INCREASING ACCESS TO SECONDARY SCHOOL LEVEL EDUCATION THROUGH THE PRODUCTION OF QUALITY LEARNING MATERIALS

JUNIOR SECONDARY LEVEL

CHEMISTRY

Module 2:
Matter and Change of State

Partners:
Ministry of Education and Botswana College of Distance and Open Learning (BOCODOL), Botswana
Ministry of Education, Science and Technology and the Malawi College of Distance Education (MCDE), Malawi
Ministry of Education, Mozambique
Ministry of Basic Education, Sport and Culture, and the Namibian College of Open Learning (NAMCOL), Namibia
Ministry of Education and the Emlalatini Development Centre, Swaziland
Ministry of Education and Culture and the Institute of Adult Education, Tanzania
Ministry of Education, Zambia
Ministry of Education, Sport and Culture, Zimbabwe
Commonwealth of Learning

COMMONWEALTH *of* LEARNING

Partners:

Commonwealth of Learning

Ministry of Education and Botswana College of Distance and Open Learning (BOCODOL), Botswana

Ministry of Education, Science and Technology and the Malawi College of Distance Education (MCDE), Malawi

Ministry of Education, Mozambique

Ministry of Basic Education, Sport & Culture, and the Namibian College of Open Learning (NAMCOL), Namibia

Ministry of Education and the Emlalatini Development Centre, Swaziland

Ministry of Education and Culture and the Institute of Adult Education, Tanzania

Ministry of Education, Zambia

Ministry of Education, Sport and Culture, Zimbabwe

Mauritius College of the Air, Mauritius

COMMONWEALTH *of* LEARNING
Suite 600 - 1285 West Broadway, Vancouver, BC V6H 3X8 CANADA
PH: +1-604-775-8200 | FAX: +1-604-775-8210 | WEB: www.col.org | E-MAIL: info@col.org

COL is an intergovernmental organisation created by Commonwealth Heads of Government to encourage the development and sharing of open learning and distance education knowledge, resources and technologies.

ISBN 1-895369-89-4

These materials have been published jointly by the Commonwealth of Learning and the partner Ministries and institutions.

CONTRIBUTORS TO PROJECT - CHEMISTRY

Course Writer	D. Puchooa
Course Reviewer	S. Tirbhowan
Course Co-ordinator	R. Dhurbarrylall
Instructional Systems Designer	R. Dhurbarrylall
Editor	C. Sooben
Text Entry	Mrs. S. Deenanath
	Mrs. P. Hurgobin
	Mrs. S. Chengalanee
Graphic Artist	F. Bredel
Lay-out and Formatting	Mrs. M. A. Frivole
Science Course Materials Management	Mauritius College of the Air

REVIEW TEAM

Botswana College of Distance and Open Learning	Lawrence Tshipana
Malawi College of Distance Education	Chris F. Layamaman
Namibian College of Open Learning	Joseph Amon
Institute of Adult Education, Tanzania	Andrew Dominick Swai
Emlalatini Development Centre, Swaziland	Simon Sipho Maseko
NDOLA Institute for Skills Training, Zambia	Christopher Chiluband
Ministry of Education, Sport and Culture, Zimbabwe	Luwis Hlombe

PILOTING TUTORS

Botswana College of Distance and Open Learning	Thandie Keetsaletse
Namibian College of Open Learning	Jona Mushelenga
Sifundzain High School, Swaziland	Saide Richards
Kibasila Secondary School, Tanzania (Ministry of Education)	John Anania
Nilrumah Teacher’s College, Zambia	F. Mubanga
NDOLA Institute for Skills Training, Zambia	Christopher Chiluband
Ministry of Education, Sport and Culture, Zimbabwe	Luwis Hlombe

JUNIOR SECONDARY LEVEL SCIENCE - CHEMISTRY

MODULE 1- Introduction to Chemistry

MODULE 2 – Matter and Change of State

Unit 1 – Matter and Change of State

Unit 2 – Building Blocks of Matter

MODULE 3 – Heat, Energy, Air and Combustion

Unit 1 – Heat, Energy, Air and Combustion

Unit 2 – Conservation of Energy

MODULE 4 – Periodic Classification of the Elements

Unit 1 – Periodic Classification of the Elements

Unit 2 –Bonding

MODULE 5 – Metals and Non-metals

Unit 1 – Metals and Non-metals

Unit 2 – Gases

Unit 3 – Acids and Bases

MODULE 2 – UNIT 1

MATTER AND CHANGE OF STATE

TABLE OF CONTENTS

MODULE 2

UNIT 1

MATTER AND CHANGE OF STATE

INTRODUCTION

We are surrounded by many forms of matter. At every moment of our life we are making use of matter. We breathe oxygen from the air. We drink water. Oxygen, air and water are forms of matter. Iron we use for construction is another example.

In this Unit we consider matter – its different states and how to convert one state into another.

OBJECTIVES

After completing this Unit, you'll be able to:

- state that matter exists in tiny particles
- describe the 3 states of matter
- describe the movements of particles in the 3 states of matter
- explain Brownian motion
- describe the process of **chemical** change and compare it to physical change
- relate chemical reactions to new substances being formed
- state that properties of reactants differ completely from those of products.

1.0 MATTER – A DEFINITION

We define matter as anything that occupies space.
Here are a few examples of matter

- Water
- Ice
- Nitrogen

They all occupy space. Fill a glass with water. Notice the water filling up space in the glass. The same thing happens to ice in a bucket. It occupies space in the bucket.

Note: Matter is also covered in Physics - Module 2: 2.1

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 1

Write down ten other examples of matter.

1…… 6……
2…… 7……
3…… 8……
4…… 9……
5…… 10……..

You will find the answer at the end of the Module.

1.1 THE NATURE OF MATTER

Matter is made up of particles. We can therefore say that matter is of a **particulate** nature. In fact the particles of matter are tiny, so tiny that we cannot see them with the naked eye. This course material you are reading right now is made of particles. To describe the particles in elements, Sir John Dalton framed the ATOMIC THEORY. He put forward the concept of any element as being made up of atoms (indivisible particles). Atoms of different elements differ.

1.2 STATES OF MATTER

Matter exists in different states. We normally talk about 3 states of matter i.e. the:

- Solid state
- Liquid state
- Gaseous state

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 2

Give a few examples of matter in each of the following states:

1. Solid

……

……

2. Liquid

……

……

3. Gaseous

……

……

You will find the answer at the end of the Module.

Let's now turn to some of the characteristics of the Solid State.

Characteristics

1.2.1 SOLID STATE

In the solid state, the tiny particles are:

- very close together, (in fact, closely packed)
- held together by strong forces of attraction,
- unable to move throughout the solid,
- able to vibrate only,
- unable to move because they are tightly bound.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 3

In the space below sketch the tiny particles of a solid. (Represent each particle as a sphere/round)

You will find the answer at the end of the Module.

Apart from the characteristics of a solid already mentioned, it

- also has a fixed volume
- has a definite shape

This can be explained by the fact that particles in solids are held by strong forces of attraction.

1.2.2 LIQUID STATE

A liquid flows easily and it can be frozen to a solid or boiled to vapour. A common liquid which we are all familiar with is water.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 4

(a) Give 5 other examples of liquids.

……

……..

(b) Can you suggest how a liquid can be

(i) frozen……..

(ii) boiled……..

You will find the answer at the end of the Module.

In the liquid state, the tiny particles:

- are further apart than in a solid
- are under the effect of weaker forces of attraction (than in solids)
- move about in a disorderly manner inside the bulk of liquid.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 5

(a) In the space below, sketch the tiny particles of a liquid.

A liquid has a fixed volume but no fixed shape. A liquid always takes the shape of the vessel in which it is placed.

(b) In the space below sketch 3 different containers and show them full of a liquid.

You will find the answer at the end of the Module.

Having looked at both the **solid** and **liquid** states, it is now appropriate for us to turn to the gaseous state.

1.2.3 GASEOUS STATE

Whereas a solid has a definite shape, a gas has no definite shape. We must visualise the particles in a gas state as being in a disorderly motion.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 6

One example of a gas is nitrogen.

(a) Give other examples of gases.

……

……

……

(b) Bearing in mind the fact that the tiny particles in a gas are still further apart (than in a liquid), sketch the tiny particles in a gas. Use the space below.

You will find the answer at the end of the Module.

Let's now look at the movements of the tiny particles in a gas. They

- move about at random
- are under the effect of very weak forces of attraction (in fact these are negligible)
- collide among themselves
- collide with the inner walls of the container
- fill entirely the closed vessel in which the gas is present.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 7

(a) How can a gas be converted into its corresponding liquid?

……

……

……

(b) What name is given to the above process?

……

……

……

You will find the answer at the end of the Module.

1.3 BROWNIAN MOTION

The particles in gases and liquids keep on moving in a disorderly manner. During such motion, it is inevitable that they collide with one another. At each collision there is a change in direction of the motion of each particle.

The erratic motion of the tiny particles in gases and liquids are called *Brownian motion*. This Brownian motion leads to 'mixing up'. It derives its name from Robert Brown, the scientist who made the discovery more than 160 years ago.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 8

(a) In the space below sketch the Brownian motion.

(b) Brownian motion is faster

(i) at higher/lower temperatures

……

(ii) with heavier/lighter particles

……

You will find the answer at the end of the Module.

1.4 DIFFUSION

Brownian motion leads to 'spreading' or 'mixing up' of tiny particles. This is called diffusion. Let's illustrate this with an example.

When a crystal of potassium permanganate is dropped in a beaker of water, the water gradually turns purple. Both crystal and water are matter and we said earlier that matter is made up of particles. The purple particles of the crystal mix with the water particles. The movement of different particles, so that they become evenly mixed is called **diffusion.**

Note: This is also a topic we deal with in Physics - Module 2, 2.3 and Biology - Module 2, Unit 4: 4.0 - 4.4

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 9

(a) *If you take a gas jar full of a coloured gas (say a reddish-brown gas such as nitrogen dioxide) and invert it over a gas jar of air (of course, colourless),*

What would you expect to happen after a few minutes?

……

……

……

Explain your answer.

……

……

……

(b) *Using a bottle of perfume how could you demonstrate the process of diffusion.*

……..

……

……

You will find the answer at the end of the Module.

We can now proceed with the following investigation.

INVESTIGATION 1: Showing mixing up

For each investigation you will require the materials indicated.	***Materials needed:*** • A glass of water • A few drops of blue ink ***Method**:* *Put water in the glass (about three quarters full)* *Put a few drops of ink, observe at intervals of 4 hours.*
You should record your answers in the space provided.	*(a) What do you observe just after?* …… …… …… …… *(b) What change do you see after 4 hours?* …… …… …… …… *(c) Record your observations after 4 hours…… .., 24 hrs……*

I am sure you observed the ink sinking to the bottom. At first the blue colour appeared at the bottom only. It gradually spread upwards. Eventually the tiny particles of ink and water got mixed up to form a pale blue mixture.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 10

(a) Is diffusion slower or faster in liquids as compared to gases?

……

……

……..

(b) Is there diffusion in solids?

……

……

……..

You will find the answer at the end of the Module.

1.5 PHYSICAL AND CHEMICAL CHANGES

In Science, we often observe changes undergone by a number of substances. These changes occur in various ways. We can change a substance by:

I. adding water to it, stirring it to form a solution;
II. mixing it with another substance;
III. heating it in air;
IV. allowing it to stand in air.

Take salt e.g. once we've added water to it, it changes by dissolving in the water. In Chemistry we refer to **Physical** and **Chemical** changes. We must know what Physical and Chemical changes are.

Any change in Science can be classified as a **Physical** or **Chemical** change.

1.5.1 PHYSICAL CHANGE

A **physical change** is one which does not produce any new substance. Moreover it can be reversed.

One example is allowing a few ice cubes to stand in its mould. After some time the ice melts to give liquid water. If this liquid is now placed back in the refrigerator, the liquid water turns to ice once again.

You will note:

- no new substance is formed;
- the change can be reversed, that is you can get back the ice.

The melting of ice is an example of a **Physical** change.

Dissolving is also a physical change. You are familiar with sugar or salt dissolving when stirred in water. The two do not dissolve to the same extent. We say that they have different solubilities in water.

A given amount of water dissolves more of sugar than of salt. While trying to dissolve more of the salt or sugar, a stage is reached when no more dissolves. We say that we have reached a saturated solution.

It is useful to know that solubility of sugar in water increases with temperature.

1.5.2 CHEMICAL CHANGE

This is just the opposite of physical change. A chemical change is a change which always produces new substances. Moreover it is not reversible.

An example is the gentle heating of some sugar in a spoon. New substances are formed. The black solid left is carbon. Can you get back the sugar?

Other examples of chemical changes include burning of wood, magnesium, paper, rusting of iron.

At this stage we can say that in a Chemical change, new substances are formed. But in a Physical change, no new substances are formed. We hope this is clear in your mind.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 11

List 5 other physical changes

……

……

……

……

……

You will find the answer at the end of the Module.

We can now proceed with the following investigation.

INVESTIGATION 2: Showing a chemical change

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Match box • Matches **Method**: *Strike a match, let it burn for a while and blow it off.* *Record your observations* …… …… …… …….. *Does it represent a physical change or a chemical change?* …… …… …… …… *Justify your answer.* …… …… …… ……

You must have observed **light** from the flame. There is also **heat** equally from the flame. A distinct **smel**l occurs. It represents a **chemical** change. New substances are formed as a result of **chemical** changes i.e the wood of the match becomes black. The wood has undergone a change - a chemical change.

We can now proceed with the following investigation.

INVESTIGATION 3: Showing new substance being formed during a chemical reaction

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Magnesium ribbon • Gas jar of oxygen • Pair of tongs • Burner **Method**: *Using a pair of tongs, hold a magnesium ribbon in a flame.* *When it catches fire, hold it in the gas jar of oxygen.* *(a) Record your observations.* …… …… …… …… *(b) What type of change is it?* …… …… …… ……

	(c) How can you represent the change? …… …… …… …… *(d) What are the reactants?* …… …… …… …… *(e) What about product(s)?* …… …… …… ……

I am sure that in

(a) you observed the magnesium burning with a very brilliant (dazzling) flame. A white 'ash like' powder is left in the gas jar. The 'powder' is magnesium oxide.

For (b) the change is chemical

(c) the answer is:

magnesium + oxygen $\xrightarrow{\text{heat}}$ magnesium oxide

[REACTANTS] **[PRODUCT]**

For (d) the reactants are magnesium and oxygen to the left of the arrow.

For (e) the product is magnesium oxide to the right of the arrow.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 12

When a piece of calcium is dropped in water, bubbles of a gas (hydrogen) occur. The other product is calcium hydroxide.

(a) What is the reactant?

……

……

(b) What are the products?

……

……

(c) How can we represent the reaction?

……

……

(d) In general, taking the reactants as A and B and products as C and D how can a chemical reaction be represented?

……

……

You will find the answer at the end of the Module.

On the left hand side of the arrow we show the **reactants,** on the right hand side of the arrow we show the **products**.

We said earlier that new substances are formed in chemical reactions. We now turn to another chemical reaction forming a new substance. We must also note that the new substance has different properties as we shall soon find out.

We can now proceed with the following investigation.

INVESTIGATION 4: Showing a chemical change and new substance formed therein

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Iron (filings) • Sulphur (powder • Burner • Glass rod **Method**: *In a crucible, prepare a mixture of iron filings and sulphur. Heat the crucible (with a lighted burner) and stir with a glass rod. Record your observations* …… …… …… …… …… …… …… ……..

You must have noted the yellow colour of sulphur disappearing and giving way to a black substance (iron sulphide).

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 13

Complete the items below to show a comparison of the properties of iron sulphide with those of iron and sulphur.

(a) Do they have the same feel (between the fingers)?

……

……

(b) Do they have the same colour?

……

……

(c) Their 'behaviour' towards a magnet.

……

……

(d) Their reactions with dilute hydrochloric acid.

……

……

You will find the answer at the end of the Module.

POINTS TO REMEMBER

- Matter is defined as anything that occupies space.
- Matter exists in three different states namely solid, liquid and gas.
- Matter is made up of tiny particles.
- The solid state has a fixed shape and volume.
- The liquid state takes the shape of the containing vessel.
- A gas fills completely the vessel in which it finds itself.
- The tiny particles in solids are closely packed together.
- The tiny particles in liquids are further apart.
- In gases, the tiny particles are still further apart.
- In liquids and gases, the tiny particles are in disorderly (zig zag) motion. This is called Brownian motion.
- Brownian motion of tiny particles is responsible for diffusion (mixing up) in liquids and gases.
- A change can be physical or chemical.
- In a physical change no new material is formed.
- In a chemical change, new substances are formed.
- A mixture has the properties of its components/constituents

MODULE 2 - UNIT 2

BUILDING BLOCKS OF MATTER

TABLE OF CONTENTS

MODULE 2 - UNIT 2

BUILDING BLOCKS OF MATTER

INTRODUCTION

In Module 2 Unit 1, we discussed matter as consisting of tiny particles. These tiny particles are called ***atoms.*** Atoms are extremely small, invisible to the naked eye or even under an ordinary microscope.

Atoms in turn are made up of even smaller particles. In this Unit, we further our knowledge on atoms combining together to form molecules.

OBJECTIVES

After completing this Unit, you'll be able to:

- state that atoms combine to form molecules which are the building blocks of all molecules
- describe that atoms combine to form molecules and crystals
- distinguish between elements, mixtures, compounds
- describe the mixing of substances to make solutions
- classify the elements into metals and non-metals
- describe methods for the separation of mixtures and solutions
- discuss water as a solvent and its uses in everyday life
- distinguish between clean/pure and polluted water.

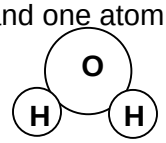
2.0 ATOMS AND MOLECULES

We normally represent an atom as (•). When 2 or more atoms combine together, a molecule is formed.

Atoms are the smallest particles of matter. Molecules are a group of two or more atoms.

Here is an atom of hydrogen (H). Two atoms of hydrogen combine together to form a molecule of hydrogen. (H H)

Likewise, 2 atoms of hydrogen and one atom of oxygen combine to form a molecule of water. Here it is



✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 1

(a) *Now we take N to represent an atom of Nitrogen. How can we represent a molecule of Nitrogen? (It contains 2 atoms of Nitrogen).*

(b) *How can we represent a molecule of Ammonia? (It contains 1 atom of Nitrogen and 3 atoms of Hydrogen).*

You will find the answers at the end of the Module.

Solids are also made of particles too. In some solids, we notice that these particles arrange themselves in the form of crystals e.g. *naphthalene, diamonds, graphite, snow flakes, table salt*

Others are non-crystalline e.g. *milk powder, flour etc.*

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 2

Table salt is chemically sodium chloride. It is a crystal. Take a sodium particle as ● and a chloride particle as ○

(a) Assuming sodium chloride to consist of cubic crystals draw a diagram to represent a building unit of sodium chloride.

You will find the answers at the end of the Module.

2.1 ELEMENTS AND COMPOUNDS

- ***Elements*** are made up of ***atoms***. An element is a pure substance. We cannot break it down further into anything simpler.

- Water is a ***compound*** i.e. it contains 2 elements - Hydrogen and Oxygen joined together. We say that a compound consists of 2 or more elements joined together.

Air on the other hand, is a ***mixture*** of several gases.

Mixture will become clearer in 2.2 shortly. For now, let's look at the composition of air as a ***mixture.***

Nitrogen claims approximately 4/5 of this mixture and Oxygen 1/5.

Traces of other substances include:

- rare gases 1%,
- water vapour (varies) and
- carbon dioxide (0.03%).

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 3

(a) Which of the components of air

(i) are compounds? ……..

(ii) are elements? ……

(b) Can you represent the component in (i) diagrammatically

You will find the answer at the end of the Module.

The earth's crust is the outer layer of earth. The crust is also a ***mixture*** of many different substances. As a matter of interest let us tell you that gold was the first metal to be obtained from earth.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 4

What are the various components of the earth's crust?

……

……

……

……

You will find the answer at the end of the Module.

2.2 MIXTURES

We can think of a mixture as the putting together of different substances and then stirring them. The amounts of the substances do not really matter. The substances do not react either in a mixture. It could therefore be easy to separate them.

It is useful to know that mixtures can be **heterogeneous** (*e.g. iron and sulphur)* or **homogeneous** *(e.g. a solution of sugar or salt in water).*

In 2.5, we'll be looking at how to separate mixtures.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 5

How can we prepare a:

(i) mixture of stones of different sizes ?

……

……..

(ii) mixture of iron and sulphur ?

……

……..

(iii) mixture of silt and water?

……

……..

(iv) *mixture of oil and water?*

……

……..

You will find the answer at the end of the Module.

We can now proceed with the following investigation.

INVESTIGATION 1: Showing a solute dissolving in a solvent

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** ▪ A glass ▪ Water ▪ Salt or sugar ▪ A spoon (as stirrer) ▪ Some sand **Method**: *Half fill the glass with water.* *Add a little salt (or sugar) and stir. The salt (or sugar) dissolves in water to form a **solution**.* *The salt (or sugar) is described as the **solute**. The water is the **solvent**.* *SOLVENT + SOLUTE ⟶ SOLUTION* *(water) (salt or sugar)* *Now repeat the above adding some sand to the water.* *Comment on the difference* …… …… …… *Is the sand a solute? Yes ☐ No ☐* *Give reasons for your answer.* …… …… ……

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 6

Answer, in each case, by 'Yes' or 'No'

*Can we have a **solution** of*

(i) *Ink in water?* ----------

(ii) *Pebbles in water?* ----------

(iii) *Sand in water?* ----------

(iv) *Dye in water?* ----------

(v) *Alcohol in water?* ----------

(vi) *Oil in water?* ----------

(vii) *Carbon-dioxide in water?*----------

(viii) *Oxygen in water?*----------

(ix) *Glucose in water?*----------

You will find the answer at the end of the Module.

2.3 METALS AND NON-METALS

Scientists have identified over 100 elements. While some occur naturally in the earth's crust, others are man-made. Some elements are very rare such as an element called ***astatine***. Scientists have estimated only 0.029g of this element in the whole earth.

We can divide the elements into groups. One way we can do that is to group them into metals and non-metals. Of the 100 or so elements, 84 are metals. The rest are non-metals.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 7

(a) *Iron and aluminium are examples of metals.*

Draw a list of 10 other metals.

1……6. ……

2. …… 7……

3. …… 8……

4. …… 9……

5. …… 10……

(b) Oxygen and carbon are 2 examples of non-metals.

Enumerate 10 other non-metals.

1. *…… 6……*

2. . …… 7……

3. . …… 8. ……

4. . …… 9. ……

5. . …… 10. ……

You will find the answer at the end of the Module.

2.3.1 PROPERTIES

Metals

Metals have properties. We recognise some as typical of metals. But remember that all metals do **not** have the same properties. We can therefore attribute some general properties to metals. Because of such properties, metals have found numerous uses in our daily living. Our pots and pans in our kitchens, for example, are made of metals because they conduct heat very well.

You must surely have noticed the electrical wiring in your house. It is made of copper wires. Can you think why? This is because copper wires will allow electricity to flow through them when you switch the power on.

Metals usually have bright surfaces. They can be beaten into sheets or drawn into wires. Most metals are solids except mercury (a liquid)

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 8

Delete as required

(a) *Metals have dull/shiny appearances.*

(b) *Metals are good/poor conductors of electricity and also of heat.*

(c) *Metals can/cannot be converted into sheets and wires.*

(d) *All metals are solids/liquids except* mercury, which is a solid/liquid.

You will find the answer at the end of the Module.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 9

In the table below, a list of metals is given.

For each, indicate one use in everyday life.

METAL	*ONE USE*
Gold	
Mercury	
Aluminium	
Copper	
Zinc	
Iron	
Nickel	
Chromium	
Lead	
Tin	
Magnesium	

You will find the answer at the end of the Module.

Non-Metals

We said earlier that some elements are non-metals. We can classify those non-metals into:

- Solids - e.g. carbon, sulphur
- Liquids - e.g. Bromine
- Gases - e.g. oxygen nitrogen

- They are poor conductors of electricity
- They have low melting points
- They break up easily
- They have low density i.e. they feel light

Just like metals have their uses in our life, non-metals too have uses. Again these depend upon their properties.

This is not all about metals and non-metals. We shall be looking at them again in a bit more detail in Module 5 Unit 1.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 10

Here is a list of non-metals:
carbon, oxygen, nitrogen, silicon, neon, helium, argon, fluorine, chlorine, bromine, iodine, sulphur, hydrogen, phosphorus.

In which column will each non-metal fit best?

SOLID	LIQUID	GAS

You will find the answer at the end of the Module.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 11

Many non-metals are put to use in everyday life.

Complete the use/application for each non-metal given in the list below.

Non-metals	***One use /application***	***Non-metals***	***One use /application***
Hydrogen		*Silicon*	
Helium		*Sulphur*	
Diamond		*Argon*	
Graphite		*Oxygen*	
Chlorine		*Nitrogen*	
Iodine			

You will find the answer at the end of the Module.

2.4 WATER

You should know by now that water exists in 3 forms:

- Solid i.e. ice
- Liquid i.e. water
- Gas i.e. steam.

As a liquid it is a very good solvent. This means it will allow a wide range of substances to dissolve in it. You must surely have noticed what happens when a spoon full of sugar or salt is stirred in a glass of water. The salt or sugar is the solute. Likewise a solute like ammonium sulphate which is a fertilizer also readily dissolves in water.

Water is also a very important liquid. There is a saying that *water is life*. *Without it, life doesn't exist*. Your body is about 70% water. So we must not underestimate its importance in life.

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 12

Make a list of other uses of water.

……..
……..
……..
……..

You will find the answer at the end of the Module.

2.4.1 WATER POLLUTION

River water in forests and uninhabited regions is unpolluted. Human activities pollute water. Fertilisers from agricultural lands get washed down into rivers. Effluents from farms may reach nearby rivers. Herbicides being sprayed on crops may be blown into rivers. Discharge of waste water from heavy industries can pollute water. Also oil spillage is another cause of water pollution.

Polluted water is harmful to all forms of life, not only to aquatic life. Humans can be adversely affected as health problems can arise from polluted water e.g. gastro-enteritis, cholera, birth defects, different types of cancers, skin disorders, falling hair, tooth decay, death.

Note: Refer to Biology - Module 8 , Unit 3: 3.7

✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 13

We have to be careful when using water for domestic purposes. We should avoid polluted water.

Give 2 ways in which we can recognise polluted water.

1st ……

……

2nd ……

……

You will find the answer at the end of the Module.

2.5 SEPARATION OF MIXTURES

Although we have mixed substances, it is possible to separate them by various methods. The following investigations will allow you to separate mixtures.

We can now proceed with the following investigation.

INVESTIGATION 2: Sorting by hand

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Material needed:** • Mixture having stones of different sizes. **Method**: *Have a look at different sizes of the stones.* *Now pick out stones of different sizes.* *Put them separately.* *Observation:* …… …… …… …… …… …… …… …… ……

I am sure you found it an easy and interesting investigation.

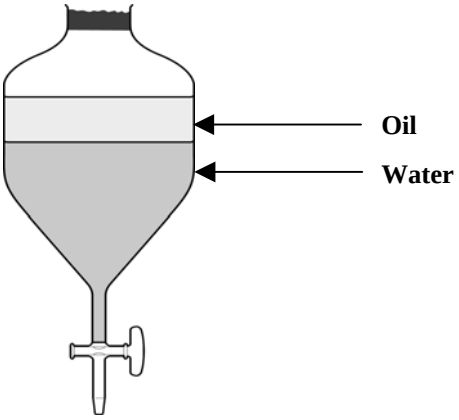
We can now proceed with the following investigation.

INVESTIGATION 3: Sorting with a magnet

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Mixture of iron filings and powdered sulphur • A magnet **Method:** *Place a magnet just above the mixture* *Observe and record what happens.* *……* *……* *……* *I am sure you noticed that the iron filings got attracted to the magnet. The sulphur was left behind.*

We can now proceed with the following investigation.

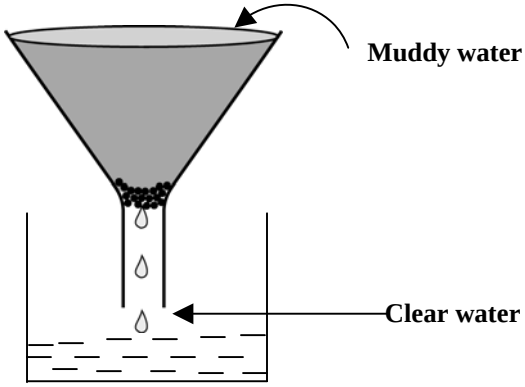
INVESTIGATION 4: Using a separating funnel

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • A mixture of oil and water • A separating funnel • A clean beaker/flask **Method**: *Put the mixture in a separating funnel.*  *Let it stand for a minute or two, open the tap of the funnel to run out the lower layer into a clean beaker/flask* *Record your observations:* …… …… …… *I am sure you noted that it is oil that is left in the separating funnel. You must have noticed that oil does not mix with water. This is because oil is of lower density than water and this is why it floats on top.*

Note: Density is explained in Physics - Module 2: 2.2.1.

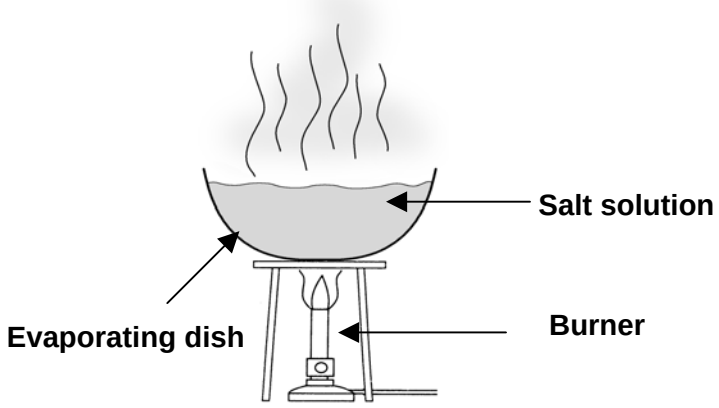
We can now proceed with the following investigation.

INVESTIGATION 5: Separation by filtration

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Muddy water • A filter funnel • A filter paper • A clean beaker **Method**: *Fit the filter paper properly into the filter funnel. Hold the funnel above the beaker. Pour muddy water into the filter paper (fitted into the funnel)*  *Record your observations:* …… …… …… *Notice the clear water collecting in the glass. Soil particles are left behind in the filter paper.*

2.5.1 EVAPORATION

If you leave a salt solution in a glass container in a warm room long enough, the water evaporates leaving salt behind. However, you will notice this is a slow process. We can accelerate the process by heating. Let's investigate this. But stop the heating as soon as the solution disappears. In evaporation, we obtain the solute (solid) whereas the solvent disappears.



We can now proceed with the following investigation.

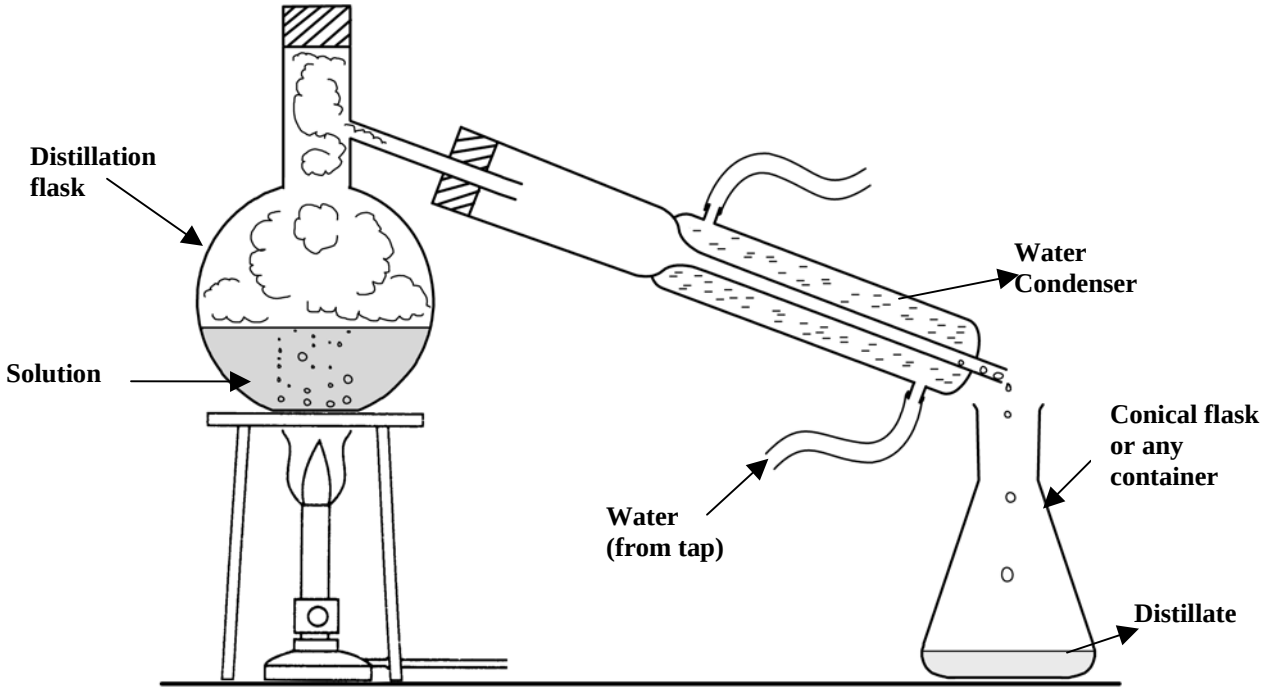
INVESTIGATION 6: Separation by evaporation

For each investigation you will require the materials indicated.	**Materials needed:** • Solution of salt in water • An evaporating dish • A burner **Method**: *Transfer the solution of salt (in water) into a clean evaporating dish. Heat with a lighted burner. Record your observations.*
You should record your answers in the space provided	…… …… …… *You must have noted that water evaporates gradually. Finally you are left with salt in the evaporating dish.*

2.5.2 DISTILLATION

Distillation is another process for separating a solvent from the solute. Let us tell you right away that distillation is an expensive process because we need a lot of heat energy to boil the solution. In distillation we obtain both the solvent and the solute from the solution.

You will recall that in evaporation we obtained the solute from the solution. Distillation can be used to obtain fresh water from sea water.



Separation by distillation

We can now proceed with the following investigation.

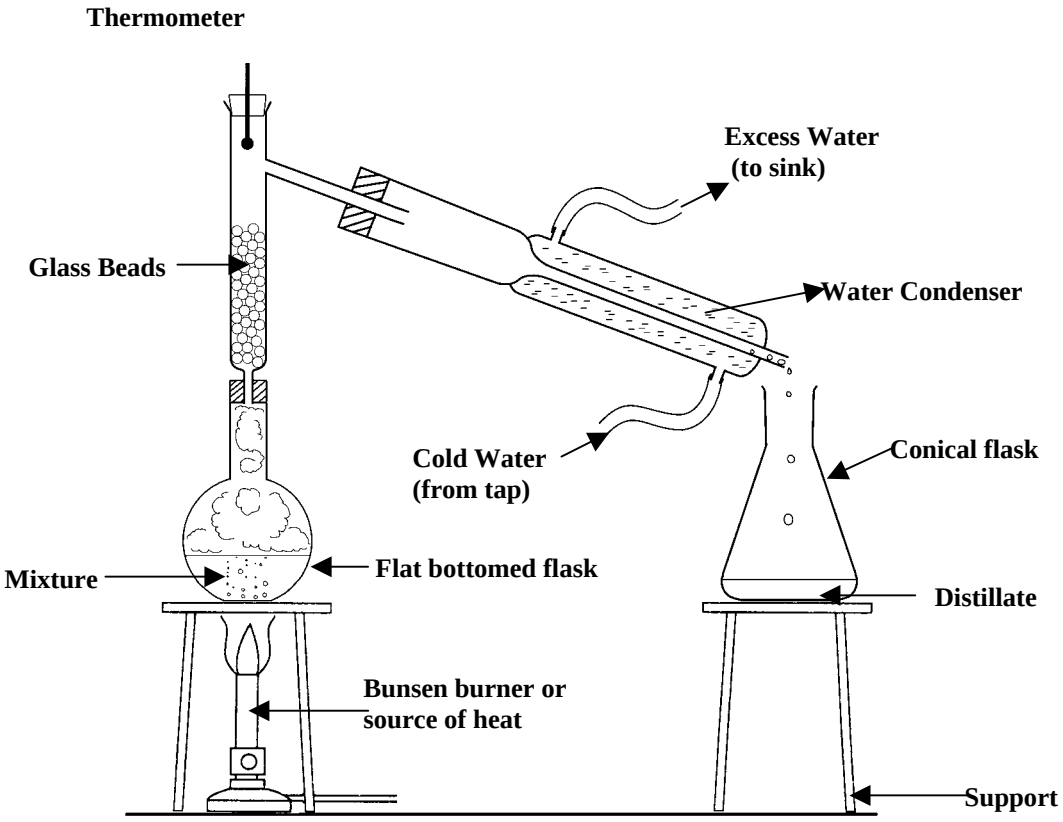
INVESTIGATION 7: Separation by distillation

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Solution of ink in water • A distillation flask with the side arm connected to a water condenser • Dry sand (little) • A clean container • A burner **Method**: *1. Transfer the ink solution into the distillation flask* *2. Put the dry sand into the solution* *3. Connect a condenser to the distillation flask* *4. Place the clean container at the open end of the condenser* *5. Cork the distillation flask* *6. Heat mixture* *Record your observation.* …… …… …….. *Do the experiment again, but do not add sand this time. Notice the difference.* *Why was sand added to the solution?* …… …… …….. *Again water collects into the glass. You must have noticed that sand ensured a steady boiling.*

2.5.3 FRACTIONAL DISTILLATION

We use fractional distillation to separate two liquids which mix completely. If you have the opportunity, try it under the supervision of your tutor in the chemistry laboratory. Here's the set-up of the apparatus you need.

We can produce whisky by fractional distillation.



We can now proceed with the following investigation.

INVESTIGATION 8: Separation by fractional distillation

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • A solution of alcohol in water • A distillation apparatus • A clean glass container • Some dry sand • A water bath • A burner **Method**: *Transfer the solution of alcohol in water into the distillation flask. Put a little dry sand in the flask.* *Using the water bath and burner, heat the distillation flask.* *Make sure that the clean glass is at the open end of the condenser in the distillation apparatus.* *Record your observations.* …… …… ……

You must have found out that the more volatile of the 2 liquids (namely alcohol) collects in the glass.

When no more alcohol collects, we are left with water in the distillation flask together with the sand. Of course we can pour out the water and obtain it free from sand by filtration.

2.5.4 CHROMATOGRAPHY

This is yet another method to separate a mixture of substances. There are many types of chromatography. Here we shall look at the simplest which is paper chromatography. Ink contains many dyes in water. We can separate the dyes using this technique.

We can now proceed with the following investigation.

INVESTIGATION 9: Paper Chromatography

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Filter paper • Drop of ink **Method**: *Drop a spot of ink at the centre of a filter paper, leave it to dry. Allow a few more drops, one at a time each time making sure that the drop dries first before allowing the next drop.* *Using a teat pipette, allow drops of water slowly and carefully on the blot of ink*. *(a) Record you observations.* …… …… …… *Draw what you see.*

We can now proceed with the following investigation.

INVESTIGATION 10: Separation by column Chromatography

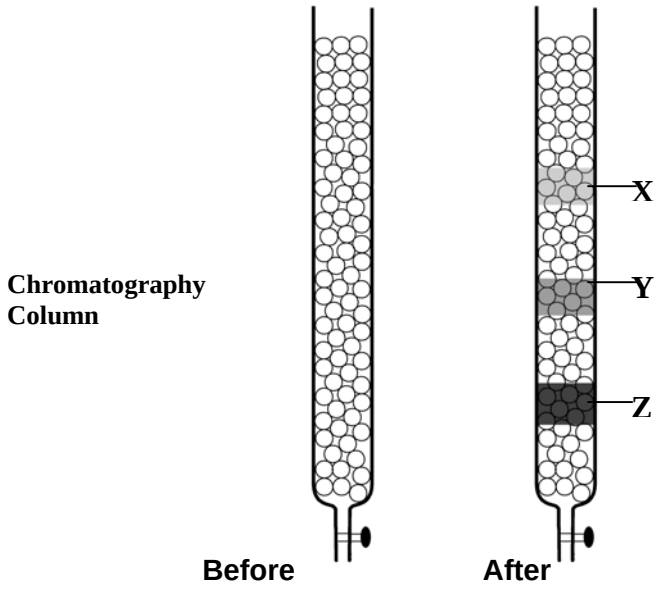
For each investigation you will require the materials indicated.

Materials:

- Solution of plant pigments
- A chromatography column (packed with inert material) such as glass beads
- A funnel
- Clean glasses of water

Method:

Using a funnel pour a little of the solution of plant pigments on the top of the chromatography column.



X, Y, Z (coloured bands)

You should record your answers in the space provided.	*(a) Record your observations* …… …… …… *(b) To collect the lowest coloured layer put a clean glass below the column and add solvent at top of the column. Collect the lowest layer which flows out. To collect successively the upper layers, repeat (b) using a separate glass for each solution.* I am sure that you observed different colours at different levels in the column. Each colour represents one pigment.

POINTS TO REMEMBER

- A change of state is a physical change
- A chemical reaction converts reactants into products
- All substances contain molecules
- Air is a mixture
- Water is a compound
- Elements are grouped into metals and non-metals
- Many elements are in everyday use by man
- We have a variety of mixtures
- When water dissolves a substance we obtain a solution
- Mixtures of substances can be separated by suitable methods.

ANSWERS TO ACTIVITIES

UNIT 1

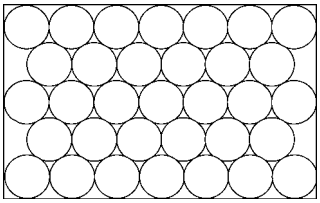
Activity 1

1. Oil. 2. Glycerine 3. Oxygen 4. Aluminium
5. Sand 6. Soil 7. Alcohol 8. Argon 9. Zinc
10. Paper

Activity 2

1. Ice, Paper, Aluminium, Sand, Zinc
2. Water, oil, mercury, alcohol, glycerine
3. Oxygen, argon, nitrogen, carbon dioxide, neon

Activity 3



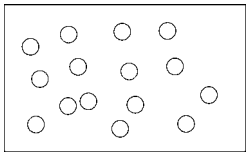
Activity 4

(a) oil, glycerine, alcohol, mercury, bromine

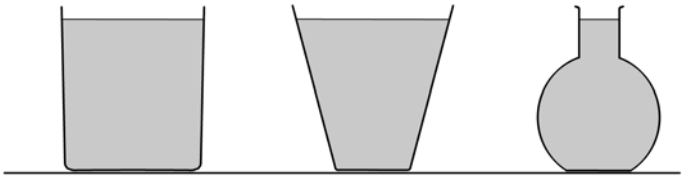
(b) (i) by cooling (ii) by heating

Activity 5

(a)

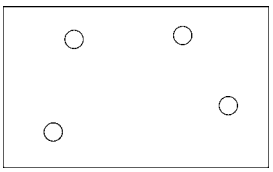


(b)



Activity 6

(a) oxygen, nitrogen, argon, water vapour, chlorine, carbon dioxide, neon

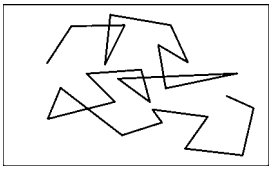
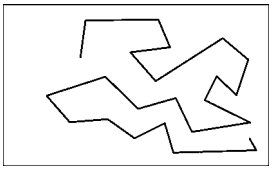
(b) 

Activity 7

(a) The gas has to be cooled sufficiently and then compressed. It will turn into liquid.

(b) The above process is called ***liquefaction***.

Activity 8

(a)  

(b) (i) At higher temperature (ii) With lighter particles

Activity 9

(a) the 2 gases will get mixed up to produce a uniformly coloured mixture (in the example given, pale red brown).

The particles of each gas will get mixed up with those of the other.

(b) The bottle is opened in one corner of a room. Its smell can be detected by a person anywhere in the room.

Activity 10

(a) In liquids, diffusion is **slower** than in gases.

(b) It is so slow that it cannot be observed/noticed.

Activity 11

1. Boiling of water.
2. Dissolving of salt or sugar in water.

3. Magnetising an iron rod/bar. 4. Condensing steam into water.
5. Breaking dry wood into pieces.

Activity 12

(a) Calcium and water (b) Hydrogen and calcium hydroxide

(c) Calcium + water $\longrightarrow$ hydrogen + calcium hydroxide

(d) A + B $\longrightarrow$ C + D

Activity 13

(a) No, between the fingers they feel different.

(b) No, iron sulphide is black. A mixture of iron and sulphur is grey and yellow.

(c) The compound i.e. iron sulphide is NOT attracted by the magnet. From the mixture, iron gets attracted to the magnet.

(d) The compound gives a foul smelling gas whereas the iron (from mixture) gives off hydrogen gas.

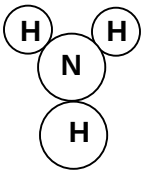
ANSWERS TO ACTIVITIES

UNIT 2

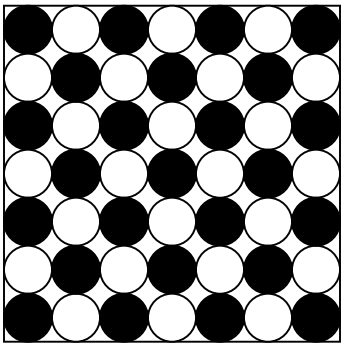
Activity 1

(a) A molecule of nitrogen is represented as 

(b) One molecule of ammonia consists of 3 atoms of hydrogen and 1 atom of nitrogen



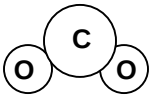
Activity 2

(a) 

Activity 3

(a) (i) carbon dioxide and water vapour (ii) Nitrogen, Oxygen, Argon

(b) Carbon Dioxide



Activity 4

Soil particles, Decaying matter, Soil water, Soil air, Living organisms

Activity 5

(i) We can put stones of different sizes in a box. Close the box and shake it.

(ii) In a small vessel we take about a small spoonful of iron. Add to it an almost equal amount of sulphur and stir.

(iii) We collect some silt and add water to it. Shake the two together.

(iv) We pour water in a glass until it is about half full. Add 2 spoons full of oil and stir.

Activity 6

(i) Yes (ii) No (iii) No (iv) Yes

(v) Yes (vi) No (vii) Yes (viii) Yes

(ix) Yes

Activity 7

(a) Zinc, Tin, Lead, Silver, Gold
Calcium, Potassium, Copper, Chromium, Magnesium

(b) Nitrogen, Chlorine, Iodine, Hydrogen, Sulphur
Argon, Phosphorous, Bromine, Fluorine, Silicon

Activity 8

To delete in each (in order)

(a) Dull (b) poor (c) cannot (d) liquids, solid

Activity 9

METAL	ONE USE
Gold	As jewellery
Mercury	In thermometers
Aluminium	In overhead cables
Copper	In electrical wires
Zinc	Outer case of cells
Iron	For construction purposes
Nickel	Nickel plating of articles or as coinage metal
Chromium	Chromium plating
Lead	Sheets or pipes
Tin	For canning food
Magnesium	In flashlight photography

Activity 10

SOLID Carbon, Silicon, Iodine, Sulphur, Phosphorus

LIQUID Bromine

GAS Oxygen, Nitrogen, Neon, Helium, Argon, Fluorine, Chlorine, Hydrogen

Activity 11

Non metals	One use /application
Hydrogen	Synthesis of ammonia
Helium	Filling balloons for meteorological purpose
Diamond	In jewellery as precious stones
Graphite	Making pencils
Chlorine	Killing germs in water
Iodine	As a mild antiseptic
Silicon	Making electronic chips
Sulphur	As a fungicide
Argon	In tubes for advertisement by night
Oxygen	For breathing
Nitrogen	For the synthesis of ammonia

Activity 12

At home for:

Cleaning purposes; Washing; Cooking; Preparing drinks such as tea; coffee; milk; Personal hygiene/cleanliness; Water plants (in pots, in the garden).

Activity 13

It is **NOT** odourless. It may have a foul smell.

It is **NOT** clear and colourless.