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

JUNIOR SECONDARY LEVEL

CHEMISTRY

Module 1:
Introduction to Chemistry

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
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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

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Unit 1 – Metals and Non-metals

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CHEMISTRY

MODULE 1 – UNIT ONE

INTRODUCTION TO CHEMISTRY

INTRODUCTION

Chemistry is one of the branches of Natural Science. The other **two** are:

- ***Biology*** which is the study of living things i.e. plants and animals and
- ***Physics*** which is the study of matter and energy and their relationship.

Chemistry deals with the nature of substances and the changes they can undergo. We shall see in Module 2 that these changes can be broadly classified into two groups. One of them is described as a ***chemical change*** or ***chemical reaction***. The other change is known as a ***physical change***.

In our daily life we come across a large number of chemicals and chemical reactions e.g. the washing liquid in your kitchen, the soap powder for washing clothes, the soap and shampoo in your bathroom are all chemicals. They are the products of chemical reactions. The paint on cars and houses too are chemicals and products of chemical reactions. Photosynthesis is an example of a chemical reaction occurring in nature.

The food items we take in our meals are also chemicals *e.g. vinegar, sugar, table salt.* In our alimentary canal, the food items are often changed chemically by reaction with water, in the presence of digestive 'juices'. Life itself rests on these chemical reactions occurring all the time.

In this Module we introduce you to Chemistry. It is an exciting subject to study!

OBJECTIVES

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

- state the meaning of CHEMISTRY
- name all the items that must be in a First-Aid kit
- identify apparatuses commonly used in the school laboratory
- estimate and measure length, mass, volume, temperature and time
- observe properties of a variety of substances
- record experimental results logically
- maintain a First -Aid Kit.
- recognise the importance of communicating results to others

1.0 STATES OF MATTER

Science deals with matter. At the same time, we must be aware of the different aspects of matter covered in Chemistry . e.g. Water is a **liquid**. When we cool it, it becomes ice which is a **solid**. When we heat it, it changes to **steam** which is a **gas** or vapour. These three different forms are the states of matter. Matter therefore exists in different states i.e. the

- solid state
- liquid state
- gas state

We will be looking at these states of matter in slightly more detail in Module 2 Unit 1.

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

ACTIVITY 1

We can classify matter into solids, liquids, gases/vapours.

Classify each of the following as solid, liquid or gas (vapour):

silver, oxygen, saliva, wood, spoon, lime juice, lime water, carbon, carbon monoxide, oil, water vapour, alcohol.

Solid	Liquid	Gas/Vapour

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

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

ACTIVITY 2

*Science deals with **MATTER***

*Match **each** of the natural sciences with*

*(i) Matter and **life***

Ans……

*(ii) Matter and **Energy***

Ans……

*(iii) Matter and its **Reactions***

Ans……

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

1.1 SAFETY IN THE LABORATORY

A Chemistry laboratory is a potential source of danger with chemicals, glassware etc.

Concentrated acids e.g. Nitric and Sulphuric acids are very corrosive. So are alkalis such as caustic soda (sodium hydroxide), caustic potash (potassium hydroxide). Poisonous gases can result from chemical reactions (e.g. chlorine, carbon monoxide). Flammable liquids can catch fire when exposed to naked flames. Glassware can break and cause injuries. If long hair is not tied back properly, there is the risk of the Bunsen flame setting it on fire! Violent reactions may occur - even explosions!!

It is useful to be familiar with the precautions to be taken in the laboratory. Chemicals, glassware have to be handled with utmost care to prevent breakages

and accidents. We have to be aware about how to avoid risks during experiments. Furthermore, a First Aid Kit must be kept in the laboratory for emergencies.

Don'ts - Do's

Some Don'ts	Some Do's
Never	***Always***
• eat in a laboratory • run in the laboratory • obstruct exits • store food in the laboratory 's refrigerator	• follow experimental procedures carefully • wear a lab coat • wear goggles • wash your hands with soap after your experiment • ask if you're not sure about something • handle equipment with care • treat accidents however minor immediately • report accidents

Before proceeding further, complete the following activity.

ACTIVITY 3

Which of the following are safety devices in the Chemistry laboratory.
*(Write **'Yes'** or **'No'** for each)*

(a) Fume cupboard ……
(b) Glass pipettes ……
(c) Pipette fillers ……
(d) Air extractors ……
(e) Laboratory goggles……
(f) Laboratory masks ……..
(g) Gloves ……
(h) Single pan balance ……

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

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

ACTIVITY 4

While performing experiments which precautionary measures should we take?

*(Write '**Yes** or '**No**' for each)*

i. Tie long hair back ……..

ii. Avoid tasting unknown chemicals ……..

iii. Avoid heating with a Bunsen burner……..

iv. Put out flames when flammable vapours occur …….

v. Add water to concentrated acids …….

1.1.1 THE FIRST AID KIT

Accidents, which occur in the laboratory such as cuts and burns, must be attended properly and fast. Therefore you must be prepared for any accident when working in the laboratory.

First Aid is all that you can do to help an accident victim before you can get medical help in a hospital.

You should be familiar with the instruments and chemicals found in the First Aid kit. In the laboratory, the First Aid kit is placed in a safe and accessible place.

It is also important for you to know how to use the instruments and chemicals found in the First Aid kit. The following are some examples that you can find in the First Aid kit and their uses.

Instrument and Chemical	**Uses**
Dry cotton wool, clean bandage, wound plaster	For treatment of wounds and cuts
Pair of scissors, new razor blade	For treatment of wounds and cuts
Mild antiseptics e.g.	To clean fresh cuts and bruises
Disinfectants for wounds, e.g. gentian violet solution	To apply on minor wounds
Sterile water and soap	For washing hands and wounds
Petroleum jell	To apply on burns

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

ACTIVITY 5

*This concerns the First Aid Kit. Which items (a) to (j) would be desirable in the kit? (Write '**Yes'** or '**No**' for each)*

(a) Dry cotton ……

(b) Mild antiseptics ……

(c) Analgesic tablets ……

(d) Disinfectants for wounds ……

(e) Antibiotic tablets ……..

(f) Clean bandage ……

(g) Plaster of Paris ……

(h) Wound Plaster ……

(i) Acid spray ……

(j) Sterile water ……

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

1.2 REACTIONS

For reactions to occur, matter must be present. In fact, matter is present in all substances we have around us. While some reactions are made to occur in the laboratory under certain given conditions, other reactions occur naturally e.g.

(i) the decaying of fruits

(ii) the souring of milk

(iii) the rusting of iron

(iv) photosynthesis

Let's now turn to some substances which comprise matter.

1.3 SUBSTANCES

1.3.1 MATTER

(a) Oxygen is a simple substance or element we use in everyday life. I am sure you must have realised that we breathe it in from the air during our lifetime.

(b) There are substances which are NOT simple. They consist of more than one element combined together. Water is a substance consisting of 2 elements combined together: Oxygen and Hydrogen. Another example is ammonia containing Nitrogen and Hydrogen.

(c) Many substances contain more than 2 elements that are combined together. Cane sugar is a substance consisting of more than 2 elements combined together: Oxygen, Hydrogen and Carbon.

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

ACTIVITY 6

1. *Name 5 simple substances or elements.*

   ……

   ……..

2. *Make a list of three substances each having 2 elements combined together.*

   ……

   ……

   ……..

3. *Draw up a list of 3 substances each with 3 or more elements combined together. Here is an example to start you off.*

   Glucose contains Carbon, Hydrogen and Oxygen

   (a) This substance is used in salads ……

   (b) This substance is found in the sea……

   (c) This substance is used in baking ……

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

We shall now see that substances containing 2 or more elements combined together are called compounds. Water is a compound.

1.4 ELEMENTS/COMPOUNDS

We can also group together **ELEMENTS** on the one hand and **COMPOUNDS** on the other. We have to bear in mind that an **element** is a simple substance, which cannot be broken down into simpler ones e.g. oxygen is an element. A **compound** consists of elements which are chemically combined together. Water is a compound consisting of 2 elements, hydrogen and oxygen.

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

ACTIVITY 7

*Subdivide the following into **elements** and **compounds**:*

carbon, carbon dioxide, water, table salt, diamond, tin, lead, steam, sand, hydrogen, copper.

Element	Compound

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

There are a number of situations involving chemical reactions.

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

ACTIVITY 8

Fill in the blanks below by selecting from the following list:

burning, respiration, photosynthesis, rusts, fermentation

a) *Iron, on exposure to air and moisture*

……

b) *We obtain energy from 'bottled gas' (in cylinder) by*

……

c) *Living organisms obtain energy as a result of*

……

d) *Alcohol is obtained from molasses or starchy materials by*

……

e) *Green plants manufacture their own food under suitable conditions by a process called*

……

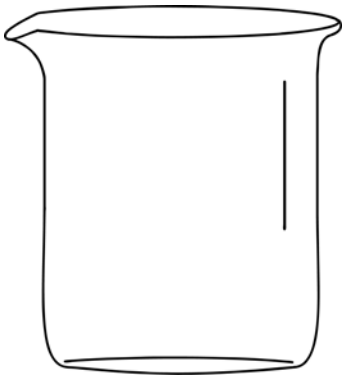
You will find the answers at the end of the module.

Chemistry Apparatus

To be able to study Chemistry properly, we must use apparatuses to perform our experiments in the laboratory. While some apparatuses are readily available, others are very expensive. We must become familiar with them and recognise them from diagrams.

Common **glassware** in the Chemistry laboratory includes: test tubes, beakers.

Test tube



Beaker

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

ACTIVITY 9

List 10 other apparatuses made of glass usually found in the Chemistry laboratory.

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

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

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

ACTIVITY 10

*Write down 10 pieces of apparatus **NOT** made of glass normally found in the Chemistry laboratory.*

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

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

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

ACTIVITY 11

a) *Sketch one of the items you have listed in activity 9.*

(b) *Sketch one of the items you have mentioned in activity 10.*

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

1.5 ESTIMATING AND MEASURING

In Chemistry we have to make measurements. We must also develop skills to handle apparatus, while making measurements to get accurate results. Accurate results are essential in Science. In the following sections, we will be going through measurements with you.

Note: Measurements are also covered in Physics - Module 1, 1.1 and Biology - Module 1, Unit 2: 2.2 to 2.2.2.

Length

We can now proceed with the following investigation.

INVESTIGATION 1: Measuring Length

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • A ruler (with cm scale) • Magnesium Ribbon • Pair of scissors • A pen **Method:** *a) Measure a strip of magnesium 12 cm long.* *b) Use the strip in (a) to cut out pieces of* *(i) 6 cm* *(ii) 3 cm* *(iii) 2 cm* *Verify the length of the remaining strip ……. cm*

I am confident you were able to carry out the steps in the investigation. Concerning the length of the remaining strip I am sure you obtained a length of 1 cm.

Mass

We can now proceed with the following investigation.

INVESTIGATION 2: Measuring Mass

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Cane sugar • A small spoon • A single pan balance • A **light** plastic lid or a paper weighing boat of negligible mass should be used. **Method:** *(a) Place the light plastic lid on the pan of the balance* *(b) Put 5 spoonfuls of cane sugar in the lid* *(c) Record the mass (W_1) = ---------- g* *(d) Find the mass (W_2) of one spoon of cane sugar* *(e) Hence calculate how many such spoonfuls you would need for 100 g of the sugar.* The mass of 1 spoonful of sugar is $W_1 \div 5$. Record this as W_2 (***Answer is in g***) The number of spoonfuls you will need for 100 g of cane sugar is calculated as $100/W_2$ (***give your answer as a whole number***)

Volume

We can now proceed with the following investigation.

INVESTIGATION 3: Measuring Volume

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • A cup of water • A tall measuring cylinder **Method:** *(a) Place a tall measuring cylinder on a table.* *(b) Pour a cup of water in the cylinder* *(c) Note the position of the level of water in the cylinder.* *d) Remember the meniscus. This is explained in both the Biology and Physics parts.* *Volume of 1 cup of water =……..cm^3*

Note: Measurement of volume is also covered in Physics - Module 1, 1.1.3.

Temperature

We can now proceed with the following investigation.

INVESTIGATION 4: Measuring Temperature

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • A thermometer • 10 ' pellets' of sodium hydroxide • A plastic spoon • A beaker (or glass) • Water **Method:** *(a) Take a small beaker (or glass)* *(b) Fill it to half its height with water* *(c) Insert a thermometer* *(d) Record the temperature of water …….^{0}C** *(e) With the help of the plastic spoon add carefully 10 pellets of sodium hydroxide. Stir cautiously with the thermometer. Record the temperature again……^{0}C*.* (f) *What is the temperature change = ……^{0}C*.*

*** Note:** Temperature can be expressed in degrees Kelvin where $T = t^0c + 273$**.**

You must have noted a rise in temperature.

The temperature change is the difference between the second temperature and the first one.

Time

We can now proceed with the following investigation.

INVESTIGATION 5: Measuring Time

For each investigation you will require the materials indicated.	**Materials needed:** • A 1 cm strip of magnesium • Dilute Hydrochloric Acid • A small beaker • A clock with a second hand **Method:** *a) Take a small beaker* *b) Pour dilute hydrochloric acid in the beaker (to about two-thirds its height). At a noted time drop a 1 cm strip of magnesium into the acid.* *As soon as the magnesium disappears (is no longer visible), note the time once again. By difference you can determine the time taken for the magnesium to react completely.*
You should record your answers in the space provided.	Observations:…… …… …… …… Result:…… …… ……

You must have observed bubbles of gas (hydrogen) being produced and the strip of magnesium decreasing in size. When the reaction was over, the magnesium just 'vanished'.

I hope you recorded the time taken for the magnesium to react completely, in seconds.

1.6 OBSERVATIONS

We have to know about proper observations in Chemistry too. Such observations include colour, size and shape. Making observations also requires developing certain skills for our observations to be accurate.

Never taste anything. This could be dangerous.

Note: **Observations are also covered in Physics, Module 1: 1.2 and Biology, Module 1- Unit 2: 2.2**

Colour

Substances, which are white, can also be described as being colour-free. Table salt is one example of a white substance.

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

ACTIVITY 12

(a) *Write down 5 substances, which are colour-free.*

……

……

*(b) Ink is **coloured**.*

*Make a list of 5 substances, which are **NOT** colour -free.*

……

……

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

Size

We can now proceed with the following investigation.

INVESTIGATION 6: Observing Size

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Coarse table salt • Refined table salt • Glucose • Cane sugar (sucrose) **Method:** *(a) Compare the size of the 2 samples of table salt* …… …… …… …… …… …… (*b*) *Compare the 2 samples of glucose and sucrose again in terms of size.* …… …… …… ……

You should have found out that

(a) refined table salt is smaller in size than coarse table salt.

(b) sucrose crystals are **larger** in size than glucose.

Feel

We can now proceed with the following investigation.

INVESTIGATION 7: Feeling different substances

For each investigation you will require the materials indicated. **You should record your answers in the space provided**.	**Materials needed:** • Sand • Fine table salt • Dry tea (powder) **Method:** (a) *Take a sample of sand between your fingers. Describe the feel of sand.* …… …… *(b) Take a pinch of table salt between your fingers. Describe the feel of table salt.* …… …… …… *(c) Take dry tea (powdered) between your fingers. Describe the feel of dry tea leaves (powdered).* …… …… …… *Did you feel the sand as gritty, the salt as fine-powdered and the dry tea as rough? If YES, you have developed good skills. If not, please try again.*

Sound

We can now proceed with the following investigation.

INVESTIGATION 8: Detecting Sound

For each investigation you will require the materials indicated.	**Materials needed:** • Solid lead nitrate • A hard glass test tube • A test tube holder • A Bunsen burner **Method:** *a) Put a pinch of solid lead nitrate into a hard glass test tube.* *b) Light up a Bunsen burner.* *c) With the help of a test tube holder, heat the test tube (at the bottom).*
You should record your answers in the space provided.	*(i) Can you hear a sound? Describe it.* …… …… …… *(ii) Can you see coloured vapour? Describe it. (Be careful the coloured vapour is poisonous*). …… …… ……

You must have

(a) heard small 'explosions' called ***decrepitation*** and

(b) seen reddish brown vapours appearing.

Shape

We can now proceed with the following investigation.

INVESTIGATION 9: Observing Shape

For each investigation you will require the materials indicated. **You should record your answers in the space provided.**	**Materials needed:** • Solid lead nitrate • Charcoal • Sucrose **Method:** *Have a look at the different materials in the list.* *(a) Do they have the same appearance?* …… …….. *(b) Do they have the same shape?* …… ……

Smell

We can now proceed with the following investigation.

INVESTIGATION 10: Detecting different smells

For each investigation you will require the materials indicated. **You should record your answers in the space provided**.	**Materials needed:** • Dry coffee (powder) • Dry tea (powder) • Milk powder • Cheese (grated) • Garlic (powder) • Alcohol (liquid) • Other spices **Method:** *Smell each separately.* *What do you notice?* …… …… ……

You must have noticed each having its own characteristic **smell.**

1.7 RESULTS - RECORDING & PRESENTATION

Results have to be recorded and presented. But we cannot record them in a disorganised way. We must present results as charts, tables, graphs. These will enable us to interpret them easily and notice trends, patterns at a glance.

Note: Results - Recording and Presentation are also covered in Physics - Module 1, 1.4 and Biology -Module 1, Unit 2: 2.3

Let us now carry out an investigation to get some practice at doing these.

We can now proceed with the following investigation.

INVESTIGATION 11: Recording Temperature

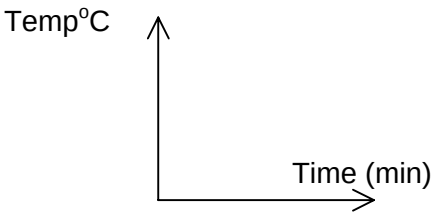
For each investigation you will require the materials indicated.	**Materials needed:** • A beaker • Water • A thermometer • A Bunsen burner • A tripod with wire gauze • Stop watch or wall clock with a second hand **Method:** *a) Half fill a beaker with water.* *b) Put it on a wire gauze itself placed on a tripod.* *c) Put a Bunsen burner below the tripod.* *d) Put a thermometer in the water.* *e) Light up the burner (low flame).* *f) Start timing.* *At intervals of 1 min, record the temperature. Stop heating after 70^0C.*

You should record your answers in the space provided.	(a) *Tabulate the values in the space below.* *(b) Plot a suitable graph.*

I hope you devised a table such as:

Time/min	Temp /^{0}C
0	…
1	…
2	…
…	…
…	…
…	…
…	…
…	…
…	…
…	…

For (b) You might choose to plot a graph of **temperature** against **time**.



The graph should be of a rising type.

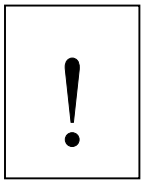
✍ ***Before proceeding further, complete the following activity.***

ACTIVITY 13

(a) *A mixture of 5 g of salt and 5g of sand is prepared. Show the composition of the mixture using a pie chart.*

(b) *100 cm^3 of alcohol is mixed with 300 cm^3 of water. Use a pie chart to show the relative volumes of the 2 liquids*.

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



POINTS TO REMEMBER

- Chemistry involves the study of matter, its properties, its reactions and possible applications.
- Precautions must be taken in the chemistry laboratory while performing experiments.
- Safety measures have to be applied.
- A First Aid Kit should be updated and renewed at regular intervals.
- Chemistry is largely based on experiments
- Apparatuses in the chemistry laboratory are predominantly of glassware
- Things can be grouped in various ways such as:
    - solids or liquids or gases
    - elements or compounds
- Measurements are generally made involving:
    - mass
    - length
    - time
    - temperature
- Observations on matter include those involving:
    - colour
    - feel
    - shape
    - appearance
    - smell
- Results can be tabulated and depicted graphically or diagrammatically (charts).

ANSWERS TO ACTIVITIES

Activity 1

Solid: Silver, Wood, Spoon, Carbon

Liquid: Saliva, Alcohol**,** Lime juice, Lime water, Oil

Gas/Vapour: Oxygen, Carbon monoxide, Water vapour.

Activity 2

(a) (i) Biology (ii) Physics (iii) Chemistry

Activity 3

(a) Yes (b) No (c) Yes (d) Yes (e) Yes

(f) Yes (g) Yes (h) No

Activity 4

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

Activity 5

(a) Yes (b) Yes (c) Yes (d) Yes (e) No (f) Yes

(g) No (h) Yes (i) No (j) Yes

Activity 6

1. carbon, hydrogen, oxygen, nitrogen, tin
2. carbon dioxide, water, ammonia
3. (a) vinegar, (b) calcium carbonate (corals) and
   (c) sodium bicarbonate (sodium hydrogen carbonate)

Activity 7

Element: Carbon, Diamond, Tin, Lead, Hydrogen, Copper

Compound: Carbon dioxide, Water, Table Salt, Steam, Sand,

Activity 8

(a) rusts (b) burning (c) respiration

(d) fermentation (e) photosynthesis

Activity 9

1.	Beaker	2.	Conical flask	3.	Measuring cylinder
4.	Pipette	5.	Round-bottom flask	6.	Burette
7.	Funnel	8.	Reagent bottle	9.	Water condenser
10.	Volumetric flask				

Activity 10

1.	Stand	2.	Tripod	3.	Test tube rack
4.	Test tube holder	5.	Pair of tongs	6.	Crucible
7.	Evaporating dish	8.	Bunsen burner	9.	Wire gauze
10.	Pipette filler				

Activity 11

(a) A conical flask (b) An evaporating dish

Activity 12

(a) Cane sugar, Glucose, Limestone, Quick lime, Fructose

(b) Dye, Copper sulphate crystals, Bromine, Nitrogen dioxide, Sulphur

Activity 13