of a lock handle and a box that covers the lock. The inner part, shown in Figure 1, is made up of simple machines.

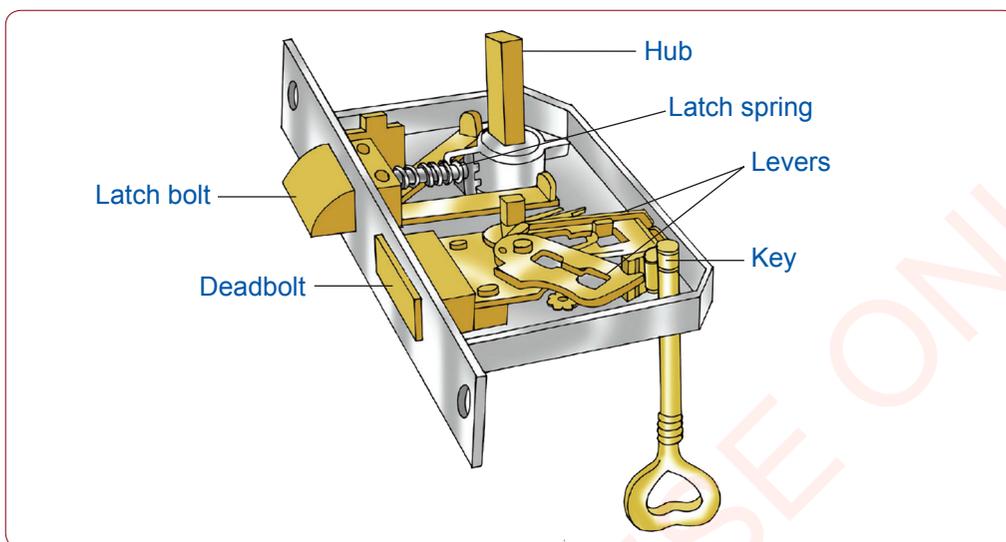


Figure 1: Structure of a mortise lock

Those machines are levers, the latch spring, latch bolt and deadbolt. These machines work together during locking and unlocking the door using the key.

### How the mortise lock works

The mortise lock has two parts to lock and unlock the door. The first part is the one with the handle to hold when closing and opening the door. This part is made up of the latch spring and latch bolt. As you turn the handle down, the latch spring pulls the latch bolt into the lock and lets the door open. The second part is the one that locks and unlocks the door using the key. This part works using a lever system and deadbolt. Each mortise lock is unlocked using a specific key. The key has teeth that correspond to a specific lock. The levers prevent the deadbolt from moving. When you insert the key and rotate it, the lever moves and releases space. The space allows the deadbolt to enter or exit the socket on the door casing.

The number of levers in a mortise lock is commonly two, three, or five. However, there are mortise locks having one lever. The security of the

mortise lock depends on the number of levers consisting the lock. For example, a mortise lock made of five levers provides more security than the one made of two or three levers. It is easier to duplicate keys for a mortise lock made of one lever or two levers than for a lock made of three or five levers.

### Activity 1: To examine the structure of the mortise lock and how it works

**Materials:** mortise lock, key, and screwdriver

#### Procedure

1. Unscrew the screws that hold the mortise lock using a screwdriver.
2. Remove the screws slowly and place them in a special place.
3. Make sure the simple machines inside the mortise lock do not disperse.
4. Observe the parts of the mortise lock that you see. How many simple machines do you see?
5. Draw a picture to show the parts of the mortise lock you saw.
6. Insert the key, lock and unlock the mortise lock. Describe what you saw when locking and unlocking the mortise lock.
7. Assemble the mortise lock as it was before opening it.

### Handling the mortise lock

The lock needs special care to last longer. Its handling depends on the type of the mortise lock. Most of the mortise locks are made of iron or copper. The outer parts of the mortise lock are cared by wiping them using a clean and dry piece of cloth. Additionally, special oils are used to lubricate the moving parts of the mortise lock. You must be careful not to bang the door frequently. Banging the door can cause the lock to break after a short period of use.

#### Exercise 1

**Answer the following questions:**

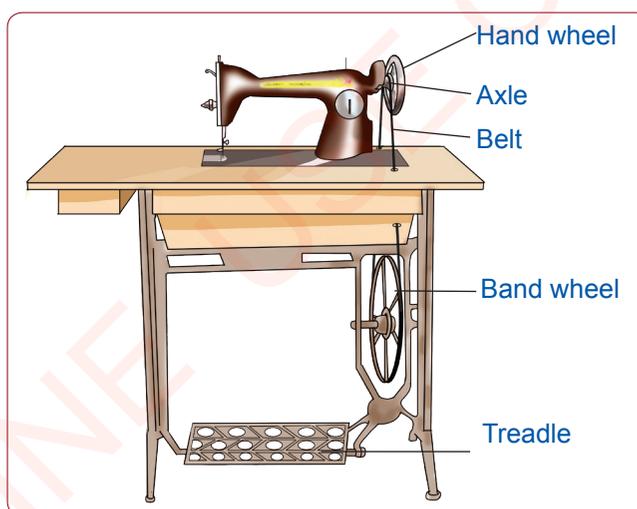
1. List simple machines found in a mortise lock.
2. Explain the functions of the simple machines in the mortise lock.
3. Why is the mortise lock grouped as a complex machine?

## Sewing machine

A sewing machine is used to sew various items such as clothes, shoes, handbags, canvas, and belts. The sewing machine is a complex machine because it is made up of two or more simple machines. There are different types of sewing machines depending on their uses and the sources of energy used by the machine. Some sewing machines are run by feet and others by hand. Other sewing machines use electric energy. Despite their differences, these machines have almost similar structures. In this subsection, you will learn about the treadle sewing machine, which is run by feet.

### The structure of a treadle sewing machine

A treadle sewing machine is made up of three main parts, namely the treadle, pulley, and wheel and axle as shown in Figure 2. The treadle is the lower part of the sewing machine that receives mechanical force by being pressed by feet. This part is the lever. The pulley is the part where there is a large wheel, called band wheel, connected by a belt to a small wheel called hand wheel. The third part is made up of the axle that is attached to the hand wheel.



**Figure 2:** *The structure of a treadle sewing machine*

### How the treadle sewing machine works

When the feet work the treadle, a mechanical force that rotates the pulley system is produced. The pulley system consists of two wheels, which are a band wheel and a hand wheel. Both wheels are rotated using a belt. When the hand wheel rotates, it rotates the axle, causing the needle to drop and rise repeatedly. The sewing machine uses two separate threads: one fed from above by the needle and the other fed from below by the bobbin mounted on a shuttle. The needle pushes the thread down through the material, catches the bobbin thread, and pulls it back up through the material.

During sewing, the cloth is moved forward so that the thread on the needle connects the two pieces of the cloth.

### **Activity 2:** *Study the structure of the sewing machine and how it works*

**Materials:** sewing machine, thread, needle and a piece of cloth

#### **Procedure**

1. Look at the parts of the sewing machine. Then, list the types of simple machines that make up the sewing machine.
2. Make sure all the parts are connected properly.
3. Remove the thread from the needle; push the pedal with your feet; and observe what is happening in the treadle, the band wheel, the hand wheel, and the needle. Write what you observed.
4. Return the thread to the needle and place the cloth under the needle. Then, work the treadle by your feet. Observe whether the piece of cloth is sewn.

### **Handling a treadle sewing machine**

For a sewing machine to work properly and last longer, it is important to keep it free from dust and rust. Thus, it should be covered with a clean cloth when not in use. The threads in use must be carefully stored to prevent them from letting dust into the sewing machine. The sewing machine has moving parts that need to be lubricated by a special oil. The oil lubricates the machine for it to run smoothly. The oil also prevents the sewing machine from getting rusty. It is not advised to use oils other than the special oil for sewing machines.

#### **Exercise 2**

**Answer the following questions:**

1. List the types of simple machines that make up a sewing machine.
2. Explain what will happen if the sewing machine belt breaks.
3. Why is the sewing machine grouped as a complex machine?
4. Explain what will happen if the sewing machine is not lubricated.

## Bicycle

A bicycle is a means of transport or exercise. Bicycles can also be used to carry luggage. The bicycle is a complex machine because it is made up of two or more simple machines. These machines work together to enable the bicycle move. There are different types of bicycles. Some bicycles are operated by feet, and others are operated by fuel or electric motor. In this section, you will learn about a bicycle that is operated by feet.

### The structure of a bicycle

A bicycle is made up of three types of simple machines. These machines are levers, pulleys, and the wheel and axle. The wheel and axle are at the front and back wheels. The second machine is the pulley. The pulley consists of a chain that connects a large gear wheel with pedals and a small gear wheel mounted at the back wheel. The third type is a lever that is made up of two pedals as well as the bicycle brake as shown in Figure 3.

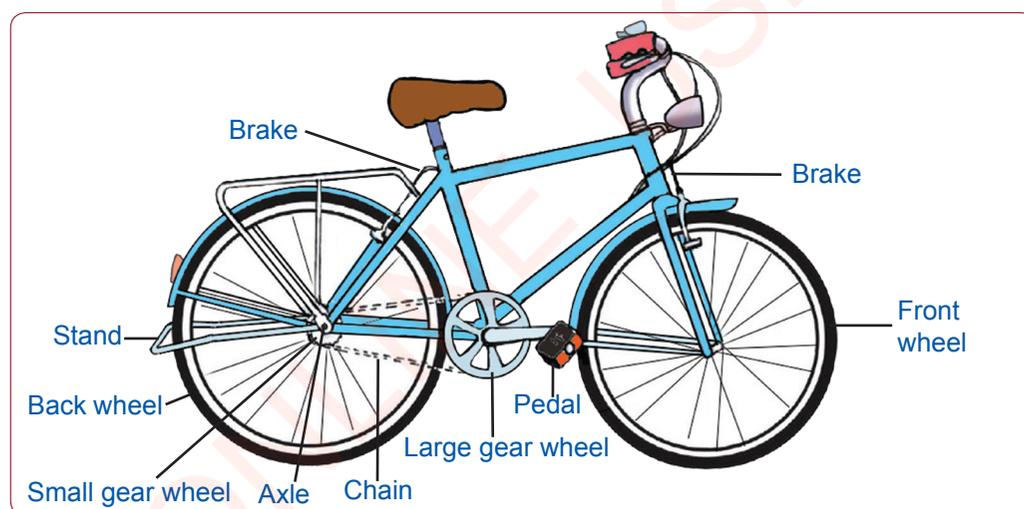


Figure 3: Structure of a bicycle

### How the bicycle works

When the pedal is rotated, it sends a force to the pulley. The pedal rotates the large gear wheel. This wheel is connected to the small gear wheel by a chain. As the chain moves, it drives the small gear wheel. When the small gear wheel rotates, it rotates the back wheel of the bicycle. This condition, in turn, moves the bicycle forward.

**Activity 3: Study the structure of the bicycle and how it works**

**Materials:** a bicycle

**Procedure**

1. Set the bicycle stand at the back wheel.
2. Rotate the pedals by hand.
3. Observe the pulley system rotated by pedals.
  - (a) What will happen if the chain breaks or falls off?
  - (b) What will happen if the axle connecting the pedal breaks?
  - (c) What is the function of the holes in the bicycle chain?

**Handling a bicycle**

The bicycle will last longer and work effectively if it is regularly inspected and repaired. In addition, cleanliness should be maintained. The bicycle must be washed with soap and water whenever it gets dirty. The bicycle has rotating parts that rub each other. Therefore, it is important to lubricate such parts. Lubricants reduce friction, rust and corrosion of the moving parts. Lubricants are applied to the chain, wheel and axles, and pedals. Lubricants are also applied to the inside of the wheel and axles system since they contain ball bearings. Ball bearings need to be lubricated to avoid eroding when the bicycle is moving. In addition, make sure that the brakes are working properly to reduce the risk of an accident.

**Exercise 3**

**Answer the following questions:**

1. List the simple machines that make a bicycle.
2. What will happen if the chain is too long?
3. What are the benefits of lubricating the bicycle chain?

**Grain milling machine**

Various grains are ground to get flour. This work is done by a grain milling machine. This machine is one of the complex machines. The grain milling machine is made up of two or more simple machines.

### The structure of a grain milling machine

The grain milling machine is made of an inclined plane called hopper for putting grains, a mill, and a flour outlet. Three types of simple machines compose a grain milling machine. These simple machines are the inclined plane, where grains are poured; the wheel and axle; and the pulley. A mill is made of a wheel and an axle. The wheel and axle are rotated by a pulley. This pulley is made of a wide belt fastened in two wheels. The large wheel is connected to the motor or engine and the small wheel is connected to the mill as shown in Figure 4. The grain milling machine can use fuel or electricity. A fuel engine machine converts fuel energy into mechanical energy. Similarly, an electrical motor machine converts electrical energy into mechanical energy.

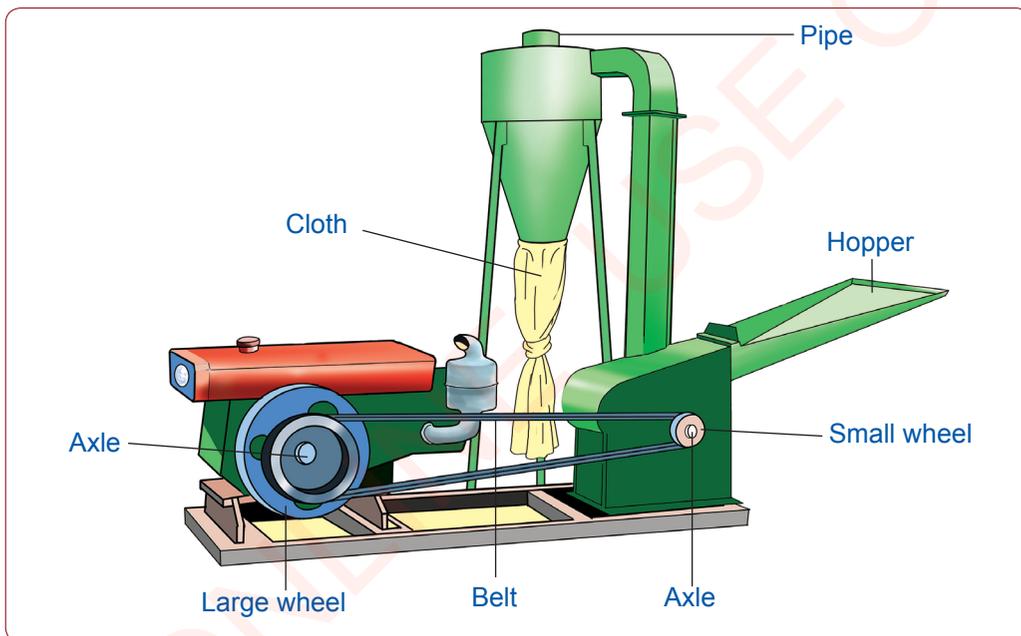


Figure 4: The structure of a fuel grain milling machine

### How a grain milling machine works

When the machine is turned on, the motor or engine rotates the axle holding the large wheel. When the large wheel rotates, it causes the belt to rotate the small wheel, which is attached to the mill. This enables the roller inside the mill to rotate rapidly and grind the grains. The mill is connected to a pipe that draws the flour from the mill. A special cloth is attached to the end of the pipe to prevent the flour from spreading.

**Activity 4:** *To examine the structure of a grain milling machine and how it works*

**Requirement:** grain milling machine and electricity

**Procedure**

1. Visit a grain milling machine near the school.
2. Study parts of the machine before it is turned on.
3. Observe how the machine works when it is turned on.

**Handling a grain milling machine**

The grain milling machine consists of rotating parts. These parts rub each other and cause a rise in temperature. It is important to check the temperature of the machine so that it does not exceed the classified limit. If the temperature rises too much, turn off the machine. Check the belt if it is properly tightened. If it is loose, tighten it so that the machine can work efficiently. Apply lubricants to all parts that rub each other. Lubricants should be changed at the appropriate time. Make repairs as soon as you find a problem. This is a good strategy to make the machine last longer. The machine should also be cleaned regularly.

**Exercise 4**

**Answer the following questions:**

1. List the simple machines that make up the grain milling machine.
2. Identify the main parts of the grain milling machine.
3. Distinguish the functions of the pulley in the grain milling machine and in the bicycle.
4. Explain what will happen if the pulley belt of the grain milling machine breaks.

**Juice making machine**

There are various juice processing machines. Example are machines that grind or squeeze fruits such as a blender and fruit squeezer. The blender is a small machine used to make juice. Juice is a beverage produced from fruits, vegetables, or roots. Fruits and vegetables are ground or squeezed,

crushed, and filtered to obtain juice. The blender is one of complex machines. This machine consists of more than one simple machine.

### The structure of the blender

The blender is made of a wheel and axle mounted on the motor. The motor is in the base of the machine and is covered to make it safe for use. The motor converts electrical energy into mechanical energy. The axle is connected to blades. As the axle rotates, it rotates the blades like a fan. These parts of the blender are shown in Figure 5 (b).

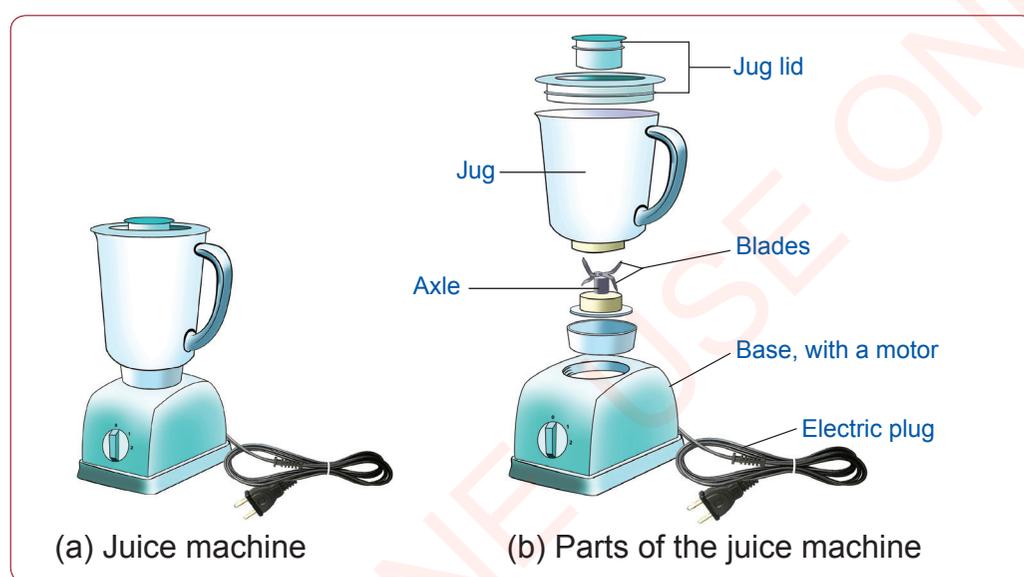


Figure 5: Structure of a juice making machine

### How a blender works

When the blender is turned on, the motor rotates the axle. The rotating axle rotates the blades at high speed. The blades grind fruits or vegetables and produce a thick liquid. Some water is added to the liquid. Then, the mixture is stirred and filtered to obtain juice.

**Activity 5:** To examine the structure of a blender and how it works

**Requirement:** blender and electricity

#### Procedure

1. Take a blender available in your environment.

2. Remove the jug with blades from the blender's base.
3. Uncover the lid of the jug and study the blade system of the blender in the jug.
4. Return the jug to the motor and turn on the blender.
5. Observe how the machine rotates and turn it off. Write what you observed.

### Handling the blender

Caring for the blender depends on its type and specific instructions. The blender should be cleaned and stored in a safe place after use. It is cleaned by wiping the base where there is a motor using a piece of cloth and soap. This part should not be immersed in water because water can damage the motor when it is turned on. Other parts should be opened and washed with soap and water. The jug should be carefully cleaned since its blades are sharp. This part can be cleaned with a soft cloth and rinsed with running water. Make sure the blades are dry before putting them back in place.

#### Exercise 5

Answer all questions in Sections A, B, C and D.

#### Section A

Choose the most correct answer and write its letter in the box provided.

1. Blades are part of the \_\_\_\_\_.  
(a) sewing machine  
(b) bicycle  
(c) blender  
(d) car wheel
2. The motor in the blender converts electrical energy into \_\_\_\_\_.  
(a) heat energy  
(b) mechanical energy  
(c) light energy  
(d) heat and light energy

3. The force in the grain milling machine is transported from the motor to the mill using the \_\_\_\_\_.
- (a) belt
  - (b) wheel and axle
  - (c) levers
  - (d) inclined plane
4. A part that locks or unlocks the door in the mortise lock is made of a simple machine called \_\_\_\_\_.
- (a) levers
  - (b) spring
  - (c) screw
  - (d) wheel and axle
5. The sewing machine is lubricated using \_\_\_\_\_.
- (a) grease
  - (b) cooking oil
  - (c) special sunflower oil
  - (d) special oil

### Section B

#### Fill in the blanks

6. To make the sewing machine last longer, it is important to do the following:
- (a) \_\_\_\_\_
  - (b) \_\_\_\_\_
  - (c) \_\_\_\_\_
  - (d) \_\_\_\_\_
7. Parts of the bicycle that should be lubricated include the following:
- (a) \_\_\_\_\_
  - (b) \_\_\_\_\_
  - (c) \_\_\_\_\_

### Section C

Write **TRUE** for a correct statement and **FALSE** for an incorrect statement in the space provided.

8. Complex machines are made up of more than one simple machine.  
\_\_\_\_\_
9. The mortise lock is a simple machine. \_\_\_\_\_
10. Machines often make work very difficult. \_\_\_\_\_
11. The sewing machine is lubricated with grease. \_\_\_\_\_
12. A hopper is a simple machine in a grain milling machine. \_\_\_\_\_

### Section D

13. List other complex machines available in your environment.
14. Give the differences between complex machines and simple machines.
15. Describe how the lever, pulley, and wheel and axle work in a bicycle.
16. Describe how to care for the mortise lock.

### Vocabulary

Blades	sharp knives mounted on a motor axle in a juice-making machine
Bobbin	a metal wheel wrapped with a sewing thread in a sewing machine
Treadle	a lever worked by the foot and imparting motion to a machine

## Chapter Six

### Scientific experiments

#### Introduction

*In Standard Five, you conducted experiments on measuring human body temperature, expansion and contraction of solid materials, liquids and gases. You also conducted experiments on transfer of heat in solid materials, liquids and air, and on how to reduce heat loss. When scientific experiments are carried out carefully and accurately, they give correct results which stimulate inquisitive mind, thinking and discovery capacity. In this chapter, you will learn about the concept of fire and carrying out experiments on firefighting. You will also learn about acids and bases and carrying out experiments to identify their properties. In addition, you will carry out experiments to identify conditions necessary for rusting and how to prevent it. The competencies developed will enable you to protect yourself from fire accidents, identify substances with acidic and basic properties, and keeping iron materials free from rusting.*

#### Fire and firefighting



#### Think

Sources of fire and proper ways of extinguishing fire

#### The concept of fire

A fire is a state involving the burning of materials in the presence of oxygen gas which is accompanied by giving out heat and light. For a fire to start, three components are needed, namely oxygen gas, heat, and fuel.

Oxygen gas supports combustion: heat raises the temperature of the combustible material. Fuel is a substance that can be burned to produce heat or power. Fuel can be in solid, liquid or gaseous forms. The interactions of oxygen gas, heat and fuel form a fire triangle as shown in Figure 1. Thus, if one component is missing, fire cannot start.

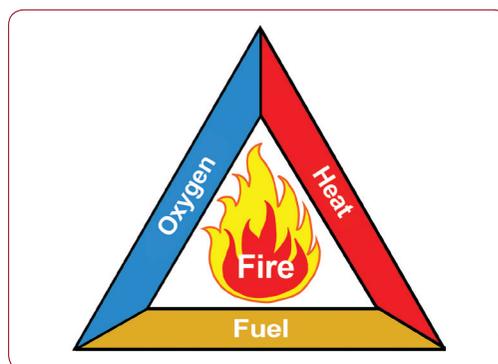


Figure 1: Fire triangle

Fire is essential in the daily life of human beings. However, fire is very dangerous in case it cannot be controlled.

Various factors can cause fire accidents. These include the following:

- (a) Cigarette smoking and improper disposal of cigarette butts;
- (b) Electrical faults;
- (c) Lightning;
- (d) Children playing with lighting matches;
- (e) Friction due to lack of lubricants, as in vehicles;
- (f) Burning of forest;
- (g) Uncontrolled burning of waste;
- (h) Clearing fields or farms using fire;
- (i) Carelessness in using candles, matches, or stoves which use kerosene, gas, charcoal, or electricity; and
- (j) Carelessness during welding.

In the event of fire, remove one of the components shown in the fire triangle to extinguish the fire.

### Classes of fire

There are various classes of fire based on the burning materials. These classes are A, B, C, D and F. Each class of fire has appropriate firefighting techniques as explained in the following sections:

### Class A fire

Fire in this category is caused by the burning of solid materials such as wood, paper, clothes, plastic, mattresses and grass. This type of fire is extinguished by water, dry sand or a fire blanket, as presented in Figure 2.

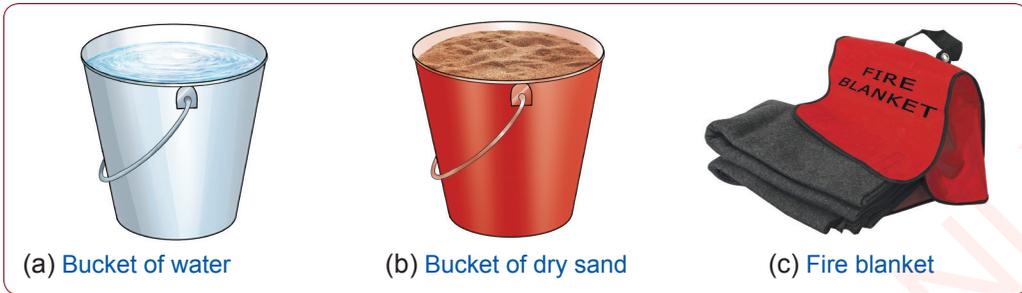


Figure 2: Equipment for extinguishing Class A fire

### Class B fire

Fire in this category is caused by explosive and flammable liquids such as petrol, diesel, kerosene, and oil based paints. If this type of fire is in a small extent, it can be extinguished using dry sand or a fire blanket. Water cannot be used to extinguish Class B fire because it spreads the flammable substance like oil that increases the extent of the fire. This fire can also be extinguished using carbon dioxide gas which is stored in a special cylinder with a black sign. In addition, dry powder stored in a special cylinder with a blue sign is also used to extinguish this type of fire. Figure 3 shows labelled carbon dioxide gas and dry powder fire extinguishing cylinders.

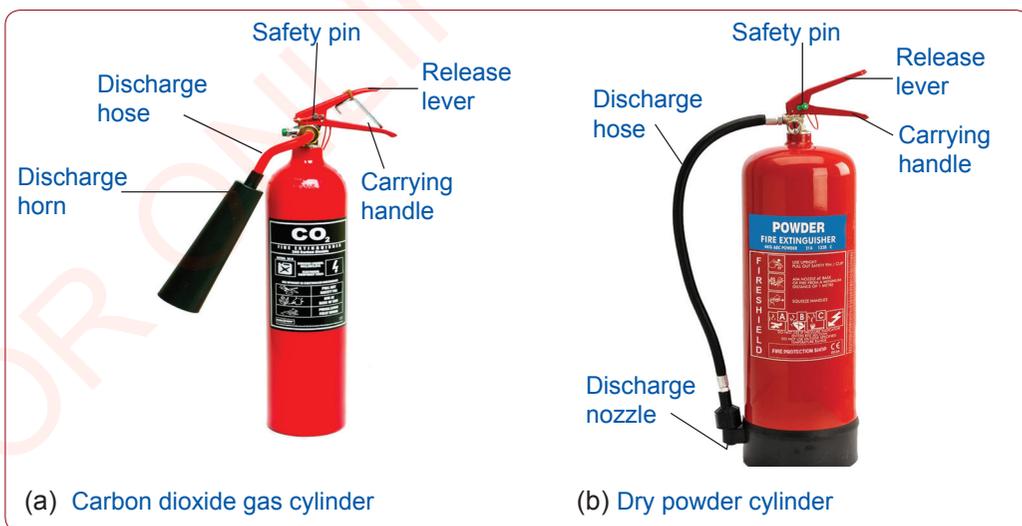


Figure 3: Cylinders containing fire extinguishing chemicals

### **Class C fire**

Fire in this category is caused by the burning of flammable gases such as butane, propane, methane, and acetylene. Water is not used to extinguish gas fire, but it can be used to cool the gas cylinder to prevent it from explosion. This type of fire is extinguished using carbon dioxide gas or dry powder shown in Figure 3. Closing the gas pipe or cylinder valve is an alternative way of extinguishing the fire caused by gas.

### **Class D fire**

Fire in this category is caused by combustible metals such as magnesium, potassium, and iron. This type of fire is extinguished using dry powder. Water is not used to extinguish Class D fire. Also, it is not advised to extinguish Class D fire using carbon dioxide gas.

### **Class F fire**

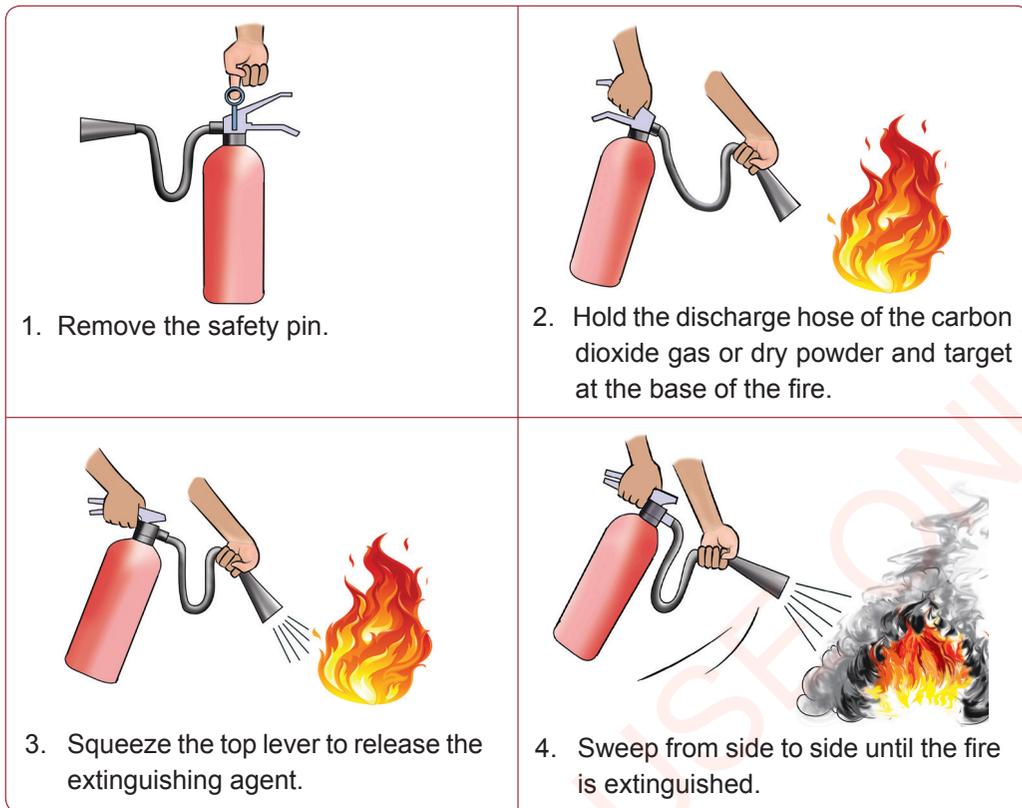
Class F fire involves cooking oil. This type of fire is extinguished using carbon dioxide gas or dry powder.

### **Fire caused by electrical faults**

Electricity is not among the classes of fire, but it can be a source of any of the fire Classes A, B, C, D and F. Normally, the fire caused by an electrical fault is extinguished based on the burning material. Thus, dry powder, carbon dioxide gas or dry sand can be used to extinguish this fire. Before extinguishing the fire caused by an electrical fault, the main electrical switch should be turned off. It is not advised to use water before turning off the main switch. This is because water conducts electricity. Thus, one may get an electrical shock. If the main switch cannot be turned off, it is recommended to use fire extinguishers which do not conduct electricity such as dry sand, dry powder, and carbon dioxide gas.

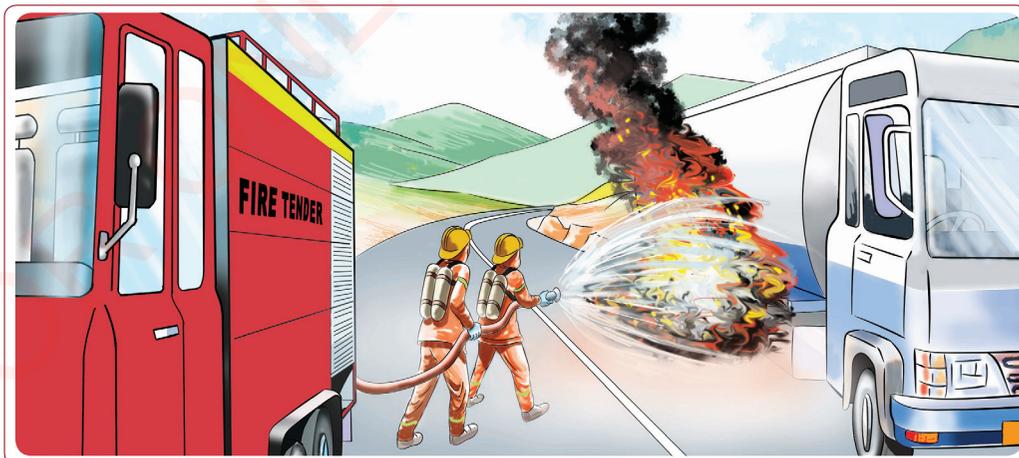
### **Procedure for firefighting**

The following are the steps to be followed in firefighting using carbon dioxide gas or dry powder, as shown in Figure 4.



**Figure 4:** Steps for using carbon dioxide gas or dry powder fire extinguisher

**Note:** Dry sand, water, fire blanket and fire extinguishers containing chemicals, are used to extinguish fire at the initial stages. At a fully developed stage, the fire will be extinguished by the firefighters who use special equipment such as a fire tender as shown in Figure 5.



**Figure 5:** Firefighters extinguishing fire

### Factors to be considered during firefighting

1. The Class A fire is not extinguished using carbon dioxide gas because of the following reasons:
  - (a) It can be expelled by wind and thus blocked from reaching the base of the fire.
  - (b) It removes oxygen gas temporarily which then returns to restart the fire.
  - (c) It is not capable of lowering the temperature of the burning solid substances.
2. Before extinguishing the fire caused by an electrical fault, switch off the main switch.
3. Use the appropriate firefighting equipment for the relevant class of fire.
4. It is important to make firebreaks around fields and forests.
5. It is important for buildings to have fire extinguishers and lightning conductors.
6. In the event of fire in your area, observe important things to save lives and properties. These are to scream, ring a bell, or press the fire alarm. Also, call the Fire and Rescue Force immediately on phone number 114. Try to extinguish the fire using the available fire extinguishers without endangering your life and that of others.

#### **Experiment 1:** *To examine whether a Class A fire can be extinguished by water*

**Aim:** To extinguish a Class A fire using water

**Materials:** pieces of paper, a match box and a bucket of water

**Caution:** Fire is dangerous. Be careful when carrying out this experiment to avoid any potential harm. Make sure that the experimental area is not too close to combustible materials such as dry grasses to prevent fire from spreading elsewhere.

#### **Procedure**

1. Take a bucket full of water to a designated area for the experiment.
2. Take a match then burn the papers. What has happened?

3. Take a bucket of water. Then, pour the water on the burning papers.

**Results:** What happened after pouring the water on the fire?

**Conclusion:** Write the conclusion of the experiment.

**Experiment 2:** *To examine whether a Class B fire can be extinguished by dry sand*

**Aim:** To extinguish a Class B fire using dry sand.

**Materials:** one litre of kerosene mixed with a quarter litre of diesel, a bucket with dry sand, aluminium dish, water and a match box

**Caution:** Fire and the materials used in this experiment are dangerous. Kerosene and diesel are flammable. Be careful to avoid health problems or effects to the environment. Use special protective equipment.

**Procedure**

1. Fill the aluminium dish with dry sand. Then, pour water into the dish containing sand until the sand is wet.
2. Pour kerosene mixed with diesel into the aluminium dish with the wet sand.
3. Take a match, then light a fire in the dish. What has happened?
4. Take dry sand from the bucket. Then, pour over the fire. Find out what happens.

**Results:** What happened after pouring the sand on the fire?

**Conclusion:** Write the conclusion of the experiment.

**Exercise 1**

**Answer the following questions:**

1. Name the firefighting equipment used to extinguish the following classes of fire:
  - (a) Class A \_\_\_\_\_
  - (b) Class B \_\_\_\_\_
  - (c) Class C \_\_\_\_\_

2. Mention three components for a fire to start.
3. Why is water not used to extinguish the fire caused by petrol or kerosene?

## Acids and Bases



### Think

Distinguishing properties of acids and bases

### The concept of acid

An acid is a chemical substance that has the characteristics such as sour taste, changes blue litmus paper to red, and corrosive in a concentrated form. There are two main types of acids: natural acids and artificial acids. Examples of natural acids are acetic acid, which is found in vinegar, and lactic acid found in yoghurt. Similarly, in some animals' digestive systems, there is a natural acid called hydrochloric acid which helps in digestion. Artificial acids are those which are manufactured in industries. Examples of such acids are nitric acid and sulphuric acid. Acids are used to manufacture various products such as car batteries liquid, fertilizers, ink, insecticides, paints, dyes, and detergents. Similarly, acids are used to add flavour to foods. In addition, acids are used in different laboratories in schools, colleges and factories for various investigations.

### The concept of base

Base is a chemical substance that has the characteristics such as slippery feel, bitter taste, turns red litmus paper blue, and corrosive in a concentrated form. Bases are found in various substances, such as ashes, soaps, in animals' bodies and in chemicals for stain removal. They are used in making medicines and other chemicals, and in breaking down fats. In addition, bases are used to reduce the amount of acid in the human body and in carrying out laboratory investigations.

## Indicators of acids and bases

Substances used to detect the presence of acid or base in various liquids are called indicators. Various types of indicators are used in scientific experiments. An example is litmus paper made from coloured flower petals like hibiscus flowers. Some indicators, such as phenolphthalein (POP), are manufactured in industries.

### Activity: To make a litmus paper indicator using flowers

**Materials:** light white plain paper, hibiscus flowers, a pair of scissors, ruler, two bowls, a knife, a piece of soap, water and lemon

**Caution:** Some of the materials used in this activity are dangerous. Be careful to avoid harm.

### Procedure

1. Take the flower petals.
2. Place the paper on the table. Then, take the flower petals and rub them on both sides of the paper. Make sure both sides of the paper are properly coloured.
3. Clean the paper to remove the dirt that might appear.
4. Cut the paper into small pieces of one centimetre wide and five centimetre long.
5. Put a soap in the bowl; then, dissolve it using water.
6. Put the paper indicator you prepared into the soap solution. What do you observe?
7. Cut the lemon and squeeze it into another bowl to get juice.
8. Insert the indicator you prepared into the juice. What do you observe?
9. Let the pieces of paper dry and use them as indicators to identify acids or bases in liquids in your environment.

### Experiment 3: To examine the properties of acids

**Aim:** To identify the properties of acidic substances using litmus paper.

**Materials:** lemons, unripe oranges, unripe mangoes, yoghurt, water, knife, blue litmus paper, red litmus paper, filter, test tube or bowl, small crusher or mortar and pestle

**Caution:** Some of the materials used in this experiment such as the knife may cause harm. Be careful during the experiment.

#### Procedure

1. Peel lemons, unripe oranges and mangoes to remove their outer skins.
2. Cut the lemon into small slices and grind them using the small crusher or mortar and pestle.
3. Add a small amount of water to the ground fruit, filter it to get juice, and put the juice in a bowl or test tube.
4. Insert blue litmus paper and red litmus paper into the fruit juice you prepared. What has happened?
5. Repeat steps 2 to 4 for all the fruits.
6. Put yoghurt in a bowl or test tube.
7. Insert blue litmus paper and red litmus paper into the yoghurt. What has happened?

**Results:** Which litmus paper changed its colour in this experiment? What is the colour change? Which litmus paper did not change its colour?

**Conclusion:** Acidic substances change the colour of litmus paper from \_\_\_\_\_ to \_\_\_\_\_.

### Experiment 4: To examine the properties of bases

**Aim:** To identify the properties of bases using litmus paper and beef fat

**Materials:** ashes or dry banana leaves, chalk or lime, gallbladder, beaker, glass or plastic bottle, bowl, beef fat, water, filter or filter paper, and blue litmus paper and red litmus paper

**Caution:** Some of the substances used in this experiment such as ashes, dry banana leaves, bile, and lime can cause health effects. Be careful and wear protective equipment.

### Procedure

1. Put the ashes in a beaker and add water to get a solution.
2. Filter the mixture obtained using filter paper.
3. Take bile from the gallbladder and place it in a glass or plastic bottle. You can use lime or chalk instead of bile.
4. Dip the red litmus paper and blue litmus paper into a glass filled with ash solution. What do you observe?
5. Dip the red litmus paper and blue litmus paper into the bile, lime, or chalk solution. What do you observe?
6. Put beef fat in a bowl. Then, pour the bile, lime, or chalk solution.

**Results:** The red litmus paper changed its colour to \_\_\_\_\_. What happened after the bile was poured into the beef fat?

**Conclusion:** The bases change the colour of \_\_\_\_\_ litmus paper to \_\_\_\_\_. Also, they break down beef fat. Thus, in the animal's digestive system, bile breaks fat into fatty acids.

### Exercise 2

**Answer the following questions:**

1. List various items that contain
  - (a) acids.
  - (b) bases.
2. What are the properties of the acid found in batteries?
3. Name five uses of
  - (a) acids.
  - (b) bases.

4. Explain three properties of
  - (a) acids.
  - (b) bases.
5. How will you know that a tomato is acidic in nature while a piece of soap is basic in nature?

## Rusting and how to prevent it



### Think

Causes of rusting and proper methods of prevention

### The concept of rust

Rust is a reddish brown coat that occurs on the surfaces of iron materials. For example, nails that have been left out for a long time without proper care develop a reddish brown coat. The coat can be scratched from the nails. Rusted nails differ from those which have been properly stored in a packet.

### Experiment 5: *To examine substances which rust and those which do not rust*

**Aim:** To determine that iron substances rust

**Materials:** water, iron nails, stainless steel or brass keys, a piece of plastic material, a piece of iron rod, stainless steel or brass spoons and bowl

**Caution:** Some materials like iron nails and iron rods are dangerous; they can cause harm and health problems. Be careful when performing the experiment.

#### Procedure

1. Put water in a bowl.
2. Dip iron nails, a piece of iron rod, a piece of plastic material, a stainless steel spoon and stainless steel keys into the water. Leave another set of such materials outside the water.

3. Take them out of water and leave them in an open area for three days.
4. After the three days, compare the conditions of the materials dipped in water with those which were not dipped in water.

**Results:** What did you observe after the materials had been placed in water and then left in an open area for three days?

**Conclusion:** Write the conclusion of the experiment.

### **Experiment 6: To examine the conditions necessary for rusting**

**Aim:** To determine the conditions necessary for the rusting of iron nails

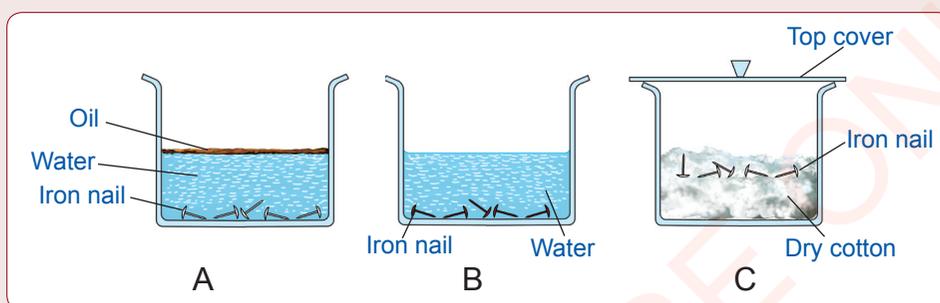
**Materials:** new iron nails, oil or grease, three 'sufuria' or 250 mL beakers with water and a source of heat

**Caution:** Iron nails, oil and grease can cause health effects. Be careful when using them and wear protective equipment.

#### **Procedure**

1. Take three beakers of 250 millilitres each and label them A, B and C. Put equal amounts of water of at least 80 millilitres in beakers A and B. Or take three small 'sufuria' and label them A, B and C. Put enough water to cover the nails in 'sufuria' A and B.
2. Boil the water in each 'sufuria' or beakers A and B for 2 to 3 minutes. Remove the 'sufuria' or beakers from the heat source and dip few new iron nails into the 'sufuria' or Beaker A. Make sure the iron nails are completely covered in water.
3. Pour enough oil to cover the entire surface of the water in 'sufuria' or beaker A. Then, place 'sufuria' or beaker A aside. See Figure 6.
4. Carefully dip few new iron nails into 'sufuria' or beaker B so that the nails are completely covered in water. Do not put oil in the beaker or sufuria B. See Figure 6.

5. Dry 'sufuria' or beaker C using a dry cloth. Also dry few new iron nails and place them in a dry cotton swab. Then, dip them in 'sufuria' or beaker C. Cover the 'sufuria' or beaker C using a dry cover. See Figure 6.
6. Place the 'sufuria' or beaker B near 'sufuria' or beaker C.
7. Leave the 'sufuria' or beakers for three days before doing the observations.



**Figure 6:** Identifying conditions necessary for rusting

**Results:** After three days, carefully check the status of the nails in each 'sufuria' or beaker whether they have rusted or not. Then, fill the results of your experiment as shown in Table 1.

**Table 1:** Conditions of iron nails after three days

Beaker / 'Sufuria' A	Beaker / 'Sufuria' B	Beaker / 'Sufuria' C

### Questions

1. What was the purpose of boiling water in 'sufuria' or beaker A?
2. Why was oil used to cover the surface of water in 'sufuria' or beaker A in step 3?
3. Why were the iron nails placed in dry cotton in 'sufuria' or beaker C and 'sufuria' or beaker C covered?
4. Why was the oil not added in 'sufuria' or beaker B?

**Conclusion:** Write the conclusion of the experiment.

### Experiment 7: To examine whether painting can prevent rust

**Aim:** To identify the methods of preventing rust

**Materials:** Two pieces of iron sheets, lead oxide paint, green, blue or red paint, brush, bucket, empty can, a piece of sandpaper or steel wire

**Caution:** Iron sheets, paints and other materials used in this experiment may cause health effects. Be careful and wear protective equipment.

#### Procedure

1. Rub two pieces of iron sheets with sandpaper or steel wire.
2. Paint lead oxide on one piece of iron sheet. Do not paint the second piece of iron sheet.
3. Leave for a while until the lead oxide paint dries.
4. Put green, blue, or red paint in any available container.
5. Apply the paint mentioned in step 4 to the iron sheet coated with the lead oxide paint.
6. Keep out the pieces of iron sheets in the open area for three days.

**Results:** (i) Which piece of the iron sheets rusted?  
(ii) Which piece of the iron sheets did not rust?

**Conclusion:** Write the conclusion of the experiment.

### Exercise 3

Answer all questions in Sections A and B.

#### Section A

Choose the most correct answer and write its letter in the box provided.

1. Which class of fire is caused by the burning of solid substances such as clothes and papers?  
(a) Class D  
(b) Class C  
(c) Class A  
(d) Class F

2. Acid is a chemical substance that changes litmus paper from \_\_\_\_\_.
- (a) red to yellow
  - (b) blue to red
  - (c) green to blue
  - (d) red to blue
3. How can rusting of iron materials be prevented?
- (a) placing them in water
  - (b) smearing them with ashes
  - (c) adding oxygen gas
  - (d) painting them
4. A base has two important properties:
- (a) it changes blue litmus paper to red and kills germs.
  - (b) it changes blue litmus paper to red and breaks down body fats.
  - (c) it changes red litmus paper to blue and breaks down body fats.
  - (d) it changes blue litmus paper to red and preven diseases.
5. Which gas is used during firefighting?
- (a) Carbon dioxide gas
  - (b) Oxygen gas
  - (c) Hydrogen gas
  - (d) Nitrogen gas
6. Write **TRUE** for a correct statement and **FALSE** for an incorrect statement in the space provided.
- (a) A fire is a state involving the burning of things in the presence of oxygen gas that is accompanied by giving off heat and light.  
\_\_\_\_\_
  - (b) Fuel is in the solid state only. \_\_\_\_\_
  - (c) Fire caused by liquids such as diesel can be extinguished by water. \_\_\_\_\_
  - (d) An acid is a chemical substance that has a sour taste. \_\_\_\_\_
  - (e) A base is a chemical substance that has a bitter taste.  
\_\_\_\_\_

### Section B

7. Why do some substances rust?
8. Name five rusting and non-rusting substances.
9. Explain the effects of rusting in your environment.

### Vocabulary

Combustion	burning of materials in the presence of oxygen gas
Concentrated	liquid present in a high proportion relative to other substances
Firefighting	the action or process of extinguishing fire
Flammable	a substance that can catch fire easily and burn rapidly
Indicator	a substance that exhibits different colours in solutions of different acidity or basicity
Litmus	special paper used for testing whether a substance is acidic or basic
Screaming	long, loud cries expressing extreme emotion or pain

## Waste disposal

### Introduction

*In Standard Six, you learnt about sources, types and effects of waste, waste management and some methods of proper waste disposal. In this chapter, you will learn about the concept of waste disposal as one of the methods of waste management, advantages of proper waste disposal, and steps for disposing waste. In addition, you will learn about the structure of an incinerator and the appropriate places for its construction. The competencies developed will enable you to use proper methods of waste disposal to conserve the environment.*

### The concept of waste disposal

Waste disposal is one of the waste management methods that involve the removal and destruction of waste substances. Waste disposal is done to prevent the effects that the waste cause to the environment, human beings and other living things. There are three types of wastes, namely solid, liquid and gaseous wastes. Methods of waste disposal are based on the types of wastes. Burning, chemical waste treatments, burying at sea, crushing and landfilling are among the common methods of waste disposal.



#### Think

Possible effects to human beings if wastes are not properly disposed

### Advantages of proper waste disposal

There are different advantages of proper waste disposal in our environment. These advantages include the following:

#### Prevention of the spread of diseases

When wastes accumulate in a given area for a long period, they become a breeding site for different insects such as houseflies and mosquitoes.

Accumulated wastes can also provide breeding sites and habitats for destructive animals such as rats, which destroy cereals and other property. Houseflies spread diseases such as dysentery and cholera, and mosquitoes spread malaria. These diseases can be prevented by destroying wastes which are breeding sites for insects that spread such diseases.

### **Prevention of unpleasant smell**

When the decomposed wastes are accumulated for a long time, they give off unpleasant smell. The smell annoys people who live around that environment. Therefore, proper waste disposal prevents such smell.

### **Keeping the environment clean**

When wastes are scattered around, the environment becomes dirty and unattractive. In contrast, proper waste disposal makes the environment clean and attractive.

### **Prevention of accidents**

When wastes are scattered or accumulated for a long time, they may become hiding places for dangerous organisms like snakes, scorpions, and centipedes. Wastes such as pieces of metals and broken glasses can cause injuries to human beings. Proper waste disposal prevents accidents such as bites from poisonous organisms and injuries from dangerous things found in the waste.

### **Prevention of water pollution**

Wastes may enter water sources and pollute water. They may contain poison or have pathogens that cause diseases to human beings and other living things. Therefore, the people using such water may be infected. Proper waste disposal reduces the possibility of wastes to contaminate water sources.

### **Proper use of land**

Stored wastes occupy a large area of land if they are not destroyed. This is because some wastes take longer to decompose. Some of the waste disposal methods tend to destruct them by compaction or ash formation. After disposing them, the land may be used for other activities.

### Generation of electricity

Heat produced from an incinerator can be used to generate electricity. The generated heat may also be used to boil water. The steam produced from the boiled water may be used to run electric generators. Electricity is used to run machines and other equipment that simplify work.

### Warming houses

In very cold areas, heat from the incinerator is used to warm water. The warm water is distributed to human settlements through special systems of pipes for warming houses.

### Production of fertiliser

Remains of some burned wastes are used as soil fertiliser. The fertiliser can be used in agriculture to increase crop yields.

### Protection of living organisms found in the soil

Some wastes are toxic to the living things found in the soil. Proper waste disposal eliminates or reduces their effects on living organisms.

#### Exercise 1

Answer the following questions:

1. What is waste disposal?
2. List two accidents that may occur when wastes are not properly disposed.
3. How does waste disposal help to conserve land?

### Steps for disposing wastes



Discuss with your fellow pupils

Steps to follow during waste disposal

It is important to follow various steps for effective waste disposal. The following are the steps to follow for effective waste disposal:

## Sorting wastes

Sorting wastes helps to group wastes based on their nature. It helps to choose proper methods that will be used to destroy or recycle them. Each type of wastes has its specific waste characteristics which differentiate it from others. Therefore, specific methods of disposal are needed for each type of wastes. Waste sorting also helps to avoid explosions and accidents that may occur when wastes composed of different chemicals are kept together. Waste sorting reduces waste disposal costs. During waste disposal, wastes are sorted and kept in groups as follows:

**Combustible wastes:** These are dry wastes such as paper, trees, leaves, and clothes.

**Non-combustible wastes:** These include ceramics, remains of household utensils, pieces of glass and metals.

**Hazardous wastes:** Some wastes can be harmful to the environment, human beings and other living things. These wastes need special attention during disposal. They also have long term effects to the environment. Examples of hazardous wastes are expired medicines, used batteries, radioactive wastes, and scrap metals.

**Non-hazardous wastes:** These are wastes that have no evidence of causing harm to the environment, human beings and other living things. Examples of non-hazardous wastes are paper and wooden materials.

**Harmful wastes during disposal:** Some wastes can cause harmful effects during disposal. Some of these wastes emit toxic gases that can affect people living around the environment. For example, wastes containing nitric acid can produce nitrogen dioxide when burnt. The resulting gas is toxic; when inhaled, it can cause health problems. Therefore, such types of wastes are separated to apply proper disposal methods. To comply with hazardous waste disposal laws, experts are normally involved.

**Non-harmful wastes during disposal:** These are wastes that have been approved to be harmless to the environment, human beings and other living things. Examples of such wastes include food remains, paper, plant leaves, grasses and worn out clothes. These wastes can be collected and

buried to decompose and produce manure that can be used in agriculture to increase crop yields.

Wastes sorting can be done using special containers that are differentiated by their colours as shown in Figure 1. The colours of the containers and the types of wastes placed in are usually as follows:

- (a) A blue-coloured container is used to keep wastes originating from paper such as boxes;
- (b) A yellow-coloured container is used to keep wastes of metallic origins such as iron;
- (c) An orange-coloured container is used to keep wastes originating from plastic such as plastic bottles;
- (d) A grey-coloured container is used to keep glass based wastes, such as broken glass cups;
- (e) A red-coloured container is used to store electronic wastes such as broken cell phones, chargers, and batteries; and
- (f) A green-coloured container is used to keep organic wastes like food remains.



Figure 1: Different containers for keeping wastes

### Selecting an appropriate area for waste disposal

During waste disposal, it is important to choose a suitable area where the disposal will not cause harm to human beings and the environment. For example, waste disposal by burning should be carefully done far away from human settlements.

### Selecting proper methods of waste disposal

The selection of proper methods of waste disposal depends on the types of wastes, disposal costs, and the laws governing the disposal of wastes in that place. Different methods can be used to dispose wastes. These include crushing and landfilling, burning, chemical treatment, and incineration. These methods of waste disposal are described below:

**Crushing or grinding wastes and landfilling:** This method is used to dispose solid wastes that cannot be easily destroyed by burning. Wastes that can be destroyed by this method include substandard and expired products. Examples of these products are radio, television, electrical goods, and canned foods. These products are crushed or ground as shown in Figure 2 and buried in a special area.



**Figure 2:** Waste disposal by crushing or grinding

**Burning of wastes:** Fire is used to destroy solid wastes that can be burnt easily. The burning method has several advantages: it is cheap; it kills destructive insects found in the waste; and it prevents spreading of pathogens. However, the method has many disadvantages. First, waste burning degrades soil fertility since it also kills organisms responsible for waste decomposition and soil fertility. Second, the smoke released during burning annoys people, and it affects the respiratory system, and third, mismanaged burning of wastes can burn houses, forests and grazing areas. Lastly, some wastes produce toxic chemicals when burnt, hence affecting health of humans and other organisms.

**Chemical treatment:** This method is normally used to dispose dangerous chemical wastes, such as cosmetics. This method involves experts due to their legal requirements. For example, when different chemicals used at school expire, the school management should report to the relevant authority for disposing them. Normally, acidic wastes are treated using alkali to make them harmless to the environment, human beings and other living things.

**Incineration:** In this method, wastes are destroyed using high temperature from a heat source. The method is used to destroy solid wastes such as hospital bandages used in dressing wounds in hospitals.

### Exercise 2

**Answer the following questions:**

1. Mention the types of wastes that can be destroyed by the chemical treatment method.
2. Using examples, explain the meaning of hazardous wastes.
3. Explain the advantages of sorting and segregating wastes into their respective groups before disposing.
4. Explain the advantages and disadvantages of burning wastes.

### An incinerator

An incinerator is a furnace or special unit for burning wastes at high temperatures. The sizes of incinerators differ depending on the uses and quantities of wastes to be burnt. Incinerators are used in different places such as schools, hospitals and industries. The materials for constructing

an incinerator depend on the intended use of the incinerator. Some of the incinerators are made in industries using steel which cannot melt easily. A simple incinerator is constructed using an iron steel bar or iron ore, cement, coarse aggregates and sand. This incinerator is used to burn wastes such as paper, sanitary pads, and cotton.

### The structure of an incinerator

The incinerator has three main parts, which are the air inlet and ash vent, the combustion chamber and the chimney, as shown in Figure 3.

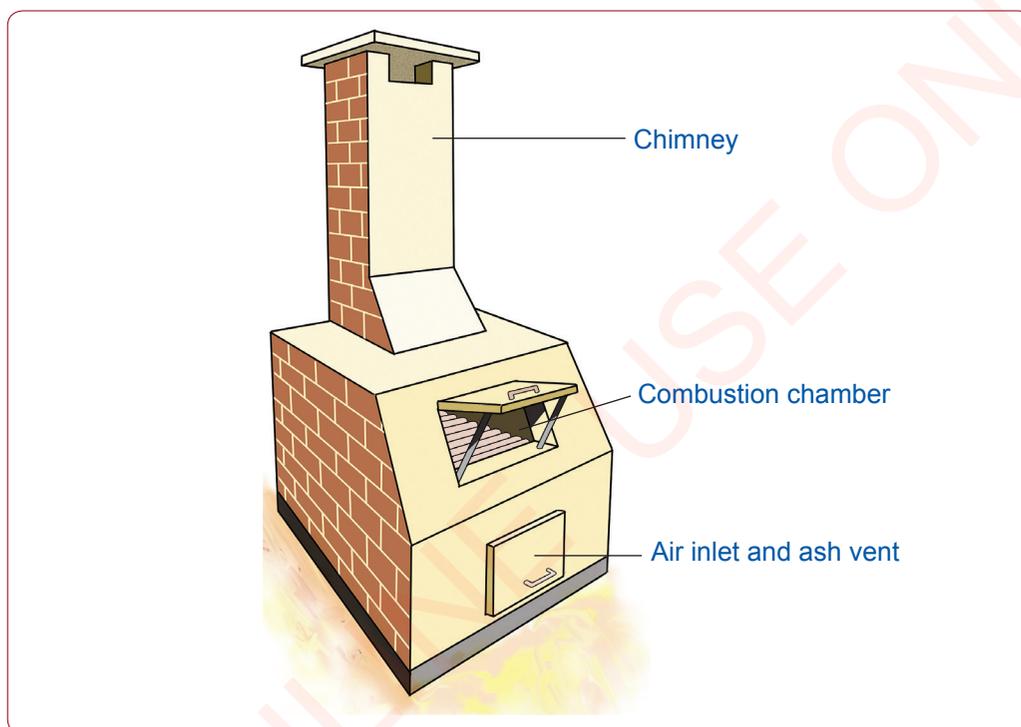


Figure 3: An incinerator

**Air inlet and ash vent:** This is the lower part of the incinerator which allows air in. The oxygen gas contained in the air helps to burn wastes placed in the incinerator. This part is also used to remove ashes after the waste is burnt.

**The combustion chamber:** This is the middle part of the incinerator found above the air inlet and ash vent. The wastes to be destroyed are placed in this part. This part is large enough to allow turning of wastes to ensure efficient burning. Gases produced in this chamber are released via the

chimney. The door in this area is always closed to prevent the emission of smoke and gas.

**The chimney:** This part is directed upwards and normally connected to a long pipe to emit smoke. The pipe helps to release smoke high in the atmosphere where it is blown by wind. Therefore, it protects people around the incinerator from the effects of smoke.

### Places for building an incinerator

Before building an incinerator, it is important to evaluate the area. An incinerator should be built away from human settlements, but it should be easily accessible. This will help to prevent smoke and unpleasant smell. The incinerator should also be built by considering the wind direction so that the smoke should not be blown towards human settlements. The incinerator should not be constructed near combustible materials. It should be constructed away from electric lines to avoid the possibility of accidents. The incinerator should also be built away from water sources to avoid water pollution.

#### Exercise 3

**Answer the following questions:**

1. What is an incinerator?
2. List four places where an incinerator is used.
3. Describe the roles of each main part of an incinerator.

#### Activity: *Constructing a model of an incinerator*

**Materials:** clay soil, sticks, rope or threads, water, machete and a picture of an incinerator

#### Procedure

1. Mix clay soil to form clay lump.
2. Cut a piece of rope that is enough to tie sticks.
3. Use the rope and sticks to construct a model with the shape as shown in Figure 3.

4. Spread clay on the model.
5. Allow the model to air-dry.

### Question

Can the model you have constructed be used as an incinerator? Why?

### Exercise 4

Answer all questions in sections A, B and C.

#### Section A

Choose the most correct answer and write its letter in the box provided.

1. Which of the following is not among the criteria to be considered when constructing an incinerator?
  - (a) To be far from human settlements
  - (b) Being in an area with a lot of wastes
  - (c) Being far from combustible materials
  - (d) Easily accessible
2. If an incinerator is constructed near combustible materials, it \_\_\_\_\_.
  - (a) will cause fast burning of wastes
  - (b) will cause a lot of smoke during burning
  - (c) produces more ashes
  - (d) may cause fire accidents
3. Identifying the types of wastes during sorting will help \_\_\_\_\_.
  - (a) to decide on the methods of disposal
  - (b) to determine the quantity of waste
  - (c) to decide how to arrange them
  - (d) to reduce waste smell
4. Generation of electricity using an incinerator requires \_\_\_\_\_.
  - (a) water to run machines that generate electricity
  - (b) boiled water to run machines that generate electricity
  - (c) steam to run machines that generate electricity
  - (d) oxygen gas to run electricity generating machines

### Section B

5. Write **TRUE** for a correct statement and **FALSE** for an incorrect statement in the space provided.
- (a) Burning of waste is not the only method of waste disposal.  
\_\_\_\_\_
- (b) The state of the waste is an important criterion for selecting the disposal method. \_\_\_\_\_
- (c) The size of an incinerator depends only on the financial capacity of the user. \_\_\_\_\_
- (d) Disposing toxic and non-toxic wastes does not involve experts.  
\_\_\_\_\_
- (e) All household wastes are disposed by incineration. \_\_\_\_\_

### Section C

6. List three methods of waste disposal.
7. Explain the characteristics of a suitable area to construct an incinerator.
8. Briefly explain what will happen if an incinerator is constructed without the following:
- (a) a chimney  
(b) an ash vent
9. What is the importance of turning wastes during burning?
10. Explain the disadvantages of constructing an incinerator near human settlements.
11. Why is it necessary to use an incinerator to dispose wastes?
12. Is it possible to generate electricity from incinerators in Tanzania? Explain.
13. Why do incinerators vary in sizes?

### Vocabulary

Chimney	a vertical pipe which conducts smoke and combustion gases up from a fire or furnace
Electrical generators	machines used in generating electricity
Organic waste	is any material that is easily decomposed. It comes from either a plant or an animal
Segregation	separating things from others.

## Body health

### Introduction

*In Standard Six, you learnt about health services provided to various groups of people and the characteristics of each group. In this chapter, you will learn about the concept of a balanced diet and diets for various groups of people. You will also learn about the importance of doing physical exercise and the risks of not doing physical exercise for various groups of people. The competencies developed will help you to build good health and prevent diseases.*

### The concept of a balanced diet



#### Think

Characteristics of a person with good health

Good health is a state of the body to be physically and mentally well. One of the things that contribute to good health is eating a balanced diet. A balanced diet is a meal which contains the right proportion of different groups of food nutrients. This meal includes all major groups of food which are proteins, carbohydrates, fats and oils, vitamins and minerals.

Protein-rich foods include meat, mushroom, fish, milk, beans and peas. The function of proteins is to build up the body and make it grow. This type of food is also responsible for building new cells to replace the old or dead cells.

Carbohydrate foods such as cassava, potatoes, rice, yams, bread and banana give heat and energy to the body. These food types enable the body

to perform various activities such as playing, tilling, walking, and running. Likewise, foods which contain fats and oil, such as coconut, groundnuts, sunflowers, and butter, give the body heat and energy. Vitamin-rich foods are vegetables and fruits, such as pawpaws, oranges, avocado, apples, cabbages, spinach, and carrots. These foods enable the body to protect itself from various diseases such as high blood pressure, diabetes, cancer, flu, diarrhoea, and recurring fevers. Cabbages, carrots, eggplants, and green vegetables are some examples of foods rich in minerals. These minerals are calcium and phosphorous. They help to build and strengthen body muscles, bones and teeth.

The body also needs enough water to perform its functions properly. Therefore water should be part of the meal. Water contains several minerals such as sodium, potassium, iron, calcium and magnesium. These minerals help various body systems to perform their functions properly. Water helps in regulating body temperature, digesting of food, and absorbing of nutrients from the food. It also helps the body to remove toxins and body wastes.

### Exercise 1

**Answer the following questions:**

1. What is a balanced diet?
2. List the main types of food groups.
3. Why is it important to eat fruits and green vegetables?
4. What is the importance of water in the body?
5. List three examples of foods which contain
  - (a) proteins
  - (b) carbohydrates
  - (c) fats
  - (d) vitamins.

### Nutritional requirements for different groups of people

Nutritional requirements vary depending on the age of people, activities they do, and health status. These groups include children under five years old, youths, manual workers, sedentary workers, pregnant women, sick people, and the elderly.

### Meals for children under five years old

Children of this age are normally at risk of getting malnutrition and various diseases if they are not given foods containing enough nutrients. This is because their immunity is weaker than that of most adults. A balanced diet for children includes a mixture of foods with various nutrients to help them obtain necessary requirements for their bodies. These nutrients enable them to grow well both mentally and physically. Eating a balanced diet enables children to recognise the taste of various foods, hence develop skills and eating habits that will last for their lifetime.

This group needs to be given a balanced meal that contains soft foods, which they can manage to eat. Such children should be given foods containing large amounts of proteins since they are at the stage of rapid growth. The foods include milk, meat, fish, beans, peas, cowpeas, and eggs. Milk is the main food for young children, and it is the main source of proteins. Milk helps to build the child's body, strengthen its immunity, and develop the brain. It is also one of the best sources of calcium and vitamins A and D, which help to build and strengthen the child's bones, teeth, eyes, muscles and the brain.

During this period, children like to play different kinds of games. Therefore, they should be given enough food rich in carbohydrates to provide their bodies with energy. Children should be given enough foods which contain vitamins and minerals as shown in Figure 1. These foods will enable their bodies to protect themselves from different types of diseases.

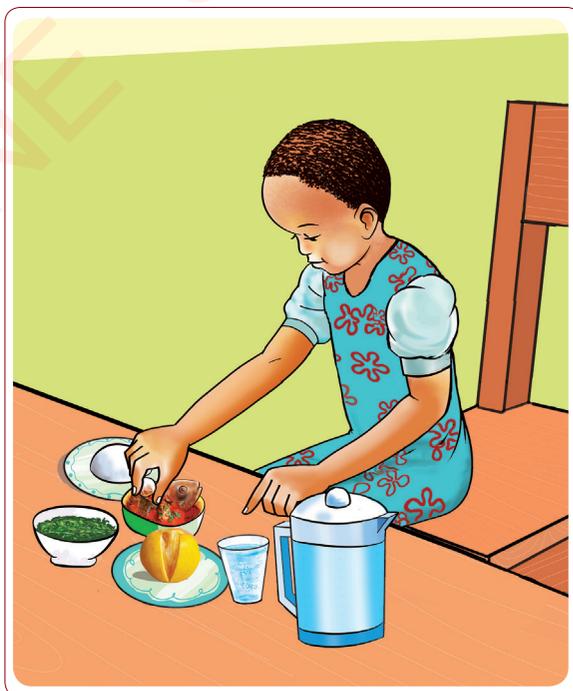


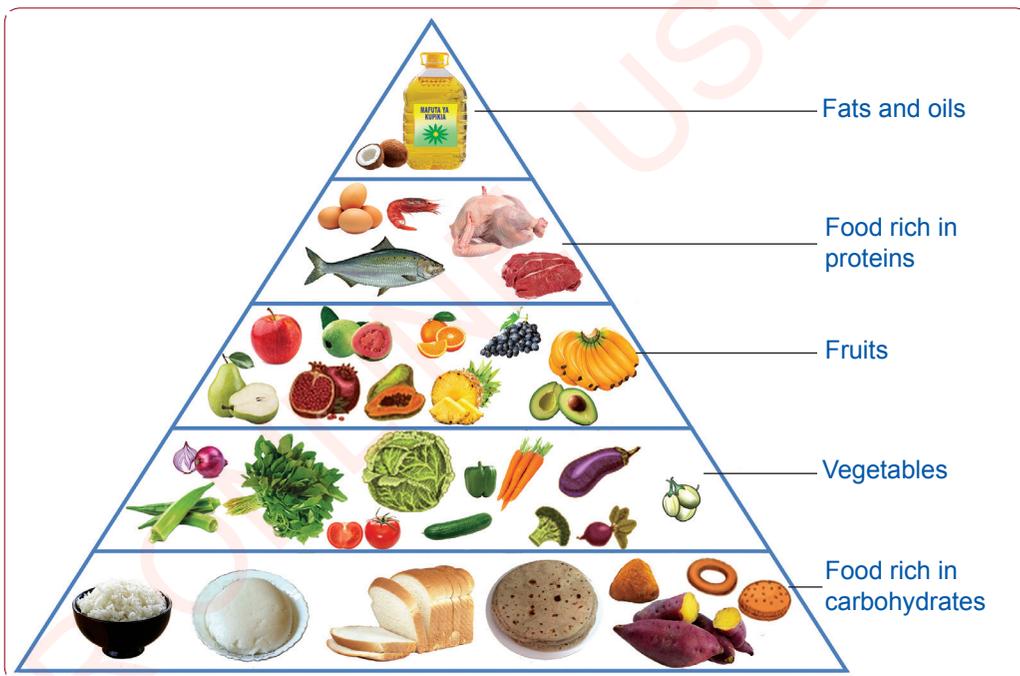
Figure 1: A meal for a child

**Activity 1: To plan a balanced meal for a four years old child**

Plan a balanced meal for breakfast, lunch and dinner for a four years old child.

**Meal for youths**

A youth is a person aged between 18 to 35 years old. During this period, the body continues to grow rapidly; thus, the youth needs a meal which contains enough nutrients which build, protect and give the body heat and energy. At this age, the youth is involved in various activities such as sport, farming, and prolonged studying. Therefore, it is important for the youth's meal to contain sufficient amounts of nutrients and in the right proportions of all types of foods. This will enable the youths to do their activities in good health. See Figure 2.



**Figure 2: Meal ratio for a youth**

**Activity 2: To plan a balanced meal for a youth**

Plan a balanced meal for breakfast, lunch and dinner for a youth.

### Meal for manual workers

People who are involved in manual jobs include porters, wheelbarrow and trolley pushers, auto mechanic or automotive technicians, and masons. People in this group need to eat a balanced diet just like other groups. They should eat a sufficient amount of food containing carbohydrates and proteins and a small amount of fats to give their bodies enough energy to perform heavy work. They should also drink enough water to facilitate digestion of food to give the body energy and to replenish the lost water through sweating. See Figure 3.

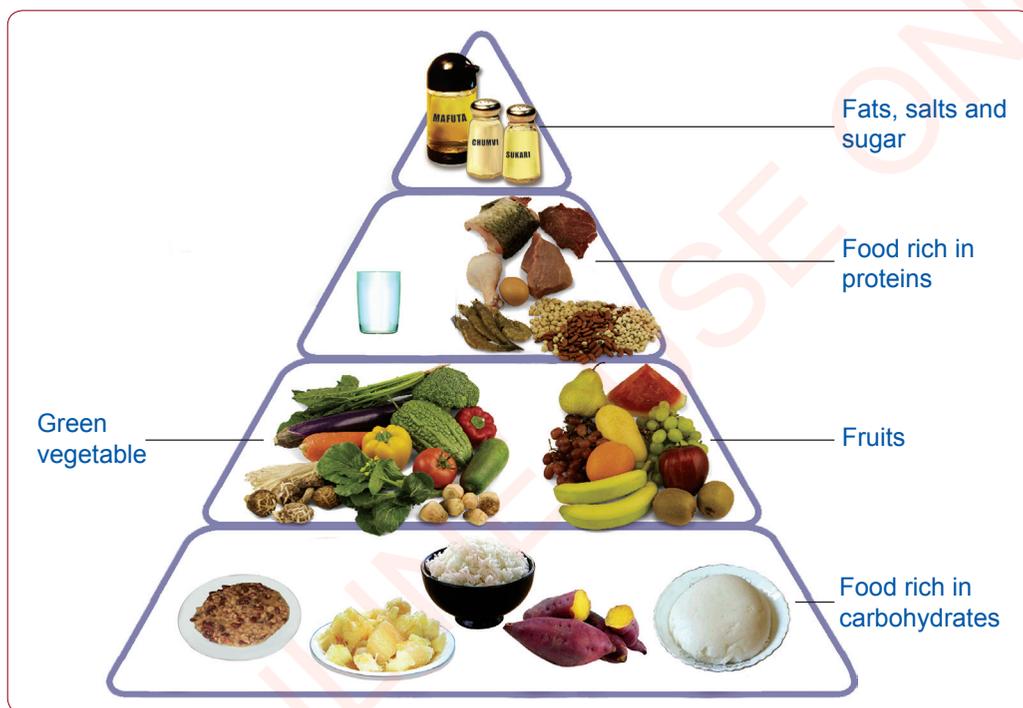


Figure 3: Meal ratio for manual workers

#### Activity 3: To plan a balanced diet for a manual worker

Plan a balanced meal for breakfast, lunch and dinner for a manual worker.

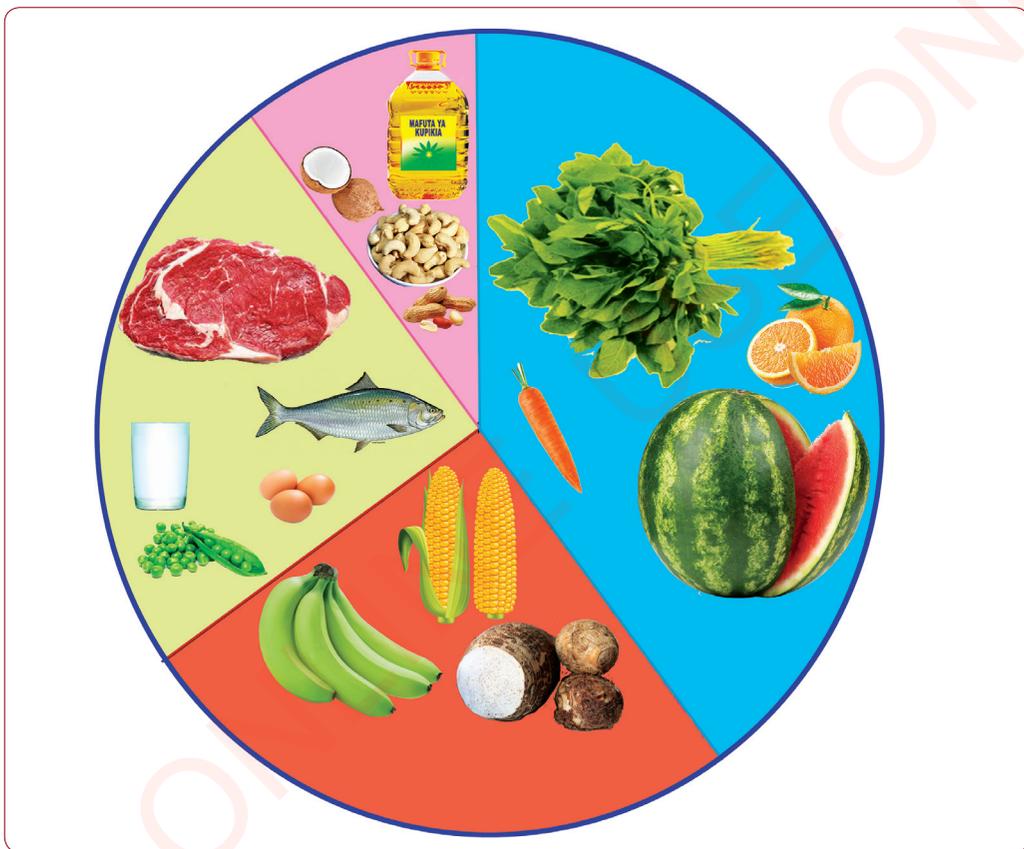
### Meal for sedentary workers

Sedentary workers are a group of people who are doing jobs which do not require a lot of energy. This group includes clerks, secretaries, librarians,

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and other officials. These people need a small amount of carbohydrates and fats. They often spend much of their time sitting while doing their duties.

People in this group need to eat a balanced diet containing a high amount of fruits and fresh green vegetables as shown in Figure 4. Fruits and fresh green vegetables reduce, regulate and maintain the body weight. These foods help sedentary workers to avoid the risk of being overweight and obese. Fruits and vegetables also help to reduce the risk of getting diseases such as high blood pressure and diabetes.



**Figure 4:** Meal ratio for sedentary workers

**Activity 4:** To plan a balanced meal for a sedentary worker

Plan a balanced meal for breakfast, lunch and dinner for a sedentary worker.

### Meal for pregnant women

Pregnant women need a balanced diet, which contains sufficient nutrients to improve their health and of the developing child. See Figure 5. They should eat meals which contain enough protein to support the development of the foetus. If the pregnant woman is not given meals which contain enough nutrients, there is a risk of giving birth to a child with health problems. Example of these problem are low weight, mental retardation, and anaemia. They should also eat foods which contain enough vitamins and minerals to prevent them from various diseases. These foods will enable the muscles and bones of the foetus to develop well. Normally, every meal eaten by a pregnant woman can either positively or negatively affect the development of the child. Minerals like iron and vitamins such as folic acid are important to ensure proper growth of the foetus. They also ensure that the mother has enough blood for safe delivery. For example, if a pregnant woman is deprived of essential minerals and vitamins in her diet, she can give birth to a child with defects in the muscles, bones, and the brain.



**Figure 5:** *Balanced meal for a pregnant woman*

#### **Activity 5:** *To plan a balanced meal for a pregnant woman*

Plan a balanced meal for breakfast, lunch, and dinner for a pregnant woman.

### **Meal for patients**

A person who cares for a patient should ensure that the patient is always given a balanced meal, because it helps to improve the body immunity against diseases. The meal also helps patients to gain energy and other essential nutrients. When a person is sick, he or she loses appetite and the ability to eat. Therefore, the patient should be given a small amount of food several times in a day. Patients should be given meals rich in proteins, vitamins, and minerals to replace the cells and tissues destroyed by various diseases. These foods will also help the patient to strengthen his/her muscles, bones, and body immunity to prevent him/her from further disease attack.

Dietary requirements for patients vary depending on the type of disease. Therefore, a balanced meal is given based on the type of disease and advice given by the medical doctor. For example, an anaemic person should also eat a meal with plenty of fresh green vegetables. The patient should also eat foods rich in iron such as meat, liver and fish to increase the ability of the body to produce red blood cells.

A patient with high blood pressure should not eat foods with high amounts of salt and fats. Salt increases heart rate to pump blood in the body. Fats narrow blood vessels and surround the heart. As a result, the heart fails to pump enough blood. Hence, the heart uses a lot of energy to pump enough blood to all parts of the body. This condition results into high blood pressure. A person with low blood pressure should eat foods with the right amount of salt. This is because the sodium found in the salt raises blood pressure.

A diabetic patient needs to reduce carbohydrate intake because such intake raises sugar level. Generally, patients are supposed to eat a balanced diet following advice from health experts.

### **Meal for elders**

This is a group of people whose bodies have reached the limit of growth. Elders should eat meals which are rich in vitamins to protect them from

recurring diseases. This is because, during this period, their body immunity is reduced. They should also eat foods rich in minerals to strengthen their bones, eyes, and body muscles. They should also eat small amounts of carbohydrates. This will help them get energy to perform simple work and avoid the risk of being obese. Elders are also required to eat foods rich in proteins. These foods will help them to replace dead cells and tissues.

The bodies of older people are weak; thus, they need close monitoring and care. Most of them have a limited ability to eat. Therefore, they should be regularly given small amounts of food in a day to help their bodies get the required amount of nutrients.

### Activity 6: To plan a balanced meal for elders

Plan a balanced meal for breakfast, lunch and dinner for the elderly.

### Exercise 2

**Answer the following questions:**

1. What particular types of foods should be given to children under five years?
2. (a) Which types of nutrients do you get when you drink milk?  
(b) What are the functions of the nutrients mentioned in (a) above in the human body?
3. Why does a sick person need meals which contain a sufficient amount of proteins and vegetables?
4. Group the following foods according to their food groups: Ugali, mango, fish, soy, coconut, orange, rice, carrot, jackfruit, cashew nut, cassava, spinach, groundnut, and meat.
5. Explain why it is important for pregnant women to eat food rich in proteins.

## Physical exercise for various groups of people

Physical exercise is important for building good health. The ability and capacity to exercise vary based on age, work, and the health status.

### Physical exercise for children under five years old

Normally, children are always active when they are healthy. Therefore, they do not need specific types of physical exercise since they are always busy with various activities. They like to draw and create various objects which help them to build their creativity. Children like to play with various objects such as dolls. They also like to transfer things from one place to another. They like to throw or catch a ball, climb chairs and ride bicycles as shown in Figure 6. They also like to jump and run. Such physical exercise helps them to build and improve their muscles and enables them to master various skills in their lifetime.

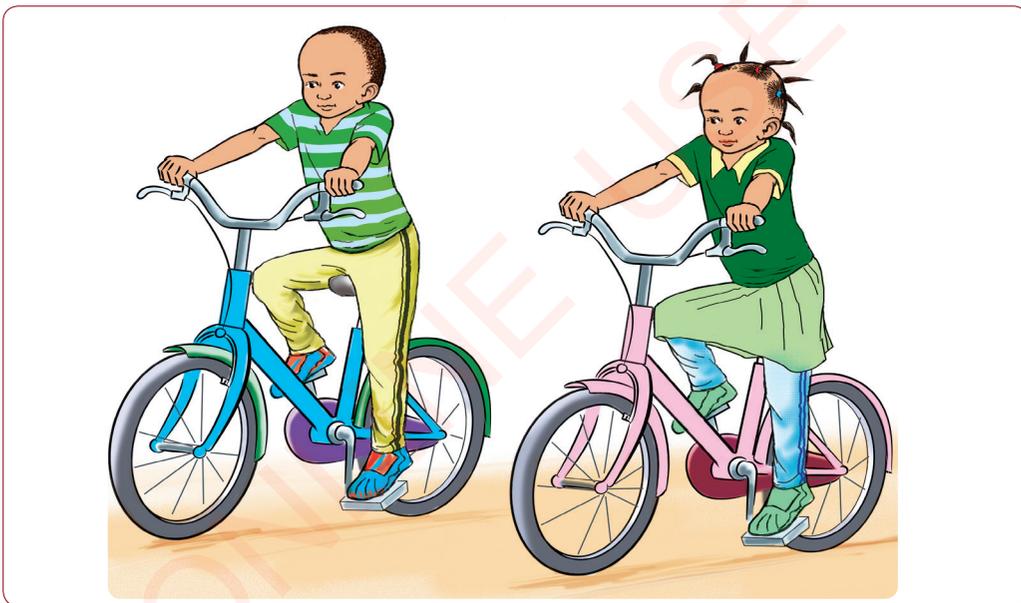


Figure 6: Physical exercise for children

### Physical exercise for youths

Youths can do various types of physical exercise without getting serious side effects. They can play various games such as football, hurdles, and running. Some of these games are shown in Figures 7 and 8. Youths can do manual work such as farming, masonry, and lifting heavy loads. This is because their muscles and bones are fully developed.

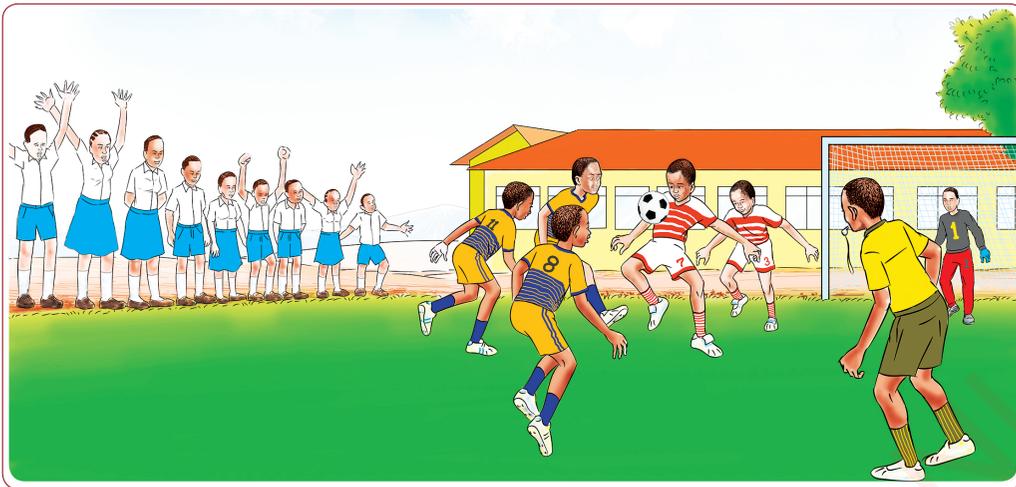


Figure 7: Football game



Figure 8: Netball game

### Physical exercise for sedentary workers

Sedentary workers are supposed to do physical exercise to make their bodies active. This group is at risk of getting diseases such as high blood pressure, cancer, diabetes, and bone diseases. Physical exercise helps them to reduce the risk of getting such diseases. It also improves their body immunity, muscles, bones, and reduces the risk of getting obese. The types of physical exercise that can be done by this group include rope skipping, running, walking and others. Figure 9 shows some of these exercises.



Figure 9: Physical exercise for sedentary workers

### Physical exercise for pregnant women

A pregnant woman should do light physical exercise such as walking as shown in Figure 10. Other types of physical exercise that can be done include stretching the neck and arm muscles. A pregnant woman should seek medical advice before exercising to avoid affecting the developing unborn child. Exercising helps the pregnant woman to strengthen her muscles and control body weight, thus, enabling her to have easy delivery. It also makes a pregnant woman to feel comfortable and relieve fatigue.



Figure 10: Physical exercise for pregnant women

### Physical exercise for elders

Elders need to do light physical exercise that will help them strengthen their muscles and bones. Such exercise includes walking, stretching their body parts, and doing simple activities, which can be managed by their bodies as shown in Figure 11. Exercise help elders to improve blood circulation, control body weight, and activate their bodies.



Figure 11: Physical exercise for the elderly

### Advantages of doing physical exercise

It is recommended to do physical exercise for at least 30 minutes everyday. Doing physical exercise regularly help

- (a) to have good health;
- (b) to strengthen the functioning of various body systems such as circulatory, digestive, and excretory systems;
- (c) to strengthen body immunity against diseases;
- (d) to reduce the risk of getting diseases such as high blood pressure, stroke, cancer, diabetes, and arthritis;
- (e) to prevent stress and depression;
- (f) to activate the brain and refresh the body; and
- (g) to strengthen relationship with other people.

## Negative effects of not doing physical exercise

Failure to do physical exercise can result into the following:

- (a) Some of the body systems and the brain will not function properly, and the body may fail to act on emergencies;
- (b) Body immunity can be affected; hence, a person will be at risk of getting various diseases;
- (c) Increase in body weight which may make a person obese and deform his or her body shape;
- (d) Getting weight related diseases such as high blood pressure, diabetes, and heart problems;
- (e) Reducing thinking capacity and quick decision making; and
- (f) Getting depression and general weakness of muscles and bones.

### Activity 7: Doing physical exercise

**Requirements:** Skipping rope, sport shoes and clothes, balls for football and netball

#### Steps

1. Take the skipping rope and play rope skipping.
2. Continue playing games such as football and netball based on your capacity for two weeks.
3. Discuss with your fellow pupils the changes which you feel in your body before and after exercising for two weeks.

### Exercise 3

Answer all questions in sections A, B and C.

#### Section A

Choose the most correct answer and write its letter in the box provided.

1. The following are the types of physical exercise EXCEPT \_\_\_\_\_.
- (a) walking
  - (b) playing ball
  - (c) rope skipping
  - (d) listening to music
-

2. Playing football is more appropriate to \_\_\_\_\_.
- (a) pregnant women
  - (b) children under five years
  - (c) elders aged 70
  - (d) youths
3. A balance diet is a meal which contains \_\_\_\_\_.
- (a) nutrients from fats, carbohydrates and proteins
  - (b) nutrients from proteins, carbohydrates, fats, vitamins and minerals
  - (c) nutrients from vitamins, minerals and proteins
  - (d) nutrients from vitamins only
4. The following mineral is essential for strengthening bones and teeth \_\_\_\_\_.
- (a) Iron
  - (b) Magnesium
  - (c) Calcium
  - (d) Potassium
5. The main function of vitamins is helping the body to \_\_\_\_\_.
- (a) get energy for working
  - (b) have enough heat
  - (c) grow and increase in size
  - (d) be protected from diseases

### Section B

6. Write **TRUE** for a correct statement and **FALSE** for an incorrect statement.
- (a) The foods which are rich in mineral nutrients help to build the body. \_\_\_\_\_
  - (b) The main function of protein nutrients is to protect the body against diseases. \_\_\_\_\_
  - (c) Doing physical exercise strengthens the body and regulates its weight. \_\_\_\_\_

- (d) Lack of physical exercise leads to diseases such as high blood pressure, stroke, and diabetes. \_\_\_\_\_
- (e) Manual workers are supposed to eat a lot of fats and lipids. \_\_\_\_\_
- (f) It is advised to do physical exercise for at least 30 minutes a day to have good health. \_\_\_\_\_

### Section C

- 7. Mention five types of physical activities which can be done at school.
- 8. Mention types of physical exercise which are appropriate for the following groups:
  - (a) Children under five years,
  - (b) The elderly,
  - (c) Youths, and
  - (d) Pregnant women.
- 9. Mention types of diseases which sedentary workers can get when they do not do physical exercise.
- 10. What are the advantages of doing physical exercise?
- 11. What are the possible effects on a pregnant woman who does not do physical exercise?
- 12. Why is it important for elders to do physical exercise?
- 13. Why is it important to do physical exercise in the morning or evening?

### Vocabulary

Balanced diet	a meal that contains the main food groups
Clerk	a person whose job involves keeping records or performing general office duties
Depression	feeling of severe dejection or mood disorder that causes distressing symptoms that affect how you feel or think
Manual worker	a person whose job involves working with hands

## Chapter Nine

### Nervous system

#### Introduction

*In Standard Six, you learnt about the circulatory system and the reproductive system. In this chapter, you will learn about the concept of the nervous system, its parts and functions. You will also learn about the functions of different sensory organs, their disorders and how to rectify those disorders. The competencies developed will help you to take care of this system and avoid behaviours that can cause disorders in the nervous system.*

#### The concept of the nervous system



#### Think

1. Reasons for closing eyes when you move from a dim light to a bright light area
2. Reasons for sweating when the temperature rises

Responding to stimuli is one of the characteristics of living organisms. Living organisms respond to stimuli through the nervous system. These stimuli include sound, taste, smell, touch, light, and temperature changes. The nervous system coordinates both voluntary and involuntary actions in the human body. Examples of voluntary actions are playing ball, eating, talking, and reading. Involuntary actions include sneezing, regurgitating, breathing and beating of the heart. These actions enable the body to recognize and respond appropriately to the changes that occur outside and inside the body.

#### Parts of the nervous system

The nervous system is divided into two main parts. These parts are the central nervous system and the peripheral nervous system. The central nervous system is made up of the brain and the spinal cord. The peripheral

nervous system is made up all the nerves that lie outside the brain and the spinal cord. See Figure 1.

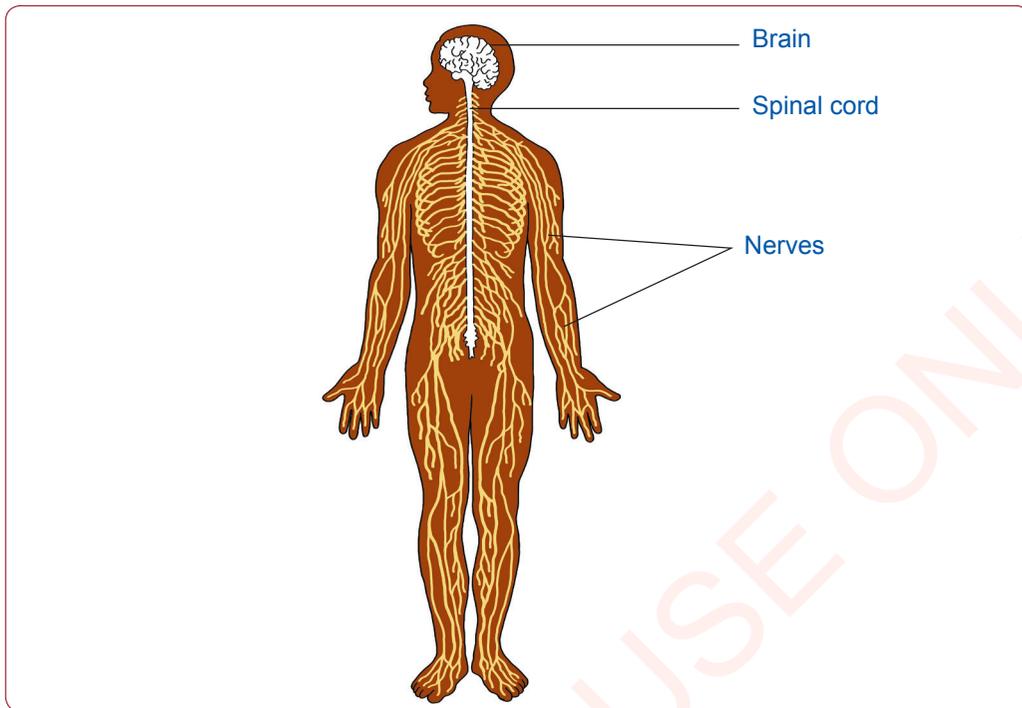


Figure 1: *The human nervous system*

### Parts of the central nervous system and their functions

The central nervous system is divided into two main parts, namely the brain and the spinal cord.

#### The brain

This is the largest and most important part of the central nervous system. Due to its importance, the brain is encased inside the skull so that it is not touched or injured by anything. The brain receives information from various sense organs through nerves. The main function of the brain is to coordinate various actions including learning, remembering, speaking, and

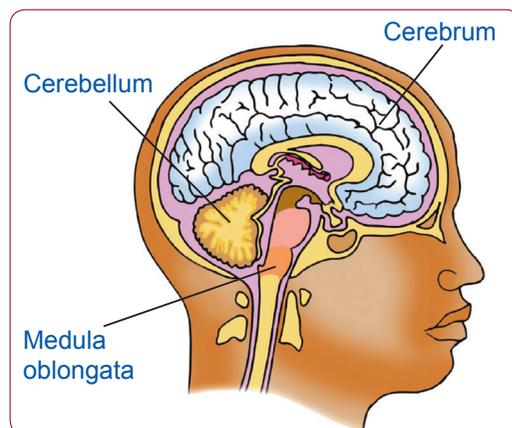


Figure 2: *Parts of the human brain*

thinking. The brain is divided into three main parts. These are the cerebrum, cerebellum and medulla oblongata, as shown in Figure 2.

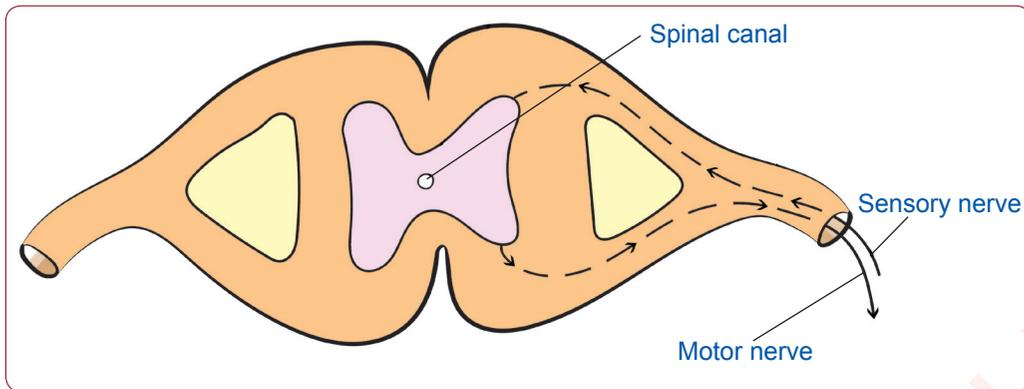
**Cerebrum:** This is the largest part of the brain. It is folded to increase its surface area. The cerebrum is divided into two parts: the left and right parts. The right part of the cerebrum coordinates actions of the left part of the body, while the left part coordinates actions of the right part of the body. The cerebrum coordinates many functions of the body, such as thinking, deciding, learning, remembering, and moving. This part also interprets senses of touch, sight, hearing, taste and smell. Hence, a person may have eyes and ears, but, if the part of cerebrum involved is damaged, he/she will not be able to see or hear.

**Cerebellum:** This part of the brain is found below the cerebrum. Its main function is to coordinate the movement of the muscles in the body. The cerebellum also receives information from parts of the ear that are involved in maintaining body balance. It also coordinates all movements related to voluntary actions of the muscles such as walking, picking up something, riding a bicycle, and swimming. These actions are performed efficiently after learning and getting used to them.

**Medulla oblongata:** This is a very small part of the brain that is connected to the spinal cord. This part coordinates all involuntary actions such as breathing, heartbeat and the increase or decrease in body temperature. Other involuntary actions include digesting food, coughing, sneezing, vomiting and swallowing. This part also coordinates all information travelling between the brain and the spinal cord.

### The spinal cord

This part of the central nervous system is connected to the medulla oblongata. In the human body, the spinal cord is found in a hollow space of the vertebral column. The spinal cord is encased inside the interlocking bones within the vertebral column, and it forms a canal from the neck to the waist. The spinal cord is soft and delicate; hence, the vertebral column protects it from mechanical injury. In each spine of the vertebral column, two nerves called motor and sensory nerves move from the spinal cord to various parts of the body. These nerves function to transmit and retrieve information from various parts of the body. See Figure 3.



**Figure 3:** A section of spinal cord

The spinal cord is a major means of communication between the brain and other parts of the body. That is why, when the spinal cord is injured, communication between the brain and other parts of the body is lost. The spinal cord communicates with the brain through nerves. The spinal cord functions to coordinate involuntary actions arising from external stimuli. Some of these actions include a sudden movement of knee jerk after being touched at its lower part. Other involuntary actions include the dilation and contraction of the urinary bladder and a rapid removal of a body part upon touching a sharp or hot object. These actions protect the body from being harmed.

The function of the central nervous system is to receive information from outside and inside the body and to produce appropriate responses. These responses are transmitted to other parts of the nervous system or organs of the body for appropriate responses.

### **Activity 1:** *Constructing a model of the central nervous system*

**Materials:** Manila sheets, light white paper, glue, wheat or cassava flour or clay, stick, and different watercolour paint

#### **Procedure**

1. Fold a manila sheet of about five centimeters wide to form a hollow tube.
2. Fold another manila sheet to form a thin long pipe.
3. Moisten the clay and make a soft lump.

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4. Cut the clay soil lump into four different parts with different sizes. Make sure they do not dry.
5. Wrap one large clay lump from Step 4 in white paper and make folds around it using a thin stick. Put the lump in the manila sheet with a hole that you have made in Step 1. This part represents the cerebrum.
6. Take two small sized clay lumps and construct a model of the cerebellum and medulla oblongata. Then connect it with the cerebrum. The portion of the model representing the medulla oblongata should be small. Paint the three parts of the brain model representing the cerebrum, cerebellum and medulla oblongata to distinguish them.
7. Take the fourth lump and lengthen it to a long stick depending on the length of the hollow manila sheet tube.
8. Insert a stick of clay lump into the pipe. This stick represents the spinal cord, and the pipe is the vertebral column that protects the spinal cord.
9. Connect the spinal cord and the brain model as shown in Figure 1. Then, let it dry.
10. Paint each part of the brain model that you made using different colours.

## The peripheral nervous system

The peripheral nervous system is made up of nerves that lie outside the brain and the spinal cord. Nerves are fibre like cells that connect all parts of the body with the central nervous system. The nerves also connect sensory organs with the central nervous system. These sensory organs include the eyes, ears, skin, tongue and nose. The nerves transmit information to the central nervous system for the body to give appropriate responses, timely and efficiently. For example, the central nervous system receives information from the nerves when a person is thirsty, hungry, in pain or needs to go to the toilet. This system provides responses to wait or fulfil those needs. These responses enable the body to function properly and safely.

### Nerve structure

Nerves are among the cell types that make up the body of an animal. They are made up of nerve cells or neurones. Each neurone is made up of a nucleus surrounded by cytoplasm. The nucleus and cytoplasm form the cell body. The cytoplasm has branches called dendrites. Dendrites take information from

their surroundings and transmit them to the cell body of the responsible nerve. On the other side of the cell body, there is a long thread-like extension called the axon. This connects the cell body of one nerve with another or a cell body of a nerve and an organ. See Figure 4.

Nerves have different structures depending on their positions in the body. These structures enable them to function properly. For example, the sciatic nerve that receives and transmits information to the limbs has long axons starting from the waist to the feet.

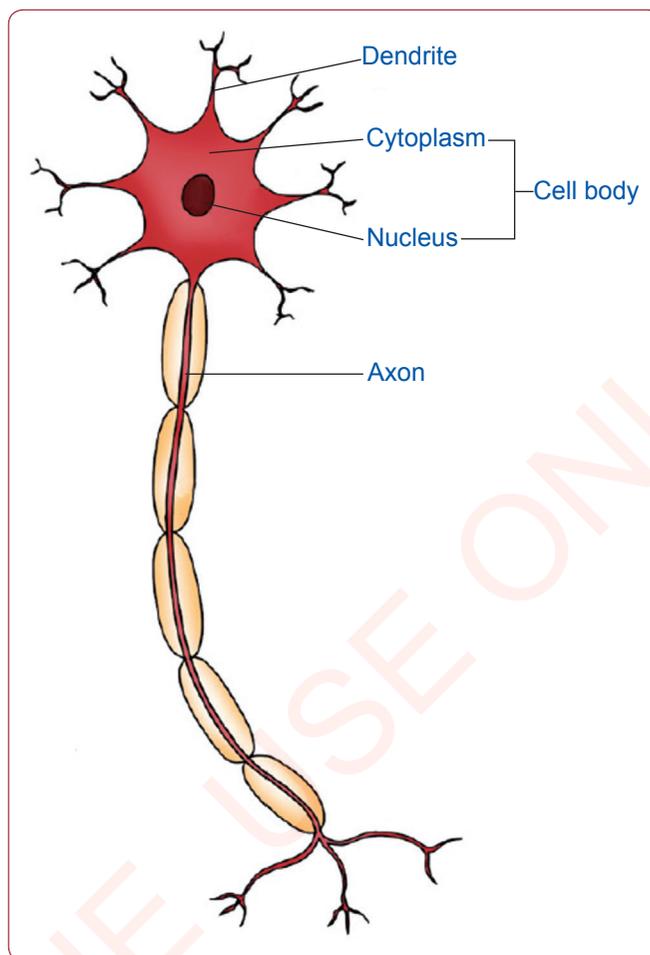


Figure 4: Structure of a nerve cell

### Types of nerve cells and their functions

Nerve cells are divided into three main types: sensory nerves, motor nerves, and relay or intermediate nerves. Sensory nerves take information from various parts of the body such as sensory organs and transmit them to the central nervous system. Motor nerves take information from the central nervous system and transmit them to various parts of the body where the response occurs. The response is based on the type of information. Relay or intermediate nerves carry information from sensory nerves to motor nerves. Thus, the intermediate nerves connect the sensory nerves with the motor nerves.

**Activity 2: To examine how nerves work**

**Materials:** chair and ruler

**Procedure**

1. Sit on a chair and place one foot on top of the other as shown in Figure 5.
2. Allow your fellow pupil to tap the lower part of the knee of your leg, which is above the other leg, using a ruler. Observe what will happen.
3. Exchange the sitting position with your fellow pupil; you should stand and do what your fellow pupil did to you. Write down what you have observed.



**Figure 5:** *The ways nerves works*

**Question**

Is the shock experienced on the foot voluntary or involuntary? Explain your answer.

## Differences between the central nervous system and the peripheral nervous system

**Table:** *Differences between the central nervous system and the peripheral nervous system*

Central nervous system	Peripheral nervous system
(i) This system is made up of the brain and the spinal cord.	(i) This system is made up of nerves outside the brain and the spinal cord.
(ii) Nerves are covered by the skull and the vertebral column.	(ii) Nerves are not covered by bones. They freely start at the beginning of a muscle or tissue to the end.
(iii) The main function of the central nervous system is to receive stimuli from outside and inside the body and provide interpretations.	(iii) The main function of the peripheral nervous system is to connect the central nervous system with other body parts. It takes stimuli from the sensory organs and inside the body, then transmits them to the central nervous system and returns the translated information to the sensory organs.

### Exercise 1

**Answer the following questions:**

1. Explain three main types of nerve cells and their functions.
2. Differentiate between voluntary and involuntary actions.
3. Describe the two main parts of the central nervous system.
4. Explain the importance of involuntary actions in securing the safety of the human body.

## Sensory organs

Sensory organs are structures of the body that are capable of receiving stimuli from external and internal changes in the body. These organs receive information and transmit them to the central nervous system. The ability to taste, see, hear, smell, and sense temperature changes is done through the sensory organs. In the human body, there are five sensory organs. These sensory organs are eyes, ears, nose, tongue and the skin. These organs are connected to the brain by nerves.

Any defect or disorder of the sensory organ affects the interpretation of the stimuli arising from the environment. For example, a disorder in the ear can cause deafness to a person, and a defect in the eyes can cause blindness to a person. Thus, sensory organs are important since they help the living organism to carry out its daily activities.

### The eye

Eyes are sense organs that enable us to see. They are located on the face in holes called eye sockets. The eyes are held in place by muscles. These muscles rotate the eye to enable it to see different directions. The eyes are the only organs that receive light and form images. The interpretation of an image is given by the brain after receiving information from the eye through the optic nerve. Light is the energy that enables us to see different objects.



#### Discuss with your fellow pupils

The changes that occur in eye vision when a person moves from the bright to dim light

### Parts of the eye and their functions

The eye is made up of two main parts: the internal and external parts. The external part is made up of eyebrows, eyelashes and eyelids. The internal part is made up of the conjunctiva, cornea, fluid called aqueous humour, pupil, iris, lens held by ciliary muscles, a fluid called vitreous humour, retina and the optic nerve as shown in Figure 6.

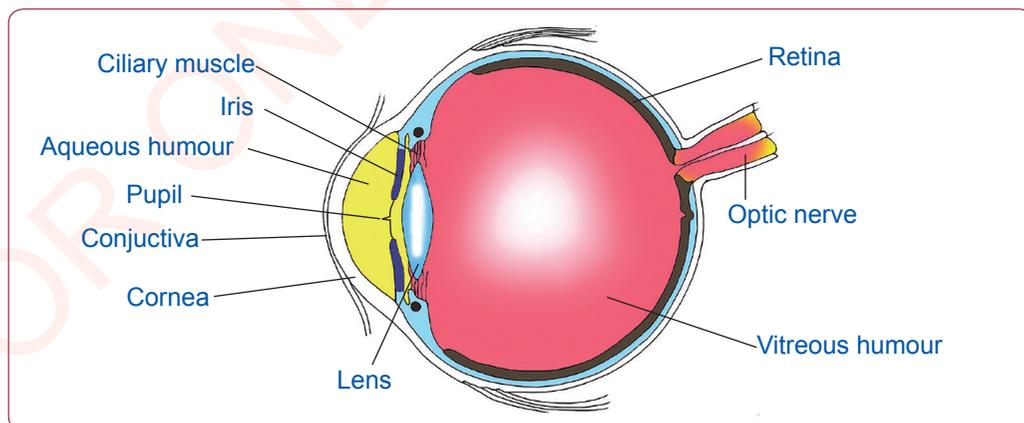


Figure 6: The internal structure of the eye

## Functions of the parts of the eye

**Eyelid:** This is a skin that covers the eye to protect it from injury and entrance of foreign objects. On the upper and lower parts of this lid, there are hairs called eyelashes. Eyelashes prevent dirty substances such as dust from getting into the eye.

**Conjunctiva:** This is a transparent thin skin that covers and protects the cornea.

**Cornea:** This is a transparent thin membrane of skin that covers the front part of the eye. This membrane refracts light to reach the lens before reaching the retina.

**Ciliary muscles:** These are muscles that expand and shrink to change the shape of the lens that allows light to pass through.

**Lens:** This is the part that allows light to pass and refracts it in order to fall on the retina to form an image of an object. The muscles holding the lens contract or relax, thus changing the shape of the lens. This process enables the person to see objects at different distances.

**Aqueous humour:** This is a salty fluid. It is located in a small part between the cornea and the lens. The fluid allows light to pass through.

**Iris:** This is a coloured membrane that regulates the amount of light entering the eye.

**Pupil:** This is a space or opening in the iris through which the light passes towards the lens.

**Vitreous humour:** This is a jelly-like fluid that fills the back part of the lens and makes the eye to be circular in shape.

**Retina:** This part has a layer of cells which are stimulated by light that facilitates the formation of images.

**Optic nerve:** Is a collection of nerves that carry information in the form of image from the retina and transmit it to the brain. The brain interprets that image.

### Activity 3: To examine the dilation and contraction of the pupil

**Materials:** Torch, a piece of cloth, a watch and a plane mirror

#### Procedure

1. Use a plane mirror to check the size of the pupil of your eye.
2. Close your eyes and wrap them using a piece of cloth for two minutes.
3. Remove the piece of cloth and open your eyes.
4. Immediately, direct the light of the torch to your pupil.
5. Look on the plane mirror to see the change in your pupil size.

**Note:** Use a torch with light intensity which will not affect your iris.  
This activity can be done in pairs.

#### Questions

1. What causes decrease or increase in pupil size?
2. What is the advantage of increasing or decreasing the size of the pupil?

### Defects of the eye and how to correct them

Correct image formation of an object takes place on the retina. The image that reaches the retina is upside down as shown in Figure 7. This image is then transmitted to the brain where it is transformed into a real object.

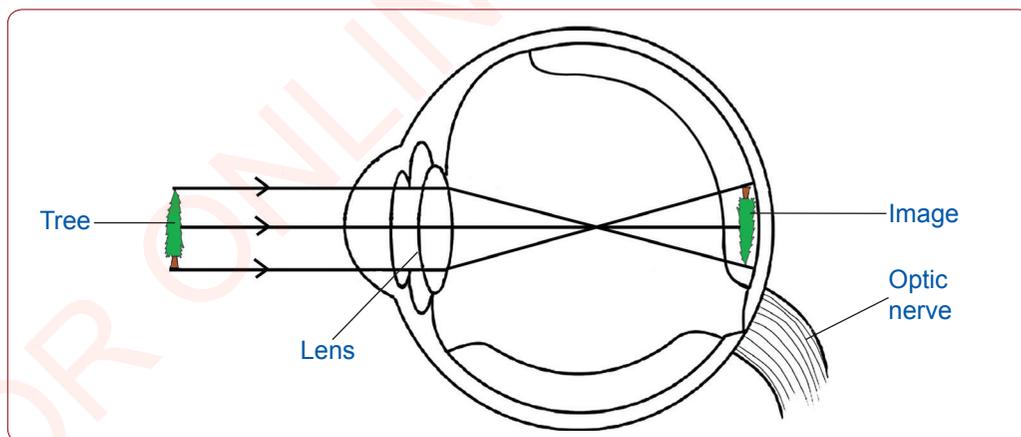


Figure 7: Image of an object in the eye

We often see people wearing spectacles. These spectacles help them to see images of different objects in their reality. A person wears spectacles

to correct a defect in his/her eyes. Two common defects can occur in the human eye. These are short sightedness and long sightedness.

### Short-sightedness or myopia

This defect occurs when a person is unable to see distant objects but can clearly see nearby objects. This problem is caused by high converging power of the lens or abnormally large eye ball that forms images before reaching the retina. Thus, light rays from distant objects converge before reaching the retina. This results into the formation of an image in front of the retina. See Figure 8.

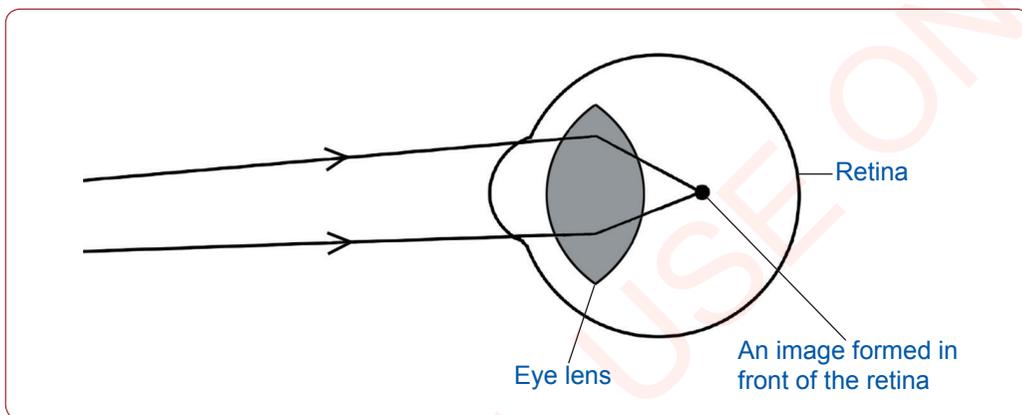


Figure 8: An eye with a short-sightedness defect

Short-sightedness is corrected by wearing spectacles with concave lenses. These lenses diverge light rays and bring them to the retina. Thus, the image of the object is seen clearly as shown in Figure 9.

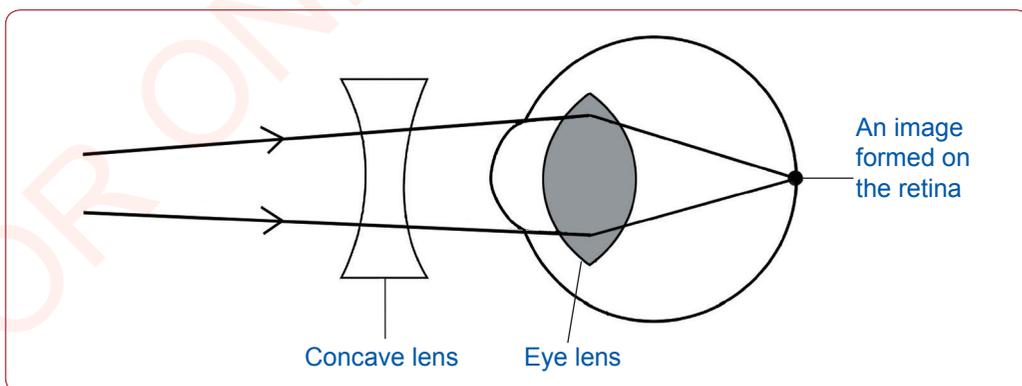


Figure 9: Correction of short-sightedness or myopia

### Long-sightedness or hypermetropia

Some people can see far objects but cannot clearly see nearby objects. This defect is caused by low converging power of the lens or the eye ball being smaller than normal. Accordingly, the image of an object is formed behind the retina. The image is then focused behind the retina rather than on it as shown in Figure 10.

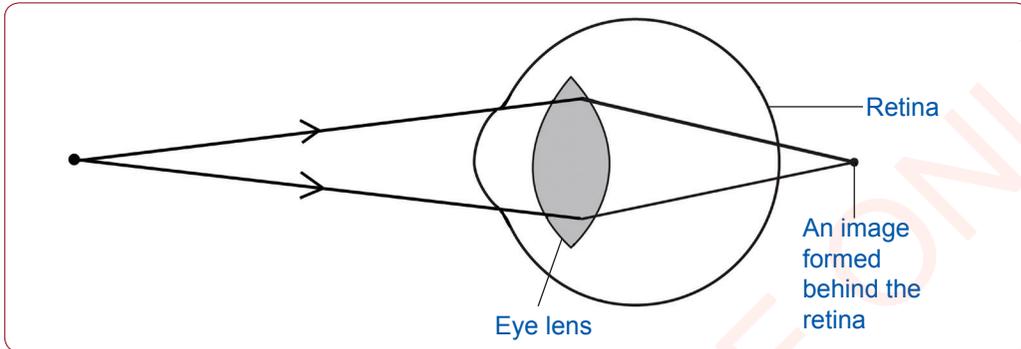


Figure 10: An eye with a long-sightedness defect

Long-sightedness is corrected by wearing spectacles with convex lenses. These lenses converge the scattered rays and land them on the retina as shown in Figure 11.

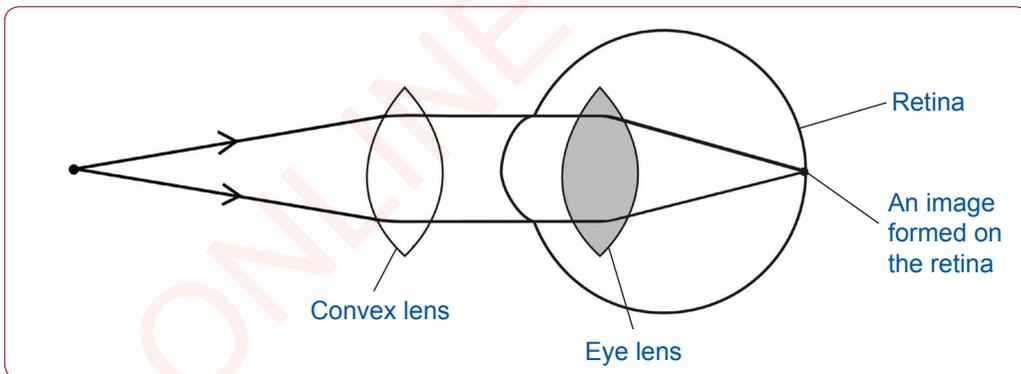
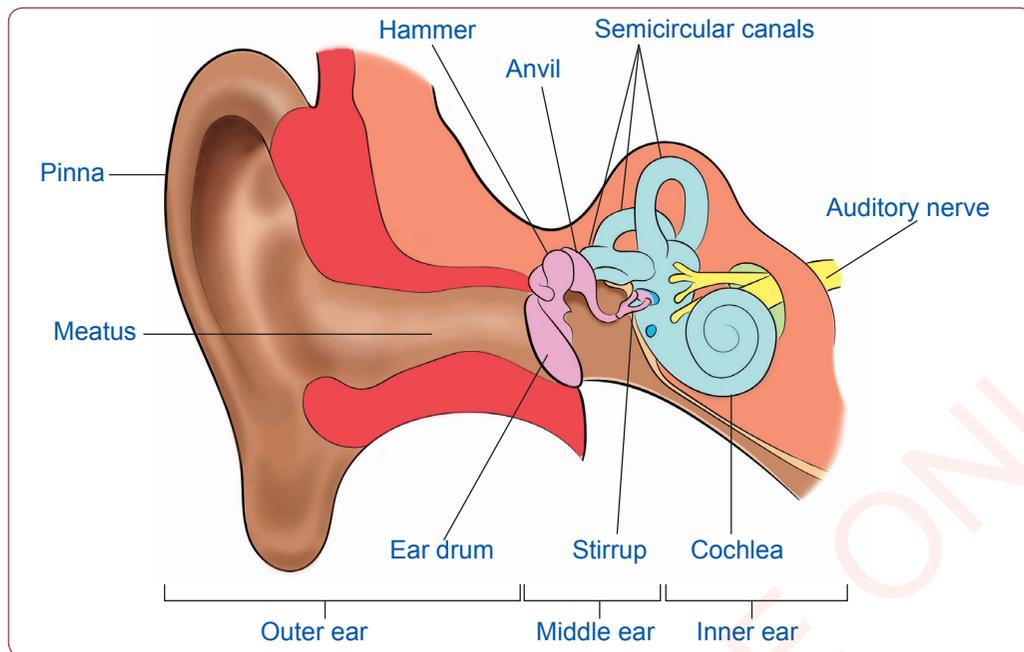


Figure 11: Correction of long-sightedness

### The ear

This is an organ for hearing sounds. The ear is also responsible for balancing the body. It is divided into three main parts. These parts are the outer, middle and inner ear as shown in Figure 12.



**Figure 12:** Parts of the human ear

The outer ear is made up of a pinna and a canal or meatus that leads to the inner ear. The function of the outer ear is to collect sound waves and direct them to the middle ear. Sound waves are vibrations that travel through the air. These vibrations cause the ear drum to vibrate and move sound waves to the middle ear.

The middle ear is made up of the ear drum and three connected bones. The bones are the hammer, the anvil, and the stirrup. These bones function to receive vibrations of sound waves from the ear drum and direct them to the inner ear.

The inner ear is made up of semi-circular canals and cochlea. The function of semi-circular canals is to balance the body. The cochlea contains fluid-filled channels and microscopic hair fibres. When sound waves reach the cochlea, the fluid present scatters and stimulates the hair fibres. The microscopic hair fibres receive the sound wave's vibrations and transmit them to the auditory nerve. This nerve transmits sound waves to the brain for interpretation. Excessive sound can hurt the ears and affect the ability to hear. Therefore, it is advised against using devices which produce loud sounds in the ear or to sit near objects that produce loud sounds.

## The tongue

This organ is responsible for detecting tastes of various substances. You cannot recognise the taste of anything without using the tongue. This ability is due to the presence of taste buds in the tongue.

When eating, a person gets a general taste of food even though every part of the tongue detects a specific type of taste. The tip of the tongue contains taste buds cells that can detect sweetness. Taste buds that detect the salty taste are found on both sides of the front part of the tongue. The central part of the tongue contains many taste buds that detect umami, a taste which is found in foods such as meat, mushrooms and tomatoes. The peripheral parts of the tongue contain taste buds that can detect the sour taste. At the back, the tongue has more taste buds that can detect the bitter taste. See Figure 13. The tongue is also used for talking, eating, and swallowing.

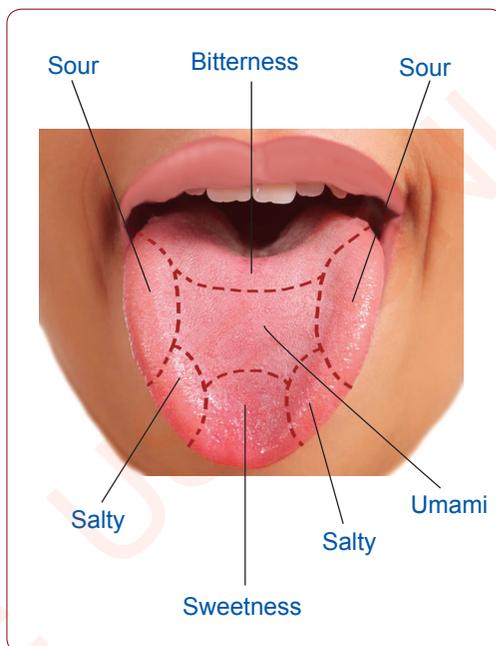


Figure 13: Tongue taste buds

## The nose

This is a protruded organ on the human face with two holes. One of the functions of the nose is to allow air to pass during breathing and speaking. Another function of the nose is to detect smells of different substances. Smells of substances travels through the air and enters the nose. Inside the nose, there are hairs that are connected to nerves as shown in Figure 14. The nerves that

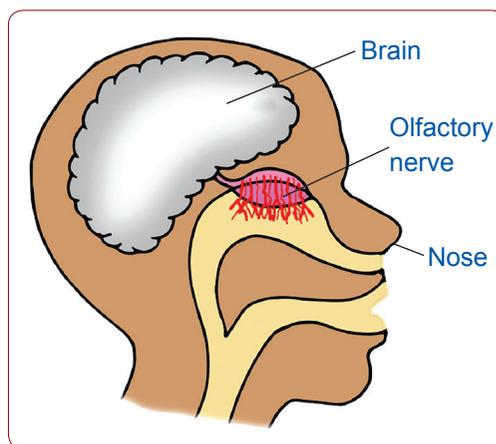


Figure 14: Parts of the nose

carry information from the nose to the brain are called olfactory nerves. When these nerves detect a certain smell, they send information to the brain for interpretation.

### The skin

This is the organ that covers the human body. The skin functions to detect sensations of warmth, cold, touch, pressure, pain, and vibrations. The skin is divided into three main parts, which are the upper layer, the middle layer and the inner layer. See Figure 15. The skin also has hairs, sensory nerves, blood vessels, and sweat glands. The upper layer has numerous nerves. However, the amounts of nerves vary from one part of the body to another. This layer contains melanin substances. Melanin gives the skin its colour. This substance helps to protect the body from direct sun rays.

Some babies are born with a skin that has a very little amount or no melanin at all.

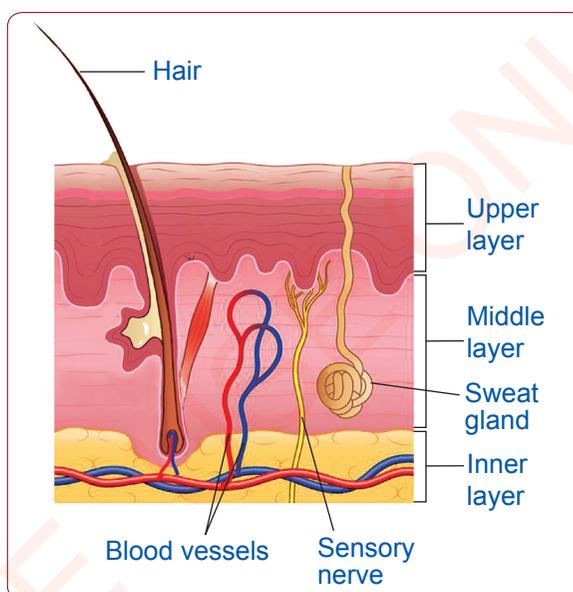


Figure 15: Parts of the skin

This condition is called albinism. The skin of a person with albinism has little ability of protecting the body from direct sun rays. Therefore, they are advised to wear hats and clothes that cover most of their bodies. Examples are trousers and long-sleeved shirts. They are also advised to use special lotions to reduce the effects of direct sun rays on their skins. This in turn helps to prevent their skins from getting wounds from sunburn.

### Disorders of the nervous system

The nervous system can experience various disorders, which can affect its functioning. These disorders can be caused by the following factors:

- (a) Diseases such as meningitis, leprosy, epilepsy and polio: These diseases affect the nerves and make the victim unable to detect the

changes in the environment. Other disease like high blood pressure can affect the brain, thereby causing stroke. This condition causes paralysis and inability to walk or talk.

- (b) Accident which affect the brain or spinal cord: These accidents affect the nervous system and make the victim unable to work properly. For example, a defect of the spinal cord can lead to paralysis.
- (c) Depression and stress which cause stroke and in turn affect the functioning of the nervous system: Drug abuse can also cause disorders in the nervous system. A drug addict may fail to make the right decisions.

### Caring for the nervous system

It is important to take care of the nervous system to enable the body to function effectively. Ways of caring for the nervous system are as follows: One should give the brain time to rest by getting enough sleep of at least eight hours a day. Sleeping calms it down and enables it to function properly. Eating a balanced diet, especially the food rich in vitamin A is important. Physical exercise is essential for the health of the nervous system. It is better to avoid stress to reduce the risk of having a stroke. It is also good to take care of the sensory organs by getting proper treatments when they are attacked by diseases. It is advised to take precautions by observing road safety rules to avoid accidents that may affect the nervous system. In addition, it is important to avoid using drugs, alcohol and cigarettes. These substances affect the proper functioning of the nervous system.

#### Exercise 2

Answer all questions in sections A, B, C and D.

##### Section A

Choose the most correct answer and write its letter in the box provided.

1. The following are the disorders in the sensory organs EXCEPT \_\_\_\_\_.
- (a) deafness
  - (b) short-sightedness
  - (c) anaemia
  - (d) long-sightedness
-

2. The sensory organ that is responsible for the sensations of hotness and coldness is the \_\_\_\_\_.
- (a) eye
  - (b) ear
  - (c) tongue
  - (d) skin
3. The function of the outer ear of the human is \_\_\_\_\_.
- (a) collecting sound waves
  - (b) interpreting sound waves
  - (c) dispersing sound waves
  - (d) stimulating the inner ear
4. The correct arrangement of the three bones in the middle ear is as follows: \_\_\_\_\_.
- (a) anvil, hammer, and stirrup
  - (b) stirrup, hammer, and anvil
  - (c) hammer, stirrup, and anvil
  - (d) hammer, anvil, and stirrup
5. The brain is divided into three parts, which are the \_\_\_\_\_.
- (a) cerebrum, medulla oblongata, and vertebral column
  - (b) cerebellum, spinal cord, and medulla oblongata
  - (c) cerebrum, cerebellum, and medulla oblongata
  - (d) medulla oblongata, cerebrum and spinal cord
6. The nerve that transmits information from the nose to the brain is called the \_\_\_\_\_.
- (a) olfactory nerve
  - (b) optics nerve
  - (c) acoustic nerve
  - (d) auditory nerve
7. The nerve that transmits information from the retina to the brain is called the \_\_\_\_\_.
- (a) auditory nerve
  - (b) optic nerve
  - (c) acoustic nerve
  - (d) olfactory nerve

**Section B**

8. Match the items in **Section A** with the correct statements in **Section B** by writing the letter of the correct answer in the space provided.

Section A	Answer	Section B
(i) Brain		(a) Bone joints that are connected from the neck to waist
(ii) Spinal cord		(b) The organ in the human body that coordinates all body actions
(iii) Vertebral column		(c) The part that allows light to pass and refracts it in order to fall on the retina
(iv) Sensory nerve		(d) Part of central nervous system protected within the vertebral column
(iv) Iris		(e) A nerve that carries information from one part of the body and transmit it to the central nervous system
(v) Myopia		(f) A nerve that carries information from the central nervous system and transmits it to other parts of the body
(vii) Cornea		(g) The part that controls the amount of light passing through the eye
		(h) Defect of short sightedness
		(i) Defect of long sightedness
		(j) A transparent membrane that allows light to pass

**Section C**

Write **TRUE** for a correct statement and **FALSE** for an incorrect statement in the space provided.

9. The function of the nose is only to smell. \_\_\_\_\_
10. The tongue is incapable of detecting the taste of the lemon. \_\_\_\_\_
11. The function of the eye lens is to prevent light rays from entering the eye. \_\_\_\_\_
12. A convex lens is used to correct long-sightedness. \_\_\_\_\_

13. The upper layer of the skin is made up of more nerves than other layers. \_\_\_\_\_
14. One can hear very well even if the ear drum ruptures. \_\_\_\_\_
15. The cochlea deals with body balance. \_\_\_\_\_

### Section D

16. Describe four functions of the tongue.
17. Explain the changes that occur in the eye when a person moves from a bright light to a dim light area.
18. Explain the advantage of a decrease and an increase in the pupil's size of an eye.
19. Mzee Kalulu went to the hospital for an eye test, and he was then given spectacles with convex lenses. What was wrong with his eyes? Explain how the defect can be correct by spectacles.

### Vocabulary

Melanin	a substance or natural pigment found in the upper layer of the skin that gives skin its colour and helps to protect the body from the sunrays
Socket	holes on the skull where the eyes are held
Taste buds	cells in the tongue with nerves that collect information of various tastes
Umami	a taste which is found in foods such as meat, mushrooms and tomatoes

## Chapter Ten

### Human respiratory system

#### Introduction

*In Standard Six, you learnt about the concept of air, characteristics of gases that compose air and uses of air in daily life. In this chapter, you will learn the concept of the respiratory system and the parts of the human respiratory system. You will also learn how breathing takes place and the disorders of the respiratory system. The competencies developed will help you to maintain body health and avoid behaviour that may affect the respiratory system.*

#### The concept of the respiratory system



#### Think

Reason for a human being to die if breathing stops

Organisms need air to survive. The air is obtained from their environment. The system which enables the body to take in air to produce energy is called the respiratory system. This system also allows carbon dioxide gas, which is produced in the process of respiration, to be removed from the body.

Breathing is the action of taking air in and out of the lungs. The air which enters the human body is a mixture of different gases. See the Table below. The air that enters the lungs contains a high amount of oxygen gas while the air that comes out contains a high amount of carbon dioxide gas.

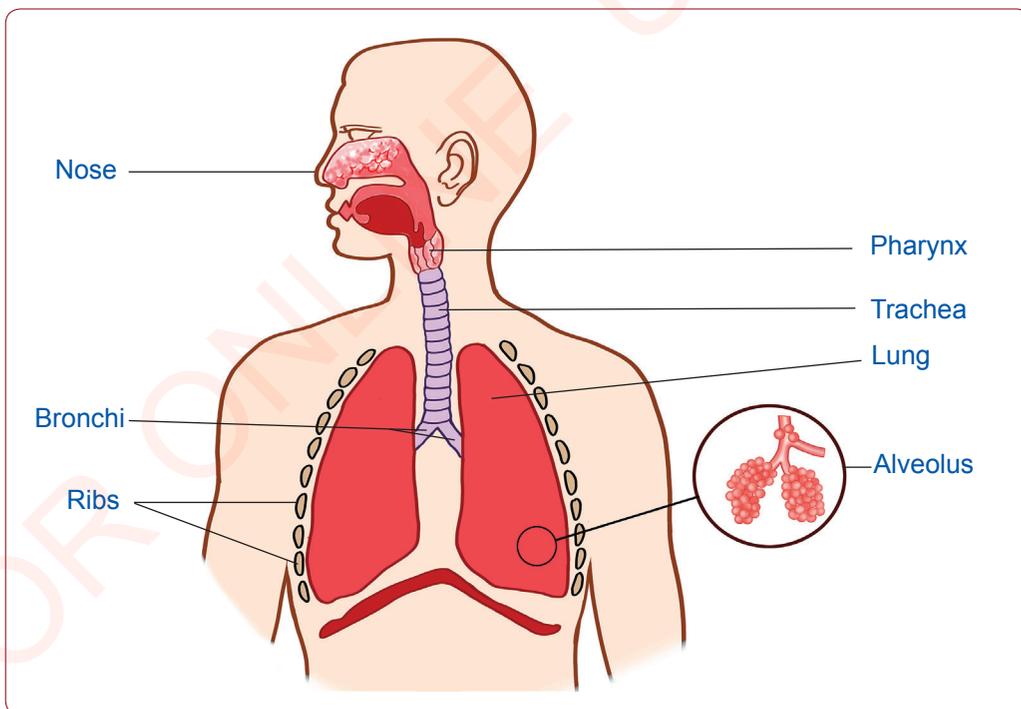
**Table:** *Composition of the air that enters and leaves the body*

Gas	Proportion in the air entering the lungs	Proportion in the air leaving the lungs
Nitrogen	78%	78%
Oxygen	21%	16.46%
Carbon dioxide	0.03%	4.47%
Other gases	0.97%	0.97%

Oxygen gas is used to burn food in the body to release energy. The process of burning food produces carbon dioxide gas. This gas must be removed from the body because, if it remains, it may become toxic and affect the health of the person.

### Parts of the respiratory system and their functions

The respiratory system is comprised of different parts, namely the nose, pharynx, trachea, bronchi and lungs, as shown in Figure 1.



**Figure 1:** *Human respiratory system*

## Nose

The nose receives and passes air that enters and leaves the lungs. The nose contains hair and mucus which prevent dusts and microorganisms from entering the lungs. The mucus in the nose adds moisture to the air to prevent dryness of the air passages. In addition, the nose warms air to match with the body temperature. It is advised to breathe using the nose rather than the mouth. This is because the mouth, unlike the nose, does not have hairs to prevent dusts and microorganisms from entering the lungs.

## Pharynx

Once air passes through the nose, it enters the pharynx. The pharynx receives air from the nose and passes it to the trachea. The pharynx is made up of strong muscles which allow air to pass without obstruction. These muscles enable the pharynx to be open to allow air to pass freely.

## Trachea

The trachea is a long tube which runs from the end of the pharynx to the lungs. At its end, it branches into two parts, namely the right bronchus and left bronchus. The right bronchus enters the right lung, while the left bronchus enters the left lung. The trachea receives air from the pharynx and passes it to the lungs through the bronchi. The bronchi have mucus which traps microorganisms and dust, preventing them from entering the lungs.

## Lungs

The lungs are located inside the chest cavity. Human beings have two lungs: one on the left side and the other on the right side. The major function of the lungs is to allow oxygen gas to enter the blood cells. Blood carries this gas to the body cells for respiration to release energy. The lungs also receive carbon dioxide gas from the blood and pass it out of the body through breathing. This gas is produced by the body cells during the production of energy. Both lungs operate at the same time.

## Alveoli

These are small air sacs in the lungs where gaseous exchange occurs. Alveoli are very small but numerous in number. These features increase the surface area for the efficiency of gaseous exchange in the lungs.

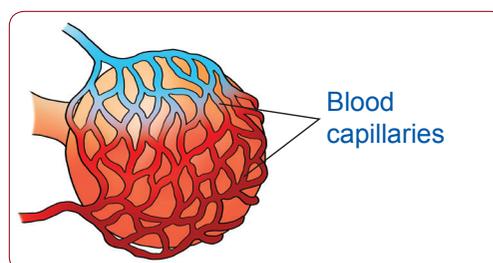


Figure 2: An alveolus

Alveoli have thin membranes, networks of blood capillaries, and a moist surface to allow the diffusion of oxygen gas in and carbon dioxide gas out of the blood stream. See Figure 2.

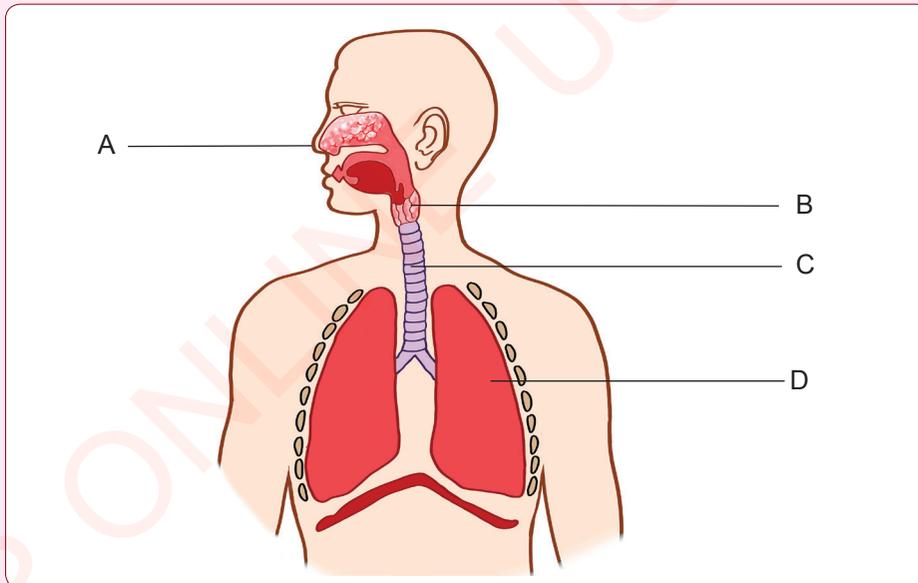
## The importance of breathing

Human beings require oxygen gas for proper functioning of their body cells. Oxygen gas is used to burn food to release energy for body use. Breathing also helps to remove carbon dioxide gas from the body. This gas, if not removed, becomes toxic to the body. All these processes are done through the respiratory system. Breathing in humans also helps in producing sounds. When air passes through the larynx or the voice box, it creates vibrations which produce sounds as in talking or singing.

### Exercise 1

Answer the following questions:

1. Name the parts labelled A-D



2. Describe the functions of any four parts of the respiratory system.
3. Explain the importance of alveoli in breathing.
4. Why is it advised to breathe using the nose instead of the mouth?

## How breathing occurs

The process of breathing occurs in two stages. The first stage is taking air in (inhalation) and out (exhalation) of the lungs. The second stage is gaseous exchange in the lungs.

**Taking air in and out of the lungs:** During breathing, different changes take place in the lungs, chest, and the diaphragm. The diaphragm is a sheet of muscles that separates the chest from the stomach, and it plays a major role during breathing.

**Taking air into the lungs (inhalation):** When a person inhales, the diaphragm moves downward. Then, the muscles between the ribs contract, causing the ribs to go up. These actions increase the space in the chest to allow the lungs to expand. When the lungs expand, the air from outside is drawn in to fill the empty space in the lungs as shown in Figure 3.

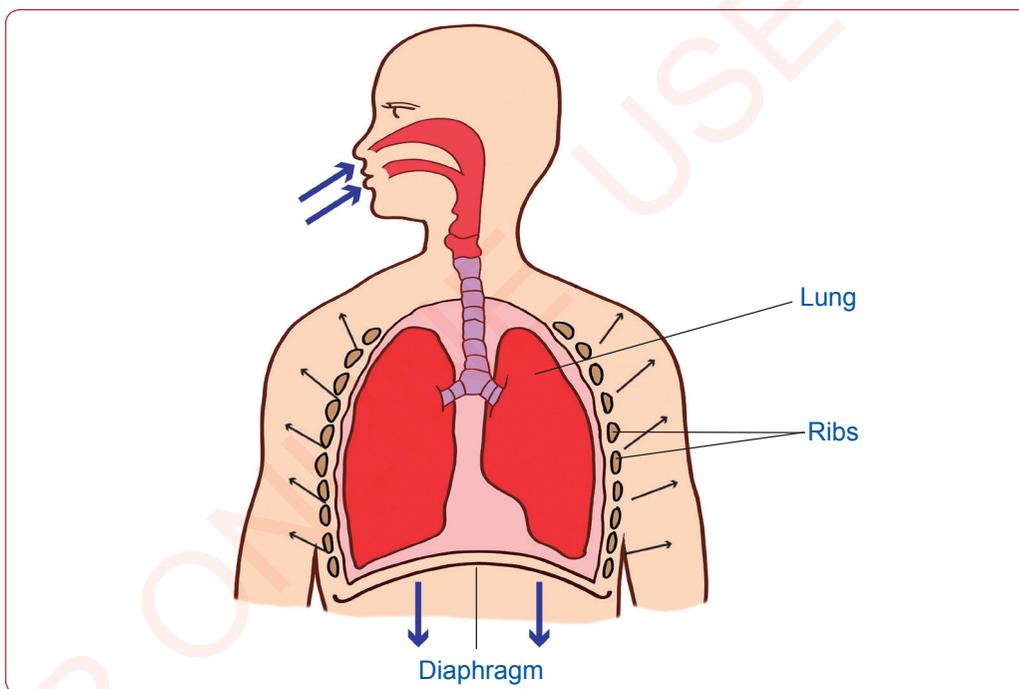


Figure 3: Inhalation

**Taking air out of the lungs (exhalation):** When a person exhales, the diaphragm moves up, the ribs move down and the muscles between the ribs relax. This reduces space in the chest; thus, the air is pushed out through the bronchi, trachea, pharynx and the nose as shown in Figure

4. The air removed from the lungs contains a higher amount of carbon dioxide gas than that which enters the lungs.

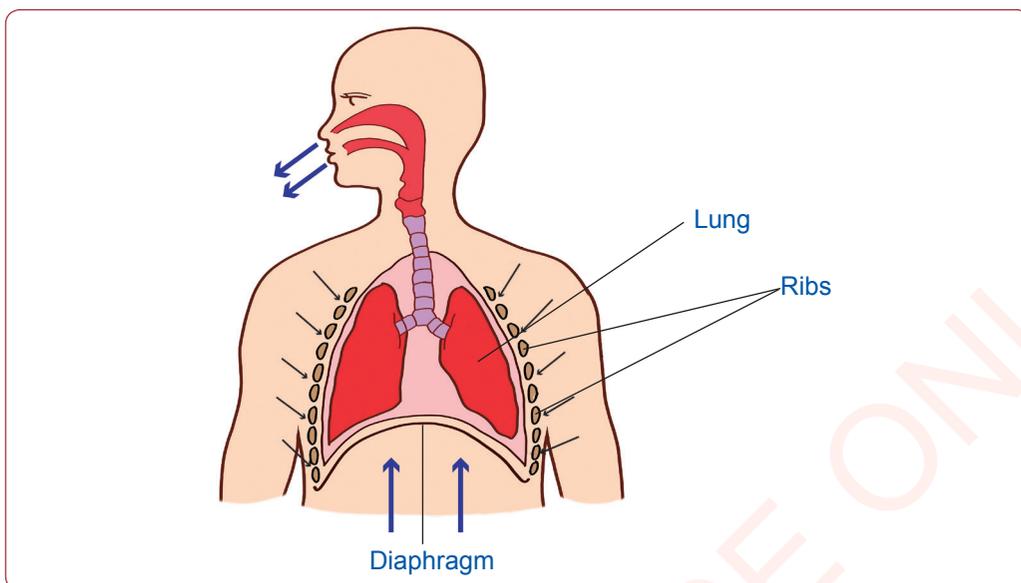


Figure 4: Exhalation

**Experiment:** *To investigate how breathing occurs*

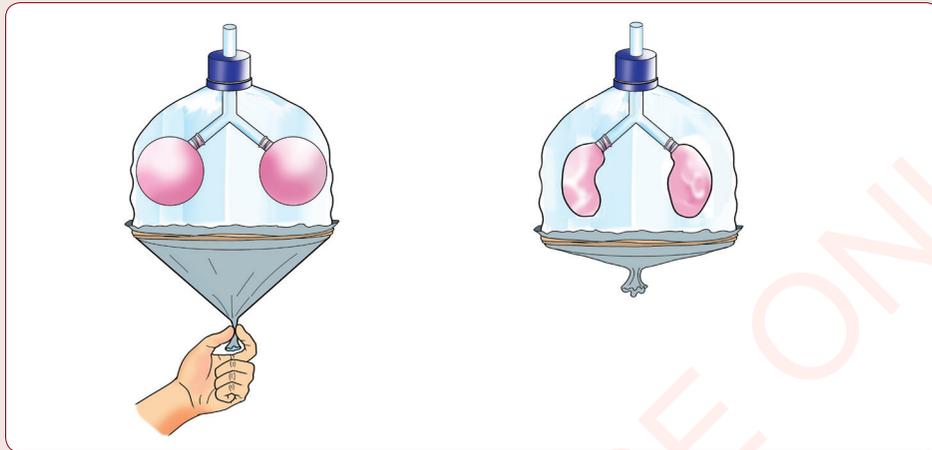
**Aim:** To identify changes that occur in the lungs, diaphragm, and ribs during breathing

**Materials:** two balloons, three tubes (one should be large and the other should be small), plastic bottle (five litre or more) with its cap, a wide rubber sheet or plastic bag, pair of scissors, and rope or rubber band

**Procedure**

1. Connect three tubes to form a Y-shaped structure.
2. Tie the two balloons to the small tubes that make the Y-shaped structure.
3. Cut and remove the base of the plastic bottle and make a hole at the centre of the stopper.
4. Take the tubes connected with balloons in Stage 2 above and pass it through the open base of the plastic bottle to the hole on the stopper. Then, tight the stopper to make sure no air is allowed to pass.
5. Cover the open base of the bottle using a tube or a plastic bag with a wide diameter. Then, tie it using the rope or rubber band as shown in Figure 5.

6. Pull the tube or plastic bag with a wide diameter at the base of the bottle downward and observe what happens.
7. Push the tube or plastic bag with a wide diameter at the base of the bottle inward. Then, observe what happens.



**Figure 5:** A model demonstrating how breathing occurs

### Results

What happened to the balloons when

- (a) the wide rubber sheet was pulled downward?
- (b) the wide rubber sheet was pushed inward?

### Conclusion

Compare the functions of the parts of the respiratory system of the model with the parts of the human respiratory system.

## Factors causing changes in the rate of breathing

Various factors change the rate of breathing. Some of these factors are shown below:

**Physical exercise or manual activities:** When you perform physical exercise or do manual activities, more energy is required by the body. The rate of breathing increases to allow more oxygen gas to enter the body to burn food. A high amount of carbon dioxide gas is also produced as a result of physical and manual activities. This gas must be removed from the lungs to prevent it from harming the body.

**Fear or anger:** The rate of breathing increases when someone is afraid or angry because more energy is required to enable fighting or running.

**Anaemia:** When a person is anaemic, the rate of breathing increases so as to increase the amount of oxygen gas required by the body using the little amount of the blood available.

**Age:** The rate of breathing is proportional to the age of the person. A child breathes faster than an adult. The rate of breathing in an adult is between 12 and 18 times per minute, while that of a child is between 22 and 60 times per minute.

**Altitude:** The rate of breathing increases as one moves from low to high altitudes above sea level. This is because, at higher altitudes, air contains a little amount of oxygen gas. Thus, the rate of breathing increases so as to get enough oxygen gas. At lower altitudes, air contains a higher amount of oxygen gas, and the rate of breathing is normal.

**Temperature:** The rate of breathing depends on environmental temperature. As the temperature increases, the rate of breathing increases. This enables the body to get more oxygen gas used to release energy for regulating body temperature to normal.

### **Differences between the inhaled and exhaled air**

Several differences exist between the inhaled and exhaled air. The air that enters the lungs has similar composition as that of the atmosphere. It contains a high amount of oxygen gas and a low amount of carbon dioxide gas. The air that leaves the lungs contains a high amount of carbon dioxide gas and a low amount of oxygen gas. In addition, the air that enters the lungs is less moist than that which leaves them.

### **Gaseous exchange in the lungs**

Gaseous exchange is the action which enables the blood to get oxygen gas and remove carbon dioxide gas produced by body cells as shown in Figure 6. Gaseous exchange occurs in the alveoli, which are found in the lungs. Alveoli are surrounded by numerous blood capillaries. They have thin membranes which enable oxygen gas to easily enter the blood by diffusion. Diffusion also enables carbon dioxide gas from blood capillaries to enter the lungs so as to be removed from the body. The oxygen gas that enters the blood is carried by arteries to the body cells to produce the energy needed by the body.

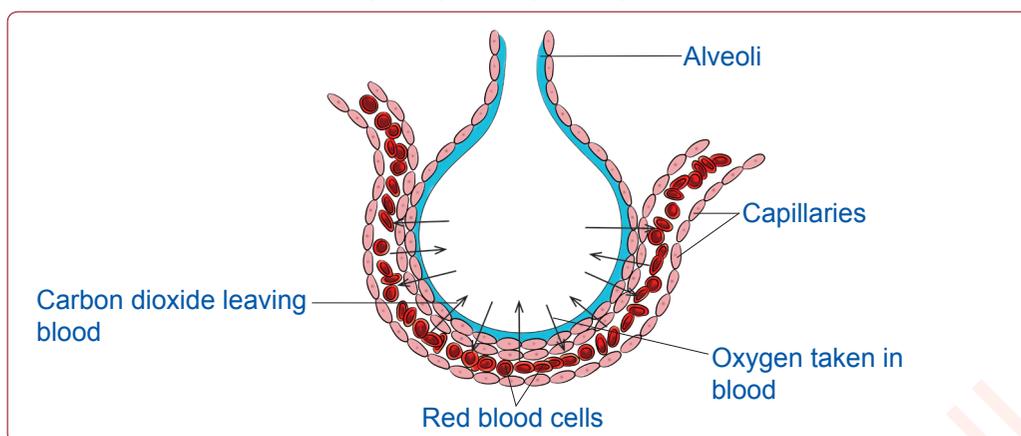


Figure 6: Gaseous exchange across the alveolus

## Disorders of the respiratory system

Disorders of the respiratory system include all conditions that prevent it from working properly. The respiratory system can be affected by lifestyle, disorders or diseases. Asthma and lung cancer are among the disorders of the respiratory system.

### Asthma

Asthma is a condition which causes airways to narrow, swell and produce extra mucus. This makes breathing difficult. It also causes ribs contraction and chest pain. Smoking cigarettes, smoke, perfumes, dust, and pollen are behaviours and substances that can stimulate asthma. These are allergic substances which initiate asthma. Asthma can also be inherited from parents. Parents with asthma are likely to pass this condition to their children.

### Symptoms of asthma

- Difficulty in breathing accompanied by wheezing or hissing sound when breathing
- Chest pressure and chest pain
- Shortness of breath
- Excessive coughing especially at night and in the morning

### Prevention of asthma

Asthma is a chronic disease which has no cure, but there are different ways which can be used to help the patient. These ways are as follows:

- Avoid asthma triggers or allergic substances such as pollen and perfumes, and
- Take medication as soon as you detect early symptoms.

## Lung cancer

Lung cancer is caused by abnormal production and growth of lung cells which form swelling in the lung. Lung cancer is caused by inhaling hazardous chemicals or radiations such as air from industries and mines. Smoking or sitting near people who smoke can result in lung cancer. Lung cancer can also be inherited from parents. This happens when one or both parents are affected by lung cancer and receive long-term treatment using radiation or chemicals. These radiations and chemicals affect their genes. Thus, the affected genes can be inherited by their children.

## Symptoms of lung cancer

Lung cancer affects the respiratory system. The following are the symptoms of lung cancer:

- (a) persistent coughing,
- (b) chest pain during breathing or coughing,
- (c) cough accompanied by blood,
- (d) breathing difficulty, and
- (e) heavy and scratching voice.

## Prevention of lung cancer

The best way to avoid lung cancer is to avoid substances causing it. These include to stop smoking and to build residential houses away from industrial or uranium mining areas. Lung cancer treatment depends on the extent to which the lungs have been affected. A lung cancer victim can be treated using surgery or radiations. If lung cancer spreads to large areas of the lung, both treatments can be used.

### Exercise 2

Answer all questions in sections A, B and C.

#### Section A

Choose the most correct answer and write its letter in the box provided.

1. Which of the following is not the function of the respiratory system?
  - (a) Transportation of oxygen gas in the tissues
  - (b) Removal of temperature and fluid from the body
  - (c) Gaseous exchange in the body
  - (d) Talking, screaming and singing

2. Gaseous exchange takes place in the \_\_\_\_\_.
- (a) larynx
  - (b) nose
  - (c) trachea
  - (d) alveoli
3. The hair and mucus found in the nose help \_\_\_\_\_.
- (a) in exchange of air
  - (b) to trap microorganisms and dust
  - (c) to transport air to the lungs
  - (d) to cool the air that enters the body through the nose
4. When air is removed from the lungs, the muscles in the ribs \_\_\_\_\_.
- (a) relax
  - (b) expand
  - (c) contract
  - (d) break down
5. Breathing takes place in two stages, namely exchanging gases in the lungs and \_\_\_\_\_.
- (a) taking in air to and from the blood
  - (b) Passing it to the larynx
  - (c) taking air to and from the lungs
  - (d) shrinking of the lungs and chest

### Section B

6. Write **TRUE** for a correct statement and **FALSE** for an incorrect statement in the space provided.
- (a) A cough accompanied with blood is a symptom of asthma. \_\_\_\_\_
  - (b) Cigarette smoke and industrial chemicals cause lung cancer. \_\_\_\_\_
  - (c) Pollen and perfume odours are among the substances that cause asthma. \_\_\_\_\_
  - (d) Adhering to good health practices and cleanliness is important for respiratory health. \_\_\_\_\_
  - (e) Using chemicals is safe for the respiratory system. \_\_\_\_\_
  - (f) The rate of breathing changes during physical exercise. \_\_\_\_\_

### Section C

7. Explain three differences between the air that enters the body and the one that leaves it during breathing.
8. By using diagrams, describe how breathing takes place in the body.
9. Explain two disorders of the respiratory system including their causes.
10. Explain the importance of breathing in living things.
11. By using a diagram, explain how gaseous exchange takes place in the alveolus.
12. Explain three factors which can change the rate of breathing.

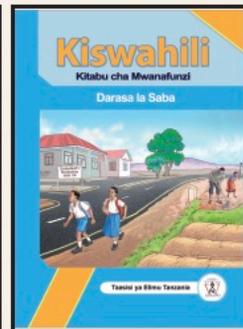
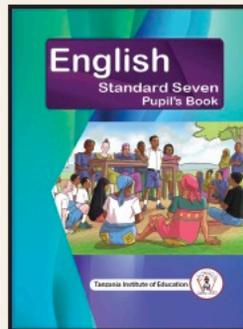
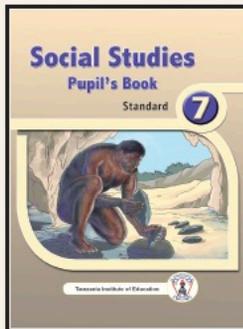
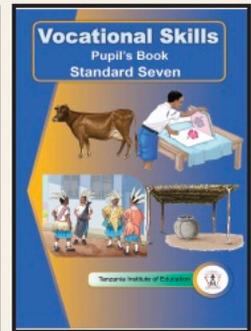
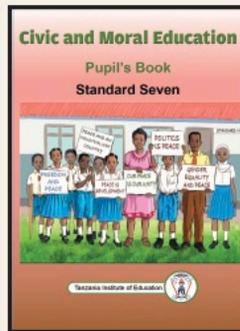
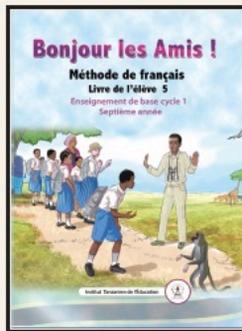
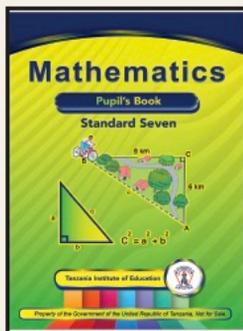
### Vocabulary

Alveolus	very small air sacs in the lungs where gaseous exchange occurs
Anaemia	a condition in which a person lacks enough healthy red blood cells to carry adequate oxygen gas in the body tissues
Diaphragm	the sheet of muscles that separates the chest from the stomach
Diffusion	the process of passing air from a region of higher concentration to a region of lower concentration
Exhalation	the process of taking out air from the lungs
Hair	a slender thread like an outgrowth in the nose that traps dusts and microorganisms
Inhalation	the process taking in air to the lungs
Larynx	a voice box, an organ located at the top of the neck and it is involved in breathing, swallowing and voice production
Mucus	a slippery secretion that is moist and traps dusts and microorganisms
Pharynx	an opening above the trachea which receives air from the nose and passes it to the trachea
Respiration	the process by which the body generates energy from the food
Trachea	a long tube which starts from the end of the pharynx to the lungs

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