NEW ORDINARY LEVEL CHEMISTRY RESEARCH BOOK

(DETAILED)

SENIOR ONE TO SENIOR FOUR

"LEARNER'S RESEARCH BOOK"

BASED ON THE NEW LOWER SECONDARY CURRICULUM

By

lwangawilliam11@gmail.com
+256750549201 / +256771803014

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Kawempe - Tula Road, Kampala

Near Kakungulu Police

Tel: +256771803014 (WHATSAPP) / +256750549201

E-mail: lwangawilliam11@gmail.com

You can also locate " Lwanga Books Ltd" easily using the " Google search" or " Google maps".

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There's No Limit To Your Success

Preface

This learner's research book has been written in line with the revised chemistry syllabus for the new lower secondary curriculum.

The main reason as to why We have written this book, is to make research easier to learners as they are making their own notes in chemistry. Therefore, this is a detailed research book for the new revised chemistry ordinary level syllabus.

This research book has been written in a Simplified way to help students read and understand the competence based chemistry on individual basis as they are coming up with their own notes. Therefore, learners understand key scientific concepts and apply them in real life.

This research book has been equipped with various images and diagrams to ensure learners understand and relate chemistry concepts well.

This learner's research book is one of the materials which are to be used to support the teaching and learning process of the new lower secondary curriculum.

Lwanga Books Ltd feels confident that this Book will be of immense value to both the learners and the teachers.

Any suggestions for improvement of this book are most welcomed, thanks.

NB: "Search" {lwanga william} on youtube and subscribe (also tap on the notification bell) to that you-tube channel and watch the subject based project lessons that are on-going. " subscription is for free"

Acknowledgement

Lwanga Books Limited is deeply indebted to all those who participated in the development of **Lwanga William S1-S4 Chemistry Learner's Research Book.**

Special thanks go to **Mr. Lwanga William**, the CEO Lwanga Books Ltd for his valuable insights and advice on all publishing matters.

We would like to express our sincere appreciation to all those who worked tirelessly towards the production of this learner's research book.

First and foremost, we would like to thank our families and friends for supporting all our initiatives both financially and spiritually, Lwanga William's parents; **Mr. William Lwanga** and **Mrs. Harriet Lwanga,** his brother; Mr. Nsubuga Grace.

The initiative and guidance of the publishing partners, Ministry of Education and Sports (MoES) and National Curriculum Development Centre (NCDC) in development and implementation of the New Lower Secondary Curriculum are highly appreciated.

We thank God for the wisdom He has given us to produce this volume of work.

May the Almighty God bless all the students that will use this book with knowledge of making their own notes as they are making research..……**AMEN**.

We welcome any suggestions for improvement to continue making our service delivery better.

"It is not what We do for you but what We will teach you to do for and by yourselves that will eventually make you successful beings in the society"

CHEMISTRY AND SOCIETY

What is chemistry?

Chemistry is a branch of science which deals with composition, decomposition and properties of matter.

Or

It is a branch of science which deals with composition, properties and changes of matter.

Note: In chemistry we study how different substances combine with other substances to form new substances. In brief, chemistry is the study of matter and its behaviours.

-People who study chemistry are called chemists

- Material objects made by application of chemistry,are fertilizers,pesticides,detergents etc

What is the importance of chemistry ?

Chemistry is important for our lives and development due to;

1. It helps in manufacturing of medicine to cure sick people.
2. It helps in manufacturing of cooking oil and sugar in the food industry.
3. It helps in manufacturing of detergents like Omo, Foma etc for cleaning purposes.
4. It helps in manufacturing of fertilizers for agriculture activity.
5. It helps in manufacturing of chemical substances which kill weeds and pests.
6. It helps in manufacturing of fuel i.e. petrol diesel etc.
7. It helps in manufacturing of shoes and clothes.
8. We study chemistry in order to start career. For example To be doctors, pharmacists , physicists etc.
9. We study chemistry in order to answer question about natural things i.e .why does iron rust?

REMEMBER:

Chemistry is a branch of Science. Science is basically the study of living and non-living things. The branch of science that study living things is called Biology. Thebranch of science that study non-living things is called Physical Science. Physical Science is made up of:

- Physics- the study of matter in relation to energy
- Chemistry- the study of composition of matter.

Chemistry is thus defined as the branch of science that deals with the structure composition, properties and behavior of matter.

Basic Chemistry involves studying:

1. The role of chemistry in society

(a) Chemistry is used in the following:

i. Washing/cleaning with soap:

Washing/cleaning is a chemical process that involve jnteraction of water,soap and dirt so as to remove the dirt from a garment.

ii. Understanding chemicals of life

Living thing grow, respire and feed. The formation and growth of cells involve chemical processes in living things using carbohydrates, proteins and vitamins.

iii. Baking:

Adding baking powder to dough and then heating in an oven involves interactionsthat require understanding of chemistry.

iv. Medicine:

Discovery, test ,prescription and dosage of drugs to be used for medicinal purposes require advanced understanding of chemistry.

vi. Fractional distillation of crude oil:

Crude oil is fractional distilled to useful portions like petrol,diesel,kerosene by applying chemistry.

vii. Manufacture of synthetic compounds/ substances

Large amounts of plastics, glass, fertilizers, insecticides, soaps, cements, are manufactured worldwide. Advanced understanding of the chemical processes involved is a requirement.

viii. Diagnosis/test for abnormal body functions.

If the body is not functioning normally,it is said to be sick/ill.

Laboaratory test aredone to diagnose the illness/sickness.
(b) The following career fields require Chemistry as one of subject areas of advanced/specialized study:
(i) Chemical engineering/chemical engineer
(ii) Veterinary medicine/Veterinary doctor
(iii) Medicine/Medical doctor/ pharmacist/ nurse
(iv) Beauty/Beautician
(v)Teaching/Chemistry teacher.

- ❖ Chemistry is the study of matter, its composition, properties and behavioural changes that form the environment.
- ❖ Chemistry is the basis of chemical industry and many chemists work in industries involved in making useful products from raw materials such as soap, detergents, cosmetics, textiles etc.

IMPORTANCE OF LEARNING CHEMISTRY

The chemical knowledge, concepts and skills enhance improvement in the quality of life of the people.
To help the learner to develop interest in and care for the surrounding environment.
It enables people to appreciate the numerous chemical products and how to use them properly.
It enables people to make progress in related careers e.g. Doctors, teachers, Nurses etc.
To enable people to discover knowledge using a practical approach and to apply the discovered knowledge in everyday life. The world today relies on chemistry as one key component in every aspect of life.
Enable man to produce enormous energies which are important in society e.g. Petrol.
The knowledge of chemistry makes us to understand the properties of substances and handle these substances with great care. Some may be poisonous, corrosive, toxic etc.
Makes us to understand how to extract substances from the earth and use theme.g. gold, copper etc.
Chemistry knowledge opens up way to science professional courses such as medicine, education and pharmacy.
The knowledge of chemistry makes us to know the effects of chemicals on the environment and subsequently puts us in position to protect our environment.
Broad knowledge in chemistry puts us in better positions to contribute towards more advancement in science and technology for better and quality human life.
The knowledge of chemistry is relevant in many ways such as making of food supplements, distillation of fuel, making of plastics, making cosmetics and dental creams, manufacture of soap and detergents, making insecticides and herbicides.etc.

Drugs

A drug is a natural or synthetic/man-made substance that when taken changes/alterthe body functioning.
A natural or synthetic/man-made substance that when taken changes/alter the abnormal body functioning to normal is called **medicine**.
Medicines are thus drugs intended to correct abnormal body functions. .
Medicines should therefore be taken on **prescription** and **dosage**.
A prescription is a medical instruction to a patient/sick on the correct type ofmedicine to take and period/time between one intake to the other.
A dosage is the correct quantity of drug required to alter the abnormal bodyfunction back to normal. This is called **treatment**.

It is the professional work of qualified doctors/pharmacists to administer correct prescription and dosage of drugs/medicine to the sick.
Prescription and dosage of drugs/medicine to the sick use medical language.

Example

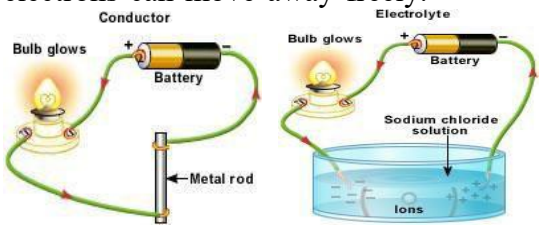
2 x 4 ; means "**2**" tablets for **solid** drugs/spoon fulls for **liquid** drugstaken "**4**" times for a duration of one day/24 hours and then repeated and continued until all the drug given is finished.
1 x 2 ; means "**1**" tablets for **solid** drugs/ spoon fulls for **liquid** drugstaken "**2**" times for a duration of one day/24 hours and then repeated and continued until all the drug given is finished.
Some drugs need minimal prescription and thus are available without pharmacist/ doctor's prescription.
They are called **O**ver **T**he **C**ounter(OTC) drugs. OTC drugs used to treat mild headaches, stomach upsets, common cold include:

- painkillers
- anti acids
- cold/flu drugs.

All medicines require correct intake dosage.
When a prescription dosage is notfollowed, this is called drug **misuse/abuse.**
Some drugs are used for other purposes other than that intended.
This is called drug abuse.
Drug abuse is when a drug is intentionally used to alter the normal functioning of the body. The intentional abnormal function of the drug is to make the victim havefalse feeling of well being.
The victim lack both mental and physical coordination.
Some drugs that induce a false feeling of well being are illegal. They includeheroin, cocaine, bhang, mandrax and morphine.
Some abused drugs which are not illegal include: miraa, alcohol, tobacco, sleeping pills.

CONDUCTORS AND INSULATORS

Conductors are made of materials that electricity can flow through easily. These materials are made up of atoms whose electrons can move away freely.



Some examples of conductors are:
1. All metals (molten or solid) and the non-metal carbon (graphite). This conduction involvesthe movement of free or delocalized electrons (e^- charged particles) and does not involveany chemical change.
2. Any molten or dissolved material in which the liquid contains free moving ions is called the electrolyte. Ions are charged particles eg Na^+ sodium ion, or Cl^- chloride ion, and theirmovement or flow constitutes an electric current, because a current is moving charged particles.

List of conductors

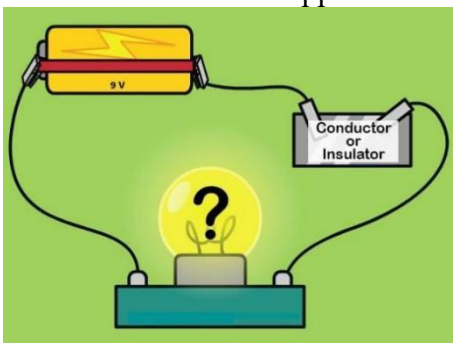
1. Copper
2. Aluminum
3. Platinum
4. Gold
5. Silver
6. Graphite
7. Salt solutions (e.g. sodium chloride)
8. Water
9. People and Animals
10. Trees

Insulators are materials opposite of conductors. The atoms are not easily freed and arestable, preventing or blocking the flow of electricity.

Some examples of insulators are:
1. Glass
2. Porcelain
3. Plastic
4. Rubber

Electricity will always take the shortest path to the ground.

Your body is 60% water andthat makes you a good **conductor** of electricity. If a power line has fallen on a tree and you touch the tree you become the path or conductor to the ground and could get electrocuted.
The rubber or plastic on an electrical cord provides an **insulator** for the wires. By covering the wires, the electricity cannot go through the rubber and is forced to followthe path on the aluminum or copper wires.



The ability to conduct electricity is the major simple distinction between elements thatare metals and non-metals.

EXPERIMENTAL CHEMISTRY

RECALL:
Chemistry is a branch of science that deals with the study of structure, compositionand properties of matter.
Chemistry as an experimental subject relies on:
- Careful handling of apparatus
- Carrying out chemical tests or chemical analysis
- Making critical observation
- Critical reporting of observations
- Drawing appropriate conclusions from observations

❖ Chemistry as a practical science tries to answer the following question.

1. What are materials made up of?
2. How is matter formed?
3. How does matter behave?
4. Why does matter behave the way it does?

There are quite a number of branches of chemistry such as Organic chemistry, Physical chemistry, Inorganic Chemistry and Analytical chemistry.

LABORATORY

A laboratory is a special place with special equipments where scientific investigations or experiments are carried out.
The laboratory is a place of adventure and discovery; in fact some of the most exciting events in the history of science have taken place in laboratories e.g. the discovery of oxygen.
When experiments are carried out in the laboratory, chemical materials and are used.
Chemicals are substances usually in solid or liquid forms that are consumed during reactions. They get usedup in reactions during the course of an experiment. E.g. Sodium hydroxide and Hydrochloric acid.

Apparatus are scientific tools that are used in carrying out scientific experiments. They are not usedup or consumed and can be used repeatedly. E.g. Beaker.

Laboratory safety rules

- Do not enter the laboratory without permission.
- Perform only the experiments assigned by the teacher.
- Learn at once the location and operation of fire extinguishers and other first aidmaterials.
- No equipment should be used until proper instructions are received from theteacher and you have proven proficiency.
- Avoid unnecessary movements in the laboratory.
- Do not play about with electrical or gas devices.
- Handle apparatus with great care.
- In case of accidents such as burns, cuts or splash of chemicals, wash with plenty of water and report to the teacher or laboratory technician.
- Do not taste or smell gases continuously.
- Do not eat or drink anything in the laboratory.
- When heating using boiling tubes or test tubes, do not turn the open end towardsyourself or any one.
- Whenever in the laboratory, use clean and dry apparatus.
- Never use faulty equipments. Check and make sure that the devices you are givenare not damaged.
- Never dispose off solid material into sinks instead throw them in solid wastecontainers or pits.
- Always make sure that you follow instructions that are given and read labels onbottles making sure that you use correct reagents.
- Do not leave reagent bottles open. As soon as you finish using a bottle, put itsstopper and return it to its right position.
- Do not keep your work space too congested.

Simple laboratory equipments or apparatus

In order to carry out experiments in the laboratory, we need special tools such as measuring device. Such a tool is referred to as an apparatus.

LABORATORY APPARATUS

These are pieces of equipment used in the laboratory for experiments.

Common Apparatus in a chemistry laboratory

Glass ware

These are pieces of equipment made of glass. Most of the apparatus in the chemistry laboratory are made of glassware for two major reasons;

1. Glass is transparent and enables the experimenter to observe easily the reactions occurring.
2. Glass does not react with most common laboratory chemicals.

Test tube

This is used for mixing and heating small amounts of liquids or soid

Boiling tube

A boiling tube is wider than a test tube and it's longer. It's used for heating substabces strongly or boiling liquids.

Measuring cylinder

This is used for measuring approximate volumes of liquid substances.

Burette

This is used for very accurate measurements of volumes. It is used in titration experiments.

Pipette

This is used to measure fixed volumes of liquids accurately.

Volumetric flask

It's used to measure precise volumes of liquids.

Conical flask

This used for mixing liquids as on shaking the liquid does not splash out. It also holds liquids or solutions for use.

Glass rod

For stirring to dissolve a solid material in a solvent.It is also used to detect formation of a crystal during evaporation of aqueous solutions.

Flat bottomed flask.

This is used for mixing of a solid with a liquid.

Round bottomed flask

This is used for heating liquids for a long period. It's used in distillation experiments.

Beaker.

Beakers are used for heating, holding and measuring liquids.

Thistle funnel

This is used for putting liquids into reaction vessels

Separating funnel

This is used for separating immiscible liquids e.g water and Kerosene.

OTHER COMMON APPARATUS (NON GLASSWARE)

1. Tripod stand.

This is used for supporting apparatus while it is heated.

2. Test tube rack

For holding test tubes during an experiment especially qualitative analysis.

3. Wire gauze

For uniform distribution of heat while heating.

4. Spatula

For scooping solid chemicals from their containers.

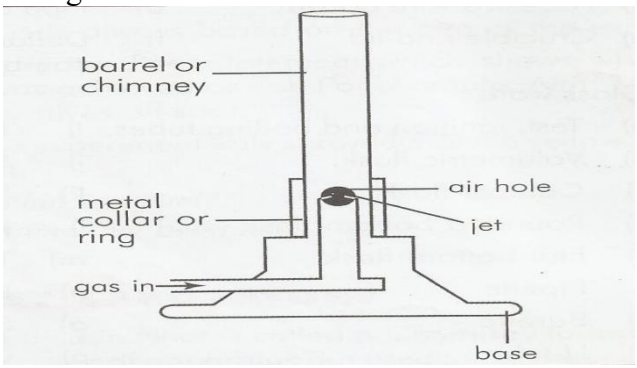
5. Filter paper

For filtration experiments to separate liquid of solution from undissolved solid.

THE HEATING APPARATUS USED IN CHEMISTRY LABORATORY

THE BENSEN BURNER

This is a simple piece of apparatus used in the laboratory for heating substances and it uses gas as a source of fuel.



The Bunsen burner mixes the gas with air in the correct proportions to give a very hot flame. The gas enters the burner through the jet at the bottom and burns at the top of the chimney. The collar has a hole on each side of it and air can pass through the hole and mix with the gas as it goes up the tube. The amount of air entering can be adjusted by turning the collar. The flames of a candle and burning oil are smoky and luminous (yellow) and are not used

for heating in the laboratory for the following reasons:
(i) They are not hot enough.
(ii) They cover apparatus with black soot (carbon).

FUNCTIONS OF PARTS OF A BUNSEN BURNER

1. **Barrel (Chimney)**

It allows gas to pass through to be used to create a flame.It transmits a mixture of gas and air up to the top of the chimney where it is lit.

2. **Collar (Metal ring)**

When adjusted it increases or decreases the size of air hole by making it smaller or bigger.

3. **Air hole**

It's an opening that allows air to enter the Bunsen burner so that when it mixes with the gas from the jet,it burns when lit.

4. **Jet.**

This is where the gas enters the burner and it provides the necessary pressure to push the gas through the Chimney

5. **Rubber tubing**

It joins the Bunsen burner to the gas cylinder and transmits the gas from the gas cylinder to the jet of the Bunsen burner.

6. **Base**

This is to ensure that the Bunsen burner is stable.It is where the burner sits and gets its support.

HOW TO LIGHT A BUNSEN BURNER

(i). Connect the Bunsen burner to the gas cylinder

(ii). Turn the collar until the air holes are closed.

(iii).Turn on the gas fully.

(iv).Light the gas at the chimney to produce a flame.

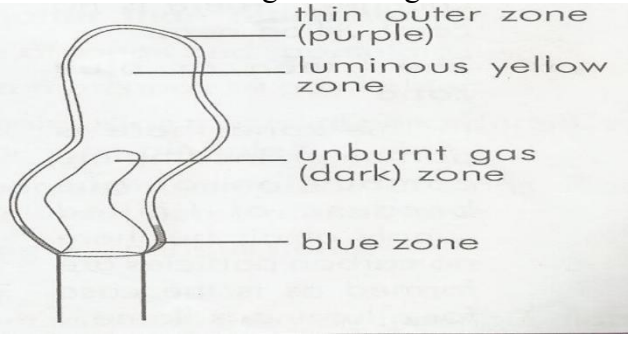
(v). Open the air holes slowly until the flame is non luminous.

FLAMES

A flame is burning gases that give out heat and light.

1. **Luminous flame (Air-holes closed)**

This is the flame produced when the air holes are closed. The flame is large and bright. It's luminous because it gives out light.



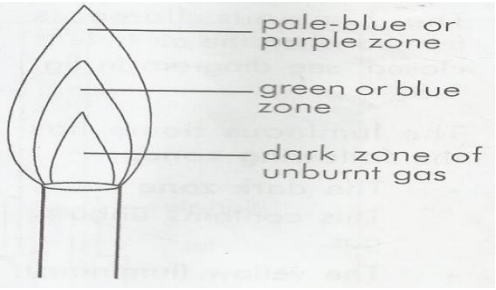
A luminous flame has four parts or zones with different colours.

(a) A dark inner zone of cool, un burnt gas.

(b) A luminous yellow zone. The gas burns in this zone but not completely as there is not enough air.
(c) A thin outer zone in which the gas burns completely as there is plenty of air. This zone does not give out light, it's difficult to see this zone.
(d) A blue zone at the bottom of the flame. The part receives plenty of air because of rising convection currents. Burning is more complete than in the yellow zone.

2. **Non-Luminous flame (Air-holes open)**

This is a flame produced when the air hole is open. Air enters the tube and mixes with the gas which burns quickly and completely. The flame becomes smaller and hotter. It gives out only a little light because it contains no carbon. The flame has three zones.



Uses of non luminous flame.

- It's used in gas cookers.
- It's also used in a gas fires

(a) An inner zone of cool unburnt gas.

(b) A green or blue middle zone. Some gas burns in this zone, but not all because there is not enough air.

(c) A pale blue or purple zone. In this zone the burning of the gas is more complete.

Burning Back

This is a phenomenon where the flame moves down the chimney and is seen to burn at the jet.It occurs when the air holes are open and the gas is turned down so that the rate at which the gas is burnt exceeds the rate at which it is supplied from the jet.

Control of Burning Back

When burning back occurs,turn off the gas,close the air hole and light it again using the normal procedure.

Experiment to find out the hottest part of the Bunsen flame

Get a piece of paper and hold it horizontally.

Pass the paper quickly through a non luminous flame around two places .

Brown patches form on the paper.The brown patch is formed at the hottest part of the Bunsen burner located just above the blue or green zone.

Differences between luminous and non luminous flame

Luminous	Non luminous
• Has four zones • Produces soot • Burns silently • Produces a lot of light • Yellow and unsteady • Large and not hot enough	• Has three zones • Does not produce soot • Burns with noise • Produces little light • Blue and steady • Small and hot enough

LABORATORY METHODS OF PREPARING GASES

The following steps are involved when preparing a gas:

1. Production

Reagents are mixed in a reaction vessel and the gas is produced.

2. Purification

The gas is passed through another reagent normally in a wash bottle to remove the impurities.

3. Drying

In most cases dried sample of gases may be required. Common drying agents include:

Concentrated sulphuric acid-the gas is passed through concentrated sulphuric acid in a wash bottle.The inlet delivery tube must be below the acid and the outlet delivery tube above the acid. Concentrated sulphuric acid is not used to dry ammonia gas because it reacts with ammonia.

Anhydrous calcium chloride- the gas is passed through anhydrous calcium chloride in a U- tube.
Calcium oxide is used to dry ammonia gas. Dried gases must not be collected over water.

Other dying agents include anhydrous magnesium sulphate,anhydrous sodium sulphate,anhydrous calcium sulphate. Phosphorus pentaoxide is another drying agent used to dry ether.

4. Collection

The method of collection depends on the density of the gas in comparison to the density of air and also the solubility of the gas in water.

(a) Over water

The gas jar is filled with water in the trough, inverted and the mouth of the jar placed over the beehive shelf.The gas displaces water from the gas jar when it is full.This method is suitable for gases that are insoluble in water eg nitrogen and oxygen.

(b) Upward delivery

(Downward displacement of air)

Gases that are less dense than air are collecteted by upward delivery eg hydrogen and ammonia.

(c) Down ward delivery

(upward displacement of air)

Gases that are denser than air are collected by down ward delivery eg carbon dioxide, sulphur dioxide, chlorine, hydrogen chloride.

(d) Freezing method

The gas is liquefied by cooling in ice-cold freezing mixture in a U-tube e.g nitrogen dioxide.

NOTE THAT:

Scientific apparatus are drawn:

(i) using a proportional **two** dimension(**2D**) cross-sections. Three dimensions (3D) are not recommended.

(ii) straight edges of the apparatus on a scientific diagram should be drawn using ruler.

(iii) curved edges of the apparatus on a scientific diagram should be drawn using free hand.

(iv) The bench, tripod or clamp to support apparatus which cannot stand on their own should be shown.

Common school chemistry laboratory chemicals include:

(i) distilled water

(ii)Concentrated mineral acid which are very corrosive(on contact with skinthey cause painful open wounds)

(iii) Concentrated alkali/bases which are caustic(on contact with skin theycause painful blisters)

(iv) Very many types of salts.

The following safety guideline rules should be followed by chemistry laboratoryusers:

(i) Enter the laboratory with permission in an orderly manner withoutrushing/pushing/ scrabbling.

(ii) Do not try unauthorized experiments. They may produce flammable,explosive or toxic substances that affect your health.

(iii) Do not taste any chemical in the laboratory. They may be poisonous.

(iv) Waft gas fumes to your nose with your palm. Do not inhale/smell gases directly. They may be highly poisonous/toxic.

(v) Boil substances with mouth of the test tube facing away from others andyourself. Boiling liquids spurt out portions of the hot liquid. Products of heating solids may be a highly poisonous/toxic gas.

(vi) Wash with lots of water any skin contact with chemicals immediately.Report immediately to teacher/laboratory technician any irritation,cut, burn, bruise or feelings arising from laboratory work.

(vii) Read and follow safety instruction.All experiments that evolve/producepoisonous gases should be done in the open or in a fume chamber.

(viii) Clean your laboratory work station after use.Wash your hand beforeleaving the chemistry laboratory.

(ix) In case of fire, remain calm, switch of the source of fuel-gas tap. Leavethe laboratory through the emergency door. Use fire extinguishers near the chemistry laboratory to put of medium fires. Leave strong fires wholly to professional fire fighters.

(x) Do not carry unauthorized item from a chemistry laboratory.

An apparator /apparatus are scientific tools/equipment used in performing scientific experiments.

The conventional apparator used in performing a scientific experiments is called **standard** apparator/apparatus.

If the conventional standard apparator/ apparatus is not available, an **improvised** apparator/apparatus may be used in performing a scientific experiments.

An improvised apparator/apparatus isone used in performing a scientific experiment **for** a standard apparator/apparatus.

METHODS OF SEPERATION OF MIXTURES

1. FILTRATION:

This method is used to separate a soluble component from insoluble component.

Example: ***Seperation of a mixture of sand and common salt.***

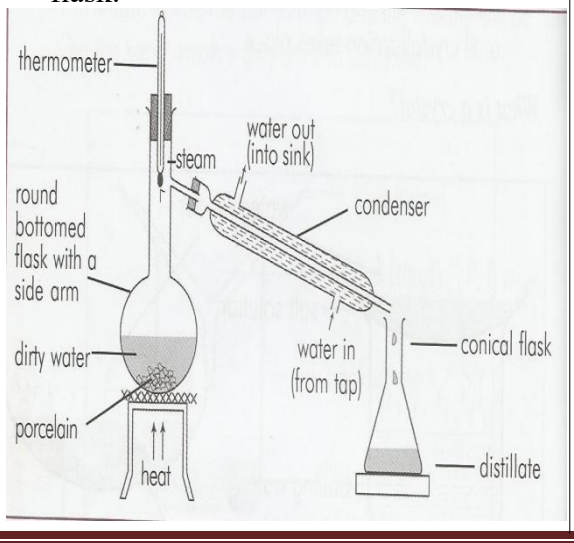
- Place a mixture of sand and salt in a beaker and add enough water to dissolve.
- Stir the mixture with stirring rod until all the salt dissolves.
- Filter the mixture and collect the filtrate(salt solution) in the evaporating dish
- Evaporate the salt solution to dryness.
- The sand remains on the filter paper as the residue.

2. DISTILLATION:

Distillation is a process of boiling a liquid to form vapour and then cooling the vapour to obtain the liquid.

Example: ***To obtain pure water from impure water***.

- Pour water into a distilling flask.
- Add sand and copper (II) sulphate to colour the water.
- Pass the water up the condenser until it flows slowly into the sink.
- Heat the flask and boil the water, the steam condenses in the condenser and collects as a distillate in a receiving flask.



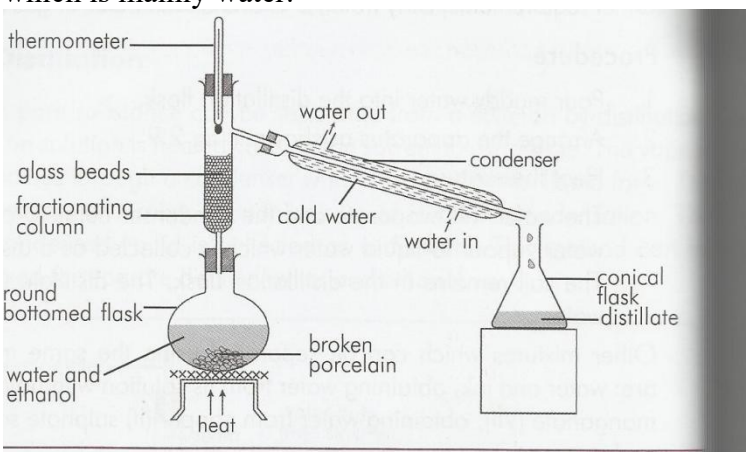
3. FRACTIONAL DISTILLATION.

Fractional distillation is the process of separating substances from a mixture by making use of the different boiling points of the substances. The distillate is collected as fractions which boil at different temperatures.

Example: ***Separating a mixture of ethanol and water***

Mix some ethanol with water and add the mixture to a distilling flask and fit the flask with a fractionating column.

Heat the mixture and collect the distillate formed until the thermometer records 82^0C. Continue heating and again collect the distillate boiling between 95^0C and 100^0C, which is mainly water.



A fractionating column provides a large cooling surface. The glass beads ensure that vapour and liquid mix well.

Application of fractional distillation.

(i) Separation of liquid air into oxygen and nitrogen.

(ii) Separation of crude oil into fractions e.g Petrol, diesel, kerosene etc.

The principle behind separation by fractional distillation is that the liquids must have different boiling points.

4. SUBLIMATION.

Sublimation is the change of state from solid to gas without passing through the liquid state.

Example.

Separating a mixture of sodium chloride and iodine.

- A mixture of iodine and sodium chloride is put in a glass beaker.
- The mixture is heated so that the iodine crystal changes to purple vapour.
- Iodine vapour condenses on cold surface forming iodine sublimate

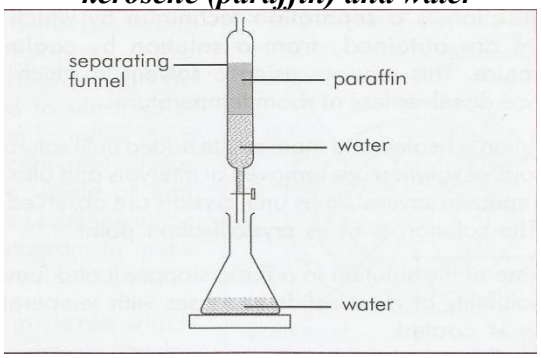
Other mixtures which can be separated by this method are:-

1. Ammonium chloride and potassium chloride
2. iron (III) chloride and sand.
3. Iodine and sand.

USE OF A SEPERATING FUNNEL

This method is used to separate immiscible liquids. Immiscible liquids are liquids which do not mix and form layers. The less dense liquid settles on top of the denser one.

Example*: Separating a mixture of kerosene (paraffin) and water*



- Pour some kerosene in a separating funnel followed by water and shake vigorously.
- Open the tap, the lower layer (water) is completely run off.
- Pour the remaining liquid (paraffin) into another container.

Other mixtures which can be separated by this method are:-

1. Petrol and water
2. Water and oil

5. USE OF A MAGNET (MAGNETISM)

This is a method of separating a magnetic substance from a non magnetic substance using a magnet.

Example: *Separation of a mixture of iron filings and sulphur*

- Put a mixture of iron fillings and sulphur in a Petri-dish.
- Pass a magnet over the mixture in a Petri dish, iron fillings are attracted to the magnet leaving behind sulphur.

Chemically the mixture of iron fillings and sulphur can be separated by use of carbon disulphide.

Sulphur dissolves in carbon disulphide leaving iron fillings to settle at the bottom. Filter the mixture to obtain iron. Warm the solution of sulphur in carbon disulphide to evaporate it and collect sulphur crystals.

6. CHROMATOGRAPHY

Chromatography means 'colour writing'. Paper chromatography is a process for separating coloured substances by using porous paper e.g. filter paper.

The substances are moved over the paper at different rates by a solvent. The components are separated into bands called a chromatogram.

Example: *Separating the solutes in ink*

- Lay a filter paper flat on the rim of an evaporating basin or small dish.
- Add one drop of ink to the centre of the paper. Wait until the ink stops spreading and then add a second drop. Wait until the ink dries, leaving a ring of coloured solutes.
- Add one drop of water (solvent) to the middle of the coloured ring. The water spreads and moves the solutes. Wait until the water is almost dry and add a second drop. Continue until a disc of coloured substance almost reaches the edge of the paper.

The dried paper with separate discs of coloured solutes obtained is called a chromatogram.

Note. The solute which has the highest solubility in the solvent travels fastest and ends up nearest to the solvent front. The least soluble solute travel slowest and ends up nearest to the original spot.

7. CRYSTALISATION.

Crystallization is a seperation technique by which crystals of a solute are obtained from a solution by cooling to room temperature e.g seperation of copper (II) sulphate from water.

8. FRACTIONAL CRYSTASTALISATION

This is a method of separating a mixture by repeated partial crystallization of the solution. The principle behind the seperation is the different solubilities of the solutes in a given solvent.

Examples of mixtures separated by this method:

1. Sodium carbonate and sodium hydrogen carbonate
2. Potassium chloride and potassium chlorate

9. EVAPORATION

This is a method used to separate a solid from a liquid in which it has dissolved e.g separating a mixture of sodium chloride and water.

10. **DECANTING**.

This method is used to separate a mixture of solid and liquid where by the solid settles on standing e.g chalk powder and water, sand and water

Exercise

1(a).What is chromatography?

(b) State the principle behind seperation of mixtures by chromatography.

2. State the method by which each of the following mixtures can be separated:

(a) Water and ethanol
(b) Water and oil
(c) Ink
(d) Sand and iodine
(e) salt and sand

SCIENTIFIC PROCEDURE

Chemistry is other science subject involves systematic ways of discovery, knowledge and solving problems.

Discovering knowledge and solving problems involves very careful investigation.

IMPORTANCE OF SCIENTIFIC PROCEDURE

> Is the guide to the mental activities and systems needed for solving the competitiveness problems.
> To minimize the influence of bias or prejudice in the experiment.
> It provides standardized approach to conduct experiment and on doing so improves theirresult.
> It is an evidence based method for acquiring knowledge.
> It trains the brain to logically examine and process all the information it receivers.

These careful investigations involve facts and verifying them.

Systematic investigation applied in chemistry includes the following steps: -

(i) Identify a problem
(ii) Hypothesis formulation
(iii) Experimentation
(iv) Observation
(v) Interpretation of data
(vi) Conclusion

(i) *Identify a problem*

This is the first step where a problem is recognized in a day life. One often comes across a question which requires explanation, such question is a problem needed to be answered by a chemist.

(ii) Hypothesis formulation

A hypothesis is a testable, assertion, statement or preposition about the relationship(s) between two or more phenomena. Hypothesis is an answer to the course of the problem that may be true or false. It is an intelligent guess to be possible answer to a problem. Sometime hypothesis can be started as an imagination that may lead either to confirmed truth or to biases about what is observed. Hypothesis comes directly from the objectives. Hypothesis formulation is done after collecting all the available information and predicting an explanation of the phenomena. Any formulated hypothesis is never accepted unless it is proved through an experiment whether it is true or false.

(iii) Experimentation

An experiment is a practical activity which makes chemistry more realistic and interesting. It makes abstract concepts to be more understandable. Experiments are done to test hypothesizes where they are true or false.

After the experiment one may decide to present the data in an essay form, graphs, histograms, table or pie charts.

(iv) Observation

To see what is happening during the experiment and write or record the results.this may be done by using sense organ of eyes, nose, tongue, ears and skin. Recording all events that you consider relevant/important.

(v) Data interpretation

Data are the actual measurements that we make. Data is the plural form of datum. The data gathered are put into categories of particular trends in order to simplify their interpretation. The data analysis helps in drawing conclusion. A person analyzing the data should be capable of reading, interpreting and explaining any trends which it shows.

(vi) Conclusion

A hypothesis will be accepted /rejected on the results obtained from the experiment. When the results of the experiment come as it was predicted, then the hypothesis will be accepted as being correct. If the experimental results do not come out as expected the hypothesis will be rejected.

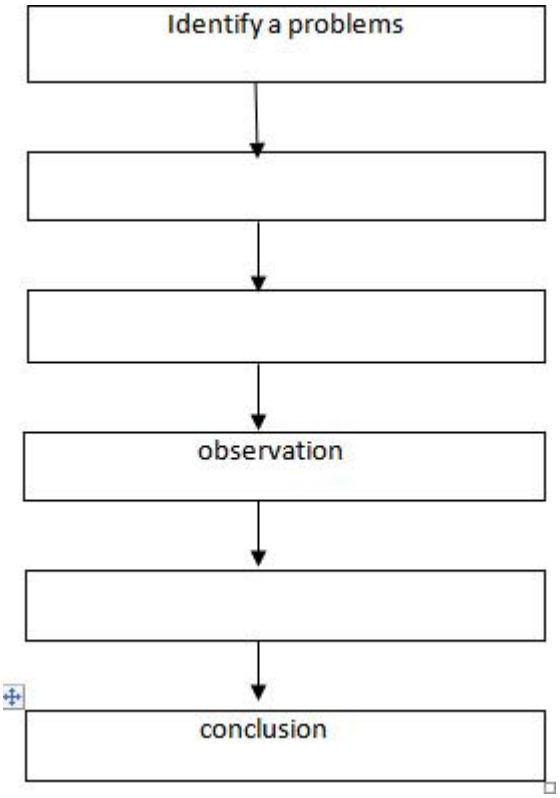
APPLICATION OF THE SCIENTIFIC PROCEDURE

The following are the common areas where the scientific procedures can be applied;

1. **When carrying out experiment**.
2. **In project work**; is a series of activities that allow the student to study, do research and act by themselves using their abilities , interests, personal experience and aptitudes.
3. **In field study**; is a collection of data that occurs outside of an experiment or laboratory setting.

REVIEW QUESTIONS

1. Fill in the boxes the missing step in the scientific procedure flow chart



2. (a) Give the importance of scientific procedures.

(b) What are the application of scientific procedures.

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