Baroque

New Lower Secondary School Curriculum

CHEMISTRY

Approved by NCDC and MoES

New Generation Books

BOOK 1

Senior One Learner's Book

Contents

Baroque Senior One Chemistry Learner's Book has been developed in response to the new competence-based ***Lower Secondary Curriculum*** for Uganda. The curriculum was developed by the Ministry of Education and Sports (MoES) under the National Curriculum Development Centre (NCDC) and launched in 2020.

The book is a result of extensive research from several credible Chemistry resources and input from experienced teachers and experts.

Baroque Senior One Chemistry Learner's Book entails;

- an active competence-based and learner-centred approach,
- appropriate and accurate content,
- adequate and relevant activities and projects that trigger discovery, critical thinking, creativity, problem-solving and interactivity,
- acceptable, appropriate, standard and grammatically correct English, which encourages vocabulary development as well as correct representation of technical terms,
- accurate, relevant, clear, and adequate illustrations that enhance learning,
- intuitive methods, illustrations, activities, and projects that have been, explored to instill the principles of Chemistry.

In pursuit of a knowledge-based society, there is need for new generation learning books that are learner-centred, sufficiently researched and innovatively developed.

Baroque Senior One Chemistry Learner's Book lays a firm foundation for learners who would like to pursue a career in Chemistry-related fields and seeks to equip all learners with the ability to apply Chemistry knowledge in day-to-day activities.

Chapter 1 Chemistry and Society

Keywords

- careers
- chemistry
- matter
- science
- society
- technology

By the end of this chapter, you should be able to:

a) explain the discrete nature of Chemistry.
b) explain why Chemistry is studied and how it overlaps with other subjects like; Biology, Physics, Mathematics and Geology.
c) explain the importance of Chemistry in everyday life and the careers linked to the study of Chemistry.
d) outline the contribution of Chemistry to the economy of Uganda.

Competency: You will assess the application of Chemistry in our everyday life and its contribution to our economy.

Introduction

Chemistry is a laboratory science, whose subject materials and theories are based on experimental observations. However, its scope goes beyond the laboratory and into every aspect of your life. It helps you to understand the nature of your planet, the environment you live in, the resources available to you and the things that affect your health.

In this chapter, you will discover the role of Chemistry in our everyday life and its contribution to our economy.

1.1 What is the Nature of Chemistry?

You previously learnt in primary school that science is the study of living and non-living things. All living and non-living things occupy space and are known as matter. At this level in Senior One, you will look at science as made up of three separate branches these are; Chemistry, Biology and Physics. Each of these branches of science deals with matter in a different way. Physics deals with the relationship between energy and matter while Biology deals with living things.

Activity 1.1(a): What Chemistry is

What to do

1. In groups, discuss what you know about Chemistry.
2. Present your findings to the rest of the class.
3. Comment on the presentations of other groups and add to your list of discoveries.

Activity 1.1(b): Finding out the relationship between Chemistry and substances used in everyday life

What to do

1. Working in groups, carefully observe the picture in *Figure 1.1* below and answer the following questions.

***Figure 1.1:** Common substances in our everyday life*

a) Name the products shown using their collective terms.
b) What are the products used for?

2. a) Identify ten other common items in your everyday life that you think are made up of chemicals.
   b) In your groups, produce a mind-map to show your conclusions.

QUICK TIP *A mind-map shows relationships between one idea and another as shown in* ***Figure 1.2***

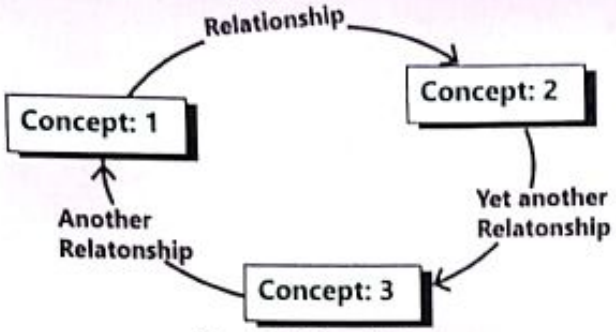


Figure 1.2: A mind map

3. Present your findings to the class.

The products you have identified in *Activity 1.1(b)* are obtained using the knowledge of Chemistry. From your discussions, you have discovered that Chemistry is all around you.

Chemistry is used in many common areas, for example; pharmaceuticals, cosmetics, plastics, food, beverages, soaps, detergents and water treatment. It is also used in various traditional activities such as food preservation and production of local items like soap.

1.2 The Meaning of Chemistry

Chemistry deals with the study of matter and the changes that occur to substances under different conditions. Many people think of Chemistry as simply mixing unknown liquids or chemicals in the laboratory like ones shown in *Figure 1.3*, but even things you do at home involve Chemistry and it is part of everything in your life. The changes you will observe and discuss in *Activity 1.2* will help you to further explain what Chemistry is all about.

Activity 1.2: Meaning of Chemistry

What you need

- paper
- candle
- box of matches

What to do

1. Place a candle on a table and light it using matchsticks.
2. Hold the piece of paper in the flame of the burning candle.
3. What changes take place to the paper?
4. Now consider the following processes which take place in daily life:

a) The rusting of a kitchen knife
b) The boiling of water
c) The rotting of fruits
   i) Describe the changes that take place in each of the three processes.
   ii) What are the necessary conditions for each of the delete changes to take place?
   iii) Name any other process in which materials change from one form to another.

What is Chemistry?

Chemistry is the study of matter, its properties, how and why substances combine or separate to form other substances, and how substances interact with energy.

Figure 1.3: Examples of Chemicals used in Chemistry

1.3 Why Study Chemistry and How it Relates to Other Subjects?

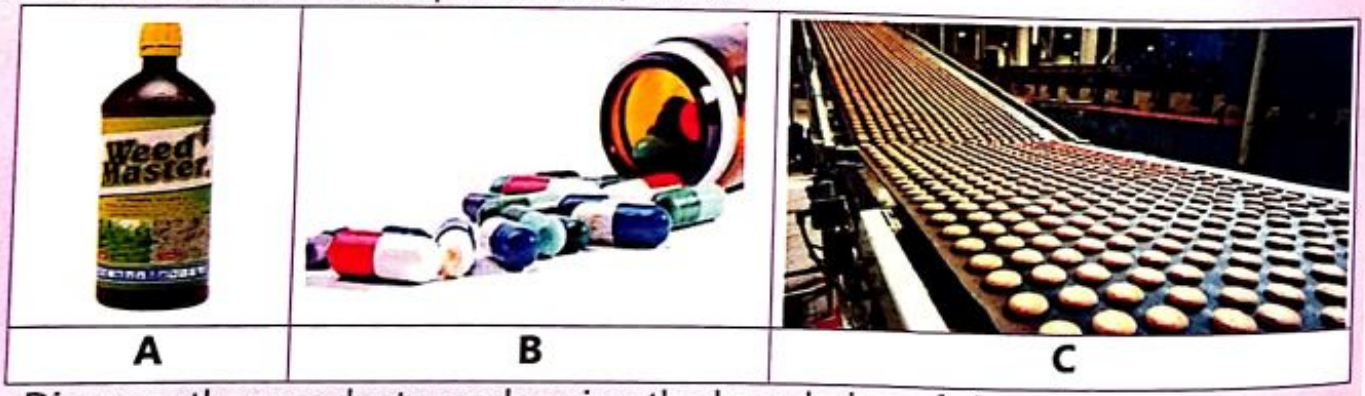
In this section, you will find out why you study Chemistry and how it relates to many other subjects such as Biology, Mathematics, Physics and Geology.

Activity 1.3(a): Finding out why you study Chemistry

What to do

In groups:

1. Discuss why we study Chemistry.
2. Identify the products A, B and C in the figure below.
3. Discuss the use of the products A, B and C.



A | B | C

4. Discuss other products made using the knowledge of chemistry.
5. Present your findings to the rest of the class.

Activity 1.3(b): Finding out the relationship between Chemistry and other subjects

What to do

In groups:

1. Discuss the relationship between Chemistry and other subjects such as Biology, Physics, Agriculture, Geology and Mathematics.
2. Share your findings with the rest of the class.

Chemistry is sometimes referred to as the "central science". This is because it uses the knowledge of Physics and Biology and the two sciences also borrow from the knowledge of Chemistry. Although Chemistry and Physics both study matter, Chemistry is concerned with the *composition of matter*, their *properties* and *reactions*, and the *formation of new substances*. On the other hand, Physics is concerned with the *nature* and *properties of matter and energy*. "Physics exists because of Chemistry"

Biology studies living organisms and Biochemistry, one of the study areas in Biology, studies the chemical compounds and processes occurring in living organisms. Biochemistry has become the basis of understanding all Biological processes.

Figure 1.4 illustrates the relationship that exists between Chemistry and other fields of science.

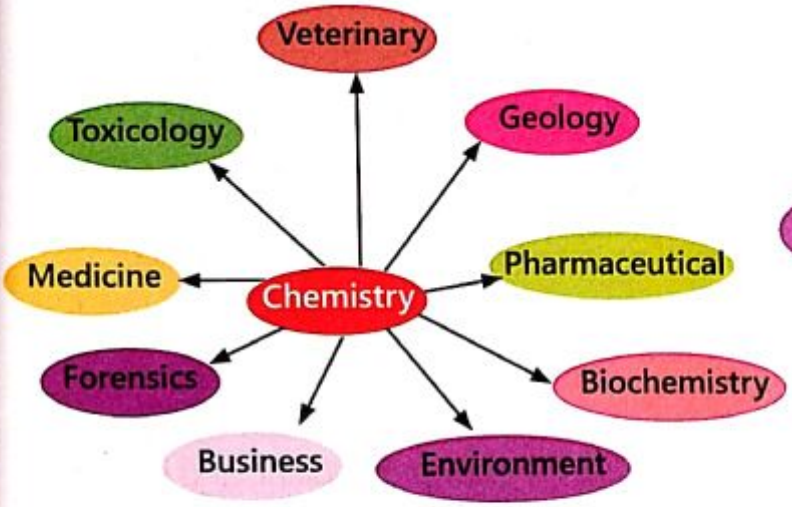


Figure 1.4(a): *Relationship between Chemistry and fields of science.*

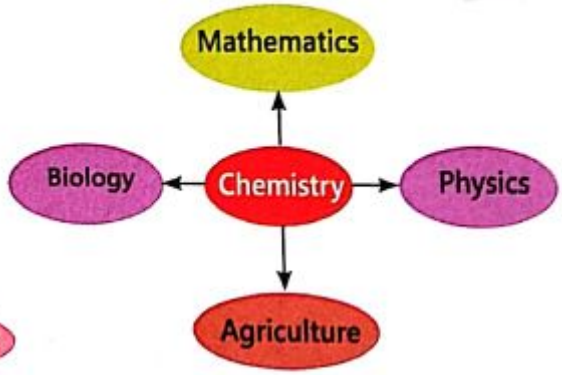


Figure 1.4(b): *Relationship between Chemistry and other subjects.*

DID YOU KNOW?

Marie Curie was a Polish and naturalised French Physicist and Chemist who won the Nobel Prize in both Physics and Chemistry. She was the first woman to win a Nobel Prize and the only person to win the prize in two different scientific fields.

1.4 Importance of Chemistry

All matter is made up of chemical elements. There are many changes that you observe in the world around you that are caused by chemical reactions. The study of chemistry helps you to understand and explain such changes.

In everyday life, you use products that contain chemicals, for example; medicines, cosmetics, foods and beverages, plastics, detergents, fertilisers and so on. It is therefore important to study the compositions, structure and changes related to the chemicals that make up these products that you use in your daily life.

Activity 1.4: Finding out the importance of Chemistry in everyday life

What to do

1. Using the explanation of what Chemistry is;
   a) Discuss various chemical processes found in different activities that you come across on a daily basis.
   b) Talk about the importance of the Chemical processes in the activities mentioned in (a).

QUICK TIP

Consider simple activities like cooking, breathing, digestion, growing of food crops, cleaning, as well as more complex activities like the production of medicines, chemical engineering, production of nuclear energy, alcohol and cigarettes.

2. Present your ideas generated in (1) in a *Table 1.1*

Table 1.1: Importance of Chemistry in our everyday life

Activity	Chemical process in the Activity	Importance of Activity in our daily life
• Cooking	• Heating the food makes it tastier and easily digestible. • Increases scent in the food. • Kills germs.	• Softens the food

Chemistry is applied in some of the daily activities for example, cooking and breathing.

The following examples illustrate how predominant and important Chemistry is in daily life.

Importance of Chemistry

The pictures below show the different products manufactured by chemists.

detergent


drugs


olive oil


yorghurt

Assignment 1.1

Chemistry in your daily life

- Carry out research to identify ten other common activities in our daily life that apply the knowledge of Chemistry.

1.5 Contribution of Chemistry to the Economy of Uganda

Figure 1.5: Chemistry in use

From earlier discussions in the previous sections, it is clear that Chemistry is part of most of your daily activities. It therefore means that Chemistry contributes significantly to your society. In this section, you will explore the contribution made by Chemistry to the economy of your country.

Activity 1.5: Investigating how Chemistry contributes to the economy of Uganda

What to do

As a class, visit a few manufacturing industries related to transport, Agriculture, Pharmaceuticals and Food processing, found around your school and identify the products made in the factories.

Sugar packaging

Answer the following questions about the products made there.

1. What chemical processes are applied in the processing of the products identified?
2. What is the importance of these products to the lives of Ugandans?
3. In groups, discuss what you have established from your field visits as a class.
4. Discuss the contributions of the industries visited and the products they make to the economy of Uganda.

QUICK TIP Relate the chemical processes used in the making of the products to their importance in the country.

5. Write a short report identifying the areas in Chemistry which contribute to the economy of Uganda and share your report with the rest of the class.

Even though manufacturing is not well developed in Uganda, there are a number of processing industries producing various products for local use, as well as for export to neighbouring countries.

Table 1.2: Application of Chemistry in different sectors. Fill the table correctly

Product	Industry	Sector
		
		
		
		
		
		

Agriculture is the main economic activity in Uganda. Chemistry is applied at various stages, for instance, in the growing of crops, poultry and fish foods. Such stages include the application of fertilisers, spraying of the crops with pesticides and herbicides to kill pests and weeds and processing of the harvested crops to preserve them longer.

You can, therefore, see that Chemistry plays a vital role in ensuring that the population in Uganda and the world at large always has food available.

Assignment 1.2

Use of agrochemicals in food production

1. Carry out research to identify the advantages and disadvantages of using chemicals to increase food production.
2. How can you safely use chemicals in food production?
3. Discuss your findings in (1) and (2) above with the rest of the class.

The continuous use of land without leaving it to fallow results in the depletion of nutrients of such land. Inorganic fertilisers are added to such soils to replenish them with nutrients. However, excessive use of inorganic fertilisers results into poor yields due to the formation of acidic soil.

DID YOU KNOW? Fish scales are a common ingredient used in making lipstick!

ICT Activity

In groups, using the Internet, conduct research on why you study Chemistry and the careers related to the knowledge of Chemistry.
Write a report and present your findings to the rest of the class using Microsoft office.

Sample Activity of Integration

Most people in Uganda depend on Agriculture for food and for employment. In addition, Agriculture contributes to the highest percentage of her exports. However, the sector is faced with many challenges including pests and parasites affecting the crops and livestock leading to poor crop and animal yield. Experts predict that if this is not solved, the country's export exchange would fall.

Figure 1.6: *Infected maize crop*

Figure 1.7: Cow affected by ticks

Task

As a Chemistry learner, you are requested to write a short message to the local council Chairperson to advise the farmers on how to prevent the pests and parasites. In your report you should include three methods to prevent pests and parasites.

Chapter Summary

In this chapter, you have learnt that:

- Chemistry is one of the three natural sciences. Its subject materials and theories are based on experimental observation.
- Common chemicals in pharmaceutics, cosmetics, plastics, foods and beverages, soaps, detergents, water treatment are related to Chemistry.
- Chemistry is the study of matter and the changes that occur to substances under different conditions.
- Chemistry is vital in our daily life and actually occurs in more activities we undertake than we are consciously aware of.
- Chemistry plays a vital role in ensuring the food security of the growing world population.
- Chemistry greatly contributes to the economy of Uganda in sectors such as mining, agriculture, transport and manufacturing.

Review Exercise:

1. Why is Chemistry referred to as a laboratory science?
2. Physics deals with the relationship between energy and matter, Biology deals with living things. What does Chemistry deal with?
3. The following are changes that take place in everyday life;
   i. Some metal surfaces get corroded with time.
   ii. Making a cup of tea.
   Describe the changes that take place in each of the processes mentioned in (i) and (ii).
4. Chemistry has contributed to society both positively and negatively. State three ways in which it has done so, explaining the positives and negatives.
5. Identify three main sectors in the economy of Uganda where Chemistry plays an important role.

Chapter 2

Experimental Chemistry

Keywords

- boiling points
- bunsen burner
- experimental
- flame
- fragile
- hazardous
- laboratory
- laboratory apparatus
- liquor
- mixture
- substance
- melting point
- precautions

By the end of this chapter, you should be able to:

a) know laboratory rules and regulations and understand the importance of risk assessment in order to work safely and know the action required in the event of an accident.
b) identify the laboratory apparatus and know how to use laboratory equipment appropriately.
c) understand the scientific method to carry out investigations and the importance of risk assessment to keep oneself and others safe.
d) know how to purify the mixture given and the substances involved.
e) know how to identify substances and their purity by using their melting and boiling points.

Competency: You should be able to explain that chemistry is a process of evidence–based enquiry involving the collection of evidence about the natural world, the identification of the trends and patterns in the evidence and the development of theories that help us explain the evidence.

Introduction

Have you ever wondered why the container holding water which is being heated is always covered? Or have you ever prepared local alcohol, melted *Kimbo* or *Cowboy* or frozen water into ice cubes? All these require a set of procedures which must be followed carefully before a final product is obtained.

Ideally, when someone visits a hospital, he/she has to undergo certain tests. In this case, there are sets of instructions which must be followed carefully before coming to the right conclusion. The result may be positive or negative. All the sets of instructions one follows and the observations made to come to the right conclusion are referred to as **an experiment.**

In this chapter, you will learn to; conduct scientific enquiries through making observations, asking questions, forming theories to answer the questions, making predictions and testing them through experimentation and drawing conclusions, or making new theories.

Experimental Chemistry is the science of observation. You make an observation and ask a question to nature, then carry out corresponding experiments and observe the outcome.

A laboratory is a special room equipped with tools for performing scientific experiments. Laboratories are found in schools and hospitals. Where else can laborties be found?

An investigation is a set of instructions or procedures that must be followed in order to come up with a conclusion.

Laboratory tools are objects that are used in a laboratory to facilitate the study of a given subject.

Apparatus are a set (collection) of tools that are used in a particular experiment.

Figure 2.1: *Part of a laboratory*

Activity 2.0: Kitchen as a home laboratory

a) At home, cooking is done in a special room using a set of tools and following special rules. Write down some of the tools and rules that you always follow while cooking in the kitchen.

b) At school, there is a special room where all investigations are carried out. This special room must have at least two exits. What name is given to this special room?

2.1 Laboratory Rules, Regulations and Safety

Laboratory rules are to safeguard you the young scientist and others while in the laboratory. Just like the school rules you have been given, laboratory rules are to be followed strictly. The Chemistry laboratory contains hazardous substances including highly flammable liquids and fragile apparatus, therefore, you need to be careful while in this laboratory.

Activity 2.1(a): Identifying laboratory rules and regulations

What to do

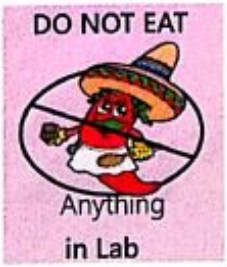
Study the laboratory rules and regulations chart provided by your teacher.
Using the knowledge from the chart, study *Figure 2.2* and answer the questions that follow.

Figure 2.2: *Learners in a laboratory*

In groups

1. Discuss the reason(s) for each rule.
2. Design posters showing each of the rules in the laboratory.
3. Form a table showing a rule and its reason as shown in *Table 2.1.*
4. Using *Figure 2.2*;
   i) discuss the laboratory rules and regulations broken by some students.
   ii) discuss the possible dangers that may arise due to breaking of the above rules.

Table 2.1: Laboratory rules, regulations and safety

No	Rule	Reason(s)
1.		Some substances in the laboratory are poisonous and can easily get in contact with food

Activity 2.1(b): Safety precautions

What to do

In groups identify the materials in *Figure 2.3* and *Figure 2.4*, giving importance of each case.

Figure 2.3: *First aid box*

Figure 2.4: *A group of assorted items*

Remember! While you are in the laboratory, always follow the instructions given to you by your teacher and laboratory technician(s).

Activity 2.1(c): Demonstrating how to deal with fire outbreaks using a fire extinguisher

What you need

- fire extinguisher
- heap of used papers
- box of matches

What to do

1. Using a lit match stick, light the heap of used papers to produce a small fire.
2. Remove the portable fire extinguisher from its location in the laboratory and then follow the steps below to extinguish the fire (Remember the acronym, "**P.A.S.S.**").

- **P**ull the pin: this will break the tamper seal.
- **A**im low, pointing the nozzle or hose at the base of the fire.
- **S**queeze the handle to release the extinguishing agent.
- **S**weep from side to side at the base of the fire until it is off as shown in *Figure 2.5*.

1st

Pull the pin (or other motion) to unlock the extinguisher

2nd

Aim at the base (bottom of the fire and stand 6 - 10 feet away)

3rd

Squeeze the lever to discharge the agent

4th

Sweep the spray from left to right until the flames are totally extinguished

Figure 2.5: *Using a fire extinguisher*

3. In groups, discuss how to deal with fire in a laboratory.

Assignment 2.1

1. Visit a petrol station and find out the materials used in case of a fire outbreak.
2. Find out the precautions taken to minimise fire outbreak.
3. In your groups, using campaigns and posters, create awareness on ways of stopping fire outbreaks in your school community.

Handling hazardous chemicals safely

As you now already know, various experiments take place in the Chemistry laboratory. Most of the experiments involve mixing or reaction of different substances in order to make an analysis. Such substances or mixtures are known as chemical reagents.

Some of the reagents that are used in the Chemistry laboratory are hazardous. International rules require that hazardous chemicals are labeled and classified as per set standards.

The classification and labeling are an essential tool for identifying hazardous properties in chemicals which may constitute a risk during normal handling or use. This could be a risk to health, property and the environment.

Activity 2.1(d): Finding out the common hazard symbols on the reagent bottles

What you need

- Reagent bottles

What to do

1. Display all the reagent bottles on a table.
2. Identify common hazard symbols on the reagent bottles and their meaning.
3. Create a table indicating the symbols and their meanings.

Table 2.2:

Symbol	Name	Meaning

2.2 Laboratory Equipment and their Uses

Scientists use the laboratory to carry out experiments. There are specific tools that are required for particular experiments, for example, the Bunsen burner for heating. A collection of tools used to carry out different experiments are referred to as ***laboratory equipment*** or ***apparatus.*** The equipment is made of different materials such as glass, plastics, metal, porcelain and wood.

Activity 2.2(a): Identifying common tools used to carry out experiments in the chemistry laboratory

In groups, use the laboratory equipment provided to carry out the following investigations.

What you need

- Laboratory apparatus

What to do

1. You are provided with different laboratory apparatus, draw, name and suggest the use of each apparatus identified.
2. Represent them in a Table as shown in *Table 2.3.*

Table 2.3

Name of the apparatus	Diagram	Use

Use some the apparatus in *Table 2.3,* to answer the *Activity 2.2(b).*

Activity 2.2(b): Finding out common tools used to carry out experiments in the Chemistry laboratory

What to do

1. Measure 5 g of sand
2. Measure 200 cm^3 of water
3. Mix the sand and water in a suitable apparatus
4. Stir the mixture
5. Using appropriate equipment, separate sand from water.
6. Measure the amount of sand and water obtained after the separation

Questions

1. Which apparatus did you use to;
   a) measure sand?
   b) measure water?
   c) mix?
   d) stir?
   e) separate sand from water?
2. Was the amount of water and sand the same before and after the separation? Explain your answer.

Safety precaution

The equipment made out of glass must be handled with care because it easily breaks. Most apparatus are made out of glass because glass is transparent and this makes it easy to observe different changes taking place during chemical reactions.

Sources of heat in the laboratory

Some experiments require heating in order for the reactions to occur. *Figures 2.6 and 2.7* show some of the heat sources used in homes.

Figure 2.6: An electric cooker

Figure 2.7: A paraffin stove

The Bunsen burner

DID YOU KNOW?

The Bunsen burner was designed by a German chemist called Robert Wilhelm Bunsen (1811). Read more about him.

At home, you use different sources of heat for cooking in the kitchen. Can you mention the sources of heat you use at home?

However, in the laboratory you use a special equipment called a Bunsen burner. *Figure 2.8* shows a Bunsen burner.

Structure of a Bunsen burner

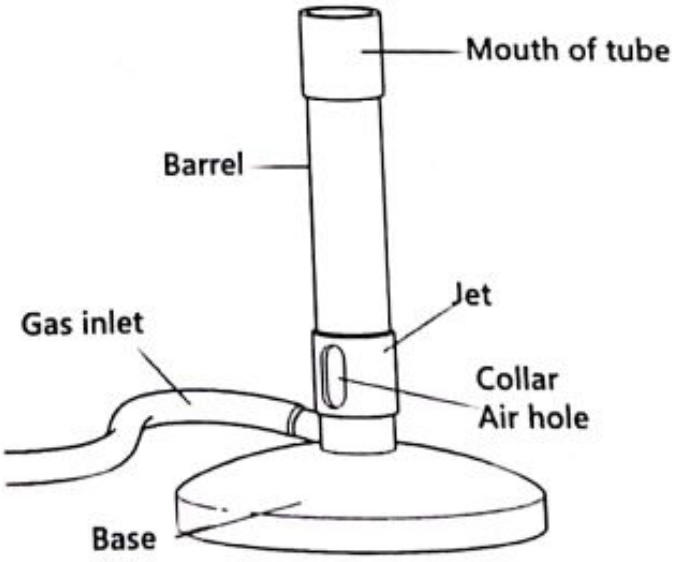


Figure 2.8: A Bunsen burner

Activity 2.2(c): lighting a Bunsen burner

What you need

- a Bunsen burner
- gas cylinder
- box of matches

What to do

1. Connect the rubber tubing to the gas cylinder.
2. Adjust the collar to completely close the air holes.
3. Light a match stick and place it slightly above the chimney or barrel.
4. Turn on the gas.
5. Open the air holes
   a) What is the colour of the flame when the air holes are:
      i) closed? ii) open?
   b) What is the function of the collar, barrel/chimney, air holes and base?
   c) State the features of the flame(s) produced when:
      i) Air hole is closed ii) Air hole is open

Safety precaution

Make sure that gas is turned off when not in use.

Bunsen flames

The gas from the cylinder mixes with air and burns when lit to produce a flame. The type of flame produced depends on whether the air holes of the bunsen burner are open or closed.

Activity 2.2(d): Comparing luminous and non-luminous flame

What you need

- bunsen burner
- nichrome wire or cardboard
- test tube holder
- box of matches

What to do

1. Close the air holes and light the Bunsen burner.
2. Observe and note the following about the flame;
   i) colours iii) stability v) any other
   ii) size iv) sound
3. Hold a clean test tube in the flame.
4. Using a pair of tongs, hold a nichrome wire across the middle of the flame.
5. Open the air holes and repeat the *procedures 2, 3* and *4*.
6. Compare the two flames
7. Which Bunsen flame would you use for;
   i) heating in the laboratory? iii) explain your answer
   ii) lighting?
8. Draw labeled diagrams of the Bunsen burner flames.

Note

Never attempt to blow off the Bunsen burner flame because it may burn you. To extinguish a Bunsen burner flame, close the air holes and turn off the tap.

Other sources of non-luminous flame

Figure 2.9, 2.10, 2.11 show sources of non luminous flame

Figure 2.9: *A gas cooker*

Figure 2.10: *Welding flame*

Figure 2.11: *A paraffin stove*

Other sources of luminous flame

Figure 2.12, 2.13, 2.14 show sources of luminous flame

Figure 2.12: *Firewood*

Figure 2.13: *Candle flame*

Figure 2.14: *Bush fire*

DID YOU KNOW?

In 2019, 90% of Ugandan households use wood fuel for cooking. 60,933 hectares of forest cover have been cut down between 2002 and 2018 for wood.

2.3 The Scientific Method of Carrying out Investigations and its Importance

As an aspiring young scientist, you are going to search for answers to solve problems in your environment. It is important to use your environment sustainably, since it is the source of food, energy and other materials.

As a chemist, you will be more like a detective: You will look for evidence. When you go to the laboratory, collect data (evidence), put the evidence together and form a theory explaining the properties that cannot be observed easily through a process called the **scientific method.** The method involves the following steps.

Table 2.3: Steps to be followed while carrying out an investigation

Step	Description	Example
	Make observations. Look around and ask questions about something that has puzzled you for some time.	Is coca cola a pure liquid?
	Formulate a hypothesis (idea) that may be true or untrue.	Coca cola could be a pure liquid or a mixture.
	Design and perform an experiment to test whether it is true or untrue.	Determine the boiling point of coca cola. Does it have a constant boiling point?
	Analyze the results and accept or change the hypothesis.	For example, if coca cola has a constant boiling point, then its a pure liquid. If it does not, you may ask yourself now on the components of the mixture
	If conclusive, accept and develop a law or a theory.	For instance, if your hypothesis was that coca cola is a pure liquid, then your results would show that it has a constant boiling point

Observation → Hypothesis → Experiment → Law/theory

2.4 Purification of Mixtures

Activity 2.4(a): Separating a mixture of salt and sand

What you need

- a mixture of common salt and sand
- beaker
- glass rod
- filter funnel
- filter paper
- water

What to do

1. Put the mixture of sand and salt in a beaker.
2. Add water to about ½ the volume of the beaker.
3. Stir the mixture with the glass rod.
   i) What happens to the salt?
   ii) What happens to the sand?
   iii) How can you separate the liquid from the sand?
   iv) How can you obtain salt from the solution in water?
   v) Is the salt obtained pure or not?

Activity 2.4(b): Separating a mixture of salt from its aqueous solution

What you need

- evaporating dish/watch glass
- beaker
- tripod stand
- Bunsen burner
- aqueous salt solution
- water

What to do

1. Half fill a beaker with water and place it on a tripod stand with wire gauze.
2. Heat the beaker of water.
3. Pour some of the salt solution on an evaporating dish or watch glass and place it on the steam bath as shown in *Figure 2.15.*
4. What do you observe?

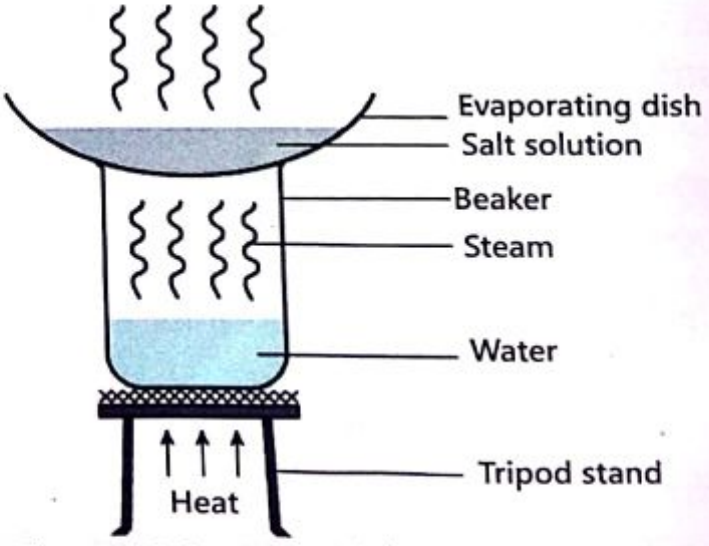


Figure 2.15: *Separating salt from its aqueous solution*

Activity 2.4(c): Separating a mixture of iron and sulphur

What you need

- bar magnet
- sulphur
- iron fillings
- petri dish

What to do

1. Put the mixture of sulphur and iron fillings on to the petri dish.
2. Pass a bar magnet just above the mixture as shown in *Figure 2.16.*
   a) What do you observe? Explain.
   b) What other mixture can be separated using this method?

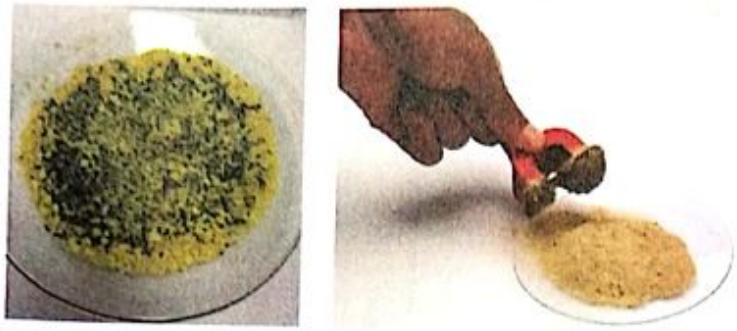


Figure 2.16: *Separating iron fillings from a mixture of iron and sulphur*

When iron is contaminated, it can be purified by using a magnet because iron has magnetic properties; it is attracted to the magnet, leaving the impurities behind.

DID YOU KNOW? One way of detecting iron metal in food is by use of a magnet.

Distillation

When a liquid mixture is heated, the liquid with the low boiling point evaporates and its vapour condenses into a liquid. The liquid formed after condensation is the ***distillate*** and what remains in the distilling flask is the ***residue.*** The process which involves evaporation followed by condensation is referred to as ***distillation.***

Activity 2.4(d): Distilling fermented liquor

What you need: A local brew for example;

- tonto
- muramba
- ajono
- malwa
- bushera
- a fermented solution of sugar and yeast

What to do

1. Study *Figure 2.17.* and identify the activity taking place.
2. What materials can be used in the laboratory in place of those used in *Figure 2.17?*
3. Set up the equipment that can be used to separate the fermented mixture provided in the laboratory.

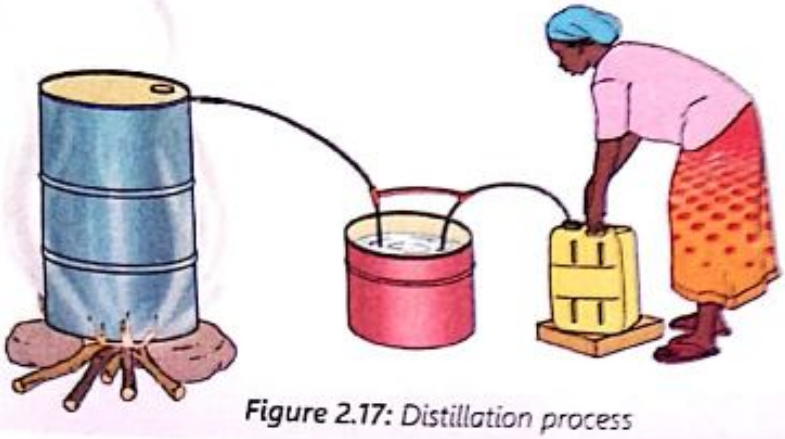


Figure 2.17: Distillation process

Paper chromatography

This is a method for separating dissolved substances from one another. It is often used when the dissolved substances are coloured, such as inks, food colouring and plant dyes.

Figure 2.18: Paper chromatography

It works because some of the coloured substances dissolve in the solvent used better than others, so they travel further up the paper as shown in *Figure 2.18*.
It also depends on how the solute is adsorbed on the stationary phase. The stronger the adsorption, the shorter the distance the solute travels.

Activity 2.4(e): Separating of dyes in ink using chramatography

What you need

- beaker
- dropper
- a filter paper
- water
- ink

What to do

1. Place a filter paper on top of a beaker.
2. Using a dropper, add a small drop of ink on the centre of the filter paper. Leave it to spread and dry.
3. Using a clean dropper, add a drop of water in the middle of the ink spot. Leave it to spread and dry.
4. Continue adding drops of water, allowing them to spread and dry until there is no further spreading as shown in *Figure 2.18*.
   a) What do you observe?
   b) Draw a chromatogram.
   c) Interpret your chromatogram in terms of solubility and rate of movement of the dye particles.

Assignment 2.2

Chromatography

1. Research and discuss;
   i) other coloured substances that can be separated using chromatography.
   ii) the use of locating agents in chromatography of colourless substances.
   iii) how chromatography is used in our daily life.
2. Present your findings to the rest of the class.

Activity 2.4(f): Obtaining a pure substance of iodine and common salt

What you need

- a glass beaker
- 10g of common salt
- cold water
- tripod stand
- round bottom flask
- 5 g of iodine
- heat source
- wire gauze
- plasticine

What to do

1. Mix 10g of common salt and 5 g of iodine in a glass beaker.
2. Set up the apparatus as shown in *Figure 2.19*.
3. Heat the glass beaker containing the mixture.
4. Cover the beaker with a round bottomed flask containing cold water and block the remaining space using plasticine.
5. Observe and write down what happens.

Safety precaution

Iodine is poisonous and corrosive and, therefore, it should not be tasted or touched with bare hands.

Some substances exist in pure form, while others exist in impure form. Pure substances have specific melting and boiling points. On the other hand, impure substances contain two or more elements physically combined and this is considered to be a mixture.

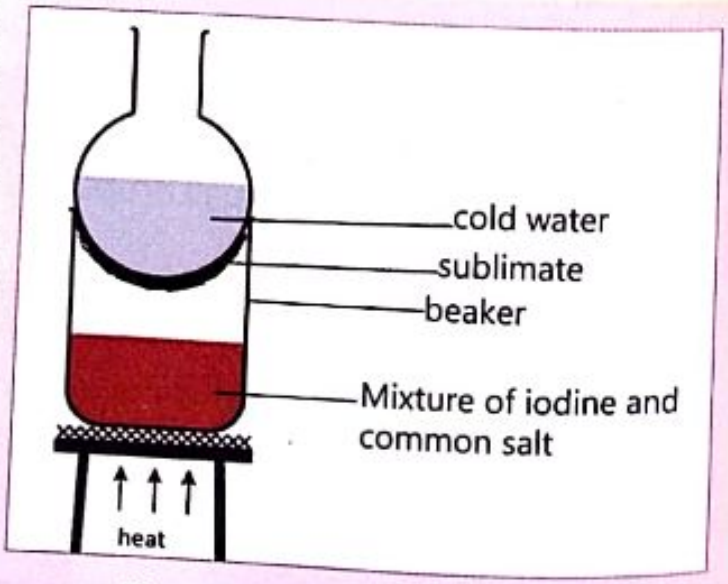


***Figure 2.19**: Purification of iodine*

2.5 Identification of Substances and their Purity by Using their Melting and Boiling Points

The fixed temperature at which a pure substance turns from solid to liquid is its ***melting point*** and from liquid to vapour is its ***boiling point.***

Simple criteria for determining purity

The purity of a substance can be tested by:

i) determining its boiling point
ii) determining its melting point/ freezing point
iii) determining its density

Activity 2.5(a): Determining the melting point of naphthalene

What you need

- a thermometer
- retort stand
- boiling tube
- stirrer
- tripod stand
- wire gauze
- beaker
- pure and impure naphthalene
- water

What to do

1. Place some naphthalene in a boiling tube and insert a thermometer in it.
2. Place the boiling tube in a beaker of water and arrange the apparatus as shown in *Figure 2.20.*
3. Heat the water while stirring gently.
4. When naphthalene begins to melt, stir with the thermometer and note the steady temperature at which the solid naphthalene melts. This is taken to be the melting point of naphthalene. Record the temperature.
5. Repeat the experiment using impure naphthalene. Record the temperature at which the impure naphthalene melts.
6. Comment on the melting point of pure and impure naphthalene and explain the effect of impurities on the melting point of naphthalene.

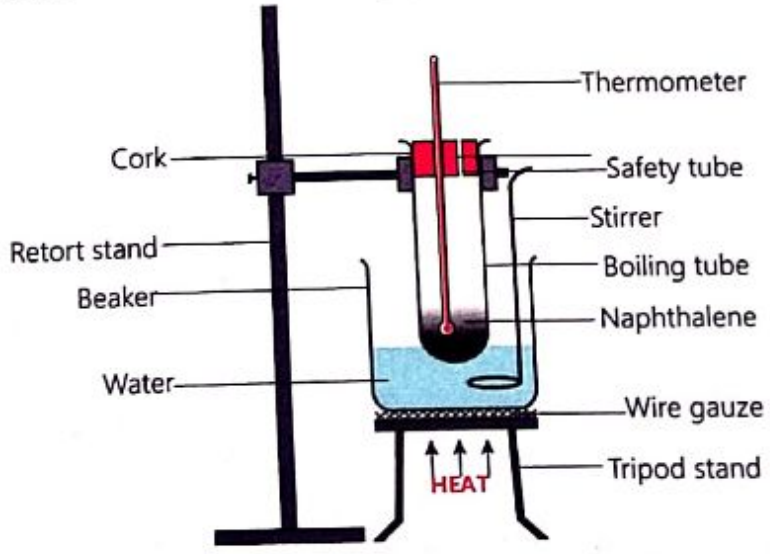


Figure 2.20: *Experiment set up to determine the melting point of naphthalene*

Activity 2.5(b): Determining the boiling point of ethanol

What you need

- a thermometer
- retort stand
- boiling tube
- stirrer
- tripod stand
- wire gauze
- beaker
- ethanol
- water
- anti-bumping stones

What to do

1. Place about 10 cm^3 of ethanol in a boiling tube and add some anti-bumping stones.
2. Suspend a thermometer to about 3cm above the surface of ethanol and place the boiling tube in a beaker of water as shown in *Figure 2.21*.
3. Heat the beaker gently and record the temperature at which ethanol boils. (This occurs when vapour condenses at the bulb of the thermometer and drops back) and Record the temperature as the boiling point of ethanol.
4. Repeat the experiment using impure ethanol.
5. Explain why;
   i) the thermometer was not dipped in the ethanol?
   ii) the safety tube was created?
   iii) the water bath was used to heat ethanol instead of heating it directly?
6. Comment on the boiling point of pure and impure ethanol and explain the effect of impurities on the boiling point of ethanol.

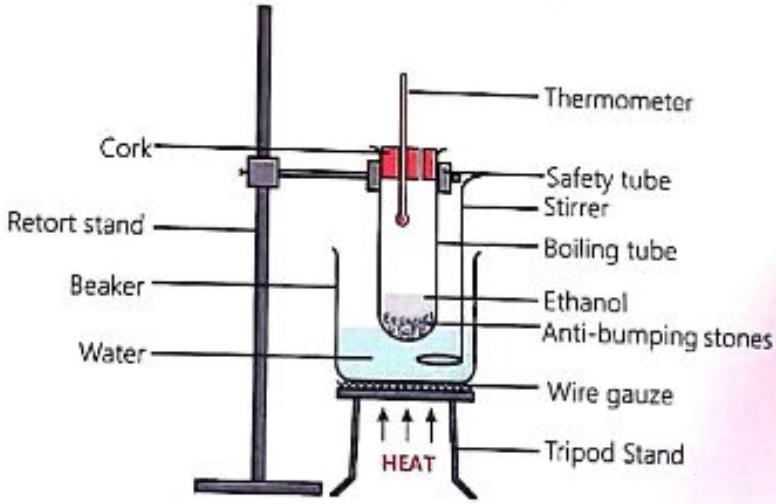


Figure 2.21: Experiment set up for determine of the boiling point of ethanol

Note

- At 1 atmosphere and at sea level, the boiling point of water is 100°C. However, the boiling point of pure liquid decreases with the increase in altitude and increases with decrease in altitude at atmospheric pressure.
- The presence of impurities, increases the boiling point and decreases the melting point of a liquid.
- Atmospheric pressure has little effect on the melting point of a solid because solid particles are very close together.

ICT Activity

In groups, prepare a brief message on the importance of a laboratory in the study of Chemistry. Use a suitable software to type your message and present your findings to the rest of the class.

Sample Activity of Integration

Your local community has completed the construction of the Chemistry laboratory at your local community secondary school. The next stage of the project involves purchase of apparatus, equipment and furniture for this laboratory.

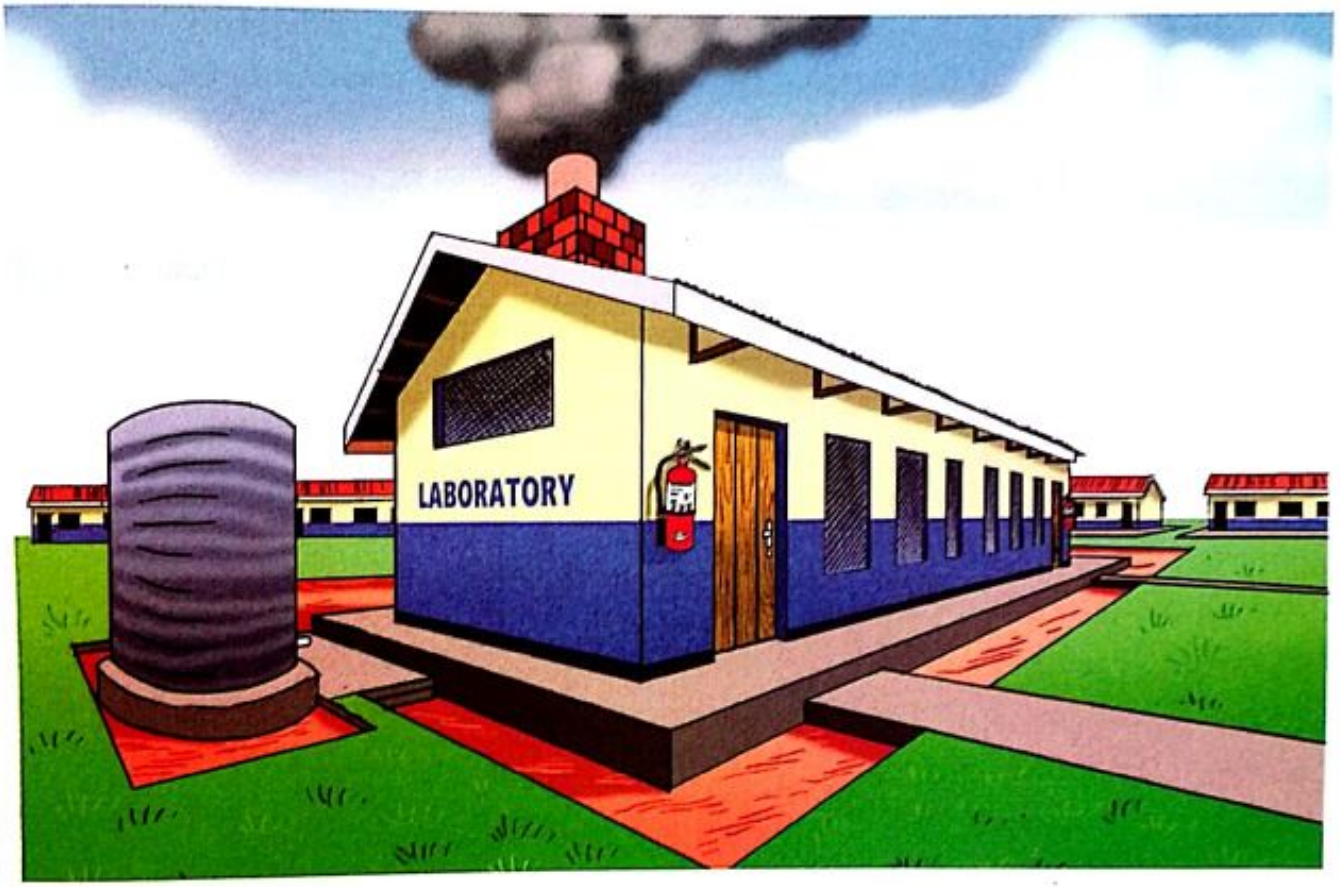


Figure 2.22: *School laboratory structure*

Task

As a student of Chemistry, write an article advising the local community committee in charge on the purchase of the apparatus equipment and furniture. In your advice give brief notes on the following;

i) the type of apparatus, equipment and furniture that should be purchased.
ii) the safe storage of the apparatus and equipment.
iii) the safe measures that should be followed by learners when using the laboratory.

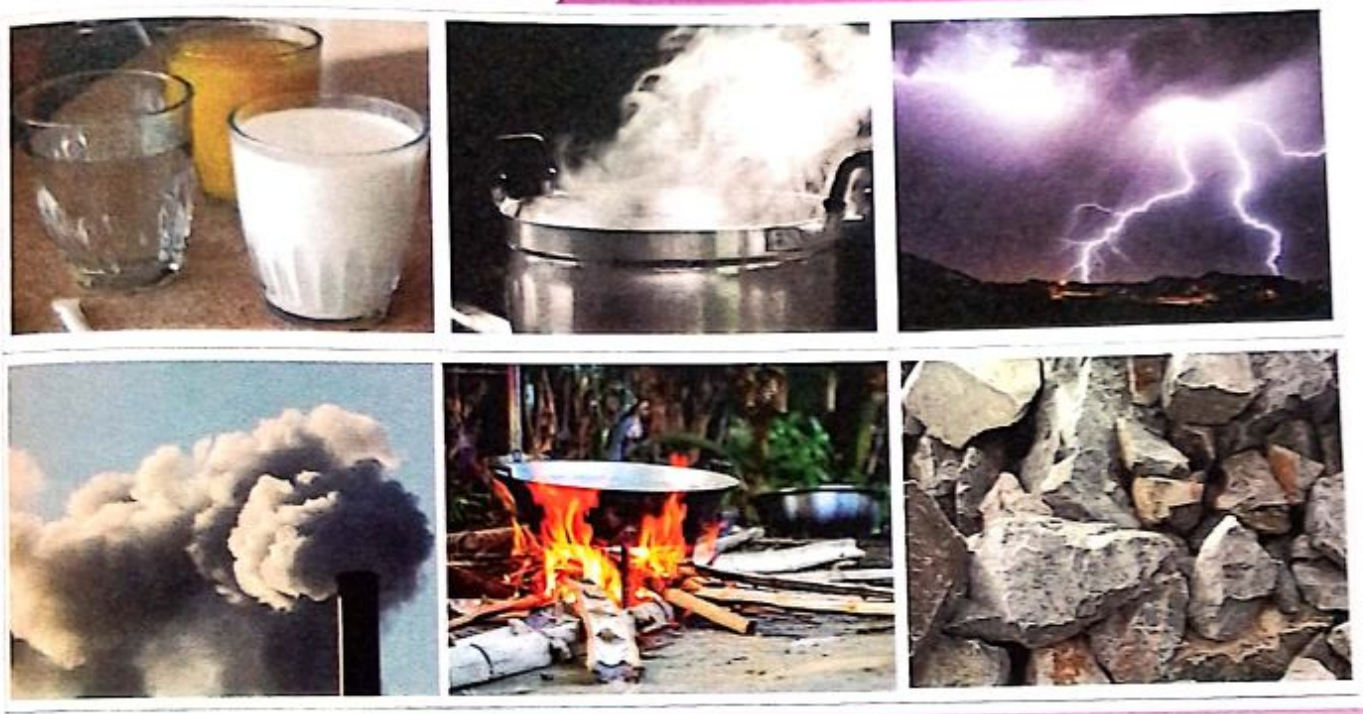
Chapter Summary

In this chapter, you have learnt that:

- A special room equipped with tools for performing experiments is called a laboratory.
- An experiment is a process in which one tests a new idea or method to see if it is useful or effective.
- Apparatus are a set (collection) of tools that are used in a particular experiment.
- There are different laboratory equipment including the; burette, pipette, conical flask, dropper, round bottomed flask, flat bottomed flask, measuring cylinder, reagent bottles, thermometer and retort stand.
- There are mainly three sources of heat in the laboratory: the Bunsen burner, paraffin stove and electric heaters.
- A flame is a region of burning gases which produce heat and light.
- A Bunsen burner produces two flames i.e. luminous flame and non-luminous flame.
- A luminous flame is produced when an air hole is closed.
- A non-luminous flame is produced when an air hole is open.
- A pure substance has a constant melting and boiling point.
- Some substances can be separated by filtration, chromatography, distillation and sublimation.

Chapter 3

States and Changes of States of Matter



Keywords

- change
- chemical change
- kinetic theory
- states of matter
- matter
- particle theory
- physical change
- anhydrous
- diffusion

By the end of this chapter, you should be able to:

a) understand that matter is anything that can occupy space and has mass and can exist in a solid, liquid and gas form.
b) understand that solids, liquids and gases have different properties, including shape, pouring and compressing.
c) know the kinetic theory of matter and use it to explain particle arrangement, interparticle forces, movement of particles and the properties of liquids, solids and gases.
d) understand that a change from one state to another involves either heat gain or heat loss.
e) appreciate the cooling effect of evaporation and how this contributes to maintaining constant body temperature.

Competency: You should be able to use the knowledge of the arrangement and motion particles to explain the properties of solids, liquids and gases.

Introduction

Your natural surrounding is made up of very many different objects that occur in different forms. You can detect or feel the presence of these objects or anything around you when you see, hear, smell, touch and taste them. For example, at home you see the chairs, cups, smoke from the kitchen, water and many other items as shown in *Figure 3.1.*

Figure 3.1: *Examples of matter in the kitchen*

What do you think is the scientific term or name given to the chairs, cups, water, smoke from the kitchen and anything else around you?

You will find out the scientific terms used to describe the general composition of objects or materials around you, the forms in which they occur and the properties of each of these forms.

3.1 What is Matter?

Anything you see, hear, smell, touch and taste is matter. Matter is anything that has mass and takes up space. Matter exists in many shapes, colours, textures and forms. Water, rocks, living things and stars are made of matter.

Matter exists in three forms i.e. solids, liquids and gases. It can also exist in **plasma** form, for example, lightening, fire and light from a bulb as shown in *Figure 3.2.*

Figure 3.2: Group of items that are made of different matter

Activity 3.1: Identifying and classifying the different states of matter

What you need

- various substances
- notebook and pen

What to do

1. Study the objects in *Figure 3.2* and identify the state of matter to which each object belongs.
2. Look around your classroom and outside. Classify the different items you see.
3. Make a table with four columns labelled solids, liquids, gases and plasma.
4. Write all solid substances you see in the picture in a column labeled solids. Do the same for the other columns.
5. Obtain physical substances you have listed as solids and liquids from your classroom or qutside the classroom and observe them critically.
6. Write down their physical properties.

3.2 The Properties of Different States of Matter

To understand the properties of matter, you need to look at the composition or particle nature of matter. Describing the composition of matter is not easy since the actual composition can only be assumed rather than observed.

Suppose you take a piece of chalk and break it up into tiny pieces and then break these tiny pieces into dust. It is still chalk. Then take the dust and then divide it until it is no longer visible. These invisible particles are still chalk.

DID YOU KNOW?

As early as 400 BC, the Greek philosopher Democritus thought that matter could be broken down until it can no longer be subdivided. He called these indivisible particles, ***atoms*** (from the Greek word meaning ***not divisible***)

By observing how particles behave in water and smoke, scientists developed a model (the particle theory of matter) to identify the composition of matter.

Activity 3.2(a): Identifying and classifying the different states of matter

What you need

- 6 beakers
- water
- measuring cylinder

What to do

1. Label the beakers provided as 1, 2, 3, 4, 5 and 6.
2. Fill all the beakers with 150 cm^3 of water.
3. Add a spatula endful of potassium manganate(VII) into beaker 1.

Figure 3.3: *Adding Potassium manganate (VII) in water*

4. Using a glass rod, stir to dissolve the crystals.
5. Measure 50 cm^3 of the solution formed and add it to beaker 2 containing 150 cm^3 of water and stir.
6. Measure 50 cm^3 of solution from beaker 2 and add it to beaker 3 and stir.
7. Measure the same amount of solution from the previous beaker and add it to the next beaker with water until you complete all the beakers.
   a) What do you observe?
   b) What conclusion do you make from the experiment? Share your findings with the rest of the class.

Note

Solids are made of small particles which are able to spread throughout the liquid. The number of particles per unit volume decreases as the amount of liquid increases. Did you realise that the colour of potassium manganate (VII) fades as you move from beaker 1 to beaker 6?

Think about it

It is easier to run fast on land than it is to swim. Why is this so?

Activity 3.2(b): Finding out if a solid, liquid and gas can be compressed

What you need

- water
- air
- 2 plastic bottles with lids
- a stone

What to do

1. Draw some air into the plastic bottle.
2. Close the opening using a lid.
3. Squeeze the bottle as shown in *Figure 3.4*. What do you observe?
4. Repeat procedure (3) using:
   i) a plastic bottle full of water.
   ii) a stone.
5. Compare the compressibility of the three states of matter.

Figure 3.4: *A compressed plastic bottle*

- Particles in air are far apart, the force of attraction between molecules of gas are negligible and, therefore, the molecules can easily be brought together.
- Particles in solids are closely packed, leaving almost no space in between them. The particles are tightly held together by strong forces of attraction.

Think about it

Why is a sponge compressible and yet it is a solid?

Activity 3.2(c): Investigating whether solids, liquids and gases have a fixed shape and volume

What you need

- a conical flask
- 100 cm^3 and 250 cm^3 beakers
- 100 cm^3 volumetric flask
- measuring cylinder
- pendulum bob

What to do

Liquid

1. Measure 100 cm^3 of water using a measuring cylinder.
2. Carefully transfer the water into the beaker provided. Then to the 100 cm^3 conical flask and finally into the volumetric flask.
3. Comment on the shape of the liquid in each container and note the volume.
4. Does the liquid flow? Share your observations with the class.

Solid

1. Comment on the shape of the solids provided.
2. Place each of the solid items given into a suitable container. Does the solid fill the available space of the container?

3. Discuss how you would determine the volume of the solids provided.
4. Do the solids flow? Report your findings to the rest of the class.

Gases: Demonstration

1. Use a mineral water bottle filled with bromine vapour and an open empty mineral water bottle of a bigger size.
2. Carefully invert the open bigger empty bottle over the bottle containing bromine vapour.
3. Quickly open the bottle containing bromine vapour. Leave it to stand.
4. What do you observe?
5. From the activities above draw a conclusion using a *Table 3.1*

Table 3.1: Properties of matter

Property	Solid	Liquid	Gas
Shape			
Volume			
Flow/pouring			
Compressibility			

6. Share your findings with the class.

3.3 The Kinetic Theory of Matter

All matter is made up of extremely tiny particles. There are spaces between the particles.

a) Each pure substance has its own kind of pure particles, different from the particles of other pure substances.
b) Particles attract each other.
c) Particles are always moving.
d) Particles at a higher temperature move faster on average than particles at a lower temperature.

There are things you experience in your daily life which can also explain that solids, liquids and gases are made up of small particles that you cannot see with our naked eyes. For example, think about air: you cannot see air particles because they are much smaller than grains of dust.

You know that they exist because you breathe in particles. You also feel the wind when many air particles are moving and hitting you. You can also see the effect of these air particles when they put out a burning candle.

Have you ever wondered why a stone cannot change its shape however much pressure is applied to it, yet water in plastic bottle changes its shape when pressure is applied to it and a balloon full of gas bursts when pressure is applied to it?

Force between particles

Activity 3.3(a): Finding out forces between solids, liquids or gases

Learners of Mutanoga Primary School report to school at 7:30 a.m. At 8:30 they enter class and settle for lessons. At 10:30 a.m they are given 30 minutes to break off. They move around school to refresh their minds. They again settle for lessons up to 1:25 p.m and then rush to the kitchen and line up for food. At 2:25 p.m they settle for the last lesson of the day which lasts two hours. After two hours, they go to their homes and school day ends.

At what time of the day do learners of Mutanoga Primary School likely to represent particles in:

a) gases b) liquids c) solids

Particles in solids

Figure 3.5: *Arrangement of particles in solids*

Particles in liquids

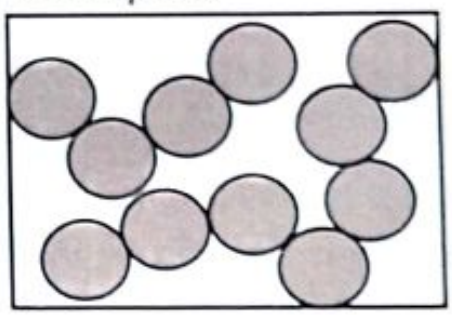


Figure 3.6: *Arrangement of liquid particles*

Particles in gases

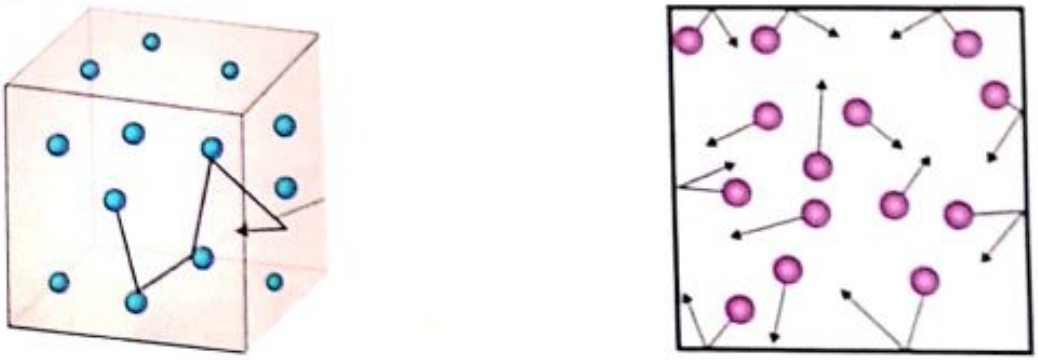


Figure 3.7: *Arrangement of gas particles*

Diffusion

When an orange is peeled from one corner, its aroma spreads out to the surrounding and can be smelt at a distance away from the corner (the source of the aroma), the region where concentration of spreading particles is highest.

Diffusion is, therefore, the movement of particles from the region of higher concentration to a region of lower concentration due to random motion of particles.

What other substances diffuse?

In *Figure 3.8(a), 3.8(b), 3.8(c), 3.8(d)* show some of the substances that differ.

Figure 3.8(a): *Red food colouring*

Figure 3.8(b): *Rosemary leaves*

Figure 3.8(c): *Fried Food*

Figure 3.8d): *Lemon Juice*

Activity 3.3(b): Demonstrating diffusion in liquids

What you need

- potassium manganate (VII)
- a tea bag
- water
- beakers

What to do

1. Fill the beaker with very hot water and another beaker with warm water.
2. Carefully place tea bag leaves into the beaker.
3. Do not shake the beaker but look at what happens to the water during the rest of the experiment.
4. What is the colour of the water at the end of the experiment.

Figure 3.9: *A set up to demonstrate diffusion in liquids*

5. Repeat the procedure 1, 2, 3 and 4 using a tiny crystal of potassium manganate(VII) instead of tea bags.
6. In groups, explain and present your observations to the class.
7. With reason compare the rate of diffusion in warm water and in very hot water.

Diffusion in Gases

If someone is cooking in the kitchen, it does not take long for the smell to travel around the house to other rooms. Gas particles from car exhaust fumes, perfumes or flowers diffuse through the atmosphere. Your nose detects the small particles. This is how you smell things around you.

Activity 3.3(c): Investigating diffusion in gases

What you need

- bromine liquid
- two empty gas jars
- gas jar covers

What to do

1. Transfer a drop of bromine liquid into a gas jar and cover it.
2. Invert an empty gas jar and place it on top of the jar full of bromine with its cover.
3. Carefully remove the cover lid and let the two open ends of the jars be in contact.
4. Leave them to stand for 30 minutes.
5. Write down your observations and share them with the rest of the class.

Activity 3.3(d): Investigating the rate of diffusion of lighter and heavier gases

What you need

- a glass tube
- pair of tongs
- clamp and stand
- cork
- concentrated hydrochloric acid
- concentrated ammonia and cotton wool

What to do

1. Clamp the glass tube horizontally.
2. Using a pair of tongs, dip a piece of cotton wool in concentrated hydrochloric acid (giving off hydrogen chloride gas) and another piece of cotton wool in concentrated ammonia (giving off ammonia gas).
3. Insert the two pieces of cotton wool simultaneously at opposite ends of a glass tube and cork the two ends as shown in *Figure 3.10*.
4. Wait for a few minutes.

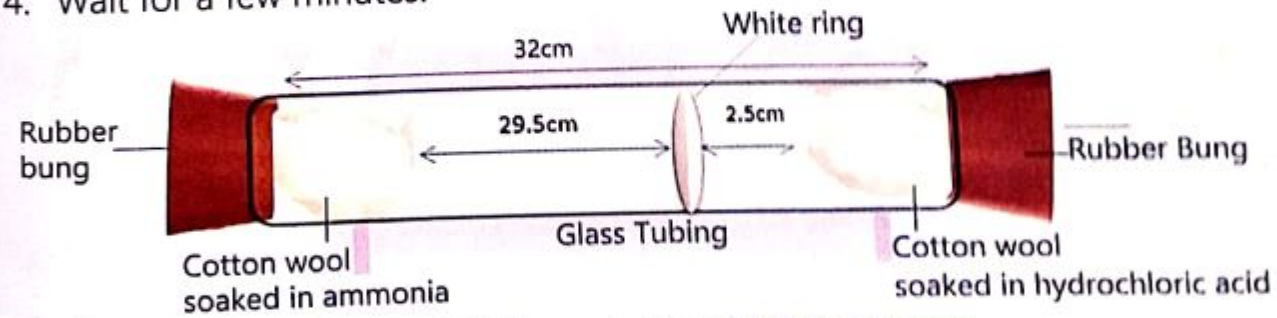


Figure 3.10: *Demonstration of diffusion in gases*

a) Why does the ring not appear immediately?
b) Which of the two gases diffuses faster in air?
c) Which of the two gases has a higher density?

From Activity 3.3(c), you have realised that ammonia gas traveled a longer distance than hydrogen chloride gas from hydrochloric acid. This is because ammonia gas has a smaller mass compared to hydrogen chloride gas and since the volume occupied by any gas is the same, the density of ammonia is lower and therefore travels faster than hydrogen chloride gas.

3.4 Changes of State by Heat Gain or Loss

The importance of any state of matter depends on its capability to change from one state to another, for example; ghee is stored only in solid form but can be used for cooking when it is in a liquid form.

Activity 3.4(a): Investigating the changes when heat is applied on ice cubes

What you need

- holder
- heat source
- glass beaker
- ice cubes

What to do

1. Set up the apparatus as shown in *Figure 3.11.*
2. Put some ice cubes in a glass beaker.
3. Introduce heat source.
4. Observe what happens.
5. Identify the changes in the state of matter.

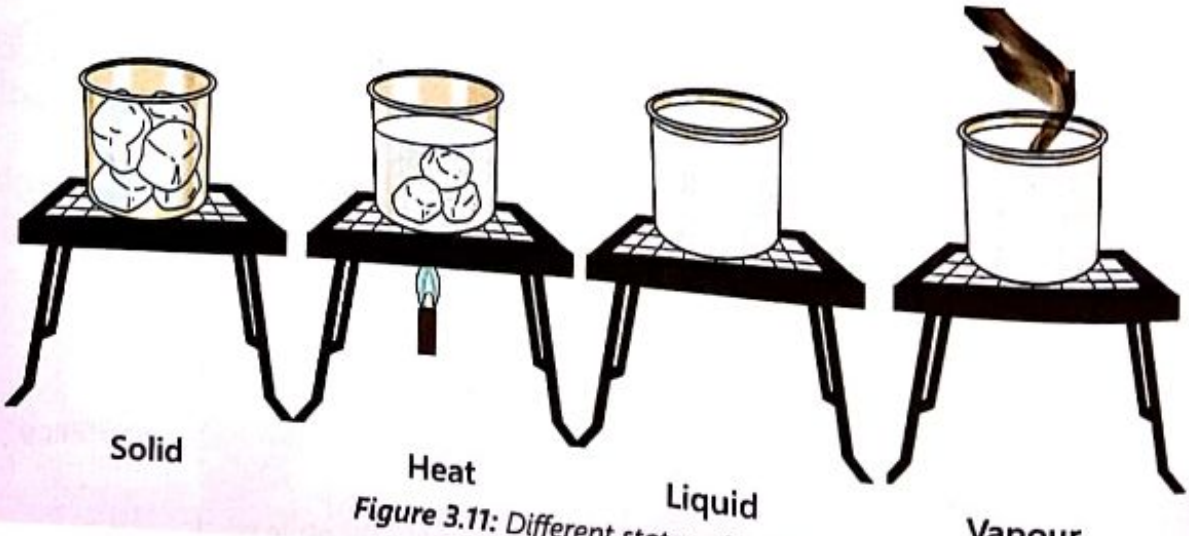


Figure 3.11: *Different states of matter*

Understand that during the process of change from one state to another, heat energy is gained or lost. Substances can move from one state to another when specific physical conditions change.

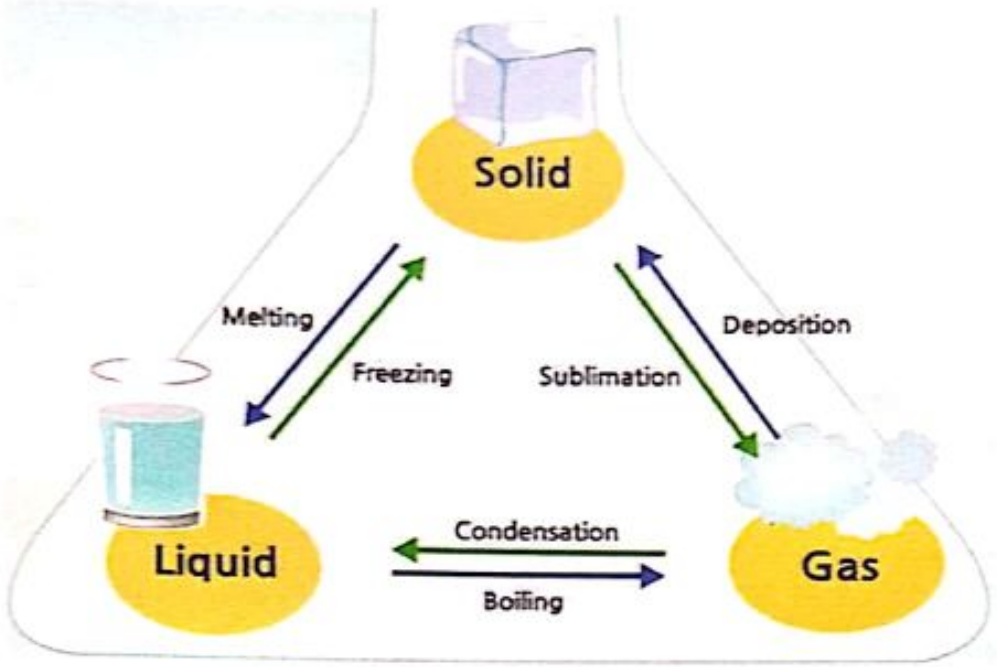


Figure 3.12: Changes of the different states of matter

The state of a substance can be changed either from solid to liquid or from liquid to vapour and vice-versa. Changing from one state to another takes place at different temperatures and pressure and such processes are shown in *Figure 3.12*.

Examples of substances that sublime when heated:

1. Iodine
2. Ammonium chloride
3. Dry ice (solid carbon dioxide)
4. Anhydrous iron(III) chloride
5. Anhydrous aluminium chloride

Activity 3.4(b): Investigating effect of heat on different states of matter

Using *Figure 3.12*, explain the effect of temperature on the following processes;

a) melting
b) freezing
c) condensation
d) evaporation
e) sublimation

3.5 The Cooling Effect of Evaporation on Maintaining Constant Body Temperature

Land animals often lose water from their skin, mouth and nose by evaporation into the atmosphere. Your sweat glands release sweat which cools our skin as it evaporates. This helps lower your internal temperature which increases blood flow to our skin. Water evaporating from the skin cools the body, keeping its temperature in a healthy range.

Activity 3.5: Cooling effect of evaporation

What you need

- water
- a dropper
- ethanol
- reagent bottles

What to do

1. Fill the reagent bottles, one with water and another with ethanol.
2. Suck up some water from the reagent bottle using a dropper.
3. Carefully add two drops of water at the back of your hand and carefully spread them using your finger as *shown Figure 3.13.*
4. Blow softly over the skin area that you just covered with water.
5. Add the same quantity of ethanol on the back of your hand and spread it using your finger.
6. Again, blow over the area.
7. When the water touches your skin, how does it feel?
   a) Does your skin feel any different when blowing on water? Can you tell a difference in temperature while blowing?
   b) Does ethanol feel any different when it touches your skin? How?
   c) Does your hand feel warmer or cooler compared with water when you blow the liquid? Why?

Figure 3.13: *Pouring a liquid on the dorsal side of the hand*

When you understand the effect of cold water on the body, and how the body responds, you are far more prepared to make life-saving decisions , either for yourself or in rescue situations.

It's actually quite simple, the body attempts to maintain a constant core temperature through a balance of heat loss and heat gain. Body heat is normally regulated through activities such as exercise and shivering. Body heat is lost by radiation or evaporation.

Assignment 3.1

1. Explain why clothes dry;
   i) on a hot day
   ii) inside the house
   iii) on a windy day
2. From the knowledge of the different states of matter, explain the process of rain formation.

DID YOU KNOW?

When air containing water rises higher, it cools to form liquid and on further cooling it forms solids in clouds. When the clouds can no longer hold such solids, the solids drop down and melt to form liquids which drop on the surface of the earth as rain.

ICT Activity

In pairs, use a suitable input device to capture images showing the different forms in which matter exists. Save the images on a secondary storage device as "forms of matter ". Classify them according to the different forms of matter. Identify the different characteristics of the different substances. Use a suitable software to present your findings to the rest of the class.

Sample Activity of Integration

In your community people use pit latrines as areas of disposal of human waste that usually produce a bad smell.

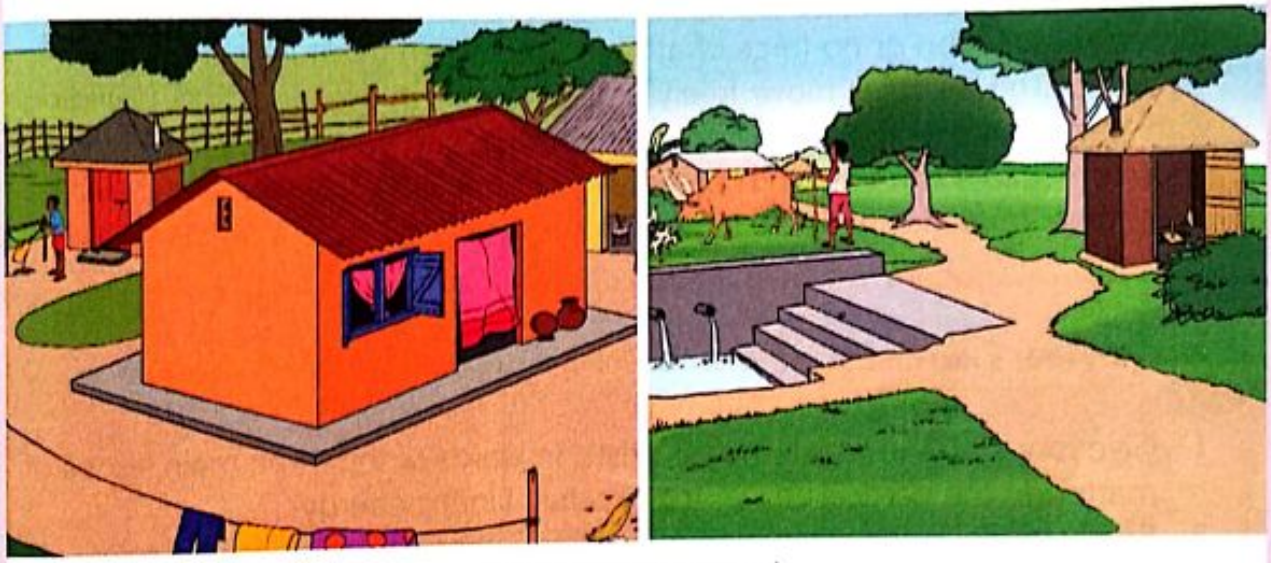


Figure 3.14: *Homesteads*

Task

As a student who understands different states of matter, use *Figure 3.14* to write a report advising your community on where these pit latrines can be constructed at their homes.

Chapter Summary

In this chapter, you have learnt that:

- Matter is anything that occupies space and has weight.
- Matter occurs mainly in three states that is solids, liquids and gases.
- It may also occur in a fourth state known as plasma.
- Matter can change from one state to another by either absorption or release of heat energy, for example, evaporation takes place by absorption of heat energy while condensation takes place by release of heat energy.
- Matter is made of small particles that are constantly moving and are arranged differently in each of the three states.
- There are strong forces of attraction between particles in solids and they therefore have a regular shape. Particles in solid state involve movement by vibration about a mean or average position. Therefore, solids do not flow, they have a definite shape and volume and cannot be compressed.
- In liquid state the particles are far apart than in solids and randomly arranged because they have weak forces of attraction between them. Particles move freely and randomly in any direction but within the bulk of the liquid. Therefore liquids can flow, have definite volume but no definite shape and they take the shape of the container in which it is put; they are incompressible.
- In gases, the particles are far apart from each other. They have negligible forces of attraction or no force of attraction between them and are randomly arranged. The particles move freely and randomly in any direction, colliding with each other and the walls of the container in which they are placed. Therefore, gases can flow and spread to fill any available space. They have no definite volume and shape and are compressible.

Review Exercises:

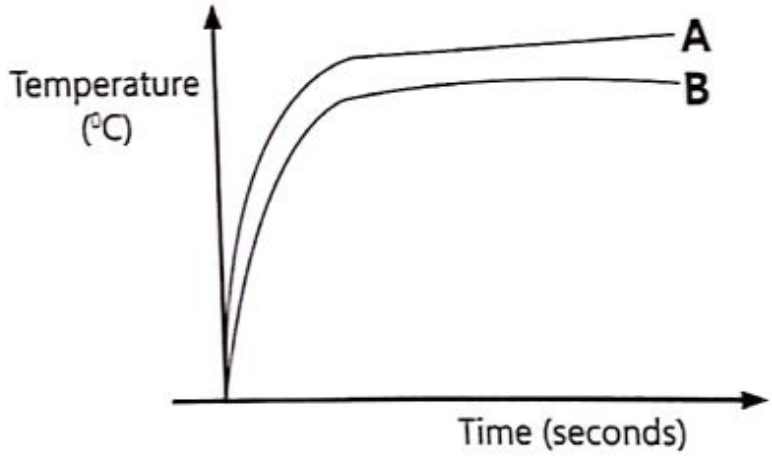
1. Give four states in which matter exists. In which of the three main states of matter do the particles have the greatest kinetic energy?
2. Briefly describe the arrangement and movement of particles in a solid.
3. Why do gases diffuse? Of all gases, hydrogen diffuses fastest. Explain.
4. Describe an experiment to show that a lighter gas diffuses faster than a heavier one.
5. Write down two properties of a solid, two of a liquid, and two of a gas.
6. What useful information can you tell from the melting and boiling points of a substance?
7. One sample of ethanol boils at around 79 ^{0}C. Another boils at around 81 ^{0}C. How can you tell they are not pure? Which one is least pure? (Pure ethanol has a boiling point of 78 ^{0}C).

8. Using the idea of particles, explain why;
   a) it is easy to pour a liquid.
   b) a gas will completely fill any container.
   c) a solid expands when it is heated.
9. The following results were obtained from an experiment to determine the freezing point of liquid naphthalene. It was cooled and the temperature recorded every 30 seconds. The results obtained are tabulated in *Table 3.2*.

Table 3.2: Temperature change for a particular duration

Time(s)	0	30	60	90	120	150	180	210	240	270	300
Temp(°C)	100	93	85	78	78	78	78	60	43	25	25

   a) Plot a graph of temperature against time to represent the information in the table.
   b) Use the graph to determine the freezing point of naphthalene.
   c) Draw the arrangement of particles of naphthalene at;
      (i) 60 seconds (ii) 120 seconds (iii) 180 seconds
10. Tea bags were placed separately into two cups; one containing hot water and another containing cold water.
    a) State what was observed in each case.
    b) Explain your observations.
11. The graphs show the boiling curve of pure water and an aqueous solution of sodium chloride.



    a) Define the term boiling point.
    b) Which boiling curve represents an aqueous solution of sodium chloride? Explain your answer.
    c) State one other factor that affects the boiling point of a liquid.
    d) State one other method used to determine the criteria of purity of a liquid other than boiling point and melting point.

Chapter 4

Using Materials








Keywords

- fabrics
- molecular structures
- natural materials
- pollution
- polymers
- synthetic materials

By the end of this chapter, you should be able to:

a) classify the materials used in everyday life into natural and synthetic group.
b) describe how the physical properties of polymers determine its uses in everyday life.
c) relate the molecular structure of materials to their uses.
d) know that polymers are useful long chain molecules made by both natural and synthetic processes.
e) know how common materials can pollute the environment and which materials can be recycled.
f) understand that heating changes the structures and properties of some materials.
g) describe natural and man-made polymers.

Competency: You should be able to explore how materials are used and relate their uses to their molecular structure.

Introduction

The basic aim of science is not only to study and understand nature but also to use this knowledge to make our lives more comfortable. Science and technology have enabled us to develop more economical and convenient methods to recover useful materials from nature and to put them to various uses.

Natural materials are any products that come from plants, animals and or the ground. Chemistry has enabled us to synthesise new materials which have better desirable properties than natural materials. You need different types of materials to meet our daily needs. Some of them are obtained from nature, while others are prepared by man. In this chapter, you will learn how materials are used and relate their uses to their structures.

4.1 Classification of Materials Used in Everyday Life

A material is a substance or a mixture of substances that constitutes an object. Materials can be pure or impure living or non-living matter. They can be classified into four main groups: metals, polymers, ceramics and composites. Learning materials are important because they can significantly increase students' achievement by supporting their learning.

Activity 4.1: Classifying of common materials as natural and synthetic

What to do: In groups:
use *Figure 4.1;*

1. to name and classify common materials that exist naturally and those that are man-made. Identify more materials in your surroundings in each category.
2. tabulate your results in *Table 4.1.*

Table 4.1: Classification of common materials

Natural	Synthetic (man-made)

3. Share your findings with the rest of the class.

Figure 4.1: *Items and materials used by man*

4.2 Physical and Mechanical Properties of Polymers and their Uses in Everyday Life

The mechanical and physical properties of materials are determined by their chemical composition and their internal structure, like grain size or crystal structure. Mechanical properties may be greatly affected by processing due to the re-arrangement of the internal structure. A description of some common physical and mechanical properties will provide information that the product designers could consider in selecting materials for a given application.

A physical property is any property that is measurable, whose value describes the state of the physical system. The change in physical properties of a system can be used to describe its changes between momentary states.

The physical properties of both synthetic and natural materials determine their uses.

Figure 4.2(a): *Uses of nylon material*

What are the properties of nylon exhibited in *Figure 4.2(a)*?

Figure 4.2(b): *Things made from cotton*

What are the properties of cotton exhibited in *Figure 4.2(b)*?

DID YOU KNOW?

Nylon was the first fully synthetic fibre. It was made without using any natural raw material (from plant or animal). It was prepared from coal, water and air in 1931 by *Wallace Carothers.*

Activity 4.2(a): Physical properties of materials and their uses

What you need

- wood
- paper
- plastic
- cotton
- sisal
- nylon
- starch
- wool
- polythene
- polyester
- protein
- rubber
- polystyrene
- glass
- silk
- polytetraflouroethene

What to do

1. Classify the above materials basing on their physical properties such as strength, flexibility, tensile and compressive strength, elasticity and absorbency (ability to absorb water).
2. Discuss the uses of the materials and relate them to their physical properties.
3. Tabulate your observations as shown in *Table 4.2*

Table 4.2: Physical properties of materials and their uses

Material	Physical property	Use

Activity 4.2(b): Investigating the volume of water remaining in each material

What you need

- cotton cloth
- nylon cloth
- a basin/bucket

What to do: In a group,

1. Take two cloth pieces of the same size, roughly half a metre square each.
2. Soak the pieces in different basins, each containing the same amount of water. Take the pieces out of the containers after five minutes and hold them above the container to drain out the water (do not squeeze the water out).
3. Spread them in the sun.
   a) Does the nylon fabric absorb less or more water than the cotton cloth?
   b) Does it take less or more time to dry than the cotton cloth?
   c) What does this activity tell you about the characteristics of the synthetic fabric?
4. Find out, from your parents, about the durability, cost and maintenance of synthetic fabrics, compared to the natural fabrics.
5. Share your findings with the rest of the class.

4.3 The Molecular Structure of Materials and their Uses

All products that surround us in school, or at home are made of one material or another. Look around and identify the products and materials they are made of. Why did they use those particular materials to make the respective products? Different materials have different strengths and weaknesses and are used for different purposes.

Materials can be classified as metals, composites, ceramics and polymers. All these exist in a solid state because their particles are arranged in an orderly manner, with strong forces of attraction in between their particles.

- ***Metals*** have a continuous structure in 3-dimensions.
- ***Polymers*** are long continuous chains. The long chains are joined together by weak forces of attraction.
- ***Ceramics*** are prepared from powdered materials, for example, clay mixed with water and hardened by heat.
- ***Composites*** are made by combining two or more materials that have different materials that blend into each other. The combined materials give composites of unique properties.

Activity 4.3: Finding out the properties and uses of materials

What you need

- concrete
- ceramic tiles
- iron
- wood

What to do

1. Compare these materials using the idea of molecular structure.

Table 4.3: Comparison of properties of materials in relation to their molecular structure

Material/ property	Metal forexample Iron	Polymer forexample wood	Composite forexample concrete	Ceramics forexample tiles
Tensile strength				
Breakage				
Porous to water				
Durability				
Malleability				
Ductility				

2. From your results above, relate the properties to their uses.

From stone and bronze to steel and concrete, materials are useful for particular purposes because they behave in a certain way under certain conditions: They have particular qualities, which we call their properties. Understanding those properties is what materials science is all about.

DO YOU KNOW? Why do plastic rulers shatter when you flex them while metallic ones simply bend? Why do some cars get rusty faster than others?

4.4 Building Materials

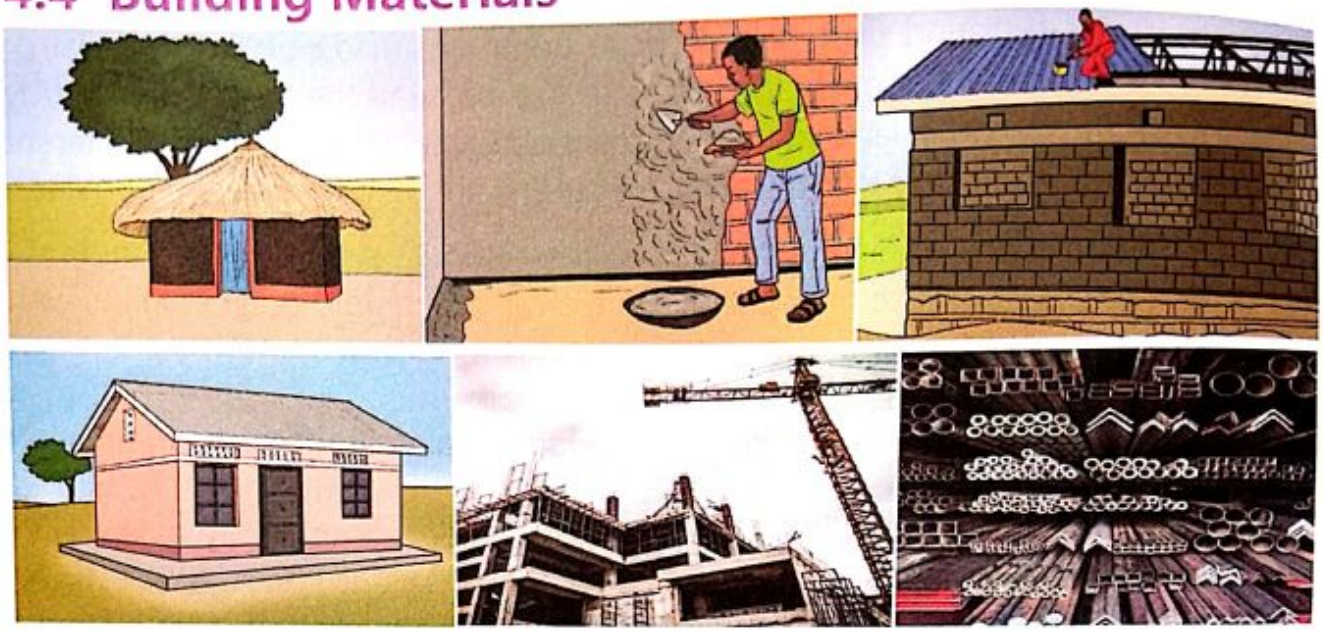


Figure 4.3: *Examples of Building Materials*

Activity 4.4(a): Finding out the uses of building materials

What to do

In groups:

1. Identify the building materials used in the buildings in *Figure 4.3.*
2. Plan and use the scientific method to investigate:
   a) the tensile strength of cement strips made of different proportions of sand and cement.
   b) the insulating properties of common roofing materials.
3. Present your findings to the rest of the class using an appropriate presentation software.

Building materials are any materials used for construction purposes, for example, materials for house building. These include wood, cement, aggregates, metals, bricks, concrete, clay that are the most common building materials used in construction. The choice of those are based on their cost effectiveness for the building project. Construction materials are generally categorized into two sources; natural and synthetic.

Activity 4.4(b): Making a strip of cement

What you need

- tin
- a spoon
- cellotape
- cement
- water
- sand

What to do

1. Take a piece of a cardboard measuring 12cm x 6cm.
2. Draw lines on the cardboard as shown in the diagram *Figure 4.4.*

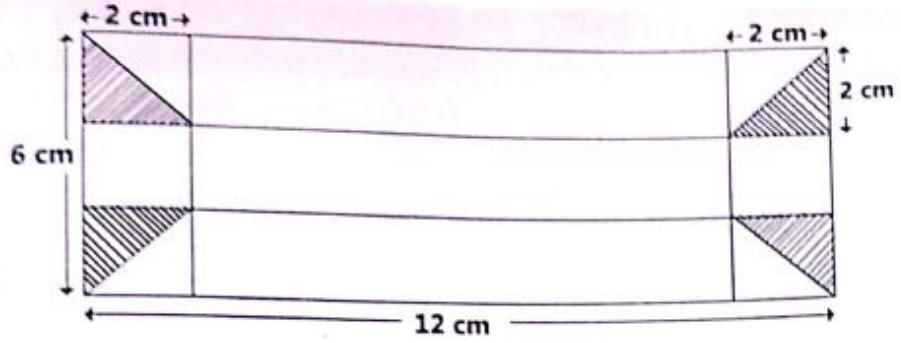


Figure 4.4: Cement blocks

3. Use a compass needle or a pair of scissors to score the surface of the cardboard along the lines you have drawn.
4. Cut out the four shaded triangles.
5. Fold up the sides to make a box and fasten the corners using cellotape.
6. Cover the bench with a newspaper and label it with your name and number.
7. Use your cardboard box as a measure.
8. Put two measures of cement and two measures of sand in a tin.
9. Add water a little at a time and mix thoroughly with a spatula to make a thin paste. Put the paste into a box and press it down to fill all spaces.
10. Smooth on the top with a knife or spatula so that it is leveled with the sizes of a box.
11. Scrape out the rest of the cement and put it on one side to throw away.
12. Wash out the tin and make it dry.
13. Make another box in the same way and label it with your name and number 2.
14. Repeat steps 6, 7, 8, 9, 10, 11 and 12 with one measure of cement and two measures of sand.
15. Make another box in the same way and label it with your name and number 3.
16. Repeat steps 6, 7, 8, 9, 10, 11 and 12 with two measures of cement and one measure of sand.
17. Hand the boxes to your teacher. Some will be kept wrapped in polythene and some will be kept open to the air. They will be left for a week.
18. Test for tensile strength of the three strips of cement and comment on your findings.

Assignment 4.1

Advantages and disadvantages of different building materials

Figure 4.5: Examples of building materials

Study the *figures above* and discuss the advantages and disadvantages of the various materials used in building?

4.5 Natural and Synthetic Processes of Making Polymers

The word '**polymer**' comes from two Greek words; **poly** meaning **many** and '**mer**' meaning **part/unit**. Polymers are, therefore, long chains of small units joined together. A polymer is made of many repeating units called **monomers.** Each small unit is actually a chemical substance. Polymers can be either natural or synthetic.

Figure 4.6: *Examples of Polymer Materials*

Our bodies are naturally built by a large protein molecules from small units called ***amino acids***. Our hair, nails etc. are made of proteins. Other examples of natural polymer are cellulose, which are cotton, sisal and wool. These are polymers which exist on their own and man has no influence on their existence.

Synthetic polymers include polyethene, synthetic rubber, polyester and nylon. These are polymers which are manufactured in industries.

Assignment 4.2

Monomers and uses of polymers

With the help of the internet or any other source, find out the monomers (building units) of the following polymers and the uses of each polymer. Give your answers as shown in *Table 4.4*

- sisal
- silk
- wool
- starch
- polyethene
- polystyrene
- cellulose
- polyester
- pvc
- glass

Table 4.4: Showing polymer, monomer and its uses

Polymer	Monomer	Uses

Polymers are materials made up of long, repeating chain of molecules called monomers. The materials have unique properties, depending on the type of molecules being bonded and how they are bonded. Some polymers bend and stretch, like rubber and polyester. Others are hard and tough like glass.

Polymers are classified into two major groups: ***Thermoplastics*** and ***Thermosets.*** Thermoplastics are materials which soften on heating, harden on cooling and can be remoulded into different shapes, for example, polythene. On the other hand, thermosets are plastic materials which get hard on heating and cannot be resoftened or remoulded but instead decompose on heating for example, bakelite and melamine.

4.6 Recycling of Common Materials that Pollute the Environment

When you go to the market, you usually get items wrapped or packed in plastic or polythene bags. This is one reason why plastic waste keeps accumulating in our homes. Disposal of plastic is a major problem to the environment. Some materials can be disposed of through natural processes such as actions by bacteria. These are called ***biodegradable.*** However, others cannot be decomposed by natural processes and they are said to be ***non-biodegradable.***

Figure 4.7: Examples of Polymer materials

Table 4.5: The approximate time taken by some materials to decompose or degenerate.
Source: Internet

Type of waste	Approximate time taken to degenerate (decay or rot)	Nature of material
Peels of vegetable and fruits	1 to 2 weeks	Biodegradable
Paper	10 to 30 days	Biodegradable
Cotton cloth	2 to 5 months	Biodegradable
Wood	10 to 15 years	biodegradable
Woolen clothes	About a year	Biodegradable
Tin, aluminum and other metal cans	100 to 500 years	Non-biodegradable
Plastic bags	10-20 years	Non-biodegradable
Plastic bottles	450 years	Non-biodegradable

1. Have you ever come across plastics in your environment? If yes, give a few examples of them.
2. Do plastics rot/decompose? Explain your answers.

Besides decomposition, the burning process of synthetic materials is quite slow and is not easily completed. In the process, it releases lots of poisonous fumes into the atmosphere, causing air pollution.

It is important to recycle plastic waste since most of the thermoplastics can be recycled. Materials can either be recyclable or non-recyclable. However, during recycling certain colouring agents are added. This limits the usage of recycling especially for storage of food.

Activity 4.6(a): Exploring how materials pollute the environment

In groups:

1. Discuss how common materials pollute the environment.
2. Suggest ways in which you can contribute towards reducing the use of plastic materials.
3. Discuss the characteristics of plastics.
4. Make a list of items that can be recycled.

It is a common practice for people to reduce the amount of plastics by burning them. However, burning plastics creates harmful gases which when inhaled, can instantly cause coughing, shortness of breath and dizziness. Long term exposure to such gases can also cause cancer. Another harmful effect of burning waste plastics is pollution which damages the ozone layer. Burning plastics is the equivalent of burning fossil fuels because almost all plastics are derived from fossil fuels. Burning plastics releases pollutants and greenhouse gases.

Figure 4.8: *Effect of burning plastics on the environment*

Assignment 4.3

Effects of burning plastics on the environment

With the help of the Internet or any other source, find out the substances produced by burning plastics and their effects on the environment.

DID YOU KNOW?

A rubber tyre is technically one single giant polymerized molecule. Rubber is one type of a polymer which can be either synthetic or natural. It is an example of thermoset plastic because it decomposes on heating and cannot be remoulded.

Harmful effects of man-made materials

In this chapter, you have learnt about various materials that are useful in our daily lives. Many of them are obtained from natural resources, while a large number of them are man-made. After use, their disposal becomes a problem, since many of them are toxic in nature and pollute the air and water.

Activity 4.6(b): Managing waste

Using markers and chats;

1. design posters on waste management and reducing waste disposal.
2. present your posters to the class.

My Environment, my responsibility

When going shopping or going to the market, bring your own renewable shopping and produce bags and bamboo bags instead of single use plastic bags. Invest in a water filter and renewable water bottles instead of drinking from plastic bottles.

4.7 Effect of Heat on the Structure of Materials

Have you ever wondered how it is possible that some materials can be shaped into any form while others cannot be? What happens when different materials are subjected to heat? In this section, you are going to investigate the effect of heat on some materials and explain why?

The arrangement of atoms primarily affects the chemical, physical, electrical, magnetic and thermal properties. Depending on the arrangement of atoms, the materials can be reshaped into new ones when they are heated, or may not soften on heating. What do you think is the name given to the plastics which can be reshaped and those which cannot be reshaped?

Activity 4.7: Investigating the effect of heat on different materials

What you need

- polyethene
- polyester
- melamine plate
- cellulose
- paper
- glass
- rubber
- plastic plate

What to do

1. Heat a small piece of each of the provided materials.
2. Identify and state what happens to each one of them.
3. Present your observations in a table as shown in *Table 4.6*.

Table 4.6: Effects of heat on materials

Material	Effect of heat on the material

4. Explain your observations to the rest of the class.
5. Identify materials that can either be reshaped into new ones or soften on heating.

ICT Activity

In groups, carry out research using the internet on how polymers have different physical properties. Use a suitable software, for example, word processing, to type your findings. Present your findings to the rest of the class using any suitable software.

Sample Activity of Integration

A construction company has been given a contract to build houses for accommodation in your village. However the local council has cautioned the company to avoid using substandard materials.

Figure 4.8: Housing structures

Task: As a student of Chemistry, using the knowledge of materials and their properties, write an article advising the local council and builders on the following:

- The building materials that should be used.
- The building materials that are recommended for the buildings.

Chapter Summary

In this chapter, you have learnt that:

- Materials can be classified as natural or synthetic.
- A natural material is any product that comes from plants, animals or from the ground.
- Synthetic materials are made by humans through chemical synthesis.
- The physical properties of materials determine their uses.
- Plastics and polythenes pollute the environment since they are non-biodegradable.
- The waste created by plastics is not environmentally friendly. On burning, plastics release poisonous gases.
- You need to use synthetic fibres and plastics in such a manner that you can enjoy their good qualities and at the same time minimize the environmental hazards for the living communities.

Review Exercise:

1. a) Name the two types of materials.
   b) Give four examples of each of the types of materials.
2. Explain what polymers are.
3. Describe how the physical properties of polymers determine uses in everyday life.
4. State the common materials that can pollute the environment.
5. Describe the effect of heat on the structure and properties of some materials.
6. What are the common materials that can be recycled?

Chapter 5

Temporary and Permanent Changes

Keywords

- chemical properties
- irreversible
- permanent changes
- products
- reactants
- reversible
- temporary changes

By the end of this chapter, you should be able to:

a) understand that many substances undergo permanent change when they are heated or burnt, forming new materials, while other substances change temporarily.

b) recognise temporary (reversible) and permanent (irreversible) changes to matter under different conditions.

Competency: You should use the knowledge of temporary and permanent changes to appreciate their occurrence and importance in everyday life.

Introduction

Everyday, you experience changes in things around you. Think of growth from childhood to adulthood, boiling an egg, freezing of water and digestion of food. All these things involve an object (matter) going through a process that can either be reversed or not.

In this chapter, you will find out that certain substances and materials, when subjected to temperature change or added to water, undergo changes. These changes can be permanent or temporary and they are important in daily life.

5.1 Effect of Heat on Substances

Activity 5.1(a): Investigating what happens to water when subjected to temperature changes

What you need

- beaker
- water
- Bunsen burner
- a tripod stand
- cover
- wire gauze

What to do: In groups;

1. Light the Bunsen burner.
2. Pour water in a beaker and place a dry cover over it.
3. Place the beaker with water on a wire gauze and a tripod stand and heat the beaker.
   a) Explain what you observe.
   b) Share your observations with the rest of the class.
   c) With reason, explain the type of change that took place.

Note If a liquid is heated, its temperature rises and eventually the liquid changes to vapour which condenses on the cooler part to form a liquid.

Activity 5.1(b): Investigating what happens when common salt is dissolved in water

What you need

- common salt
- beaker
- water
- measuring cylinder
- heat source
- glass rod

What to do

1. Add 2 spatula endful crystals of common salt to 20 cm^3 of water in a beaker and stir.
2. Place 10 cm^3 of the solution into an evaporating dish and heat the solution gently to dryness.
   a) What do you observe?
   b) Explain your observation and share it with the rest of the class.
   c) With reason, explain the type of change that took place.

Activity 5.1(c): Investigating the effect of heat on a candle wax

What you need

- a small piece of candle
- matchstick
- watch glass

What to do

1. In groups, place a candle on a watch glass and light it using a matchstick as shown in *Figure 5.1.*
2. Let it burn for some time
   a) What do you observe?
   b) Explain your observation to the rest of the class.
   c) With a reason, explain the type of change that took place.

Figure 5.1: *Burning candle*

Note Be careful when lighting a match stick to avoid being burnt.

Activity 5.1(d): Investigating the effect of heat on zinc oxide

What you need

- boiling tube
- clamp and stand
- Bunsen burner
- Zinc oxide
- Heat source

What to do

1. Put two spatulas of zinc oxide in a boiling tube.
2. Clamp the boiling tube in a slanting position.
3. Heat the boiling tube gently, then strongly, until there is no further change.
   a) What do you observe?
   b) With a reason, explain the type of change that took place.

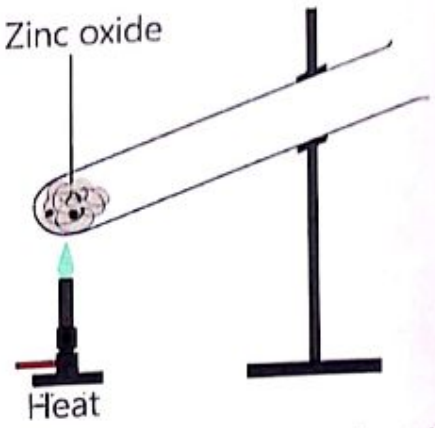


Figure 5.2: *The effect of heat on zinc oxide*

Activity 5.1(e): Investigating the effect of heat on hydrated copper(II) sulphate crystals

What you need

- boiling tube
- test tubes
- beaker
- delivery tube
- cork
- teat pipette
- clamp and stand
- Bunsen burner
- water
- hydrated copper(II) sulphate

What to do

1. Put 2 spatulas of hydrated copper(II) sulphate in a boiling tube.
2. Assemble the apparatus as shown in the *Figure 5.3.*

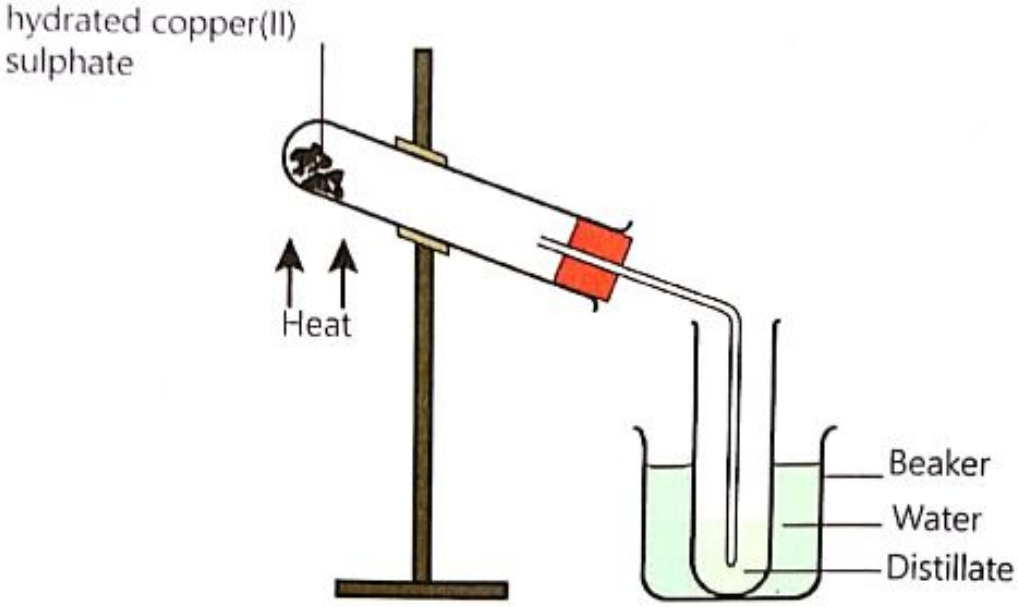


Figure 5.3: *Effect of heat on hydrated copper(II) sulphate*

3. Heat the boiling tube gently while rotating it until there is no further change.
4. Allow the product and residue to cool.
5. Divide the residue into two parts and put each portion into a test tube. Add 2-3 drops of the distillate to one portion using a teat pipette. Feel the bottom of the test tube and note the colour of the solid.
6. Repeat using 2-3 drops of tap water.
7. What do you observe?
8. With a reason, explain the type of change that took place.

In *Activities 5.1(a)* to *5.1(e)*, you must have realized that the changes that took place were reversible and led to the formation of the substance as before. Such changes are referred to as **temporary** or **physical** changes. This occurs when there is only a change of state and shape of the substance. The state and colour changes on heating, but on cooling the substance regains its original colour. The changes are there only for a short period of time and affect the chemical substance but not its composition.

Assignment 5.1

Temporary and permanent change

In groups, discuss the changes that take place in everyday life;

a) temporary

b) permanent

5.2 Permanent Changes

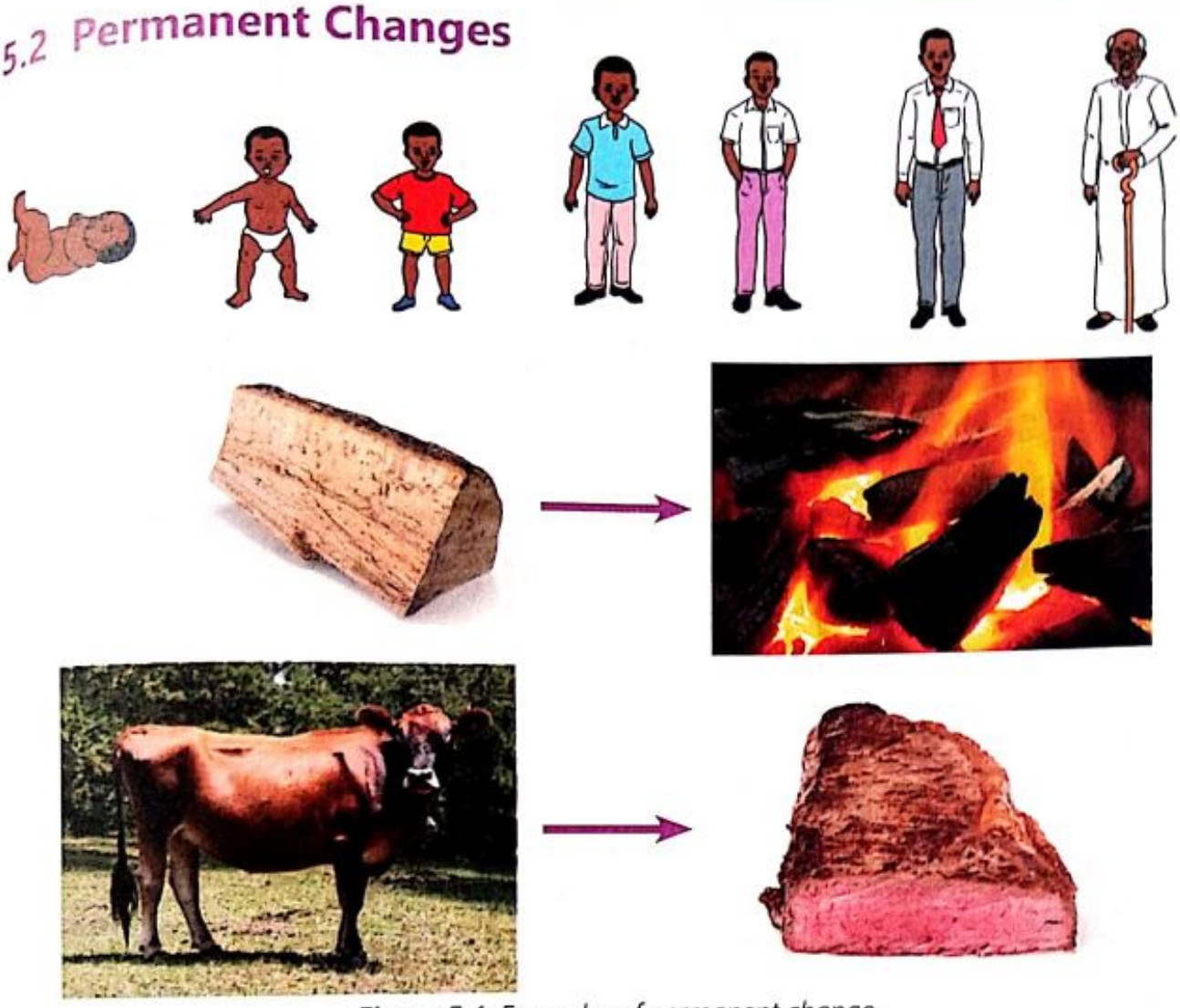


Figure 5.4: *Examples of permanent change*

1. What do you observe in *Figure 5.4*?
2. Explain with reasons the type of changes that are shown in *Figure 5.4*.

Activity 5.2(a): Investigating what happens when an egg is boiled

What you need

- wire gauze
- tripod stand
- heat source
- 2 eggs
- 2 beakers
- water

What to do

In groups, carry out the following investigation;

1. Break one egg into a beaker and observe the state.
2. Boil the second egg in a beaker of water for 15 minutes.
3. Remove the egg, cool it in cold water and break it.
4. Compare the two eggs.
5. Explain your observation.
6. With a reason, explain the type of change that took place.

Activity 5.2(b): Investigating what happens when a piece of paper is burnt

What you need

- a piece of paper
- a box of matches

What to do

In groups,

1. Light the piece of paper using a matchstick and place it on a metallic cover.
2. What do you observe?
   a) Explain your observation and share your findings with the rest of the class.
   b) With a reason, explain the type of change that took place.

Figure 5.5: *Burning paper*

Safety precaution

Be careful when lighting a matchstick to avoid being burnt.

Activity 5.2(c): Investigating the effect of heat on ammonium dichromate

What you need

- stand
- bunsen burner
- evaporating basin
- tripod stand
- wire gauze
- clamp
- ammonium dichromate

What to do

1. Put two spatulas of ammonium dichromate into an evaporating basin.
2. Place the evaporating basin on the wire gauze on the tripod stand.
3. Heat using a low Bunsen burner flame until there is no further change.

Figure 5.6: *Effect of heat on ammonium dichromate*

a) What do you observe?
b) With reason, explain the type of change that took place.

Activity 5.2(d): Investigating the effect of heat on copper(II) carbonate

What you need

- boiling tube
- test tubes
- delivery tube
- cork
- clamp and stand
- Bunsen burner
- copper(II) carbonate
- lime water

What to do

1. Put two spatulas of copper(II) carbonate in a boiling tube.
2. Clamp the boiling tube as shown in *Figure 5.7*.
3. Insert a corked delivery tube into the boiling tube.
4. Measure about 5 cm^3 of lime water into a test tube.
5. Clamp the test tube below the delivery tube.
6. Heat the boiling tube gently and then strongly until there is no further change.
   a) What do you observe?
   b) With reason, explain the type of change that took place.

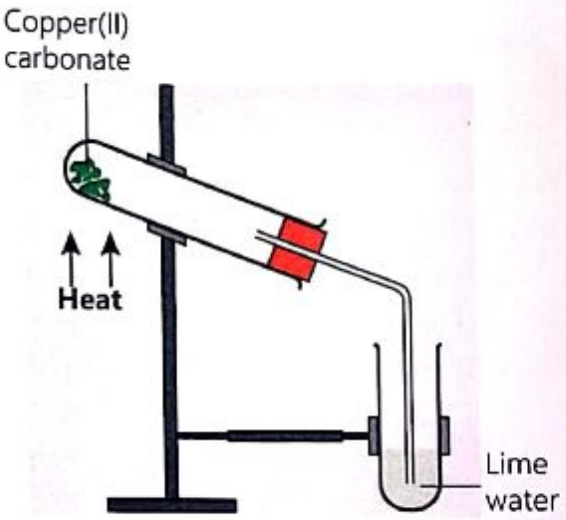


Figure 5.7: *Effect of heat on Copper(II) carbonate*

In *Activities 5.2(a)* to *5.2(d)*, you must have realised that there were changes in colour, volume, and heat that took place. These changes are irreversible and leads to formation of different substances. These changes are referred to as **permanent** or **chemical** changes.

A chemical change occurs when one substance is transformed into one or more new products via a chemical reaction. In a chemical change the number and type of atoms remain constant but their arrangement is altered.

Assignment 5.2

Application of temporary and permanent changes in our daily life

In groups,

1. discuss the application of temporary and permanent changes in your daily life.
2. present your findings to the rest of the class.

Note

- A permanent change is either accompanied by loss of heat to the surroundings or gain of heat from the surroundings.
- When you eat, your body digest the food and convert sugars into energy, proteins into body cells, and so on. When you breathe, your lungs absorb oxygen from the air you breathe in and use the oxygen to enrich your blood. All these activities in your body are permanent changes. Their end results cannot be reversed.

Activity 5.2(e): Differentiating between physical and chemical changes

What to do

a) Using results of *Activities 5.1 and 5.2*, discuss in groups the difference between temporary and permanent change.
b) Put your results in a table.
c) Present your results to the rest of the class.

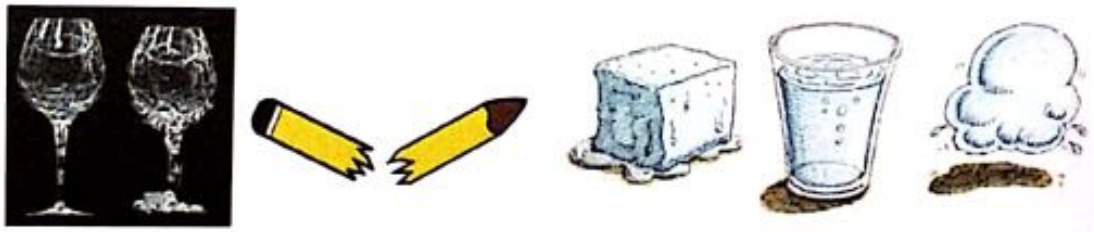


Figure 5.8(a): *Physical changes*

Figure 5.8(b): *Chemical changes*

ICT Activity

In pairs, use a suitable input device, for example, a digital camera or smart phone to capture images of the different types of changes encountered around your home and school. Classify them into temporary or permanent changes. Use a suitable software to present your findings to the rest of the class.

QUICK TIP

Use the knowledge obtained from ICT about output storage devices

Sample Activity of Integration

Waste management is important because it takes advantage of science to deal with our daily waste.

Figure 5.9: Making use of disposed plastics

Task: Using the knowledge acquired on temporary and permanent changes, write a letter explaining to your community the different ways you can manage waste in the environment.

Chapter Summary

In this chapter, you have learnt that:

- A change in which the product has the same chemical properties as the reactants is known as a temporary change.
- In a temporary change, the change is reversed, the initial substance is reformed, and there is only a change of the state and shape of the new substance.
- Temporary changes are also known as reversible changes. They include: melting of ice, vaporisation of liquid, magnetisation of iron, sublimation of iodine, and others.
- A change in which the product(s) have chemical properties which are different from those of the reactants is known as a permanent change and cannot easily be reversed.
- It is accompanied by either loss of heat to the surroundings or gain of heat from the surroundings.
- Permanent changes are also called irreversible changes.
- Permanent changes include burning, decomposition, photosynthesis, rotting.

Review Exercise:

1. Differentiate between permanent and temporary changes.
2. Mention at least five examples of permanent and temporary changes in daily life.
3. With a reason, classify the following changes as either permanent or temporary changes.
   a) Melting of naphthalene
   b) Burning of zinc in air
   c) Magnetisation of iron
   d) Heating of nichrome wire
   e) Rusting of iron
   f) Explosion of hydrogen gas in air
   g) Dissolving salt in water

Chapter 6

Elements, Compounds and Mixtures





Keywords

- element
- symbols
- chemical formula
- atoms
- molecules
- compounds
- mixtures
- homogenous
- heterogeneous

By the end of this chapter, you should be able to:

a) know the criteria for determining whether a substance is pure or not.
b) understand that substances are elements, mixtures or compounds.
c) identify different mixtures and devise ways of separating pure substances from them.
d) know that, when added together, some liquids mix while others form two layers.

Competency: You should be able to recognise the characteristics of elements, compounds and mixtures.

Introduction


Aluminium


Gold watch


Milk


Sugar


Sand


Salt

Figure 6.1: *Elements, compounds and mixtures*

You are surrounded by matter. The variety of matter in the world and the universe is surprising. All matter is made of elements, compounds and mixtures.

In this chapter, you will investigate the criteria for determining whether a substance is pure or not and identify the substances as either elements, mixtures or compounds. In addition, you will identify the different mixtures and ways of separating pure substances from them.

6.1 Criteria for Determining Purity of Substances

In *Chapter Two,* you learnt that a pure substance is a material that has constant composition and consistent properties throughout the sample. It contains only one type of atoms, molecules or compound. For example, pure water is a molecule made up of oxygen and hydrogen atoms. However, being a universal solvent, it is hard for water to exist naturally in pure form, unless it is distilled water.

Activity 6.1: Determining the melting point of ice made from distilled water and ice made from tap water

What you need:

- beaker
- stirrer
- retort stand
- stop clock
- thermometer
- tripod stand
- boiling tube
- wire gauze
- ice made from tap water
- ice made from distilled water

What to do:

In groups;

1. Place about 100g of crushed ice made from distilled water into a beaker.
2. Insert a thermometer in the crushed ice and record the initial temperature. After every thirty seconds record the temperature until all the ice melts.
3. Record the results in *Table 6.1.*

Table 6.1: Time taken for the two samples of ice to melt

Time(s)	0	30	60							
Temperature(°C)										

4. Repeat procedure 1,2 and 3 using 100g of ice made from tap water.
5. Using your results, individually plot a graph of temperature against time for both samples on the same axes.
6. From your graph, which one of the two samples has a lower melting point? Explain your answer.
7. Discuss and present your findings to the rest of the class.

Note Materials in the world make up matter and are composed of atoms which make up elements. The elements make up compounds and mixtures

6.2 Classification of Substances

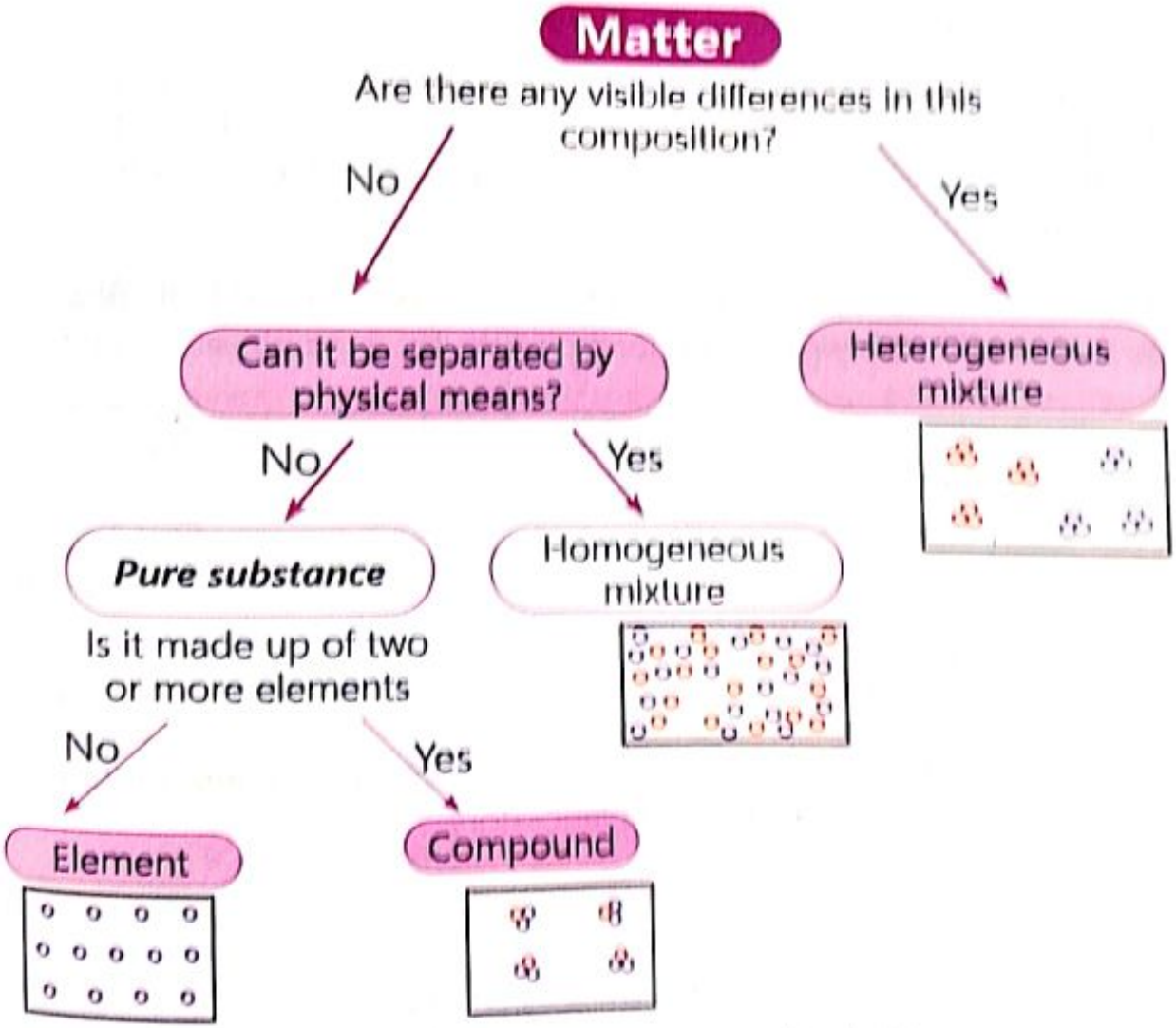


Figure 6.2: Identification of elements, compounds and mixtures

Activity 6.2(a): Classifying substances as elements, mixtures and compounds

What you need

You are provided with the following list of substances:

- Carbon dioxide
- hydrochloric acid
- sugar
- air
- chlorine
- gold
- chlorophyll
- oxygen
- salt
- water
- charcoal
- soil
- sweat
- iron
- milk
- diamond
- copper(II) sulphate
- muddy water
- aluminum foil
- potassium permanganate
- cake.

What to do:

In groups

1. Basing on their characteristics, classify these substances provided as elements, compounds and mixtures.
2. Copy and complete *Table 6.2*.

Table 6.2: Classification of substances as elements, mixtures and compounds

Substances	Characteristics	Category

3. Present your findings to the rest of the class.

Suppose you have a block of charcoal and split it until you cannot split it any further. It still remains charcoal. These smallest indivisible particles are referred to as **atoms**. Atoms of the same kind form an element, for example, carbon, hydrogen, oxygen, iron, aluminum and nitrogen.

Atoms of different kind form a compound, for example, water and salt. Atoms which can be separated by physical means form mixture, for example, air and milk.

DID YOU KNOW?

John Dalton was the first to adapt the ideas about atoms in 1803.

Most elements exist naturally and few are made by man. Some compounds occur naturally in the atmosphere, earth's crust and in living organisms.

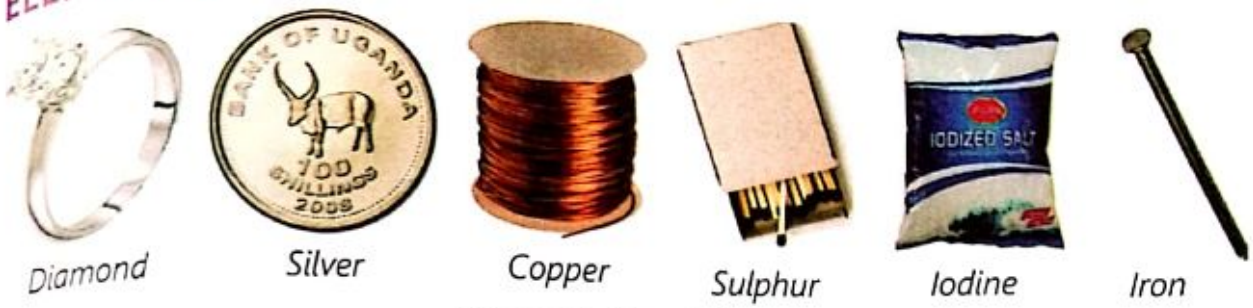
Most compounds are prepared in the laboratory. Similarly, some mixtures occur naturally and others are prepared in the laboratory.

Assignment 6.1

In groups:

1. discuss and list down naturally occurring:
   a) compounds
   b) mixtures
2. using the internet or any other available sources, suggest examples of artificial (man-made) mixtures.

ELEMENTS



Diamond Silver Copper Sulphur Iodine Iron

Figure 6.3: *Uses of elements*

An element is a pure substance that cannot be split or divided into two or more simpler forms by any known chemical means. It is made up of atoms of the same kind. Elements are divided into two; metals and non-metals.

Metals are elements which are good conductors of electricity, are hard, ductile, lustrous and malleable. Elements are used in manufacturing materials you use in daily life including building and roofing materials, medicine, jewelry, currency, kitchen equipment and many others.

Assignment 6.2 **In groups:**

1. Classify elements in *Figure 6.3* as:
   i) metals ii) non-metals
2. Suggest two uses of each element in your individual life.
3. Discuss what is meant by;
   i) ductile ii) brittle iii) sonorous iv) malleable v) lustrous

Examples of elements with their symbols (first 20 elements)

You use symbols in your daily life; for example, in mathematics, you use arithmetic operators to represent addition, subtraction, multiplication and division. In Chemistry, a symbol of an element is generally a letter(s) that represents atoms of that element. Atoms of elements are represented by symbols. Symbols can be one or two letters used. If one letter is used it must be a capital letter but if two are used, the first is capital and the other small.

Table 6.3: The first twenty elements and their symbols

Atomic number	Name of element	Symbol	Atomic number	Name of element	Symbol
1	Hydrogen	H	11	Sodium	Na
2	Helium	He	12	Magnesium	Mg
3	Lithium	Li	13	Aluminum	Al
4	Beryllium	Be	14	Silicon	Si
5	Boron	B	15	Phosphorous	P
6	Carbon	C	16	Sulphur	S
7	Nitrogen	N	17	Chlorine	Cl
8	Oxygen	O	18	Argon	Ar
9	Fluorine	F	19	Potassium	K
10	Neon	Ne	20	Calcium	Ca

Table 6.4: Other elements and their symbols

Elements	Symbols
Copper	Cu
Zinc	Zn
Iron	Fe
Mercury	Hg
Lead	Pb
Bromine	Br
Cobalt	Co
Manganese	Mn

However, when writing the symbols of some elements, we use the first letter or the first two letters of their Latin names.

Table 6.5: Symbols of elements derived from latin names

Element	Latin name	Symbol
Sodium	Natrium	Na
Potassium	Kalium	K
Copper	Cuprum	Cu
Iron	Ferrum	Fe
Lead	Plumbum	Pb
Gold	Aurum	Au
Silver	Argentum	Ag
Mercury	Hydrargyrum	Hg

DID YOU KNOW?

Jons Jacob Berzelius proposed that symbols of the elements should be got from their Latin names.

COMPOUNDS

carbon dioxide

chalk

common salt

water

soap

pure sand

Figure 6.4: *Different compounds*

The word **compound** is scientifically used to mean **complex** or **more than one**. Think of a compound microscope with more than one lens or a compound leaf with more than one leaflet.

In Chemistry, a compound is, therefore, a substance made up of two or more elements chemically combined together in a fixed ratio. The expression 'chemically combined' is used to emphasise the fact that compounds are formed as a result of chemical reaction/change.

Properties of compounds are different from those of the original elements that make them. A chemical reaction is either accompanied by evolution of heat or absorption of heat.

Naming compounds: Example of compounds

Activity 6.2(b): Finding out elements present in the compounds

Table 6.6: Examples of compounds

Compound	Common name given (if any)	Chemical formula	Elements present
Sodium chloride	Table salt/ common salt	NaCl	Sodium, chlorine
Silicon(IV) oxide	Silica /sand	SiO_2	
Dihydrogen oxide	Water	H_2O	
Sodium hydroxide	Caustic soda	NaOH	
Calcium oxide	Quick lime	CaO	
Calcium hydroxide	Lime water	$Ca(OH)_2$	
Potassium hydroxide	Caustic potash	KOH	
Calcium carbonate	Limestone	$CaCO_3$	Calcium, carbon, oxygen

Activity 6.2(c): Preparing a compound of iron and sulphur

What you need

- boiling tube
- mortar and pestle
- petri dish
- heat source
- iron powder
- sulphur
- weighing scale

What to do

In your groups,

1. Weigh exactly 1.6g of sulphur on a petri dish and weigh 2.8g of iron powder on another petri dish.
2. Place both the iron powder and sulphur into a mortar.
3. Using a pestle, grind the two to form a uniform mixture and divide it into three portions:
   i) pass the magnet over one portion
   ii) Add the second portion to water

What happens in both cases?

4. Transfer the third mixture into a boiling tube.
5. Heat the tube gently as shown in *Figure 6.5.*
6. When it glows red hot, stop heating and leave the contents to cool.
7. Examine the product and divide it into two portions:
   i) pass a bar magnet over one portion
   ii) add water to the second portion

What happens in both cases?

8. Suggest some properties of a compound.

Figure 6.5: Heating a mixture of iron powder and sulphur

From *Activity 6.2(c)*, you found out that sulphur and iron are heated or reacted in definite proportions to form iron(II) sulphide. During the combination of the two elements, the mixture glows red because heat is given off. The compound formed is not attracted to a magnet, but before heating iron is attracted to magnet leaving sulphur.

6.3 Mixtures

Most substances are found mixed in nature. The air that surrounds you is a mixture of gases, the water you use contains dissolved substances, the soil you grow food on is a mixture of various minerals and the juice you drink and blood in your body are made up of different components which are physically combined. Such substances are referred to as mixtures. *Figure 6.6* shows examples of mixtures.

Food

Orange Juice

Soil

Blood

Figure 6.6: Different mixtures

Activity 6.3(a): Naming the components in the mixture

What to do

In groups:

1. Discuss and write down the components of each mixture in *Figure 6.5;*
   i) food
   ii) orange juice
   iii) soil
   iv) blood
   v) air
   vi) milk
2. Suggest some of the properties of the mixtures.
3. Present your findings to the rest of the class.

You found out that a mixture is made up of two or more components which are physically combined such as; food, are present in any proportion, can be easily separated by a physical method and do not require any change in energy to take place.

Mixtures can be broadly classified as homogeneous mixtures and heterogeneous mixtures. The word homogenous means uniform while heterogeneous means non-uniform. When two liquids dissolve into each other, they form a mixture which is referred to as a solution. In a solution, a component which dissolves the other is called a solvent and the one which is being dissolved is a solute. A solute and a solvent can either be a solid, liquid or gas. The most common solvent in the laboratory is water. Ethanol and Propanone are other solvents used in the laboratory.

Activity 6.3(b): Making a homogeneous mixture of sugar and water

What you need

- spatula
- petri dish
- glass rod
- sugar
- water
- beaker

What to do

In groups:

1. Measure 10g of sugar into a petri dish.
2. Measure 150cm^3 of water and transfer it into a beaker.
3. Using a spatula, add sugar, a little at a time while stirring.
   a) What do you observe?
   b) What name is given to the final product?
   c) What other name is given to the sugar and water in the final product?
   d) From your observation, what is a homogenous mixture?
   e) In your groups, suggest other substances that form a similar mixture and present your findings to the rest of the class.

In *Activity 6.3(b)*, you found out that sugar dissolves in water to form a uniform solution. Sugar is the solute and water which dissolves sugar is a ***solution***. When sugar is added to water at a given temperature and it can no longer be dissolved, the solution is said to be **saturated.**

Activity 6.3(c): Preparing a heterogeneous mixture

What you need

- spatula
- petri dish
- glass rod
- chalk dust
- water
- beaker

What to do

1. Measure 10g of chalk dust into a petri dish.
2. Measure 150cm^3 of water and transfer it into a beaker.
3. Add chalk dust to the water while stirring and then allow it to stand.
   a) What do you observe?
   b) What happens to the chalk dust?
   c) What name is given to the mixture formed?
   d) Which other substance forms the same mixtures in (c)?

Did you know?

A suspension such as passion fruit juice is a mixture in which particles are dispersed throughout the entire liquid and settle on standing.

Assignment 6.3

In groups, discuss the difference between a solution and a suspension.

Separation of mixtures

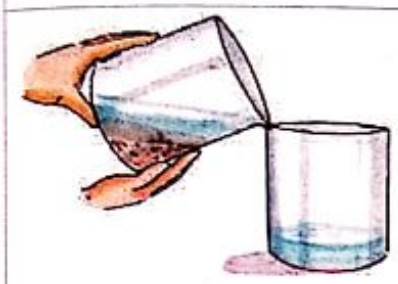
Pure substances are used in homes, hospitals and school laboratories. Therefore, there is a need to separate these mixtures into pure components.

Think about

The methods used to separate the foods and drinks at home and complete *Table 6.7*.

Table 6.7: Methods of separation of foods and drinks at home

Method	Examples of food/drinks	Principle used
 sieving		
 winnowing		
 filtration		

 churning		
 hand picking		
 decantation		

Note

Rock salt is a mixture of salts of sodium chloride (common salt), calcium sulphate, magnesium sulphate. Rock salt can also be regarded as a mixture of rock and common salt, which is soluble in water.

Activity 6.3(d): Obtaining pure salt from rock salt

What to do

In your groups;

1. plan and carry out an investigation to obtain pure salt from rock salt.
2. write down the procedure to obtain pure salt from rock salt and discuss it with your teacher.
3. carry out the experiment.
4. share your findings with the rest of the class.

Rock salt is impure. When water is added to it, common salt dissolves forming a solution while the impurities, which are insoluble, remain. These impurities are filtered off and the remaining solution is evaporated to dryness where water evaporates and leaves pure common salt behind. Pure sodium chloride can also be obtained by **fractional crystallisation**.

6.4 Miscible and Immiscible Liquids

Activity 6.4(a): Investigating what happens when two different liquids when are mixed together

What you need

- water
- paraffin
- cooking oil
- ethanol
- measuring cylinder
- 5 beakers

What to do

1. Label the beakers as 1,2,3,4 and 5.
2. Measure 10cm^3 of each of the pairs of liquids as shown in *Table 6.8* into the beakers and shake.
3. Allow the mixture to settle for some time.
4. Record your observations and discuss with the rest of the class.

Table 6.8: Mixing two different liquids

Beaker	Components	Observation
1	Water and ethanol	
2	Water and cooking oil	
3	Water and paraffin	
4	Cooking oil and paraffin	
5	Ethanol and paraffin	

When two liquids are mixed and they dissolve into each other to form a uniform layer, such liquids are called ***miscible liquids.*** When they form two distinct layers, such liquids are called ***immiscible liquids***. Immiscible liquids form liquid junctions which separates the two layers and the less dense liquid forms the upper layer.

Activity 6.4(b): Separating a mixture of cooking oil and water

What you need

- beaker
- measuring cylinder
- separating funnel
- cooking oil
- water

What to do

In groups;

1. Pour 50 cm^3 of cooking oil into a separating funnel.
2. Add 50 cm^3 of water and fix a stopper.
3. Shake and leave to settle as shown in *Figure 6.7*.
4. Write down your observations.
5. Explain why the upper layer forms.
6. Explain the principle used to separate the mixture.

In *Activity 6.4(b)*, you find out that the oil forms the upper layer because it is less dense, and water forms the lower layer because it is denser than oil. Now in groups, name other pairs of liquid in your environment which can form two distinct layers when mixed together.

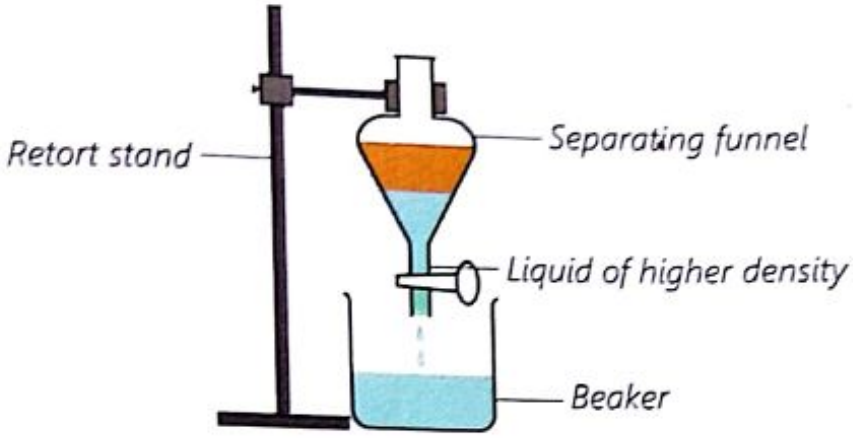


Figure 6.7: *Separation of immiscible mixtures*

Activity 6.4(c): Separating a mixture of ethanol and water

What you need

- a mixture of ethanol and water
- thermometer
- fractionating column
- lei-big condenser
- beaker
- tripod stand
- wire gauze
- heat source
- retort stand
- a round bottomed flask

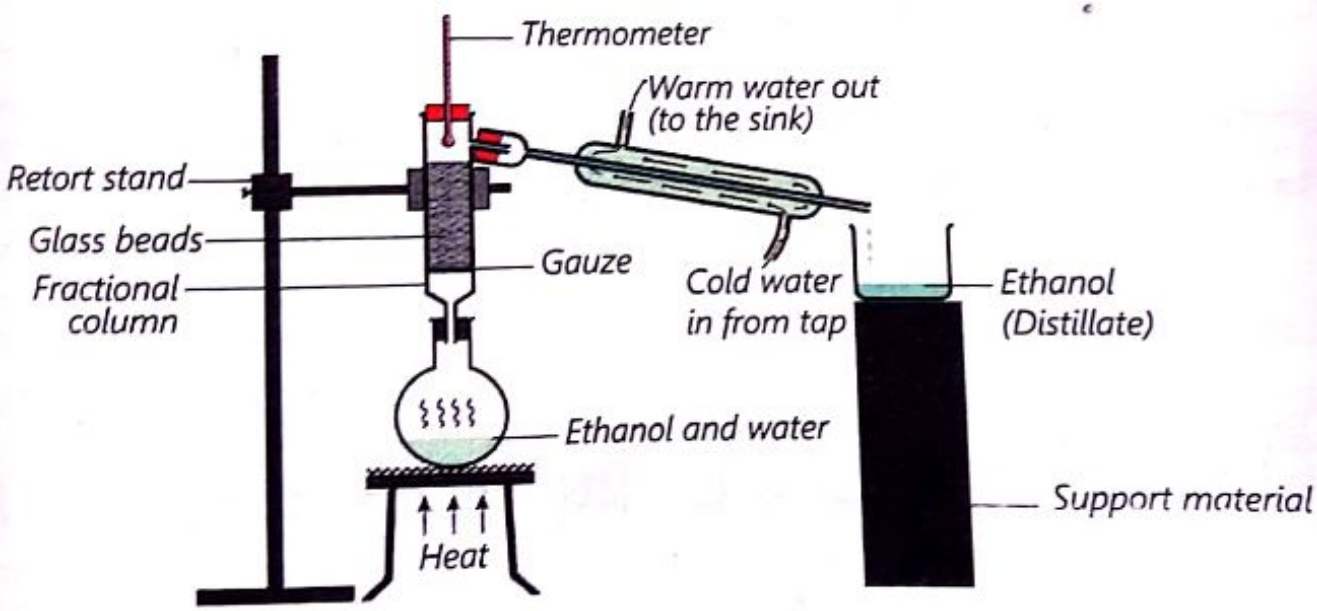


Figure 6.8: *Fractional distillation*

What to do

1. Put a mixture of ethanol and water into a round bottomed flask
2. Set up the apparatus as shown in *Figure 6.8.*
3. Add anti-bumping stones into the mixture in the flask.

4. Heat the mixture until it starts boiling and collect the distillate at different temperature intervals of 78°C, 83°C, 88°C, 92°C, 97°C.
5. Place a small portion of each distillate collected and burn it. What do you observe?

Questions

1. Discuss the importance of;
   i) glass beads
   ii) anti- bumping stones
2. What is the role of water in the Liebig condenser?
3. Why does the water go in at the bottom of the condenser?
4. What is the principle behind this method?

In *Activity 6.4(c)* you realised that ethanol is collected as a distillate because it has lower boiling point and water remains in the distilling flask because it has higher boiling point. The method used to separate miscible liquids with different boiling point is ***fractional distillation.*** Now discuss in your groups where this method is applied in real life. From *Activities 6.4(a)* to *6.4(c)*, you realize that mixtures can be separated by physical means such as dissolution, filtration, evaporation, distillation and many others.

In Chemistry, a mixture is a material made up of two or more different substances which are physically combined. A mixture is the physical combination of two or more substances in which the identities are retained and are mixed in the form of solutions, suspensions and colloids.

A mixture consists of components which are present in any proportion by mass. It takes up the average properties of its components, does not need energy to be formed and its components can be isolated by physical means.

ICT Activity

In groups, use the internet to research about the different compounds and mixtures. Construct a table grouping the different compounds and mixtures using any suitable software, for example word processing software. Make hard copies and present your findings to the rest of the class.

Sample Activity of Integration

Air is a mixture of various components with varying importance ranging from supporting to saving lives. Oxygen is one of the components of air and highly essential in pure form. 21% of air is made up of oxygen. You require oxygen for many different functions like metabolism, burning, respiration, in emergency survival oxygen tanks. There is always panic in hospitals across the country whenever they run short of this gas yet it's a natural gift.

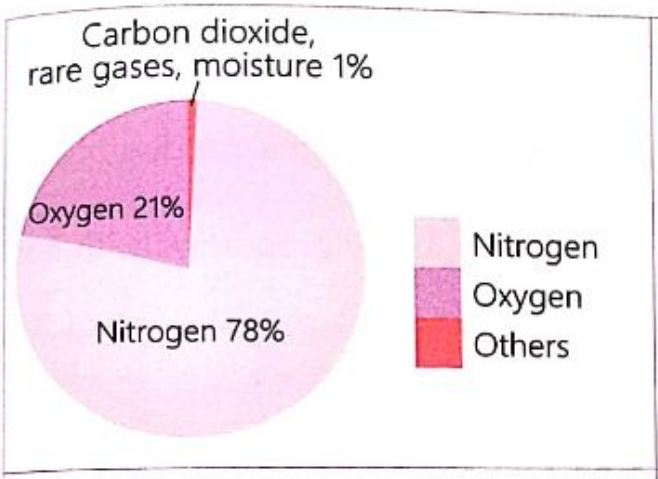


Figure 6.9: Components of air

Figure 6.10: Uses of oxygen

Task

Write an article for district healthy officers to be translated into local languages across the country assuring people that oxygen is readily available and can be obtained in large quantities.

In your article indicate;

1. components of air
2. the properties of each component that enable them to be separated from the rest
3. how oxygen can be obtained on large scale
4. how the percentage of oxygen can be obtained

Chapter Summary

In this chapter, you have learnt that:

- An atom is the smallest indivisible, electrically neutral particle of an element that can participate or take part in a chemical reaction.
- A substance made up of two or more elements chemically combined together in a fixed ratio is called a compound.
- A substance consisting of two or more elements or compounds which are physically combined together and can be separated by physical means is called a mixture.

- A homogeneous mixture is one in which all the components completely dissolve to form a uniform mixture.
- A heterogeneous mixture is one whose components exist in two or more clearly visible separate (distinct) physical states.
- A solvent is a substance which dissolves a solute to form a solution.
- A solution is a uniform or a homogeneous mixture of a solvent and solute(s).
- A solution which cannot dissolve any more solute at a specific temperature in the presence of an undissolved solute is called a saturated solution.
- A mixture of a liquid and an un-disolved solid solute where tiny solid particles spread throughout the liquid but may settle on standing is called a suspension.
- An aqueous solution is a solution in which water is a solvent.
- A filtrate is what passes through the filter paper and the residue is what remains on the paper.
- Immiscible liquids are liquids which do not mix in any proportion with each other.

Review Exercise:

1. State the difference between compounds and elements.
2. a) Define the term:
   i) mixture ii) compound
   b) Give four differences between mixtures and compounds.
3. Explain the following terms.
   a) solution c) suspension
   b) aqueous solution d) sediment
4. Name two solids other than chalk that form suspension.
5. At home you make several solutions.
   a) Write down three solids you dissolve in water to make a solution.
   b) Three solutions you make by dissolving a solid in water.
6. Classify the following as solution or suspension.
   a) Orange juice
   b) Milk
   c) Passion fruit juice
7. What is meant by the term:
   a) Filtrate b) Residue
8. Describe two ways of separating the solid from the liquid in suspension.
9. How would you separate salt and sugar? Mention any safety precaution you would take.
10. Water and paraffin are immiscible. How would you separate the mixture?

Chapter 7 Air






Keywords

- air
- atmosphere
- air pollution
- burning
- corrosion
- rusting
- oxides

By the end of this chapter, you should be able to:

a) understand that air is a mixture of different gases that can be separated and used.
b) explain how air pollution can affect the atmosphere.
c) understand and appreciate that processes such as burning and rusting/corrosion use oxygen from the air to form oxides.

Competency: You should be able to appreciate that air is a mixture of gases in which oxygen is the active constituent and you can describe the process that may affect air quality.

Introduction

Our natural surrounding consists of air particles which are very much smaller than grains of dust. You know that they exist because you breathe in air particles. You also feel the wind when many air particles are moving and hitting you. For example, when you look outside the window, you see parts of the tree like branches and leaves moving sideways. These movements are in response to the moving air particles in the atmosphere.

In this chapter, you will find out the composition of air in the atmosphere, discuss air pollution and its effects on the environment and how oxygen is used in burning and rusting/corrosion to form oxides.

7.1 Air as a Mixture

Activity 7.1(a): Determining the components and composition of air

In groups, research about the following:

a) the components of air and their composition.
b) the major components of air.
c) other substances present in small quantities.
d) present your findings to the rest of the class using a pie chart.

Activity 7.1(b): Investigating effects of components of air on some compounds

What you need

- Cobalt(II) chloride
- iron
- watch glass
- drinking straw
- lime water
- test tube
- Copper(II) sulphate

What to do

1. Using a drinking straw, blow your breath into a test tube containing lime water.
2. Leave the test tube of lime water open in a test tube rack for three days.
3. Place anhydrous Copper(II) sulphate or cobalt(II) chloride on a glass watch in the atmosphere.
4. Place a piece of iron outside for three days.
5. What do you observe in 1,2, 3 and 4?
6. What is the relationship between your observations in 1 and 2?
7. Suggest the component of air that is responsible for your observation in 3 and 4.
8. Present your observations and conclusions to the rest of the class.

Carbon dioxide from the atmosphere reacts with calcium hydroxide solution (a solution of calcium hydroxide is lime water) to form an insoluble substance which does not dissolve in water, therefore, forming a milky suspension. Oxygen combines with iron in the presence of moisture to form hydrated iron(III) oxide which appears as a reddish-brown coating on the iron surface.

In Activity 7.1(a), you looked at air as a homogeneous mixture consisting of different gases with oxygen and nitrogen as major components. The major components of air are separated from each other by fractional distillation of liquid air, because of the difference in their boiling point.

Activity 7.1(c): Determining how a fractionating column works

What to do

In groups:

1. Examine the fractionating column given to you and identify its features.
2. What are the uses of these features identified in (1)?
3. Discuss how the fractionating column is used to separate liquids with different boiling points.
4. Discuss how it is used to separate nitrogen and oxygen mixture.

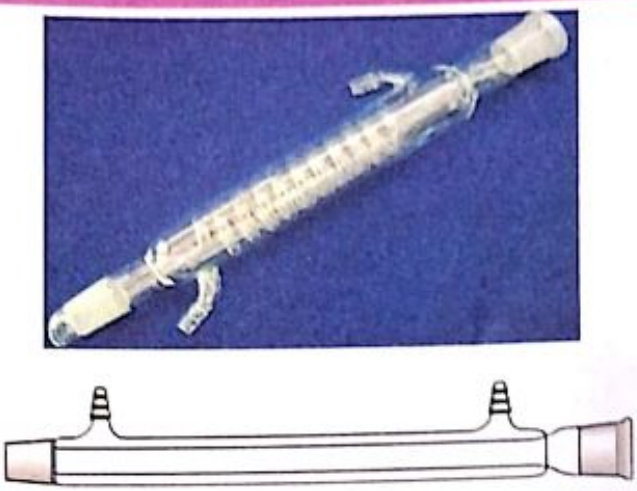


Figure 7.1: *Fractionating column*

Separation of components of air involves filtration. Water vapour and carbon dioxide, are removed and the remaining dry air, free of carbon dioxide is compressed to 200 atmospheres and it becomes warm.

Heat is removed by a network of pipes carrying liquid nitrogen. The cold compressed air is allowed to expand rapidly thus cooling even further to the point where most air is liquified. The remaining gaseous mixture is then separated by fractional distillation.

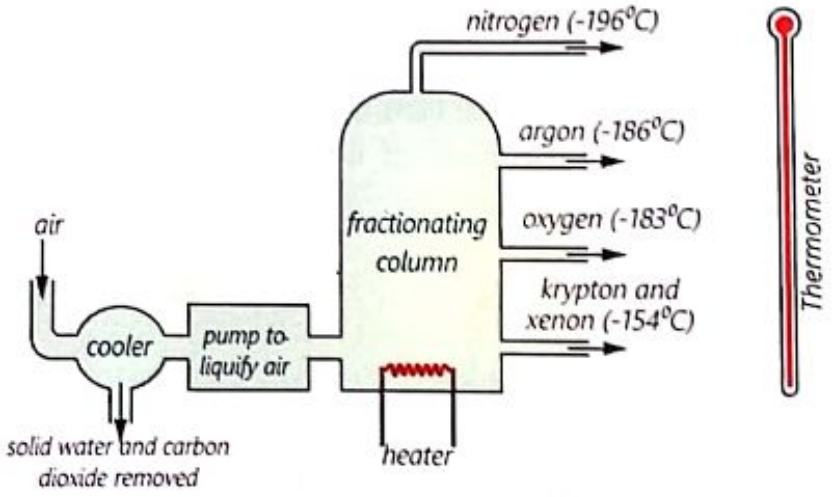


Figure 7.2: *Fractional distillation of liquid air*

Assignment 7.1

In groups:

1. Explain why;
   a) air is first filtered.
   b) solid water and carbon dioxide are removed.
2. How is the dry air liquefied?
3. Which component is given off first and why?

Assignment 7.2

What is Air?

Using the previous knowledge of mixtures and compounds, discuss in groups why air is a mixture and not a compound.

7.2 Air Pollution

You must have witnessed moving vehicles like cars and motorcycles releasing exhaust fumes and making the environment dusty. Even at the at the school or home kitchen, these gases are released when using fossil fuel and burning waste such as plastic as shown in *Figure 7.3*. Where do the gases produced go?

***Figure 7.3:** Pollution of air*

Air pollution is the introduction of substances into the atmosphere that directly or indirectly endanger the lives of living organisms. The substances which cause air pollution are called **pollutants**.

Activity 7.2(a): Identifying the source of pollutants, effects and measures to be taken to prevent air pollution

In groups, carefully observe the pictures in *Figure 7.3* and identify some of the air pollutants, their sources, effects and measures taken to prevent their effects on the environment. Record your finding in *Table 7.1*.

Table 7.1: Identification of sources of pollutants, effects and measures to prevent air pollution

Pollutant	Source	Effect	Measures to be taken
Chalk dust	Chalkboard	Affects the eyes and the respiratory system	Use of alternative means such as dustless chalk, white boards, flip charts

1. Present your findings to the rest of the class.
2. Research about and name other pollutants, their sources, effects and measures taken to reduce their effects on the environment.

DID YOU KNOW?

Lichens shown in *Figure 7.4* are found in places with minimum air pollutants and are used as an indicator for the purity of air.
What is the state of air in your community?

Figure 7.4: *Lichens growing on a tree*

Importance of different components of air

Figures 7.5, 7.6, 7.7, 7.8 shows the different uses of components of air.

Figure 7.5: *Uses of Nitrogen*

Figure 7.6: *Uses of rare gases*

Figure 7.7: *Uses of Oxygen*

Figure 7.8: *Uses of Carbon dioxide*

Activity 7.2(b): Finding out uses of air and the atmosphere

In a group,

1. Discuss the importance of each component of air:
   a) In our daily life
   b) Atmosphere

QUICK TIP *From your discussions identify the natural and commercial uses of air.*

2. Present your findings to the rest of the class.

7.3 Combustion / Burning

What happens when you light a matchstick, burn a piece of paper or light a candle? The process that takes place is ***combustion***. This is a chemical reaction in which a substance combines with air to form energy.

Combustion can be slow (with no flame) or rapid (produces flame). Examples of rapid combustion are; burning bushes and burning charcoal, while examples of slow combustion include; digestion of food, and fermentation/decay. *Figure 7.9* shows the burning of charcoal.

Figure 7.9: *Burning of charcoal*

Activity 7.3(a): Investigating what is necessary for wood/ candle to burn

What you need

- a box of matches
- candle
- plasticine
- stop clock
- beakers of various sizes

What to do

1. Place a candle on a piece of paper on a table.
2. Light the candle.
3. Invert the beaker over the burning candle and at the same time, start the stop clock and note the time it takes for the candle to go off. Why do you think eventually the candle went off after some time?
4. Repeat procedure 3 using the beakers provided.
5. Comment on your results and present your findings to the rest of the class.

Note Using the plasticine, block any opening

Activity 7.3(b): Determining the percentage of oxygen in air used up when iron rusts

What you need

- trough
- test tube
- water
- steel wool

What to do

1. Wet the steel wool.
2. Push the wet steel wool at the bottom of the test tube.
3. Fill the trough with water and invert the test tube in the trough of water.
4. Record the initial length of the column of air either by putting a rubber band or marking the initial level of water. Let the length be z cm.
5. Set up the apparatus as shown in the diagram and *Figure 7.10* leave the set up to stand for seven days.

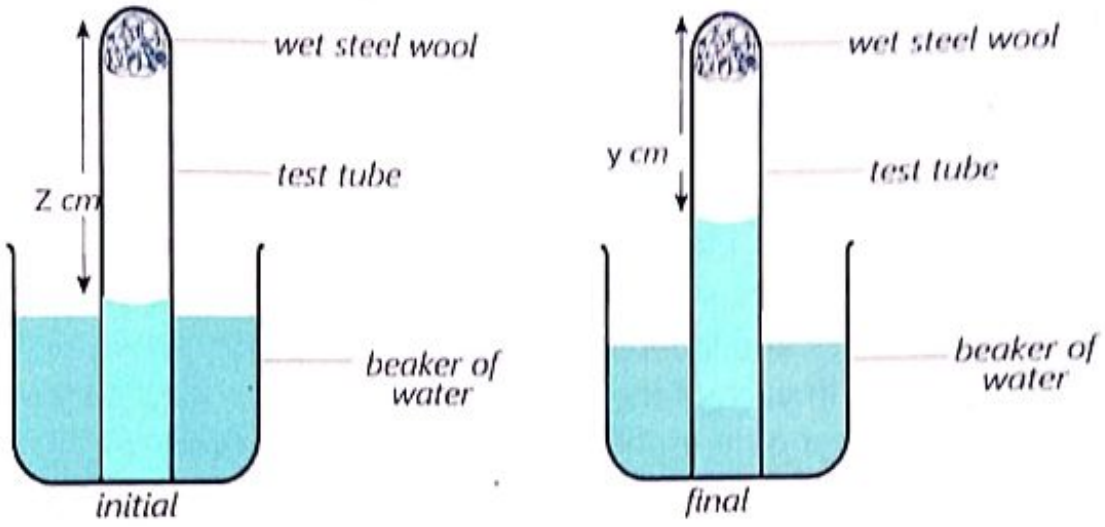


Figure 7.10: *Investigating the percentage of air used up during rusting*

6. Record the final level of water after seven days.
   i) What did you observe?
   ii) Calculate the percentage of oxygen used in rusting.

Hint:

Percentage of oxygen used in rusting $= \frac{(z-y)}{z} \times 100$

where z= Initial level of water

y= Level of water after rusting

For combustion to take place, oxygen must be present. In the absence of oxygen, the burning substance is extinguished. For rusting to take place, it also requires oxygen. From the previous activity, you found out that when steel developed brown coating, the level of water increased in order to occupy space which was originally occupied by the used up oxygen.

Rusting

A farmer accidentally left a hoe outside for a week. The hoe had developed a reddish-brown coating shown in *Figure 7.11*. He immediately compared it with the hoes that were kept in the house. The immediate question in the farmer's mind was why had the hoe developed the coating.

Figure 7.11: *Rusting of iron*

Activity 7.3(c): Investigating the conditions necessary for rusting to occur

What you need

- test tubes
- six iron nails
- anhydrous calcium chloride
- test tube rack
- long cotton wool
- glass rod
- cooking oil

What to do

In groups:

1. Take three test tubes and label them A, B and C.
2. Place 2 clean nails in each of the test tubes.
3. Add tap water in test tube A until the nails are fully covered.
4. Cover the nails in test tube B with freshly boiled water and cover the surface of water with a layer of cooking oil.
5. Plug a tight ball of cotton wool into test tube C and push it down to half of the test tube using a glass rod. Then put a small layer of anhydrous calcium chloride on top of the cotton wool and cover it again with cotton wool.
6. Place the three test tubes with their contents in a large beaker and keep them safe for two to three days.
   a) Draw a setup of the experiment.
   b) Explain why the following were used:
      i) freshly boiled water
      ii) cooking oil
      iii) anhydrous calcium chloride
   c) Record and interpret your observations.
   d) Compare your observations and results with other groups.

Most metals react with some gases in the atmosphere and as a result, change their original appearance. Reaction of metals with gases in the atmosphere is called ***corrosion***. Corrosion of iron is called rusting. From *Activity 7.3(c)*, you found out that for rusting to take place, water and oxygen from the atmosphere must be present. However, there are some substances which accelerate the rate of rusting.

Activity 7.3(d): Investigating the factors that accelerate the rate of rusting

What you need

- four test tubes
- clean nails
- common salt solution
- test tube rack
- soap solution
- vinegar
- tap water

What to do

In groups:

1. Take four test tubes and label them A, B, C and D.
2. Place 2 clean nails in each of the test tubes.
3. Add tap water in test tube A until the nails are fully covered.
4. Cover the nails in test tube:
   a) B with soap solution
   b) C with salt solution
   c) D with vinegar
5. Place the four test tubes with their contents in a test tube rack and let them stand for 3 days.
6. Observe your set up every day and record your observations.
7. In which test tube did iron develop a brown coating:
   a) the shortest time?
   b) the longest time?
8. Present your findings to the rest of the class.
9. Research on how temperature affects the rate of rusting of iron.

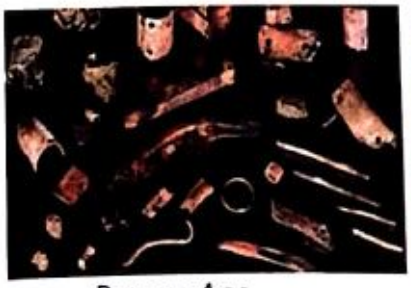
DID YOU KNOW?

The closer your car is to a water body, the quicker rust problems will form. Keep your vehicle covered as often as possible, particularly when you are parking it near a **water body.**

DID YOU KNOW?

The Iron Age followed the Bronze and Stone Age

Stone Age



Bronze Age

Iron Age

Figure 7.12: *Stages of materials advancement*

Activity 7.3(e): Iron and society

Figure 7.13: Methods of protecting iron from rusting

Since time immemorial, iron has been used to make items for both domestic and industrial use. However, iron rusts and there is need to prevent the rusting.

What to do

In groups, *using Figure 7.13;*

1. describe the methods that can be used to prevent rusting and where they are applied.
2. discuss disadvantages of rusting.
3. present your findings to the rest of the class.

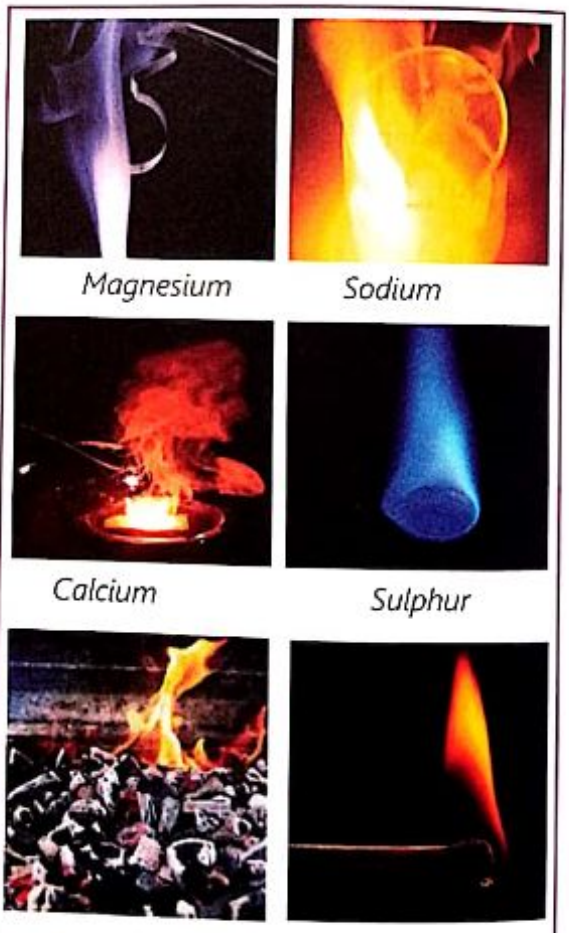
Burning of elements in air

For any burning to take place, oxygen must be present. When elements combine with oxygen, they form a compound called an ***oxide***. Both metals and non-metals burn in oxygen as shown in *Figure 7.15.* Carbon, hydrogen, sulphur and phosphorous are some of the examples of non- metals. Magnesium, sodium, iron and copper are examples of metals.

When a metal is exposed to the atmosphere for a long time, it combines with oxygen from the atmosphere to form a coating of oxide on its surface as shown in *Figure 7.14.* This process is called ***corrosion.***

Corroded zinc *Corroded copper*

Figure 7.14: *Corrosion of metals*



Magnesium *Sodium*

Calcium *Sulphur*

Carbon *Phosphorous*

Figure 7.15: *Elements burning in air*

Activity 7.3(f): Writing an equation

Write word equations for the reaction between oxygen and the above elements.

QUICK TIP *In Chemistry, we write equations just as we write algebraic and simultaneous equations in mathematics.*

A chemical equation is just a summary of a representation of a chemical reaction. The reactants are written on the left and the products on the right-hand side. An arrow is used to show the change from reactants and products.

The physical states of products and reactants are indicated using the following: (aq)- aqueous, (g)-gas, (l)-liquid, (s)- solid.

Magnesium (s) + Oxygen(g) → Magnesium oxide(s)

ICT Activity

In groups, use the Internet and watch videos about the processes involved in the separation of air into various components. Summarise your findings and present to the rest of the class using any suitable software, for example Microsoft Word and PowerPoint.

Sample Activity of Integration

In your community, farmers need to open up land for farming and agriculture. During the dry season they decide to burn the bushes so as to clear the vegetation as shown in *Figure 7.16*.

Task

As a Chemistry student, write a short message sensitising the community about effects of bush burning to the atmosphere and suggest methods to stop fires that were started.

Figure 7.16: *Bush burning*

Chapter Summary

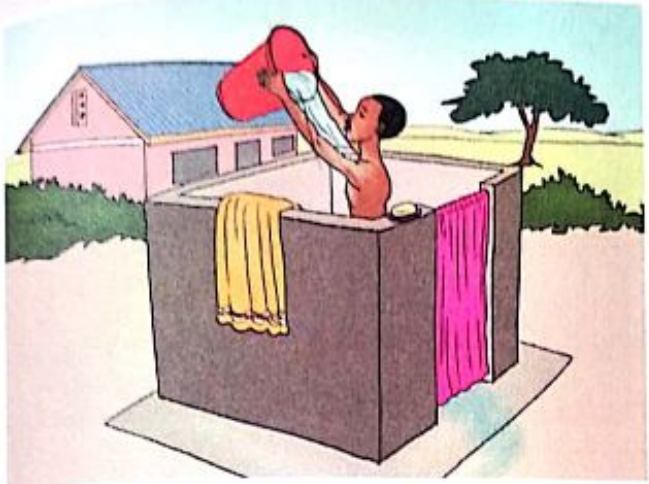
In this chapter, you have learnt that:

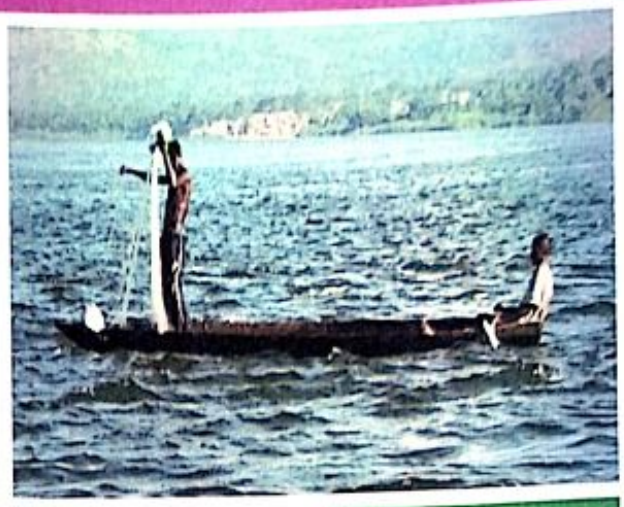
- Air is a mixture of gases.
- The components of air include nitrogen, carbon dioxide, oxygen, rare gases and water vapour.
- The major components of air are nitrogen and oxygen. They are separated by fractional distillation due to their difference in boiling points.
- Rusting is the process by which a brown coating forms on iron in the presence of water and oxygen.
- Rust is hydrated Iron(III) oxide.
- Water and oxygen are the conditions necessary for rusting to take place.
- The common pollutants in the air include carbon dioxide, sulphur dioxide, carbon monoxide, dust and smoke.
- The major source of air pollution is burning fossil fuels.

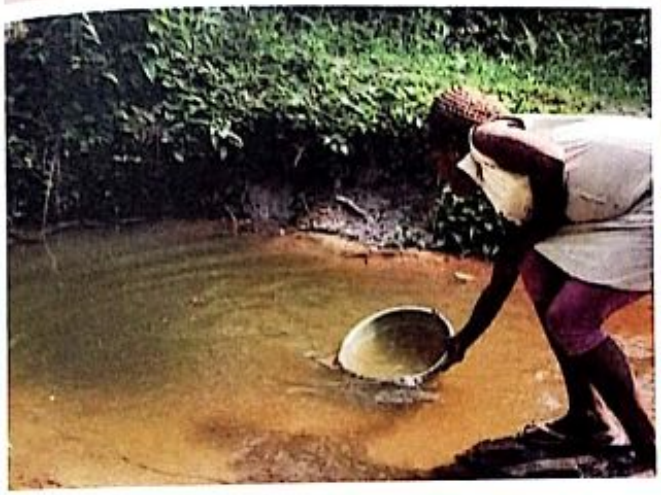
Review Exercise

1. During the separation of components of air, carbon dioxide is first removed from air before liquifaction of the remaining air.
   a) How is carbon dioxide removed?
   b) Why is carbon dioxide removed before liquification of air?
   c) Name the physical process used to separate oxygen from liquid air.
   d) Why is it possible to use the process named in (c) above?
2. a) Name two major components of air.
   b) Name the process by which the components of air are separated.
3. a) What is the approximate percentage composition of the atmospheric air by volume?
   b) Name four substances found in the atmosphere in small quantities
4. Describe experiments you would carry out in the laboratory to show that air contains:
   a) Water vapour b) Carbon dioxide c) Oxygen
5. What are the natural processes that;
   a) decrease the concentration of oxygen in the atmosphere?
   b) increase the concentration of oxygen in the atmosphere?
6. a) What is the chemical name for rust?
   b) State the conditions necessary for rusting to take place
   c) Draw labelled diagrams to show how it could be demonstrated in the laboratory that the conditions you have named in 6 (b) are necessary for an iron nail to rust.
7. a) Name four methods used to prevent rusting.
   b) Explain why a scratched tin-plated iron sheet starts to rust after a short period whereas a scratched zinc plated iron sheet will not when both are exposed to moist air.

Chapter 8 Water







Keywords

- cycle
- effluent
- sewage
- sludge
- treatment
- water

By the end of this chapter, you should be able to:

a) describe the occurrence of water as a natural resource, its physical properties, chemical properties and importance in everyday life.
b) explain how water is recycled by natural processes.
c) explain the process of water and sewage treatment.

Competency: You should be able to investigate evaporation and condensation as natural processes essential for replenishing supplies of fresh water in the water cycle.

Introduction

Water is the most abundant compound on the earth's surface, covering approximately 70% of the earth. It is a compound that consists of hydrogen and oxygen chemically combined together and exists in all three states of matter, that is, solid, liquid and gas.

8.1 Occurrence of Water

Water occurs naturally in liquid form at room temperature. *Figure 8.1* shows several sources of water which are categorised as rain, underground and surface water.

Figure 8.1: *Sources of water*

Properties of water

Just like any other substance, water has specific physical and chemical properties that make it different from the others. You will investigate some of these physical and chemical properties.

Physical Properties

Activity 8.1(a): Identifying sources of water

What to do

In groups,

1. identify sources of; i) surface water ii) underground water
2. present your findings to the rest of the class.

Activity 8.1(b): Finding out the physical properties of water

In groups, using your prior knowledge of *Chapter Six*, discuss and list down the physical properties of pure water.

Present your findings to the rest of the class.

Activity 8.1(c): Investigating water as a universal solvent

What you need

- tap water
- borehole water
- beakers
- watch glass
- a source of heat
- tripod stand
- wire gauze

What to do

In groups:

1. Half-fill a beaker with water and place it on a tripod stand.
2. Using a Bunsen burner, heat the water gently until it boils.
3. Discuss your observations.
4. Place the sample of borehole water given on a watch glass.
5. Place the watch glass on top of the beaker and heat the water gently.
6. Examine the watch glass when all the water has evaporated.
7. Discuss your observation and present your findings to the rest of the class.

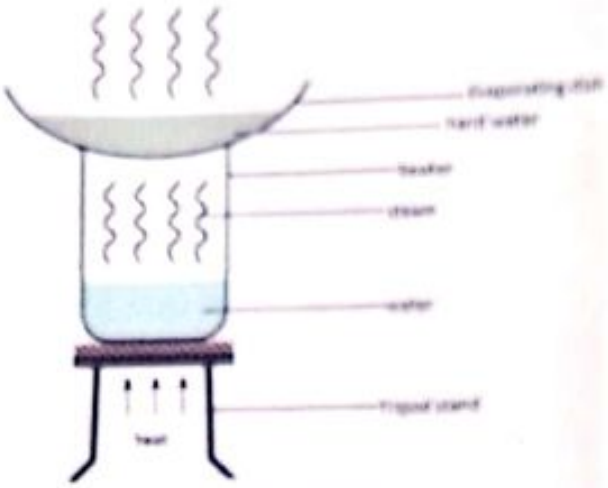


Figure 8.2: Set up of boiling water

From your observation, you will find out that water contains dissolved gases and solids, making it habitable by aquatic animals. This makes water a universal solvent, since it practically dissolves everything, it is, therefore, difficult to find water in its pure form.

Activity 8.1(d): Investigating the Effect of water on some compounds

What you need

- sodium hydroxide pellets
- anhydrous calcium chloride
- anhydrous cobalt(II) chloride
- concentrated sulphuric acid/ ethanol
- hydrated sodium carbonate crystals
- iron(III) chloride
- calcium oxide
- watch glasses
- spatula
- labels
- beakers

What to do

In groups,

1. label seven watch glasses with respect to the chemicals given above except for sulphuric acid which is to be put in a beaker, and its initial volume noted.
2. put a spatula endful of each of the chemicals and place it on the labeled watch glasses respectively.
3. leave the chemicals exposed to the atmosphere for a day.
4. expose concentrated sulphuric acid for a week and note its final volume.
5. discuss your observations with the rest of the class.

Safety Precaution

Carefully handle the chemicals provided since they are highly corrosive (concentrated sulphuric acid)

When substances are exposed to the atmosphere, some lose their water of crystallisation and crumble into powder, others absorb water from the atmosphere and dissolve in it to form a solution, or remain in the same state.

Note

- A substance that loses its water of crystallisation to the atmosphere is efflorescent and the process is ***efflorescence.***
- A substance that absorbs water in the atmosphere and retains its physical state is hygroscopic and the process is called ***hygroscopy.***
- A substance that absorbs water from the atmosphere and dissolves in it to form a solution is deliquescent and the process is ***deliquescence.***

Assignment 8.1

In groups, classify compounds given in *Activity 8.1(d)* as deliquescent, efflorescent or hygroscopic substances.

Chemical properties

Cold water reacts with some metals to form hydrogen and the corresponding metal hydroxide. For example, sodium reacts with cold water to form hydrogen and sodium hydroxide solution.

Activity 8.1(e): Finding out what happens when cold water reacts with potassium and sodium

What you need

- water trough
- potassium
- sodium
- a pair of tongs
- knife
- litmus paper

What to do

In groups,

1. pour water in a water trough.
2. using a dry knife, cut a small piece (pea size) of potassium metal and place it in between filter paper to remove the oil.
3. using a pair of tongs, drop it into a trough of cold water.
4. carefully observe what happens to the metal.
5. record your observations.
6. test the liquid in the trough using blue and red litmus paper and describe what happens to each paper.
7. repeat the procedures 1-6 using sodium.
8. present your responses to the rest of the class clearly indicating which of the two metals is more reactive.
9. write a word equation for both reactions.

Figure 8.3(a): *Reaction of potassium with water*

Figure 8.3(b): *Reaction of sodium with water*

i) Potassium was first discovered in 1806 by electrical breakdown: electrolysis of potassium chloride. Using the internet, read more about this.

ii) Sodium was first discovered in 1807 by the electrical breakdown; electrolysis of sodium chloride.

Water is a natural resource which every living organism needs to survive, thus the slogan *"Water is life."*

Activity 8.1(f): Uses of water

What to do

In groups,

1. research on the uses of water and classify them as domestic, industrial, agricultural, recreation, transport, tourist attraction and habitat.
2. report your findings to the rest of class.

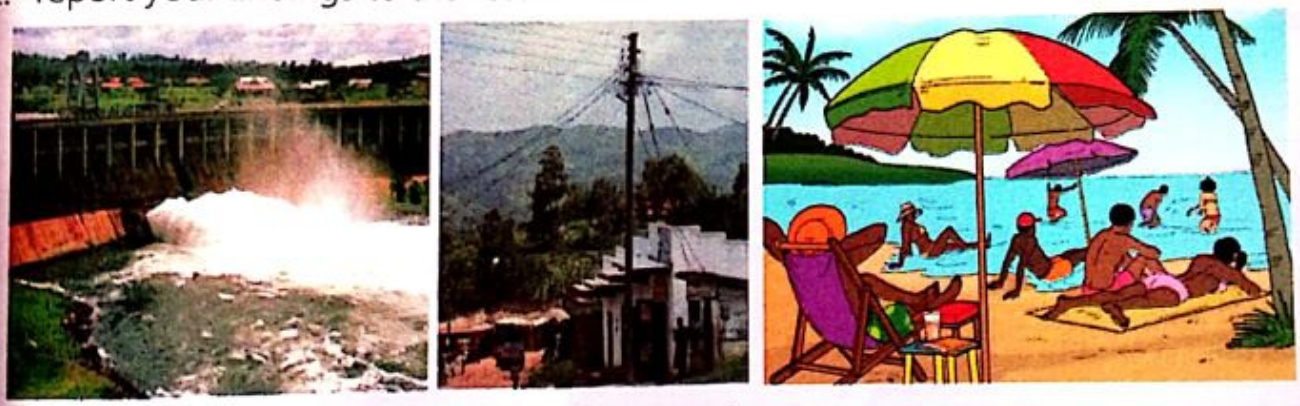


Figure 8.4: Uses of water

Water occurs naturally. *Figure 8.4* shows uses of water. At home and school, the commonest liquid substance you come across is water. Most activities are done using water, for example, washing, cooking and bathing. Individuals may not be able to operate without water because water is used as solvent in industries, used to generate hydro electric power and no wonder the saying, "Water is life".

8.2 The Water Cycle

In spite of the fact that a lot of water is used daily domestically, industrially and in irrigation, the amount of water on earth remains fairly constant. It keeps on changing from one state to another depending on the conditions of its environment.

In *Chapter 3*, you looked at the different states in which water exists: liquid, solid and gas. The change of states helps water to purify itself in the water cycle.

Activity 8.2(a): The water cycle

What you need

- manila paper
- markers
- pencils
- ruler

What to do

In groups,

1. state the conversions of water into the different states with respect to what takes place on earth.
2. draw a water cycle.
3. compare your findings with the other groups and make one general water cycle chart.

QUICK TIP *Use arrows to indicate the transfer from one state to another*

4. Present your findings to the rest of the class.

My Environment, my responsibility

For us to make the best use of water from various sources, we must learn to use the water sparingly and also to keep it clean. When undesirable materials enter water, the water becomes unsuitable for some purposes and, therefore, such water is said to be polluted. These materials cause harm to both plants and animals.

Activity 8.2(b): Water pollution

What you need

Water cycle chart

Figure 8.5: *Water Pollution*

What to do

In groups,

1. use a water cycle chart to identify some of the water pollutants.
2. discuss sources of the water pollutants, effect (impact), and measures taken to prevent their effect on the water bodies. Record your finding in *Table 8.1.*

Table 8.1

Pollutant	Source	Effect	Measures to be taken
Excreta	Animals	Breeds germs that spread diseases like diarrhea, cholera and typhoid	Sensitize the community on proper disposal of excreta

3. Present your findings to the class.

8.3 Water Treatment / Purification

Natural water is obtained from lakes, rivers, springs, wells, oceans and rainfall, among others. Water obtained directly from these sources contains pollutants. It usually contains dissolved substances and sometimes suspended solid particles and micro-organisms. The purification/treatment of water is normally done by water works that remove pollutants from water, making it safe for human use.

This is achieved by the following methods: filtration, sedimentation, disinfection/chlorination, softening and neutralisation as shown in *Figure 8.6*.

Activity 8.3: Water treatment

Visit a water treatment plant

1. Draw a flow chart indicating the different stages of water treatment and its importance.
2. Write a report indicating stages of water treatment and discuss it with the rest of the class.

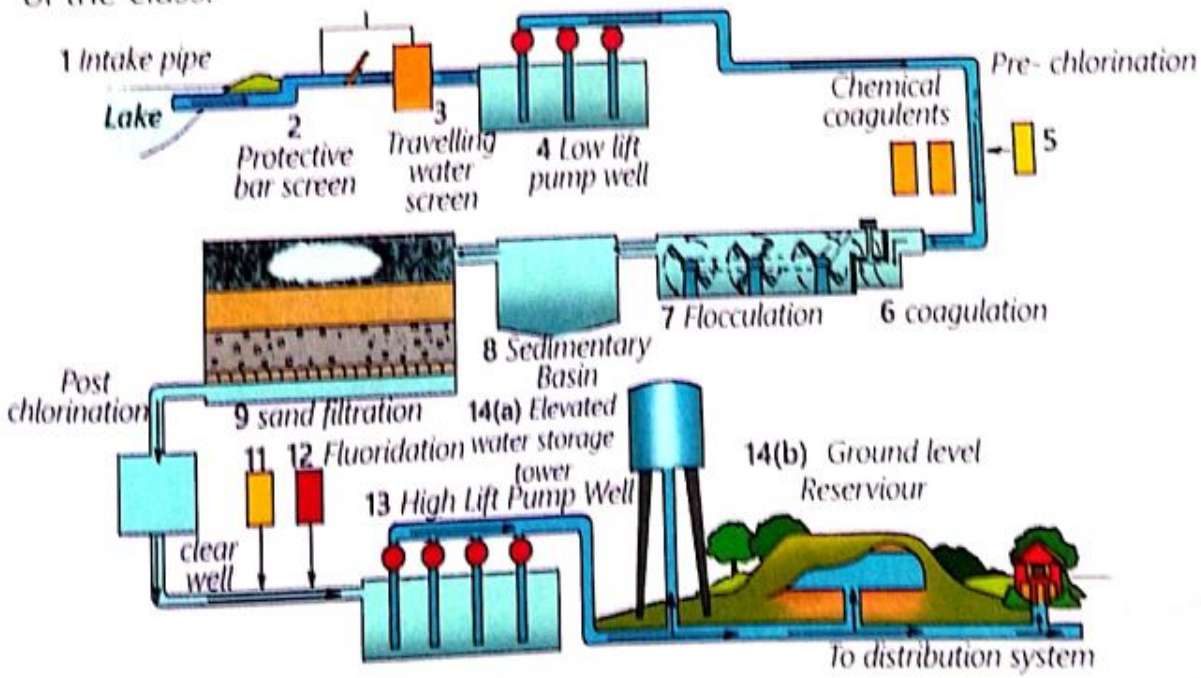


***Figure 8.6:** Water treatment process*

How important is water treatment?

- Water treatment is any process that improves the quality of water to make it more acceptable for a specific use, for example, drinking, laundry, industrial use and recreation.
- A chemical called potash alum is added to settle suspended particles which are filtered off using sand and gravel. Chlorine is added after filtration to kill germs and soda ash added to regulate the pH of the solution and to remove hardness in water.

Sewage treatment

Have you ever wondered what happens to waste water from homes, industries, and markets? This water is very dirty and unsafe to be used by human beings and to be released to the environment. This water is, therefore, supposed to be treated before it is released into the environment for various uses as shown in *Figure 8.7*.

The untreated water of that kind is called **sewage** and the process of removing the contaminants from water containing household, industrial, hospital and animal waste. is called **sewage treatment**.

Assignment 8.2

Visit a sewage plant

1. Find out and discuss stages involved in sewage treatment and the gases produced.
2. Write a report and present it to the rest of the class. In your report, include the meaning of sewage treatment, stages involved, and substances added during treatment.

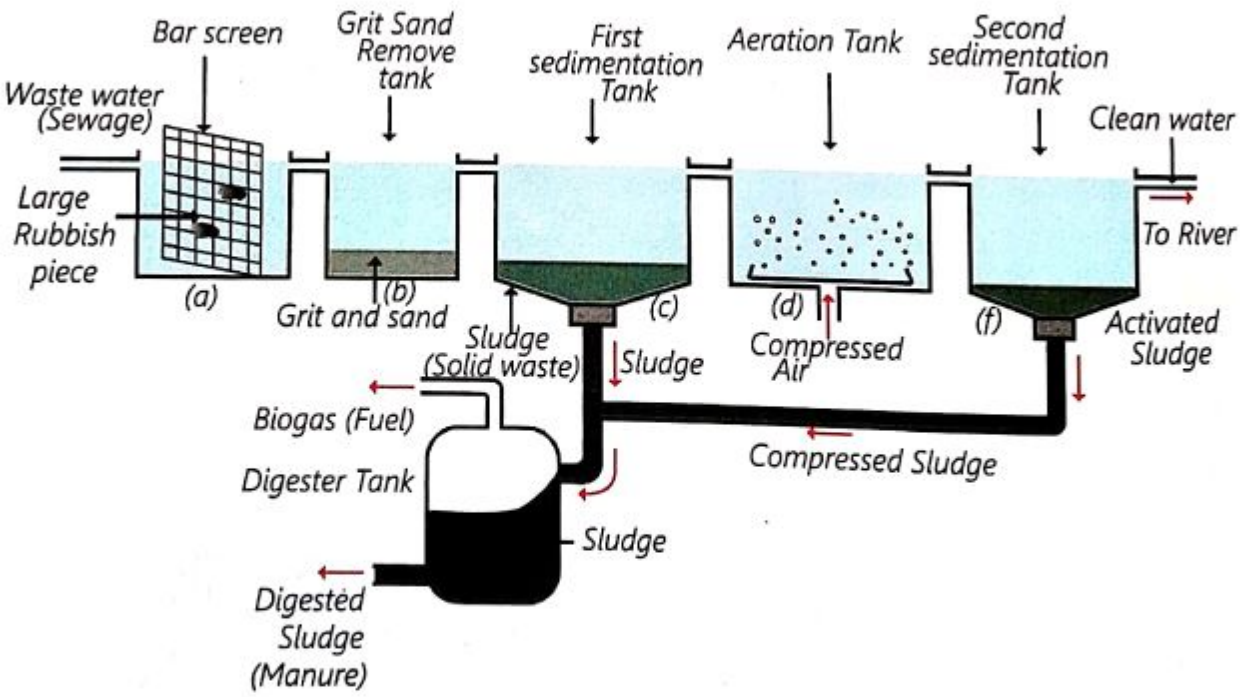


Figure 8.7: *Sewage treatment process*

Note

To make this water safer for drinking, it still has to be boiled.

DID YOU KNOW?

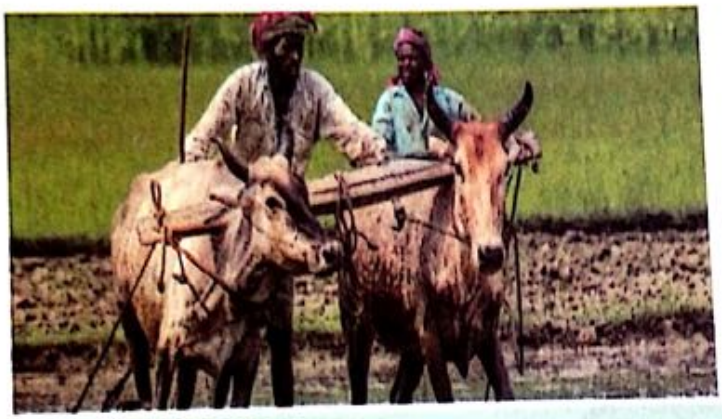
1. That manure and tar are got from sludge which is the solid part of the sewage.
2. Biogas which is used as a fuel is one of the by-products of sewage treatment.

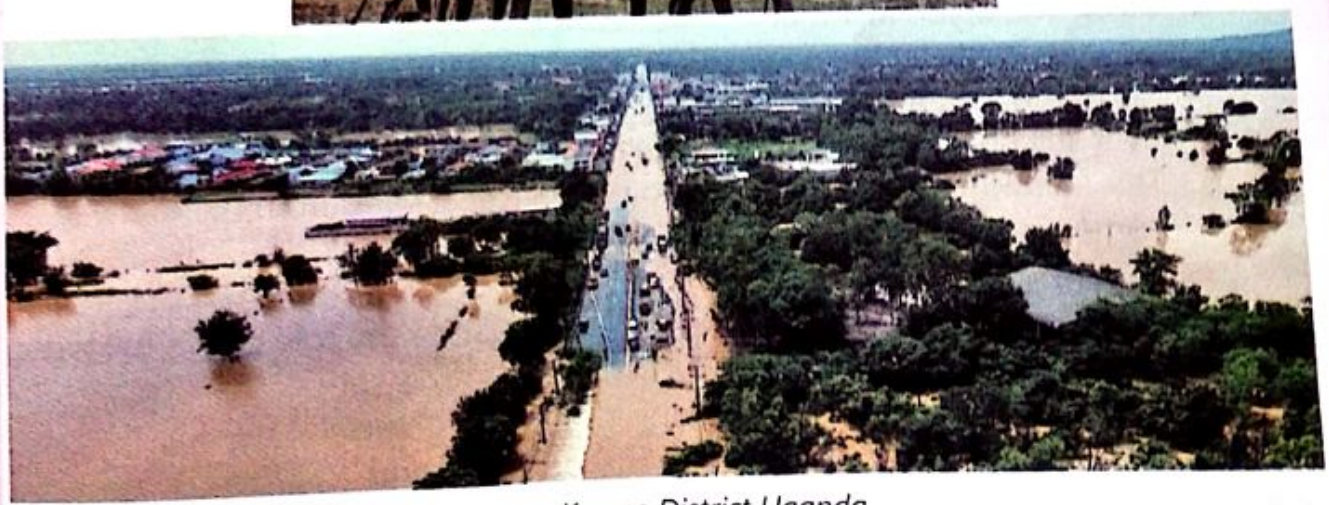
ICT Activity

In groups, use the internet to research and watch videos of the processes involved in water and sewage treatment. Use a suitable software to summarize the processes that are involved. Present your findings to the rest of the class using any other software, for example, Microsoft word or Powerpoint.

Sample Activity of Integration

People have encroached on wetlands in search of land for settlement, farming and setting up industries. This has caused major problems to the country and prompted the government to campaign against wetland encroachments.





source: Kasese District Uganda

***Figure 8.8:** Effect of wetland encroachment*

Task: Write a speech to explain to your community why government is against wetland encroachment.

Chapter Summary

In this chapter, you have learnt that:

- Water is a universal solvent since it dissolves a wide range of substances.
- The amount of water remains fairly constant.
- Some substances absorb or give up their water of crystallisation when exposed to the atmosphere.
- Water has many uses.
- Cold water reacts with some metals, giving off hydrogen gas and forming hydroxide solutions.
- Water undergoes treatment before it is supplied for domestic use.
- Water can be obtained from sewage. The effluent (liquid part of sewage) obtained after sewage treatment is then released into a water body.

Review Exercise:

1. a) What is meant by the term water pollution?
   b) Name two substances that cause water pollution in your locality.
   c) Describe briefly the steps followed in water purification.
   d) State the role of soda ash in water purification.
2. a) In sewage treatment, the sewage is brought into contact with appropriate bacteria under controlled conditions.
   (i) Explain what is meant by the term 'sewage'
   (ii) What is the role of bacteria in sewage treatment?
   (iii) State the condition under which bacteria is active during the treatment of sewage.
   b) Distinguish between 'sludge' and an 'effluent' in relation to sewage treatment.
   c) State three uses of the byproducts of sewage works.
3. a) Describe how each of the following metals react with cold water:
   (i) Sodium (ii) Potassium
4. How would you test that a colourless liquid:
   a) contains water? b) is pure water?
5. Some power stations use river water for cooling and dump it back in the river still hot. Explain how this affects the river.
6. The following set up was used to obtain clean water from muddy water at home. Gravel, sand and charcoal were firmly packed.

Figure 8.9: A column gravel, sand and muddy water

a) State the role of the following in this set-up:
   (i) gravel
   (ii) sand
   (iii) charcoal
b) Is this water safe for drinking? Give a reason for your answer.

Chapter 9 Rocks and Minerals

Keywords

- rock
- igneous
- sedimentary
- metamorphic
- magma
- fossils
- weathering

By the end of this chapter, you should be able to:

a) describe how igneous, sedimentary, and metamorphic rocks are formed.
b) identify the physical properties of rocks and distinguish between the different types.
c) explain the process of weathering and how weathered particles form the basis of soil.

Competency: You should appreciate that the rocks are composed of different minerals and that these minerals determine the properties of these rocks.

Introduction

Do you know what rocks are? They are found everywhere. They are made up of different minerals. You may have thrown them, sat on them, stepped on them and dug them out of your gardens.

Every year, tonnes of rocks are used to build houses, roads and bridges as shown in *Figure 9.1*. The breakdown of rocks brings about soil formation.

Figure 9.1: *Extraction of rocks*

9.1 Physical Properties

You will look at some types of rocks and identify them.

Physical Properties of Rocks

Activity 9.1(a): Identification of rocks

What you need

Sedimentary rock

Igneous rock

Metamorphic rocks

Figure 9.2: *Rocks*

What to do: In groups,

1. Examine each type of rock in *Figure 9.2* and record its colour, pattern, texture and particle size.
2. Discuss what you have observed and present your responses to the rest of the class.
3. Individually draw a dichotomous key using the information from your observation.

Use the knowledge from Biology to construct the dichotomous key.

Activity 9.1(b): Finding out the minerals in rocks

1. Using the Internet or any other sources, identify the minerals found in rocks and tabulate your results as shown.

Minerals in igneous	Minerals in sedimentary	Minerals in metamorphic

2. In a group, discuss the uses of minerals found in rocks in your daily life.
3. State the importance of sedimentary rocks in daily life.

9.2 Formation of Rocks

Types of Rocks

Refer to Figure 9.2.

Igneous rocks: are formed from hot liquid magma from inside the earth. When magma comes to the surface as lava and cools and solidifies above the ground, the rocks are called *extrusive*.

Sedimentary rocks: are products of weathering of pre-existing rocks, transportation of weathering products and deposition of the materials, followed by compaction and cementation of the sediments to form a rock.

***Metamorphic rocks*:** are formed when igneous and sedimentary rocks are subjected to high heat or pressure.

The Rock Cycle

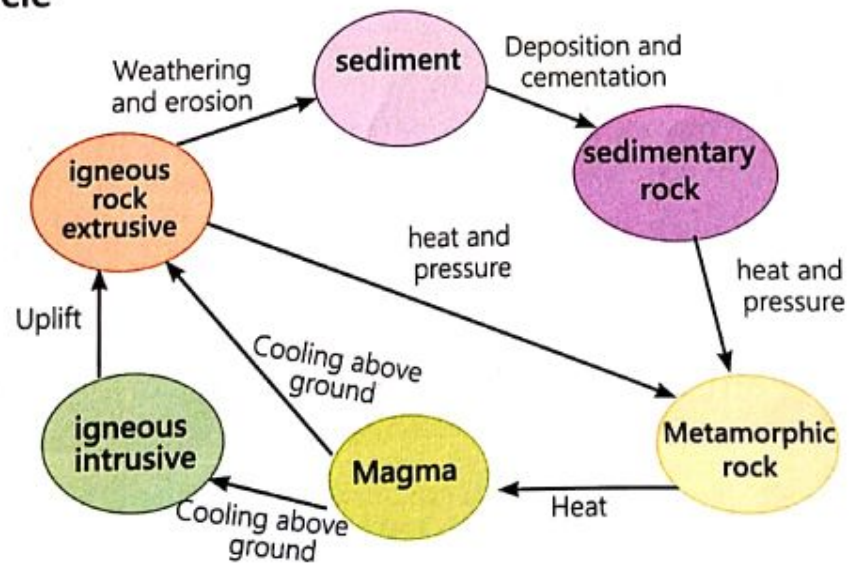


Figure 9.3: *Rock cycle*

DID YOU KNOW? That metamorphic rocks are the hardest rocks.

9.3 Weathering

Figure 9.4: A rock showing weathering

What is weathering?

Activity 9.3(a): Identifying effect of plants on rocks

What to do

1. Study *Figure 9.4.*
2. What is the effect of the plants growing on the rocks?
3. Share your findings with the class.

Activity 9.3(b): Investigating effect of water on soluble rocks

What you need

- sugar or copper(II) sulphate
- water
- beaker
- shallow tray
- dropper
- wooden block

What to do

1. Place the tray on a wooden block so that it is slanting.
2. Heap some small mounds/hills of sugar to represent a rock.
3. Fill a beaker with water and use a dropper to add water gently to the top of the mound.
4. What do you observe? Relate your observation to rocks.

Activity 9.3(c): Effect of wind on rocks

What you need

- sand
- shallow tray
- hair dryer

What to do

1. Heap sand onto a shallow try.
2. Using a hair dryer, gently blow on to the sand from an angle.
3. What do you observe? Share your findings with the class.

Activity 9.3(d): Finding out the effect of temperature on rocks

What you need

- glass bottle with a lid
- water

What to do

1. Fill a bottle with water and make sure there are no air bubbles. Screw the lid on the bottle.
2. Place the bottle in a plastic container into a freezer and leave it overnight.
3. What do you observe? Relate your observation to rocks.

These activities show how weathering occurs. In reality, weathering takes a long time. ***Weathering*** is the breaking down or dissolving minerals and rocks on the surface of earth. Plants, water, wind and change in temperature all cause weathering. There are three types of weathering: ***physical, chemical*** and ***biological.***

Physical weathering

Physical weathering is mainly influenced by physical factors. It is also called ***mechanical weathering.***

Figure 9.5(a): *Physical weathering*

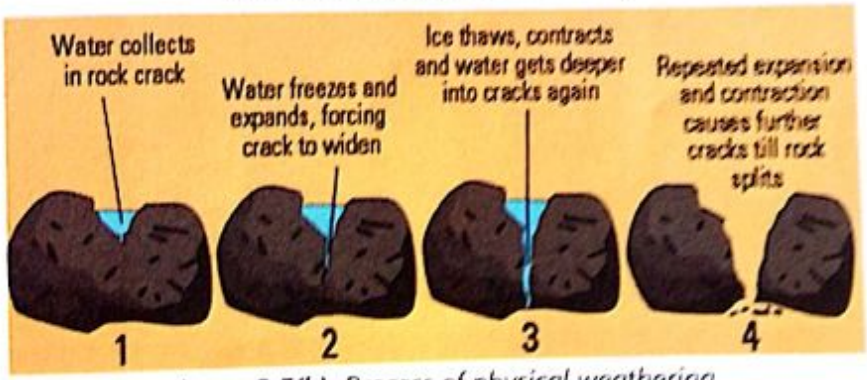


Figure 9.5(b): *Process of physical weathering*

Activity 9.3(e): Physical weathering

What to do: In groups,

1. what do you observe in *Figure 9.5(a)*?
2. using the Internet or any other sources, discuss the factors that influence physical weathering?

Chemical Weathering

Chemical weathering occurs when rocks react with other substances such as water, oxygen and acids. This weakens, decomposes and alters the rock's mineral composition. When carbon dioxide in the air dissolves in rain water, carbonic acid is formed. It dissolves the rocks that contain carbonates.

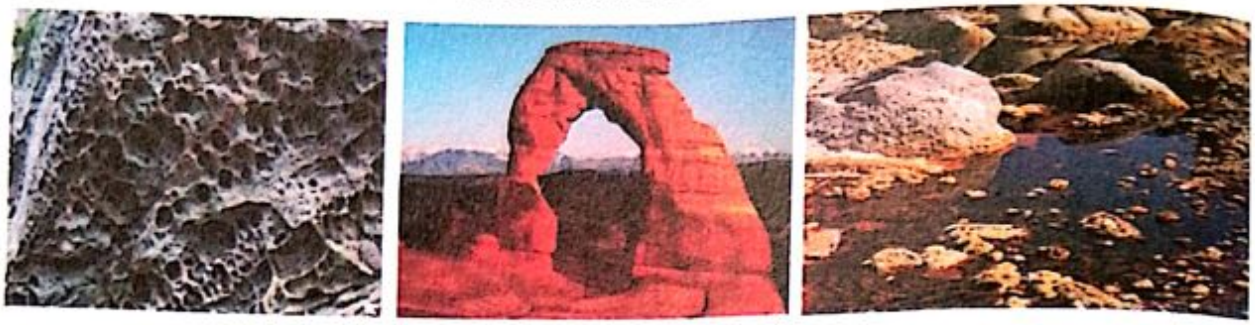


Figure 9.6: Chemical weathering

Assignment 9.1

In groups, using the Internet or any other sources, do research on chemical weathering and discuss the factors that influence it.

Biological Weathering

Biology is the study of living things and non-living things. Therefore, biological weathering is the breakdown of rocks into small particles by the actions of living organisms for example, plants, animals and microbes. Biological weathering involves both physical and chemical weathering.

Figure 9.7: Biological weathering

Activity 9.3(f) Biological weathering

Refer to *Figure 9.7*

What to do

In groups, discuss:

1. how living organisms contribute to biological weathering.
2. how important weathering is.

That water is the greatest contributor to weathering.

ICT Activity

In groups, use the Internet or visit the library to research about the minerals found in the different types of rocks and present the results in a table. Use a suitable software, for example, presentation software, to present your findings to the rest of the class.

Sample Activity of Integration

The demand for housing is increasing due to the rise in population. This has in turn created a huge demand for construction materials. In particular, business opportunities for people who sell stones is on the rise.

Figure 9.8: *Construction stones*

Task: Using the knowledge acquired in this chapter, write a report explaining to traders dealing in construction stones, the appropriate stones to use for the following purposes:

1. decoration
2. fire resistance
3. use in areas with high water content
4. heavy engineering work like roads, bridges and foundations

Chapter Summary

In this chapter, you have learnt that:

- A rock is any naturally occurring solid or aggregate of mineral or mineral-like matter.
- Rocks are divided into three types: igneous, sedimentary and metamorphic.
- Rocks are classified according to: composition, texture, constituent particles and size.
- Igneous rocks are as a result of solidification of magma.
- Sedimentary rocks are formed by weathering.
- Metamorphic rocks are formed from either igneous or sedimentary rocks.
- Sedimentary rocks are the only rocks with fossils.
- Igneous rocks form the biggest part of the crust.
- Weathering is the breakdown of rocks into small particles.
- Weathering occurs without movement of weathered particles, unlike erosion.
- Weathering occurs in three types, that is, physical, chemical and biological.
- Physical weathering is caused by atmospheric conditions such as temperature and pressure.
- Physical weathering does not cause changes in the composition of rocks.
- Chemical weathering causes changes in the composition of rocks.
- Biological weathering is caused by actions of living organisms such as plants, animals, bacteria and fungi.

Review Exercise:

1. Using suitable examples, explain what the following terms mean:
   a) rock
   b) metamorphism
   c) sedimentation
2. a) Describe how sedimentary rocks are formed.
   b) What are the properties and importance of sedimentary rock?
3. How are igneous rocks used by people?

GLOSSARY

acid: is a substance which donates a proton and accpets electron
air: mixture of gases
anhydrous: compound without water of crystalisation
atmoshpere: space around us
apparatus: set of tools used in a particular experiment
atom: smallest electrically neutral indivisible particle of an element that can take part in a chemical reaction
boiling: process by which a liquid turns in to a gas at a constant temperature and pressure
boiling point: temperature at which a liquid turns to a gas
chemical change: one in which new substances are formed
chemical equation: symbolic representation of chemical reaction in form of symbols and formulae
chemical formula: chemical symbols showing the elements present in a compound and their relative proportions
chromatogram: separations of coloured solutes (dyes) as they appear on the filter paper
chromatography: a method of separation of a mixture of soluble solutes in a common solution
combustion: chemical reaction in which a substance combines with air to form energy
compound: mixture of two or more elements chemically combined together in a fixed ratio
condensation: the process by which gases turn into liquid
corrosion: reaction of metals with gases in the atmosphere
diffusion: spreading or movement of particles from the region of their higher concentration to the region of their lower concentration due to random motion of particles
effluent: an outflowing of water or gas to a natural body of water, from a structure such as a wastewater treatment plant, sewer pipe, or industrial outfall
element: pure substance which cannot be split up into any simpler substance by any known chemical process
environment: everything around us
evaporation: process by which water is turned to gas due to heating
experiment: process in which someone tests a new idea or method to see if it's effective
fabrics: cloth produced by weaving or knitting textile fibres
flame: region of burning gases which produce heat and light
flammable: easily set on fire
freezing: process by which liquid is turned in to solid at a constant temperature and pressure
freezing point: temperature at which a liquid turns to solid
fuel: any substance we use to provide energy
greenhouse gases: are gases that absorbs and emits radiant energy within the infra-red
heterogeneous mixture: mixtures which are non-uniform
homogeneous mixtures: mixtures which are uniform
hydrated: compound containing water of crystallisation
immiscible liquids: liquids which form two layers when mixed
investigation: set of instructions that must be followed in order to come up with a conclusion
ict: information communication technology
laboratory: special room equipped with tools for performing experiments
lime water: common name for calcium hydroxide

luminous flame: type of flame produced when the air hole is closed

magma: molten or semi-molten natural material from which all igneous rocks are formed

material: substance or the mixture of substances that constitutes an object

matter: anything that occupies space and has weight

melting: the process by which a solid turns in to liquid at a constant temperature and pressure

metal: an element that readily forms positive ions

mixture: a substance consisting of two or more elements or compounds which are physically combined together and can be separated by physical means

molecule: smallest particle of an element or compound that can exist on its own

neutralisation: reaction where an acid reacts with a base to form salt and water only

non- luminous: type of flame produced when the air hole is open

non metal: chemical element that mostly lacks the characteristics of a metal

physical change: process in which no new substances are formed

pollution: introduction of substances that directly or indirectly endanger the lives of living organisms

polymer: a chemical compound with molecules bonded together in long, repeating chains

precaution: measure taken in advance to prevent something dangerous, unpleasant, or inconvenient from happening

pure substance: defined as one made of only one type of atom or molecule. the physical properties of a pure substance include well defined melting point and boiling point

pure water: water without any dissolved salts and gases

reaction: process through which reactants are converted to products

renewable: can be used up and can be replaced after their use

residue: particles which cannot pass through the filter paper

rock: naturally occurring solid mass or aggregate of minerals or mineral like matter

rusting: chemical process by where iron reacts with oxygen in presence of water to form hydrated iron (iii) oxide

saturated solution: a solution that cannot dissolve any more solute at a specific temperature in presence of un-dissolved solute

sewage: waste water that is produced by a community of people

sludge: a water-formed sedimentary deposit which may include all suspended solids carried by the water and trace elements in solution in the water

solute: substance that dissolves into the solvent

solution: uniform or a homogenous mixture of a solvent and solute(s)

solvent: substance which dissolves a solute to form a solution

sublimation: process by which a substance changes from solid state to gaseous state without passing through the liquid state

suspension: mixture of liquid and an insoluble solid solute where tiny solid particles spread throughout the liquid but may settle on standing

symbol: notation of one or two letters representing a chemical element

water: chemical compound consisting of two hydrogen atoms and one oxygen atom

weathering: breaking down or rocks dissolving minerals and rocks on the surface of earth

unsaturated: solution: one that can dissolve more solute at a specific temperature

INDEX

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Baroque Senior One Chemistry Learner's Book has been developed basing on the *New Lower Secondary School Curriculum*, whose aim is to enable learners to make informed decisions as citizens and family members and to give them the learning skills they need to think critically and study efficiently.

The Learner's Book has been designed to allow learners to work individually and with others in practical and interactive activities that are related to theoretical concepts in this course. It is expected that learners will apply investigative and problem-solving skills, communicate scientific information effectively, and appreciate the contribution that the study of Chemistry makes to their understanding of the world.

The Learner's Book caters for the different teaching and learning styles and needs in order to enable learners to develop skills and knowledge that will be of long-term value in a world where Chemistry is always increasingly important, rather than just focusing on large quantities of factual information.

The following aspects have been given consideration while developing the content of this book; respect for human life, awareness of the importance of living in harmony with the environment, independent and critical thinking, and the innovative application of science and technology in solving problems.

On completion of this course of study, the learner should be able to;

- tell the significance of Chemistry in a modern scientific world,
- explain the relevance of Chemistry in everyday life,
- explain the role of Chemistry in enabling materials to be used in the service of mankind,
- develop the ability to work independently and collaboratively with others,
- describe the importances and limitations of science in relation to social and economic development.

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