

Illustrative

CHEMISTRY

FOR SECONDARY SCHOOLS

FORMS 1 & 2

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PREFACE

Illustrative Chemistry for Secondary Schools: Forms 1 and 2, is a book that has been written in such a way that is easily readable and understandable to learners. This book covers Chemistry topics for forms 1 and 2 as prescribed in Tanzania syllabus.

Chemistry knowledge and skills can easily be acquired through reading this book. Experiments, activities and exercises are well covered in this book to cater for learner-centered approach. This book covers the following topics:

1. Introduction to Chemistry
2. Laboratory techniques and safety
3. Heat sources and flames
4. The scientific procedure
5. Matter
6. Elements, Compounds and mixtures
7. Air, Combustion, rusting and fire fighting
8. Oxygen
9. Hydrogen
10. Water
11. Fuels and energy
12. Atomic structure
13. Periodic classification
14. Formula, bonding and Nomenclature

I wish you all the best as you interact with this book.

John Meshack Mandiga,

Kibaha- Pwani,

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Chapter 1

Introduction to Chemistry

1.1 THE CONCEPT OF CHEMISTRY

The word *Chemistry* comes from the word *Alchemy*. Alchemy is an earlier set of practices that encompassed elements of Chemistry, metallurgy, philosophy, astrology, mysticism and medicine. The word alchemy in turn is derived from the Arabic word “*al-kimia*” or “*kimi*” which is Egyptian name, meaning “*cast together*”.

By definition, Chemistry is the branch of science which deals with composition, decomposition, structure and properties of matter. The people who study Chemistry are called **Chemists**. Hundreds of years ago people were interested in what we call Chemistry. These people are called **alchemists**.

1.2. BRANCHES OF CHEMISTRY

There are many branches of Chemistry. In this level of study the five (5) major branches of Chemistry will be considered,

- **Organic Chemistry:** is the study of carbon and its compounds.
- **Inorganic Chemistry:** is the study of other substances not containing carbon.
- **Analytical Chemistry:** is the study of separation, identification and composition of materials and the development of tools used to measure properties of matter.
- **Physical Chemistry:** is the study of the physical characteristics of materials and the mechanisms of their reactions.
- **Biochemistry:** is the study of chemical processes that occur inside of living organisms.

1.3 APPLICATION OF CHEMISTRY

Most of the products we use are produced through application of Chemistry. There is no way in life we can interact with industrial and non-industrial products and do away with the

fact that the knowledge of Chemistry is applied in order to get those products. Examples of products made through application of Chemistry are fertilizers, pesticides, drugs, vaccines, detergents,

toothpaste, insecticides, soft drinks, common salt, paints, cement, clothes, fuels, lubricants and grease.

Chemistry is an important subject that is applied in different fields such as mining, agriculture, medicine, manufacturing, education, food and beverage industry, home care and cosmetics industry, film industry,

water treatment and purification. The places where Chemistry is applied among others are hospitals, homes, factories, laboratories, research centres, universities, water treatment plants and mining centres. In our homes, Chemistry may be used in baking, cooking and washing clothes with soap.

1.4 IMPORTANCE OF CHEMISTRY

The application of Chemistry knowledge directly relates with the importance of Chemistry. Chemistry is applied in different fields to produce very important products or rendering helpful services.

1. WATER TREATMENT

- The knowledge of Chemistry is used to produce chemicals like *water guard* that kill germs present in water.
- **Liquid chlorine:** is another chemical which is added in water to kill harmful bacteria. Chlorine

is a useful disinfectant that is used in swimming pools to kill bacteria. Potassium Aluminum Sulphate is a chemical which when added into water fine particles found in water settles down to allow the process of *sedimentation*.

2. TRANSPORT AND COMMUNICATION

- Liquid fuels like gasoline (petrol), diesel and kerosene are used by different means of transport. These fuels are produced by chemical processes
- The gaseous fuels like natural gas (methane), liquefied petroleum gas (LPG) are also processed by using

the knowledge of Chemistry.

- Non-petroleum fossils like biodiesel and alcohols are produced through application of Chemistry.
- Chemical processes are applied to produce papers, and wires. These products are very essential in communication.

3. AGRICULTURE

- Agriculture is the science of livestock keeping and production of crops.
- Products like *pesticides, insecticides, herbicides, fungicides,*

fertilizers, hormones, and growth agents are important in the field of agriculture. All the named products are produced through chemical processes. Farmers use the products

- in order to get better agricultural yields.
- Other products used by farmers are *weed killers* and *animal vaccines*.

4. FOOD AND BEVERAGE INDUSTRY

- Biochemical products like carbohydrates, lipids, proteins, vitamins, minerals, enzymes, food additives, flavors and colours are produced through chemical processes.
- The food industry has also benefited from chemical processes like *food preservation*. Food preservation can be employed industrially in canning and bottling of foods.
- Soft drinks like coca cola and Pepsi are produced through chemical processes like *carbonation*.
- Carbonation is also involved in production of *beer, wine, tonic water* and many others.

5. MANUFACTURING INDUSTRY

- Manufacturing is the production of goods for use or sale using labor and machines, tools, chemical and biological processing or formulation. Manufacturing relies on Chemistry and its chemical processes. The raw materials and products depend much on Chemistry knowledge.
- Products like cement, cars, plastic containers, chemicals, textiles, paper, rubber, glass, computers, mobile phones and many others are produced by application of Chemistry knowledge.

6. HOME CARE AND COSMETICS INDUSTRY

- Home care products like soaps, detergents, disinfectants, air fresheners, paints, polish and vacuum cleaner are used to make the home and its surrounding cleaner and more comfortable to live. All these products are made through application of chemical processes.
- Cosmetics like *lip stains, face powder, bronzer, eye lash curler, nail polish, eye liner, lotions and creams* are produced chemically. Other beauty products are *deodorants* and *primers*.

7. MEDICINE

- Chemically produced substances like drugs, vaccines and food supplements are very important in our lives. Prevention of illness and diseases, treatment of diseases ensures our well-being.
- In general the field of medicine backed up by Chemistry knowledge grants us with healthier living.

8. FILM INDUSTRY.

- A film camera catches the picture using chemicals on film. The first popular photographs were captured on copper plates in the 1840s.
- Video recorder, digital cameras and video tapes are produced by the aid of Chemistry knowledge.
- A piece of film consists of a light sensitive *emulsion* applied to a tough, transparent base. The emulsion consists of silver halide grains suspended in a gelatin colloid, in the case of colour film.
- Development chemicals applied to an appropriate film can produce either a positive (showing the same densities and colours as the subject) or negative image (with dark highlights, light shadows).

9. MINING INDUSTRY

- Mining is the extraction of valuable minerals or other geological materials from the earth. Extraction metallurgy is the practice of removing valuable metals from an ore and refine the extracted raw materials into pure form. Chemical processes especially electrolysis are very essential in converting metal oxides or sulphides into a pure metal.
- The knowledge of Chemistry is very important in all these processes.

1.5 CHEMISTRY FOR PROFESSIONAL DEVELOPMENT

The study of Chemistry is very important in many professions or careers. Professionals like geologists, engineers, nurses, medical doctors, farmers, horticulturalists, floriculturists, pharmacists, laboratory technicians, researchers and science teachers depend on the knowledge of Chemistry in their careers. Through studying Chemistry, skills are acquired by such professionals

SUMMARY

- (a). In Chemistry we study the substances which make up the earth, the living things and the universe in general.
- (b). People who study Chemistry are called chemists.
- (c). People who were interested in Chemistry hundreds of years ago are called alchemists.
- (d). Chemistry deals with the composition, decomposition, structure and properties of matter.
- (e). Major five branches of Chemistry are organic Chemistry, inorganic Chemistry, analytical Chemistry, physical Chemistry and biochemistry.
- (f). The importance of Chemistry is revealed in such fields as medicine, agriculture, mining Industry, water treatment, film industry, home care and cosmetics industry, transport and communication, food and beverage industry and manufacturing industry.

REVIEW QUESTIONS

1. Match the items in list A with their corresponding statements in LIST B.

LIST A

- i. Agriculture
- ii. Medicine
- iii. Manufacturing industry
- iv. Transport industry
- v. Food and beverage industry

LIST B

- A. Clothes, dyes
 - B. Fertilizers, pesticides, weed killers, animal vaccines.
 - C. Fuels, lubricants, oil, grease, coolant, drugs, animal vaccines, food supplements.
 - D. Paints, chemicals, vanishes, cement, plastics
 - E. Detergents, beauty products, shoe polish, tooth paste, disinfectants, insecticides.
 - F. Drugs, vaccines, food supplements
 - G. Soft drinks, common salt, yeast, baking powder, canned food.
2. Write **TRUE** or **FALSE** for the following statements.
- i. Matter is anything that has mass and occupies space
 - ii. The people who study Chemistry are called chemists.....
 - iii. We cannot apply Chemistry in our homes when we are baking, cooking

Chapter 2

Laboratory Techniques and Safety

2.1 INTRODUCTION

The term *laboratory* come from the same Latin word as the English word labour, which means *hard work*.

By definition, a laboratory is a special room or building that is designed and used for scientific experiments. Chemical experiments are carried out in a *chemistry laboratory*.

2.2 RULES AND SAFETY PRECAUTIONS IN A CHEMISTRY LABORATORY

The laboratory is meant to be a quiet and safe place to work in . In view of this, safety in the laboratory is of great importance to both students and teacher. The laboratory can be very dangerous place if safety regulation is not followed.

LABORATORY RULES.

Laboratory rules are specified guidelines required to be followed when working with the laboratory. Here is a set of rules to be followed when dealing with the laboratory.

- Never enter the laboratory without the permission or presence of the teacher.
- Always dress appropriately for the laboratory activities
- Always keep the windows open for proper ventilation
- Always master the location of all exit
- Always read instruction carefully before you start any experiment or activity.
- Never run in the laboratory
- Never eat or drink anything in the laboratory
- Never quarrel or fight in the laboratory
- Never use laboratory apparatus for drinking or storing food
- Never taste or sniff chemicals unless advised on how it should be done
- Never throw any solid into the sink or water ways
- Always use the fume chamber when carrying out experiments where harmful

gases are produced.

- Always wash your hands with soap and water before you leave a laboratory
- Always perform the intended experiments.
- Always replace covers and stoppers on the container after using the chemicals.
- Never spill liquids on the floor.
- Always keep the gangways and exits clear.
- Always report any breakages or accident to the teacher immediately.
- Always keep your bench top clean, dry and well arranged.
- Always direct the mouth of the test tube away from you or others when heating substances.
- Always use a clean spatula to remove chemicals from containers.
- Always use a lighter or wooden splints to light burners, remember to strike the match before turning on the gas tap.
- Never touch electrical appliance with wet hands.
- Always turn off any gas or water taps that are not in use.
- Never use dirty, cracked or broken apparatus.
- Never heat flammable liquids with a Bunsen burner flame.
- Never remove chemicals or equipment from the laboratory.
- Always wash off any chemical spillage on your skin or clothes with plenty of water.
- Always keep inflammable substances away from naked flames.
- Never casually dispose of chemicals and wastes inappropriately.
- Always clean up the equipment and store properly after use.

LABORATORY SAFETY MEASURES

Laboratory safety measures are precautions undertaken in order to minimize risks when carrying out laboratory activities. Laboratory safety measures can be explained as follows:

1. The laboratory should be equipped with protective clothes like laboratory coat and safety glasses all the time
2. All people using the laboratory should not put themselves or anyone else in danger by either smoking, causing panic in case of an unwanted chemical reaction, damage or injury. The supervisor should be called in case of such situation.
3. The fume cupboard should be used whenever working with hazardous or toxic substances and for every experiment where easily evaporable chemicals are employed
4. All flammable substances should not be exposed to open flame
5. When working with concentrated acids or alkalis protective gloves

and safety glasses should be worn.

6. Immediately rinse with water and neutralize if necessary in case a chemical comes in contact with your skin. In case a chemical come in contact with your eyes wash with running water and call the supervisor.
7. A pipette bulb should be used instead of mouth suction when pipetting harmful or evaporable substance.
8. Organic solvent of extremely hazardous and toxic substance should be disposed of into the designated waste container.
9. All flammable liquids should not be mixed with oxidizing substance as this can cause fire.
10. All chemicals that easily react with each other should be stored separately.
11. There should be equipment for monitoring contamination in order to give alert of any possible dangers in the laboratory.
12. Refrigerator and freezers should be used for working with laboratory chemicals only.
13. Adequate *first aid* kits should be available in the laboratory
14. There should be clear instruction on how to use fire extinguishers in case of fire.
15. All persons working in the laboratory should not accidentally get into contact with harmful chemicals by ensuring that cupboards, storage cabinet and drawers have locks.
16. There should be regular inspection and checking of stored chemicals in order to avoid using expired substances.
17. Chemical containers should be stoppered and regularly checked to ensure that they do not leak.
18. Accidental use of wrong substances should be avoided by labeling all chemicals.
19. All spills should be cleaned immediately.
20. There should be emergency exits and easily accessible.
21. Gas cylinders should be in good working condition always, they should be labelled, stored and well supported.

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