Strand 1: Diversity of matter

Introduction

Matter is defined as anything that has mass and takes up space and includes all living and non-living things in our environment. These elements have mass (the amount of substance contained in matter) and volume (the space occupied by matter). Some can be seen and touched, such as sand, stone, water, kerosene, chairs, tables, exercise books and trees. Others can only be felt, such as air (a mixture of gases). All matter contains very tiny particles, which are atoms, molecules and ions. These particles form the basic units of matter. Generally, matter can appear in three different forms, namely as a solid, a liquid or a gas. Living things or organisms are made up of building blocks called 'cells'.

The following sub-strands and modules are covered in this Strand:

- Sub-strand 1: Materials
  - Module 1: Classifying and ordering materials
- Sub-strand 2: Living cells
  - Module 2: Animal and plant cells

Sub-strand 1: Materials

Module 1 Classifying and ordering materials

Objectives

At the end of this module, you should be able to:

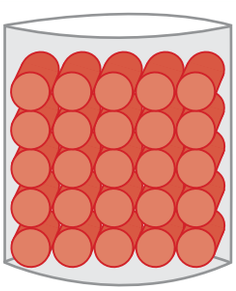
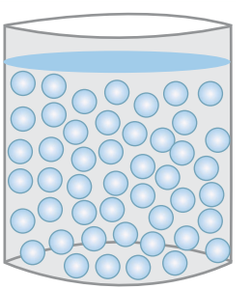
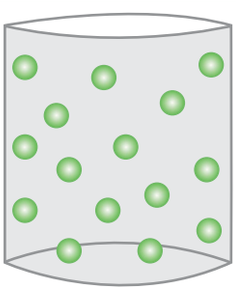
- recognise materials as important resources that provide for human needs
  - classify materials into liquids, solids and gases
  - discuss the importance of liquids to humans
  - discuss the importance of specific solids to life
- understand that the periodic table displays different elements made up of metals and non-metals and noble gases, all arranged in a specific order
  - demonstrate the knowledge of the orderly arrangement of metals, non-metals and noble gases in the periodic table.

Unit 1.1: Solids, liquids and gases

Material is any matter or substance from which objects are made. Human beings use a wide range of materials daily to make life comfortable. Some examples of materials are metals (iron, copper, gold, nickel, etc.), non-metals (plastic or polythene, wood, glass, water, palm oil, kerosene, carbon dioxide, smoke, methane, oxygen, water vapour or steam, etc.). Materials and their products are **processed** to make them useful.

Solids, liquids and gases

Solids, liquids and gases are the three states of matter. They exist differently at various conditions.

	Solids	Liquids	Gases
Characteristics	• Rigid • Have a **regular** shape and volume • Particles (atoms) are closely packed • **Force of attraction** between particles are strong	• Do not have a regular shape; only take the shape of their containers • Particles are less closely packed together as compared to solids • Force of attraction between particles are weaker compared to solids but stronger compared to gases • Liquids can flow from one point to another	• Have no regular shape and volume • Little or no force of attraction between particles
Diagram			

PROJECT FOR HOME

Make a list of objects at school and at home. Classify these objects as a solid, liquid or gas.

There are many types of solids, liquids and gases that can occur naturally in nature, or be synthetic or manufactured by humans.

Examples of solids include ice, soil, wood, rocks, mobile phones, meat, fruit and vegetables.

Examples of liquids include water, juice, petrol, diesel, paraffin and shampoo (a liquid detergent for washing hair).

Examples of gases include water vapour, oxygen, household gas (for cooking and heating) and methane.

Ways to describe materials

Various materials look different and can be described based on its physical **characteristics** like texture (how it feels), appearance (how it looks), colour and shape.

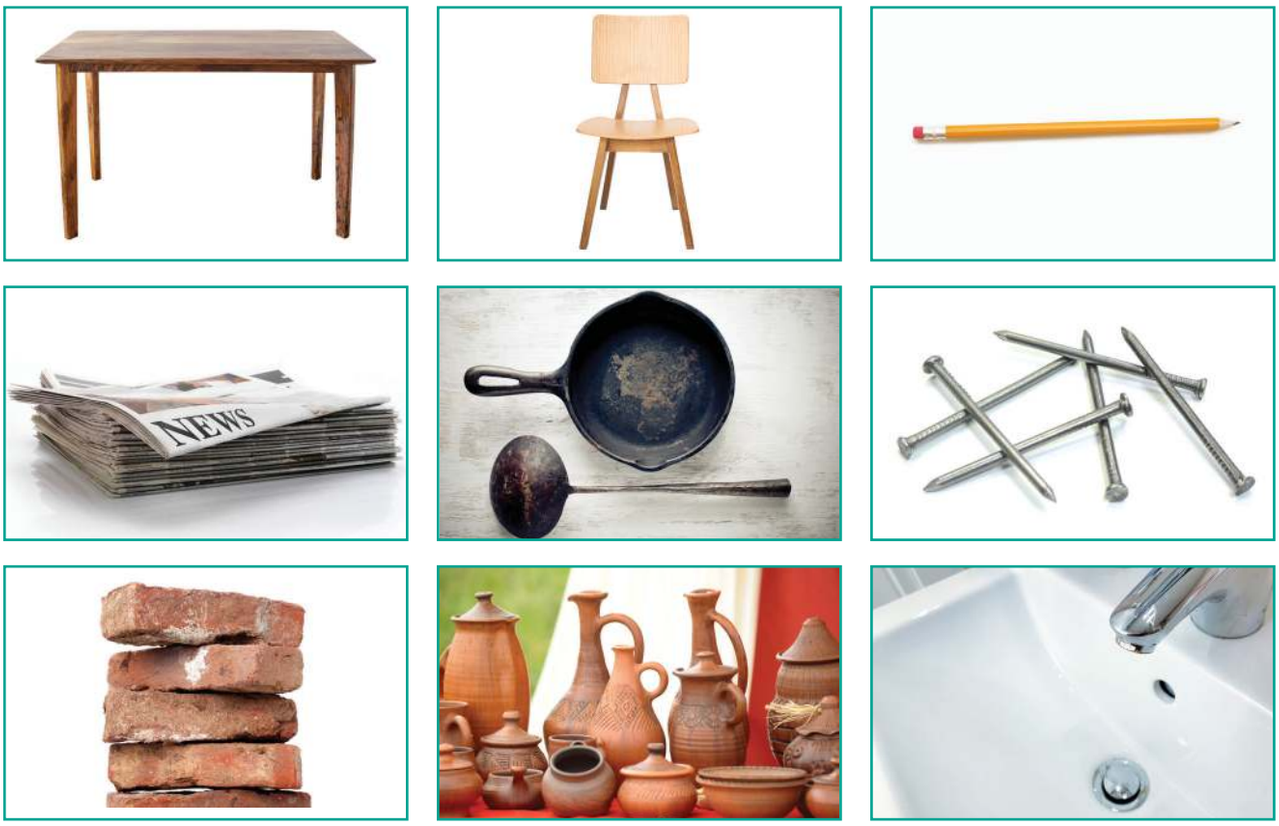


Figure 1.1: Tables, chairs, pencils and paper can be made from wood; cast iron pans and nails can be made from metals; bricks and ceramics can be made from sand. All these objects have different characteristics.

ACTIVITY 1.1.1 Group and compare solids, liquids and gases and give examples

1. Look at the following list: helium, brick, candle, air in a balloon, cooking oil, oxygen, ice, juice, petrol. Copy the table below and classify the items as solids, liquids or gases.

Solids	Liquids	Gases

2. Working in groups and discuss the differences between solids, liquids and gases. Try to answer these questions:
   a) What makes a solid different from a liquid?
   b) Can a solid become a liquid? Can a liquid become a solid? If so, how?
   c) In what way are liquids like gases?
   d) Can a liquid become a gas? Can a gas become a liquid? If so, how?
   e) What is the difference between a liquid and a gas?
3. Write down other examples of solids, liquids and gases. Think of items in the shop or supermarket, at school, or at home.

The importance of liquids

Water is an important natural resource needed to support life on Earth. Human beings, animals and plants all require water to survive. In Ghana, fresh water can be derived from many sources, such as wells and boreholes (underground water), streams, lakes, rivers, ponds, rainwater and dams. Water from the sea is not considered fresh water, but salt water. Fresh water is largely used in everyday life for **domestic** purposes, such as drinking, cleaning, washing and irrigation (agricultural purposes). Water is also used for **industrial** and **commercial** purposes, such as manufacturing and processing (heating, cooling, generating electricity, raw material), as a means of transportation as well as for **recreation**.

ENVIRONMENTAL ISSUES

Water is an important resource for Ghana, and it is, therefore, essential to conserve it. Water conservation also includes ensuring that water resources are kept clean.

Figure 1.2: Fishing boats in front of Cape Coast Castle

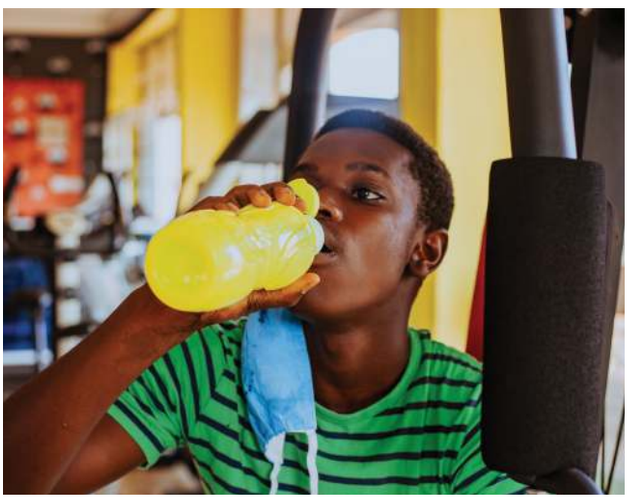


Figure 1.3: Fresh drinking water is important for life as well as health

Figure 1.4: We use water to wash and clean our clothes

Figure 1.5: The agriculture industry uses water for irrigating crops

Water conservation

Water conservation simply means a careful and economical use of water. It is important to **conserve** water in our environment since water supports life. The global increase in human population requires that water be conserved to meet the growing demand. Water conservation is also necessary to meet the water needs of future generations.

Ways to conserve water include

- harvesting rainwater by using rain gutters.
- ensuring well-planned piping systems for houses.
- regularly checking for and repairing pipe leakages.
- making a conscious effort to reduce and/or stop water wastage.

CULTURAL IDENTITY AND GLOBAL CITIZENSHIP

It is important for young people to think about how to conserve resources and use resources sustainably. This is important for Ghana as well as for the rest of the world.

PROJECT FOR HOME

Over a period of one week, record how water is used at school, at home and in your community.

ACTIVITY 1.1.2 Do a report on the importance of water to human life and the need to conserve it

1. Use the internet to search for information about the importance of water to humans and the need to conserve it. Your report can be a written report, an oral report, or a poster.
2. Then, in groups of three or four, describe the need to conserve water for human use. Discuss
   - why the human body cannot survive without water.
   - the different ways in which humans use water in everyday life.
   - how one can conserve water.
   - the ways in which human activities spoil natural water supplies.

Water is only one type of important liquid. Liquids can be pure, for example water and ethanol (pure alcohol), or they can be mixtures, for example vegetable oil, kerosene (paraffin), seawater and bleach. Liquids are used for various reasons around the house, in the community and in industrial areas.

Types of solids

Solids, a state of matter, are very important for so many reasons. We use solids as building materials, to make different kinds of tools, computer chips and components, energy storage devices, solar cells, as **catalysts**, and so forth. Nearly all technology depends on the physical and chemical characteristics of solids.

COMMUNITY SERVICE

Littering can pollute the environment, including the soil. Organise to clean up your community. Bring together a group of people who will spend an hour per week picking up litter and disposing of recyclable materials in an appropriate way.

Solids in the environment that support life

Rocks are solid materials that break down into smaller particles to form soil, which sustains life on Earth. Most plants depend on soil for support, mineral nutrients and water. Without soil, plants would not be able to produce the food that animals and other organisms depend on. Soil also serves as a habitat for both macro-organisms (such as earthworms and termites) and micro-organisms (such as bacteria).

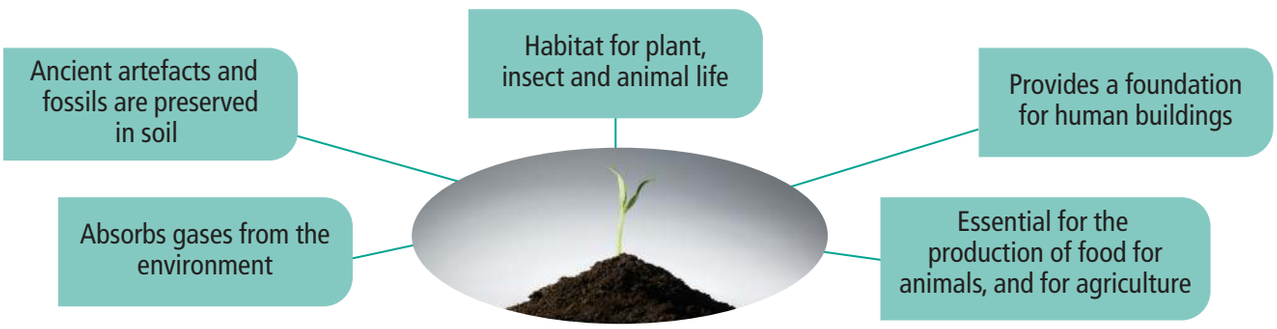


Figure 1.6: A visual mind map of the importance of soil

Other useful solid materials

Solid materials can be useful for a variety of reasons. Look at this table showing how solid materials can be used.

Use	Examples of materials
Building/construction	Aluminium roofing sheets, thatch grass, cement blocks, ceramic bricks
Transportation	Plastic, metals and rubber used to build bicycles, motor tricycles and cars
Information and telecommunication	Plastic, metals and optical fibre used to build radios, televisions, mobile phones; wood to make paper and pencils

CREATIVITY AND INNOVATION

What recyclable materials could be used to create new products and objects?

ACTIVITY 1.1.3 **Identify and classify different types of solids and explain their usefulness**

1. Working in groups, brainstorm examples of different solids. Give examples of solid materials that are
   - **a)** metals
   - **b)** ceramics
   - **c)** plastics
   - **d)** made from plants/plant products.

   Also give examples of what each material is used for and what objects are made from the solid material.
2. Talk about
   - **a)** the advantages and disadvantages of mining.
   - **b)** what plastics are made from.
   - **c)** the usefulness and problems caused by plastics.
3. Use the internet to search for information to explain the need to preserve useful solid materials (such as the ones mentioned in question (1) in the environment.

Unit 1.2: The periodic table

The periodic table is an important chart that is used in chemistry. On the table, substances called 'elements' are arranged in order of their increasing atomic numbers. In this type of arrangements, all elements with similar **properties** fall in vertical columns called 'groups', and horizontal rows called 'periods'.

Elements

Figure 1.7: Examples of how chemical symbols are written

An element is a pure substance that cannot be chemically broken down into simpler or different substances. Each element is given a name represented by letter(s) of the English alphabet. The letters given to the elements are called 'chemical symbols'. Elements whose symbol has only one letter is written as a capital letter, whereas elements with two-letter symbols will have the first letter written in a capital letter and the second letter written as a small letter. An example is the chemical symbol for hydrogen, which is 'H' and not 'h'. The chemical symbol for chlorine is 'Cl' and cannot be written as 'CL or cL'.

The world is made up of different kinds of materials called 'matter' and any portion of matter is made up of elements. Each element has its own properties that can be classified either as physical or chemical. The chemical properties of a substance are the characteristics used to identify the substance and what makes it different from other substances.

Metals and non-metals

For centuries, humans have benefited from elements that are considered metals and non-metals. A metal is any element that is a good conductor of heat and electricity. Metals have certain properties or characteristics that make them different from non-metals. Metals are

- shiny (lustrous).
- can be drawn into wires (ductile) without breaking.
- can be manipulated into shapes (malleable) without breaking.
- are good thermal (heat) and electrical conductors.

On the periodic table, the first two groups on the left-hand side plus the transition elements in the middle, are all metals. Aluminium, although it is a member of group 3, is also a metal.

Elements that are non-metals are found at the extreme right-hand side of the periodic table. Non-metals are

- poor conductors of heat and electricity.
- **dull**.
- **brittle** and break easily.

Elements that come between metals and non-metals are known as semi-metals (metalloids). Their characteristics lay somewhere in between those of metals and non-metals, and they are mostly used as semi-conductor materials. Examples include silicon and boron.

Noble gases

These elements are found in the far right-hand side of the table, that is, group 0 of the periodic table. They are called inert gases and do not react (are unreactive) with other elements because they are stable. They conduct electricity. The noble gases include helium and argon.

Figure 1.8: Helium is used to fill balloons

The arrangements of elements in the periodic table

In the periodic table, the various elements are arranged in order of their atomic numbers. Members of the same group also share the same physical and chemical properties.

INTERNET

This website has an interactive periodic table that you will find useful: https://ptable.com/#Properties

Terminology needed to fully understand the periodic table

To fully understand the periodic table, you must familiarise yourself with the following terminology.

- **Periodic table:** a table or chart that arranges elements into groups based on their chemical properties and increasing atomic number.
- **Period:** the horizontal row of the table.
- **Group:** a vertical column of the table.
- **Atomic number:** the number of protons an element has in its atom.
- **Nucleus:** the central part of the atom and it is positively charged.
- **Proton:** a sub-particle of the atom that is positively charged.

ACTIVITY 1.2.1

Work out the order of arrangement of elements in the periodic table, and identify metals, non-metals and noble gases

Look at the periodic table on page 11.

1. The number in the top left of each block is the atomic number. Work out and describe how the elements in the periodic table are arranged.
2. Use the following information to work out and describe why elements in the periodic table are arranged in groups (columns):
   - Lithium (Li), sodium (Na) and potassium (K) are reactive metals. When they come into contact with water, they fizz and burn.
   - Beryllium (Be), magnesium (Mg) and calcium (Ca) metals react with oxygen to form metal oxides.
   - Fluorine (F) and chlorine (Cl) can both form a poisonous gas.
   - Helium (He), neon (Ne) and argon (Ar) are noble gases/elements that do not combine readily with other elements.

The table will help you understand how the elements are arranged in the periodic table based on their increasing atomic numbers.

From your table, you will note that:

- $_{11}$Na, $_{3}$Li and $_{19}$K found in group 1 of the main periodic table are all metals and have the same physical and chemical properties.
- Group 2 elements such as $_{4}$Be, $_{12}$Mg, $_{20}$Ca and $_{21}$Sc, $_{22}$Ti, $_{23}$V and $_{24}$Cr of the transition elements are all metals.
- Elements like $_{9}$F and $_{17}$Cl in the group 7, and $_{2}$He, $_{10}$Ne and $_{18}$Ar in the group 0 are non-metals.

ACTIVITY 1.2.2 Name the first 20 elements in the periodic table, give their symbols and identify metals, non-metals and noble gases

Use the periodic table on page 11.

1. Write down, in order and as a numbered list, the names of the first 20 elements. Write the full name with the symbol in brackets.
2. Of these 20 elements, identify the element/s that
   - **a)** the Sun is composed of.
   - **b)** are found in all fuels (wood, coal, petroleum, kerosene).
   - **c)** is the key element in all living organisms.
   - **d)** is the main ingredient of air.
   - **e)** is the important element in the air that we breathe.
   - **f)** plants need in large quantities and are the three main ingredients of chemical fertiliser.
   - **g)** are metals.
   - **h)** are non-metals.
   - **i)** are noble gases.
3. Here is an alphabetical list of the symbols for the first 20 elements:
   Al, Ar, B, Be, C, Ca, Cl, F, H, He, K, Li, Mg, N, Na, Ne, O, P, S, Si.
   - **a)** Without looking at the periodic table, try to put the elements in order and give the full name for each symbol.
   - **b)** Then look at the table and fill in any gaps and/or correct your mistakes.

KEY WORDS

brittle – hard and easy to break; cannot bend without breaking
catalyst – something that starts a chemical reaction
characteristics – unique features of a thing
commercial – to do with sales or retail, such as shops
conserve – save, or use responsibly
domestic – relating to the home or personal use
dull – not shiny
force of attraction – energy that causes particles to come together
industrial – to do with processing or manufacturing (making) products
processed – do a series of things to something in order to change it in some way
properties – characteristics
recreation – leisure activities, or things that people do for fun such as sports
regular – arranged in a definite shape or pattern