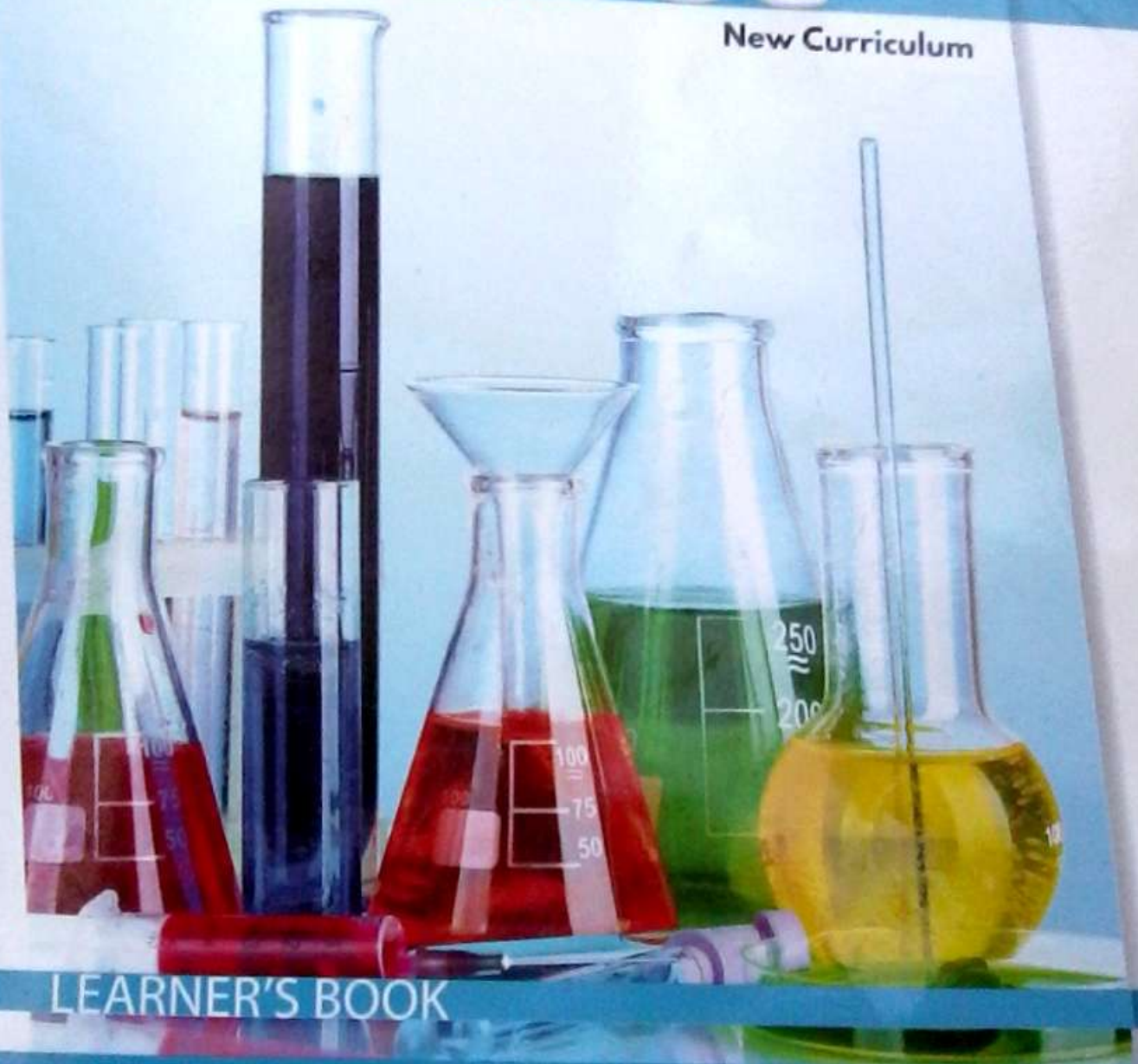
FOCUS ON

Combined Science

New Curriculum



LEARNER'S BOOK

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college press

FORM 1

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Contents

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Topic 1 Laboratory safety and apparatus

Learning objectives	Activities
• Explain laboratory rules. • Identify laboratory apparatus. • Demonstrate the use of laboratory apparatus.	• Discussing laboratory rules. • Discussing and drawing laboratory apparatus • Taking readings from laboratory apparatus

Scientists need to do practical work and experiments to enable them to understand the world around us. In *Combined Science Form 1*, you will also be doing many practical activities and experiments in a science laboratory, in a classroom and outside the classroom. Your teacher may demonstrate some of these experiments or you may do them yourself. You will use materials, chemicals, **apparatus** and equipment.

In this topic, you will find out about some laboratory apparatus and how to use them. There is a danger that accidents and injuries can happen, so it is important that you find out about safety rules in the laboratory.

Laboratory rules

Science experiments are an important part of the subject Combined Science. Conducting experiments will help you to understand what scientists do and how they work. Doing the experiments will also help you to understand science concepts more easily.

In the science laboratory, there are many potentially dangerous chemicals. Some of the experiments that you will do involve lighting gas burners and using chemicals and sharp objects. The apparatus is also very expensive and needs to be taken proper care of. There are laboratory safety rules that you need to follow to avoid accidents and injuries when you are working in the science laboratory.

Something interesting

There are safety symbols that are used to show hazards with laboratory chemicals. It is important to make a note of these when using chemicals and take the appropriate safety measures. Containers of chemicals have the following warning signs on them to warn you of their potential danger.

Corrosive Toxic Flammable

Word help

apparatus: equipment used in scientific experiments and practical activities

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Activity 1.1 Assignment

Discussing safety in the laboratory

Work with a partner

Discuss unsafe and safe behaviour in the laboratory.

You will need:

- poster paper
- coloured pens or pencils

Method

1. Study Figure 1.1 showing learners working in a science laboratory. List the unsafe activities shown in the picture and explain why each is unsafe.
2. State whether the following statements are true or false:
   a) The science laboratory is a good place for playing jokes on your friends.
   b) Spilled chemicals should be wiped up immediately.
   c) It is unnecessary to report minor accidents in the laboratory.
   d) Doing your own experiments, not given by the teacher, is a good creative activity.
   e) Chemicals should never be tasted.
   f) There should be a first aid kit in the laboratory.
3. Discuss and decide on some rules for your science classroom or science laboratory. Write down at least three rules and share these with the class.
4. As a class make a poster showing the laboratory safety rules you all agreed on. Display the rules on the wall in the science laboratory for everybody to see.

Figure 1.1 Some unsafe activities in the science laboratory.

Figure 1.2 A safety rules poster.

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Laboratory apparatus

We use many different pieces of apparatus and equipment in science experiments. In Combined Science you will observe things, measure things, heat things and mix and separate things. In the next activity, you will find out about some of the apparatus that you will use.

Activity 1.2

Answer the following questions.

1. You will use several different pieces of apparatus in Combined Science.
   a) Study Figure 1.3. In your group, discuss what each piece of apparatus is used for.
   b) On your own, make labelled drawings of any five pieces of apparatus.

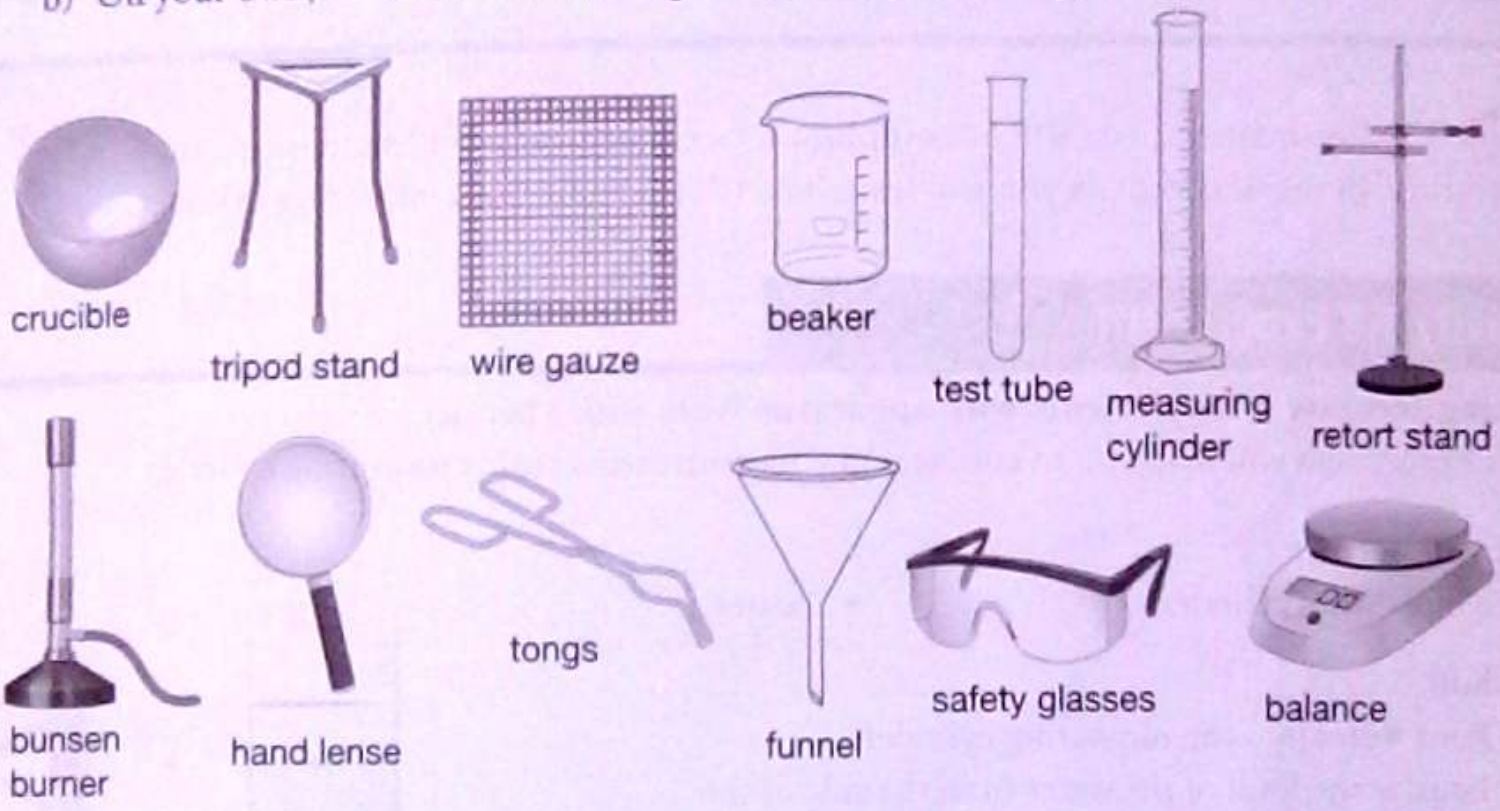

Figure 1.3 Laboratory apparatus

c) Copy the following table. Complete the information in the table about the names and uses of different pieces of laboratory apparatus.

Laboratory apparatus	Use
test tube	
thermometer	used to measure temperature
	used to measure volume of a liquid
beaker	

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crucible	
evaporation dish	a gas burner used to heat, for example water
spirit burner	
spatula	
tripod stand	used to pour liquid into a container
wire gauze	
	used for holding test tubes
	used for viewing small objects
	used to protect eyes

Search the Internet for more laboratory apparatus.

In Topic 15 Measurements, you will discover how to accurately measure length, mass, time and temperature. In the next activity you will learn how to accurately use a measuring cylinder.

Activity 1.3 Experiment

Taking accurate measurements with apparatus Work with a partner

This experiment will help you to take accurate measurements with a measuring cylinder

You will need:

- a measuring cylinder
- water

Method

1. Pour water into the measuring cylinder.
2. Look at the level of the water from the side of the cylinder. Keep your eyes in line with the **meniscus** of the water. Read the volume of water from the bottom edge of the meniscus.
3. Make a note of the reading on the scale of the measuring cylinder.

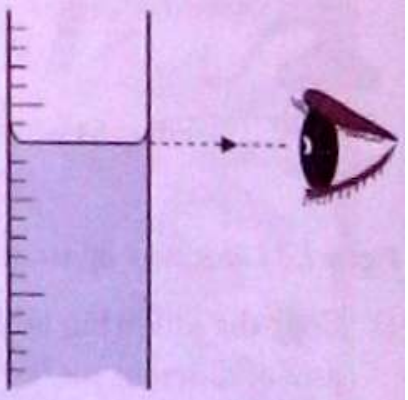

Figure 1.4 Reading volume accurately from a measuring cylinder

Questions

1. A measuring cylinder is used to measure the volume of a liquid.
   a) What was the volume of water that you measured in the measuring cylinder?
   b) Describe to your partner how you would take an accurate reading using a measuring cylinder.
   Draw a diagram to show how to take an accurate reading from a measuring cylinder.

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2. We can also determine the mass of a liquid.
   a) What apparatus would you use to measure the mass of the water in the measuring cylinder?
   b) Write down step-by-step instructions on how to measure the mass of water in a measuring cylinder.

Word help

meniscus: the curved upper surface of a liquid in a tube

Summary

- Science laboratories contain chemicals which can be dangerous, and expensive apparatus that can be broken, so it is important to have laboratory rules to avoid any accidents.
- There are different safety symbols that warn about hazardous laboratory chemicals.
- There are many pieces of apparatus that are used in science laboratories, such as test tubes, beakers, thermometers, measuring cylinders, funnels, Bunsen burners, crucibles, spatulas and magnifying lenses.
- Each piece of apparatus should be safely used for a specific task.

Topic assessment

Answer the following questions.

1. There are safety rules in a science laboratory.
   a) State two things that you **should not** do in a science laboratory. [2]
   b) State two things that you **should** do in a science laboratory. [2]
2. There are several potentially dangerous things in a science laboratory.
   a) Give two examples of dangerous things.
   b) Explain why these things are dangerous. [2]
3. State what each of the following pieces of apparatus are used for:
   a) Measuring cylinder
   b) Spirit burner
   c) Crucible
   d) Wire gauze
   e) Evaporating dish [5]

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Cell membrane

The cell membrane is a layer that surrounds the outside of the cytoplasm. It is living. The cell membrane gives the cell its shape and holds the content of the cell together. It controls the movement of substances into and out of the cell.

Nucleus

The nucleus is the control centre of the cell. It is a round organelle found in the middle of animal cells and on the side of plant cells.

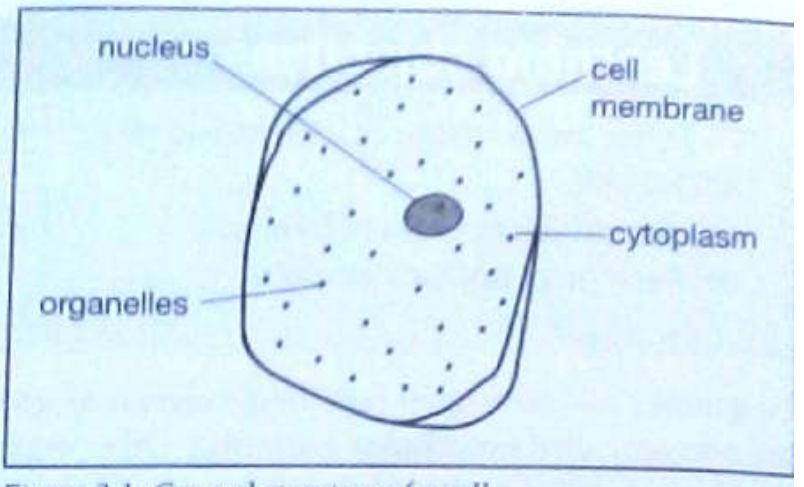

Figure 2.1 General structure of a cell

Structure of a plant cell

Plant cells consist of cytoplasm, a cell membrane, a nucleus and organelles. However, they also have a cell wall on the outside of the cell membrane and special organelles called chloroplasts and vacuoles.

Cell wall

The cell wall is a tough, **rigid** outer layer. The cell wall is made of a substance called **cellulose**. The cell wall is non-living. The cell wall gives the cell its regular shape and protects the structures inside the cell. The rigid cell wall also supports the plant.

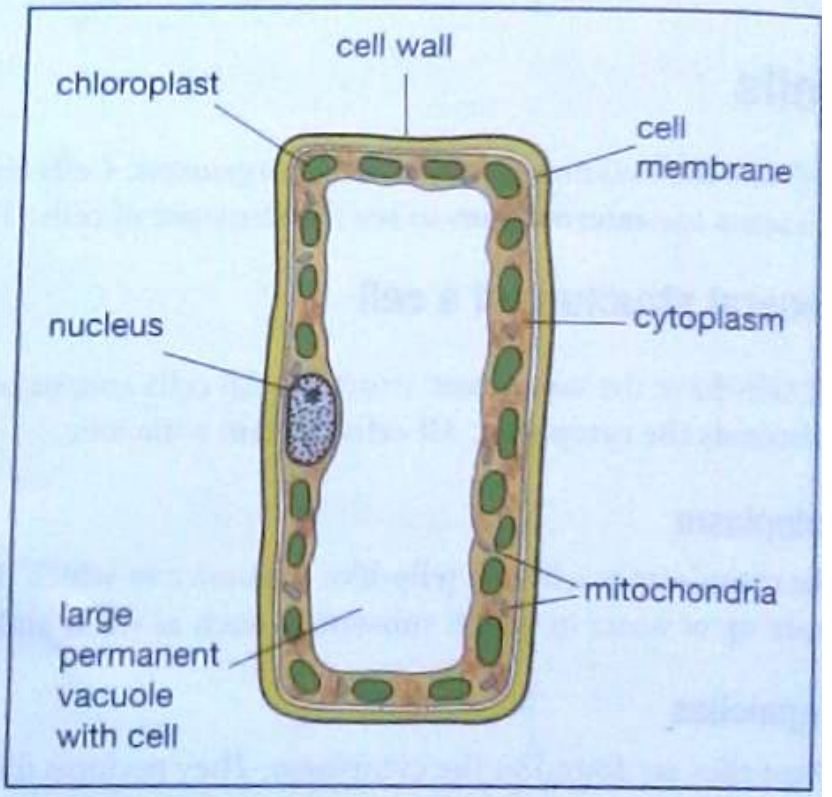

Figure 2.2 Basic structure of a plant cell

Word help

cellulose: the substance from which cell walls are made; forms part of fibre in our diet

rigid: unable to bend

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Chloroplasts

Chloroplasts are only found in plant cells. They are organelles in which food is made by a process called **photosynthesis**. You learnt about photosynthesis in Grade 7 and you will learn more about photosynthesis in Forms 2 and 3.

Vacuole

The permanent vacuole is usually found in the centre of plant cells. It is used to store substances and is filled with a liquid called **cell sap**. When the vacuole is full, it helps to keep the cell firm.

Activity 2.1 Cooperative learning

Observing plant cells Work with a partner

Do an investigation to observe onion cells with a bioviewer.

You will need:

a bioviewer with slides of onion cells or any plant cells.

Method

Follow the instructions.

1. Use a bioviewer to observe the slide of onion cells. You should see plant cells that look like the photograph of onion cells in Figure 2.3. This photograph of onion cells was taken through a microscope.
2. Observe the onion cells on the bioviewer slide or in Figure 2.3, which shows a photograph of onion cells.

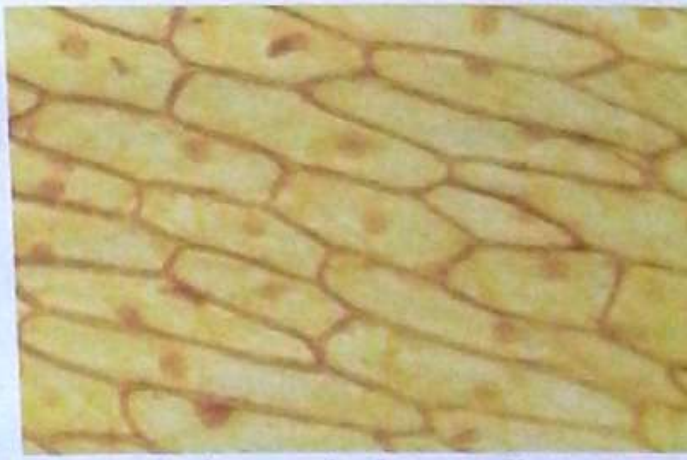

*Figure 2.3 Photograph of onion cells as seen un a microscope (**magnification** 100×)*

Word help

cell sap: a liquid found inside the vacuole, which consists of water with dissolved substances in it

magnification: the amount by which something is made larger

photosynthesis: a process in plants used to make food from sunlight, water and carbon dioxide

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Observations

1. Make an accurate drawing of three onion cells.
2. Give the drawing a heading.
3. Identify the following parts of the onion cells: nucleus, cell wall and cytoplasm.
4. Label these parts on the drawing.

Structure of an animal cell

All animal cells consist of cytoplasm, a cell membrane, a nucleus and organelles. Figure 2.4 shows the structure of an animal cell.

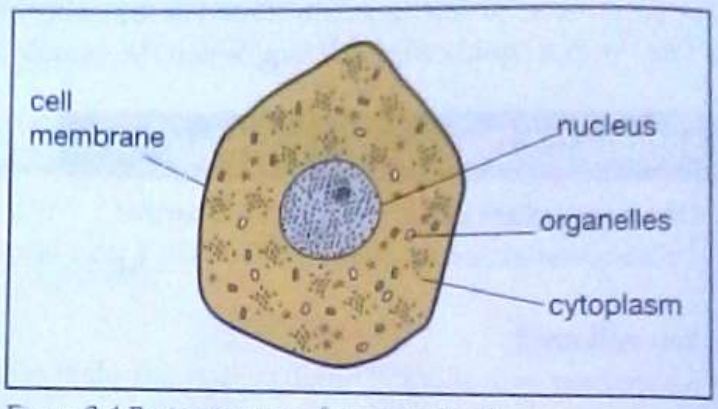

Figure 2.4 Basic structure of an animal cell

Activity 2.2 Cooperative learning

Observing animal cells Work with a partner

Do an investigation to observe human cheek cells with a bioviewer.

You will need:

a bioviewer with slides of human cheek cells or any animal cells.

Method

Follow the instructions.

1. Use a bioviewer to observe a slide of human cheek cells. You should see animal cells that look like the photograph of human cheek cells in Figure 2.5. This photograph of human cheek cells was taken through a microscope.
2. Observe the human cheek cells on the bioviewer slide or in Figure 2.5, which shows a photograph of human cheek cells.

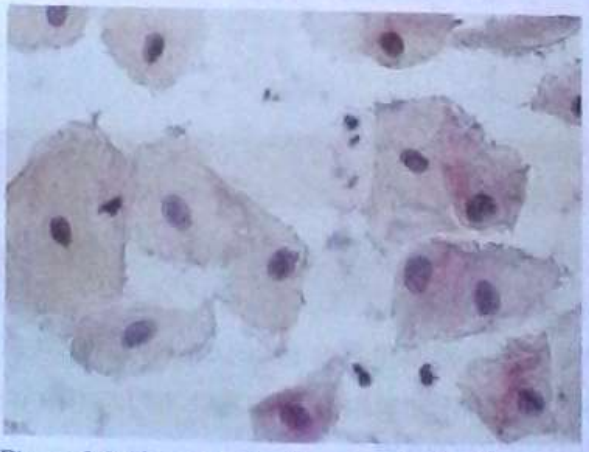

*Figure 2.5 Photograph of human cheek cells as seen under a microscope (**magnification** 100×)*

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Observations

1. Make an accurate drawing of three human cheek cells as observed through a microscope.
2. Give the drawing a heading.
3. Identify the following parts of the cheek cells: nucleus; cell membrane and cytoplasm.
4. Label these parts on the drawing.

Comparing plant and animal cells

Plant cells and animal cells have the same basic structure. Plant and animal cells have a cell membrane, cytoplasm and a nucleus.

Plant cells differ from animal cells as they have a cell wall. The cell wall gives the plant cell a regular shape, while animal cells have an irregular shape. Plant cells have a large **permanent** vacuole. In animal cells vacuoles are **temporary** or absent. Table 2.1 summarises the differences between plant and animal cells.

Table 2.1 Differences between plant and animal cells

Part or feature	Plant cells	Animal cells
Shape	Regular, flexible	Irregular, rigid
Cell wall	Present, made of cellulose	Absent
Vacuole	Large, permanent	Small if present, usually temporary
Chloroplasts	Present	Absent

Activity 2.3 Investigation

Comparing plant and animal cells Work with a partner

Do an investigation to find the similarities and differences between plant and animal cells.

You will need:

- a bioviewer
- bioviewer slides of human cheek cells or a photograph of human cheek cells (see Figure 2.5)
- bioviewer slides of onion cells or a photograph of onion cells (see Figure 2.3)

Method

Follow the instructions.

1. Compare the structure of cheek cells and onion cells. Observe the cells through the bioviewer. Study the photograph of the onion cells (Figure 2.3) and the photograph of the cheek cells

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(Figure 2.5). You can also refer to the drawings of the onion cells and cheek cells that you made in Activity 2.1 and Activity 2.2.

2. When comparing the cells, look at features such as the shape, the outer layers and the structures found in the cells.
3. In a table, record the differences between animal and plant cells.
4. Write down the similarities between animal and plant cells below the table.

Activity 2.4

Answer the questions.

1. Name three structures that are found in all cells.
2. Name two structures that are only found in plant cells.
3. Describe two differences between an onion cell and a human cheek cell that can be seen under a microscope.

Activity 2.5 Research

The discovery of cells Work on your own

Scientists only found out about the existence of cells in plants and animals after the invention of the microscope. This was more than 400 years ago. The first microscopes did not look anything like our modern ones. Scientists could observe very little using these microscopes, compared to today.

Do research on the Internet or in the library to find out about the discovery of cells. Include information about when the word *cell* was first used and by whom.

Write a report of one page in your exercise book. Illustrate your report.

Word help

permanent: always present
temporary: not always present

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Summary

- All cells, both plant and animal, consist of a jelly-like substance called cytoplasm, in which organelles are suspended.
- Plant cells consist of a cytoplasm and organelles such as a cell wall, cell membrane, nucleus, mitochondria, vacuoles and chloroplasts. Each of these organelles has a different function.
- A plant's cell wall is non-living and is made from cellulose.
- Vacuoles are filled with cell sap and are used to store substances.
- Chloroplasts are organelles that make food by photosynthesis.
- Animal cells consist of cytoplasm and organelles such as a cell membrane, nucleus and mitochondria.
- Plant and animal cells differ in various ways, such as their shape, the presence or absence of a cell wall and chloroplasts, and the size of their vacuole.

Topic assessment

Answer the questions.

1. All living things are made up of cells.
   a) Draw and label an animal cell, for example a human cheek cell as seen under a microscope. [3]
   b) Plant cells differ from animal cells. List two structures found in plant cells that are not found in animal cells. [2]
2. Plant cells have a large organelle suspended in the middle of the cell.
   a) Name this structure. [2]
   b) What liquid is found inside this structure? [1]
3. A plant cell has a tough, rigid structure as the outside layer.
   a) Name this structure. [1]
   b) What is the function of this structure? [1]
4. Plant and animal cells are enclosed by a living layer.
   a) Name this layer. [1]
   b) What is the function of this layer? [1]

[Total marks: 12]

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Topic 3 Nutrition

Learning objectives

- Define a balanced diet.
- List the components of a balanced diet.
- Name the functions of nutrients.

Activities

- Naming different kinds of foods
- Identifying the nutrients in foods
- Discussing the functions of nutrients

In *Junior Science and Technology*, you learnt about sources of food, the importance of food for the body and what a balanced diet is. You also learnt about some eating disorders, for example anorexia and obesity. You learnt how improper eating habits might lead to deficiency diseases, such as scurvy and rickets.

In this topic, you will learn more about the components of a balanced diet, and the nutrients that a balanced diet should supply.

Nutrition and diet

Nutrition is the process of providing food that is necessary for good health and growth. Nutrition is one of the processes that all living things need to survive. **Nutrients** are chemical substances that living things need to live. Animals get their nutrients from the food that they eat. Plants get nutrients from the air, water and soil.

Your **diet** consists of all the food and liquids that you eat and drink. In this topic you will learn about types of nutrients and how to have a healthy, balanced diet.

A balanced diet

Humans need different nutrients in their diets to provide:

- energy for different activities such as walking and running
- building blocks for growth and repair of cells
- substances to keep us healthy.

The food we eat should form part of a **balanced diet**. A balanced diet consists of different nutrients in the correct amounts as well as enough energy for your daily activities.

Word help

balanced diet: a diet that contains different nutrients as well as water and fibre

diet: the food that a person eats

nutrition: the process of providing or getting the food needed for good health and growth

nutrients: chemical substances in food

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Components of a balanced diet

A balanced diet contains the correct types and amounts of different foods. The types and amounts of food required depend on your level of activity. If you are active and participate in sport you will need more energy foods, such as whole grains and healthy oils, than a person who is not active. Look at the food pyramid in Figure 3.1. It shows the types and **relative** amounts of different foods in a balanced diet. Water and **fibre** are also necessary components in a balanced diet. The food pyramid shows that you also need regular exercise and that you need to control your weight.

Indigenous knowledge

The national dish of Zimbabwe is *sadza*. It is made with mealie-meal from maize and is cooked slowly until thick, like porridge. *Sadza* is eaten with relish. The relish could be a stew made from vegetables or *nyama* (meat) such as beef or chicken.

Word help

constipation: a condition whereby a person finds it difficult to empty their bowels

fibre: food found in plants that cannot be digested by human beings

immune system: a system that protects our bodies from invasive, harmful organisms such as bacteria and viruses

relative: in this context, the amounts of foods that should be eaten in proportion to other foods

serving: a quantity of food suitable for one person

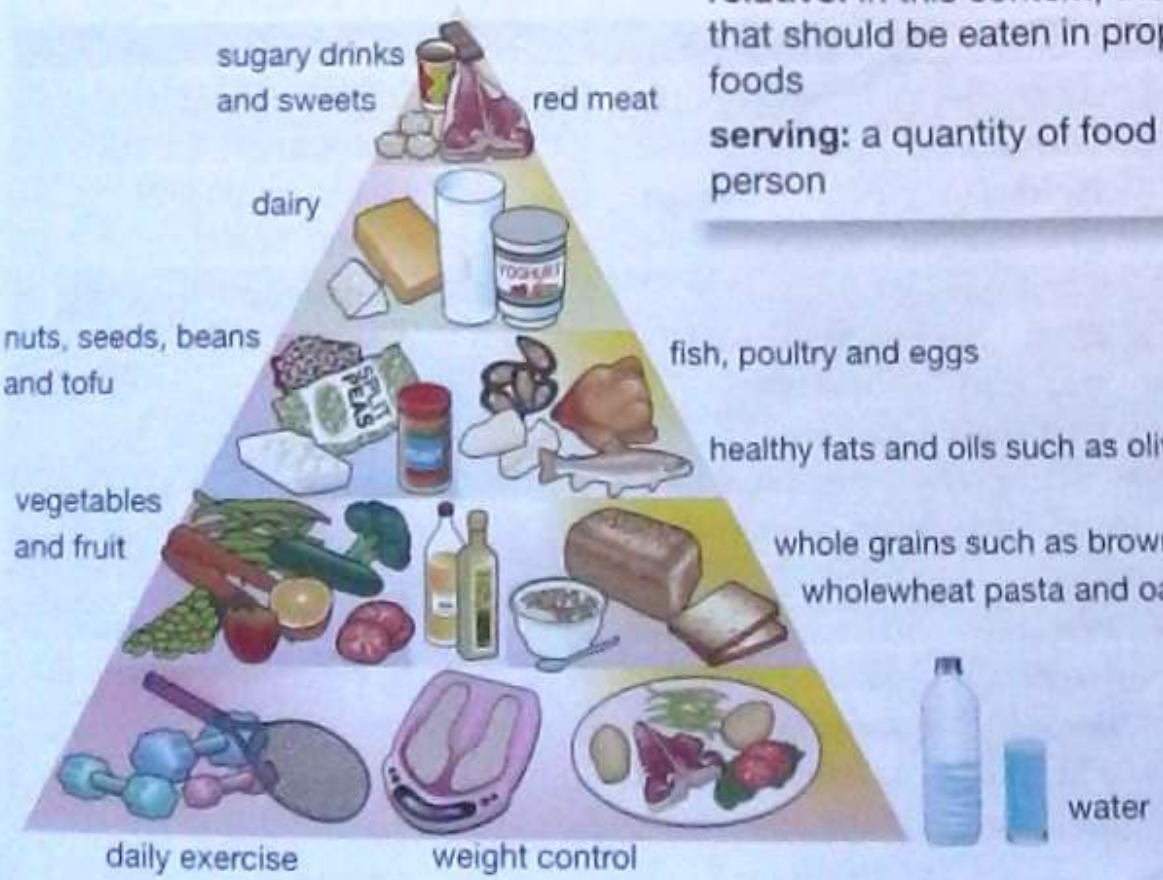

Figure 3.1 This food pyramid shows all the types of food for a balanced diet.

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Activity 3.1

Study Figure 3.1 and answer the questions.

1. Explain what a balanced diet is.
2. List two foods that are:
   a) whole grains
   b) dairy.
3. List three foods that should be limited in a balanced diet.
4. Name the foods that should be eaten in the highest amounts, according to the pyramid.
5. Name two other non-food related factors that are shown in the pyramid.

Food nutrients and their functions

Foods contain different nutrients. The types of nutrients are carbohydrates, proteins, fats, vitamins, fibre, mineral salts and water. For example, milk contains proteins, fats, mineral salts and vitamins while potatoes contain carbohydrates, vitamins and mineral salts. Nutrients have different functions in our bodies. Study the following table that shows these functions.

Something interesting

You can remember the types of nutrients by learning this mnemonic:
Can **P**hilip **F**ind **V**ery **F**illing **M**agic **W**atermelon?

Table 3.1 Nutrients, their functions and sources

Food nutrient	Functions	Sources
Carbohydrates (sugars and starches)	The body's main source of energy	bread, sweets, potatoes, maize, rice, pasta and cassava, sugar
Proteins	Needed for growth and repair of cells in our bodies	fish, eggs, chicken, milk, nuts, cheese, peas, meat, beans
Fats	Provide energy Form a layer under the skin that helps keep our body temperature constant Form a layer around nerves and some organs to protect them	dairy products, margarine, cooking oil, nuts and seeds
Vitamins (Vitamin A, B, C, D, E and K)	Needed in small amounts Boost the **immune system**, which helps us fight disease Build strong bones and teeth	Fruit, cereals, vegetables, milk and other dairy products

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Mineral salts (Calcium, iron)	Needed in small amounts Important for normal growth and development	Fruit, cereals, vegetables, cheese
Fibre	Helps food move through the digestive system; prevents **constipation**, heart disease and some types of cancer	Whole grains, vegetables and fruit
Water	Makes up about 60% of our body Important for chemical reactions in cells Makes up the blood and urine Helps with digestion of food	Tea, coffee, soft drinks, fruit

Activity 3.2

Answer the questions.

1. Look at the pictures of different foods in Figure 3.3. Make a list of the nutrients that each of the foods shown in the pictures contains.
2. List:
   a) one function of carbohydrates
   b) two functions of fats
   c) one function of vitamins
   d) two functions of proteins.
3. Name two foods that:
   a) contain proteins
   b) contain mineral salts
   c) provide energy.
4. Explain what could happen to a young child if he or she did not eat enough fruit and vegetables.
5. Explain why water is important in a balanced diet.

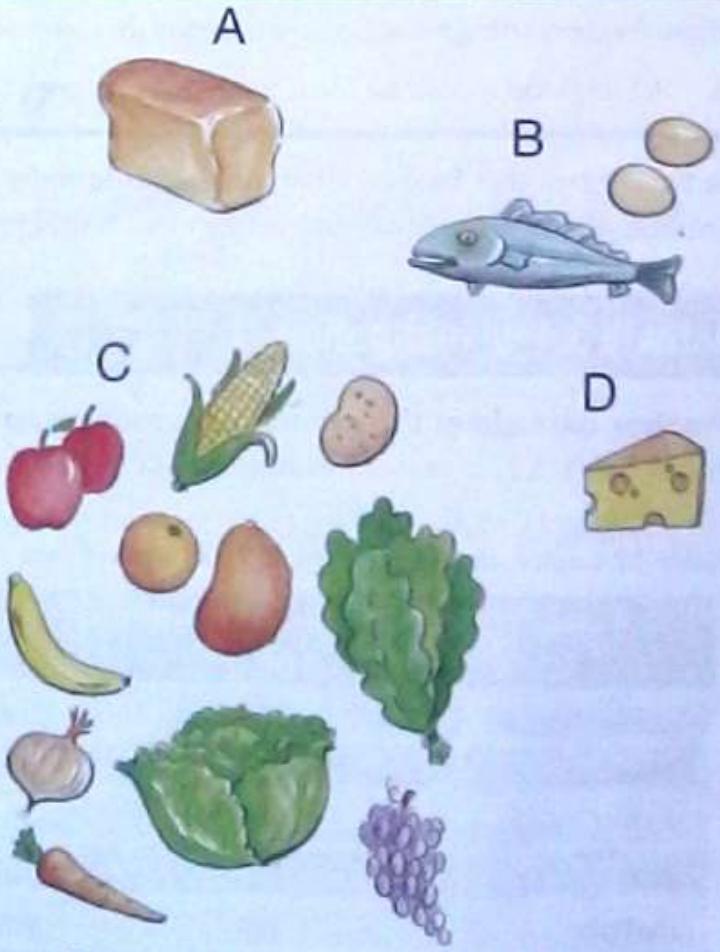

Figure 3.3

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When we purchase processed foods, it is always good to look at the nutritional value/composition of the food. The nutritional value/composition is given in a label on the packaging. For example, we can see how much sugar, fat or salt is contained in a serving of cereal.

Activity 3.3 Investigation

Analyse the nutritional value of food Work in a group

1. Collect the empty packaging from three processed foods, for example a cereal box, a pasta packet or a jam jar. On each container, find the label that gives information about the nutrients in the food in the container.
2. Copy the table below. Use the nutrient information on the container to complete the information.

Name of food	% daily value per serving*			
	proteins	carbohydrates	fats	vitamins

* This is a guide to the nutrients in one serving of food. For example, if the label lists 30% for carbohydrates, this means that one serving provides you with 30% of the carbohydrates you need in a day.

3. Which food would be most likely to form part of a balanced diet? Explain your answer.

You have learnt that foods contain different nutrients in differing amounts. For example, the amount of carbohydrates in bananas and maize meal is different.

Activity 3.4 Investigation

Analyse data about the amount of carbohydrates in food Work on your own

Study Table 3.2. It shows the amount of carbohydrates in 100 g of ten different foods.

Table 3.2 Carbohydrate content in different types of food

Food	Carbohydrates per 100 g	Food	Carbohydrates per 100 g
yams	25	groundnuts	10
bananas	22	maize meal	69
milk (cow)	4	sorghum	70
pineapples	12	pumpkins	6
carrots	10	goat meat	0

1. Which two foods listed in the table provide the most energy?

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2. If carrots contain only a small amount of carbohydrates, suggest two other necessary nutrients that they contain.
3. Goat meat does not contain any carbohydrates. Give one reason why we need to eat meat.
4. Use the information in Table 3.2 to draw a bar graph to show the amount of carbohydrates in the ten different foods. Remember to label the axes and use a suitable scale.

Everyone eats different foods but these foods are not always healthy. It is important to analyse the food you eat to check that you are eating a balanced diet.

Activity 3.5 Assignment

Comparing diets Work in a group

You will need:

- poster paper
- coloured pencils or wax crayons

1. Talk about what each person has eaten over the past day. Make a list of all the foods and drinks each person has eaten since yesterday for breakfast, snack, lunch and dinner. Not everyone in the group may have had three main meals in the day. Some may have had more, smaller meals or snacks.
2. Study the lists and discuss what each person has eaten. Is it a balanced diet? Is it healthy? Why or why not?
3. Use some of the foods and drinks in your lists to design three balanced meals for a day. Include a morning and afternoon snack.
4. Make a poster showing a food pyramid similar to Figure 3.1 to show all the foods that you have included in the balanced meals for the day.
5. Search the Internet for information on healthy eating habits.

Summary

- Humans need different nutrients in their diet to provide them with energy, building blocks for growth and repair of cells and to keep them healthy.
- A balanced diet consists of a variety of different types of food and provides the right amounts of nutrients necessary for good health.
- Different people need different types and amounts of nutrients, depending on their age and level of activity.
- The main food nutrients in a balanced diet are carbohydrates, proteins, fats, vitamins, mineral salts, fibre and water:
  - Carbohydrates and fats are important for supplying energy.
  - Proteins are needed for growth and repair.
  - Vitamins and mineral salts keep us healthy.
  - Fibre helps move food through the digestive system.
  - Water is important for chemical reactions in the body.

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Topic assessment

Answer the questions.

1. Figure 3.4 is a pie chart that shows the amounts of the nutrients in maize meal. Use the information to answer the questions.

   a) Name the main nutrient in maize meal [1]

   b) What percentage of the total nutrients in maize meal is:
   i. fat? ii. protein? [2]

   c) Suggest two nutrients that would be included in 'Other' in the pie chart. [2]

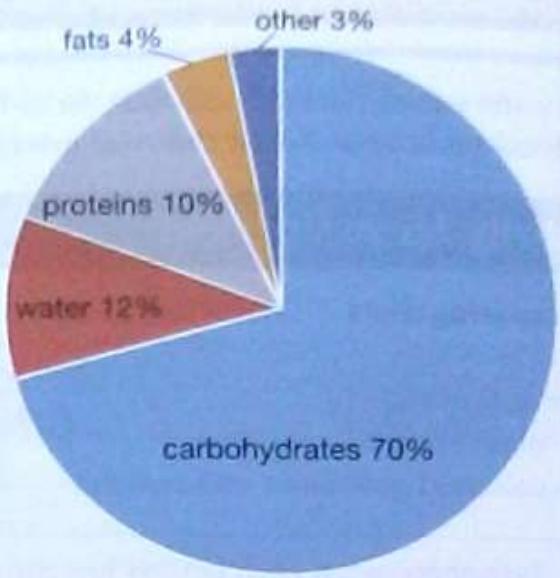

Figure 3.4

2. The following table shows the meals that two learners ate in one day. Study the information and answer the questions.

Meal	Learner A	Learner B
Breakfast	1 bowl porridge oats made with milk 1 cup fresh orange juice 1 slice wholewheat toast with honey	1 bowl cornflakes 4 teaspoons sugar 1 slice white bread with jam
Snack	1 banana 1 small packet of cashew nuts	1 can cola 1 doughnut
Lunch	1 wholewheat chicken mayonnaise sandwich 1 apple 1 glass of water	2 packets hot chips 1 steak pie 1 chocolate bar 1 can fizzy orange juice
Dinner	1 piece of stewed lamb 1 serving boiled potatoes 1 serving each of broccoli, beans and carrots 1 cup herbal tea	1 piece of fried fish 1 serving fried chips 1 can cola 1 bar of chocolate

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a) Define the terms:
   i. diet
   ii. balanced diet [5]
   iii. nutrient. [3]

b) i. Which learner, A or B, has a balanced diet? Explain your answer. [8]
   ii. Draw a table like the one below to classify the foods in Learner A's day into each of the four nutrient groups.

Carbohydrates	Proteins	Fats	Vitamins and mineral salts

   iii. Into which food groups do most of Learner B's food fall? [2]
   iv. Name two foods in Learner A's diet which are high in fibre. [2]
   v. Give two reasons why fibre is important in a balanced diet. [2]
   vi. If you had to give Learner B advice on how to improve his or her diet, what would you say? Write at least three sentences. [3]

[Total marks: 30]

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Topic 4 The respiratory system

Learning objectives	Activities
• State the percentage composition of air. • Identify respiratory gases. • Describe the test for carbon dioxide gas. • Test for oxygen gas.	• Discussing the composition of air • Comparing oxygen in inhaled and exhaled air experiment • Blowing into lime water or bicarbonate indicator • Using glowing wooden splint to test for oxygen

In Grade 7 you learnt about the human respiratory system. This system is used to bring air from the outside into our bodies. Air is made up or **composed** of several gases, including oxygen and carbon dioxide. We use up oxygen in the air we breathe in, and we then produce carbon dioxide that we breathe out. Taking air into our body is called **inhalation**. Expelling air out of our body is called **exhalation**. This process of inhalation and exhalation is called breathing.

In this topic, you will build on what you learnt in Grade 7. You will learn about the **composition** of air and you will also perform some tests to investigate the presence of gases in air.

Air and respiratory gases

The air around us is made up or composed of a mixture of gases, including the respiratory gases oxygen and carbon dioxide.

The composition of air

The amount of each gas in the air is different and is recorded as a **percentage** of the whole. So if the whole is 100%, then each gas is expressed as a percentage out of 100. This is called the **percentage composition** of air.

Word help

composed: made up of
composition: the way something, such as a mixture, is made up
exhalation: the process of breathing out
inhalation: the process of breathing in
percentage: an amount out of one hundred
percentage composition: the composition of a mixture written as percentages

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Figure 4.1 shows the percentage composition of gases in air. Nitrogen and oxygen make up the largest percentages of air, while there is very little carbon dioxide in air. Other gases include argon, ozone and methane. The amount of water vapour in the air varies depending on where you are on Earth and the time of day.

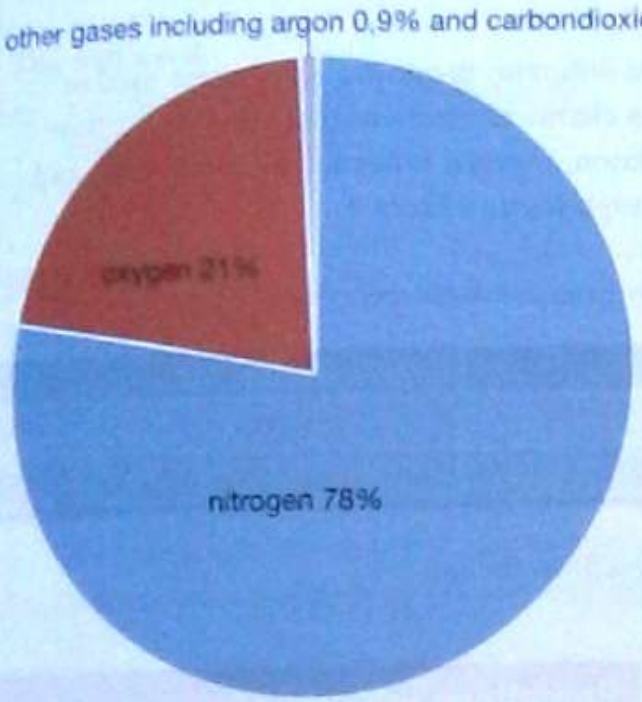

Figure 4.1 Pie chart to show percentage composition of air

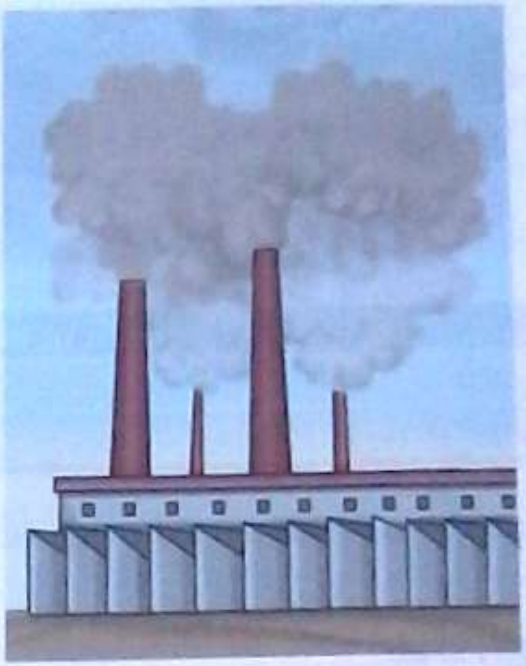

Figure 4.2 Polluted air contains many harmful gases

Air that is polluted will have a different gas composition compared with clean, unpolluted air. In polluted air, there will be a higher percentage of harmful gases such as carbon monoxide, nitrogen oxide and sulfur dioxide.

Activity 4.1

Answer the questions.

1. Study Figure 4.1 that shows the percentage composition of air.
   a) Name the main gas in air.
   b) Name two respiratory gases shown in the pie chart.
2. Use the information in Figure 4.1 to draw a table that shows the percentage composition of air.
3. a) Explain why the percentage composition of air can vary.

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Respiratory gases

Oxygen and carbon dioxide are the **respiratory gases**. The air we breathe in, or inhale, has a high oxygen content and a low carbon dioxide content. The air we breathe out, or exhale, has a high carbon dioxide content and low oxygen content.

It is important to note that breathing and **respiration** are different. Breathing is a process used to move air into and out of our bodies. Respiration involves chemical reactions that take place inside all living cells. Energy is made by the reactions of respiration. Oxygen is needed for respiration and carbon dioxide is produced. You will learn more about respiration in Form 4.

Table 4.1 Table to show the approximate percentage of respiratory gases in inhaled and exhaled air

	% in inhaled air	% in exhaled air
Oxygen	21	16
Carbon dioxide	0.03	4

We can test air to find out if the respiratory gases are present in the air.

Oxygen in air

It is possible to test for the presence of oxygen in air. To test for the presence of oxygen, a glowing **splint** is used. A splint is a thin, wooden stick. When a material burns it uses up oxygen and produces carbon dioxide. Burning is also called **combustion**. In the next activity you will discover what happens to a glowing splint if oxygen is present.

Something interesting

When oxygen was first discovered more than 250 years ago, it was named 'fire air' because it made things burn.

Word help

combustion: burning a substance with oxygen; heat and light are made

respiratory gases: the gases oxygen and carbon dioxide, which are important in the reactions of respiration

respiration: a series of chemical reactions used by cells to make energy; oxygen is needed and carbon dioxide is produced

splint: a thin piece of wood

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Activity 4.2 Demonstration

Testing for oxygen in air Work as a class

Observe a demonstration of the test for oxygen in air.

You will need:

- a container (with lid) with air inside
- matches or a lighter
- a wooden splint

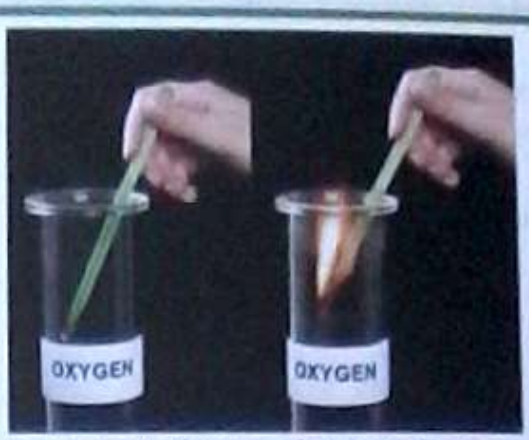

Figure 4.3 A glowing splint is used to test for the presence of oxygen.

Method

Follow the instructions.

1. Have the container with air ready.
2. Use a match or lighter to light the wooden splint. Let the splint burn for a few seconds.
3. Blow the splint so that the wood is not on fire but just glowing.
4. Hold the container upside down and take the lid off. Hold the glowing splint in the container.
5. Observe what happens to the glowing splint.

Observations and results

Describe what you observe.

Conclusion

Give a conclusion for the demonstration.

Questions

Answer the questions.

1. Explain why a glowing splint can be used to test for oxygen.
2. Explain why you held the container upside down before you placed the glowing splint inside.
3. Suggest what would happen if you had blown air into the container before placing the glowing splint inside. Explain your answer.

It is also possible to find out how much of the air consists of oxygen.

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Activity 4.3 Demonstration

Determine the percentage of oxygen in air Work as a class

Observe a demonstration on how to determine the percentage of oxygen in air.

You will need:

- a shallow trough
- matches
- a test tube
- sticky putty
- a small candle
- water
- a measuring cylinder
- a marking pen

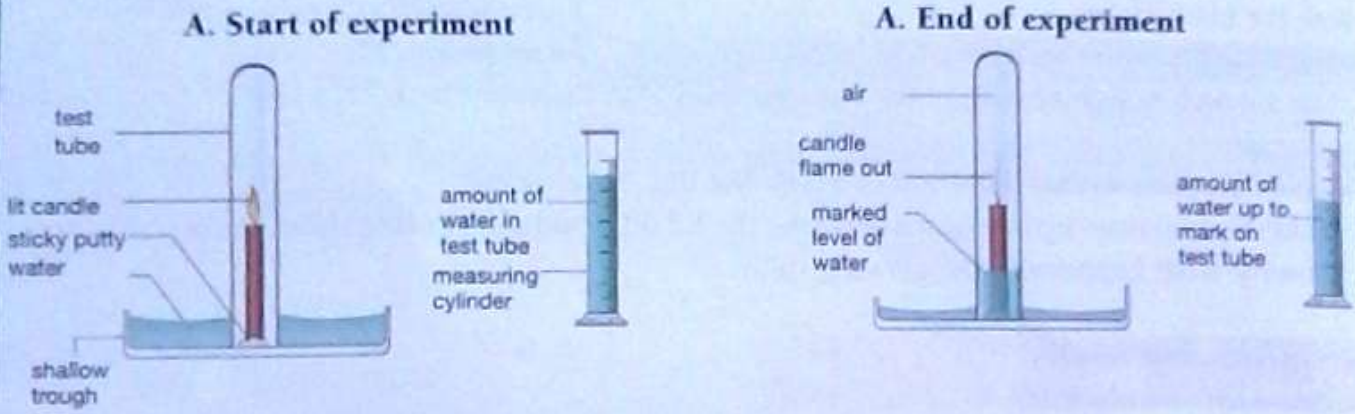

Figure 4.4 Apparatus used to measure the amount of oxygen in air

Method

Follow the instructions.

1. Fill the test tube with water to the top. Pour the water into the measuring cylinder and record the volume of the test tube in millilitres.
2. Stick the candle in the middle of a shallow trough using sticky putty.
3. Carefully pour some water into the trough.
4. Light the candle and place the test tube upside down over the candle so that it rests on the bottom of the trough.
5. The candle flame will go out as soon as the oxygen in the test tube is used up. The water should rise up the test tube. When the flame on the candle goes out, measure the height of the water in the test tube using a marking pen.
6. Remove the test tube from the trough and fill it with water up to the mark that you made. Measure the volume of water in the test tube.

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7. Record the volumes in a table similar to the one below.

Volume of water in the test tube at start of experiment (ml)	
Volume of water after candle flame goes out (ml)	

Observation and results

Calculate the percentage of oxygen that was used up by the burning candle. Use the following formula:

Volume of water at start = a

Volume of water after flame goes out = b

$$\frac{a-b}{a} \times 100 = \text{percentage of oxygen in air}$$

The result is the percentage of oxygen in the air.

Questions

Answer the questions.

1. Name the gas that was used up by the burning candle.
2. What happened to the water in the trough when the candle was burning?
3. The result of the calculation is the percentage of oxygen in air.
   a) What was the percentage of oxygen in this investigation?
   b) Is the percentage the same as in Figure 4.1?
   c) Discuss and then suggest any reason why the percentage might not be the same.

Carbon dioxide in air

It is possible to test for the presence of carbon dioxide in air. Lime water can be used to show that carbon dioxide is present in a sample of gas. Lime water is a clear, colourless liquid that turns a cloudy-white colour in the presence of carbon dioxide.

Activity 4.4 Experiment

Testing for carbon dioxide in exhaled air Work with a partner

Do an experiment to test for the presence of carbon dioxide in exhaled air.

You will need:

- two test tubes or small transparent containers
- drinking straws
- lime water

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Method

Follow the instructions.

1. Place about 10 ml of colourless lime water in two tubes.
2. Take a deep breath in and then gently exhale (blow) through a drinking straw into the clear lime water in one of the test tubes.
3. Observe the colour change in the lime water.

Observations and results

Describe the colour change in the lime water before and after the experiment.

Conclusion

Give a conclusion for the experiment.

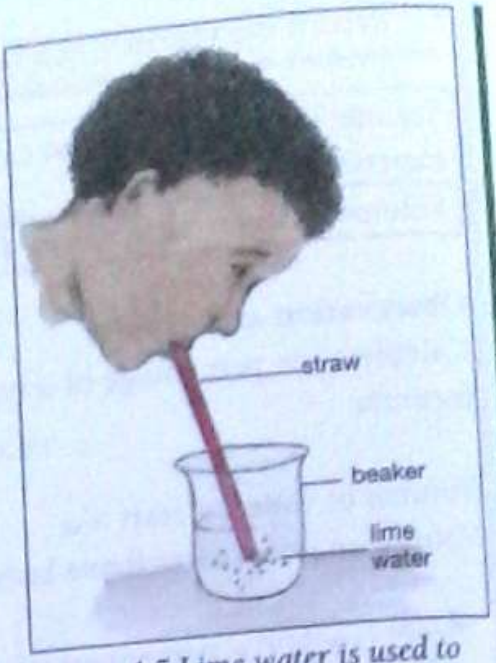

Figure 4.5 Lime water is used to test for the presence of carbon dioxide.

Questions

Answer the questions.

1. Explain why two test tubes of lime water were used.
2. Suggest what would happen to the lime water in the test tube that you did not exhale into after some time. Explain your answer.
3. If you exhaled into an empty test tube and then inserted a glowing splint, what would happen? Explain your answer.

Summary

- The percentage composition of air is 78 % nitrogen, 21 % oxygen, 0,03 % carbon dioxide and the remainder is made up of small amounts of other gases such as argon, ozone and methane.
- Breathing is a process that moves air into and out of our bodies.
- Respiration is a series of chemical reactions that take place in living cells, and use gases to create energy and waste.
- Oxygen and carbon dioxide are known as respiratory gases.
- We breathe in air with a high oxygen content and we breathe out air with a high carbon dioxide content.
- We can test for oxygen in the air using a glowing splint, as the splint will ignite in the presence of oxygen.
- We can test for the presence of carbon dioxide using clear limewater, as it will turn cloudy-white in the presence of carbon dioxide.

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Topic 5 Transport systems

Learning objectives	Activities
• Describe water movement in plants. • Identify components of blood stating the functions of each component.	• Demonstrating water movement in a plant using potassium permanganate/ methylene blue/coloured solution • Observing components of blood on slides

In Grade 7 you learnt about the structure and function of the human circulatory system. You learnt that the circulatory system consists of the heart, blood vessels and blood. Blood is important for transporting substances such as respiratory gases and nutrients to and from the cells.

Blood is pumped through blood vessels by the action of the heart. So the human circulatory system is a **transport** system.

Plants also have a transport system. They have special cells that are used to transport water and nutrients throughout the plant.

In this topic, you will learn about how substances move in plants and animals. You will also extend your knowledge of blood, which is part of the human transport system.

Transport mechanisms

All living cells need a supply of oxygen and nutrients. **Waste products** such as carbon dioxide need to be removed from the cells. For these substances to be transported they need to be in a **solution**. The nutrients and the gases (oxygen and carbon dioxide) are soluble and dissolve in water.

Word help

diffusion: the movement of particles from an area of high concentration to an area of low concentration

solution: a mixture in which a substance is dissolved in a liquid

transport: move something from one place to another

waste products: unwanted substances that are produced in an organism (plant or animal) and need to be removed

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Diffusion

In plants and animals, substances in a solution are transported through the process of **diffusion**. Liquids and gases are made up of tiny **particles**. These particles have energy and move around in random directions in the liquid or gas. Gases and soluble solid substances (nutrients) can dissolve in water. The gas and solid particles then move between the water particles. Diffusion is the movement of particles of dissolved solid substances and gases from an area where they are in a high **concentration** to an area where they are in a lower concentration. Diffusion happens until the substances are evenly spread.

The activity demonstrates the diffusion of a soluble solid in a liquid (water).

Activity 5.1 Experiment

Demonstrate diffusion Work in a group

Do an experiment to demonstrate diffusion.

You will need:

- a glass beaker
- water
- a spatula or spoon
- methylene blue

Method

Follow the instructions.

1. Fill a beaker with water.
2. Place one or two crystals of methylene blue at the bottom of the beaker using the spatula or spoon.

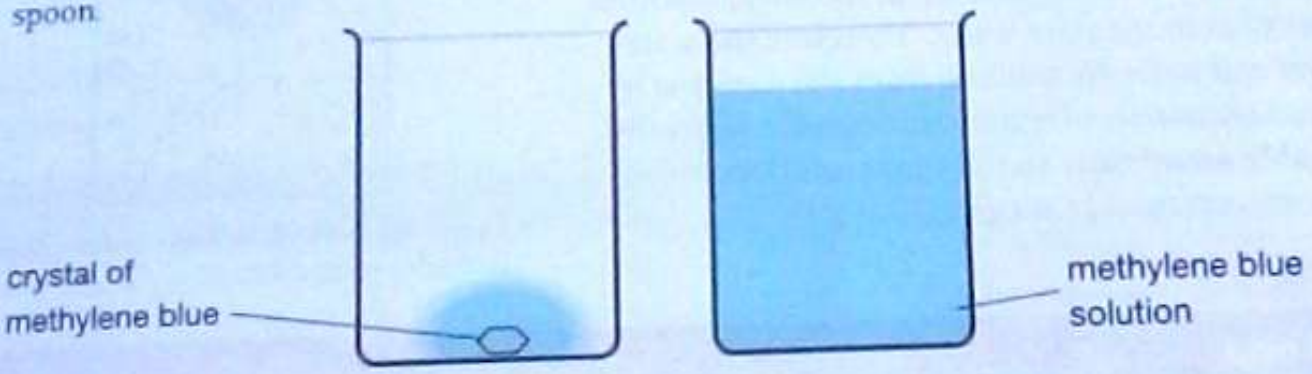

Figure 5.1 Demonstrating diffusion

3. Observe what happens to the methylene blue crystal.

Observations and results

Describe what you observe.

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Answer the following questions.

1. Name the process that you have shown in the experiment.
2. Complete the following sentences using the following words:

lower	high	diffused

The methylene blue crystal particles were in a _____ concentration when they were first place in the water. After a time, the particles _____ towards an area where they were in a _____ concentration.

Osmosis

Plants need to take up water from the soil. This is done through the process of **osmosis**.

Osmosis is a special type of diffusion. It is the movement of water particles through a cell membrane from a solution where they are in a higher concentration to a solution where they are in a lower concentration.

Study Figure 5.2 on the next page. There are two compartments. The one compartment contains pure water. Pure water has a high concentration of water particles because there are no substances dissolved in it. The other compartment is a sugar solution. The concentration of water particles in the sugar solution is lower than in the pure water. Therefore the water particles will move by osmosis from the pure water (high concentration of water) through the **partially permeable membrane** to the sugar solution with a lower concentration of water.

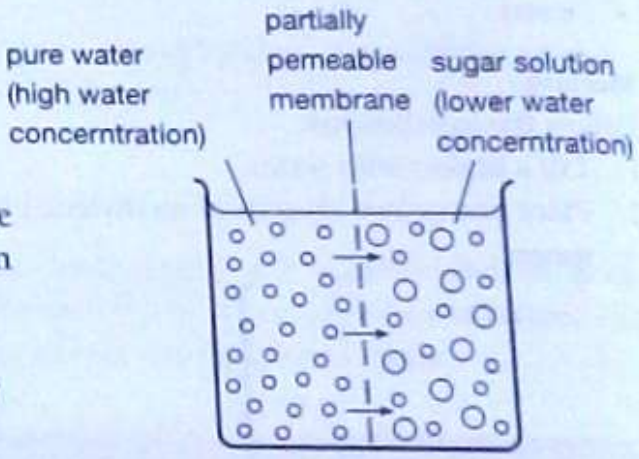

Figure 5.2 Osmosis is the movement of water through a membrane.

Word help

concentration: the amount of a substance when it is mixed with another substance
osmosis: movement of water molecules through a membrane from a high concentration to a lower concentration
partially permeable membrane: a membrane that allows through only particles of certain substances and not others.
particle: a very small part or bit that makes up matter

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Transport in plants

Transport in plants takes place by diffusion and osmosis. Dissolved nutrients move into and out of cells through the plant by diffusion and water moves by osmosis.

Movement of water in plants

Plants absorb water from the soil by osmosis. In the soil outside the plant, the concentration of water is higher than in the plant cells in the **root hairs**. Water from the soil enters a plant through its root hairs.

Figure 5.3 Water moves through osmosis into a root through root hairs.

Word help

root hairs: tiny extensions of cells in plant roots through which water moves

Activity 5.2 Experiment

The movement of water in plants Work in a group

Do an experiment to observe the movement of water in plants.

Safety

For health and safety reasons, we do not use actual human blood.

You will need:

- two containers large enough to hold the plant stalks
- a scalpel, sharp knife or blade
- a hand lens
- water
- potassium permanganate
- potted plants such as celery, kale, rape or leeks

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Method

Follow the instructions.

1. Make up about 250 ml coloured solution by dissolving a few potassium permanganate crystals in water in a container.
2. Place a freshly cut plant stalk in the container.
3. Leave the plant stalks for a day or two.
4. Carefully cut a cross-section through the stalk using the scalpel. See Figure 5.4. Cutting across is called a **cross section** or transverse section.
5. Observe the stalk slice with a hand lens. The stalk slice should look like Figure 5.5.

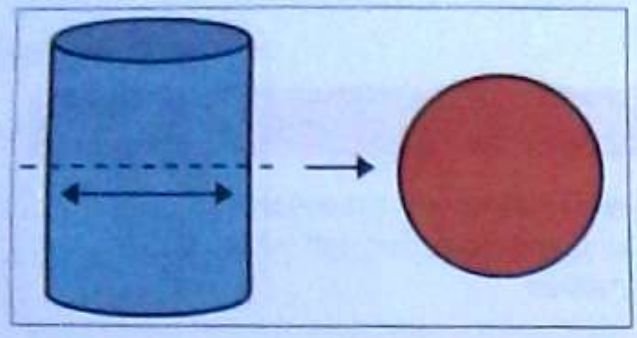

Figure 5.4 A cross-section (transverse) section

Figure 5.5 View of cross-section of stalk using a hand lens

Observations and results

1. What do you observe inside the slice of the plant stalk?
2. Draw a diagram of the cross-section of the stalk. Label the diagram.

Questions

Answer the following questions.

1. Explain what has happened to the coloured water.
2. By what process did the coloured water move into the plant?

Transport in humans

You have already learnt that the transport system in humans is the circulatory system. Substances such as oxygen, carbon dioxide and nutrients move around the body. These substances ar dissolved in the blood or they are carried in special blood cells.

Components of blood and their functions

Blood consists of the following parts:

- **Plasma:** This is the liquid part of blood. Plasma consists of water, **dissolved** substances such as

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oxygen and nutrients and waste products such as carbon dioxide.

- **Blood cells:** There are two types of blood cells **suspended** in the plasma, namely red and white blood cells.
  - **Red blood cells** do not have a nucleus. They are made up of a special substance called **haemoglobin**. Haemoglobin is a red pigment and gives blood its red colour. It carries oxygen and carbon dioxide around the body.
  - **White blood cells** are larger than the red blood cells and there are fewer of them in the blood. White blood cells have a nucleus. The function of the white blood cells is to defend the body against invading organisms that could cause diseases.
- **Platelets**: Platelets are **cell fragments**. Platelets are the smallest of the blood cells. They play a role in blood clotting and therefore prevent blood loss after an injury.

Something interesting

- There are 30 billion red blood cells in a teaspoon of blood.
- It takes less than a minute for a drop of blood to travel from the heart, through your body, and back to the heart again.

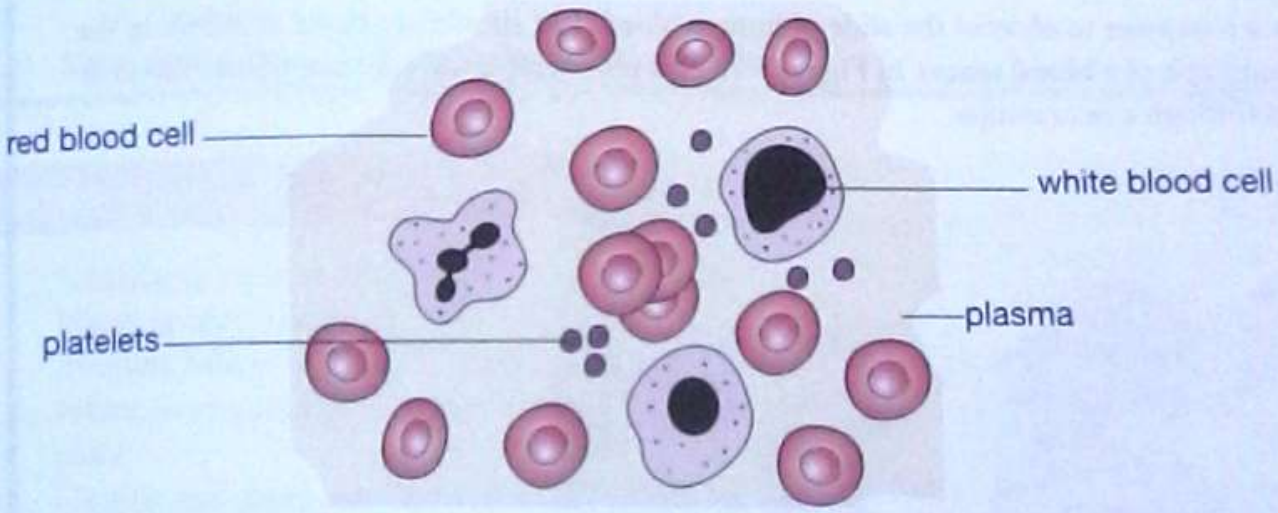

Figure 5.6 The components of blood

Word help

blood smear: a thin layer of blood on a slide
cell fragments: pieces of cells that have broken off
dissolved: when a solid becomes part of a liquid and forms a solution
haemoglobin: a red pigment found in red blood cells
suspended: floating

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In the next activity you will observe a slide of human blood and identify the components of blood.

Activity 5.3 Investigation

Safety

For health and safety reasons, we do not use actual human blood.

Observing blood Work on your own

Do an investigation to observe human blood under a microscope.

Note: For safety reasons real human blood should not be used at school.

You will need:

- a bioviewer
- slides of human blood

Method

Follow the instructions.

1. Use a bioviewer to observe the slide of human blood. You should see blood as shown in the photograph of a **blood smear** in Figure 5.7. This photograph was taken of human blood as seen through a microscope.

Figure 5.7 Photograph of a blood smear as seen under a microscope

2. Observe the blood smear on the bioviewer slide or in Figure 5.7.
   a) Make an accurate drawing of a few cells as seen in the blood smear.
   b) Give the drawing a heading.
   c) Identify the following parts in the blood smear cells: red blood cells, white blood cells and platelets.
   d) Label these parts on the drawing.

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Activity 5.4

Answer the questions.

1. Define the following terms:
   a) Diffusion
   b) Osmosis
2. Name two substances in humans that are transported:
   a) to cells
   b) away from cells.
3. Write a paragraph in your own words to describe how water moves into a plant from the soil.
4. Blood consists of different components including red and white blood cells.
   a) Give the main function of:
      i. red blood cells
      ii white blood cells
      iii. platelets.
   b) Name three substances that may be dissolved in plasma.

Summary

- Substances such as oxygen and nutrients need to be transported to all living cells. Waste products, such as carbon dioxide, need to be transported away from them.
- Animals have a circulatory system that transports substances around their bodies.
- Plants have a transport system consisting of special cells that form tubes inside the plant.
- Liquids and gases can move in a solution from an area where they are in a high concentration to an area where they are in a lower concentration. This process is called diffusion.
- Water particles can move through a partially permeable membrane from a solution where they are in a high concentration to a solution where they are in a lower concentration. This process is called osmosis.
- Plants absorb water from the soil into their roots by osmosis.
- In animals, substances are transported when they are dissolved in blood.
- Blood consists of red blood cells, white blood cells, a liquid called plasma and cell fragments called platelets.
- Red blood cells are important in transporting oxygen around the body, while white blood cells play a role in protecting us from disease.

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Topic 6 Reproductive systems

Learning objectives	Activities
• Describe the structure of a simple flower. • Describe pollination and fertilisation. • State the signs of puberty.	• Observing a flower using a hand lens or bioviewer • Emphasising pre-menstrual symptoms such as period pain

All organisms reproduce. Reproduction is the production of new organisms called **offspring**. You learnt about reproduction in earlier Grades. There are two types of reproduction, asexual and sexual reproduction. Offspring produced by asexual reproduction have only one parent, whereas in sexual reproduction two parents are involved.

In Grade 3 you learnt about the different parts of a plant and their functions. You learnt that the flower is the part of the plant that is involved in reproduction. In Grade 5, you extended your knowledge and found out about different types of reproduction in plants and animals. In Grade 6, you focused on the human reproductive system, puberty and pregnancy.

In this topic, you will learn about sexual reproduction in plants and animals.

Reproduction in plants and animals

Sexual reproduction involves the joining together of sex cells called **gametes**. The male gamete joins the female gamete in a process called **fertilisation**. After fertilisation, a new organism grows.

There are reproductive structures in plants and animals that are **specialised** to produce gametes. There are also specialised structures for the process of fertilisation.

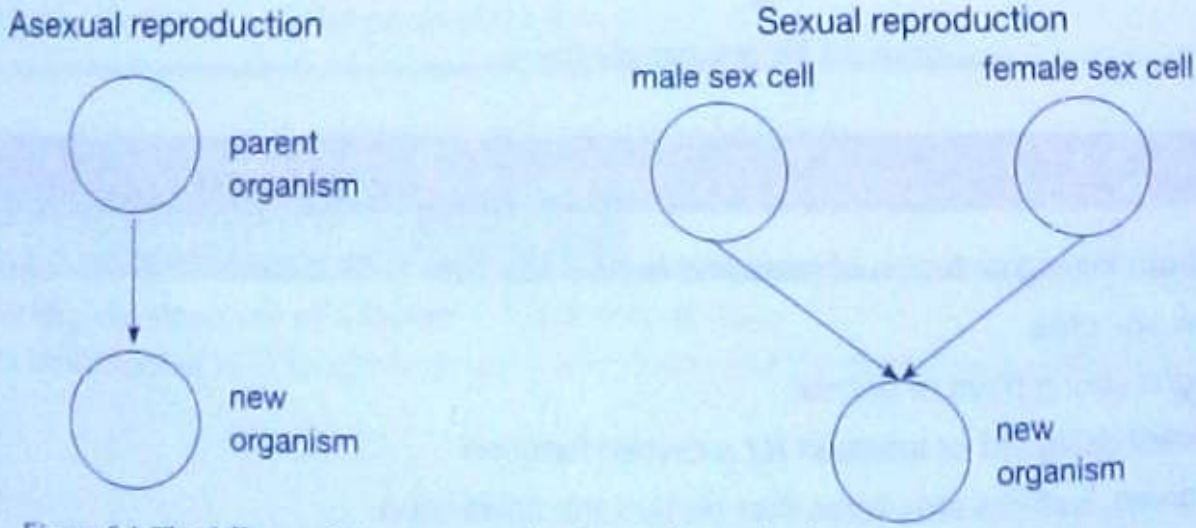

Figure 6.1 The difference between asexual and sexual reproduction

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Reproduction structures and processes in plants

The flower is the sexual reproduction organ in plants. The flower's structure makes it well suited for sexual reproduction.

General structure of a flower

The outer part of a flower is made up of **sepals**. These are green, leaf-like structures that protect the flower while it is growing as a bud. The **petals** form inside the sepals. The petals are often brightly coloured. The male and female reproductive structures form inside the petals.

- The male part of a flower is called the **stamen**. Each stamen consists of a thin stalk or **filament** and a swollen end at the top called the **anther**. **Pollen** grains containing the male sex cells form inside the anthers.
- The female part of a flower is called the **carpel**. It consists of the **stigma**, the **style** and the **ovary**. The stigma is a swollen, sticky structure at the top. The style is a stalk that joins the stigma to the ovary. Inside the ovary are **ovules**. Each ovule contains a female sex cell.

Figure 6.2 The structure of a flower

Word help

fertilisation: joining or fusion of male and female sex cells

gametes: sex cells

offspring: a young plant or animal

specialised: designed or adapted for a certain function

sepals: green, leaf-like structures that protect the flower bud

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petals: often brightly coloured structures that surround the reproductive parts of a flower
stamen: the male part of a flower; made up of the filament and anther
filament: the stalk that supports the anther; part of the stamen
anther: produces the pollen grains; part of the stamen
pollen: made in the anther; contains the male sex cells
carpel: the female part of the flower
stigma: sticky part of the carpel; receives pollen grains
style: a stalk that supports the stigma
ovary: the swollen part at the base of the carpel; contains ovules
ovule: contains the female sex cell; becomes a seed after fertilisation

Activity 6.1

Answer the questions.
The flower is the reproductive structure of a flowering plant.

1. Name the male part of the flower.
2. Name the two parts of the male part of the flower.
3. Describe the function of the male part of the flower.
4. Complete the sentences below.

   The female part of the flower is called the _____. It consists of three parts, the _____, the _____ and the _____. Inside the _____ are ovules that contain the _____.

5. Describe the function of the female part of the flower.
6. What is the function of the petals of the flower?

In the next activity, you will examine the different parts of a flower.

Activity 6.2 Investigation

Observing the structure of a flower Work on your own
Do an investigation to observe the structure of a flower and the reproductive structures.

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You will need:

- large flowers such as hibiscus
- a hand lens
- a razor blade or scalpel

Method

Follow the instructions.

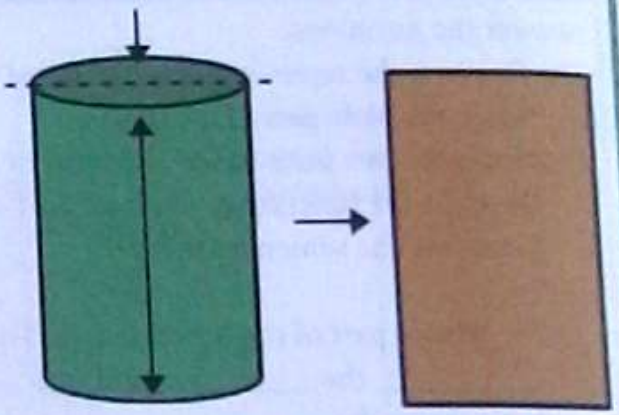
1. Examine the flower. Use Figure 6.2 to help you identify the parts. Identify the sepals, petals, stamens and carpel.
2. Find the stamens. Touch the top of the anthers with your finger. What do you observe on your finger?
3. Find the carpel. Touch the top with your finger. What do you observe on your finger?
4. Carefully cut the flower in half, lengthways, from top to bottom. Cutting lengthways is called a **longitudinal section**.
5. Look at the ovary with a hand lens. Identify the ovules.

Safety

Warning! Be careful when using a sharp cutting tool.

Observations

1. When you touched the stamens, what did you observe on your finger?
2. When you touched the carpel, what did you observe on your finger?
3. Make an accurate drawing of the **longitudinal section** of the flower.
   a) Give your drawing a heading.
   b) Label the following parts: sepals, petals, stamen, anther, filament, carpel, stigma, style, ovary and ovules.



Pollination and fertilisation

Pollination and fertilisation are processes in sexual reproduction in plants. Both these processes take place during sexual reproduction in plants to produce seeds that will grow into new plants.

Pollination

Pollination is the process by which pollen is transferred from the stamen (male part) to the carpel (female part) of a flower. Pollen grains contain the male sex cells. The male sex cells need to be carried to the carpel for sexual reproduction to take place. Pollen is transferred by **pollinating agents** such as wind, birds or insects. Insects are attracted to the brightly coloured flower petals. You learnt about pollinating agents in Grade 5.

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Pollination can take place in two ways:

- **Self-pollination** is the transfer of pollen from the stamen to the carpel on the same flower or another flower on the same plant. (See Figure 6.4.)
- **Cross-pollination** is the transfer of pollen from the stamen of a flower on one plant to the carpel of a flower on another plant of the same type. (See Figure 6.5.)

Figure 6.4 Self-pollination

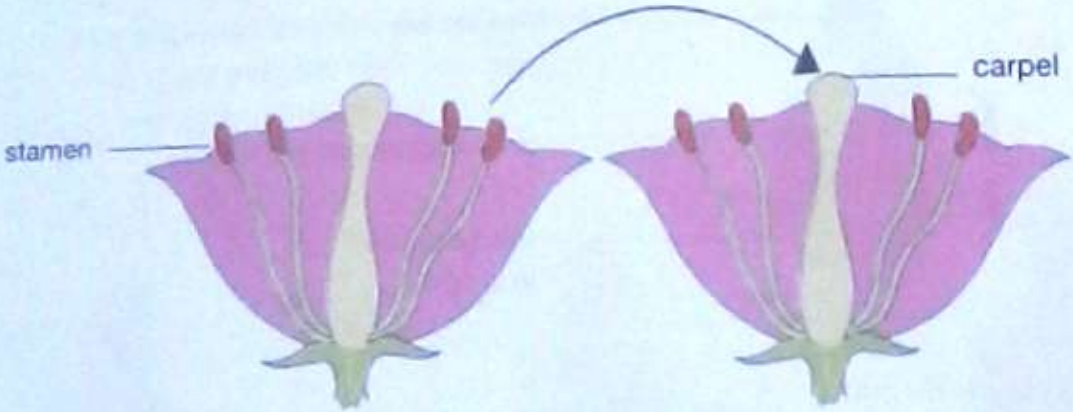

Figure 6.5 Cross-pollination

Word help

fruit: the ovary that becomes swollen after fertilisation and contains the seeds
fuse: join together
germinate: when a seed begins to grow into a new plant
longitudinal section: when an object is cut vertically, along its length
pollination: when the pollen from the stamen reaches the carpel
pollinating agents: something that moves pollen from the anthers to the stigma, for example insects, wind, birds
zygote: the first cell that forms when a male and female sex cell join at fertilisation

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Fertilisation

In sexual reproduction, fertilisation is the joining together of the female and male sex cells. In flowering plants, the male sex cells inside the pollen grains must join with the female gamete inside the ovule during fertilisation. This forms a seed. When the seed **germinates**, a new plant will grow. You investigated germination of seeds in Grade 6.

During pollination, the pollen grains land on the sticky stigma. A pollen tube grows out of the pollen grain, down the style into the ovary and into an ovule. A male sex cell moves down the pollen tube and **fuses** with the female sex cell (egg cell) inside the ovule. A cell called a **zygote** forms. The zygote grows inside the ovule to form a seed. The surrounding ovary becomes the fruit.

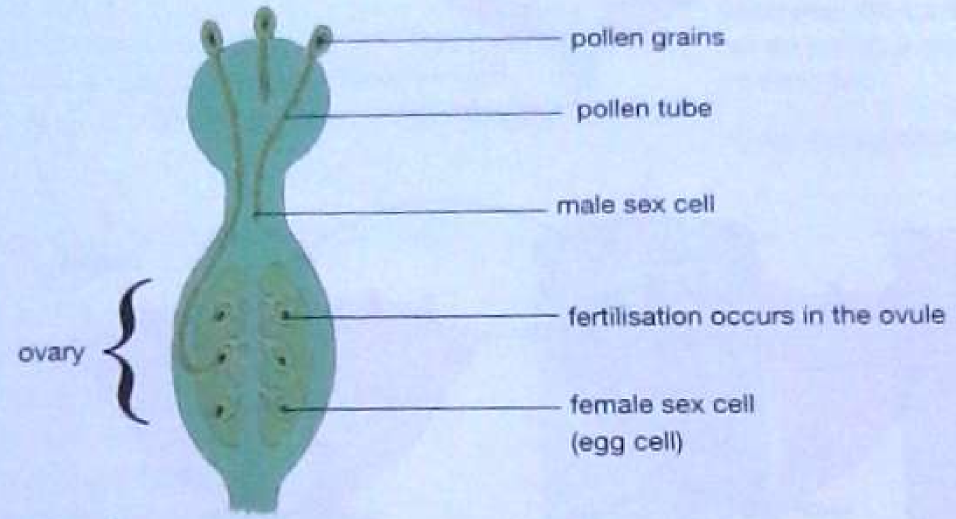

Figure 6.6 Fertilisation takes place in the ovule.

Activity 6.3

Answer the questions.

1. Pollination and fertilisation are different processes that take place during sexual reproduction in plants.
   a) Explain the difference between pollination and fertilisation.
   b) After fertilisation, which part of the flower forms the seeds and which part forms the fruit?
2. Name two pollinating agents.
3. Explain the difference between self- and cross-pollination.
4. Explain why a flower's petals are often brightly coloured.
5. Search the Internet for information on how different types of flowers are pollinated.

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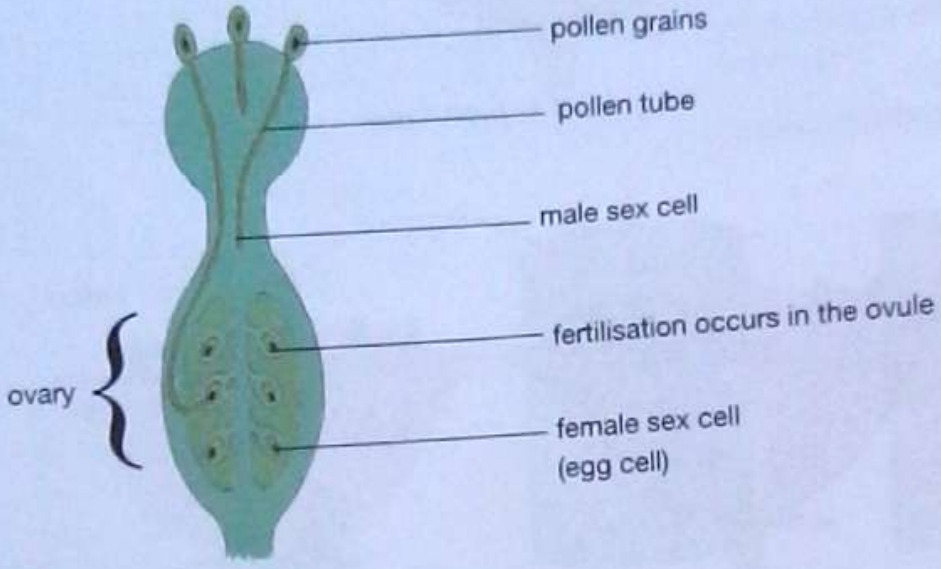

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Reproduction in humans

Humans reproduce sexually. You learnt about the structure of the male and female reproductive systems in Grade 6. As with plants, you may remember that human reproduction also involves the fusion of male and female sex cells. In this section, you will extend your knowledge of puberty. You will also find out about some symptoms girls can experience during the menstrual cycle.

Puberty

When the body of a human being is preparing to reproduce, many changes take place. **Hormones** bring about these changes. This is called **puberty**. Puberty is a time of sexual maturation when physical and emotional changes take place. Puberty occurs at different ages in boys and girls. These changes happen at different times in different people and occur gradually over a period of two to five years. Puberty is a natural step in every person's development.

Physical changes in boys during puberty

The physical changes in males include the growth of facial, body and pubic hair. The body becomes more muscular and the voice deepens. The penis becomes larger and wider. The skin may become oily, which can cause pimples. Males may also sweat more during puberty. Figure 6.7 shows the physical changes that occur in males at puberty.

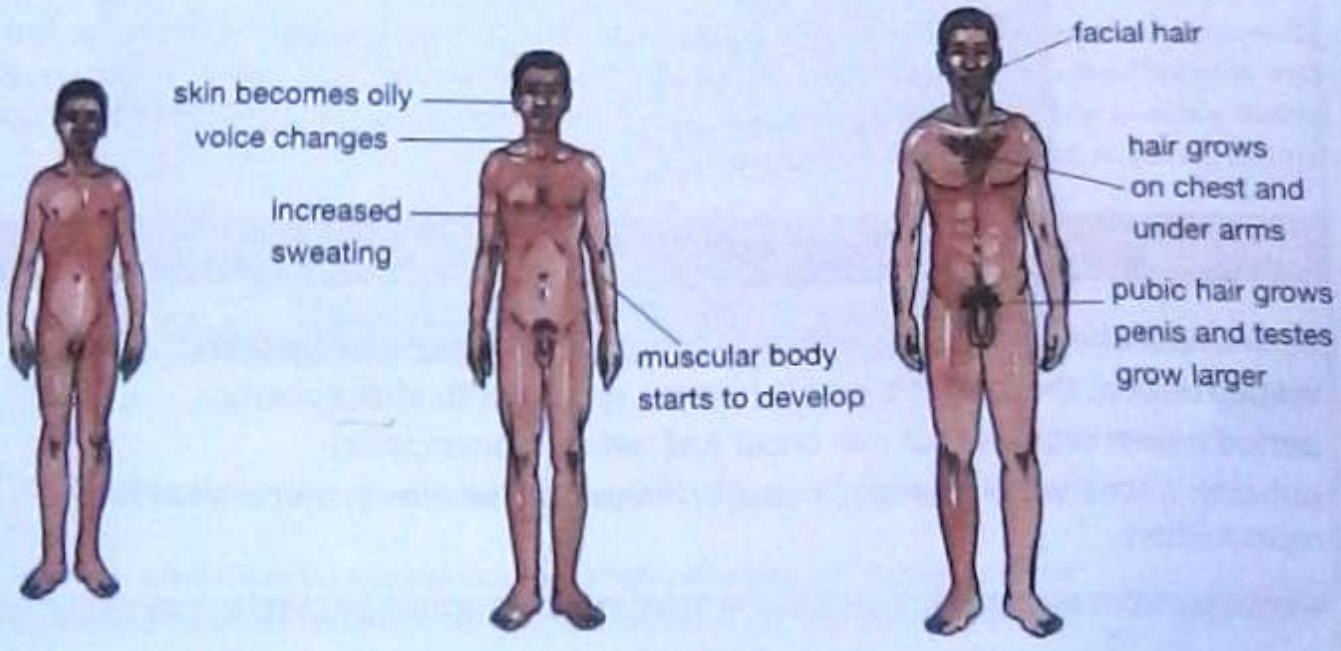

Figure 6.7 Physical changes in males during puberty

Physical changes in girls during puberty

The physical changes in females include larger breasts, the growth of pubic and underarm hair and

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widening of hips. **Menstruation** or periods start. The skin may become oily, which can cause pimples. Figure 6.8 shows the physical changes that occur in females

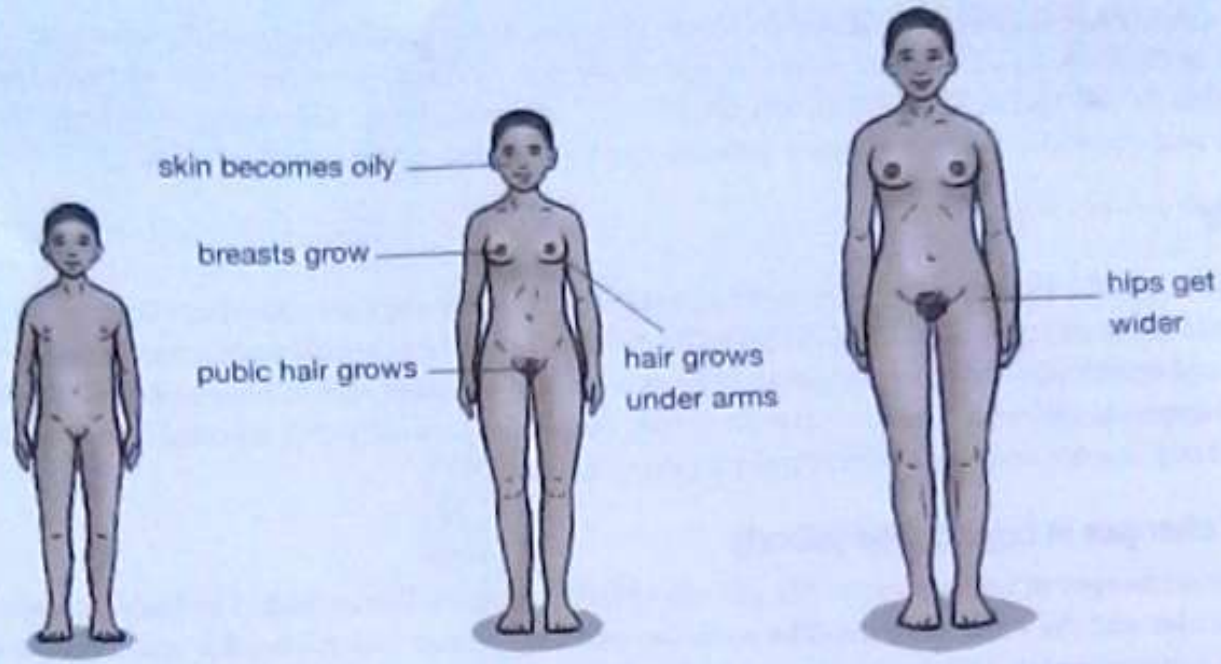

Figure 6.8 Physical changes in females during puberty

Pre-menstrual symptoms

Menstruation, or periods, begins in girls at puberty. Menstruation occurs about once a month. It is the flow of blood from a girl's vagina. Sometimes, just before menstruation, girls experience cramps called **period pains** as well as other symptoms. These are called pre-menstrual symptoms (PMS). These may happen a week or more before menstruation.

Word help

hormones: chemical substances that bring about changes in the body
menstruation: the loss of blood in females each month after puberty
period pains: cramps that can occur just before menstruation
puberty: a time when changes occur in males and females in preparation for reproduction

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Some of these symptoms are:

- changes in mood
- sensitivity in the breasts
- acne
- wanting to eat certain foods (cravings)
- increased hunger and thirst
- tiredness.

Pre-menstrual symptoms can usually be relieved by taking painkillers. If a girl has serious pre-menstrual pains, she should get help from a health worker or doctor.

Activity 6.4

Study Figure 6.9 that shows changes in the human body during puberty. Answer the questions that follow.

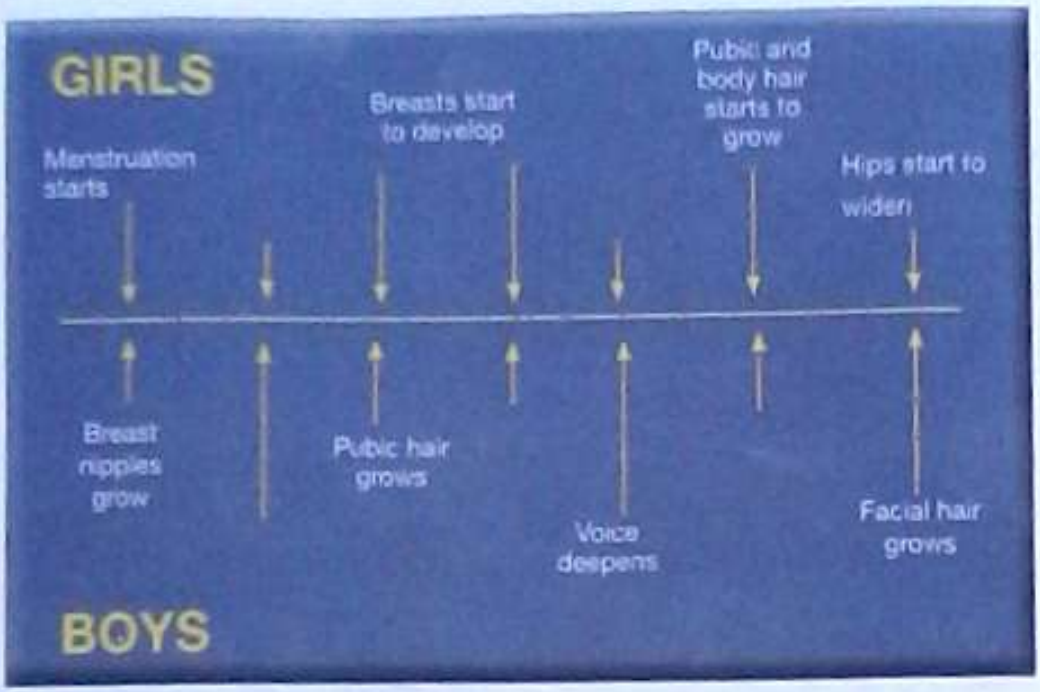

Figure 6.9 Chart to show changes that take place during puberty in females and males

1. Draw a table to compare the physical changes that take place during puberty in males and females.
2. State two similarities between males and females that happen during puberty.
3. State two differences between males and females that happen during puberty.

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Summary

- Sexual reproduction takes place in both plants and animals. It involves the joining together of gametes in a process called fertilisation.
- The structure of a flower is well suited to its role as the reproductive organ of plants.
- Pollination is the process by which pollen, containing the male sex cell, is transferred by wind, birds or insects from the anther to the stigma in a flower.
- The male sex cell inside pollen fuses with the female gamete inside the ovule of a flower. A zygote forms and the ovule develops into a seed that can germinate into a new plant.
- Puberty is the time in the life of girls and boys when changes in their body takes place, preparing them for reproduction.
- Sometimes girls experience pre-menstrual symptoms such as period pains, before menstruation.

Topic assessment

Answer the questions.

1. Flowers are the reproductive organs in flowering plants.
   a) Name the three parts of the carpels. [3]
   b) Name the two parts of the stamens. [2]
   c) In which structure are the:
      i. male sex cells produced
      ii. female sex cells produced? [2]
2. Define pollination. [2]
3. Define fertilisation. [2]
4. Draw a diagram to show how fertilisation occurs in flowering plants. [5]
5. Puberty is a stage in a human's life during which many changes take place.
   a) State any two changes that happen in males during puberty. [2]
   b) State any two changes that happen in females during puberty. [2]
   c) Explain the term 'menstruation'. [2]
   d) Describe three symptoms that girls can experience just before menstruation occurs. [3]

[Total marks: 25]

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Topic 7 Health and diseases

Learning objectives	Activities
• Describe a healthy person. • State the importance of personal hygiene. • List ways of disposing litter or waste, stating their advantages and disadvantages. • Describe the methods of transmission of diseases.	• Discussing the state of a healthy person • Cleaning classrooms • Carrying out simple disinfection of drains • Discussing the cleaning of a toilet • Picking up and burying waste • Discussing methods of disease transmission

You have learnt about different aspects of health and disease in earlier grades. A healthy person looks after their body and also makes sure that their environment is clean.

Diseases are easily spread or **transmitted** in unclean or **unhygienic** conditions. In Grade 4, you found out how easy it is for cholera to spread from one person to another. In Grade 5, you discovered that some diseases are spread during unprotected sex. These are called **sexually transmitted diseases**. **Epidemic** diseases such as Ebola and influenza (flu) are diseases that spread quickly through a whole community. You discussed how to prevent and control epidemics in Grade 7. You also found out about **chronic diseases**. These are diseases that people live with for a long time for example, diabetes, asthma and high blood pressure.

In this topic, you will explore types of **hygiene** such as personal and food hygiene. You will investigate hygiene in your home and at school and you will find out about waste disposal. You will also extend your knowledge of some diseases such as Ebola and cholera. You will discuss how they are spread and how they can be prevented.

Health, hygiene and disease

Health, hygiene and disease are all connected. Healthy people practise good hygiene, which means that their bodies and their homes are clean and diseases do not spread in their environment. Disease can occur in unhygienic places.

Being healthy

We all want to be healthy and well. **Wellness** happens when we look after our physical, mental and social **well-being**.

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- **Physical wellness** means having a healthy body. Regular exercise and a balanced diet make our bodies healthy. You learnt about a balanced diet in Topic 3.
- **Mental wellness** means a person's emotional wellbeing. A mentally well person can cope better with everyday stresses at school, work and home.
- **Social wellness** means that a person is able to have good relationships with other people. The person is spiritually fulfilled and can also contribute positively to the community.

Figure 7.1 Physical, mental and social health are important for our wellness.

Word help

- **chronic diseases:** diseases that people live with for a long time
- **concept map:** a diagram that is used to show information and how pieces of information and ideas are connected
- **epidemic:** a disease that easily spreads in a community
- **hygiene:** cleanliness
- **sexually transmitted diseases:** diseases such as HIV/Aids that are spread by sexual contact
- **transmitted:** passed from one person to another
- **unhygienic:** not clean
- **well-being:** a person's state of health and happiness
- **wellness:** a person's state of health

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Activity 7.1 Discussion

What does it mean to be well and healthy? Work in a group

- Discuss what it means to be well and healthy.
- Talk about the different aspects of wellness. Search the Internet for information on wellness.
- Discuss what other learners in your group do to keep healthy in these different aspects.
- Draw a **concept map** to show the issues you have discussed.
- Report back to the rest of the class.

Personal and food hygiene

Hygiene means keeping yourself and your environment clean. Good personal and food hygiene are important to prevent the spread of disease.

Personal hygiene

Personal hygiene involves taking care of your own body. It involves doing things in your daily life that maintain your health and well-being. For example, you should shower or bath every day, brush your teeth twice a day and wash your hands after going to the toilet and before preparing food. It is important to take care of your own personal hygiene so that you can be healthy. If you do not look after your personal hygiene, it is easy for diseases to spread.

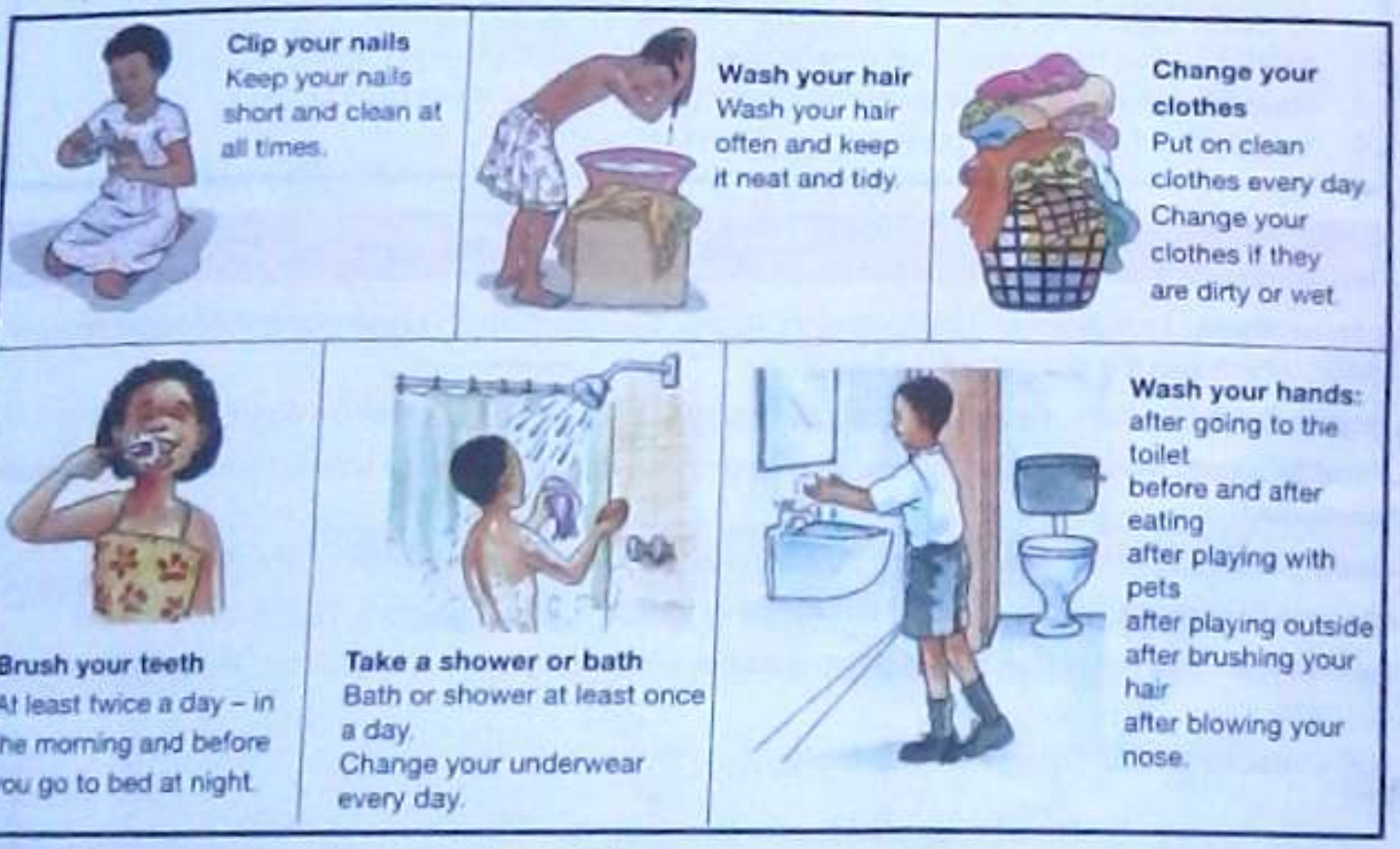

Figure 7.2 Personal hygiene is important to stay healthy.

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Food hygiene

Food hygiene means handling, serving, storing and cooking food in a way that prevents the spread of disease. A person with dirty hands can spread bacteria, viruses and **parasites** around the kitchen and onto food. These harmful germs can **contaminate** food and, if it is eaten, it can cause **food poisoning**. It is important that a person who is working with food washes his or her hands with soap and water before starting to prepare food and after touching raw food such as meat, poultry and vegetables.

Food should be stored at the correct temperature and should be cooked correctly according to the instruction labels on the food packet. Food that has passed its **expiry date** should not be eaten. Meat should be cooked all the way through and pre-cooked food should be reheated only once.

Activity 7.2

Answer the questions.

1. Define the following terms:
   a) Epidemic
   b) Chronic diseases
   c) Contaminated
   d) Hygiene
2. There are three areas that affect the overall wellbeing of a person.
   a) Name these three areas.
   b) For each of these areas, explain what a person should do to remain well.
3. State three things that we can do every day to maintain good personal hygiene.
4. Suggest three methods of practising good food hygiene.

Word help

- **contaminate:** to make something dirty or to mix disease-causing organisms with food or drink, which can be dangerous to health
- **expiry date:** the date, shown on food packaging, by when food must be eaten
- **food hygiene:** handling, serving, storing and cooking food in a way that prevents disease from spreading
- **food poisoning:** an illness caused by bacteria in food; causes vomiting and diarrhoea
- **personal hygiene:** cleansing and maintaining (grooming) of our body to prevent disease
- **parasites:** organisms that live in or on another organism, for example ticks, fleas, the malaria parasite
- **tabulate:** to place information in a table

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In the next activity, you will analyse information about hygiene and health.

Activity 7.3 Discussion

Discuss hygiene and health Work in a group

Study Figure 7.3. It shows some of the ways that we can keep clean and stay healthy. Each colour block suggests a different way that we can stay healthy.

Figure 7.3 Personal and food hygiene help us to stay healthy.

1. In your group, discuss the information in Figure 7.3.
2. In your exercise book, draw a table like the one that follows.

Good personal hygiene	Good food hygiene	Good mental and social health	Good physical health

3. Use Figure 7.3 to **tabulate** the things that people can do to stay healthy. You may have some extra ideas of your own. Add these to your list.

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Environmental hygiene

Environmental hygiene refers to the cleanliness of the places where we live and work. It means cleaning surfaces where people live and work using cleaning chemicals, as well as regularly removing of rubbish and waste. Good environmental hygiene prevents the spread of diseases.

Hygiene at home and at school

It is important that the areas where we live, study or work are clean and hygienic so that we can stay healthy. Diseases are spread in dirty, unhygienic places.

Activity 7.4 Investigation

Investigating the cleanliness of the classroom

Work with a partner

Do an investigation to determine the cleanliness of your classroom. Find out if it is really clean and how to keep it clean.

You will need:

- a hand lens
- plastic gloves, if available
- pencil and paper

Method

Follow the instructions.

Part A

1. Check your science classroom. Look for signs that show it has not been cleaned yesterday or today. You can look for dust, litter, cobwebs and other dirt.
   - Run your finger along the windowsill, the corner of the floor, a desk and so on.
   - Look for cobwebs in corners, near windows and doors.
   - Check the windows.
   - Check the apparatus and equipment.

Indigenous knowledge

People who live in rural areas of Zimbabwe need to fetch water from wells, boreholes and rivers. Water is carried by women to villages, often over great distances. The water is used for cooking, drinking and bathing. Sometimes the water is boiled to kill disease-causing organisms. Women traditionally clean the clay floors and walls of their homes by rubbing soil onto them. Some herbs can be added to the soil to polish the floor.

Word help

environmental hygiene: maintaining and improving basic environmental conditions that affect the well-being (health) of people

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- Check the wastepaper basket/rubbish bin.
- Check the shelves and cupboards.

2. Record what you find/observe.

Part B

- Discuss with your partner why the rooms should be cleaned every day and how they can be cleaned.
- Find out from the teacher or the school staff when the classrooms are cleaned.

Part C

Share your results/findings with the class.

Questions

Answer the questions.

1. List the places that were not clean.
2. Suggest why some places in the science laboratory were not clean.
3. How often are the classrooms cleaned?
4. Make suggestions on how the class can keep the classroom clean.

In the next activity, you will work in groups and have a cleaning day at school.

Activity 7.5 Cooperative learning

Cleaning the classroom! Work in a group

Arrange a cleaning day your the school. You need to clean the science classroom.

You will need:

- plastic gloves
- brooms, mops, dusters and cloths
- water and buckets
- **detergents** or cleaning liquid

Method

Follow the instructions.

1. Organise yourselves into groups. Allocate a cleaning task to each group. Examples of cleaning tasks that might be required in the classroom:

- Washing windows
- Cleaning the tables, chairs and other furniture
- Cleaning the apparatus and equipment in the science laboratory

Figure 7.4 Cleaning the classroom

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- Cleaning the shelves and cupboards
- Picking up litter and cleaning the waste paper basket/rubbish bin
- Sweeping the floor
- Mopping the floor

2. Each group must choose the correct cleaning material and equipment to carry out the cleaning task they are responsible for.
3. Decide on the best order to perform the different cleaning tasks. Sweeping and mopping the floor should be left until last.

Questions

Answer the questions.

1. Explain why the order of cleaning tasks should be considered.
2. In a table, list the cleaning equipment and the tasks that it is used for.

Activity 7.6 Simulation

Make an information pamphlet about cleaning drains and toilets Work with a partner

Have a discussion and make an information pamphlet on drain and toilet hygiene.

You will need:

- pictures
- paper
- coloured pencils
- pens
- glue
- resource material

Method

1. Do some research on the Internet or in the library and find out what kind of germs are found around dirty drains and toilets. Also find out what the purpose of a **disinfectant** is and which kind of disinfectants can be used in drains and in toilets.
2. Discuss how you would clean a drain and a toilet. Talk about the equipment you would use and how you would use it.
3. Make an information pamphlet that explains the importance of hygiene in drains and toilets.

Figure 7.5 Cleaning the toilet

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The information pamphlet should also include step-by-step guidance on how to clean drains and toilets.

4. Present the information in the pamphlet to the rest of the class.

Questions

1. What is the purpose of a disinfectant?
2. Make suggestions on how the class can keep the toilets and drains clean.

Disposing of litter and waste

Most people make a lot of **litter** and waste in their daily lives. Litter is small pieces of rubbish that are left lying around. **Waste** refers to any material that is unwanted. There are different kinds of waste including:

- domestic or household waste or garbage
- industrial waste, for example building and mining waste
- biological waste, which is sewage produced by humans (such as urine and faeces).

Some waste matter, for example vegetable and fruit peels, can be naturally broken down by organisms that live in the soil. This waste is called **biodegradable** waste. Plastics and building materials cannot be broken down naturally and are called **non-biodegradable**.

All this waste needs to be removed or **disposed** of. Since there is only a certain amount of land on Earth that can be used for waste disposal, humans need to find ways to reduce the amount of waste they produce.

Something interesting

Humans need to reduce, recycle and reuse.

- We need to **reduce** the amount of materials that we take from our environment.
- Some materials can be made into something else instead of being thrown away. This is called **recycling**.
- Many things can be **reused**, for example glass jars and plastic bags.

Word help

biodegradable: materials like leaves, vegetables and fruits that can be broken down by micro-organisms

detergents: chemicals that remove dirt; used for cleaning

disinfectant: a chemical liquid that kills bacteria

disposed: thrown away

landfill site: a huge man-made hole into which rubbish is placed

litter: rubbish such as paper, tins and bottles that are left lying around

non-biodegradable: materials like plastic, metal and glass that cannot be broken down by micro-organisms

waste: unwanted materials

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Methods of disposing solid waste include burying, burning and recycling.

Burying waste

Most domestic waste is buried in a place called a **landfill site**. Landfill sites are usually situated outside towns. A landfill is a huge hole that is filled with waste and then covered with soil. Landfills need to be carefully managed to make sure harmful chemicals and materials that produce dangerous gases are not buried. These harmful substances can move downwards in the ground and enter underground water supplies. Non-biodegradable waste that is made in homes should not be buried in the garden, but rather taken to a landfill dump, where it can be properly disposed of.

Figure 7.6 Burying of waste in a landfill

Biodegradable waste such as uncooked vegetables and fruits, leaves and grass cuttings can be placed in a hole in the ground or a compost bin and used to make compost. Compost can be used to fertilise soil for crop and garden plants.

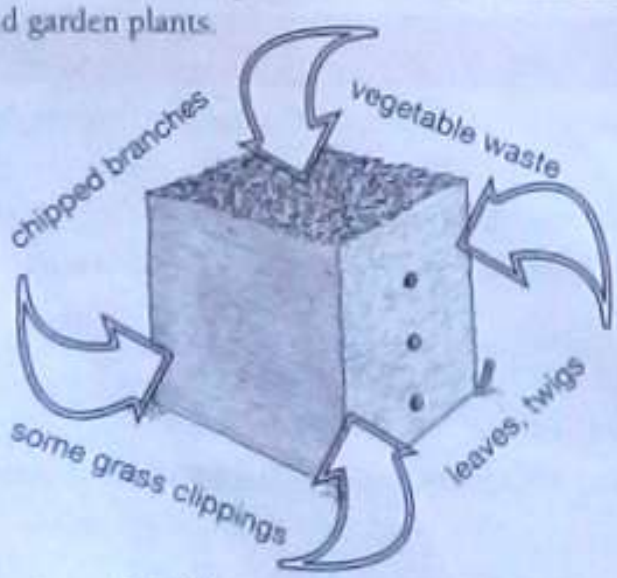

Figure 7.7 Making compost from biodegradable waste

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Burning

Many people burn household waste in a hole or bin in their gardens. Although burning reduces the volume of waste, burning can produce harmful chemicals, cause bush fires and produce large amounts of smoke.

Figure 7.8 Burning waste produces harmful gases and smoke.

Recycling

Recycling means to use waste materials to make other products. Waste paper, plastic, metal and glass can be recycled. Recycling reduces the amount of waste that needs to be disposed of. Waste for recycling is usually sorted into recycling bins.

Figure 7.9 Recycling reduces production of waste.

In the next activity you will find out about recycling plastic in Zimbabwe.

Activity 7.7 Case study

Recycling in Zimbabwe Work on your own

In Zimbabwe, plastic and paper are recycled as a business. People are paid to collect plastic. This earns them up to about 50 cents per kg. The collected plastic is processed into other useable plastic materials such as bags.

Paper, cans and glass materials are recycled in different companies across Zimbabwe. The website referenced below has a list of such companies. Get involved! Contact one in your area if you want to help.

(Source: http://www.ema.co.zw/index.php/2014-06-12-03-51-59/2014-06-12-12-03-26/reports-a-publications/59-recycling-companies-database/file.html)

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Figure 7.10 Recycling of waste

Questions

1. List three materials that can be recycled.
2. Suggest two reasons why recycling is important in Zimbabwe.
3. A person collects 40 kg of plastic and sells it to a recycling firm. According to the information provided, how much would he or she earn?

Each method of waste disposal has its advantages and disadvantages. Table 7.1 shows the advantages and disadvantages.

Table 7.1 The advantages and disadvantages of different waste disposal methods

	Advantages	Disadvantages
Burying	Free	Harmful chemicals from waste can get into ground water Finding a suitable site for a landfill may be difficult
Burning	Reduces the volume of waste so less space is taken up	Releases harmful gases and smoke into the air, which cause pollution
Recycling	Provides an income for some people Reduces the amount of waste Reduces pollution	Could be unhygienic

Activity 7.8 Simulation

Sorting recyclable Work in a group

Do a simulation activity and sort recyclable waste materials.

You will need:

- plastic gloves
- six large containers in which to place waste
- a large sheet of cloth or plastic

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Method

1. Do some research on recycling in Zimbabwe. Find out about different companies that collect specific recyclable waste.
2. Prepare six large bins labelled Glass, Paper, Scrap metal, Tins, Plastic and Organic.
3. Collect all the waste from the school rubbish bins.
4. Throw the waste on a large plastic or cloth sheet on the ground for sorting.
5. Sort the waste into the six bins.
6. Contact the relevant companies to come and collect the recyclable waste.
7. Use the biodegradable waste to make compost for the school garden.

Methods of disease transmission

If you are healthy, you should not have any kind of disease. In earlier grades, you learnt about some diseases, for example malaria and cholera. Diseases are caused by microscopic organisms such as bacteria, protozoa, fungi and viruses. Disease-causing organisms are called **pathogens**.

Diseases can be spread or transmitted to people in different ways, for example by contact, water, food or through the air. Some diseases are transmitted to people by other organisms, usually other animals. Organisms (animals) that transmit disease-causing microscopic organisms are called **vectors**. If you know how the pathogen/disease-causing organism is transmitted, you can prevent yourself from being **infected** and getting the disease. In this section you will learn about some **infectious** diseases and how they are **transmitted**.

Cholera

Cholera is caused by a bacterium. Infection with this bacterium causes serious **diarrhoea** that can be fatal within a few hours if left untreated. Cholera can spread from one person to another in food or water, especially if it is contaminated with **faeces** from an infected person. To prevent the spread of cholera, it is important to wash your hands after going to the toilet, drink clean water and practise good food hygiene.

Word help

pathogens: disease-causing organisms
vectors: organisms like mosquitoes that carry diseases from one person to another
infected: when a person has a disease-causing organism in his or her body
infectious: a disease that can be spread from one person to another
transmitted: spread

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Ebola

Ebola is caused by a virus. It is easily spread from one infected person to another person by coughing and sneezing. It is also spread through contact with body fluids, such as blood or **mucus**, or with any surface contaminated with these fluids from an infected person. The spread of Ebola is difficult to prevent. Some ways to prevent Ebola from spreading include washing hands, not eating **bushmeat** and staying away from people with the infection.

Something interesting

- The Ebola virus spreads quickly through a person's body and it is easily transmitted to other people.
- Over a short period of time in 2015 and 2016, over 25 000 people in West Africa were infected with the Ebola virus.
- Ten thousand of these people died. Some of these were health workers.
- Medical scientists and pharmaceutical companies have been working hard to develop medication/a vaccine to reduce or prevent the spread of this deadly disease.

Malaria

Malaria is caused by protozoa parasites. The parasites live inside certain mosquitoes. The mosquito is the vector that transmits the protozoa parasite to humans. The protozoa parasite is transmitted to humans when an infected mosquito bites a person and transfers the parasite into the person's blood. Using mosquito repellent and sleeping under a mosquito net can help to prevent the spread of malaria.

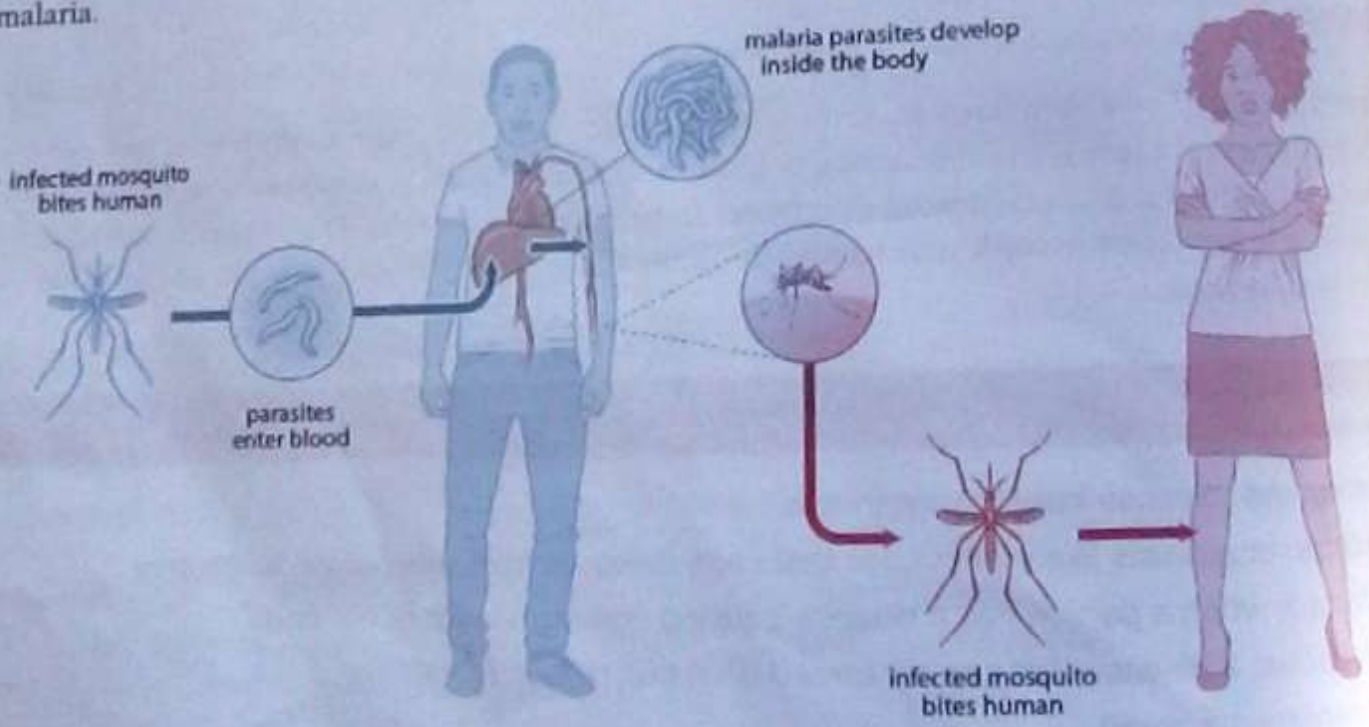

Figure 7.11 ***Transmission of** malarial parasite*

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Bilharzia

Bilharzia is caused by the bilharzia parasite, which is a type of worm called a blood fluke. There are different types of blood flukes that cause bilharzia. Depending on the type, either the **intestines** or the bladder is affected.

People become infected through direct contact with contaminated fresh water where certain types of water snail live. The snails are the vector and transmit the worm that causes the disease.

The cycle begins when an infected person urinates or **defecates** in fresh water. The infected person releases the eggs of the parasite into the water.

The eggs hatch and tiny **larvae** are released into the water. The larvae enter the fresh water snail and develop into worms. The worms are released into the water and infect a person that comes into contact with them.

The worms **bore** through the person's skin and enter into the bloodstream/blood vessels. The worms live in the blood. There they travel through the blood vessels to the bowel and bladder.

The worms mature in the person's body. They reproduce and produce eggs. These eggs pass through the walls of the bladder, intestine or both. They leave the body through the person's urine or faeces.

It is not possible to become infected with bilharzia by a person who is infected. A person can only be infected through contaminated water that has the snails living in it. Bilharzia can be prevented by not urinating, defecating, washing or swimming in fresh water containing the fresh water snails that transmit the worms that causes the disease.

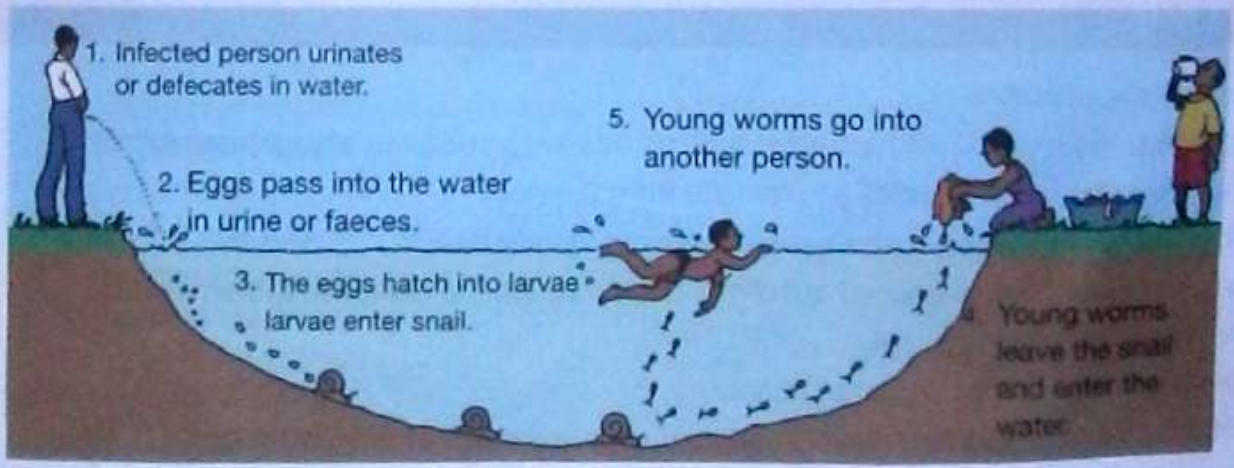

Figure 7.12 Transmission of the bilharzia parasite

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Typhoid

Typhoid fever is caused by a bacterium. It is very infectious, which means that it can easily spread from one person to the next. An infected person can pass the bacterium out of their body in their faeces. If someone eats food or drinks water that is contaminated with infected faeces, he or she can become infected with the bacterium and develop typhoid fever. Typhoid can be prevented by drinking clean water and practising good personal and food hygiene.

Activity 7.9

Answer the questions.

1. Some microscopic organisms cause disease. What is the term used for a disease-causing organism?
2. Name one disease that is caused by:
   a) a virus
   b) a bacterium
   c) a parasite.
3. Personal hygiene plays an important part in being healthy. What part does personal hygiene play in preventing the **transmission** of diseases such as cholera, Ebola and typhoid?
4. Draw a table like the one below. Complete the table to show the causes of cholera, Ebola, malaria, bilharzia and typhoid and how they are transmitted.

Name of disease	Type of organism	Vector	Method of transmission

Word help

bore: pierce; puncture
bushmeat: the meat of wild animals, such as monkeys and bats, slaughtered for food
defecates: discharges faeces (excrement) from the body
diarrhoea: an illness in which a person releases watery faeces
faeces: the solid waste passed out of the body through the digestive system (anus)
intestines: the bowels or gut
larvae: immature stage of some organisms
mucus: a slimy, yellow substance produced by some parts of the human body
transmission: the spread (of disease) from one person to another or from animals to people

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Activity 7.10 Cooperative learning

Make a poster about a disease Work in a group

Make an information poster about one of the following diseases: cholera, Ebola, malaria, bilharzia and typhoid.

You will need:

- large sheets of paper or card
- coloured pencils or paints
- pictures from magazines or the internet

Method

Follow the instructions:

1. Choose one of the diseases you have learnt about. Search the Internet for information about the disease.
2. Plan and make a colourful poster giving information about the disease and how it is spread. The poster should not have much writing – just enough to inform and advise.
3. Display the posters around the school.

Summary

- A healthy person is physically, socially and mentally well.
- Personal hygiene means keeping clean and healthy. It involves doing things such as brushing your teeth, washing your hair and hands, showering, wearing clean clothes and clipping your nails.
- Food hygiene means handling, serving, storing and cooking food in a way that prevents the spread of disease.
- Environmental hygiene means keeping the places where we live and work clean.
- It is important that we correctly dispose of litter and waste such as household garbage, industrial waste and sewage.
- There are three ways to dispose of solid waste – burying, burning and recycling. Each of these has advantages and disadvantages.
- Disease-causing organisms called pathogens can be spread by water, in the air, in food and by physical contact.
- Infectious diseases such as cholera, Ebola, bilharzia and typhoid are caused by different pathogens and are spread in different ways.

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Term 2

Chemistry

Topic number	Topic	Learning objectives
8	Separation	• State methods of separating mixtures.
9	Matter	• Identify the three states of matter. • Describe the arrangement of particles in solids, liquids and gases. • Describe the properties of solids, liquids and gases in terms of the kinetic theory. • Identify mixtures, elements and compounds. • Identify metals and non-metals on the periodic table.
10	Acids, bases and salts	• Identify acids and bases using red and blue litmus. • List properties of acids and bases.
11	Industrial processes	• Outline the production of peanut butter. • Outline the production of oil from peanut butter. • State uses of oil.
12	Oxidation	• State conditions necessary for rusting. • Explain methods of preventing rusting.
13	Organic chemistry	• Identify forms of fuel. • Compare the efficiency of different fuels.

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Topic 8 Separation

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Learning objectives	Activities
• State methods of separating mixtures.	• Carrying out experiments to illustrate methods of separating

In *Junior Science and Technology* you learnt the difference between pure and impure materials. A pure material is one that consists of only one type of substance. For example, pure water consists only of particles of water. An impure material contains particles of different substances. **Mixtures** are impure materials as they consist of more than one type of substance. For example, air is a mixture of different gases and soil is a mixture of different types of particles, organisms, water and gases.

Figure 8.1 Soil is an example of a mixture.

The substances in a mixture do not chemically combine together, which means that they are easy to separate. In Grade 4, you learnt about some ways to separate mixtures. For example, a mixture of sand and water can be separated into sand and water by filtration. You also found out about purifying water by filtration and distillation.

In this topic, you will extend your knowledge of mixtures and types of mixtures and find out about some ways to separate mixtures.

Mixtures

A mixture is made up of two or more substances that have different **physical properties**. A physical property is a characteristic of a substance that can be seen and measured, for example **density**, hardness, boiling point or size of particles. The physical properties of the components of the mixture do not change when they are mixed. In some mixtures, the different substances are still clearly visible after mixing. The substances that make up the mixture can be separated from the mixture.

Word help

density: the mass of a substance relative to its volume; how compact a substance is
mixtures: when two or more substances are mixed together but can be separated through physical means because no chemical changes have taken place
physical properties: characteristics of substances that can be seen and measured, such as size, density and mass

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Types of mixtures

A mixture can be made up of:

- two solids mixed, for example salt and sand, iron filings and sulfur, sand and stones
- an **insoluble** solid and a liquid, for example sand and water
- two liquids, for example oil and water
- two or more gases, for example air consists of nitrogen, oxygen, carbon dioxide, rare gases and water vapour
- a **soluble** solid and a liquid, for example water and salt form a **solution**.

Solutions

In Grade 6, you found out about solutions. A solution is a mixture of a soluble solid, called the **solute**, and a liquid, called the **solvent**. The solid **dissolves** in the liquid. This forms a mixture in which the solid is not visible. For example, when salt dissolves in water, this results in a salt solution. The salt particles can no longer be seen in the water. Water is a universal solvent because many substances can dissolve in water.

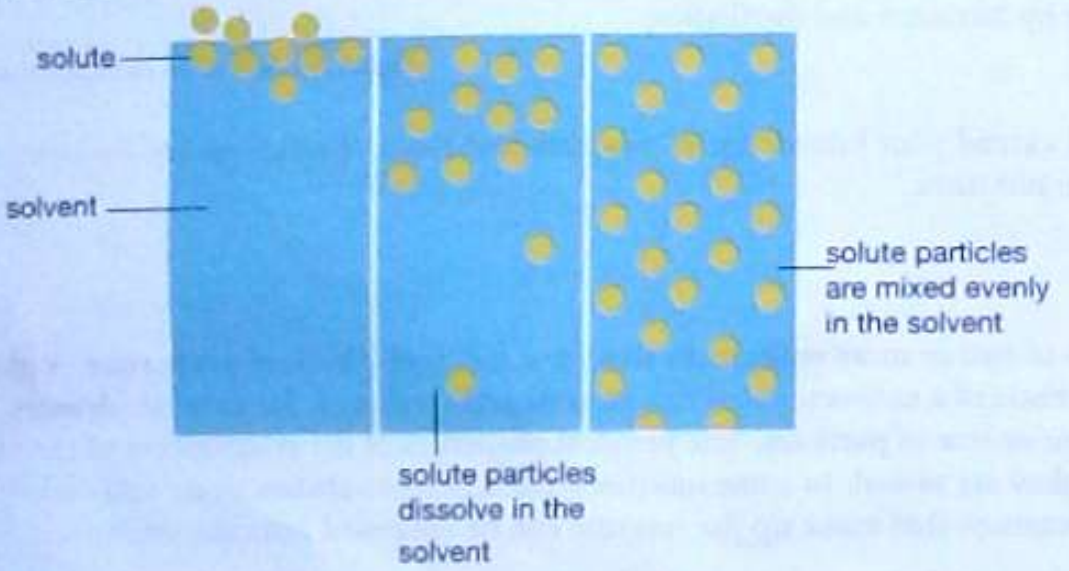

Figure 8.2 Solute particles are mixed evenly in a solution.

Word help

dissolves: the physical process that occurs when solid particles become evenly spaced between liquid particles

insoluble: a solute (solid) that will not dissolve in a solvent (liquid)

soluble: able to dissolve

solution: mixture of liquids and solids in which the solid can no longer be seen

solute: a solid substance that is mixed into a solution

solvent: the liquid part of a solution

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When copper sulfate crystals are left to stand in water, they dissolve very slowly. The crystals first break up into smaller particles to mix with the water. The particles then spread out through the water until the whole mixture (solution) is pale blue. When dissolving, the solute particles spread into the spaces between the solvent. The solute particles continue to move about until they are evenly spread throughout the solvent.

If no more of a soluble substance can dissolve in water, the solution is **saturated**.

Dissolving is a **physical change** and as such no new substances are formed. Both the solute and solvent keep their properties. This change can also be reversed. For example, salt or copper sulfate and the water in which it was dissolved can be separated again.

Separation methods

In mixtures, the different substances are still clearly visible after mixing and can be separated. In solutions, the solute is not visible in the solvent but the substances can be separated.

The components of a mixture can be separated by different separation methods. The method that is used depends on the type of mixture and the physical properties of the substances in the mixture. Separation methods physically separate mixtures; no chemical reactions take place.

Physical separation methods include filtration, magnetism, winnowing, decanting and evaporation.

Filtration

Filtration is a method used to separate a mixture consisting of a liquid and an insoluble solid. For example, sandy water, which consists of solid soil particles and water. The particles of the solid can still be seen. The mixture can be strained through **filter paper** to separate the solid soil particles from the water.

Filter paper acts like a fine sieve. It allows liquids and dissolved substances with particles of a certain size to pass through it and collect in a collecting container. These particles are called the **filtrate**. The particles of the insoluble substance cannot pass through the filter paper and so they remain in the filter paper. This is called the **residue**.

Word help

filter paper: a porous material used to separate mixtures of solids and liquids
filtrate: the liquid and dissolved substances that passes through the filter in the filtration process
physical change: a change in a substance that can be reversed
residue: the solid that remains in the filter paper after the filtration process
saturated: a solution that contains the maximum number of soluble particles

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Activity 8.1 Experiment

Separating sand and water by filtration Work in a group

Do an experiment to investigate using filtration as a method to separate a mixture of an insoluble solid (sand) and a liquid (water).

You will need:

- a funnel
- a piece of filter paper
- a beaker
- a collecting container
- a teaspoon
- one teaspoon of sand
- water

Method

Follow the instructions.

1. Half fill the beaker with water.
2. Add one teaspoon of sand to the beaker. Stir the water and sand mixture well.
3. Fold a piece of filter paper as shown in Figure 8.3. Place the filter into a funnel.

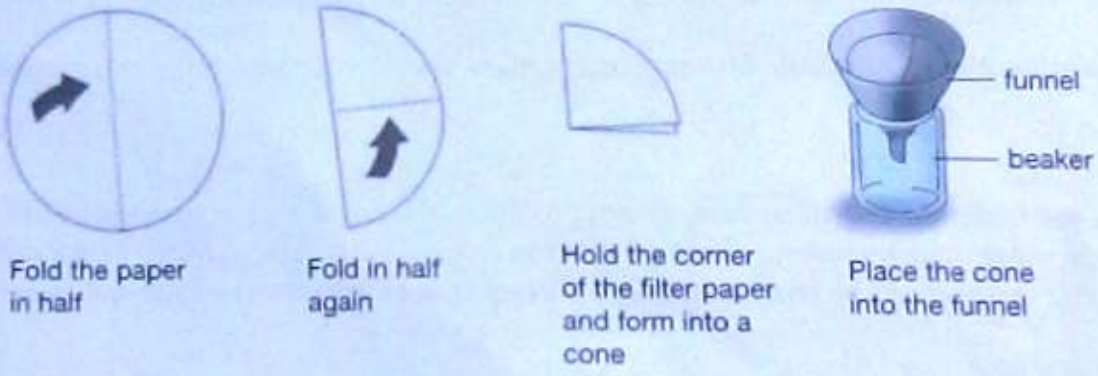

Figure 8.3 Folding filter paper for filtration

4. Place the funnel into a collecting beaker.
5. Pour the mixture into the funnel and allow the liquid to pass through.

Figure 8.4 Separating a mixture of sand and water by filtration

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Observations and results

1. Describe what the mixture looked like before it was poured through the filter paper.
2. What did the liquid that came through the filter paper (filtrate) look like?
3. Identify the solid particles (residue) that remained in the filter paper.
4. Were you able to separate the sand mixture?

Conclusion

Write a conclusion for this experiment.

Questions

Answer the questions.

1. What kind of substances can be separated by filtration?
2. What properties of the sand are used to separate the sand-water mixture?
3. Complete the sentences by filling in the missing words.

Sand is a/an _____ solid and can therefore be _____ by filtration. The liquid that passes through the filter paper and into the collection container is called the _____. The sand was captured in the filter paper and is called the _____.

Activity 8.2

Answer the questions.

1. Tea leaves can be separated from hot water by filtration. Name the following in the tea and water mixture.
   a) The filtrate
   b) The residue
2. Suggest why very small bacteria can sometimes pass through filter paper during water purification.

Magnetism

A **magnet** can be used to separate mixtures if one substance in the mixture is magnetic and the other substance is not magnetic. For example, a mixture of iron filings and sulfur powder.

In the next activity you will separate iron filings from sulfur using a magnet.

Word help

magnet: a material, such as a metal, that is able to attract other magnetic substances

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Activity 8.3 Experiment

Separating iron filings and sulfur Work with a partner

Do an experiment to separate iron filings and sulfur out of a mixture. The iron filings are magnetic and the sulfur is not magnetic.

You will need:

- a magnet
- paper
- a teaspoon
- iron filings
- sulfur powder

Method

Follow the instructions.

1. Mix small amounts of iron filings and sulfur powder on a piece of paper.
2. Hold the magnet close to the mixture as shown in Figure 8.5.

Figure 8.5 Separating iron and sulfur with a magnet

Observations and results

Describe what happened when you held the magnet over the mixture on the piece of paper.

Conclusion

Write a conclusion for this experiment.

Questions

Answer the questions.

1. Complete the following sentences by filling in the missing words.

   The _____ in the mixture were attracted to the magnet and the _____ was not. This method of separation is known as _____.

2. Could this mixture of iron filings and sulfur powder have been separated by filtration? Explain your answer.
3. Which of the following mixtures can be separated using a magnet?
   a) Oil and water
   b) Iron nails in a sandpit
   c) Copper scrapings from salt
   d) Sand and water

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Winnowing

Winnowing is a separation method that is used to separate a mixture of two solids of different mass by using wind. Farmers often use this method to separate lighter **chaff** particles from heavier seeds of grain. Chaff is the dry scaly part that surrounds a seed. The chaff particles are carried away by the wind. The heavier seeds of grain are separated from the chaff.

Indigenous Knowledge

Winnowing baskets, weaved by women, are traditionally used in Zimbabwe for winnowing grain. This Tonga basket has a reinforced rim that allows larger amounts of grain to be winnowed.

A traditional Tonga winnowing basket

Figure 8.6 Winnowing is used to separate chaff from grain

Word help

winnowing: a method for separating heavier and lighter components of a mixture by wind or by blowing air
chaff: the dry leaf-like structures around seeds

Activity 8.4 Experiment

Separating sand and sawdust by winnowing Work in a group

Do an experiment to separate sand, the heavier substance, and sawdust (or powdered leaves), the lighter substance, by winnowing.

You will need:

- a sheet of paper
- sawdust or powdered dry leaves
- sand

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Method

Follow the instructions.

1. Mix a handful of sand with a handful of sawdust or powdered dry leaves on the sheet of paper.
2. Take the mixture outside onto an open piece of ground. A light breeze should be blowing.
3. Hold the sheet of paper containing the mixture, at shoulder height. Tilt it slightly so that the mixture slides off slowly and the wind can blow through the mixture.

Observations and results

Record your observations.

1. Do both components of the sand and sawdust (or powdered leaves) mixture fall onto the same place on the ground?
2. Is there a component that blows away?
3. Did the wind separate the two components?
4. Complete the following sentences:

   The dry, crushed leaves or sawdust were _____ than the sand and so the _____ carried them away.

Conclusion

Write a conclusion for the experiment.

Questions

Answer the questions.

1. Explain what winnowing is.
2. Suggest where winnowing would be used.
3. Explain why the sawdust was carried away by the wind.

Decanting

Decanting is a method to separate a mixture of two liquids with different densities, for example oil and water. Water has a greater density than oil. When mixed with water, oil will float on the surface of the water. The less dense liquid can then be carefully poured off the top.

Word help

decanting: a separation method used to separate liquids of different densities

Activity 8.5 Experiment

Separating oil from water by decanting Work with a partner

Do an experiment to separate a mixture of two liquids of different densities.

You will need:

- a beaker
- a measuring cylinder
- water
- oil

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Method

Follow the instructions.

1. Half fill the beaker with water.
2. Add the same amount of oil to the water and stir well.
3. Leave the oily water mixture to stand until the oil floats to the surface.
4. Carefully decant the oil into the empty measuring cylinder.

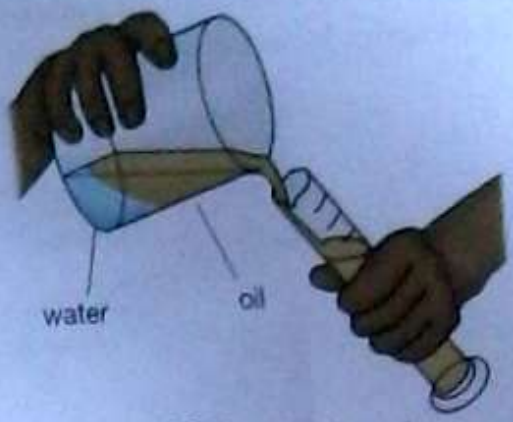

Figure 8.7 Decanting is used to separate liquids with different densities.

Observations and results

Record your observations.

1. Describe the water after the oil had been stirred into it.
2. Describe what happened to the oil and water mixture when you let it stand for some time.

Conclusion

Write a conclusion for this experiment.

Questions

Answer the questions.

1. Complete the sentences below by filling in the missing words.

   Decanting is a method used to separate two liquids with different _____ in a mixture. The _____ is _____ and sinks to the bottom. The oil can then be _____.

2. Honey has a greater density than water. Which liquid could be decanted from a mixture of honey and water?

Evaporation

Evaporation is a process during which a liquid is heated and changes to a gas. When liquid water is heated, it changes to **gaseous** water vapour. You learnt about evaporation in *Junior Science and Technology*. Evaporation takes place faster in hot, dry and windy conditions.

Evaporation can be used as a method to separate two substances in a solution. One substance, the solute, is dissolved in a liquid, the solvent. For example, if a substance such as salt (solute) is dissolved in water (solvent), then when the water evaporates, the salt will be left behind as **crystals**.

Word help

crystals: solid pieces of a substance that have a special arrangement of particles; can form after evaporation

evaporation: the process that occurs when a liquid is heated and changes to a gas

gaseous: being like a gas, having properties of a gas

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Table salt is produced through the process of evaporation. Energy from the Sun is used to evaporate sea water or water from salt lakes.

Figure 8.8 Evaporation over a salt lake to produce table salt

In the next activity, you will separate salt from a salt solution using evaporation.

Activity 8.6 Experiment

Separating a soluble solid (salt) from a solvent (water) by evaporation Work in a group
Perform an experiment to recover salt (soluble solid) from a solvent (water) in a solution through evaporation.

You will need:

- a beaker
- two evaporating dishes
- a tripod stand
- wire gauze
- a Bunsen burner
- a teaspoon
- salt
- water

Method

Follow the instructions.

1. Half fill the beaker with water.
2. Add five teaspoons of salt to the water and stir until the salt has dissolved.
3. Continue adding salt to the water a little at a time, until no more salt will dissolve. This is a saturated solution.
4. Pour some of the saturated solution into each of the two evaporating dishes.

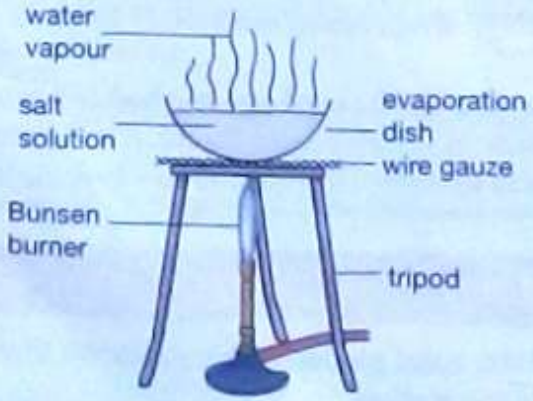

Figure 8.9 Evaporation is used to separate salt from water

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5. Place one evaporating dish in a warm, dry place for a few days. Place the other evaporating dish on the stand over the Bunsen burner.
6. Heat the salt solution slowly until the water has evaporated.

Observations and results:

1. Describe what happens to the water as it is heated in the evaporating dish on the Bunsen burner.
2. Explain why the evaporation of water from the salt solution in the warm, dry place took longer.

Conclusion

Write a conclusion for the experiment.

Questions

Complete the following sentences by filling in the missing words.

1. When mixed together, the salt (_____) dissolved in the water (_____) to form a salt _____.
2. Excess salt was added to make a _____ solution.
3. Evaporation happened _____ when the solution was placed over the Bunsen burner. This is because there was more _____ that made the water (liquid) turn into a _____ more quickly.
4. Evaporation was _____ for the solution left in a warm place.

Activity 8.7

Answer the questions.

1. Define the following terms:
   a) Decanting
   b) Solution
   c) Evaporation
2. Explain how you would separate the following mixtures:
   a) A solution of sugar and water
   b) Sand and iron filings
   c) A mixture of sand and a salt solution to obtain the sand.
3. Describe how you could separate small metal pins from sand.

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Summary

- Mixtures are made up of two or more different substances that have different physical properties.
- A solution is an example of a mixture that consists of a soluble solid (the solute) and a liquid (the solvent).
- There are various ways to separate the components of a mixture, such as filtration, magnetism, winnowing, decanting and evaporation. The method you choose depends on the physical properties of the mixture's components:
  - Filtration is used to separate a mixture that consists of a liquid and an insoluble solid.
  - Magnetism is used to separate a magnetic substance from a non-magnetic substance.
  - Winnowing uses the wind to separate a mixture of two solids of different masses.
  - Decanting can be used to separate two liquids with different densities.
  - Evaporation is used to separate two substances in a solution, such as salt in water.

Topic assessment

Answer the questions.

1. Sugar water is a mixture of sugar and water. Which substance is:
   a) the solute
   b) the solvent
   c) the solution? [3]
2. During an experiment, a teacher accidentally drops some steel drawing pins into a bowl of sugar. Suggest two methods that could be used to remove the drawing pins from the sugar. Briefly explain each method. [6]
3. Give the correct term for each of the following:
   a) The liquid passing through filter paper.
   b) A substance that can dissolve in a liquid.
   c) Material deposited onto a filter.
   d) A method used to separate two liquids of different densities.
   e) A method used to separate the chaff from seeds.
   f) The process that causes water to change from a liquid to a gas when it is heated.
   g) The process that occurs when a liquid evaporates and crystals are left behind.

   [7]

[Total marks: 16]

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Topic 9 Matter

Learning objectives	Activities
• Identify the three states of matter.	• Identifying the three states using salt, water and air
• Describe the arrangement of particles in solids, liquids and gases.	• Compressing gas in a syringe

• Describe the properties of solids, liquids and gases in terms of the kinetic theory.	• Carrying out experiments on heating:
	  • ice
	  • candle wax
	  • iodine crystals
	• Discussing particle arrangement in solids, liquids and gases

• Describe the factors that affect solubility.	• Dissolving potassium permanganate crystals in water
• Identify mixtures, elements and compounds.	• Mixing iron and sulfur, sand and maize grains • Heating the iron and sulfur
• Identify metals and non-metals on the periodic table.	• Identifying elements on the Periodic Table

Matter is all around us. You learnt about matter in Grade 5 and you discovered that matter can exist in different states or forms called solids, liquids and gases. In Grade 6, you found out that matter is made up of particles called **atoms**. **Elements** can be chemically combined (bonded) to form **compounds**. In Grade 4, you also explored **mixtures** that are formed when different substances are mixed together. The components of a mixture are not chemically combined and so, as you investigated in Topic 8 Separation, they can be separated.

In this topic you will focus on how the arrangement and energy of particles of matter changes states. You will explore elements, compounds and mixtures in more detail. You will analyse how elements are arranged in the periodic table.

Matter

Everything around you is made up of matter. Matter takes up space and has **mass**. There are four important assumptions about matter that help scientists explain many things that you see around you:

- All matter is made up of particles.
- There are forces of attraction between the particles.
- The particles are in constant motion.
- There are spaces between the particles.

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Word help

atoms: the smallest particles of a chemical element
compounds: formed when atoms chemically react together
elements: the simplest units of atoms
mixtures: when different substances are mixed together; can be separated by physical methods into their separate components
matter: anything that has mass and volume (occupies space)
mass: the amount of matter in a material; measured in units such as grams or kilograms
properties: characteristics
states: forms

The three states of matter

Matter exists in three different phases or **states**: solid, liquid and gas. The difference between these states is the energy and arrangement of the particles.

In the next activity you will identify the states of different substances.

Activity 9.1 Experiment

Identifying the three states of matter Work in pairs

Do an experiment to identify the three states of matter.

You will need:

- a beaker
- a syringe
- water
- stones.

Method

Follow the instructions.

1. Pull the plunger out of the syringe so that it is full of air (gas). Push the plunger in whilst holding your finger in front of the nozzle.
2. Observe the water in the beaker. Over a basin, tip the beaker and pour the water out.
3. Hold some stones in your hand. Try to bend or squash them.

Observations and results

1. Observe each state of matter. Can you feel the gas (air) against your finger? Does the water (liquid) pour? Can you change the shape of the stone (solid)?
2. Identify each of the materials as a solid, liquid or gas. Give a reason for your answer.

Conclusion

Write a conclusion for the experiment.

Salts (solid)

Stones (solid)

Water (liquid)

Air (gas)

Figure 9.1

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In Activity 9.1, you saw that solids, liquids and gases look and feel different. They each have different **properties** or characteristics.

Properties of solids, liquids and gases

The **properties** of each state of matter depend on the arrangement and the energy of the particles that make up the matter.

The particles that make up matter are constantly moving. In each state of matter, the particles are arranged in a particular way and the particles have a certain amount of movement energy or **kinetic energy**. In Topic 17 Energy, you will learn more about kinetic energy. All particles in matter have kinetic energy.

- Particles in a solid state have the least amount of kinetic energy. They vibrate in a fixed position and they are packed closely together.
- Particles in a liquid state have medium amounts of kinetic energy. They move slowly and have small spaces between them.
- Particles in a gaseous state have the greatest amount of kinetic energy. They move rapidly and have large spaces between them.

Particles in a solid such as an ice cube are tightly packed together and vibrate in one position.

Particles in a liquid such as water are loosely arranged and move over each other.

Particles in a gas such as water vapour are far apart and move in all directions.

Figure 9.2 Particles are arranged differently in solids, liquids and gases.

Table 9.1 summarises how particles are arranged and how particles move in solids, liquids and gases.

Table 9.1 Arrangement and movement of particles in each state of matter

State of matter		
Solid	**Liquid**	**Gas**
Particles are closely packed, in a regular pattern. Very small spaces between the particles.	Particles touch one another, but with larger spaces between the particles than in a solid.	Particles are far apart with very large spaces between them.
Particles **vibrate** in one place.	The particles move freely over each other.	The particles move very fast and randomly in all directions.
A solid has a fixed shape and size.	A liquid takes the shape of the container it is in and can flow and be poured.	A gas fills the container it is in and can escape from the container if it is not covered.
A solid cannot be compressed.	A liquid can be slightly compressed (squashed).	A gas can easily be compressed (squashed).

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Activity 9.2 Experiment

Compressing a solid, a liquid and a gas Work with a partner
Do an experiment to investigate whether a solid, liquid or gas can be compressed.

You will need:

- water
- salt
- three 50 ml plastic syringes

Method

Follow the instructions.

1. Pull the plunger out to the maximum volume so that the syringe is full of air (gas).
2. Completely close off the nozzle of the syringe with your finger. Push the plunger down as far as it will go.
3. Fill the syringe with water. Close off the nozzle with your finger and push the plunger down, as in Step 2.
4. Pour salt in the syringe. Close off the nozzle with your finger and push the plunger down, as in Step 2.

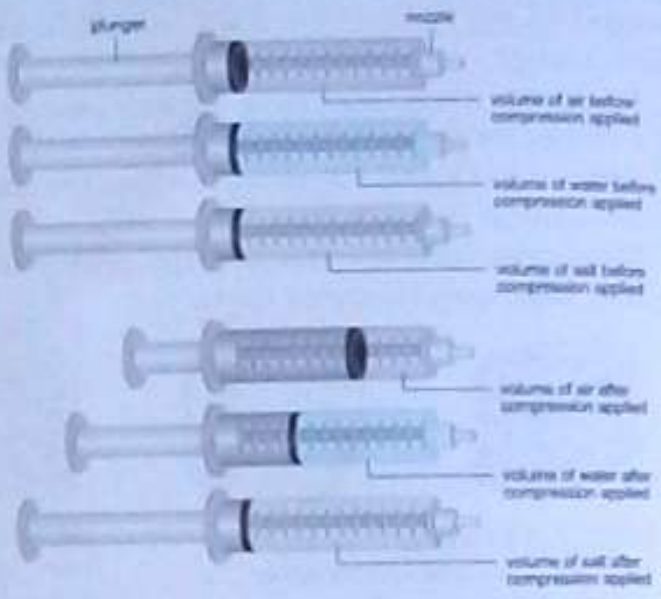

Figure 9.3 Compressing air, water and salt

Observations and results

Record your observations in a table. How far can you push in the plunger when a solid, liquid or gas is in the syringe?

Conclusion

Write a conclusion for the experiment.

Questions

1. Complete the sentences below by filling in the correct word.
   a) The arrangement of _____ in solids, liquids and gases determine how much the material can be compressed.
   b) When a material is compressed the particles are forced closer together.
      i. Solids _____ be compressed because there are very _____ spaces between the particles of a solid.
      ii. Liquids can be slightly compressed as the spaces between the particles are slightly bigger than in _____ and the particles can move around one another.
      iii. Gases can be compressed a lot as there are very _____ spaces between the particles of a gas. When the gas is compressed, the particles move closer together and take up _____ space; the volume _____.

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2. Matter is made up of moving particles. Answer the following questions:
   a) Explain why gases are able to fill the container they are in, whatever the size of the container.
   b) Explain why solids cannot change their volume.
   c) Explain why liquids can change their shape but keep their volume.

In the next activity, you will discuss the arrangement of particles in solids, liquids and gases.

Activity 9.3 Discussion

Discussing particle arrangement in solids, liquids and gases Work in a group. Have a discussion about the particle arrangement in solids, liquids and gases. Summarise your discussion in a table, including:

1. a diagram of particles in each state of matter
2. a description of how the particles behave in each state of matter
3. a description of how the particles are arranged in each state of matter.

The Kinetic Theory

Scientists use **theories** to explain certain **phenomena** in nature. A theory called the Kinetic Theory can be used to explain the changes of states of matter. The Kinetic Theory states that all particles in a substance move and have **kinetic energy**.

Change of state

Matter can change from one state to another when it is heated or cooled. This is called **change of state**.

When heating a material, the heat energy gives the particles in the material more kinetic energy. The greater the temperature of a material, the faster the particles move.

- In solids, the particles are close together and vibrate. If a solid is heated (energy added), the particles gain kinetic energy and move faster and further apart. The solid changes into a liquid. This is called **melting**.
- In a liquid, the particles are loosely arranged and move over each other. The particles move faster than in a solid. If the liquid is heated, the particles gain more kinetic energy, move faster and further away from each other. The liquid boils and particles are able to escape from the surface of the liquid to form a gas. This is called **evaporation**.
- In a gas, the particles are far apart and move randomly and very fast in all directions. If the gas is heated it will try to take up more space.
- With heating, some matter can change from the solid state into the gas state without first becoming a liquid. This is called **sublimation**. When cooled, the gas changes directly to a solid. This is called **deposition**.

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When a material is cooled, heat energy is removed. The particles move slower and closer together and change state. The particles have less kinetic energy.

- When a gas is cooled, the particles have less kinetic energy and do not move so fast and far apart. The particles move closer together and the gas changes state to form a liquid. This is called **condensation**.
- When a liquid is cooled the particles have less kinetic energy. The particles in a liquid move slower and closer together. The liquid changes state to form a solid. This is called **solidifying** or **freezing**.

Word help

change of state: change from one form to another, for example liquid to solid
condensation: a process that causes a gas to change to a liquid when it is cooled
evaporation: a process that causes a liquid to change to a gas state when it gains energy
freezing/solidifying: a process that causes a liquid to change to a solid when it is cooled
kinetic energy: the energy of a moving object
melting: a change from solid to liquid by gaining heat energy
physical change: a change that can be reversed
phenomenon: an occurrence; something that happens
sublimation: a process that causes a solid to change to a gas when it is heated
deposition: a process that causes a gas to change to a solid when cooled
theory: a scientific explanation for events based on experiments and research
vibrate: make very small movements

The changes in state of water are summarised in Figure 9.4.

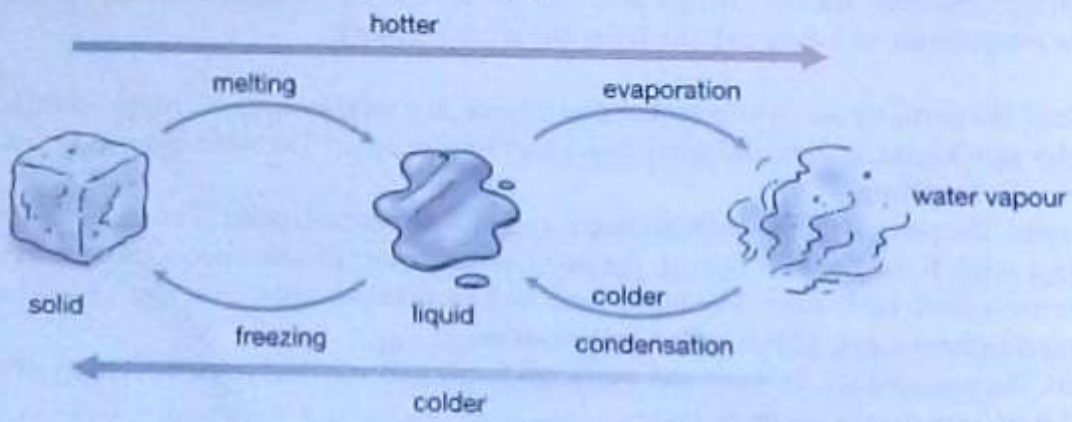

Figure 9.4 The changes in state of water

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Activity 9.4

Answer the questions.

1. Which state of matter has particles with the most kinetic energy?
2. Water is in two states when it boils in a kettle: liquid and gas. Explain how the particles in the gas state escape from the boiling water.
3. Describe what happens and then explain how it happens in each of the following examples:
   a) A block of ice is heated
   b) Melted candle wax is left to cool
   c) Water boils

Changing state by heating or cooling a substance is a **physical change**. A physical change occurs when the form of a substance changes without changing its chemical composition. For example, water as a solid (ice) has the same particles as water in a liquid state and as water in the gas state (water vapour). Change of state is temporary and can be reversed.

Safety

Be careful when heating iodine, as the fumes give off a very strong smell. You should wear safety glasses when doing this experiment.

Activity 9.5 Experiment

In the next activity, you will investigate the changes in state of different substances.

Experiment to investigate the change in states of matter Work in a group

Do an experiment to investigate the change in state of matter.

You will need:

- a beaker
- ice cubes
- matches or lighter
- cotton wool
- spirit or Bunsen burner
- iodine crystals
- spatula
- a candle holder
- a candle
- evaporation dish

Method

Follow the instructions.

Part A: Change in state of water

1. Place an ice cube in a beaker.
2. Heat the beaker containing the ice cube over the spirit or Bunsen burner.
3. Continue heating until you have observed two different changes in state. Change in state from ice to liquid and from liquid to gas (water vapour).

Part B: Change of state in candle wax

1. Place a candle in a candlestick holder.

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2. Light the candle and let it burn for a few moments.
3. Blow out the candle flame and allow the wax to cool.
4. What happens to the state of the candle wax:
   a) when the flame is lit?
   b) a few minutes after the flame has stopped burning?

Part C: Change in state of iodine crystals

1. Add two or three iodine crystals to the evaporation dish using a spatula. Place the glass filter funnel over the iodine crystals.
2. Place a plug into the top of the glass filter funnel.
3. Place the iodine crystals over the spirit or Bunsen burner.
4. Light the spirit or Bunsen burner and heat the iodine crystals.
5. What do you observe in the glass filter funnel?
6. Remove the funnel from the flame and let it cool.

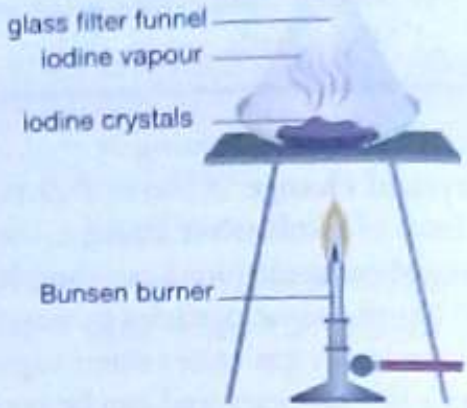

Figure 9.5 Heating solid iodine to show sublimation

Observations and results

Complete the table below.

Process	Change of state
Heating ice	Solid ice _____ to form _____ water.
Heating water	Liquid water _____ and _____ into a gas (water vapour steam).
Heating iodine crystals	Solid crystals _____ to form a purple gas (vapour).
Heating candle wax	Solid candle wax _____ into _____ wax.
Cool candle wax	Liquid candle wax solidifies into solid wax.
Cool iodine vapour	Iodine vapour forms _____ when it is cooled.

Conclusion

Write a conclusion for the experiment.

Questions

1. Complete the sentences below by filling in the missing words to describe the changes in state.
   a) When a solid is heated it forms a _____. This process is called_____.
   b) On further heating, the liquid _____to form a _____.
   c) If cooled, a gas will form a _____.
   d) When heating iodine crystals they turn directly into a _____. This process is called _____.
2. When the iodine gas is cooled, what change of state occurs?

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Solubility and dissolving

In Topic 8 Separation, you learnt about solutions. A solution is a mixture of a solute dissolved in a solvent.

Solubility is the property of a substance (the solute) that allows it to dissolve in the solvent. When a substance does not dissolve in a solvent it is **insoluble**. When a substance dissolves in a solvent it is **soluble**. When no more solute can be dissolved in the solvent the solution is saturated.

Activity 9.6 Experiment

Investigating the solubility of different substances Work with a partner

Do an experiment to investigate the solubility of different substances.

You will need:

- two test tubes
- two test tube stoppers/corks
- a spatula
- potassium permanganate or copper sulfate crystals
- sand
- warm water

Method

Follow the instructions.

1. Half-fill both test tubes with warm water.
2. Add two spatulas of potassium permanganate or copper sulfate crystals to one test tube and two spatulas of sand to the other test tube.
3. Cork the test tubes and shake gently.

Observations and results

Record what you observe. Which substances dissolve in water and which do not?

Conclusions

Write a conclusion for this experiment.

Questions

Fill in the missing words.

1. The potassium permanganate crystals _____ in the water and form a pink-purple solution. Potassium permanganate is _____ in water.
2. Sand did not dissolve in the water and remains as a solid at the bottom of the test tube. Sand is _____ in water.

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In Topic 8 Separation, you learnt about solutions. A solution is a mixture of a solute dissolved in a solvent.

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You will need:

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- two test tube stoppers/corks
- a spatula
- potassium permanganate or copper sulfate crystals
- sand
- warm water

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2. Add two spatulas of potassium permanganate or copper sulfate crystals to one test tube and two spatulas of sand to the other test tube.
3. Cork the test tubes and shake gently.

Observations and results

Record what you observe. Which substances dissolve in water and which do not?

Conclusions

Write a conclusion for this experiment.

Questions

Fill in the missing words.

1. The potassium permanganate crystals _____ in the water and form a pink-purple solution. Potassium permanganate is _____ in water.
2. Sand did not dissolve in the water and remains as a solid at the bottom of the test tube. Sand is _____ in water.

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Factors affecting solubility and rate of dissolving

Some solutes have a higher solubility than others. This means that they dissolve easier and quicker in a particular solvent. The speed (time taken) at which a solute dissolves is known as the **rate** of dissolving. The faster a solute dissolves, the faster the rate of dissolving.

There are factors that affect the rate at which a solute dissolves, these include: particle size, temperature and stirring.

Particle size

The **rate** at which a solute dissolves depends on the size of the solute particles. Dissolving depends on solvent particles colliding with the outer surface of the solute particles. A solute dissolves faster when ground into small particles. This is because more **surface area** is exposed. Fine icing sugar with smaller sugar grains dissolves faster than white granulated sugar, which is coarser and has larger sugar grains.

Word help

insoluble: will not dissolve in a solvent
rate: the speed at which something happens
solubility: the amount of solute that will dissolve in 100 g of water or other solvent
soluble: dissolves in a solvent
surface area: the outside area of an object

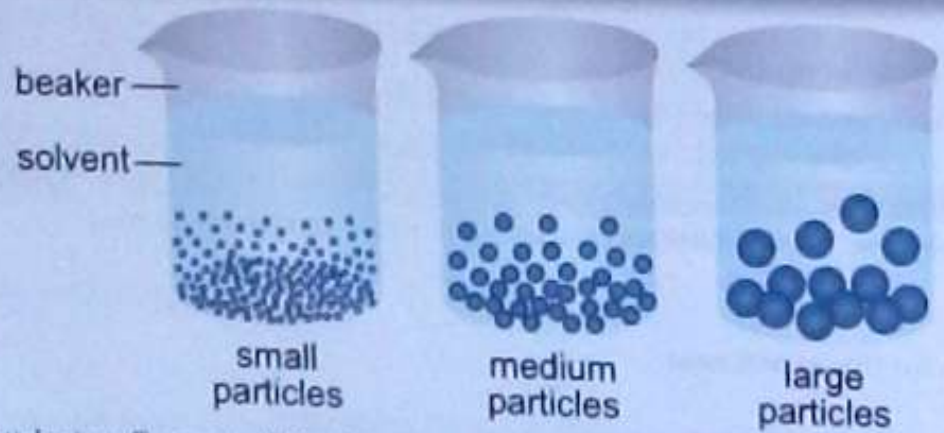

Figure 9.6 Particle size affects rate of dissolving.

Temperature

Heating a solvent gives the particles more kinetic energy. This makes the solvent particles move more rapidly and therefore collide with the solute particles more often and with more force. This means that the solute will dissolve quicker.

Something interesting

A solution that is saturated with solute at a particular temperature cannot become more saturated at a higher temperature.

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Stirring

Dissolving will happen more quickly when the solvent is stirred. The stirring allows the particles of the solvent and solute to collide more often.

Activity 9.7 Experiment

Investigating factors that affect the rate of dissolving Work in a group

Do an experiment to investigate the factors that affect the rate of dissolving.

You will need:

- small plastic or glass bottles with lids or test tubes with corks/stoppers
- spirit or Bunsen burner
- a tin can
- a spatula
- a watch or cell phone with a seconds timer
- a glass rod
- matches or a lighter
- water
- white granulated sugar, castor sugar and icing sugar

Method:

Follow the instructions.

Part A: The effect of particle size on rate of dissolving

1. Half-fill three bottles or test tubes with water.
2. Add two spatulas of white sugar (large particles) to one test tube, two spatulas of castor sugar (medium particles) to the second and two spatulas of icing sugar (small particles) to the third.
3. Put the stopper into the test tube and gently shake all three test tubes.
4. Time how long each type of sugar takes to dissolve in the water.

Part B: The effect of stirring on rate of dissolving

1. Half-fill three bottles or test tubes with water.
2. Add two spatulas of white sugar to each test tube and put in the stoppers.
3. Leave one test tube to stand unstirred, use the glass rod to stir the second test tube once and continuously stir the last one.
4. Time how long it takes the sugar to dissolve in each test tube. For the second and third test tubes, time how long it takes from when the stirring is stopped until all the sugar has dissolved.

Part C: The effect of temperature on rate of dissolving

1. Boil some water in a tin can. Half-fill one test tube with hot water and a second test tube with cold water.
2. Add two spatulas of white sugar to each and put in the stoppers.
3. Leave the test tubes to stand and time how long it takes until all the sugar is dissolved.

Observations and results

For parts A, B and C, record your results in a table.

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Conclusion
Write a conclusion for each part of the experiment.

Questions
Explain why the solubility of sugar changes:
1. when the temperature is higher
2. when the different types of sugar are used
3. when the solution is stirred.

Activity 9.8

Read the information about a rate of dissolving experiment and answer the questions.

In an experiment, six students dissolved five grams of two different samples, A and B, of the same substance in water at 25 °C. They repeated the experiment at 70 °C. The table below gives their results.

Table 9.2 Time taken to dissolve (seconds)

	Time taken at 25 °C (s)		Time taken at 70 °C (s)	
Student number	Sample A	Sample B	Sample A	Sample B
1	10	15	5	8
2	9	14	4	7
3	9	15	5	7
4	10	14	4	7
5	9	15	5	8
6	10	15	5	8

1. Which sample is
   a) more soluble at 25 °C?
   b) more soluble at 70 °C?
2. Which sample do you think is finely ground? Explain your answer.
3. Explain why the difference in the size of the particles of the substance affects the rate of dissolving.
4. Suggest why samples A and B dissolve more quickly at 70 °C than at 25 °C.

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Mixtures, elements and compounds

You learnt about mixtures in Grade 4 and you extended your knowledge about types of mixtures in Topic 8 Separation. You have also described methods for separating the components of mixtures. In Grade 6 you learnt about the structure of the atom and discussed elements and compounds. In this topic you will identify mixtures, elements and compounds based on their properties.

Mixtures

A mixture is an impure substance that consists of two or more substances. In some mixtures the different substances are still visible after mixing, for example, sand and maize kernels. Mixing does not change the properties of each substance. No chemical change takes place when the two substances are mixed.

Substances in a mixture can be separated by physical methods. The method of separation depends on the properties of the substances in the mixture.

There are different types of mixtures: solid in a solid (sand and maize kernels), liquid in a liquid (oil and water) and solid in liquid (sand in water/mud). The properties of each of these substances do not change in the mixture.

Activity 9.9 Experiment

Investigating properties of mixtures Work with a partner

Do an experiment to investigate the properties of mixtures. Mixtures can be separated by physical means.

You will need:

- two test tubes
- a magnet
- forceps
- iron filings
- sulfur powder
- sand
- maize kernels

Method

Follow the instructions.

Part A: Mixing sulfur and iron filings

1. Mix equal volumes of iron filings and sulfur powder in a test tube.
2. Use the magnet to separate the mixture.

Part B: Mixing sand and maize

1. Mix equal volumes of sand and maize kernels in the second test tube.
2. Using the forceps, separate the sand from the maize kernels.

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Observations and results

1. Describe what you could see in both mixtures.
2. Could you separate the substances in the mixture after mixing?

Conclusions

Write a conclusion for the experiment.

Questions

1. Describe what you could see in mixtures A and B.
2. Did the components of mixtures A and B look the same before and after mixing them together?
3. Was it possible to separate the components of mixtures A and B?

Elements and compounds

An **element** is a pure substance that is made up of atoms of only one type. We cannot use chemical means to break an element down into simpler substances. The smallest particle in an element is an atom. Examples of elements are iron and sulfur.

Figure 9.7a) Iron is an element and consists only of iron atoms.

b) Sulfur is an element and consists only of sulfur atoms.

Sometimes elements bond in a chemical reaction to form a new substance. This new substance is a **compound**. A compound is a pure substance made up of two or more different elements that are chemically bonded. Compounds are therefore made up of more than one kind of atom. The atoms are combined together chemically. Atoms in a compound can only be separated by chemical means. For example, the elements iron and sulfur can react chemically to form the compound iron sulfide. Iron sulfide is different to the original mixture of iron and sulfur and it cannot be physically separated into iron and sulfur.

Properties of a compound:

- Compounds have their own chemical and physical properties. These properties are different from the elements that make them up.
- Compounds are the result of a chemical change that happens when two substances react to form a new substance. It is a permanent change and it cannot be reversed.

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Activity 9.10

Answer the questions.

1. Draw a table like the one below. Place the following substances into the correct column. hydrogen, sand, water, iron sulfate, copper, carbon dioxide, chlorine

Mixture	Element	Compound

2. Copper and chlorine atoms can be bonded to form copper chloride.
   a) Is this a physical or a chemical change?
   b) Copper and chlorine are _____.
   c) Copper chloride is a _____.

In the next experiment you will investigate the properties of a compound formed by a chemical reaction.

Activity 9.11

Investigating properties of compounds Work as a class

Do an experiment to investigate the properties of compounds. Compounds cannot be separated by physical means. They can only be separated chemically.

You will need:

- one test tube
- a spirit or Bunsen burner
- clothes peg or tongs
- iron filings
- sulfur powder

Method

Follow the instructions.

1. Mix equal volumes of iron filings and sulfur powder in a test tube.
2. Hold the test tube with the clothes peg or tongs and heat the bottom of the test tube over the burner.
3. Stop heating as soon as the mixture begins to glow.
4. Observe what happens to the mixture.
5. When the test tube is cool, hold a magnet near the solid.

Figure 9.8 Iron and sulfur react chemically to form iron sulfide.

Observations and results

1. Write down what the iron filings and sulfur look like before heating.
2. Is it possible to separate the iron filings from the sulfur before and after heating?
3. Could you see the iron filings in the mixture before and after heating?

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Conclusions
Write a conclusion for the experiment.

Questions
Complete the following sentences by filling in the missing words.

1. On heating the iron and sulfur, a _____ change takes place, which causes a glow, and a black solid is formed. The iron _____ be separated from the sulfur using a magnet.
2. The experiment shows that _____ changes always result in the formation of a new substance. A change may not occur when two substances are mixed, but when supplied with _____ energy, there is a chemical change.

The periodic table

The periodic table of the elements is a table that shows the classification of chemical elements. Figure 9.9 shows the periodic table.

The periodic table shows the name of each element, its chemical symbol and **atomic number**. The atomic number is the number of **protons** in the nucleus of the atom of a particular element. The elements are organised into columns and rows based on the structure of their atoms and their properties.

Something interesting

The Russian chemist Dmitri Ivanovich Mendeleev (1834–1907) devised the periodic table of the elements in 1869. He arranged the elements known at that time in a regular pattern, according to their properties. He also realised that the table was incomplete and left gaps for as yet undiscovered elements.

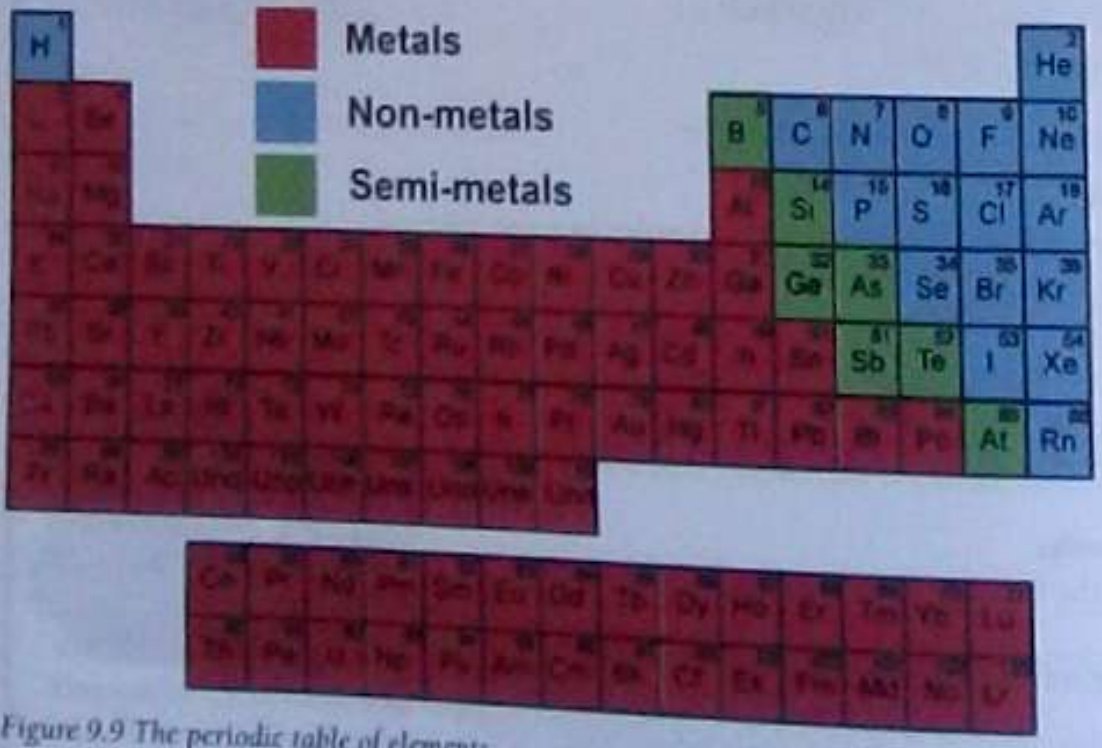

Figure 9.9 The periodic table of elements

Word help

atomic number: the number of protons in the nucleus of an atom of a particular element

protons: positively charged particles inside an atom

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The elements in the periodic table (see Figure 9.9) are arranged into three main categories: metals, metalloids and non-metals.

- Metals are arranged on the left-hand side of the table. These elements are shown in red.
- Non-metals are found on the far right-hand side of the table. These elements are shown in blue.
- Semi-metals are found in the region between the metals and non-metals. These elements are shown in green.
- Each element has its own name, symbol, atomic and position on the period table.

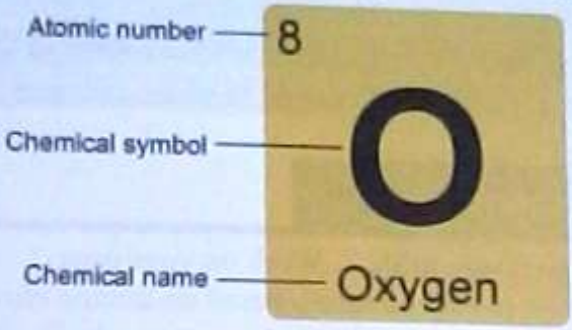

Figure 9.10 The description of each element is given in the periodic table.

Elements of the periodic table

Each element has its own chemical symbol. The table below lists the first 20 elements of the periodic table based on their atomic numbers, their symbols and an interesting fact about each element.

Table 9.2 The first 20 elements of the periodic table

Atomic number	Element	Symbol	Interesting fact
1	Hydrogen	H	The most abundant element on Earth and the atmosphere
2	Helium	He	Makes balloons float in the air
3	Lithium	Li	Lightest of all metals
4	Berylium	Be	Very expensive and toxic
5	Boron	B	Used in bleach
6	Carbon	C	Found in all living things
7	Nitrogen	N	Makes up 78% of air
8	Oxygen	O	Makes up about 21% of air
9	Fluorine	F	Most chemically reactive element
10	Neon	Ne	A gas used to light up neon signs
11	Sodium	Na	One of two elements in table salt (NaCl)
12	Magnesium	Mg	Used in flash photography

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13	Aluminium	Al	Used in mirrors, coins and elements of some aircrafts
14	Silicon	Si	Used to make glass
15	Phosphorous	P	Used in cells during energy production
16	Sulfur	S	Produced during volcanic eruptions
17	Chlorine	Cl	One of two elements in table salt (NaCl)
18	Argon	Ar	Makes up about 1% of air
19	Potassium	K	Explodes when exposed to water
20	Calcium	Ca	Strengthens bones and teeth

Activity 9.12 Individualisation

Identifying elements on the periodic table Work on your own

Use Table 9.2 to identify the first twenty elements based on atomic number in the periodic table (Figure 9.9). Classify them into metals, metalloids or non-metals. Record your answer in a table. Search the Internet for information on the periodic table.

Activity 9.13

1. What is the most abundant element on Earth and in the atmosphere?
2. In the periodic table, metals are found on the _____ hand side of the table and non-metals are found on the _____ hand side of the table.
3. Most elements on the periodic table are metals. True or false?
4. Which element does the symbol B represent on the periodic table?

Summary

- Matter is made up of particles called atoms. These atoms have spaces between them, are in constant motion and are attracted to each other.
- The Kinetic Theory states that all particles in a substance move and have energy.
- Matter exists in three states: solid, liquid and gas. Each of these states has different properties in terms of how its particles are arranged and the amount of energy in each particle.
- Matter can change from one state to another when it is heated or cooled.
  - melting occurs when a solid is heated and changes to a liquid state
  - evaporation occurs when particles in a liquid are heated and change to a gas state
  - some solid matter when heated can change to a gas in a process called sublimation
  - when matter in a gas state is cooled, it can change to a liquid state by condensation
  - when a liquid is cooled it can change to a solid by solidifying or freezing.
- Solubility refers to a property of a substance that allows it to dissolve in a solvent.
- The rate of dissolving is affected by particle size, temperature and stirring.
- A mixture is an impure substance that consists of two or more substances which combined

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without any chemical changes taking place. The components in a mixture can be separated by physical methods.

- An element, for example iron or sulphur, is a pure substance made up of only one type of particle.
- When elements bond together in chemical reactions, a new substance is formed called a compound. An example is iron sulfide.
- The periodic table classifies all the chemical elements known to scientists at present into metals, non-metals and metalloids.
- The name, chemical symbol and atomic number for each element are shown on the table.

Topic assessment

Answer the questions.

1. Define the following terms:
   a) Sublimation
   b) Evaporation
   c) Solubility
   d) Compound
   e) Atom [10]
2. When a substance changes state, there is a change in its particles' energy.
   a) Describe the energy change when a substance changes from a solid to a liquid. [2]
   b) What is this process called? [1]
3. The diagram below shows a summary of changes of state.

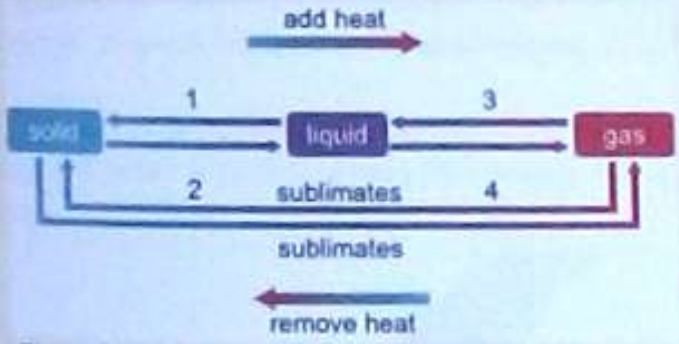

Figure 9.11 Summary of changes in state

   a) Name the processes at 1, 2 and 3 on the diagram.
   b) Provide a label for the arrow marked 4. [4]

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4. Some sugar is dissolved in water. Which diagram in Figure 9.12 shows how the particles are arranged in a solution? [2]

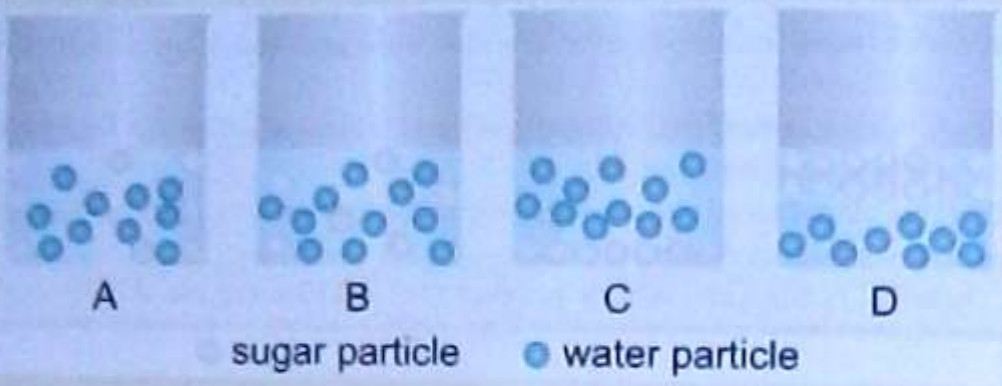

Figure 9.12

5. Complete the following sentences:
   a) A _____ dissolves in a _____ to make a solution. [2]
   b) When no more solute can dissolve in a given solvent, the solution is said to be _____. [1]
6. List three factors that affect the solubility of solutes. [3]
7. The periodic table classifies elements.
   a) Name the three main groups of elements. [3]
   b) i. Which elements are found to the right of the periodic table? [1]
      ii. Which elements are found to the left of the periodic table? [1]

[Total marks: 30]

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Topic 10 Acids, bases and salts

Learning objectives	Activities
• Identify acids and bases using red and blue litmus. • List properties of acids and bases.	• Dipping litmus paper in HCl, NaOH, H_2O, $CuSO_4$, tap water

People have always known that lemons and vinegar taste sour, but it was only in the 1700s that it was discovered that lemons and vinegar both contain acids. Bases, for example, milk of magnesia, are also important chemicals. Bases taste bitter and feel soapy to the touch. Many household chemicals are acids or bases, and we use acids and bases every day at school and at home. In this topic, you will find out about ways to identify acids and bases and some of their properties.

Acids and bases

Acids and **bases** can be harmful and **corrosive**, so it is important that we have a way of identifying them. It is difficult to identify an acid or a base by looking at it. You have to use an acid-base **indicator**. An indicator changes to different colours when added to an acid or a base.

Identify acids and bases

An indicator called **litmus paper** is used to find out whether something is an acid or a base. When acids are in a solution, they turn blue litmus red. When bases are in a solution they turn red litmus blue. Substances are called **neutral** when they neither acidic nor basic. When an acid and a base react, they **neutralise** each other to form salt. The resulting salt will be a solid and it could be acidic, basic, or neutral. You will learn about **neutralisation** reactions in Form 2.

Both red and blue litmus paper should be used to test a solution. If the colour of the litmus does not change the result is **inconclusive**. This means that it does not indicate that the substance is an acid or a base.

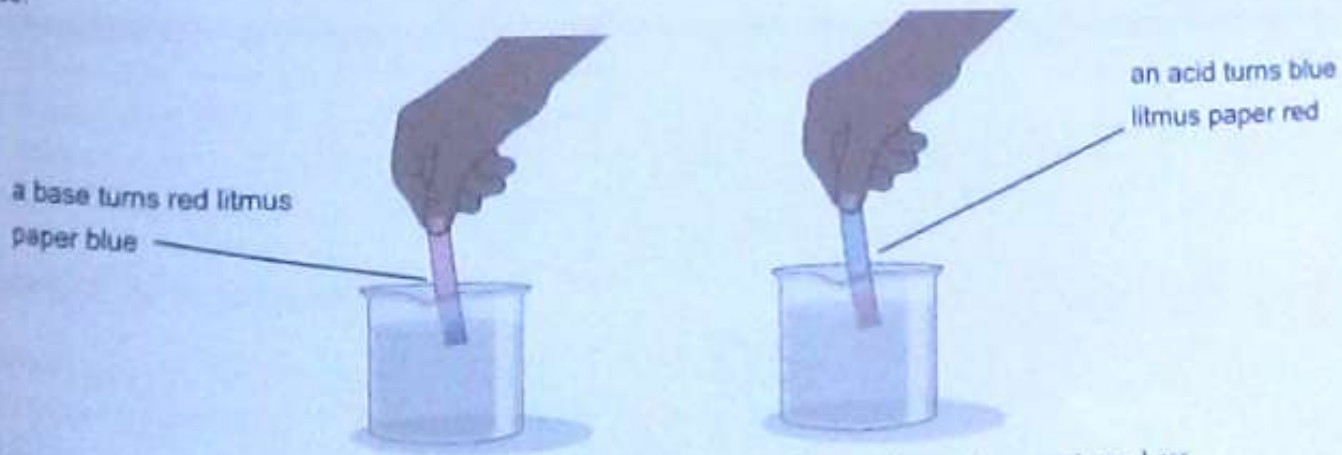

Figure 10.1 Litmus paper is used to test whether a solution is an acid or a base

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Figure 10.2 Many acids and bases are found in our homes

Something interesting

Our stomach has a very strong acid to help digest our food. It is ten times more acidic than lemon.

Something interesting

We use many substances that are bases or acids in our homes. For example, cleaning chemicals base, vitamin C tablets and orange juice.

Word help

acids: corrosive, sour-tasting solutions with certain chemical properties
bases: solutions that are soapy to the touch and have certain chemical properties
corrosive: able to damage a substance by chemical reactions
inconclusive: not a definite result
indicator: a substance that changes to a different colour in the presence of acids and bases
litmus paper: a paper that is used to test whether a substance is an acid or a base
neutral: neither acidic nor basic
neutralise: to make a substance neither acidic nor basic
neutralisation: a reaction that happens when an acid and a base are mixed to form a neutral solution

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Activity 10.1 Experiment

Identifying acids and bases using litmus paper Work with a partner

Do an experiment to identify acids and bases using litmus paper.

Safety

Safety symbol for corrosive substances

You will need:

- red and blue litmus paper
- five test tubes
- dilute hydrochloric acid
- sodium hydroxide solution
- distilled H_2O
- copper sulfate solution
- tap water

Method

Follow the instructions.

1. Place a small amount of each substance to be tested into each of the five test tubes.
2. In front of each test tube, place one piece of red and one piece of blue litmus paper.
3. Dip both red and blue litmus papers into each solution.
4. Observe any colour changes.

Observations and results

Record your results in a table.

Conclusion

Write a conclusion by filling in the missing words in the sentences below.

Hydrochloric acid is an example of an _____ and it turns blue litmus _____. Sodium hydroxide is an example of a _____ and it turns red litmus _____. Litmus paper is an _____ and can be used to tell us if something is acidic or basic.

Questions

Answer the questions.

1. What colour does blue litmus turn in an acid?
2. What colour does blue litmus turn in a base?
3. What colour does red litmus turn in a base?
4. What colour does red litmus turn in an acid?
5. When a solution does not change the colour of the litmus, it is said to be _____

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Properties of acids and bases

It is sometimes possible to tell the difference between acids and bases by their properties. Table 10.1 lists the properties of acids and bases.

Indigenous knowledge

Farmers can use lime (a base) to neutralise their soils.

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Table 10.1 Properties of acids and bases

Property	Acid	Base
Taste	Sour	Bitter
Smell	Often burns the nose	Usually no smell (except ammonia!)
Texture	Sticky	Soapy
Indicators	Turns blue litmus red	Turns red litmus blue
Reactions	Acids react with bases to form salts	Bases react with acids to form salts
Examples	vinegar, citric acid in citrus fruits, hydrochloric acids, sulfuric acids	ammonia, potassium hydroxide, sodium hydroxide

Activity 10.2

Answer the questions.

1. What can be used to test if a solution is acidic or basic? Explain.
2. Acids and bases can react with each other.
   a) What is formed when an acid and a base react?
   b) What is the name of this reaction?
3. Which of the following is an example of an acid?
   i. Tap water
   ii. Copper sulfate
   iii. Milk of magnesia
   iv. Sodium hydroxide
4. If a solution is soapy, it is most likely a _____.
5. An unknown liquid turns blue litmus paper red and has a sharp smell that can burn the nose. Is it acidic or basic?
6. Search the Internet for information on acids and basis.

Summary

- Indicators are used to find out whether a substance is an acid or a base. Bases in solution turn red litmus paper blue and acids in solution turn blue litmus paper red.
- A substance that is neither an acid nor a base is called a neutral substance.
- Acids and bases can be distinguished from each other, as they have different properties.

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- Acids have a sour taste, a sticky texture, they turn red litmus paper blue and they react with bases to form salts.
- Bases have a bitter taste, no smell, a soapy texture and they react with bases to form salts.

Topic assessment

Answer the questions.

1. Scientists used litmus paper to test a sample of lake water. The results were:
   Litmus test – red.
   The best conditions for a certain fish species occur when the lake water is neutral, not acidic or basic. Do the test results show that the lake water is a good environment for this species of fish? Explain your answer. [3]
2. When there is a lot of air pollution, the pollution in the air can mix with the rain and acid rain will fall.
   a) What colour will this turn litmus? [1]
   b) Acid rain makes the soil become acidic, which kills plant life. What kind of substance can farmers add to the soil to neutralise the soil? [1]
3. If a solution is not acidic or basic, it is _____. [1]
4. Complete the information in the table about the properties of acids and bases. [4]

Acids	Bases
Turn blue litmus paper	
	React with bases to form salts
Have a sour taste	
Vinegar is an example of an acid	

[Total marks: 10]

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Topic 11 Industrial processes

Learning objectives	Activities
• Outline the production of peanut butter • Outline the production of oil from peanut butter. • State uses of oil	• Preparing peanut butter • Pressing peanut butter to produce oil

An industrial process involves different steps to manufacture a product and is carried out on a very large scale. In Zimbabwe, the production of peanut butter is an example of an industrial process.

Processing peanuts

Peanuts are grown as grain **legumes** and also as an oil crop, as they have a high oil content. In Zimbabwe peanuts are mainly grown in Manicaland and Mashonaland East. Peanuts are often farmed by women. Through the sale of peanuts and peanut butter, women can supplement their household income. Peanut butter is a sandwich spread that is made from ground, dried and roasted peanuts.

Figure 11.1 Peanut production is important in Zimbabwe.

Something interesting

- Peanuts have a relatively low yield of about 500 kg/hectare of land, but they are a vital part of the diet in rural Zimbabwe.
- A nut is a fruit that has a hard outer covering. Although peanuts are called nuts they are actually legumes. Peanuts grow underground, unlike nuts like walnuts and almonds that grow on trees.

Indigenous knowledge

- Crop rotation is a farming practice. Different crops are grown each growing season in the same field. This reduces the impact of harmful plant pests and diseases.

In Topic 3 Nutrition, you learnt the value of a diet that is made up of **nutritious** foods. Peanuts have significant **nutritional value**. They are rich in **protein**, **fats** and **oils**, **carbohydrates**, **fibre**, vitamin B, **phosphorous** and **iron**. Peanuts are a good **rotation crop** and they are also used in animal feed production.

In 2014, Zimbabwe produced 84 000 tons of peanuts. To make peanut butter (*dovi* in Shona, *idobi* in Ndebele), the peanut 'nuts' need to be processed.

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Production of peanut butter

Figure 11.2 shows the different steps in the production of peanut butter. The process begins with cleaning and shelling the peanuts. They are then **graded**, roasted and ground, cooled and then packaged as the end product. Each of these steps needs a specific piece of equipment, such as a winnowing basket. You learnt about winnowing in Topic 8 Separation. A sheller and a peanut butter making machine are also needed.

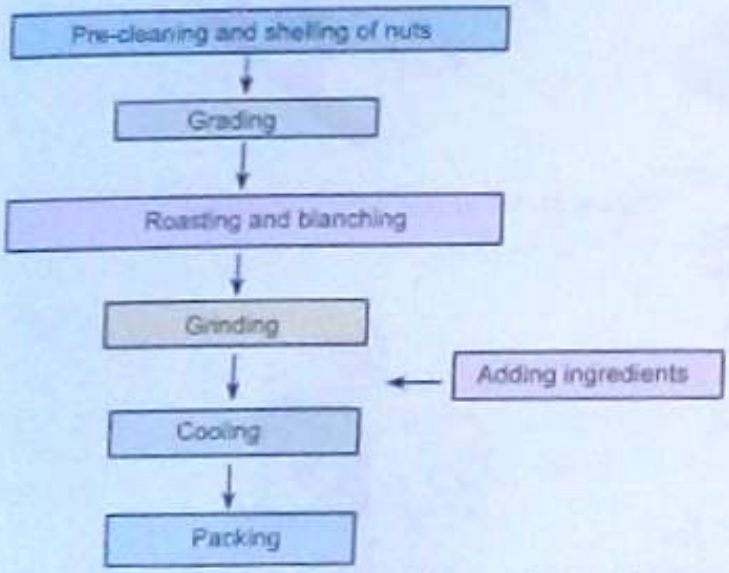

Figure 11.2 Flow chart to show production of peanut butter

Indigenous knowledge

Intercropping is commonly used in rural Zimbabwe. This is where more than one crop is planted on the same piece of land. For example, when maize, cowpeas, peanuts and pumpkins are all grown together on one piece of land. This ensures that the soil is kept covered and protected from the hot sun, so retaining some moisture and keeping parasitic infections under control.

Entrepreneurship

Starting a peanut butter manufacturing business in Zimbabwe could be a good idea. Before starting, a thorough feasibility study and market research must be carried out.

Word help

carbohydrates: a food group that is important as an energy source for the body
fats and oils: nutrients that supply energy to our bodies
fibre: indigestible material in our diet that helps food to move through the digestive system
grade: sort according to quality
iron: an essential mineral involved in transporting oxygen
legumes: a type of plant, such as beans, peas and lentils, that is a source of protein
nutritious: high in nutrients
nutritional value: the quantity and quality of nutrients in a food, including the amount of energy it contains
protein: a nutrient that is essential for building muscle, skin and bones
phosphorous: an essential mineral in our diet
rotation crop: a crop that is grown at a different time to other crops on the same land to reduce the impact of diseases and pests

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Shelling peanuts

At the start of the shelling process, farm materials such as sticks and stones are removed by passing the peanuts over a series of sieves. Small material passes through the sieve and larger pieces stay on top. Once the peanuts have been sieved, they are shelled. Special shelling machines can be used.

Shelling involves removing the peanut shells with the least damage to the seeds inside (the raw peanuts). At an industrial level, the peanuts pass between a series of rollers where the peanut shells are gently cracked. The cracked peanuts are then repeatedly passed over screens and blowers, where they are shaken, gently tumbled and air-blown until all the shells are removed. Another option would be to shell the peanuts by hand and use a winnowing basket to separate the lighter shells from the peanuts.

Figure 11.3 A peanut shelling machine

Roasting peanuts

The peanuts are **roasted** in special ovens at 180 °C for about 10 minutes. This process destroys certain **enzymes** in the peanuts that may produce bad flavours. Roasting also enhances the colour, flavour and texture of the peanuts.

Figure 11.4 A peanut roasting oven

Grinding peanuts and making peanut butter

Another machine rubs the peanuts between rubber belts to remove the outer skin around each peanut. The result is peanuts that are paler in colour than they were with skins. This is called **blanching**.

Word help

roasted: cooked by exposing to heat in an oven or over a fire for a long time
enzymes: protein molecules that speed up chemical reactions in cells
blanching: changing the colour of something

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The peanuts are then ground in a grinding machine twice. The first time reduces the nuts to a medium grind, and the second to a fine, smooth texture. One grinding would produce too much heat and would damage the flavour. The peanuts are ground alone first and then ingredients are added to them like salt, sweetener and stabiliser. The stabiliser stops the oil from separating out of the peanuts. To make crunchy peanut butter, incomplete grinding is used. The roasted peanuts can also be ground with a grinding stone (*guyo/imbokodo*) or pestle and mortar.


industrial grinding machine


grinding stone


pestle mortar

Figure 11.5 Grinding machines a) industrial grinding machine b) domestic grinding stone and c) pestle and mortar

Packaging peanut butter

After grinding, the peanut butter is cooled and taken to a filling machine where the correct amount of peanut butter is poured into jars. An automatic capping machine places a lid on each jar. The jars are sealed and labelled. They are packed into boxes ready to be transported to stores for sale.

Figure 11.6 Packaged peanut butter made in Zimbabwe

Activity 11.1 Simulation

Preparing peanut butter Work in a group

Make peanut butter from raw peanuts.

You will need:

- a winnowing basket
- a roaster
- a sheller
- a peanut butter making machine or grinding stone (*guyo/imbokodo*)
- pestle and mortar
- a spoon
- two clean glass jam jars
- raw peanuts (groundnuts)

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Method

Follow the instructions.

1. Using your hands, shell the peanuts.
2. Pour all the peanuts into the winnowing basket. Using your fingers, remove the husk by crushing and rolling the peanuts gently. Try not to break the peanut inside.
3. Stand outside. While gently flicking the winnowing basket, use the wind to separate the lighter husks from the peanuts.
4. Continue steps 2 and 3 until only peanuts are left in the basket.
5. Lay the peanuts on a tray and dry them in the sun for one day.
6. Pre-heat the roaster to 180 °C.
7. Place the tray into the pre-heated roaster and roast the peanuts for 10 minutes or until slightly golden.
8. Allow the peanuts to cool.
9. Separate the peanuts into two batches.
10. Place the first half onto the grinding stone and grind until smooth peanut butter is made.
11. With the other half, use the pestle and mortar to crush the peanuts, until crunchy peanut butter is made.
12. Taste each of the peanut butters. Add salt if necessary.
13. Spoon the peanut butter into two clean jam jars and refrigerate. Keep some for Activity 11.2.

Observations and results

Describe the taste and texture of the two peanut butters.

Conclusion

Write a conclusion for this experiment by filling in the missing words.

Using our hands, we _____ the peanuts, throwing away the _____ and keeping the peanuts. Then the peanuts were _____, which gives them the correct colour and _____. We used two methods to grind the peanuts. The smoothest peanut butter was made using the _____.

Questions

Answer the questions.

1. Explain each of the major processing steps in producing peanut butter.
2. Suggest why commercially produced peanut butter is smoother than that produced in the laboratory.
3. Search the Internet for information on how to make peanut butter.

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Method

Follow the instructions.

1. Using your hands, shell the peanuts.
2. Pour all the peanuts into the winnowing basket. Using your fingers, remove the husk by crushing and rolling the peanuts gently. Try not to break the peanut inside.
3. Stand outside. While gently flicking the winnowing basket, use the wind to separate the lighter husks from the peanuts.
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Questions

Answer the questions.

1. Explain each of the major processing steps in producing peanut butter.
2. Suggest why commercially produced peanut butter is smoother than that produced in the laboratory.
3. Search the Internet for information on how to make peanut butter.

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Production of peanut oil

Peanuts have a high oil content of 45–55%, providing lots of energy. This oil can be extracted directly from the clean, shelled peanuts using an oil press or indirectly from peanut butter using the decanting separation method learnt in Topic 8 Separation. Peanut oil is commonly used in the kitchen for frying and baking or is added to a dish to give it a nutty flavour. Peanut oil can also be used as massage oil.

Something interesting

Peanut oil can also be made using an oil press as shown in Figure 11.7. A lot more oil is obtained than the separation method that you used in Activity 11.2.

Activity 11.2 Simulation

Pressing peanut butter to produce oil Work in a group

Make peanut oil from peanut butter.

You will need:

- smooth and crunchy peanut butter made in Activity 11.1
- a clean jam jar

Method

Follow the instructions.

1. Place the peanut butter in the fridge in a jar.
2. After a few days the oil should have separated out and formed a layer on top.
3. Slowly tip the jar containing the peanut butter and pour the layer of oil into the clean jam jar.

Observations and results

Record the volume of oil produced from the smooth and the crunchy peanut butter. What did the oil look like?

Conclusion

The oil contained in peanuts can be separated using the separating technique called _____ learnt in Topic 8 Separation.

Questions

Answer the questions.

1. What is the percentage of oil in peanuts?
2. Was there a difference in the amount of oil produced from smooth and crunchy peanut butter? If so, suggest a reason.

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Uses of peanut oil

Peanut oil has many potential uses, including:

- Cooking oil – it has a high burning and smoking point
- Baking
- Skin moisturiser
- Baby care products such as nappy rash cream
- Massage oil – it has a light and nutty smell

Figure 11.7 An oil press is used to produce peanut oil.

Activity 11.3

Answer the questions.

1. Name the separation methods used in peanut butter and peanut butter oil production.
2. Suggest two reasons for roasting peanuts.
3. Where are peanuts grown in Zimbabwe?

Summary

- Processing peanuts into peanut butter and peanut oil is an industrial process in Zimbabwe.
- Peanuts are legumes that are rich in nutrients and are grown in Manicaland and Mashonaland East.
- During peanut butter production, peanuts are cleaned, shelled, graded, roasted, blanched and ground before being packaged into jars.
- Peanut oil is extracted from peanuts using an oil press or from peanut butter using decanting.

Topic assessment

Answer the questions.

1. For peanut butter production to be most profitable, every part of the peanut should be put to use. Suggest a use for the husks of the peanut. [1]
2. Name the steps in the production of peanut butter, from shelling the peanuts to the final product. Write a short description for each step. Choose either the industrial process or the domestic process. [9]

[Total marks: 10]

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Topic 12 Oxidation

Learning objectives

- State conditions necessary for rusting.
- Explain methods of preventing rusting.

Activities

- Carrying out experiments to investigate conditions necessary for rusting

Materials can change when they are exposed to different conditions. For example, wood can break down if it stays wet for a long time. In *Junior Science and Technology Grade 6*, you found out about what happens to materials when they are exposed to heat, water, acids and oxygen.

In *Junior School Agriculture Grade 5*, you learnt about basic farm tools and how to maintain them by drying, oiling, greasing, cleaning and painting. You also learnt about the characteristics of good storage facilities, such as good ventilation. In this topic, we will further investigate how to protect metals from reactions such as rusting.

Rusting

Most materials are subjected to **corrosion** and **decay** by sunlight, water, pollution, living organisms (bacteria, fungi, termites) and fire.

Iron and steel can corrode in a particular way, called **rusting**. Iron and steel easily rust when they are exposed to water and air. Rust is a brown, flaky material that falls off as the iron surface gradually corrodes.

Rusting is an example of an **oxidation reaction**. When iron and steel come into contact with water and oxygen in the atmosphere, the iron is **oxidised** to form iron oxide, also known as rust. Any iron object will gradually rust and disintegrate if it is exposed to oxygen and moisture for a long time.

The chemical reaction in words is:

iron + oxygen + water → iron oxide (rust)

Figure 12.1 Iron and steel will rust over time

Word help

corrosion: damage to an object as a result of a chemical reaction
decay: the breakdown of dead organic matter by micro-organisms such as bacteria and fungi
rusting: corrosion of a material containing iron by the formation of iron oxide
oxidation reaction: a reaction in which oxygen is added to a substance, or the reaction with oxygen
oxidised: when a substance has lost electrons

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Conditions necessary for rusting

Iron reacts slowly with oxygen and moisture in the air to form iron oxide or rust. Both water and oxygen must be present for rusting to occur.

Methods of preventing rusting

Rusting cannot be reversed, so objects made from iron and steel must be protected against rusting. Rust prevention methods involve coating the iron or steel with something that prevents them from coming into contact with moisture and air. Painting, **galvanising** or **electroplating** are some of these methods.

Painting

By coating iron with oil, grease or paint, the oxygen cannot come into direct contact with the iron. The disadvantage of this method is that the protective coat must be renewed frequently.

Figure 12.2 Painting prevents rusting

Word help

galvanising: coating with a protective layer of zinc

electroplating: coating a metal with another less reactive metal by electrolysis

Galvanising

Iron can also be protected against rusting by coating it with a thin layer of another metal that does not react with oxygen, for example zinc. The most common method is hot-dip galvanising, which involves immersing the iron object in a bath of molten zinc at about 449 °C.

Something interesting

Galvanised iron sheeting is commonly used for roofing in many parts of the world.

Figure 12.3 Galvanising prevents rusting

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Electroplating

In electroplating, an electric current is used to deposit a thin layer of a non-corroding metal onto the surface of an iron or steel object.

Something interesting

Shiny bicycle handlebars are made by electroplating steel with chromium.

Electroplating is done by a chemical process called **electrolysis**. For electrolysis to happen three components are needed: a power source, **electrodes** and an **electrolyte**. When an electric current is passed through a salt solution, which is an electrolyte, the salt decomposes into simpler substances.

The iron-containing item to be electroplated is suspended in an electrolytic solution made from the salt of a non-corroding metal. A block of silver or chromium is also suspended in the solution. When an electric current is passed through the solution, chromium or silver will be deposited onto the iron-containing item.

The **negative electrode** is the object that should be electroplated. The **positive electrode** is the metal that should be coated. The electrolyte should be a solution of the coating metal, such as its metal nitrate or sulfate.

Word help

electrolysis: the breakdown of a compound into its elements when an electric current passes through a solution containing that compound
electrode: a conductor through which electricity can pass
electrolyte: a solution that can conduct electricity
negative electrode: the negative rod that carries electric current into a solution
positive electrode: the positive rod that carries electric current out of a solution

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Figure 12.4 shows how a metal spoon can be electroplated with silver. The metal spoon is connected to the negative electrode of the power supply. A piece of silver is connected to the positive electrode. The electrolyte is a silver nitrate solution.

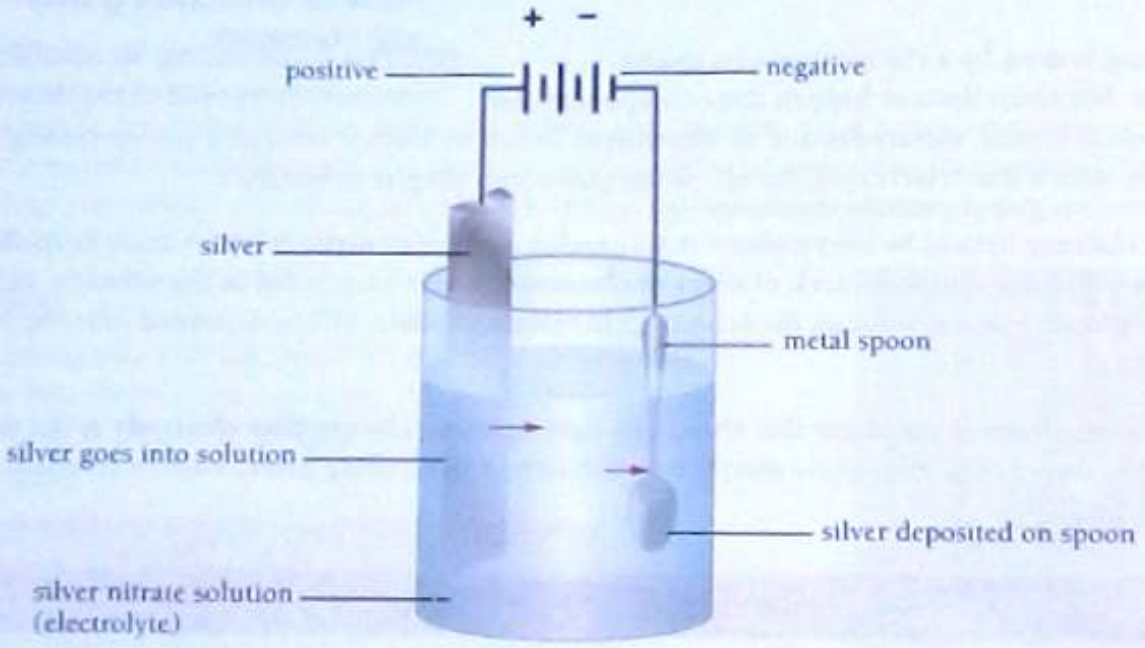

Figure 12.4 Electroplating a spoon with silver.

Electroplating is useful for coating a cheaper metal such as iron or copper with a more expensive one, such as silver or chromium.

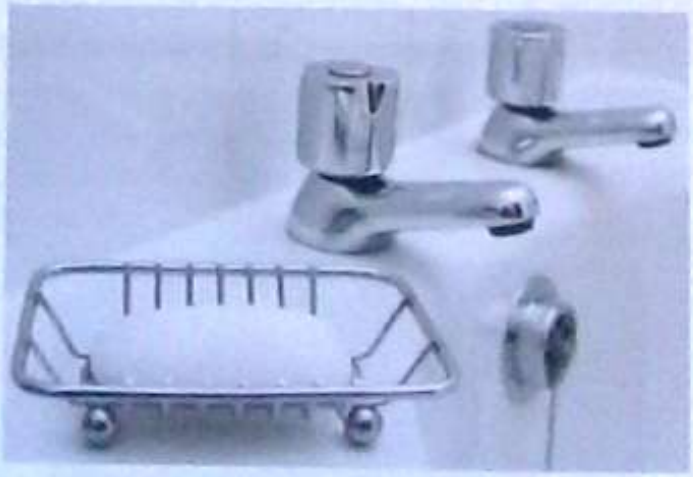

Figure 12.5 Chrome plating protects iron from rusting and makes it look more attractive.

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Activity 12.1 Experiment

Experiment to investigate conditions necessary for rusting Work with a partner

Do an experiment to investigate the conditions necessary for rusting.

You will need:

- three iron nails
- test tube rack
- cooking oil
- tap water
- three test tubes
- a rubber stopper
- solid calcium chloride
- boiled water

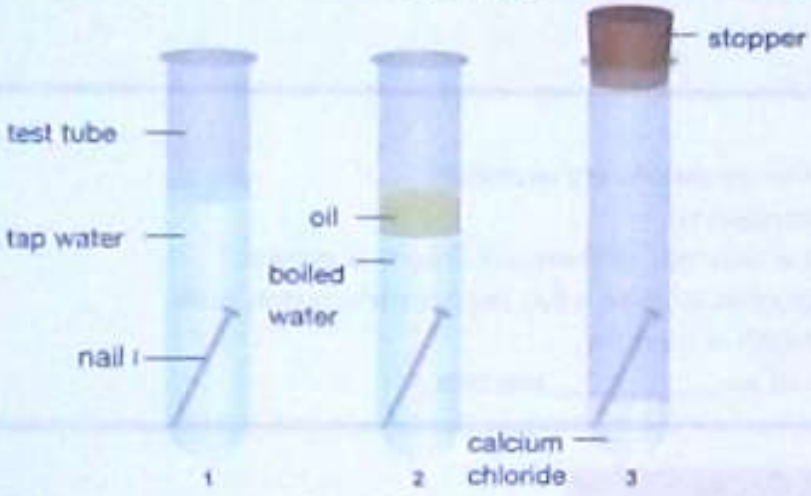

Figure 12.6 Testing the conditions for rusting

Method

Follow the instructions.

1. Set up the test tubes as in Figure 12.6.
2. a) In test tube 1, place a nail in tap water and leave it open to the air.
   b) In test tube 2, place a nail in boiled water and cover it with a layer of oil to keep the air out. Boiling water removes oxygen from it.
   c) In test tube 3, place a nail and a small amount of calcium chloride. The calcium chloride removes moisture from the air. Place a stopper on this test tube.
3. Leave the test tubes for several days.

Observations and results

Record your observations in a table.

Conclusion

Write a conclusion by completing the sentences below.

The nail in tap water _____ because both _____ and _____ were present.
The layer of oil in test tube 2 prevented any _____ from coming into the boiled water and so this nail did not _____

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The calcium chloride _____ the air completely, and so rusting could not happen because of the lack of _____.

Questions

Answer the questions.

1. Explain why only the nail in test tube 1 rusted.
2. Suggest why the nail in test tube 3 did not rust.
3. If the calcium chloride was not present, would the nail in air rust?
4. Explain the function of the cooking oil in test tube 2.

Activity 12.2

Answer the questions.

1. For rusting to occur two conditions are necessary.
   a) Name these two conditions.
   b) Will rusting occur if only one of these conditions is present?
2. Write down a word equation to show what happens when iron rusts.
3. Rusting occurs by a chemical reaction.
   Rusting is an example of an _____ reaction.

Summary

- Iron and steel objects can corrode and rust when they are exposed to water and air.
- Rusting of iron and steel occurs when an oxidation reaction takes place between the metal, oxygen and water. This reaction forms iron oxide, which is also known as rust.
- Objects need to be protected against rusting and this is usually done by covering them with a substance to prevent them coming into contact with air and water.
- Methods used to prevent rusting include:
  - painting an object with oil, grease or paint
  - galvanising the object by coating it with a layer of metal that does not react with oxygen, such as zinc
  - electroplating an object with a non-corroding metal such as silver or chromium, using electrolysis.

Topic assessment

Answer the questions.

1. Rusting occurs when a chemical reaction takes place.
   a) What is the name of the reaction that causes rusting? [1]
   b) State two conditions that are needed for rusting to occur. [2]

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2. There are different ways to prevent rusting.
   a) Name three different methods that can be used to prevent rusting. [3]
   b) Electroplating occurs when one metal is covered by a thin layer of another metal, using electrolysis. Draw a labelled diagram to show how electroplating works, using a tap and chromium to coat the tap. [6]
3. A farmer has an iron gardening fork. List three ways in which he can maintain the fork after digging in a moist field? [3]
4. Galvanised steel is often used when rusting needs to be prevented. Explain this technique. [3]
5. Explain why a new car does not rust immediately. [2]

[Total marks: 20]

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Topic 13 Organic chemistry

Learning objectives	Activities
• Identify forms of fuel • Compare the efficiency of different fuels.	• Discussing forms of fuel • Carrying out experiments to compare the efficiency of fuels

In *Junior Science and Technology*, you discussed different aspects of fuels. In Grade 3, you found out that fuels exist as solids, liquids or gases. In Grade 4, you demonstrated that fuels burn in the presence of oxygen. This is called **combustion**. Fuels can be classified as renewable and non-renewable energy sources. In Grade 5 you found out that renewable fuels can be replaced once they have been used up, whereas non-renewable fuels cannot. You will learn more about this in Topic 17 Energy. In Grade 6, you focused on the **sustainable** use of fuels.

Organic chemistry is a branch of chemistry that involves the study of organic compounds. Examples of organic compounds include carbohydrates, fats and proteins. You learnt about these in Topic 3 Nutrition. **Fuels** are also organic compounds. All fuels can burn to produce energy. Examples of fuels include paraffin, petrol, diesel, wood, gas and oil.

In this topic, you will be introduced to organic chemistry and take a deeper look at different forms of fuel. You will also compare the efficiency of different fuels.

Fuels

All organisms are made up of **organic compounds**. Organic compounds contain carbon and hydrogen and sometimes nitrogen, sulfur and phosphorus. Organic compounds such as carbohydrates and fats can be stored in plants and animals. Organic compounds store energy which we could use.

Some organic compounds contain only carbon and hydrogen atoms. These compounds are called **hydrocarbons**. All fuels such as wood, petrol, oil and cooking gas are hydrocarbons. Fuels are a source of energy. When a fuel burns in the presence of oxygen the stored **chemical energy** is converted to **heat energy**. Almost any material containing carbon can be burned, if oxygen is present, as a fuel to release stored energy.

Figure 13.1 A fuel is a source of heat energy when it burns.

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Forms of fuel

Fuels can be in a solid, liquid or gaseous state. You learnt about the three states of matter in Topic 9 Matter.

Solid fuels include wood and **coal**. In rural areas in Zimbabwe, trees are chopped down for wood, as it is a cheap fuel that is easy to obtain from the environment. The careless cutting down of indigenous trees in large areas of Zimbabwe leads to **deforestation**, causing damage to the environment. Coal is mined in Zimbabwe. Coal is formed by the remains of plants that lived thousands of years ago.

Indigenous knowledge

The Hwange coal seams are approximately 10 metres thick. Other coal reserves in Zimbabwe occur at Lumbimbi, Gokwe, Penhalonga, Beitbridge and near Triangle.

Figure 13.2 Coal is a solid fuel and is mined in Zimbabwe.

Liquid fuels include petrol, diesel, paraffin and oil. Most fuels are obtained from **petroleum** oil. Petroleum is a liquid that is extracted from the ground and is refined to produce fuel. Petroleum is formed by the remains of small animals and plants that lived thousands of years ago.

Figure 13.3 Petrol is a liquid fuel.

Word help

coal: a fuel rich in carbon, which comes from plant remains
chemical energy: energy which is released during a chemical reaction
combustion: the burning of substances in the presence of oxygen
deforestation: cutting down trees without replacing them
fuels: substances that produce heat energy
heat energy: energy which causes a rise in temperature, it comes from the Sun, burning of fuels and electrical energy in heating elements

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hydrocarbons: organic compounds made up of only hydrogen and carbon
organic compound: a compound that contains carbon and hydrogen and sometimes nitrogen, phosphorus and sulfur atoms
petroleum: a liquid fuel that comes from small plant and animal remains

Gaseous fuel such as cooking gas is a mixture of different gases and is found naturally in combination with petroleum and natural gas. Gaseous fuel is stored under pressure as a liquid in gas cylinders. Liquid petroleum gas (LPG) is produced during oil refining and natural gas processing. Liquid petroleum gas is mostly used as cooking and heating fuel.

Figure 13.4 Gaseous fuels are stored as a liquid in cylinders.

Something interesting

- Liquid petroleum gas (LPG) is commonly used for cooking. It is made of a flammable mixture of natural gases. ('Flammable' means that the material ignites and burns easily.)
- Coal, petroleum and natural gas are fuels that were formed millions of years ago. During that time plants lived in shallow seas. When these plants died, they sank to the seafloor and became mixed with other materials that became buried under layers of rock. Under great pressure and heat over millions of years these plants transformed into coal, petroleum and natural gas. Today, these fuels are mined and drilled from below the Earth's surface. When they are burnt, they release their stored energy.

Activity 13.1 Assignment

Discussing forms of fuel Work in a group.

- Discuss different forms of fuel and their uses.
- Collect pictures of different forms of fuel.
- Classify the fuels into solids, liquids and gases and make a poster to show the different forms of fuel.
- Do research on the Internet or the library about different forms of fuel.

Word help

efficiency (of a fuel): the amount of heat energy released when a fuel burns
inefficient: not producing the most possible heat energy

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Efficiency of different fuels

Fuel **efficiency** refers to how well the stored chemical energy in the fuel is converted to heat energy during combustion.

Wood is an **inefficient** fuel because it burns quickly and does not produce a lot of heat energy. A lot of the heat is wasted when burning wood. Coal has a higher carbon content than wood and therefore, when coal combines with oxygen during combustion, it has a higher heating value.

Liquid fuels, such as petrol and diesel, are more efficient fuels than solid fuels. They do not produce smoke like wood does. Gaseous fuels are the most efficient fuels.

Something interesting

Fuel efficiency in vehicles refers to the distance a vehicle can travel per unit of fuel. Fuel-efficient vehicles require less fuel to go a certain distance. Using less fuel means that less carbon dioxide is produced and so there is less air pollution. The cost of running a vehicle will also be reduced. Diesel is a more efficient fuel than petrol. This means that the fuel economy of a vehicle using diesel is higher than one using petrol.

In the next activity, you will compare the efficiency of different fuels by comparing how much heat energy is released from a burning fuel.

Activity 13.2 Experiment

Comparing the efficiency of fuels Work in a group

Do an experiment to compare the efficiency of fuels.

Figure 13.5 Apparatus used to find out the efficiency of a fuel

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You will need:

- Bunsen burner
- tongs
- tin plate
- water
- matches or lighter
- stop watch
- wood
- a beaker
- tripod stand and gauze
- methylated spirits
- methylated spirit burner
- thermometer
- paraffin

Safety

Paraffin and methylated spirits are flammable. Be careful when using a flame near them.

Method

Follow the instructions.

1. Place 100 ml of water in the beaker and set up the apparatus as shown in Figure 13.5. Use 50 ml paraffin in the spirit burner.
2. Record the temperature of the water.
3. Light the spirit burner and start the stop watch.
4. Record the temperature of the water after 10 minutes.
5. Repeat steps 1 to 4 using 50 ml of methylated spirits in the spirit burner. Record the results.
6. Repeat steps 1 to 4, using a Bunsen burner.
7. Go outside and use a tin plate to pack a small wood fire. Set up the tripod, beaker and thermometer as before. Light the fire.
8. Record the temperature after 10 minutes.

Observations and results

Record the results in a table.

Fuel	Initial temperature (°C)	Final temperature after 10 minutes (°C)
paraffin		
methylated spirits		
gas		
wood		

Conclusion

Write a conclusion for this experiment.

Questions

Answer the questions.

1. Which fuel was the least efficient? How did you come to this conclusion?
2. Suggest some ways in which you could improve the accuracy of your results.

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Activity 13.3

Answer the questions.

1. Energy is released when hydrocarbons are burned.
   a) What is the name of the process that takes place when a hydrocarbon burns in air?
   b) What substance in air reacts with a hydrocarbon when it burns?
2. Different fuels have different efficiencies.
   a) What is meant by fuel efficiency?
   b) Which form of fuel is the most efficient? Explain why.

Summary

- Organic compounds contain carbon and hydrogen and sometimes nitrogen, sulphur and phosphorous.
- Fuels are organic hydrocarbons that contain only carbon and hydrogen.
- Fuels contain stored energy that is released when they burn in the presence of oxygen.
- Solid fuels include wood and coal, liquid fuels include petrol, diesel, paraffin and oil, and gaseous fuels include methane, propane or a mixture of gases like liquid petroleum gas (LPG).
- Liquid petroleum gas is stored under pressure in gas cylinders and is used for cooking and heating.
- Different fuels have differing fuel efficiencies depending on how well they produce heat energy during combustion. Gaseous fuels are the most efficient, followed by liquid fuels and then solid fuels.

Topic assessment

Answer the questions.

1. Fuels release heat energy when they combust.
   a) Name three forms of fuel.
   b) Give an example of a fuel in each form. [6]
2. Complete the following sentences by filling in the missing words.
   a) During combustion, _____ energy is converted to _____ energy. [2]
   b) Combustion happens in the presence of _____. [1]
   c) Organic compounds that contain hydrogen and carbon are called _____. [1]
3. Some fuels are more efficient than others.
   a) Explain what is meant by fuel efficiency. [3]
   b) Explain why coal is more efficient as a fuel than wood. [2]
   c) In an experiment to compare the efficiency of different fuels, what measurement was taken to do the comparison? [1]
4. Wood is an easily obtainable fuel in the rural areas of Zimbabwe. However, the cutting down of trees is leading to deforestation.
   a) Explain what deforestation is. [1]
   b) Suggest how deforestation can be prevented. [1]
   c) Suggest an alternative source of fuel that would be appropriate in the rural areas of Zimbabwe and why it would be suitable. [2]

[Total marks: 20]

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Term 3

Physics

Topic number	Topic	Learning objectives
14	Data presentation	• Present data in the form of tallies, tables and bar graphs. • Interpret data presented in the form of tallies, tables and bar graphs.
15	Measurements	• Estimate physical quantities. • Identify appropriate instruments for measuring physical quantities. • Measure accurately. • Identify types of errors in measurement. • Read an instrument scale to the nearest division. • Identify units including SI units.
16	Force	• Demonstrate the effect of forces on position, shape and size. • Identify various types of force. • State the SI unit of force. • Identify instruments for measuring force.
17	Energy	• Describe effects of energy. • Identify different forms of energy. • List forms of potential energy. • Identify energy conversions. • Construct energy chains. • Identify energy convertors.
18	Magnetism	• Distinguish magnetic material from non-magnetic materials. • The Earth as a magnet.

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19	Electricity	• State the two types of charges. • Describe the production of charges. • Define current. • Distinguish between conductors and insulators. • Identify components of direct current (d.c.) circuit. • Draw and label a simple direct current (d.c.) circuit.

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Topic 14 Data presentation

Learning objectives	Activities
• Present data in the form of tallies, tables and bar graphs.	• Collecting and presenting data in the form of tallies, tables and bar graphs. • Class surveys • Fieldtrip to local store
• Interpret data presented in the form of tallies, tables and bar graphs.	• Interpreting data from a bar graph

Data means information, such as facts and statistics. Scientists collect data when they perform experiments and do research. In Grade 4, you collected data about the weather over a few days. You presented information about the temperature on a graph. Scientists can look at or **interpret** data and use it to make **conclusions** about their experiment. For example, from your graph of the average temperature of an area, you could see which day was the hottest and which was the coolest.

In this topic, you will learn about some of the ways to present the data that you collect.

Ways to present data

When scientists do experiments and investigations, they collect information. This is the result of their investigation. Sometimes the results are numbers, for example the average temperature over a week. This is called **quantitative data**. Sometimes the results are observations, for example cats are more aggressive at night, which is when they like to hunt. Aggression would be a quality that can't be measured exactly. This is called **qualitative data**.

Scientists need to decide what would be the best visual or graphic way to present data. In this topic, you will find out about ways to present quantitative data.

Collecting and presenting data

There are several ways to present the data that you collect during investigations and experiments. Ways to present data include tallies, tables and bar graphs.

Word help

conclusions: statements made about the results of an investigation
data: information
interpret: understand and explain the meaning of
qualitative data: information made up of words, shows qualities rather than numbers
quantitative data: information made up of numbers; can be measured

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People admire this 7 metres high replica of the Ishango bone on the Munt Square in Brussels. The original carved bone, found by explorer Jean de Heinzelin de Brancourt in 1960 in the Belgian Congo, dates back 22 000 years, and is the first proof of mathematical knowledge of humans.

Figure 14.1 A photo of a tally on a bone that is about 35 000 years old

Tallies

A **tally** is an easy way of showing how often something happens. This is called the **frequency**. Tally charts are some of the oldest known methods of presenting data. Figure 14.1 shows an example of an ancient tally on a bone that was found inthe Belgian Congo.

Study the tally chart shown in Figure 14.2. The chart tallies the transport types used by learners to travel to school.

Transport type	Tally	Frequency
Bike	𝍸 ||	7
Car	||	2
Walk	𝍸 𝍸 ||||	14
Bus	𝍸 𝍸	10
Total	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 |||	33

Figure 14.2 A tally chart of transport types used by learners

When doing a tally, you make four vertical lines and then one horizontal line across the four vertical lines to show five counts. You then leave a space and continue making more vertical lines and a horizontal line. Each group of lines counts for five. Notice how the number of people walking is

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presented by two completed tally blocks and then four vertical lines, which tally 14. You can also use this chart to find out the total number of children in the class by adding together the total tallies in the second column or all the frequencies in the third column.

Tables

Presenting data in a table helps to make it clear and easy to read and understand. A table should always have a descriptive heading. Each row and column should be labelled. For example, imagine you did a survey to find out what the favourite fruit of the learners in your class is. You can present the results in a table like the one below.

Favourite types of fruit of learners in the class	
Type of fruit	**Number of learners**
Banana	14
Mango	6
Marula	9
Apple	1

Figure 14.3 A table of favourite fruit of friends/the class

Bar graphs

A bar graph (also called a bar chart) is a visual display of data on a graph. Bar graphs have vertical bars of different heights on a pair of axes. We can use the information presented in the table in Figure 14.3 to draw a bar graph.

The heights of the bars show the values represented in the table.

A bar graph is a good way to show the frequency of something. By looking at the bar graph in Figure 14.4 we can easily see that bananas are the most popular fruit and apples are the least popular. Bar graphs are used when the data is in groups or **categories**, for example, days of the week, types of transport, types of fruit etc. There are spaces between the bars of the bar graph.

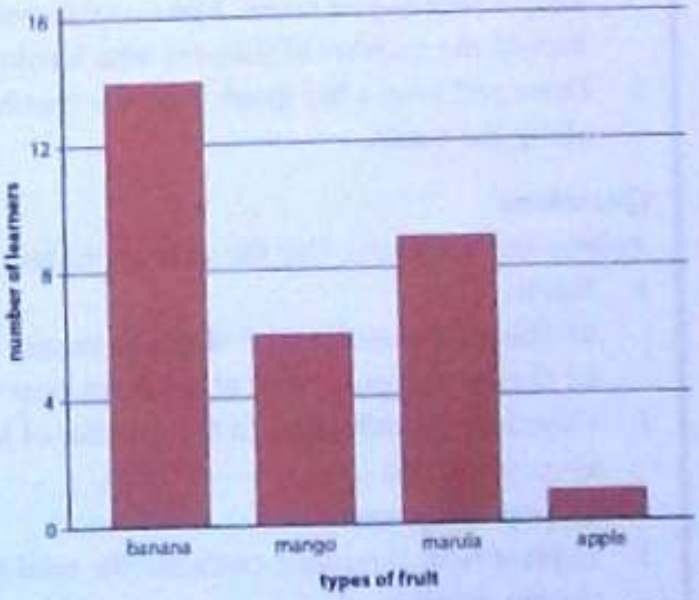

Figure 14.4 Bar graph to show learners' favourite fruit

Word help

tally: a record of an amount of something

frequency: the number of times something occurs

categories: groups

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Rules for drawing bar graphs

- Draw two axes: one horizontal axis (the x axis) and one vertical axis (the y axis).
- The groups or categories always go on the x axis.
- Label the x axis. In this case it is 'Types of fruit'.
- Use a ruler to measure and mark equal spaces on the x axis, one space for each type of fruit. Remember to leave a space between each bar on the axis. Write the name of the fruit under each space on the x axis.
- Label the vertical or y axis. In this case, it is the number of learners.
- Mark off a scale on the y axis. For example, you could make one centimetre represent one learner.
- Draw your bars on the graph using the data from the table.
- You can colour in the bars using coloured pencils or wax crayons.

Activity 14.1 Investigation

Conducting a survey Work as a class

Conduct a survey to find out which types of music are the most popular among learners in the class.

You will need:

- a pen
- a ruler
- paper

Method

Follow the instructions.

1. Decide on four of the most common categories of music, for example jazz, hip-hop, rap, kwaito, gospel or pop.
2. Conduct a survey to find out learners' favourite music, either through a questionnaire or by asking each learner verbally.
3. Keep a tally as you count. Make a table with the types of music as a heading for each column. Record the number of learners who favour each type of music.
4. Draw and label a bar graph with the number of learners up the y-axis and the types of music along the x-axis.

Questions

Answer the questions. Use the data on the bar graph to determine the answers.

1. Name:
   a) the most popular type of music in your class
   b) the least popular type of music in your class.
2. Calculate the difference in the number of learners who like:
   a) pop and rap
   b) pop and gospel.
3. Explain how you could calculate the total number of learners in your class using the data on the bar graph.

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In the next activity, you will work in groups to conduct a survey in a local store.

Activity 14.2 Investigation

Investigating the busiest hours at the local store Work in a group

Do a field trip to a local store to investigate the busiest hours at the store.

You will need:

- a pencil
- paper
- clipboard or notebook

Method

Follow the instructions.

1. Go to a store near your school. Get permission from the storeowner or store manager to conduct a survey in the store over a few hours.
2. Count the number of customers that enter the store during each hour that you are there by making a tally chart.
3. After a few hours, add up the tallies for each hour and record the number in your tally chart.
4. Draw a table with clearly labelled columns and rows to show the data that you have collected.
5. Use the data in the table to create a bar graph showing the number of customers visiting the store during each hour. Refer to the rules for drawing bar graphs on page 134. The hours should be recorded on the x axis and the number of customers on the y axis.

Scientists analyse data in bar graphs to get information. In the next activity, you will analyse data about the amount of sugar in different foods.

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Activity 14.3 Assignment

Analysing data on a bar graph Work with a partner

Study the bar graph in Figure 14.5. Answer the questions that follow.

Figure 14.5

Questions

Answer the questions. Use the data on the bar graph to determine the answers.

1. Which food has:
   a) the most sugar?
   b) the least sugar?
2. What would be a suitable title for this bar graph?
3. How many categories are there in this bar chart?
4. What is the percentage of sugar in:
   a) soda?
   b) bread?
5. What is the difference in the percentage of sugar in chocolate and peanut butter?
6. Draw a table of the data given in the bar chart.

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Summary

- Scientists collect quantitative data from investigations. This data needs to be presented in a way that it can be interpreted and viewed by other people.
- The following are some of the methods of presenting data:
  - Tallies are five lines (four vertical and one diagonally across) that are used to show the frequency of something occurring. For example, you can use tallies to demonstrate how many learners to travel to school by car every day.
  - Tables consist of rows and columns and are used to make data clear and easy to understand.
  - Bar graphs are used when data is in categories. They consist of vertical bars of different heights on a pair of axes. There are rules for drawing bar graphs. For example, there must be spaces between the bars.

Topic assessment

A restaurant in your neighbourhood knows it needs more waiters but cannot afford to hire any for a full day. You help them out by telling them you can work out their busiest times so that they can hire waiters just for those hours.

1. Draw a table to show the information below.

10:00–11:00	𝍸 | | |
11:00–12:00	𝍸 𝍸
12:00–13:00	𝍸 𝍸 | |
13:00–14:00	𝍸
14:00–15:00	| |

[8]

2. Use the data in the table to draw a bar graph. [8]
3. Use the bar graph to determine:
   a) which hour is the busiest time
   b) how many customers were served in total for the day. [2]
4. What advice would you give to the restaurant owner about hiring waiters? [2]

[Total marks: 20]

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Topic 15 Measurements

Learning objectives

- Estimate physical quantities.
- Identify appropriate instruments for measuring physical quantities.
- Measure accurately.
- Identify types of errors in measurement.
- Read an instrument scale to the nearest division.
- Identify units including SI units.

Activities

- Estimating length, time, mass and temperature
- Taking measurements at different points
- Measuring length, time, temperature and mass

To do experiments and find out about the world around us, it is important to be able to make accurate measurements. In this topic, you will learn about instruments that you can use to measure length, mass, temperature and time. You will find out which units of measurement are used. You will also learn how to make sure that your own measurements are accurate.

Measurement of physical quantities

Measurement means to find out the size, length or amount of something using a measuring instrument. In science, **physical quantities** are features of something that can be measured, for example mass, length and volume. Each physical quantity has a **unit**. For example, in Figure 15.1 the physical quantity of a length is 100 m. 100 is the **numerical value** and metre (m) is the unit.

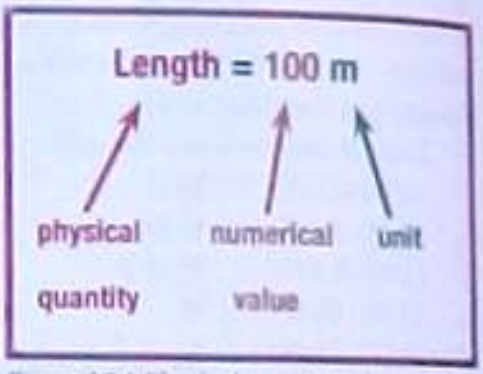

Figure 15.1 Physical quantities have a numerical value and a unit.

Word help

physical quantities: things that can be measured, such as time, mass, length and temperature
unit: a quantity used to express or describe a measurement, for example metre or kilograms
numerical value: a number

Physical quantities and SI units

When scientists measure physical quantities, they use an instrument marked in **standard units**. These standard units are called SI units. For example,

Something interesting

The standard units used all over the world are determined by the International System of Units. SI units are abbreviated as SI, from the French *le Système International d' Unités*. The base SI units are listed in Table 15.1. All other units are **derived** from these base units.

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a ruler has marks showing centimetres and millimetres. These are internationally agreed units for different physical quantities. Everybody in the world uses these SI units.

The physical quantities you need to know are length, mass, time and temperature.

Figure 15.2 A metre rule can be used to measure the length of an object.

Physical quantity measured	SI unit	Symbol
mass	kilogram	kg
length	metre	m
time	second	s
temperature	Kelvin	K
amount of a substance	mole	mol
electric current	ampere	A
light intensity	candela	cd

Length

Length is the distance between two points. The SI unit for length is the **metre** and the symbol is m. A metre is made up of smaller units called centimetres (cm) and millimetres (mm).

100 cm = 1 m
10 mm = 1 cm

The instrument used to measure length is a **metre rule**. The metre rule is made from a long rigid piece of wood or steel and can measure distances up to one metre in length. When using a metre rule, the metre rule should be placed alongside the object being measured.

Word help

standard units: units for measurements that are used by scientists all over the world
derived unit: a unit that is defined in terms of the seven base units
derived: taken from
metre: the unit used for length
metre rule: an instrument used to measure length

Figure 15.2 A metre ruler can be used to measure the length of an object.

Mass

Mass is the amount of matter in an object. The SI unit for mass is the **kilogram** and the symbol is kg. A kilogram is made up of smaller units called grams (g) and milligrams (mg).

1 kg = 1 000 g
1 g = 1 000 mg

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Mass is measured using a **balance**. A balance can be **analogue** or **digital**. Analogue instruments have pointers to show a measurement, whereas digital instruments have measurements displayed as numbers. There are different types of balances, for example a triple beam balance (Figure 15.3), a digital balance (Figure 15.4) and a spring balance (Figure 15.5). You will use a spring balance in Topic 16 Force.

Figure 15.3 shows a triple beam balance. A triple beam balance has three scales for reading the mass. When using this balance, the sliding masses are moved so that the pointer lines up with the zero mark. To read the mass of an object, you have to add all the measurements on the three beams.

Something interesting

How heavy is a kilogram? It is defined by a real block of platinum, which is to be found at the Office of Weights and Measures in Paris. If a scientist says they have a lump of any material that is one kilogram in mass, then it has to have exactly the same mass as the platinum block in Paris.

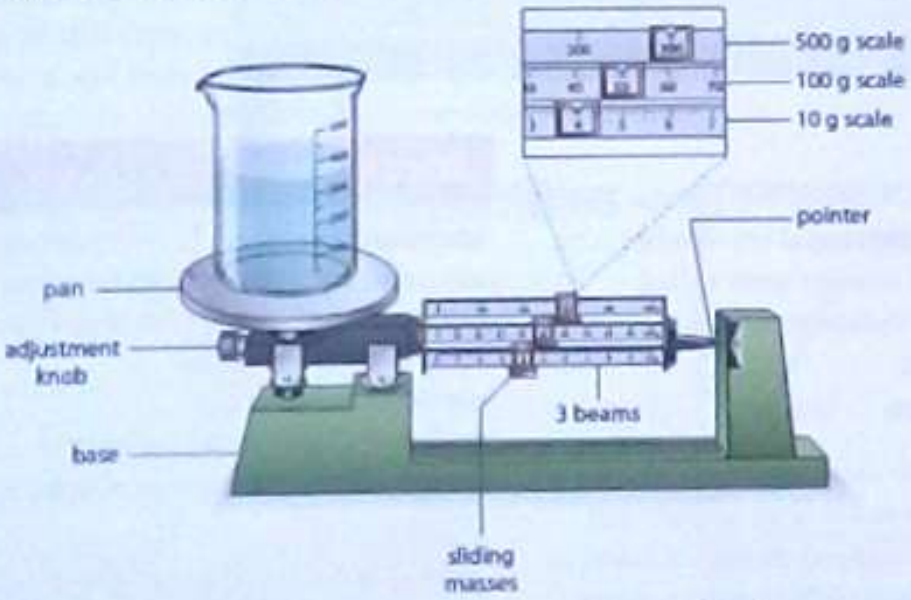

Figure 15.3 A triple beam balance measuring a mass of 444 g

Figure 15.4 A digital balance

Figure 15.5 The two types of spring balance

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Time

In science, the duration of time it takes for an event to happen needs to be measured. The SI unit for time is the second (s). The other units of time are minutes and hours.

1 h = 60 min
1 min = 60 s

A **stopwatch** is used to measure the time taken. The stopwatch can be started and stopped as required, while this is not possible with a watch or clock. Stopwatches can be analogue or digital. Some cell phones come with stopwatches installed.

Figure 15.6 a) analogue stopwatch b) a digital stopwatch

Temperature

Temperature is a measure of how hot or cold something is. Temperature is measured using a **thermometer** in degrees Celsius (°C). You can see in Table 15.1 that the SI unit for temperature is Kelvin (K). Temperature has a fixed starting point of zero Kelvin (0 K). This zero unit is equal to −273 °C.

Something interesting

The Kelvin scale is the SI unit for temperature:
0° Celsius = (0 + 273) = 273 Kelvin
100° Celsius = (100 + 273) = 373 Kelvin
Absolute zero temperature is 0 K and −273°C.

There are different types of thermometers including mercury and liquid (such as coloured alcohol) thermometers. There are also digital thermometers.

Mercury and liquid thermometers consist of a narrow glass tube with markings indicating the scale in degrees Celsius (°C). The mercury or liquid collects at the base of the thermometer in a bulb. When the thermometer is placed in a beaker with warm water, the mercury or liquid will expand and push up the thread. The point where the mercury or liquid does not move any further is where a temperature reading is taken using the scale.

A digital thermometer has temperature **sensors** inside round-tipped **probes**. The information gathered by the sensors is shown on a digital display screen.

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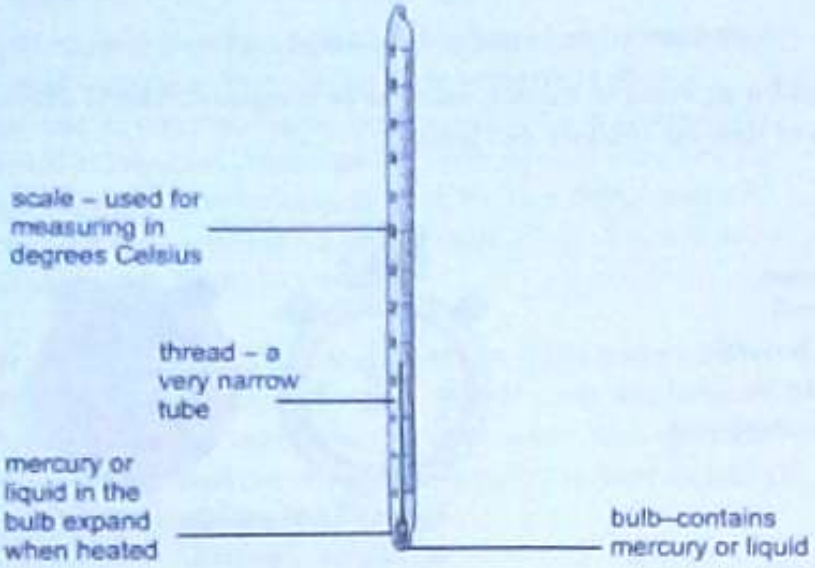

Figure 15.7 A mercury or liquid thermometer

Figure 15.8 A digital thermometer

Word help

kilogram: the unit used for mass
balance: an instrument used to measure mass
analogue: showing a measurement on an instrument by using a pointer
digital: showing a measurement on an instrument using displayed numbers; works with a battery
stopwatch: a special device that can be used for timing
thermometer: an instrument used to measure temperature
sensor: a detection device
probes: parts of an instrument that are used for measuring quantities

Activity 15.1 Investigation

Answer the questions.

1. What is the mass shown?

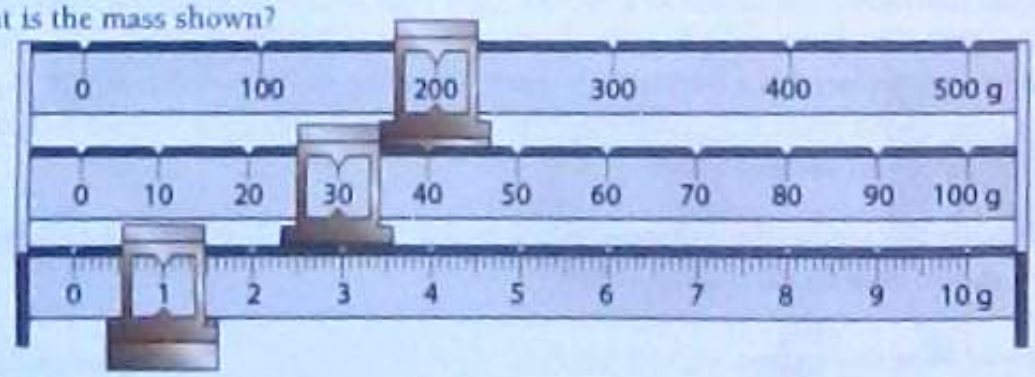

Figure 15.9

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2. What time has been taken?

Figure 15.10

3. Write down the temperature shown in the two thermometers in Figure 15.11 and 15.12.

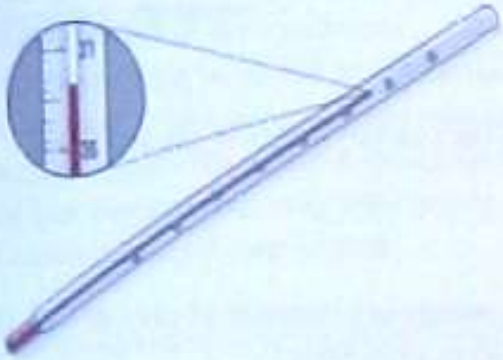

Figure 15.11

Figure 15.12

Estimation of physical quantities

Sometimes instead of an accurate measurement of a physical quantity, only a rough **estimate** is needed. For example, estimation can be used if you need to find out roughly how much material you would need for a specific task or how much food you would need for your birthday party. Sometimes an estimation of a physical quantity can be made before it is actually measured. It is then possible to check whether the measurement you have made is reasonable.

Word help

estimate: to roughly calculate or judge the amount of something

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Activity 15.2 Experiment

Estimating physical quantities Work in a group

Do an experiment to estimate and then measure physical quantities: length, mass, time and temperature.

You will need:

- a metre rule
- a stop watch
- a balance scale
- a thermometer
- a beaker
- cold and hot tap water
- soil
- a cup

Safety

Be careful when working with hot water

Method

Follow the instructions.

Part A: Estimating and measuring length

1. Estimate and record your estimation, in metres (m), of the length of the following.
   a) The width of the classroom door
   b) The height of the classroom wall
   c) The length of this book
2. Which measuring instrument would you use to accurately measure a) to c) in Step 1?
3. Measure and record the actual measurement of a) to c) in Step 1.
4. Indicate how accurate your estimation was by stating: accurate or not accurate for each of a) to c) in Step 1.
5. Record your results in a table like this:

Item	Estimation of the length (unit)	Actual measurement of the length (unit)	Accurate OR not accurate
Width of classroom door			
Height of classroom wall			
Length of the classroom			
Length of this book			

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Part B: Estimating and measuring mass

1. Estimate and record your estimation, in kilograms (kg) or grams (g), of the following:
   a) Your science book
   b) Your pen
   c) A cup of soil
2. Which measuring instrument would you use to accurately measure a) to c) in Step 1?
3. Measure and record the actual measurement of a) to c) in Step 1.
4. Indicate how accurate your estimation was by stating: accurate or not accurate for each of a) to c) in Step 1.
5. Draw a table to record your results.

Part C: Estimating and measuring time

1. Estimate and record your estimation, in seconds (s) or minutes (min), of the time it takes to:
   a) walk the length of the classroom
   b) take your science book out of your suitcase and place it on your desk.
2. Which measuring instrument would you use to accurately measure a) and b) in Step 1?
3. Measure and record the actual measurement of a) and b) in Step 1.
4. Indicate how accurate your estimation was by stating: accurate or not accurate for a) and b) in Step 1.
5. Draw a table to record your results.

Part D: Estimating and measuring temperature

1. Estimate and record your estimation, in ° Celsius, of the temperature of:
   a) a beaker of cold tap water
   b) a beaker of hot tap water
2. Which measuring instrument would you use to accurately measure a) and b) in Step 1?
3. Measure and record the actual measurement of a) and b) in Step 1.
4. Indicate how accurate your estimation was by stating: accurate or not accurate for a) and b) in Step 1.
5. Draw a table to record your results.

Word help

zero error: an error made when a measuring instrument has not been adjusted to ensure that the pointer is on the zero mark

Accurate measurement of physical quantities

It is important to be **accurate** when taking measurements. There are ways to limit errors in measuring and to ensure accurate measurements. One way to minimise errors and improve accuracy is to take repeated measurements and then find the **average**.

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With very small objects it is easier to measure a large number of the same object at once and then divide the total measurement by the number of objects. This will give you an average measurement for each object. If the objects are all the same then this will be an accurate measurement.

Example 1

If you want to find out how many insects there are on a plant, the accuracy would be improved if they were counted a few times and the average was found.

Figure 15.13 Sometimes we need to count objects a few times and then take an average.

Example 2

If you want to find the mass of a small screw, it would be easier to find the total mass of 20 screws and then divide by 20 to find an accurate mass for one screw.

Figure 15.14 We can find the mass of one screw by measuring the mass of 20 and finding the average.

Errors in measurement

There are two common errors that could occur when taking measurements. These are called parallax error and zero error.

Parallax error

Parallax is the change in the **apparent** position of an object when the position of the person looking at it changes.

A **parallax error** sometimes occurs when measurements are made in science.

Word help

accurate: exact
average: a number obtained by adding several amounts together and dividing the total by the number of amounts
parallax: the effect when the position of an object appears different depending on the point from which it is viewed
apparent: something that seems true but is not necessarily true
parallax error: an error in reading a measurement that occurs if the person taking the measurement looks at the instrument from the incorrect position
line of sight: a straight line along which a person views an instrument

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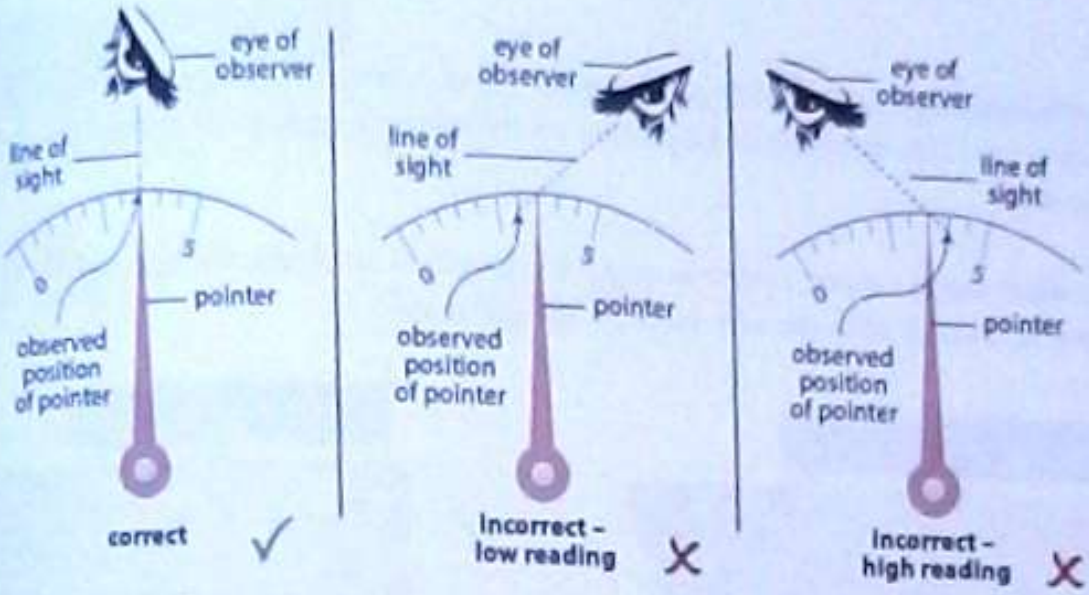

Figure 15.15 Errors in parallax can result in inaccurate readings.

Figure 15.16 shows an example of how an error of parallax can happen. It shows three children measuring the length of a box. They are each standing in a different position and have a different **line of sight**. Child A is too low and too much to the right side and will read the measurement at an angle, which would not be accurate. Child C is too high and too much to the left and will read the measurement at an angle, which would not be accurate. Child B is in the correct position, directly in line with where the measurement should be taken. Child B will take the most accurate measurement.

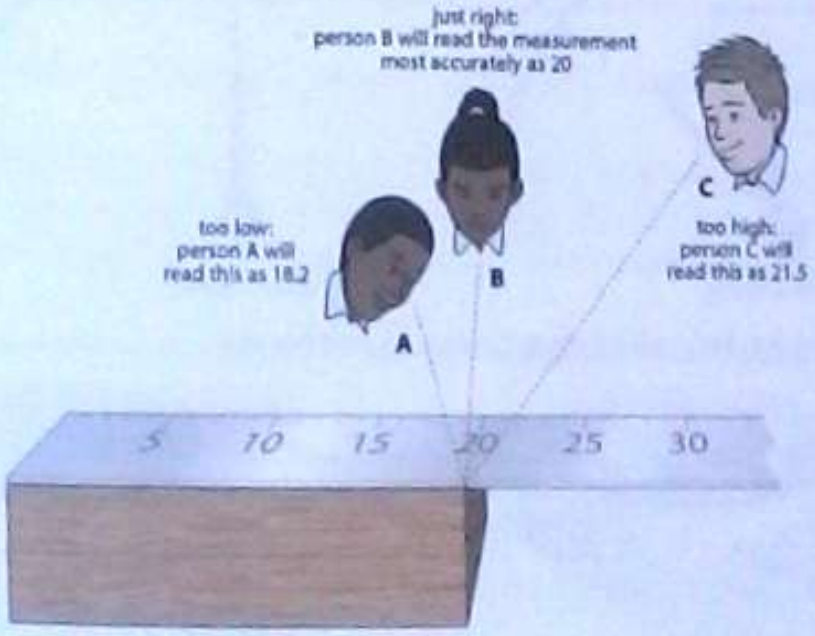

Figure 15.16 Measurements should be taken in line of sight.

To avoid a parallax error, the person taking the measurement must make sure that their line of sight is directly in line with the instrument's pointer and scale.

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Zero error

When using a measuring instrument, it is important that it is 'zeroed' before measuring, otherwise a **zero error** can occur. This means that the pointer on the instrument must be exactly positioned next to zero on the scale.

For example, when using a metre rule to measure the length of an object, the one end of the object should be lined up exactly with the zero mark on the metre rule.

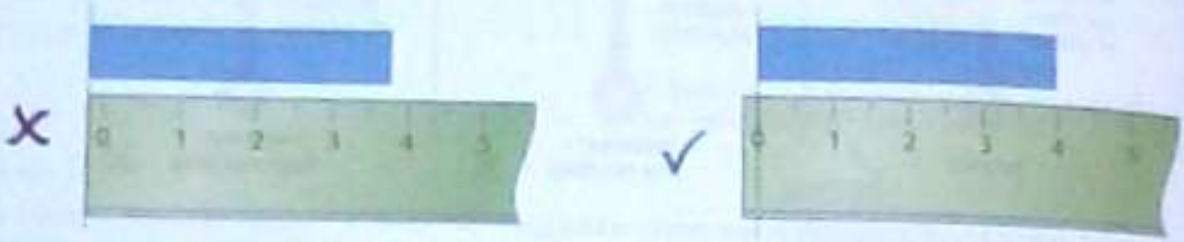

Figure 15.17 Measuring using a ruler – ensure it is lined up to zero

When using a balance to measure the mass of an object, the pointer must be set on zero before the object is weighed. When there is nothing on the balance the reading should be zero.

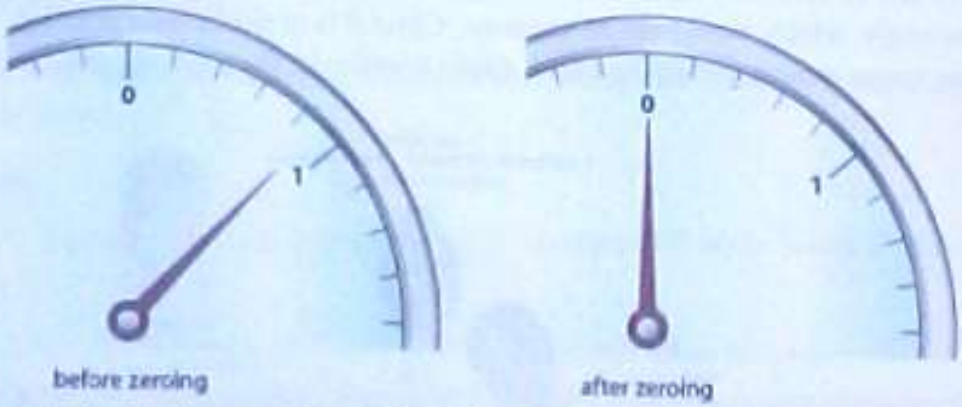

Figure 15.18 A scale that has been zeroed correctly and one that has not

Figure 15.19 Digital balance not zeroed

Figure 15.20 Digital balance that has been zeroed

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Activity 15.3 Experiment

Find out about zero error Work in a group

Do an experiment to find out about zero error.

You will need:

- a scale balance
- a cup or book

Method

Follow the instructions.

1. Use the adjustment knob to move the pointer off the zero mark.
2. Place a cup or book on the scale and find its mass. Record it.
3. Now remove the object and use the adjustment knob to zero the pointer.
4. Find the mass of the object again and record it.

Questions

1. Explain what the term 'zero error' means.
2. Describe what happens when the scale is not 'zeroed'.
3. Explain how this could affect an experiment.

Activity 15.4

Answer the questions.

1. What would be the most accurate way of measuring how long it takes for your friend to do one star jump?
2. Estimate how high the biggest tree in your school is. Explain how you got to your answer.
3. What would be the most accurate way to find out the mass of half a piece of chalk?
4. A thermometer shows a reading of 42 degrees Celsius. What would this temperature be in Kelvin?

Summary

- In order to find out size, length, mass, temperature or time, scientists need to use measuring instruments to take accurate measurements.
- Physical quantities are features of an item that can be measured; they have a numerical value and unit, for example 100 cm.
- Standard units (SI unit) are internationally agreed units of measurement for physical quantities.
  - The SI unit for length is metres (m) and it is measured using a metre ruler.

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- Mass is measured in kilograms (kg) using a balance such as a triple beam balance, spring balance or digital balance.
- The SI unit for time is seconds (s) and it is measured using a stopwatch.
- The SI unit for temperature is degrees Celsius (°C) or Kelvin (K).

- When people do not need an accurate measurement, they sometimes use estimates to measure an item.
- If you want to improve the accuracy of a reading, you can take repeated measurements and find the average.
- Parallax error can occur when a person takes a reading on an instrument while their eye (and so their line of sight) is incorrectly positioned.
- Zero error can occur when a person does not set the pointer of an instrument to the zero position before taking a measurement.

Topic assessment

Answer the questions.

1. Name the instrument that you would use to measure:
   a) mass b) temperature c) length d) time [4]
2. There are internationally agreed units of measurement called SI units.
   What is the SI unit for:
   a) mass b) time c) temperature d) length? [4]
3. Figure 15.21 shows different instruments used for measuring different physical quantities.
   Write down the measurement shown on each of the instruments.
   Remember to include the SI unit. [8]

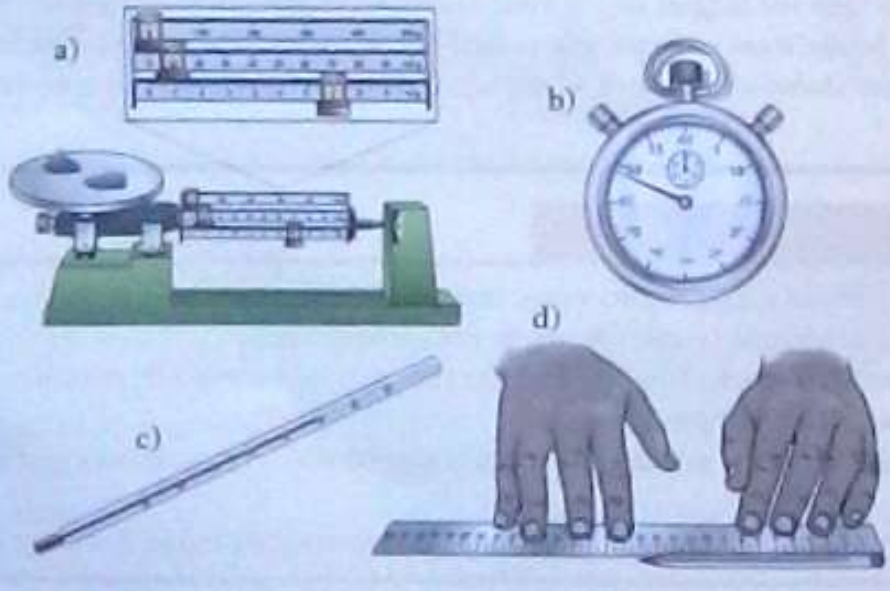

Figure 15.21

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4. There are two sources of inaccuracy when taking measurements.
   a) Name these two sources of inaccuracy. [2]
   b) For each source of inaccuracy, describe how you can ensure that your readings are accurate. [4]
5. You have been asked to find out how long it takes for a liquid to boil. Describe how you could do this so that an accurate result is obtained. [3]
6. Sometimes scientists make estimates.
   a) What is an estimate? [1]
   b) How can you check how accurate an estimate is? [2]

[Total marks: 28]

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Topic 16 Force

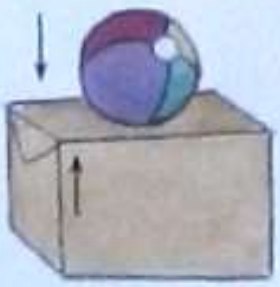
Learning objectives	Activities
• Demonstrate the effect of forces on position, shape and size.	• Carrying out experiments on effects of forces
• Identify various types of force.	• Carrying out experiments on gravitational force, push and pull, electrostatic force, magnetic force, friction
• State the SI unit of force	
• Identify instruments for measuring force.	• Measuring force using a spring balance or force meter

A force is a push or a pull. You learnt about different types of forces in earlier grades in *Junior Science and Technology*. In Grade 3 and Grade 6, you learnt about magnets, magnetic force and uses of magnets. In Grade 5, you learnt about frictional force and how it can be overcome. In Grade 7, you discussed gravitational force or gravity. In this topic, you will extend your knowledge of forces and do activities to show the effects of different forces.

Effects, types and measurement of forces

For a force to exist, two objects have to work together or **interact**. Forces always work in pairs. When one object **exerts** a force on another object, the other object pulls or pushes back. The forces between the two objects are always the same size, but the push or pull is in the opposite direction.

Figure 16.1 A force is a push or a pull



The forces between the two objects are equal in size but in opposite directions.

Figure 16.2 Forces always exist in pairs.

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Activity 16.1 Investigation

Show that forces work in pairs Work with a partner

Do an investigation to show that forces work in pairs.

You will need:

a balloon

Method

Follow the instructions.

1. Blow up a balloon and hold the end closed.
2. Hold the balloon up above you and let it go.

Figure 16.3 Forces work in pairs in opposite directions

Observation and results

Write a sentence to describe what happened to the balloon.

Conclusion

Write a conclusion to explain how the balloon shows that forces work in pairs.

Effects of forces

A force cannot be seen but you can see the effects of a force. You saw in Activity 16.1 that as the air inside the balloon escaped, it exerted a pushing force on the balloon. When a force is applied to an object it can:

- change the object's position
- change the object's shape
- change the object's speed
- change the direction in which the object moves.

Change of position

A force can cause a **stationary** object to move and change position. For example, when you place a soccer ball in front of you and kick it, your leg and foot exert a force on the ball and the ball then moves forward.

Figure 16.4 A force can cause a stationary object to move and change position.

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Change of shape

A force can change the shape of a solid object. For example, when you squeeze a cooldrink can, the force exerted on the can by your hand causes the can to change shape.

Figure 16.5 A force can change the shape of an object.

Change in speed

A force can cause the speed of a moving object to change. A force can cause the object to **accelerate** and move faster or it can cause the object to **decelerate** and move slower. For example, when riding a bicycle, the harder and faster you pedal the greater the force and the faster the bicycle goes.

Figure 16.6 A force can change the speed of an object.

Change in direction

A force can cause a moving object to change direction. For example, when a tennis ball approaches a tennis player, the player hits the ball and it changes direction. The tennis racket exerts a force on the ball to change direction.

Figure 16.7 Force can cause a moving object to change direction.

Word help

interact: have an effect on each other
exerted: applied
stationary: not moving
accelerate: speed up
decelerate: slow down

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Activity 16.2

Decide whether each of the following statements is true or false.

1. The speed of the object does not change when a force acts on it.
2. All forces are pushes.
3. When an object speeds up, it accelerates.
4. Forces act in pairs.

In Activity 16.3 you will observe the effects of forces on foam rubber.

Activity 16.3 Investigation

Observe the effect of force on objects Work in a group

Do an investigation to observe the effect of force on objects.

You will need:

- foam rubber or a bath sponge
- springs
- trolleys
- rubber bands

Method

Follow the instructions.

1. Take the foam rubber or bath sponge and exert pull, push and twisting forces on it. Observe what happens to the shape and size of the foam rubber or bath sponge.
2. Take the spring and push it in (compress it). Observe what happens to the shape and size of the spring.
3. Take two trolleys and place them end-to-end. Release the springs. Observe what happens to the trolleys.
4. Take a rubber band and stretch it by pulling. Observe what happens to the rubber band.

Observations and results

Record your observations in a table like this.

Object	Force exerted	Effect of force
Foam rubber or bath sponge	Pull	
Foam rubber or bath sponge	Push	
Foam rubber or bath sponge	Twist/bend	
Spring	Push	
Spring	Pull	
Trolleys	Push	
Rubber band	Push	
Rubber band	Pull	

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Conclusion
Write a conclusion for the experiment to state what happens to objects when they have different forces applied to them.
Search the Internet for information on the effects of forces on objects.

Types of forces

There are two main types of forces. These are called **contact** and **non-contact** forces.

Contact forces

A contact force is a type of force in which two objects exert a force on each other by touching. They are in direct contact with each other.

Examples of contact forces include mechanical force and friction.

Mechanical force

A **mechanical force** can be a push or a pull that is applied directly to an object. For example, look at Figure 16.8, which shows a man pushing a wheelbarrow. He is applying a pushing force to the wheelbarrow to move it forward. The man can apply a pulling force to the wheelbarrow by moving backwards and pulling the wheelbarrow.

Figure 16.8 A man applies a mechanical force to move the wheelbarrow.

Friction

You learnt about friction and its effects in Grade 5. You discussed friction between the tyres and the road surface. You also found out about ways to manage friction.

Frictional forces occur between two objects that are moving against one another. Friction is the resistance that an object **encounters** when moving over a surface. Friction always happens in the opposite direction of movement. Frictional force slows down a moving object or causes it to stop.

Word help

contact forces: forces between objects that are touching each other
non-contact forces: forces between objects that are not touching each other
mechanical force: a push or a pull
encounters: experiences

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For example, when a man pushes a wheelbarrow across a surface, there is friction between the wheelbarrow's wheel and the ground. There is also friction between the man's feet and the ground. (See Figure 16.9.)

Figure 16.9 Friction occurs when a wheelbarrow is pushed.

Friction is the result of two rough surfaces coming into contact and moving in opposite directions. All objects have bumps and ridges on their surfaces that make them rough and cause friction. You get less friction on smoother objects.

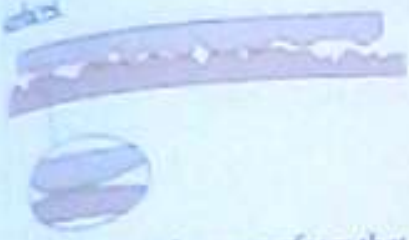

Figure 16.10 The ridges on surfaces that are in contact and move in opposite directions cause friction.

Indigenous knowledge

The first people to ever make fire did so by rubbing sticks together. The friction between the sticks created enough heat to start a fire.

Activity 16.4

Answer the questions.

1. Contact forces are forces between two objects that are in contact with one another.
   a) Name two contact forces.
   b) Describe one example of each type of contact force.
2. Define the term 'friction'.
3. Explain why rough surfaces produce more friction than smooth surfaces.

In the next activity you will investigate how different surfaces affect friction.

Activity 16.5 Experiment

Investigate how the type of surface affects friction Work in a group

Do an experiment to investigate what effect different surfaces have on friction.

You need:

- a shoe
- corrugated cardboard
- smooth cardboard

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- aluminium foil
- elastic band
- ruler

Method

Follow the instructions

1. Cut the elastic band in half and tie it to a shoe.
2. Pull the elastic band until the shoe just starts to move. See the Figure 16.11.
3. Use a ruler to measure how far the elastic band had to stretch before the shoe moved.
4. Tape some aluminium foil to the surface on which you are working. Pull the shoe using the elastic band and measure it again.
5. Repeat these steps for the corrugated cardboard and the smooth cardboard.
6. Record the results in a table.

Figure 16.11 Experiment to investigate which surface causes the most friction

Observations and results

1. On which surface did the elastic band stretch the most before the shoe moved?
2. On which surface did the elastic band stretch the least before the shoe moved?
3. On which surface is there the greatest friction?

Questions

1. Suggest two other materials you could use to test how much friction is produced.
2. Think back to earlier grades about overcoming friction. Suggest one way in which you could change the experiment to investigate ways to reduce friction.
3. Suggest how you could change the investigation to find out which types of shoes had the most friction on a surface.

Conclusion

Write a conclusion for the experiment.

Non-contact forces

Non-contact forces are types of forces where the two objects exert a force on each other without being in direct contact with each other. The effect of the force can be observed. Non-contact forces can be a pull or a push.

Examples of non-contact forces include gravitational force, magnetic force and electrostatic force.

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Gravitational force

Gravity is the reason why objects fall to the ground. You learnt about **gravitational force** in Grade 7. Gravitational force is a non-contact pulling force that the Earth exerts on any object that has mass. The force is exerted towards the centre of the Earth. All objects have a gravitational force, no matter how small they are. The more massive an object is, the larger its gravitational force will be. The closer the objects are to each other, the greater the gravitational force will be.

When you hold a ball and let it go, it falls directly downwards. The object is pulled towards the centre of the Earth even though the object and Earth are not in direct contact with each other.

All objects have a force that attracts them towards other single objects. Even you attract other objects. However, because you have a small mass, the force is not strong. For example, there is a pulling force between two people sitting next to one another. The reason why they do not move towards each other is because the pull of gravitational force is greater than the pulling force between the two people.

There is also gravitational force between the planets in space that **orbit** the Sun. A gravitational force exists between the Earth and the Moon and between the Earth and the Sun. Planets in the Solar System are held in their orbits by the gravitational force of the Sun. Each planet also has its own gravitational force.

Word help

gravity: a downward force towards the centre of the Earth
gravitational force: the force of gravity
orbit: path around something

Something interesting

Sir Isaac Newton was born in 1643 and was famous for his work on gravity. He was inspired to develop his theory of gravity after watching apples fall from trees.

Figure 16.12 Gravitational force pulls objects towards the centre of the Earth and pulls two objects together.

Figure 16.13 Planets in the Solar System are held in their orbits by gravitational forces.

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Weight

The **weight** of an object is the gravitational pull between the Earth and the object. The SI unit for weight is the **newton**. The measuring instrument for finding the weight of an object is a spring balance or force meter. You will learn more about this later in this topic.

Mass refers to the amount of matter in an object and is measured in kilograms. The measuring instrument for finding the mass of an object is a balance scale. The greater the mass of the object, the greater its weight will be. An object that has a mass of 1 kg will have a weight of approximately 10 N.

Word help

weight: a force between an object and the Earth
newton: the SI unit for weight
mass: the amount of matter in an object

In the next activity, you will show that the force of gravity is the same no matter what the mass of an object.

Activity 16.6 Investigation

Investigate gravitational force Work with a partner

Do an experiment to investigate gravitational force.

You will need:

- balls of varying mass

Method

Follow the instructions.

1. Hold two balls of different mass at the same height above the ground.
2. Let them go at exactly the same time.
3. Observe the balls hitting the ground.

Figure 16.14 When dropping objects of different mass, they reach the ground at the same time.

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Observations and results

Write a sentence to describe what happened when the balls hit the ground.

Conclusion

You should have seen that the balls hit the ground at the same time. This occurs because the **acceleration** due to the force of gravity is the same no matter what the mass of an object. You will learn about acceleration in Form 3.

Magnetic force

Magnetic force is a non-contact force that is exerted between two magnetic objects. You discussed magnets and magnetic fields in Grades 5 and 6.

Something interesting

The magnetic force has been known to mankind for over 2 000 years and was first harnessed by the Han Dynasty of China in ancient compasses known as 'lodestones'.

Magnets can be any shape, but they all have the same properties. Examples of magnetic materials are iron, cobalt and nickel.

The region around a magnet where the magnetic force can be detected is called a **magnetic field**. If a magnetic object is placed in a magnet's magnetic field it will experience a magnetic force and be attracted to the magnet. The magnet and the object do not have to touch for the magnetic force to be exerted.

Figure 16.15 The magnetic field around a bar magnet

Magnets have two poles, a north pole (N) and a south pole (S). When two north poles or two south poles are brought close together they repel each other. This is a pushing force and the magnets move apart. Like poles repel each other.

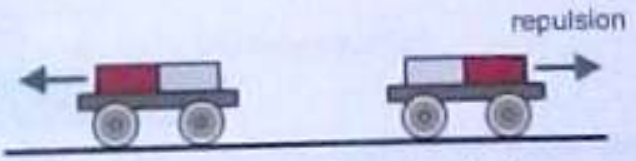

Figure 16.16 Two like poles repel each other

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When a north pole and a south pole are brought close together they attract each other. This is a pulling force and the magnets move closer together. Opposite poles attract.

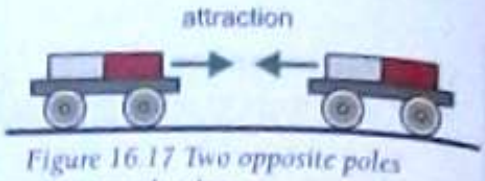

Figure 16.17 Two opposite poles attract each other.

Activity 16.7 Experiment

Investigating magnetic force Work in a group

Do an experiment to investigate magnetic force.

You will need:

- two bar magnets
- iron filings
- metal objects such as iron nails, brass belt buckles aluminium foil, chrome objects, nickel coins
- non-metals such as plastic, paper, wood and glass
- sheet of paper
- iron filings

Method

Follow the instructions.

1. Determine which metals and non-metals are attracted by the bar magnet. Copy and complete a table such as the one below.

Magnetic materials	Non-magnetic materials

2. Take one of the non-magnetic materials and place it between the bar magnet and one of the magnetic materials (See Figure 16.18.) Observe whether or not the magnet still attracts the magnetic object.

Figure 16.18 Place a non-magnetic object between a magnet and a magnetic object.

3. Take a sheet of paper and hold the bar magnet directly below the paper. Sprinkle iron filings lightly on the paper. Observe how the iron filings arrange themselves in a pattern around the two poles of the magnet. This pattern shows the shape and strength of the magnet's magnetic field. The magnetic field is the strongest near the magnet's poles.

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4. Hold the two magnets with their north poles facing each other. Feel the direction of the force between them. Is it an attracting or a repelling force?
5. Hold the two magnets with the south pole of one magnet facing the north pole of the other and feel the direction of the force between them. Is it a repelling or an attracting force?
6. Place the two magnets directly under the paper with iron filings on it and repeat steps 4 and 5. Observe the patterns formed when
   a) the same two poles (north–north or south–south) face each other
   b) two different poles (north–south) face each other.

Conclusion

Write a conclusion

- about the magnetic force when a non-magnetic object is placed between a magnet and a magnetic object
- about the attracting and repelling force of magnets.

Questions

Answer the questions.

1. Which materials were magnetic?
2. Does a non-magnetic object stop the effect of a magnetic field? Does this show that magnetism is a contact force or non-contact force?
3. Is there a difference in the magnetic field pattern as shown by the iron filings when two like poles face each other and when two different poles face each other?
4. Where is the magnetic field of a magnet the strongest?

Word help

acceleration: an object's capacity to gain speed
magnetic force: the force exerted on a magnetic object
magnetic field: the area around a magnet where a magnetic force is exerted
repel: push away

Electrostatic force

Electrostatic force is a non-contact force that exists between two electrically **charged** particles. There are two types of charge: a negative charge indicated by a minus sign (–) and a positive charge indicated by a plus sign (+). The electrostatic force can be either a push force or a pull force, depending on whether the charges are the same or opposite. Two objects that have the same charge, either both positive or both negative, push each other apart or repel each other. Two objects with

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different charges, one positive and one negative, will pull each other together. This push or pull occurs as a result of electrostatic forces between the charges. The objects do not need to be in contact with each other for the push or pull to occur.

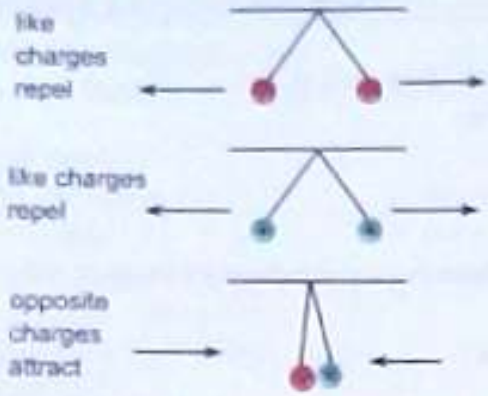

Figure 16.19 Unlike charges attract and like charges repel.

Something interesting

Lightning occurs when small ice particles in the air bump into each other and become electrically charged. Positively charged particles move to the top of a cloud and negatively charged particles move downwards. Since opposite charges attract, the negative charges try to connect with the positive charges, and a burst of electricity occurs, which is seen as lightning.

Objects are usually electrically **neutral**. They have no charge. Sometimes objects can become electrically charged when they rub against each other. In Grade 6 you learnt about the structure of an atom. An atom is made up of a central nucleus that consists of neutrons (neutral) and protons (positively charged). Surrounding the positively charged nucleus are electrons (negatively charged). Therefore all objects contain positive charges (protons) and negative charges (electrons). If the object contains equal numbers of positive and negative charges, it is neutral. If the object loses electrons it then contains more positive charges than negative charges and is positively charged. If the object gains electrons it then contains more negative charges than positive charges and is negatively charged.

When objects rub against each other, electrons (negative charge) can move from the one object to the other. As a result, their charge changes and they will push or pull each other because of electrostatic forces. One object becomes more positively charged and one object becomes more negatively charged. For example, if you rub a balloon with a wool cloth, the balloon gives some charges to the wool cloth. The balloon and cloth will have different charges. When they are held near each other, they will attract each other. If two balloons that have both been rubbed with the wool cloth are held next to each other, they will move apart or repel each other. This happens because both balloons have the same charge.

Word help

electrostatic force: a force that occurs between charged particles
charged: an electrical property of matter; either positive or negative
neutral: having no charge

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...ity 16.8 Experiment

...estigating electrostatic force Work in a group

...n experiment to investigate electrostatic force.

...u will need:

- ... strip of Perspex
- ...astic ruler
- ...ool cloth or silk cloth, if available
- ...lass rod
- inflated balloons
- plastic bags
- pieces of paper

...thod

...low the instructions.

...ub the plastic ruler with the wool cloth.

...ar the paper into small pieces.

...ring the ruler near the pieces of paper. Observe what happens.

...en bring the Perspex strip near the pieces of paper. Observe what happens.

...ach the Perspex strip to a piece of string so that it hangs horizontally. (See Figure ...20.) Rub it with the wool cloth to make sure that it is charged.

...ub the plastic ruler with the wool cloth and bring the ruler near the Perspex strip. ...serve what happens.

...ub the glass rod with the wool cloth and bring it near the hanging Perspex strip. Observe ...at happens.

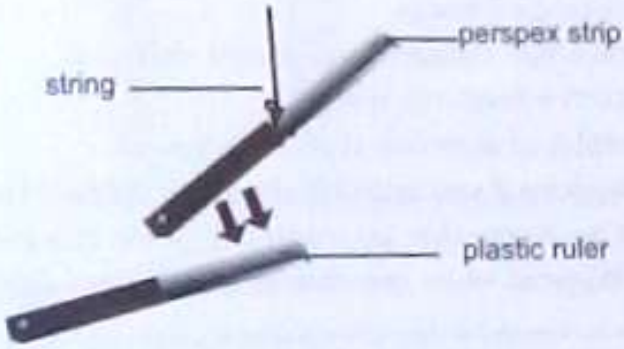

Figure 16.20 Unlike charges attract

...servations and conclusion

1. What happened to the pieces of paper when they were held next to:
   a) the plastic ruler?
   b) the Perspex strip?
2. What happened to the plastic ruler and Perspex strip when they were held close to each ...other?
3. What happened to the glass rod when it was held next to the Perspex strip?

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Questions

Answer the questions.

1. When the plastic ruler was rubbed with the wool cloth, did its charge change? Explain your answer.
2. The charged plastic ruler and Perspex strip picked up the pieces of paper when you brought them close to the paper.
   a) Is electrostatic force dependent on the distance that one charged object is from another charged object?
   b) Since both the Perspex strip and the plastic ruler were able to pick up the bits of paper, what was the original charge on the paper?
3. Draw two diagrams similar to Figure 16.20 to show
   a) What happens between the plastic ruler and the pieces of paper after the ruler has been rubbed with the wool cloth and is held next to the paper.
   b) What happens to the Perspex strip and the glass rod after they have been rubbed with the wool cloth and are held next to each other.

Activity 16.9

Answer the questions.

1. Non-contact forces are forces that exert an effect on objects without touching them.
   a) Name three non-contact forces.
   b) Describe how each non-contact force can be observed.
2. Magnetic objects exert a magnetic force.
   a) Give three examples of materials that are magnetic.
   b) Explain what happens if you position the south poles of two magnets next to each other.
3. Electrostatic forces are forces that are exerted between charged objects.
   a) Describe what happens when two objects with different charges are placed next to each other.
   b) Look at Figure 16.21. Using scientific terms, explain how the paper became stuck to the plastic comb.

Figure 16.21

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Measurement of force

Force is a physical quantity that can be measured. You learnt about this earlier in Topic 16 Force, when you discussed the SI unit for weight.
The SI unit of force is the newton. The symbol is N. The SI unit for force is a derived SI unit.

Instruments for measuring force

Forces can be measured using a **force meter**. A force meter is made of a spring with a hook attached to it. The larger the force applied, the longer the spring stretches and the greater the reading. The scale of a force meter is in newtons.

Word help

force meter: an instrument used for measuring weight
spring balance: an instrument used for measuring mass, which can then be converted to weight

A **spring balance** is a type of force meter. It measures how much a spring stretches when an object is hung from it. This is the object's mass. The scale on a spring balance measures the mass in grams or kilograms. The mass reading on a spring balance can be converted to weight by multiplying the mass by the force of gravity (about 10 N per kg). Weight is measured in newtons.
Figure 16.22 shows a force meter and a spring balance.

Figure 16.22a) Force meter and b) a spring balance

Activity 16.10 Experiment

Measuring forces using a force meter Work in a group

Do an experiment to measure force using a force meter.

You will need:

- a force meter
- five 100 g masses
- string

Method

Follow the instructions.

1. Hang the force meter vertically.
2. Tie a mass to the force meter.

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3. Measure the force.
4. Add the second mass to the force meter.
5. Measure the force.
6. Repeat steps 4–5 for the 3rd, 4th and 5th mass.

Observations and results

Record your results in a table like the one below.

Mass (g)	Force reading (N)
0 g	
100 g	
200 g	
300 g	
400 g	
500 g	

Conclusion

Write a conclusion for this experiment to describe how different masses on the force meter exerted different forces.

Questions

1. Explain the relationship between mass, weight and force.
2. Predict the result if you placed an 800 g mass on the force meter.
3. Think back to Topic 15 when you discussed accurate measurements. Describe two things you could do in this experiment to improve the accuracy of your measurements.

Summary

- When a force acts on an object, it can change its position, shape, speed or direction in which the object moves.
- Forces are pushes or pulls, and when they are exerted between objects, they work in pairs in the opposite direction.
- Force is measured using a force meter.
- A contact force is a force exerted between two objects that are touching each other. Examples are mechanical force and friction.
  - A mechanical force is exerted directly on an object.
  - Friction occurs when two objects move against each other in opposite directions.
- Non-contact forces include gravitational, magnetic and electrostatic force.
  - Gravitational force is the force exerted towards the centre of the Earth on any object that has

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mass. Weight is a physical quantity of an object. It shows the gravitational force between the Earth and an object, and is measured in newtons (N), whereas mass is the amount of matter in an object and is measured in kilograms (kg).

- Magnetic force is exerted between two magnetic objects and it can be detected in a magnetic field around the objects. Magnets have a north and south pole. Like poles repel each other, whereas unlike poles attract each other.
- Electrostatic force exists between charged particles. Objects with the same charge (both positive or both negative) will repel each other, while objects with different charges will attract each other.

Topic assessment

Answer the questions.

1. Classify the following as contact forces or non-contact forces. Use a table for your answers.
   a) A motorbike's rubber tyres on a road
   b) Two metal nails attracting each other
   c) A cup falling to the floor
   d) Tug of war
   e) A plastic ruler and paper attracting each other [5]
2. Choose the correct answer.
   a) Forces can be:
      i. pushes only
      ii. pulls only
      iii. pushes or pulls
   b) What is the derived SI unit and symbol for force?
      i. The newton, n
      ii. The newton, N
      iii. The neutron, N
   c) What is the weight of a 30 kg box on the Earth?
      i. 3 N
      ii. 30 N
      iii. 300 N
   d) Which of the following are magnetic poles?
      i. North and south
      ii. East and west
      iii. Red and blue
   e) What do two unlike electrical charges do when they are brought close together?
      i. They attract.
      ii. They repel.
      iii. They make an electric charge. [5 × 2 = 10]

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3. Look at Figure 16.23, which shows two balloons moving apart. Explain how this has occurred. Use the following words in your answer:
charge, positive, negative, attract, opposite charges [5]

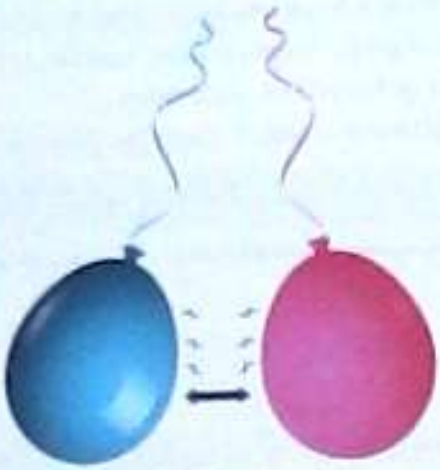

Figure 16.23 Electrostatic force

[Total marks: 20]

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Topic 17 Energy

Learning objectives	Activities
• Describe effects of energy	• Demonstrating the effects of energy: burning fuels, bouncing a ball, making objects move, compressing a spring
• Identify different forms of energy	• Running up stairs, lighting a torch, clapping hands, raising a brick
• List forms of potential energy	• Carrying out experiments to show potential energy
• Identify energy conversions	• Lighting a torch Using a dynamo to light a bulb Using a catapult and solar panel
• Construct energy chains. • Identify energy convertors	• Discussing various energy conversions

You learnt about different aspects of energy in earlier grades. In Grade 3, you found out that different fuels can supply energy. In Grade 4, you extended your knowledge by describing different forms of energy such as heat, light, sound, kinetic (movement) and potential energy. In Grade 6, you discovered that electrical energy could be made in different ways, for example by wind, water and the Sun.

In this topic, you will consider energy in more depth. You will do some practical activities to show the effects of energy, as well as how energy can be changed from one form to another.

Effects and forms of energy

It is difficult to define what energy is, but it is easy to see what it does. Although we cannot see energy, we can observe the effects of energy in the world around us. You learnt about different forms of energy such as kinetic or movement energy, potential, light, heat, electrical and sound energy.

The effects of energy

The effects of energy are the things we see as a result of energy. For example, a car is a **system** that consists of different parts that use energy. The parts of the car move and the whole car moves because of fuel. The engine gets hot and the lights can be switched on. These are all examples of the effects of energy.

We can see, feel and hear the effects of energy.

- Light is a type of energy we can see.
- Heat is a type of energy we can feel.
- Sound is a type of energy we can hear.
- Movement is a type of energy we can see when objects move.

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Forms of energy

Energy is the ability to do work. There are different forms of energy.

Kinetic energy

Kinetic energy is the energy that an object has when it is moving. All moving objects have kinetic energy. Kinetic energy is also called movement energy. For example, when you kick or bounce a ball, you use energy to move the ball. The moving ball has kinetic energy. A car uses fuel so that it can move and it has kinetic energy.

Figure 17.1 The moving soccer ball has kinetic energy.

Potential energy

Potential energy is stored energy that can be released to do work. There are different types of potential energy. These are gravitational potential energy, elastic potential energy and chemical potential energy.

Gravitational potential energy

When you hold a ball above the surface of the Earth, it has gravitational potential energy. If you let the ball go, it is pulled towards the Earth by the force of gravity. You learnt about gravity in Topic 16 Force. The higher you lift the ball, the more gravitational potential energy it has.

Figure 17.2 A ball held above the Earth has gravitational potential energy.

Elastic potential energy

An object that is elastic is something that returns to its original form after it has been stretched or squeezed out of shape. Potential energy is stored in an elastic object when it is squeezed or squashed. The more an object is stretched or squeezed, the greater its elastic potential energy.

Figure 17.3 A stretched catapult has elastic potential energy.

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Chemical potential energy

Fuels such as petrol and diesel have chemical potential energy. When fuels are burnt they release energy. A battery that is used to power cell phones or light torches has chemical potential energy. Food also has chemical potential energy. The energy in food is released inside our bodies so that cells can do work. You learnt about food energy in Topic 3 Nutrition.

Figure 17.4 Food contains chemical potential energy.

Light energy

Light is energy that we can see. The main source of **natural** light energy is the Sun. Light energy is important for green plants to make food by photosynthesis. All organisms on Earth depend on food made by photosynthesis. We can make **artificial** light using candles, paraffin lamps and electric light bulbs.

Word help

system: a collection of connected parts that work together
kinetic energy: energy that causes movement
natural: from nature; not made by humans
artificial: made by humans

Something interesting

Temperature is measured in ° Celsius. Heat energy is measured in joules (J).

Heat energy

Heat energy is energy that passes from a hot object to a cooler one. The greater the heat energy of a substance is, the higher its temperature. Heat energy is energy we can feel. For example, when we touch an object we can feel if it is hot or cold. The main sources of heat energy are the Sun and burning fuels.

Figure 17.5 The Sun is the main source of light and heat energy on Earth.

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Electrical energy

In earlier grades, you found out about electricity. You discussed the flow of electric current and made electric circuits. Electrical energy is made when electrons move through **conductors**. A conductor is a material, such as copper wire, through which electrical energy can move. Electrical energy is a useful form of energy as it can be changed into many other forms. You will learn about how energy changes from one form to another later in this topic.

Figure 17.6 Lightning is a form of electrical energy.

Sound energy

Sound energy is energy that is produced when an object or substance **vibrates**. Sound energy moves through materials like air as **sound waves**. The louder the sound is, the greater the vibration. We can detect sound waves using our ears. Musical instruments make sound waves when part of them, or the air inside them, vibrates.

Figure 17.7 Musical instruments such as the mbira make sound energy.

Word help

conductor: a material that transmits electricity
vibrate: to quickly move backwards and forwards
sound waves: the way sound travels

In the next activity, your teacher will show you the effects of different types of energy.

Activity 17.1 Demonstration

Demonstrating the effects of energy Work as a class

Your teacher will demonstrate the effects of energy.

You will need:

- a candle
- a ball
- a spring
- a catapult
- a piece of magnesium ribbon
- a candle
- matches or a lighter

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Method

Follow the instructions.

Your teacher will show you the different effects of energy using the apparatus above.

Observations and discussion

Watch carefully and record your observations in a table like the one below.

Apparatus	Form of energy	What happened
candle	light and heat	When the candle was lit, it produced light and heat energy

Activity 17.2

Answer the questions.

1. There are various forms of energy.
   a) Write one sentence to explain what energy is.
   b) Name six different forms of energy.
2. Heat energy and temperature are different.
   a) Explain how they are different.
   b) What measurement unit is used for:
      i. temperature?
      ii. heat energy?
3. Potential energy is stored energy.
   a) Name three types of potential energy.
   b) Give an example of each type of potential energy.

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Sources of energy

Energy is stored in sources of energy. A source of energy can supply the energy that we can use to do work. A system is necessary to convert the energy from the source to a more useful type of energy. For example, a solar panel is a system that uses the energy from the Sun to make electricity. The Sun is the source of energy and the solar panel converts the energy from the Sun into electricity that we can use.

There are two main groups of energy sources: **renewable energy sources** and **non-renewable energy sources**. A renewable energy source is a source such as wind energy that can be replaced or reused. We will be able to use renewable energy sources for a long time. A non-renewable energy source is one that cannot be replaced once it has been used up. For example, once all the coal has been mined, there will no longer be any more available to make energy.

Renewable energy sources

Renewable energy sources include hydropower, wind power, solar power and biofuels.

- **Hydropower** – Hydropower is also called hydroelectricity. Water flows from a dam like Kariba Dam into **turbines** that change the kinetic energy of the water into electricity.
- **Wind power** – Kinetic energy from wind is used to turn huge blades. The kinetic energy of the turning blades is used in a turbine to make electricity.

Figure 17.8 Wind turbines use wind energy to make electricity.

- **Solar power** – Light energy from the Sun is trapped by solar panels and converted into electricity.
- **Biofuels** – Crop plants like maize and sugar cane are **fermented** to form alcohol such as ethanol. Ethanol can be used as a fuel in some cars. Wood is also a biofuel that is used by many people in rural areas.

Something interesting

Firewood collection in Zimbabwean towns is a problem. There are electricity shortages in urban areas and so many people collect firewood by cutting down trees. This is causing deforestation and erosion in areas around towns.

Figure 17.9 Solar panels use the energy from the Sun to make electricity.

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to produce heat for cooking. Trees that are cut down for wood need to be replaced to ensure that this source of energy is renewable.

Non-renewable energy sources

- **Fossil fuels** – Fossil fuels include coal, oil and natural gas. They were formed by dead plants and animals that lived millions of years ago. When these organisms died, they were buried under layers of soil and, over a long time, their remains turned into fossil fuels. Fossil fuels like coal are used in power stations to make electricity.
- **Nuclear power** – Nuclear energy comes from splitting the nucleus in the atoms of some elements such uranium. Large amounts of heat energy are released when this happens. This heat energy can be used to drive turbines for electricity generation.

Activity 17.3

Answer the questions.

1. There are two groups of energy sources.
   a) Name these two groups.
   b) Explain the difference between them.
   c) Give an example of an energy source from each group.
2. Suggest an advantage and a disadvantage of using:
   a) fossil fuels
   b) solar power
   c) hydropower.

Energy conversions

You have learnt that energy comes in different forms. Energy can be changed or **converted** from one form to another. These conversions are called **energy transformations**. For example when you switch a kettle on the water gets hot. Electrical energy has been converted to heat energy. All around us energy is being changed from one form to another.

Some examples of energy conversions include:

- Gravitational potential energy of water in Kariba dam is converted to electrical energy as it passes through the turbines in the Kariba dam wall.

Word help

renewable energy sources: energy sources that are continually replaced
non-renewable energy sources: energy sources that are not replaced as they are used up
turbine: a machine that makes power through a wheel that is turned
fermented: breaking down of substances by micro-organisms to produce alcohol
converted: changed
energy transformations: changing energy from one form to another

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- Chemical potential energy in rocket fuel is first converted into kinetic energy and then to gravitational potential energy as the rocket burns its fuel and accelerates into space, moving away from the Earth.
- Wind turbines convert the kinetic energy in the wind to electrical energy.

Energy chains

An energy chain is a diagram that shows energy conversions.

Example:
gravitational potential energy of water behind dam wall → kinetic energy of falling water → kinetic energy of turbines → electrical energy

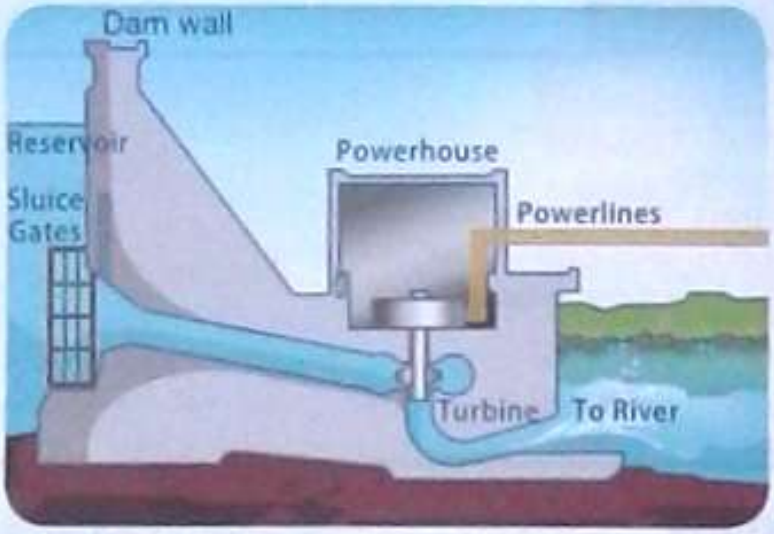

Figure 17.10 Energy is converted at a hydroelectric power station.

Activity 17.4 Investigation

Demonstrating energy transformations Work with a partner

Do an investigation to demonstrate energy transformations.

You will need:
- a brick
- a torch
- a small stone
- a catapult

Method

Follow the instructions.

Part A

1. Go outside and hold a brick above the ground, then drop it.
2. Describe the energy conversion that has taken place.

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Part B

1. Switch on a torch.
2. Describe the energy conversion that has taken place.

Part C

1. Go outside and place a small stone in a catapult.
2. Fire the catapult into an empty area where there are no learners, animals or buildings.
3. Describe the energy conversion that has taken place.

Questions

Draw energy chains to show the three energy conversions that you observed.

Energy converters

An energy converter is a system that converts one form of energy to another. If it is man-made, the energy converter is called a **machine**. Examples of man-made energy converters include electric light bulbs, batteries, generators, dynamos and solar panels. A **dynamo** is a type of generator. Generators use a fuel such as diesel to make electricity. A dynamo consists of coils or wire and magnets. When it is turned, it produces kinetic energy that is changed into electricity. You will use a dynamo in Activity 17.5.

Something interesting

Engineers make energy conversions efficient. They make sure very little energy is wasted. For example, when you use a drill a lot of energy is wasted in the form of heat and sound.

Naturally occurring energy conversion systems also exist. For example, the body converts chemical potential energy in food to kinetic and heat energy in our bodies. Gravitational potential energy in a waterfall is converted to sound and kinetic energy. Plants convert light energy from the Sun into chemical energy during photosynthesis.

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Activity 17.5 Experiment

Demonstrate an energy converter Work with a partner

Do an experiment to demonstrate how an energy converter such as a dynamo works.

You will need:

- a dynamo
- a bulb

Method

Follow the instructions.

1. Your teacher will connect the bulb to the dynamo, if it is not already connected.
2. Turn the dynamo handle, first slowly and then faster.
3. Observe what happens to the bulb.

Figure 17.11 Using a dynamo to light a bulb

Observation and results

1. Describe what happened when you turned the dynamo handle.
2. How did the speed of the turning dynamo affect the brightness of the bulb?

Question

Draw an energy chain to show the energy conversion that took place.

Something interesting

Cyclists sometimes use dynamos on their bicycles. The kinetic energy of the bicycle's turning wheel is used to light a bulb so that the cyclist is visible on the road.

Word help

machine: an instrument that consists of different parts that work together to do a certain job

dynamo: a machine that converts kinetic energy into electrical energy

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Activity 17.6

Figure 17.12 A to E, shows different energy converters. Draw the energy chain that shows the energy conversion in each of the energy converters.

Figure 17.12 Examples of energy converters

Activity 17.7 Assignment

Research solar panels Work with a partner

- Do research using the library and the internet to find information about solar panels.
  - Who first designed them?
  - How are they made?
- Draw an energy chain to show how solar panels convert energy.
- Present your information in the form of a poster.

Summary

- Energy is the ability to do work.
- We cannot see energy but we can see, hear and feel its effects.
- There are different forms of energy:
  - kinetic or movement energy, for example a moving ball
  - potential energy is stored energy that can be released, for example gravitational potential energy, elastic potential energy and chemical potential energy
  - light energy, for example energy from the Sun or from an artificial light
  - heat energy is energy that passes from a hot object to a cooler one
  - electrical energy is made when electrons move through conductors

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- sound energy moves as sound waves and it is produced when an object such as a musical instrument vibrates.

- Renewable energy sources such as hydropower, wind, solar power and biofuels can be replaced or reused.
- Non-renewable energy sources such as fossil fuels and nuclear energy cannot be replaced once they have been used up.
- Energy transformations refer to energy changing from one form to another and they can be demonstrated with energy chain diagrams.
- Machines such as light bulbs, dynamos and batteries are energy converters.

Topic assessment

Answer the questions.

1. Copy the sentences and fill in the missing words.
   a) Energy enables an object to do _____.
   b) Potential energy is energy that is _____ in an object.
   c) Kinetic energy is energy of _____.
   d) When a ball is held above the ground it has _____.
   e) When a catapult is pulled back it has _____.
   f) The main source of light and heat energy on Earth is _____. [6]
2. How can you detect the effects of the following types of energy?
   a) Heat energy
   b) Kinetic energy
   c) Sound energy [3]
3. Copy and complete the table. [7]

Form of energy	Example
Sound energy	Given off by vibrating objects such as a guitar string
Chemical potential energy	
	Given off by hot objects
	Stretched rubber band
Light energy	
	Carried by an electric current

4. Draw an energy chain for each of the following energy conversions:
   a) A generator using fuel to make energy.

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g) A dynamo lighting a bulb.
h) A bow hitting a cricket ball.
i) A torch.

[8]

Energy converters are systems or machines that change energy from one form to another.

a) Name two energy converters, one man-made and one natural. [2]

b) For each converter you have named, explain how it changes energy from one form to another. [4]

[Total marks: 30]

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Topic 18 Magnetism

Learning objectives	Activities
• Distinguish magnetic material from non-magnetic materials. • Identify the poles of a magnet. • The Earth as a magnet.	• Using magnets to identify magnetic and non-magnetic materials • Suspending a bar magnet to determine polarity • Using a compass

You have encountered magnetism in your day-to-day life, as well as in *Junior Science and Technology*. In Grades 3 and 6, you explored magnets and their properties. You identified magnets as a source of magnetic force and you explored magnetic fields. In Topic 16 Force, you classified magnetic force as a non-contact force that acts between a magnet and a magnetic object.

You learnt that magnets have two poles called the north pole and south pole. In Grade 6, you demonstrated the forces of attraction and repulsion as pull and push forces between like and unlike poles. In this topic, you will consolidate your knowledge of magnets and consider some ways to use magnets.

Magnetism and magnets

Magnetism refers to magnetic force caused by the unique properties of certain materials. Magnets are usually made of metal iron, or another material that has lots of iron in it, for example steel. Magnetic force is a non-contact force that acts at a distance. The magnet does not need to touch an object for a force to be exerted. In Topic 16 Force, you learnt about magnetic force. Magnets can attract some objects. Objects that are attracted by magnets are called **magnetic**. Objects that are not attracted by magnets are called **non-magnetic**.

Magnets have two poles: a north and a south pole. Magnetism is concentrated around the poles (ends) of a magnet. The magnetic force is focused at the poles and lessens at the sides.

There are different types of magnets that are named according to their shape or use.

Types of magnets

Magnets come in different shapes and sizes depending on the use of the magnet in a specific device. Types of magnets include bar magnets, horseshoe magnets, C-magnets and E-magnets or electromagnets.

Bar magnets

Bar magnets consist of a straight bar of magnetic material, with one end containing the north pole

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...the other end containing the south pole. The ...ow of a bar magnet results in a weak magnetic ...ld. The magnetic force is weak on the sides ...and is concentrated at the ends of the bar magnet. ...e ends of the bar magnet are only a small area ...mpared to the size of the magnet.

...gnets are used in refrigerator doors, in ...ompasses and in science laboratories.

Figure 18.1 A bar magnet

...eshoe magnets

...eshoe magnets are bar magnets that are bent in a U shape. In a horseshoe magnet, ...th the north pole and south pole point in the same direction. This results in a strong ...netic force that is stronger around both poles. A magnetic object will experience ...gnetic force of both the poles instead of only one pole (as with a bar magnet).

Figure 18.2 A horseshoe magnet

...eshoe magnets can be used for lifting any metal object, depending ...the size and strength of the horseshoe magnet. Large horseshoe ...gnets are used in construction and engineering where large, heavy metal ...cts need to be lifted and moved.

...magnets

...gnets are shaped like the letter C, in an arc. There are two kinds of ...gnets: the north and south pole can either be on the inside or outside ...the magnet (Figure 18.3).

...gnets are used to create a magnetic force in a motor. C-magnets are used ...ices such as washing machines, fridges, cars, air conditioners, speakers ...generators.

Figure 18.3 C-magnets are used in motors.

...rd help

...gnetism: a physical property of some materials that allows them to exert magnetic forces
...gnetic: capable of being attracted by a magnet
...-magnetic: incapable of being attracted by a magnet

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Word help

electromagnet: a metal core that is made into a magnet when an electric current passes through a coil that surrounds it
temporary: lasting for a short time
permanent: continuous or remaining unchanged

Electromagnets are used in factories and in metal scrap yards to lift large, heavy iron and steel objects.

Figure 18.4 Cranes use electromagnets to lift and drop scrap metal.

E-magnets

An E-magnet or **electromagnet** is a type of magnet in which the magnetic field is caused by an electric current. Electromagnets consist of a coil of wire wound around a soft iron core. The wire is connected to a power source. When an electric current flows through the wire, it causes a magnetic field that magnetises the iron core. When the electric current in the wire does not flow, the magnet loses it magnetic properties. Electromagnets are referred to as **temporary** magnets, because the magnetism can be switched on and off. Bar and horseshoe magnets are **permanent** magnets, they are magnetic all the time.

A simple electromagnet can be made by winding copper wire around an iron nail. The wires are connected to a battery. When the electric current passes through the wire, the magnetic field around the nail causes it to become magnetised.

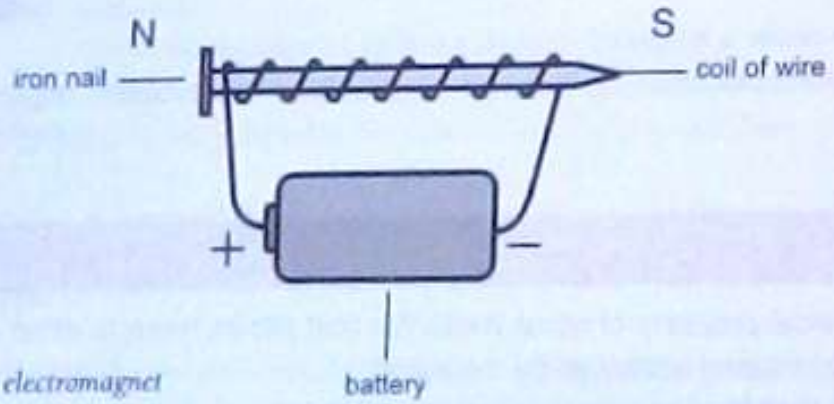

Figure 18.5 A simple electromagnet

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Magnetic and non-magnetic materials

Materials can be classified into two groups depending on their magnetic properties. If a material experiences a magnetic force when it is brought near a magnet, then it is a magnetic material. If a material does not experience a magnetic force when it is brought near a magnet, then it is a non-magnetic material. We investigated magnetic and non-magnetic materials in Grade 6. Magnetism is a physical property of a material.

All magnetic materials are metals, but not all metals are magnetic. Metals that are naturally magnetic are iron, nickel and cobalt. Any metal that contains iron, nickel and cobalt is magnetic.

Most materials such as plastic, glass and certain metals such as aluminium are not magnetic because they do not experience a force in a magnetic field.

Something interesting

Data (information) is mostly stored on magnetic storage devices. Some examples of magnetic storage devices are hard disk drives in a computer and the magnetic strips on the backs of bank cards. Magnetic storage devices use a medium coated with a material that can be magnetised. Different patterns of magnetisation in the magnetisable material store the data. The information is accessed using read/write heads.

The magnetic field around these magnetic storage devices is very weak and you will not be able to detect it with another magnet. However, if you bring a strong magnet close to a magnetic storage device you will demagnetise the device and lose all the data stored on it.

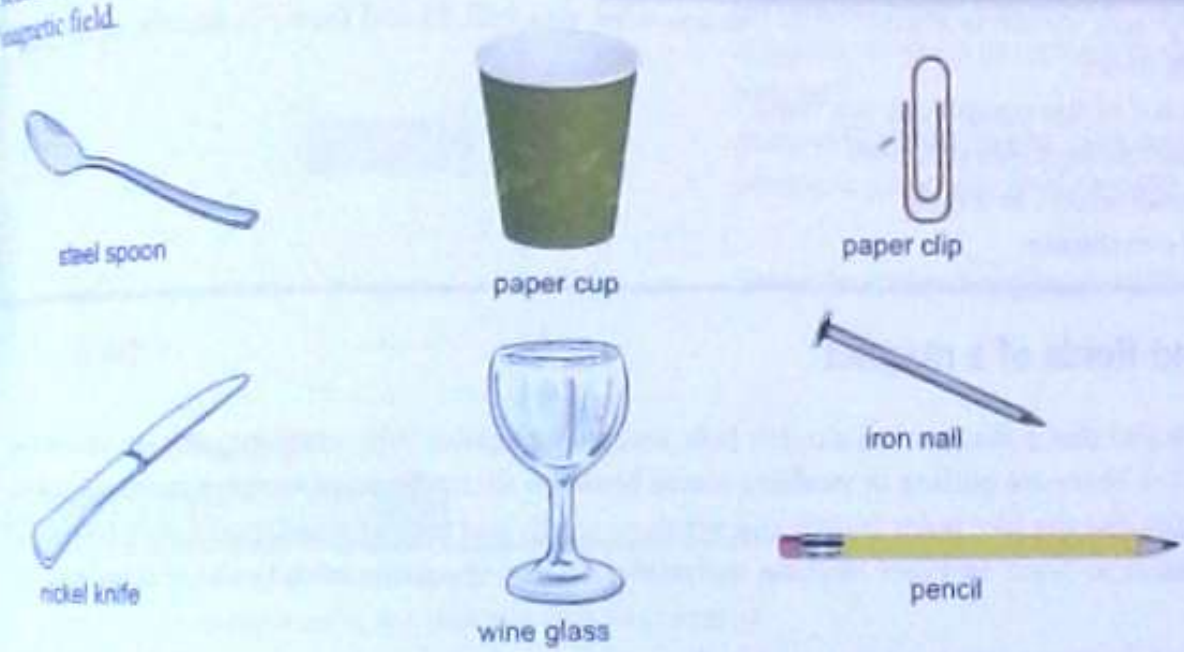

Figure 18.6 Examples of magnetic and non-magnetic material

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Activity 18.1 Assignment

Design an experiment to test if objects are magnetic or non-magnetic Work in a group

Design an experiment to determine if various objects are magnetic or non-magnetic materials.

Figure 18.7 Equipment needed to design the experiment

1. Work out how to test whether objects are magnetic or non-magnetic. You will need the equipment shown in Figure 18.7. Discuss what you will do and then conduct the experiment.
2. Write down
   - a list of the equipment you used
   - the method that you used
   - your results in a table
   - a conclusion

Poles and fields of a magnet

You have learnt that a magnet has a north pole and a south pole. When two magnets are placed close to each other, there are pulling or pushing forces between them. The unlike poles (north and south) attract (pull) and the like poles (north and north or south and south) repel (push) each other. You did an experiment in Topic 16 Force to show the attraction and repulsion of the poles of a magnet.

Surrounding every magnet is an area in which a magnetic object would experience a force. This is called the **magnetic field**. The magnetic field is the region around a magnet where the magnetic force can be detected. You cannot see the magnetic field around a magnet, but you can make it visible by using iron filings. When you place a sheet of paper over a magnet and sprinkle a thin layer of iron

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...ings on the paper, the iron filings form a pattern. The iron filings will line up along the **magnetic field lines**. You observed the magnetic field lines in an experiment in Topic 16 Force.

Figure 18.8 The magnetic field lines of a) a bar magnet and b) a horseshoe magnet

Magnetic field lines show the direction and strength of the magnetic field around a magnet. Outside the magnet the direction of the magnetic field lines is always from the north pole to the south pole. Inside the magnet the direction of the magnetic field lines is always from the south pole to the north pole. The magnetic force is the strongest at the poles (ends) of a bar magnet where the field lines are the most concentrated.

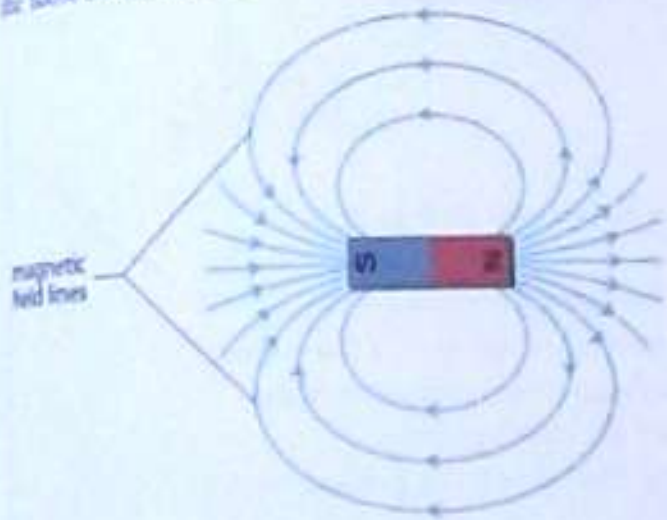

Figure 18.9 The magnetic field lines of a bar magnet

Word help

magnetic field: the area around a magnet where a magnetic force is exerted

magnetic field lines: invisible lines where a magnetic force exists

Activity 18.2 Assignment

Determining polarity of a bar magnet Work in groups

Do an experiment to determine the polarity of a bar magnet.

You will need:

- one bar magnet marked with north and south poles
- one bar magnet with the poles taped over
- a piece of string
- a retort stand
- a compass

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Method

Follow the instructions

Part A: Determining the polarity of a bar magnet by using another magnet

1. Take one bar magnet and tape it over so that the poles are not visible. Mark the ends A and B.
2. Tie one end of the string to the bar magnet with the poles taped over. Tie the other end of the string to a retort stand so that the magnet hangs freely.
3. Leave the poles of the second magnet visible.
4. Bring one pole of the second magnet close to the hanging magnet. Observe what happens.
5. Turn the second magnet so that the poles face the opposite way. Hold it close to the hanging magnet. Observe what happens.
6. Record which ends you think are the north and the south poles.

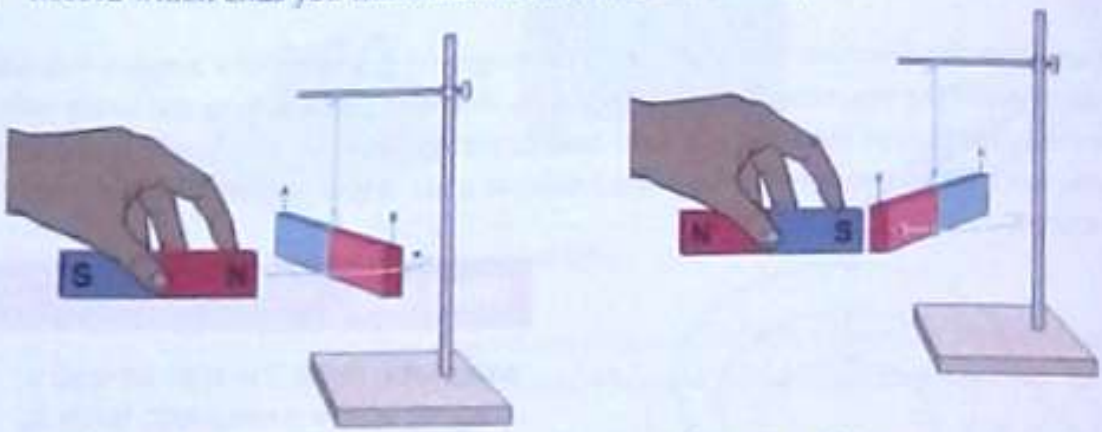

Figure 18.10 Holding two bar magnets close to each other to determine polarity

Part B: Determining the polarity of a bar magnet by using a compass

1. Place the magnet with the poles covered and marked A and B on a flat surface.
2. Place the compass alongside the bar magnet. Observe the compass reading.
3. Record which ends you think are the north and the south poles.
4. Uncover the poles of the magnet. Decide if you determined the poles correctly.

Figure 18.11 Holding a compass close to a bar magnet to determine polarity

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Observations and results

1. Describe what you observed when the marked bar magnet was brought close to the hanging, covered magnet.
2. Describe what you observed about the direction the compass showed.
3. Determine which pole is which for the magnet with the covered poles.
4. Did you determine the correct polarity for the covered magnet?

Conclusion

Write a conclusion for the experiment.

Questions

1. Explain what causes the magnets to behave in different ways.
2. How do you know there is a force present even though it cannot be seen?

Earth as a magnet

The Earth has a molten core consisting of iron and nickel. This molten core gives the Earth its magnetic properties and actually turns the Earth into a giant bar magnet.

Just like a magnet, the Earth has opposite poles: the North Pole at the top of the globe, and the South Pole at the bottom of the globe. It is surrounded by a magnetic field. The direction of the Earth's magnetic field lines is from the magnetic north pole to the magnetic south pole.

The Earth's magnetic poles and geographic poles are opposites. The Earth's magnetic south pole is where the geographic North Pole is and the Earth's magnetic south pole is where geographic North Pole is. This is explained in more detail in the following section.

Something interesting

In the 1600s, an English scientist named William Gilbert suggested that the Earth was a magnet. He also suggested that the Earth had magnetic poles. Today this is a generally accepted fact.

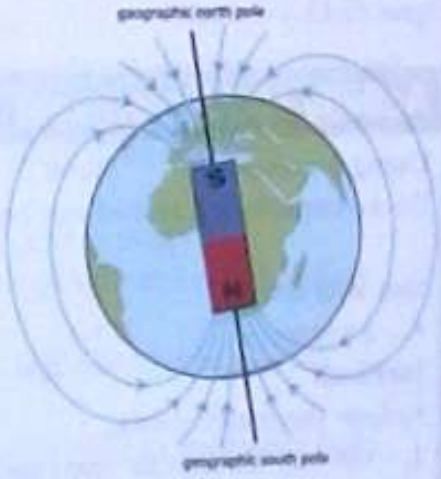

Figure 18.12 The magnetic field of the Earth

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A compass

A compass is an instrument that we use to find out where we are on Earth. It can also help us find the direction in which we want to go. A compass needle is a small, thin bar magnet that can move freely. One side of the needle can be red or it can be an arrow. The needle swings around to line up with the Earth's magnetic field lines. There are also marks on a compass showing the wind directions east, south, north and west. When the needle stops moving, the red part or arrow always points to the Earth's geographic North Pole.

Look at Figure 18.12. It shows that the red part of the bar magnet actually points to the Earth's magnetic south pole. The red point or arrow of a compass needle is its north pole. Because opposite poles attract, it would align in the direction of the Earth's magnetic south pole. The Earth's magnetic south pole is actually its geographic North Pole.

Figure 18.13 A compass

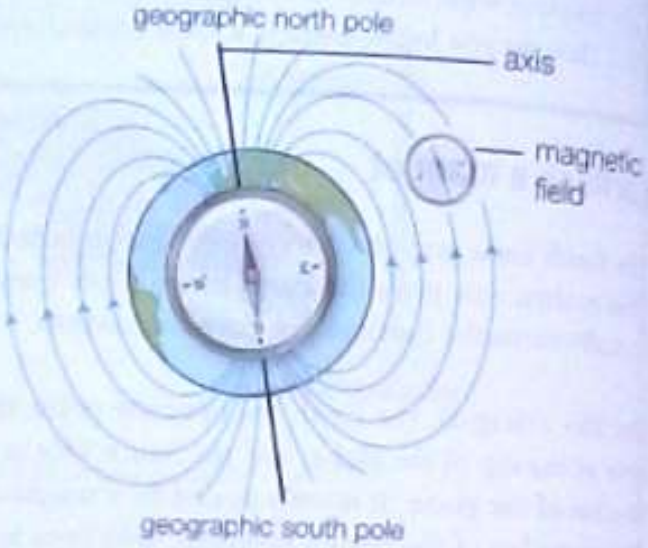

Figure 18.14 A compass points to the magnetic south pole of the Earth.

Activity 18.3 Experiment

Using a compass Work in pairs

Do an experiment to find out how a compass works

You will need:

- a compass

Method

Follow the instructions.

1. Go outside into an open area. Hold the compass flat on your hand. Note how the needle points to the N of the compass points.
2. Use your compass to face east, then west, then south.
3. Draw a map to show what you saw when you faced the different directions.

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Observations and results

Did the compass needle change position as you moved?

Conclusion

Write a conclusion for the experiment.

Questions

1. Why should you hold the compass flat?
2. Which pole of the compass needle is actually pointing to north? Explain your answer.

Activity 18.4 Research assignment

Research magnetism on Earth Work in groups

Do research on the Internet or in the library on a topic related to magnetism.

The effects of magnetism can be seen in different ways on Earth. Find out about one of the following:

- What are magnetic storms?
- What is an aurora and where can it be seen?
- How do animals use the Earth's magnetic field for navigation?

Present your information in the form of a poster that can be displayed in class.

Summary

- Magnetic objects are made from materials that attract magnets, and non-magnetic objects are made from materials that do not attract magnets.
- Magnets have a north and south pole and their magnetic force is concentrated around their poles.
- There are different types of magnets, such as bar magnets, horseshoe magnets, C-magnets and electromagnets.
- Some magnets are magnetic all the time and are called permanent magnets.
- Some magnets, such as electromagnets can be switched on and off, and are therefore called temporary magnets.
- All magnetic materials are metals, for example iron, nickel and cobalt, but not all metals are magnetic.
- Iron filings sprinkled around a magnet will show the magnetic field as magnetic field lines running from the north pole to the south pole.
- The Earth also has magnetic properties – it has opposite poles and a magnetic field.
- A compass uses the Earth's magnetic force to help us find our position and direction.

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Topic assessment

Answer the questions.

1. Magnets exert magnetic forces.
   a) Name two:
      i. magnetic materials
      ii. non-magnetic materials.
   b) Where is the magnetic force of a magnet strongest? [4]
2. Answer each of the following questions using words and/or diagrams.
   a) What is a magnetic field?
   b) What are magnetic field lines?
   c) Why does a compass needle swing to the north?
   d) How does an electromagnet work? [4 × 4 = 16]
3. Magnets are used in everyday life. Give one use of:
   a) a bar magnet
   b) an electromagnet [2]

[Total marks: 22]

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Topic 19 Electricity

Learning objectives	Activities
• State the two types of charges.	• Rubbing polythene or Perspex with a dry cloth
• Describe the production of charges. • Define current. • Distinguish between conductors and insulators.	• Carrying out experiment on conductivity of different materials.
• Identify components of a direct current (d.c.) circuit. • Draw and label a simple direct current (d.c.) circuit.	• Drawing circuit diagrams using symbols.

Electricity is a useful form of energy. You learnt about electricity in *Junior Science and Technology*. In Grade 4, you found out about sources of electricity and some of the dangers associated with electricity. You also discovered that materials that can transfer electricity are called **conductors** and materials that do not transfer electricity are called **insulators**. You extended your knowledge in Grade 5 when you learnt about electric current and electrical circuits. In Grade 6, you focussed on the difference between alternating current (a.c.) and direct current (d.c.).

In this topic, you will find out about charges and how they are produced. You will consolidate your knowledge of electrical conductors and insulators and you will construct and draw electrical circuits.

Types of charge

Objects can be positively charged, negatively charged or neutral (no charge). In Grade 6 you learnt about the structure of an atom. Atoms are made up of negatively charged electrons, positively charged protons and neutrons that have no charge. A material that is electrically neutral has an equal number of positive and negative charges. If an object gains electrons, it will become more negatively charged. If an object loses electrons, it will become more positively charged.

Figure 19.1 The structure of an atom

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The production of charge

In Topic 16 Force, you learnt about electrostatic force. You conducted an experiment in which you charged various materials by rubbing them with a woollen or silk cloth.

Figure 19.2 Charge can be produced by friction

Activity 19.1

Answer the questions.

1. Learners rubbed a balloon with a woollen cloth.
   a) Explain what happens to the charges on the balloon and cloth.
   b) What will happen when the balloon and cloth are held near each other?
   c) Explain what would happen if two balloons were rubbed together?
   d) Name the type of non-contact force that is exerted by the balloon and cloth.
   e) If a plastic ruler is rubbed with a woollen cloth, explain what you will observe if small pieces of paper are held close to it.
2. Complete the following sentences:
   a) When some materials are rubbed, they get a _____ charge as a result of gaining _____.
   b) When some materials are rubbed, they lose electrons and so the material has a _____ charge on its surface. The other material has a _____ charge.
   c) _____ objects repel and _____ objects attract.

Static and current electricity

There are two different types of electricity: static and current electricity. **Static electricity** was discussed in Physics Topic 16 Force. You learnt that static electricity is the build-up of charges on an object, usually as a result of friction. If the charges on two objects are different, there is attraction between them. **Current electricity** is the flow of charged particles through a conductor.

Word help

conductor: a material that transfers electricity
insulator: a material that does not transmit electricity
static electricity: a type of electricity that results from a build-up of charge on an object
current electricity: a type of electricity that results when charge flows through a conductor
electrical circuit: the pathway through which electric current moves
conductivity: how well a material is able to transfer electricity

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Static electricity

Static electricity describes the build-up of charge in one material and the removal of charge from a second material. Static electricity results from electrostatic forces. The discharge of static electricity between two charged objects can be observed as small sparks.

Figure 19.3 Static electricity

Current electricity

Current electricity is the flow of charge. This means there is movement of charge from one point to another. You learnt that atoms contain negatively charged electrons. Electrons flow as an electric current in a solid conducting material such as a copper wire.

Something interesting

Direct current (d.c) is electric current that flows in only one direction. Batteries and cells supply d.c electricity. Alternating current (a.c) is electric current that constantly changes direction. Mains electricity is a.c. current.

In order for an electric current to flow, there must be a complete path through which the electrons can move. The path is called an **electrical circuit**. A source of electrical energy, such as a cell, battery or mains supply, is also needed. A cell or battery has a negative and positive terminal. The current flows from the positive terminal of a cell through the conducting wires to the negative terminal.

Electrical conductors and insulators

Materials that allow electric current to flow through them easily are called conductors. Materials that do not allow electric current to flow through them are called insulators.

Activity 19.2 Experiment

Investigating conductivity of different materials Work in a group

Do an experiment to investigate the **conductivity** of different materials.

You will need:

- batteries
- copper wire
- light bulbs
- a piece of wood
- an iron bar
- a plastic ruler
- string

THE HEAD
CHISWITI SECONDARY SCHOOL
25 MAY 2017
PO BOX 300 MT DARWIN
CELL

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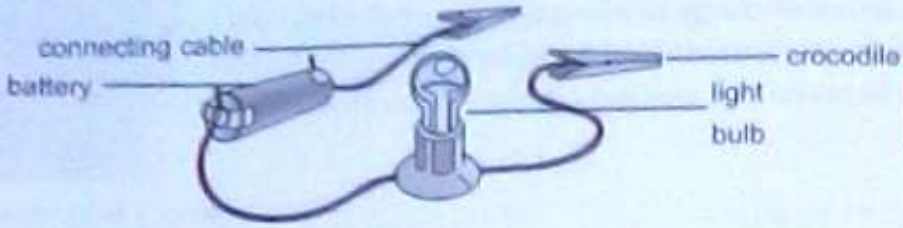
Method



Safety

Always be careful when working with electricity!

Figure 19.4 A simple electrical circuit for testing conductivity of different materials

1. Make a simple circuit. You will need a battery connected to two wires and a light bulb, as shown in Figure 19.4.
2. Connect different materials using the crocodile clips to find out which ones conduct electricity. If they do conduct electricity, the light bulb will light up. You may even notice that the bulb glows with a different brightness depending on which substance you use.

Observations and results

Record the results in a table like the one below.

Material	Bulb glows (yes/no)	Conclusion Is the material a conductor or insulator?

Conclusion

Write a conclusion for the experiment.

Questions

1. What is a conductor?
2. Explain why connecting wires are usually covered by plastic or rubber.

Electrical circuit components

An electrical circuit has different components. It needs a source of electricity, such as a battery or cell, connecting wires and an appliance such as a light bulb that uses electrical energy to do work. A switch can also be included to control the flow of current through the electrical circuit.

Something interesting

When two or more cells are used in series, this is called a 'battery' of cells. In other words a battery is a connected collection of cells.

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Table 19.1 shows some components of electrical circuits and the symbols that are used to represent them.

Table 19.1 Components of electrical circuits and their symbols

Circuit component	Function	Symbol
connecting wires 	Provide a path for electric current	
cell or battery 	A supply of electrical charge. The longer line is the positive terminal of the cell and the shorter line the negative terminal of the cell.	
bulb 	Converts the electrical energy into light and heat energy.	
switch 	Breaks or closes a circuit, stopping or starting the current flow. When the switch is open the current does not flow, when the switch is closed the current flows.	
resistor 	Restricts the flow of current in a circuit, slowing the current down.	
ammeter 	Measures the size of the current.	
voltmeter 	Measures the electrical energy in a circuit.	

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We can draw electrical circuit diagrams using the standardised symbols for each component. These are shown in Table 19.1

Figure 19.5a) An electrical circuit

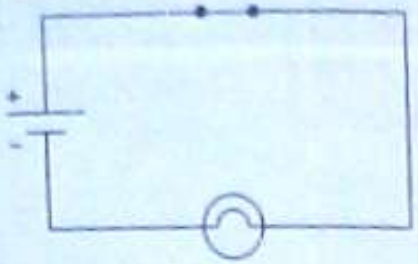

Figure 19.5b) An electrical circuit diagram

Activity 19.3 Assignment

Drawing and constructing an electrical circuit Work in pairs

Draw an electrical circuit using the appropriate symbols, and then construct it.

You will need:

- a battery
- ammeter
- bulbs
- cell
- switch
- resistor
- connecting wires

Safety

Always be careful when working with electricity!

Method

1. Use the symbols in Table 19.1 to draw an electrical circuit. The circuit must contain a cell, a bulb, a resistor and a switch. You must also include something to measure the current.
2. Construct the circuit using the components.

Questions

1. A circuit is needed for the flow of electric charge.
   a) How did you know that the circuit you made was complete?
   b) What instrument is used to measure electric current?
2. What is the function of the cell in an electrical circuit?

Summary

- Atoms consist of positively charged protons, negatively charged electrons and neutral neutrons, which have no charge.
- Materials are neutral when they have equal numbers of positive and negative charges, but will be negatively charged if they gain electrons and positively charged if they lose electrons.

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- Static electricity is the build-up of charges on an object.
- Current electricity is the flow of charge through a conductor.
- Conductors are materials that allow the flow of electrical charge or current through them.
- Insulators are materials that do not allow current to flow through them.
- An electric circuit consists of a source of electric current, such as a battery or cell, connecting wires, appliances such as light bulbs and sometimes a switch.
- There are standard symbols for the electrical components in a circuit that can be used in drawings.

Topic assessment

Answer the questions.

1. All substances are made of particles called atoms.
   a) Name the three components of an atom. [3]
   b) Give the charge of each component. [3]
2. Complete the following sentences.
   a) An electric current is the flow of _____ particles.
   b) Electric current flows from the _____ terminal of a cell towards the _____ terminal.
   c) A _____ is a device that opposes the flow of electric current. [4]
3. Learners wanted to test the conductivity of different materials. They set up a circuit and connected the materials.
   a) Explain what is meant by the terms 'conductor' and 'insulator'. [2]
   b) Which of the following materials are conductors and which are insulators?
   plastic ruler, wood, copper wire, iron bar [4]
4. Symbols are used to represent various components of electric circuits.
   a) Identify each of the symbols shown below. [3]

Figure 19.6

   b) State the function of each component. [3]
5. Draw a simple circuit diagram to show a circuit that contains a cell, bulb, resistor, switch and ammeter. [6]

[Total marks: 28]

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End of term examination – Biology

Paper 1 Theory

Multiple choice

Choose the correct answer to each of the questions below from those provided. Write down the letter (A to D) next to the question number.

1. When mixing or heating up chemicals you should always wear:
   A glasses
   B safety goggles
   C safety hat
   D running shoes.

2. If you have an accident in the science laboratory, such as breaking a piece of glassware, you should immediately:
   A report to teacher
   B run
   C clean it up
   D leave the room.

3. The piece of apparatus shown in Figure 1 is a:

Figure 1

   A wash bottle
   B pipette
   C funnel
   D beaker.

4. What is the function of the cell nucleus?
   A to act as a brain
   B to control the activities of the cell
   C to control movement of molecules into and out of the cell
   D to store substances.

5. Which of the following are important in food hygiene?
   I the person cooking food should wash their hands
   II food should be cooked at any temperature
   III food that has passed the expiry date should be thrown away

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A I and II
B II and III
C I and III
D III only

6. What nutrient is found in both cassava and pasta?
A protein
B fat
C carbohydrate
D fibre

7. What are the four main food groups in a balanced diet?
A carbohydrates, fats, minerals and vitamins
B carbohydrates, fats, proteins, minerals and vitamins
C carbohydrates, proteins, fibre and minerals
D carbohydrates, fats, water and vitamins

8. A Form 1 learner did a test to show that atmospheric air is different from the air that she breathes out. Which of the following would be the correct result for her test?
A bicarbonate indicator changed from red to colourless
B bicarbonate indicator did not change colour
C limewater changed from cloudy white to colourless
D limewater changed from colourless to cloudy white.

9. The percentage of oxygen and carbon dioxide in the atmosphere is:
A 21% oxygen and 65% carbon dioxide
B 15% oxygen and 0,5% carbon dioxide
C 21% oxygen and 0,03% carbon dioxide
D 21% oxygen and 0,3% carbon dioxide.

10. Diffusion is:
A the movement of particles from a high concentration to a lower concentration
B the movement of particles from a low concentration to a higher concentration
C the movement of particles in water
D the movement of particles through a membrane.

11. The function of red blood cells is to:
A transport nutrients around the body
B transport heat energy around the body
C transport oxygen to the cells
D produce platelets.

12. A learner set up part of a celery plant as shown in Figure 2 A. After a few days she cut the stem and observed the end as shown in Figure 2 B.

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Figure 2 A

Figure 2 B

Which of the following best explains what has happened?

A water has travelled through the stem of the plant
B water has travelled through the xylem tubes of the plant
C the red coloured water entered the plant by osmosis
D the red coloured water entered by diffusion.

13. Figure 3 shows a section through a flowering plant.

Figure 3 Section through a flower

Which of the labeled parts represent the male part of the flower?

A 1
B 2
C 3
D 4

14. During puberty the bodies of both males and females change. Which of the following changes happen in both boys and girls?

A growth of a beard
B growth of pubic hair
C deepening of the voice
D all of the above.

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15. Diseases can be transmitted in different ways. Which of the following diseases does not have a link with water for its transmission?

A cholera
B bilharzia
C malaria
D Ebola.

[15 marks]

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Paper 2 Theory

Answer all the questions.

QUESTION 1

a) Miriam wanted to measure two exact amounts of water for an investigation. The amounts are shown in Figure 1.

Figure 1 Measuring water for an investigation

i. What apparatus did she use to measure the water? (1)

ii. How much water did she measure in each piece of apparatus shown in Figure 1? (2)

iii. What piece of apparatus would she use to pour the water into a small test tube? (1)

[4 marks]

b) Safety in a science room is important.

i. Explain why is it important to have safety rules in a science room. (1)

ii. State **two** important rules that learners working in a science room should follow. (2)

iii. Look at Figure 2, which shows safe and unsafe practices in a science room. List two safe practices and two unsafe practices. (4)

Figure 2 Safe and unsafe practices in a science room

[7 marks]

c) Fruit is part of a balanced diet. The table below gives some information about the composition of a certain fruit.

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Nutritional component	Amount in 100 g of fruit
Energy	162 kJ
Proteins	0.6 g
Sugars	8.7 g
Fats	trace
Fibre	1.6 g

i. If the average daily amount of protein needed by a person is 60 g, how many grams of this fruit would the person need to eat per day if this was their only source of protein? (3)

ii. Name three components of a balance diet that are NOT shown in the table. (3)

[6 marks]

QUESTION 2

a) Define the following terms:

i. inhalation

ii. osmosis

iii. cross-pollination.

(3 x 2 = 6)

b) Plants and animals are made up of cells. All cells have three structures in common.

i. What three structures are found in both plant and animal cells? (3)

ii. Name one structure that is only found on the outside of plant cells (1)

iii. Name one structure found inside plant cells which is not found in animal cells. (1)

[5 marks]

c) Learners at a school did a survey to find out how a village community disposed of waste. They collected information and drew a bar chart to show how much waste was disposed of in different ways, as a percentage of the total waste. Figure 3 shows their results.

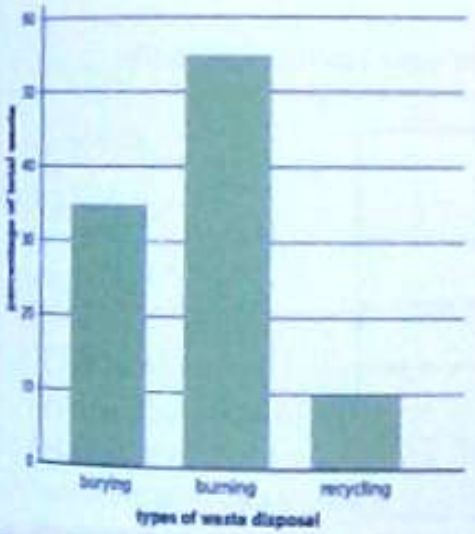

Figure 3 Bar graph to show different ways of disposing waste in a village

i. What is the most favoured way to dispose of waste in the village? (1)

ii. Calculate the total amount of waste that is buried and burnt. (3)

iii. Describe one **disadvantage** for each type of waste disposal. (3)

[7 marks]

[Total marks = 35]

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Paper 3 Practical Exam paper

Time: 1 1/2 hours **Mark allocation:** 40
Learner requirements: pen, pencil, eraser, ruler.
Answer **both** questions using the spaces provided.

QUESTION 1

Figure 1 shows three pieces of apparatus drawn **(not to the same scale)** and labelled **A**, **B** and **C**.

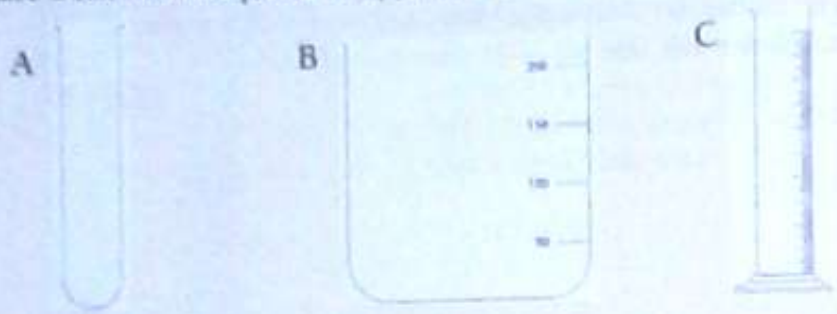

Figure 1 Three pieces of apparatus (not to scale)

a) You will be given a large bottle with some water in it. Decide which of **A**, **B** or **C** would be the most suitable to measure the volume of liquid in the bottle you have been given. Then put your hand up and ask your teacher to give you the item you have chosen **by saying the letter A, B or C.**

i. Write down the name of the piece of apparatus you have chosen. (2)

ii. Explain how you can accurately measure the volume of the liquid in the bottle. State the steps in your method. (3)

iii. Mention one precaution you would take when measuring the volume of water. (1)

iv. Carry out your method. Copy the table below and record your results. Fill in the units of measurement. (5)

Volume of liquid (_____)
TOTAL volume in bottle = _____

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b) Make a clear, labelled diagram of the piece of apparatus you used to measure the volume of water. The drawing should be 6 cm high and 1.5 cm wide. Label three parts of the piece of apparatus and give your drawing a heading. (5)

c) Name each of the other two pieces of apparatus out of **A**, **B** and **C** that you **did not use** and give one reason why each was unsuitable. (4)

[20 marks]

QUESTION 2

You will be given a liquid, **D**, in a container and plant parts E and F.

a) i. Describe the appearance of the liquid **D**. (1)

ii. Use a drinking straw to blow air into liquid **D** continuously for three minutes. Describe the appearance of the liquid **D** after blowing air into it. (1)

iii. Name liquid **D**. (1)

b) i. Name the gas that caused the change of appearance in liquid **D**. (1)

ii. Where has this gas come from? (1)

c) Plants use this gas to make food in the presence of light. Look carefully at plant parts **E** and **F**.
Both are foods used in the human diet.
Using a tick (✓) to show presence and cross (X) to show absence, complete the table below to show the main food types in E and F.

Food type	E	F
Carbohydrates		
Proteins		
Fat		
Vitamins		
Mineral salts		
Water		
Fibre		

(7)

d) Cut **E** longitudinally/lengthwise.

i. Make a large labelled diagram of the cut surface of **E**. (4)

ii. Part **E** formed from a part of a flower. Name the part. (1)

iii. Name the structures inside the flower from which the seeds inside **E** have formed. (1)

iv. Name **two** processes that had to occur in the flower for part **E** to form. (2)

[20 marks]

[Total marks = 40]

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Paper 1 Theory

Multiple choice

Choose the correct answer to each of the questions below from those provided. Write down the letter (A to D) next to the question number.

1. Look at the diagram below that shows an experiment, which was set up to show conditions for rusting. Which nail will rust?

   A, B, C or D

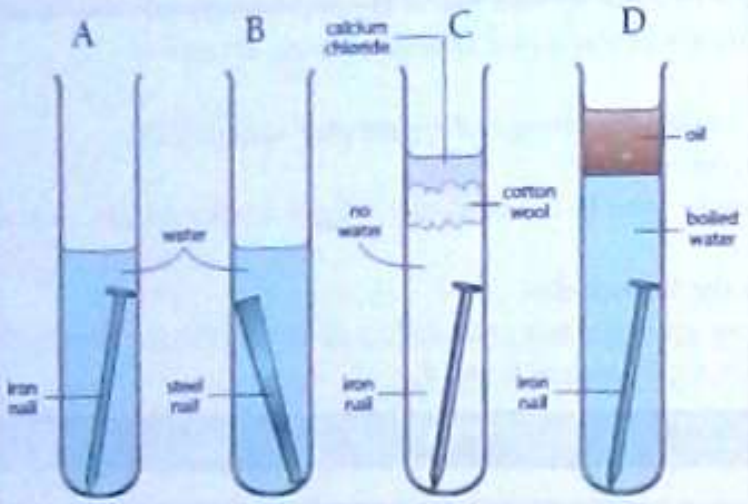

Figure 1

2. How does galvanising prevent rusting?
   - A Using an electric current, one metal is coated with a less reactive metal.
   - B A layer of paint is put onto the metal to prevent water from touching it.
   - C Immersing the metal in a bath of molten zinc at about 449 °C.
   - D A plastic coating is put onto the metal to keep it dry.

3. Which of the following is NOT a method of separating?
   - A filtration
   - B mixing
   - C winnowing
   - D magnetism.

4. When salt _____ in water, a mixture is formed. Select the correct word to fill the blank.
   - A separates
   - B dissolves
   - C evaporates
   - D decants.

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5. Filtration is used to separate _____ substance from a solution. The solution that passes through the filter is called the _____. Select the correct words to fill the blanks:
   A an insoluble, residue
   B an insoluble, filtrate
   C a soluble, filtrate
   D a soluble, residue

6. Which of the following factors affect solubility?
   I temperature
   II stirring
   III particle size
   IV type of molecule

   A I and II only
   B IV
   C I, II and III
   D none of them

7. Which of the following is the odd one out?
   A Ice melts when heated
   B Iron turns pink in copper sulfate solution
   C Water freezes when cooled
   D Water evaporates when heated

8. Which of the properties listed is true of a physical change?
   A The atoms are rearranged into different molecules
   B New substances are formed
   C The changes are easily reversed
   D The changes are not easily reversed

9. Which of the following cannot be explained by the Kinetic Theory?
   A When the temperature of gas particles is increased they have more kinetic energy
   B When a solid is heated it expands
   C When a liquid is heated it turns into gas
   D When copper sulfate and potassium iodine solutions are mixed a white substance is formed

10. When an acid and base are mixed they form a salt in a process called _____. Select the correct word to fill the gap
   A salting
   B neutralisation
   C acidification
   D solidification

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11. If you dip litmus paper into a solution and it turns blue, the solution is said to be _____. Select the correct word to fill the gap:
    A neutral
    B basic
    C acidic
    D saturated.

12. Which of the following is NOT a physical property of an acid?
    A sour taste
    B has a pH of less than 7
    C turns red litmus paper blue
    D sticky.

13. The diagram below has missing labels A, B and C. The labels A, B and C are:

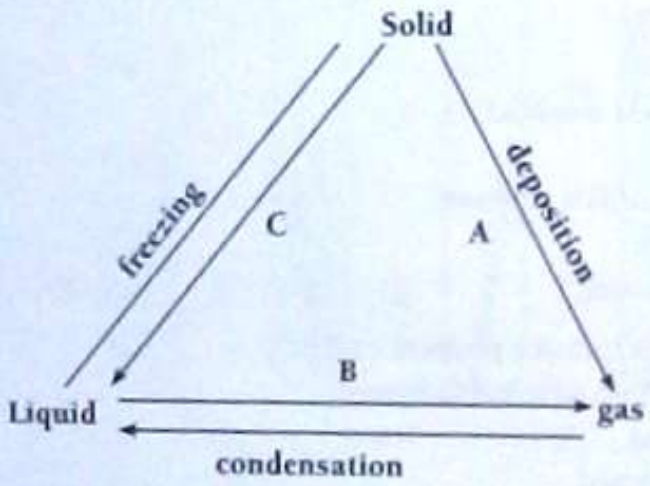

Figure 2

    A melting; condensation; evaporation
    B sublimation; evaporation; melting
    C boiling; evaporation; melting
    D freezing; evaporation; melting.

14. Which of the following statements about the periodic table is correct?
    A Compounds are arranged according to their atomic number.
    B Metals, non-metals and metalloids are arranged in the periodic table.
    C Elements are arranged in the periodic table according to the structure of their atoms and their properties.
    D All metals are arranged on the right-hand side of the periodic table.

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15. If you want to make smooth peanut butter, you would:

A harvest the peanuts when they are still young and tender

B boil the peanuts before grinding

C use a large rock to grind the peanuts

D grind the peanuts for longer using a fine grade grinder.

[15 marks]

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Paper 2 Theory

Answer all the questions.

QUESTION 1

a) Figure 1 shows a diagram of the periodic table of elements.

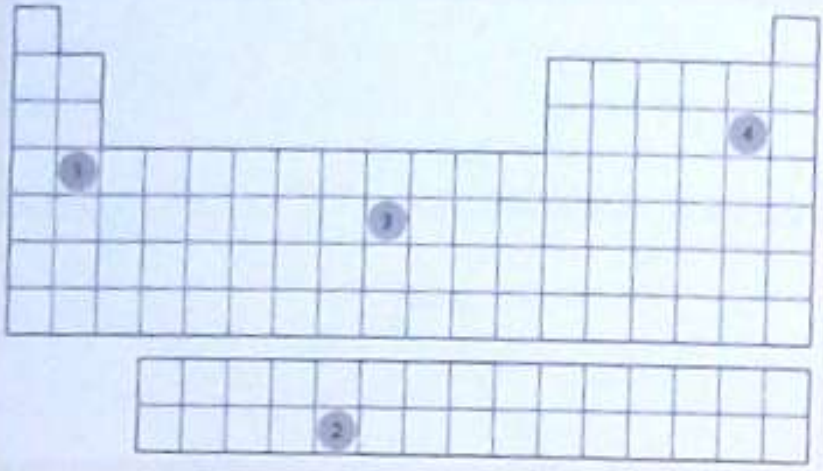

Figure 1

i. In which area of the table, 1, 2, 3 or 4, would you expect to find metals? (1)

ii. In which area of the table, 1, 2, 3 or 4, would you expect to find non-metals? (1)

iii. Which class of elements best conducts electricity? (1)

iv. Of the following compounds, which is most likely to be a part of living organisms? Explain why.

$C_6H_{12}O_6$

BF_3

$MoCl_2$

CsI (2)

v. Copy the table below and place the following substances into the correct column.

Mixture	Element	Compound

sulfur, carbon dioxide, soil, air, neon, salt (5)

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b) The table below shows four different body fluids, their pH and their reaction with litmus paper.

Body fluid	pH	Reaction with litmus paper
Blood	7.4	Turns blue
Bile	8.2	Turns blue
Saliva	6.8	Turns red
Gastric juice	1.7	Turns red

i. List the four body fluids in order of pH, from the most acidic to the most basic. (3)

ii. Which body fluid is closest to neutral? (1)

iii. What would the reaction with litmus paper be for a neutral substance? (1)

iv. Copy and complete the following sentence:
The reaction between an acid and a base is called _____ and a _____ is formed. (2)

v. Name a common acid and a base found in the laboratory. (2)

vi. Vinegar used at home in the kitchen has a sharp smell and a sour taste.
Is it acidic or basic? (1)

[20 marks]

QUESTION 2

a) The Kinetic Theory explains the properties of the different states of matter. The particles in solids, liquids and gases have different amounts of energy. They are arranged differently and move in different ways.

i. Copy and complete the table below by describing the arrangement and movement of particles and drawing the particles for each state of matter. (9)

	Solid	Liquid	Gas
Arrangement of particles			
Movement of particles			
Diagram			

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b) Learners performed an investigation to find out which fuels were the most efficient. They tested different fuels to see which fuels heated an amount of water to 60°C the quickest. Their results are shown in the table below

Fuel	**Time taken to heat 100 ml of water to 60°C (mins)**
gas	5
spirit burner with paraffin	12
spirit burner with methylated spirits	9

Draw a bar chart to show these results. (6)

[15 marks]

[Total = 35 marks]

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Paper 3 Practical Exam paper

Time: 1 1/2 hours **Mark allocation:** 40

Learner requirements: pen, pencil, eraser, ruler.

Answer **both** questions.

QUESTION 1

A learner is given a mixture of iron filings and sulfur. Design an experiment that the learner could perform in the school science laboratory to:

a) separate the iron filings from the sulfur

b) show that the mixture cannot be separated into its components once it has been heated.

Present your answer as a practical assignment. Use the following headings:

Experiment heading (1)

Apparatus and chemicals (3)

Method (5)

Observations - answer the following questions:

i. What did the iron filings look like?

ii. What did the powdered sulfur look like?

iii. How easily are the iron filings separated from the sulfur before and after heating?

iv. Could you see the iron filings in the mixture before and after heating? (7)

Conclusion (4)

[20 marks]

You are given sugar in three different forms:

- fine icing sugar
- granulated sugar
- castor sugar

Design an experiment showing that the size of the sugar particles affects the rate of dissolving.

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Present your answer as a practical assignment. Use the following headings:

Experiment heading (1)
Apparatus and chemicals (3)
Method (5)
Observations and results (7)
Record your results in a table (4)
[20 marks]
[Total marks = 40]

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End of term examination - Physics

Paper 1: Theory

Multiple choice

Choose the correct answer to each of the questions below from those provided. Write down the letter (A to D) next to the question number.

1. When using a measuring cylinder to find the volume of a liquid, which of the following may lead to inaccurate measurements?
   I parallax error
   II zero error

   A both I and II
   B I only
   C II only
   D neither I nor II

2. The weights of four objects, 1 to 4, are compared using a balance as shown in Figure 1.

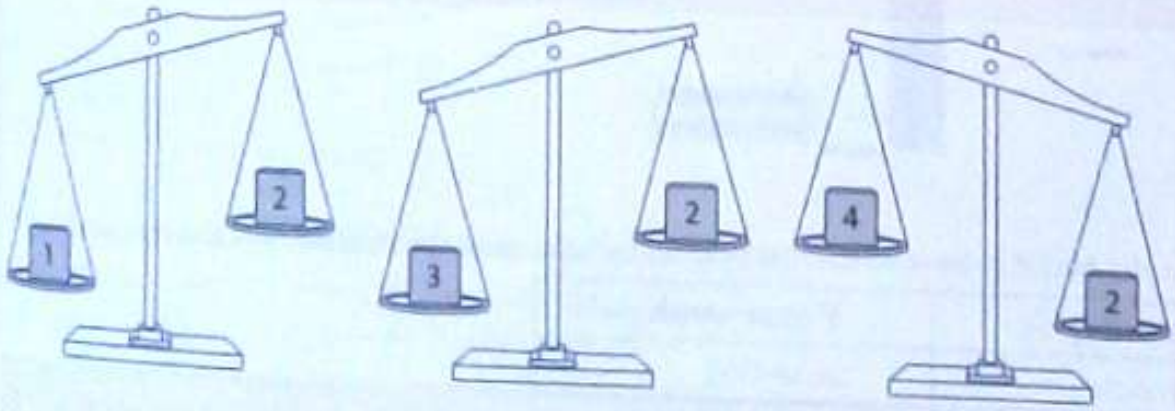

Figure 1

Which object is the lightest?
A object 1
B object 2
C object 3
D object 4

THE HEAD
CHISWITI SECONDARY SCHOOL
25 MAY 2017
PO BOX 300 MT DARWIN
CELL

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3. Figure 2 shows a man diving into water.

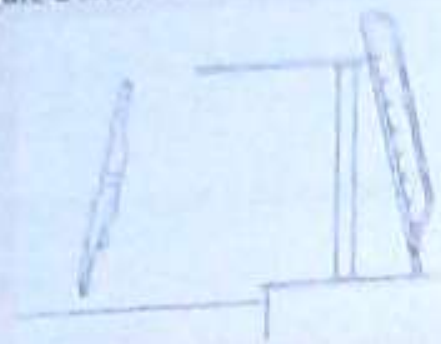

Figure 2

Which form of energy is increasing as he falls?

A chemical energy
B gravitational energy
C kinetic energy
D heat energy

4. What source of energy is converted by a hydro-electric power station?

A hot rocks
B falling water
C oil
D waves.

5. A magnetised metal rod XY is placed near a magnet. End X is attracted when it is placed near to the north pole of the magnet and also when it is placed near to the south pole.

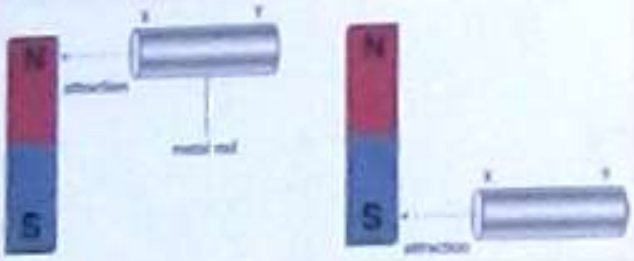

Figure 3

How does the end Y behave when it is placed, in turn, near the two poles of the magnet?

Y near north pole	Y near south pole
A attraction	attraction
B atraction	repulsion
C repulsion	attraction
D repulsion	repulsion

6. Which electrical component would not normally be found in a battery-operated torch (flashlight)?

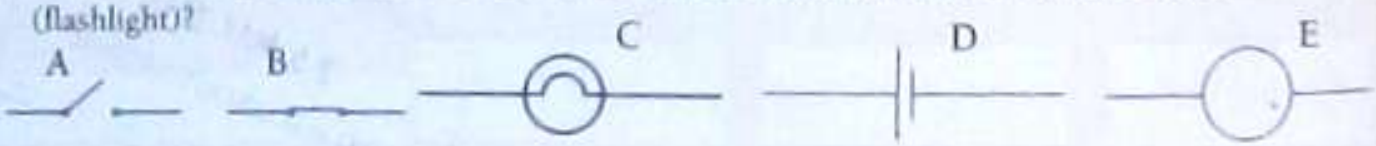

Figure 4

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7. A polythene rod repels an inflated balloon hanging from a nylon thread.
What charges must the rod and the balloon carry?
A The rod and the balloon carry opposite charges.
B The rod and the balloon carry like charges.
C The rod is charged but the balloon is not.
D The balloon is charged but the rod is not.

8. Which of the following materials conduct electricity?
I aluminium II silver III iron IV plastic
A only aluminium
B only aluminium and silver
C aluminium, silver and iron
D all of them.

9. Which of the following is correct?
A A force is a push only.
B A force can be a push or a pull.
C A force is measured in kilograms.
D A force is measured in newtons.

10. A rock balancing at the edge of a cliff is likely to have:
A no energy
B gravitational potential energy
C kinetic energy
D chemical potential energy.

11. When a catapult is fired, which of the following energy conversions take place?
A chemical energy ⟶ heat energy
B heat energy ⟶ kinetic energy
C elastic potential energy ⟶ kinetic energy
D gravitational potential energy ⟶ heat energy.

12. What needs to be done so that the bulb lights up in this circuit?

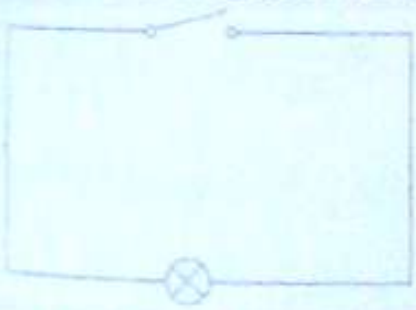

Figure 5

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A another lamp needs to be added
B another cell needs to be added and the switch needs to be closed
C the switch needs to be closed
D a resistor needs to be added.

13. Where is the strongest magnetic field around a bar magnet?
A at the poles
B in the middle
C above and below
D at the south pole.

14. Figure 6 shows a triple beam balance. What is the reading on the balance?

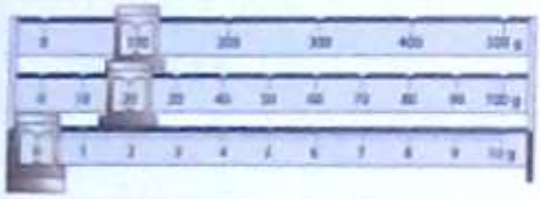

Figure 6

A 100 g
B 120 g
C 20 g
D 140 g

15. In which direction do the lines run in a field diagram?
A from north to south
B from south to north
C from pole to pole
D across the magnet.

[15 marks]

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Paper 2 Theory

Answer all the questions.

QUESTION 1

a) Figure 1 shows a liquid-in-glass thermometer.

Figure 1

i. Name a suitable liquid to use in the thermometer. (1)

ii. State the reading on the thermometer in °C. (1)

iii. What happens to the volume of liquid in the thermometer as the temperature is increased? (1)

b) The thermometer bulb is placed in melting ice. Explain why the liquid moves in the capillary tube of the thermometer. (1)

[4 marks]

QUESTION 2

a) A learner wanted to find the mass of three stones. He used a balance to find the mass of each stone. The balance readings are shown in Figure 2 below.

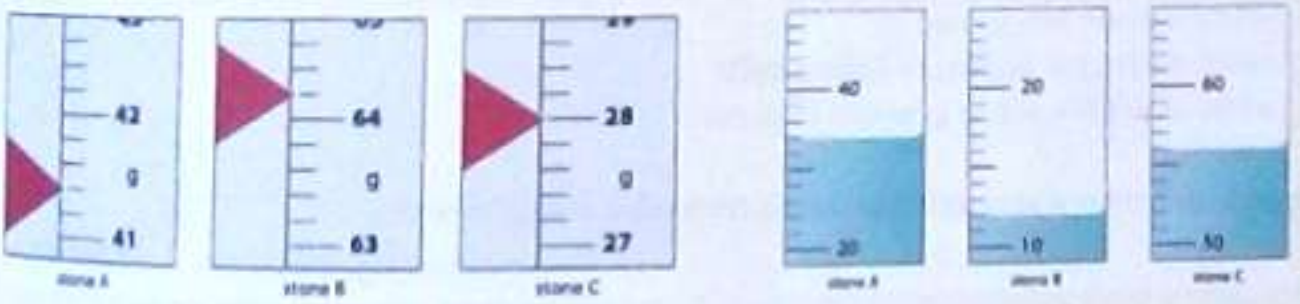

Figure 2 Balance readings for three stones

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i. Copy the table below into your exercise book. Record the masses of the three stones in the second column. (3)

Object	Mass (g)	Volume (cm3)
A		
B		
C		

ii. The learner was then interested in measuring the volume of the stones. He put the three stones in three different measuring cylinders with some water and recorded the change in volume of the water. This change is indicated on the measuring cylinders in Figure 3 for the three stones and is shown in millilitres (ml) below.

Figure 3

Record the readings of the three measuring cylinders in the table above in the third column. (3)

iii. The density of an object can be calculated using the following formula:

$$density = \frac{mass}{volume}$$

Calculate the density of the stone C (in g/cm3) from your recorded values of mass and volume in the table. (3)

[9 marks]

QUESTION 3

a) Energy can change from one form to another. Write down the enegy transformations that take place:

i. when a crane lifts a crate (2)

ii. when a dynamo is used to light a bulb (2)

iii. when water is used to generate electricity (3)

b) Distinguish between renewable and non-renewable energy sources. (2)

[9 marks]

QUESTION 4

a) An insulated wire wrapped around a core and carrying a current makes an electromagnet as shown in Figure 4. It could be used to sort scrap metal on a conveyer belt.

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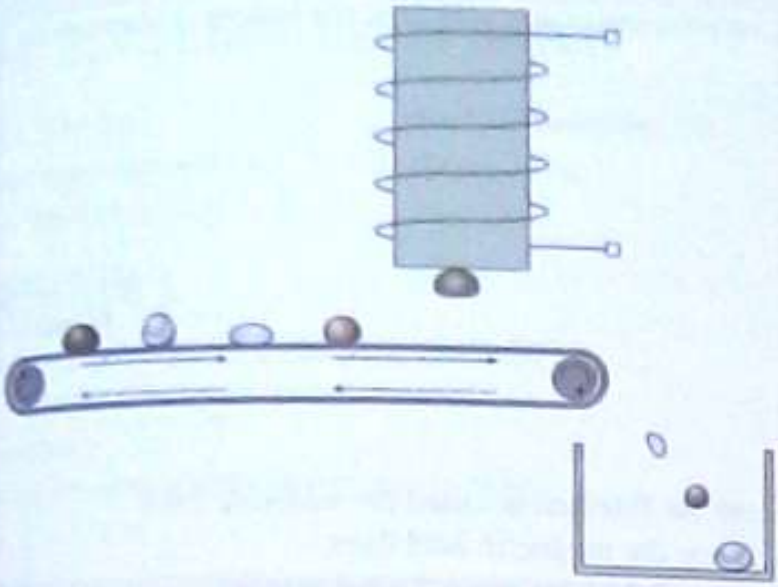

Figure 4 An electromagnet used to sort scrap metal

i. Name a suitable material for the core of the electromagnet. (1)
ii. Which of the metals shown in Figure 4 would fall into the bin? (1)
iii. When the electric current is switched off, the metal sticking to the electromagnet drops off. Explain why this happens. (1)

[3 marks]

QUESTION 5

a) A boy wants to test various objects to see if they contain materials that conduct electricity. He sets up the circuit shown in Figure 5 below.

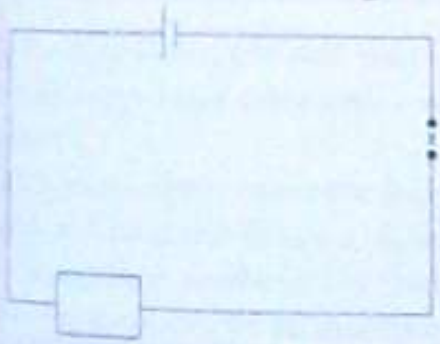

Figure 5 A circuit to test conductivity

i. Name one object that the boy could connect at **X** to show whether or not a current passes through the circuit. (1)
ii. What word is used to describe an object that does not conduct electricity? (1)

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iii. The boy uses this circuit to test various materials. Which of the following materials in objects conduct electricity?

Brass
Graphite centre of a pencil
Piece of rubber tubing
Plastic ruler
Wooden casing from a pencil

(2)
[4 marks]

QUESTION 6

a) The region where the magnetic force can be detected is called the magnetic field.

i. Explain how you would be able to see the magnetic field lines. (2)

ii. Draw a diagram to show the magnetic field lines around a bar magnet. Include arrows to show the direction of the field lines. (4)

[6 marks]

[Total marks = 35]

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Paper 3: Practical Exam paper

Time: 1 1/2 hours **Mark allocation**: 40

Learner requirements: pen, pencil, eraser, ruler.

Answer **both** questions.

QUESTION 1

Investigate the heating of a thermometer bulb

Apparatus:

Incandescent lamp, thermometer, metre ruler

Method:

Carry out the following instructions, referring to Figure 1. Record all your observations.

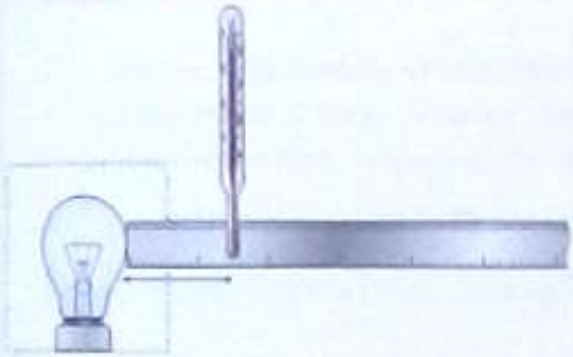

Figure 1

During the experiment, you will read temperature values from the thermometer. You are provided with a lamp and a metre ruler with a scale marked in 1 mm divisions. Do **not** move the lamp or the metre ruler.

1. Switch on the lamp. Leave the lamp switched on until you have completed all the readings. Draw a table to record the distance, d, between the thermometer bulb and the surface of the lamp, and the temperature shown on the thermometer in °C.
2. Place the thermometer so that its bulb is a distance d =100 mm from the surface of the lamp, as shown by the scale provided. Wait for about 30 s. Record the distance and temperature in a table.
3. Move the thermometer so that its bulb is a distance d = 80 mm from the surface of the lamp. Wait for about 30 s. Record the distance d and the temperature in your table.
4. Repeat the steps described in 2 and 3, but use values of d = 60 mm, 40 mm, 20 mm and 10 mm. Record all your temperature readings in your table. (10)

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Safety

You may find it more comfortable to use the card provided to shield your eyes from the direct rays of the lamp. Do not place the card between the lamp and the thermometer.

QUESTIONS

a) Predict the temperature reading when d = 120 mm. (2)

b) Mention any two ways that the accuracy of readings could be improved in this investigation. (4)

c) Write a conclusion for this investigation. (4)

[20 marks]

QUESTION 2

a) In this experiment you will find out about heat energy loss during transfer of water from one beaker to another.

Apparatus:

thermometer; two beakers; a measuring cylinder

Method:

Carry out the following instructions referring to Figure 2. Record all of your observations.

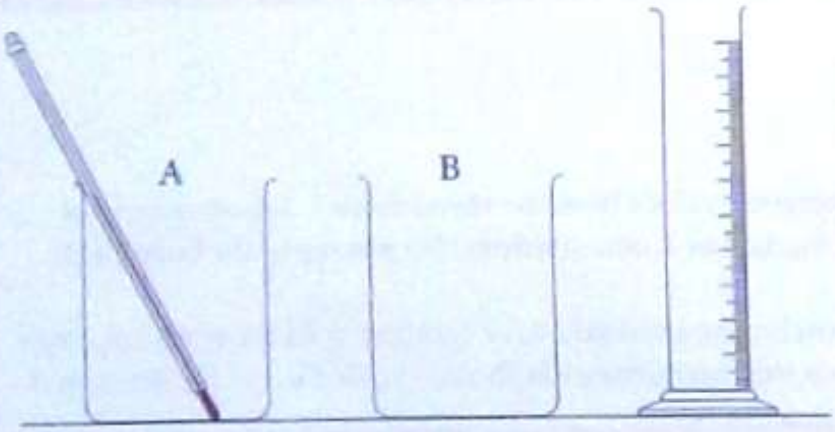

Figure 2

1. Measure 50 ml of water at room temperature using the measuring cylinder. Transfer this into the beaker labelled **A**.
2. Measure and record the temperature h_1 of the water in beaker **A**.
3. Measure 50 ml of hot water using the measuring cylinder. Transfer this to the beaker labelled **B**.

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4. Measure and record the temperature h_1 of the water in beaker **B**.

5. As soon as you have recorded the temperature h_1 pour the water from beaker **B** into beaker **A**.

6. Measure and record the temperature h_3 of the mixture of hot and cold water in beaker **A**. There will be 100 ml of water in beaker **A**.

7. Do not pour the water out of beaker **A**. Using the measuring cylinder measure another 50 ml of hot water into beaker **B**. Record the new temperature value of h_2.

8. As soon as you have recorded the new temperature h_2 add the water from beaker **B** to the water already in beaker **A**. You should now have 150 ml of water in beaker **A**.

9. Measure and record the new temperature h_3 of the mixture of hot and cold water in beaker **A**.

10. A theoretical calculation based on the equation 'heat energy lost by hot water = thermal energy gained by cold water' predicts **higher values** of the temperature h_3 than the values that are obtained by this experiment.

Suggest:

i. a practical explanation for this difference,

ii. any two practical improvements that you could make to the procedure for this experiment to obtain a result that is closer to the theoretical result.

[10 marks]

b) Use the instruments for measuring force.

Apparatus:
a measuring instrument; three different masses; string

Method:
Follow the instructions.

1. Use the measuring instrument to find the weight of the masses.
2. Record your results in a table. (5)

Questions:

i. What is the measuring instrument called? (1)

ii. Draw a labelled diagram to show how you set up the apparatus. (4)

[10 marks]

[Total marks = 40]

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- sufficient opportunities for learners to apply and practise scientific skills and develop scientific literacy
- activities that allow for different methodologies
- varied activities that allow learners to work individually, in pairs or in groups
- activities that are suitable for both formative and summative assessment
- additional activities that are suitable for remediation or extension
- word boxes that contain difficult words and subject-specific terms, with clear and simple definitions
- cross-cutting themes that offer opportunities for rich discussion and debate
- integration with other learning areas
- attractive full-colour artwork and a learner-friendly layout
- exemplar tests that help prepare learners for the exam
- a detailed index that helps learners to find content quickly and easily
- a supporting FOCUS ON Combined Science Form 1 Teacher's Guide.

The **FOCUS ON Combined Science Form 1 Learner's Book** has been approved for use in Zimbabwe Secondary School by the Ministry of Primary and Secondary Education in 2017.

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