KENYA CERTIFICATE OF SECONDARY EDUCATION

TOP NOTCH CHEMISTRY

Students' Form one Notebook

Paragon of excellence

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fourth edition

This book belongs to:

Name_____

Class_____Admission number_____

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REV/CHEM/04/02/15

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CHAPTER ONE: INTRODUCTION TO CHEMISTRY

By the end of this chapter you should be able to:

- ✓ Define chemistry
- ✓ List the branches of chemistry
- ✓ Explain the properties of the three states of matter.
- ✓ Explain the role of chemistry in the society.
- ✓ State and identify the use of common laboratory apparatus.
- ✓ Observe safety in the laboratory
- ✓ Operate a Bunsen burner

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

Branches of chemistry

There are four major branches of chemistry

- ✓ Physical chemistry
- ✓ Inorganic chemistry
- ✓ Organic chemistry
- ✓ Analytical chemistry

Matter

Matter is anything that has mass and occupies space.

States of Matter

Naturally, there are basically **three** states of matter.

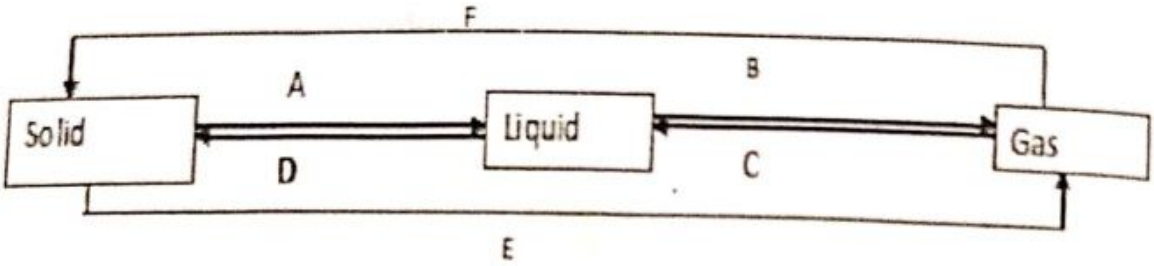
(i) **Solid**-e.g. soil, sand, copper metal, stones, vehicles.
(ii)**Liquid**-e.g. water, diesel, ethanol/alcohol, Mercury (liquid metal).
(iii) **gas**- e.g. Oxygen, Nitrogen ,Water vapour.

Properties of matter

SOLID	LIQUID	GAS
Made up of particles which are **very** closely packed.	Made up of particles which are moderately closely packed.	A gas is made up of particles which are furthest and very free from each other.
has a definite shape	Has no definite shape. It takes the shape of the container it is put	Has no definite shape.
has a definite volume	has a definite volume	Has no definite volume. It Occupies every space in a container.
Has definite mass	Has definite	Has definite mass

Interconversion of states of matter

The three states of matter are inter-convertible as shown below



Name process

A. melting/fusion
B. boiling /evaporation
C. condensation
D. freezing
E. sublimation
F. .deposition

Mixtures

Separation of mixture

- A mixture is a combination of two or more substances that can be separated by physical means. In your primary science you learned about several methods of separating mixture such as:-

a) **sorting**-this involve physically picking one pure substance from a mixture with another
   i. e. g. sorting maize from a mixture of maize and beans

b) **Decantation**-this involves pouring out a liquid from a solid-liquid mixture where the solid is insoluble in liquid. e. g. Obtaining water from a mixture of sand and water

c) **Skimming**-this involve scooping floating particles. E.g. cream from milk

Conductors and non-conductors

- **A conductor** is a substance that allows electric current to pass through.
- **A non-conductor** is a substance that does not allow electric current to pass through.

Note:

All **metals** and **graphite** are good conductors of electricity. All **non-metals** do not conduct electricity **except** carbon **graphite**

Examples of conductors are: mercury sodium, magnesium, copper, lead, Aluminium, potassium, calcium and graphite

Examples of non-conductors are: rubber, dry wood, plastics, sand

Drugs and drug abuse

A **drug** is a natural or man-made substance that when taken changes the normal body functioning
Medicine is natural or man-made substance that when taken changes the abnormal body functioning to normal.
Medicines must be taken on **prescription** and **dosage**.

A prescription is a written medical instruction from a qualified medical officer /pharmacist to a patient on the correct **type** of medicine to take and **period** between one intake to the other.

A dosage is the correct **quantity** of a drug required

Treatment Is the changing of abnormal body function back to normal after of intake prescribed dosage. 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 to the sick use medical language.

Example

2 x 4; means the 2 represents the quantity of medicine while 4 represents the number of times the drug should be taken in 24 hours. To get the time interval just take 24 hours divided by the number of times e.g $\frac{24}{4} = 6hours$

.Some drugs need minimal prescription and thus are available without pharmacist/ doctor's prescription. They are called **Over the Counter** (OTC) drugs. OTC drugs used to treat mild headaches, stomach upsets, common cold and include:

i. Painkillers
ii. Anti acids
iii. cold/flu drugs.

Types of drugs

- **Sedatives** –drugs that are used to suppress anxiety and relax muscles
- **Antibiotics**- drugs used to treat bacterial infections
- **Tranguilizers** is **a drug that has a sedative or calming effect without** inducing sleep.
- **Anesthetics** –these are drugs that produces a complete or partial loss of feeling especially during surgery.

Drug abuse

Drug abuse is use of a drug for any other purpose other than what it is intended for or overdose/under dose.

Some drugs that induce a false feeling of wellbeing are **illegal.** They include heroin, cocaine, bhang, mandrax and morphine.

Some abused drugs which are **not illegal** include: miraa, alcohol, tobacco, sleeping pills.

Drug dependency is a condition where one cannot function without using that drug

Harmful effects of drug abuse

- Taking of drugs like heroin and cocaine causes hallucination
- Depression
- Excessive use of drugs can lead drug dependency and addiction
- Smoking of tobacco causes lung cancer, discolours teeth
- Taking alcohol cause liver damage (liver cirrhosis)

The role of chemistry in society

(a) Chemistry is used in the following:

1. **Entry into careers**

The following career fields require Chemistry as one of subject areas of advanced/specialized study:

- Engineering
- Medicine
- Body therapy
- Education

- ❖ Pharmacy
- ❖ Food technology

2. **In manufacturing** :

I. In manufacture of chemicals e.g. soap, salt,, body oils, cooking oil ,ammonia , fertilizers, sulphuric (VI) acid.
I. Manufacture of drugs to fight diseases e.g. Antibiotics
II. Food production to fight hunger
III. Baking: Adding baking powder to dough and then heating in an oven involves interactions that require understanding of chemistry.
IV. Medicine: Discovery, test ,prescription and dosage of drugs to be used for medicinal purposes require advanced understanding of chemistry
V. Fractional distillation of crude oil: Crude oil is fractionally distilled to useful portions like petrol, diesel, and kerosene by applying chemistry.
VI. Manufacture of synthetic fabrics eg.nylon ,polyester and teflon

NB: in chemistry substances are called **chemicals** and people who work with chemicals are called **chemists**

The School Chemistry Laboratory

Chemistry is studied mainly in a science room called a school **chemistry laboratory**.

Laboratory is a special science room where experiments are carried out. It is also where chemicals and apparatus are kept.

Essentials of a good laboratory

- It should be spacious for easy movement.
- Should be well ventilated for easy circulation of air
- It should have a working fume cupboard where experiments emitting poisonous gases are carried out.
- It should be well lit for clear observations of the reactions.

Necessity of laboratory safety rules

- ✓ To avoid accidents and injuries during practical experiments in the laboratory.
- ✓ To avoid damage to and breakage of apparatus and laboratory fittings.
- ✓ To avoid wastage of laboratory chemicals

***Common school chemistry laboratory chemicals include*:**

(i) Distilled water

(ii)Concentrated mineral acids which are very corrosive (on contact with skin they cause painful open wounds)

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

(iv)Very many types of salts

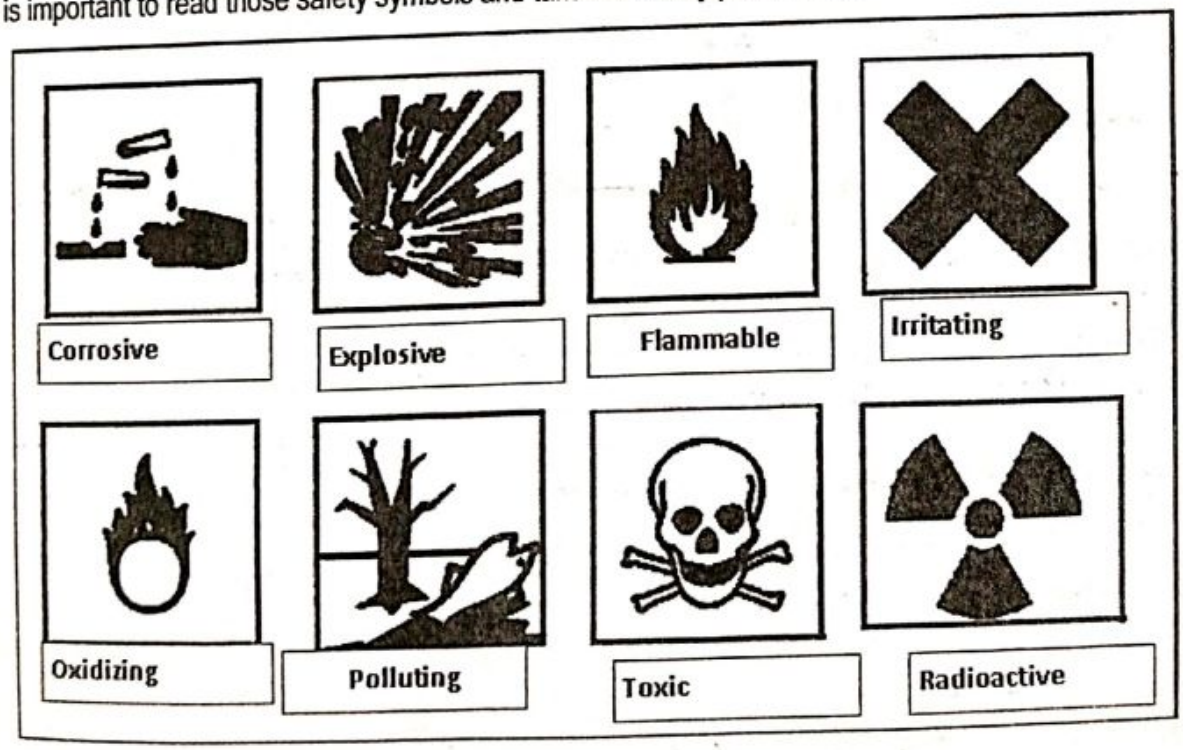
Safety guideline rules in the chemistry laboratory.

i. You should never run when you are in a laboratory because you may trip, fall and injure yourself or others.
ii. Do not try unauthorized experiments. They may produce flammable, explosive or toxic substances that affect your health.
iii. Do not taste or eat any chemical in the laboratory. They may be poisonous.

iv. Waft gas fumes to your nose with your palm. Do not smell gases directly. They may be highly poisonous
v. Boil substances with mouth of the test tube facing away from others and yourself. Boiling liquids spurt out portions of the hot liquid. Products of heating solids may be a highly poisonous gas
vi. In case a chemical gets on your skin or in your mouth rinse it immediately with lots of clean water
vii. Report immediately to teacher/laboratory technician any irritation, cut, burn, bruise or feelings arising from laboratory work.
viii. Read and follow safety instruction to avoid accidents or poison
ix. Clean your laboratory work station after use. Wash your hand before leaving the chemistry laboratory.
x. In case of fire, remain calm, switch off the source of fuel-gas tap. Leave the laboratory through the emergency door. Use fire extinguishers near the chemistry laboratory to put out medium fires. Leave strong fires wholly to professional fire fighters.
xi. Do not carry unauthorized item from a chemistry laboratory.
xii. Experiments in which poisonous gases are produced must be carried out in a fume chamber
xiii. Always keep flammable substances away from flames because they easily catch fire.
xiv. Always put off flames that are not in use to avoid accidents and minimize fuel wastage
xv. Always hold test-tubes or boiling tubes using test-tube holder when heating to avoid being burned.
xvi. Always work on a clean bench
xvii. Label all chemicals to avoid confusion
xviii. Always use a clean spatula to scoop substances to avoid contamination.

Laboratory safety /hazard signs

Laboratory chemicals have safety symbols which helps to know the harmful effects of the chemicals. It is important to read those safety symbols and take necessary precautions.



Apparatus used in chemistry.

- **Apparatus** are scientific equipment used by chemists in performing scientific experiments. They are made of metal, wood, plastic or glass.
- Most standard apparatus in a school chemistry laboratory are made of **glass** because:
  - *Glass is more transparent and thus reactions /interactions inside are clearly visible from outside*
  - *Glass is comparatively unreactive to many chemicals.*
  - *Glass has high melting and boiling points hence can withstand high temperature when heating.*

Disadvantages of glass apparatus

-They have high chances of breakage in cases they fall during experiments.

- ✓ *They are comparatively expensive compared to plastic.*

nb: Some materials like beakers, syringes, measuring cylinders may however be made of plastic.

Advantages of plastic apparatus

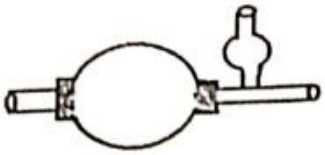
- ✓ *Have low chances of breaking*
- ✓ *They are relatively cheaper to buy compared to glass.*

Disadvantages of plastic apparatus

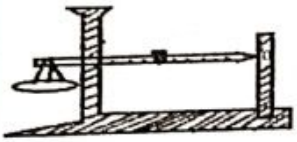
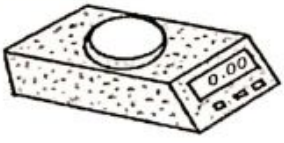
- ✓ *Plastic tend to react with some laboratory chemicals.*
- ✓ *May not be transparent and hence reactions cannot be easily observed as they progress.*
- ✓ *They cannot be used in heating experiments*
- Metallic apparatus are not widely used because most of them react widely with chemicals.
- Apparatus are designed for the purpose they are intended in a school chemistry laboratory:

(a)Apparatus for measuring volume

Name	diagram	Use
Measuring cylinder		Measuring cylinders are apparatus used to measure **approximate** volume of liquid/ solutions. They are calibrated/ graduated to measure any volume required to the maximum. Measuring cylinders are named according to the maximum calibrated/graduated volume e.g. 10ml, 50ml, 100ml etc
Burette		Burette is a long and narrow apparatus used to measure **accurate** but different volumes of a liquid solution.
Pipette		Pipette is a long and narrow apparatus that widens at the middle used to measure and transfer **small and very accurate** and **fixed volumes** of a liquid

		solution
Pipette filler		Pipette filler is used to suck in a liquid solution into a pipette instead of using the mouth..
Volumetric flask.		A volumetric flask is thin /narrow but widens at the base/bottom. It is used to measure **very accurate and fixed** volumes of a liquid solution.
Syringe		used to measure **small and accurate** volumes of liquids and gases
Graduated beakers		used to measure different approximate volumes also used to boil liquid substances

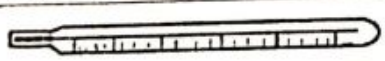
(b) Apparatus for measuring mass

Name	diagram	Use
Beam balance		A beam balance has a pan where a substance of unknown mass is placed. The scales on the opposite end are adjusted to "balance" with the mass of the unknown substance. It is used to measure mass in grams.
Electronic/electric balance.		To measure accurate and smaller masses in grams

Other apparatus for measuring mass :

Spring balance

(c)Apparatus for measuring temperature

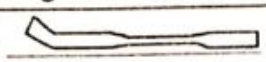
Name	diagram	Use
Thermometer		A **thermometer** has alcohol or mercury trapped in a bulb with a thin enclosed outlet for the alcohol/mercury in the bulb.it is used to

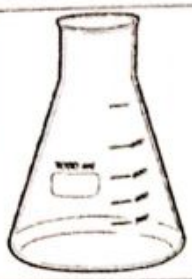
		measure temperature during experiments.

(d)Apparatus for measuring time

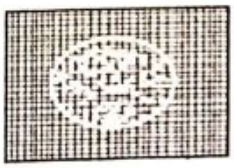
Name	diagram	Use
stop watch/clock		It is the standard apparatus for measuring time during experiments. Time is measured using hours, minutes and second.

(e) Apparatus for scooping

Name	diagram	Use
1. Spatula		- A spatula is used to **scoop** solids substance from containers.
2. Deflagrating spoon		- A deflagrating spoon is used to **scoop** solids which do not require accurate measurement and for holding substances being heated. - Used for holding burning substances.
Apparatus for holding substances		
Test tube.		- A test tube is used to hold liquids or solid during experiments - It can also be used for heating solids in the laboratory.
Boiling/ignition tube.		A boiling/ignition tube is wider and bigger than a test tube. Used to hold substances when being heated.

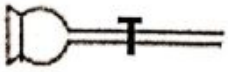
Conical flask.		-Conical flasks thus hold exact volumes of liquids that have been measured using other apparatus. The narrow mouth ensures no spillage during swirling. -it is used for general laboratory experiment.
Round bottomed flask		Used for heating liquid substances, it ensures, it ensures **even distribution of heat hence prevent cracking of the flak.**
Flat bottomed flask		Used for general laboratory experiments.

(f) Apparatus for holding unstable apparatus (during heating).

Tripod stand		A tripod stand is a three legged metallic apparatus which unstable apparatus are placed on (during heating).Beakers. Conical flasks, round bottomed flask and flat bottomed flasks are placed on top of tripod stand.
Wire gauze/mesh		: (i) Ensure even distribution of heat to prevent cracking glass apparatus (ii) Hold smaller apparatus that cannot reach the edges of tripod stand
Pipe clay Trial-angle		Supporting crucibles during heating
Clamp and stand		A clamp stand is a metallic apparatus which tightly hold apparatus at their "neck" firmly. A clamp stand has a wide metallic base that ensures maximum stability. The height and position of clamping is variable. This require practice
Test tube holder		A test tube holder is a hand held metallic apparatus which tightly hold test/boiling/ignition tube at their "neck" firmly on the other end. Some test tube holders have wooden handle that prevent heat conduction to the hand during heating.

Pair of tong.		A pair of tong is a scissor-like hand held metallic apparatus which tightly hold firmly a small solid sample on the other end. *It is used to safely hold corrosive or hot solids*

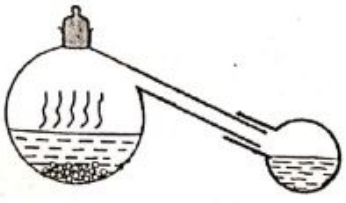
(h) Apparatus for holding/directing liquid solutions/funnels (to avoid spillage).

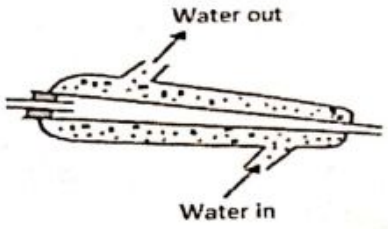
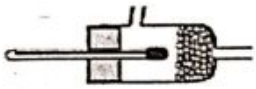
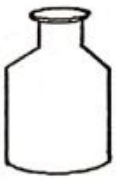
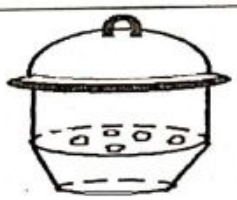
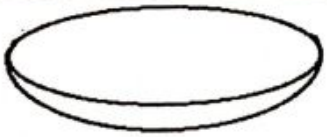
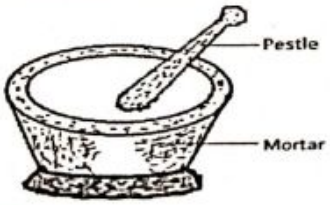
Filter funnel .		Used to direct liquid solutions safely through the wide mouth of the filter funnel into other apparatus without spillage. Filter funnel is also used to place a filter paper during filtration.
Thistle funnel		Used to carefully deliver liquid substances into reaction vessel during reactions.
Dropping funnel		Used to add controlled amount of liquids into reaction vessel
Separating funnel		It is used to separate immiscible liquids

Apparatus used to add liquids drop wise to reaction vessels

Eye dropper bottle		used to add substances into a solution drop wise
Dropper/teat pipette		used to deliver liquids drop wise

Other apparatus

Retort flask		used to prepare nitric (V) acid

Liebig condenser		Used to condense vapours into liquid in distillation
Fractionating column		To allow the liquid with higher boiling point to condense and flow back to the flask if it vaporizes before its boiling point.
Wash bottle		used for rinsing vessels with narrow necks
Reagent bottle		used for storing bench reagents
Crucible		used for heating substances that require strong heating
Desiccators		used for drying or keeping substances dry
Evaporating dish		used when evaporating liquids
Mortar and pestle		used for crushing substances
Test-tube rack		used for holding boiling tubes and test tubes

. Gas jar		A gas jar is a long wide glass apparatus with a wide base. It is open on one end. It is used to collect/put gases.

Apparatus for heating/Burners

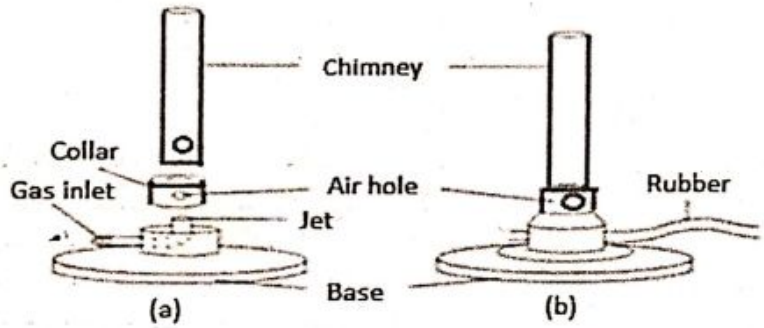
Some apparatus that can be used for heating are:

a. Bunsen burner
b. Portable burner/gas stove
c. Candle
d. spirit burner
e. kerosene stove

Bunsen burner

The Bunsen burner is the **standard** apparatus for heating in a Chemistry school laboratory.

Diagram of a Bunsen burner



Functions of Different Parts of a Bunsen Burner

a. **Base plate** –wide and heavy to provides support for the Bunsen burner to stand on its own
b. **Jet**-a hole through which laboratory gas enters the chimney.
c. **Collar**- It controls the amount of air entering the chimney used during burning.
d. **Air hole in the chimney;** an opening that allow air to enter and mix with the laboratory gas from the jet.
e. **Chimney**- allows air to mix with the laboratory gas from the jet. The mixture of gases when ignited burn to produce a flame.
f. **Gas inlet**-allows laboratory gas from cylinder in the laboratory through the gas taps into the Bunsen burner.

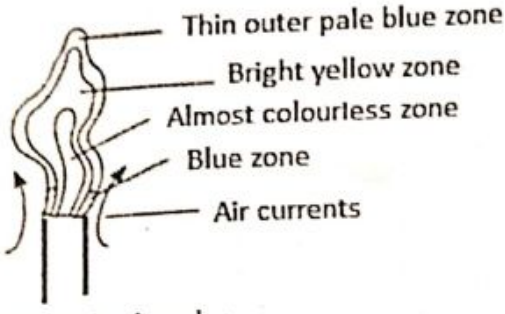
Procedure for lighting/igniting a Bunsen burner

a. Adjust the collar to ensure the air holes are closed.
b. Connect the burner to the gas tap using rubber tubing. Ensure the rubber tubing has no side leaks.
c. Turn on the gas tap and immediately Ignite the top of the chimney using a lighted match stick/gas lighter/wooden splint.

Bunsen burner flames

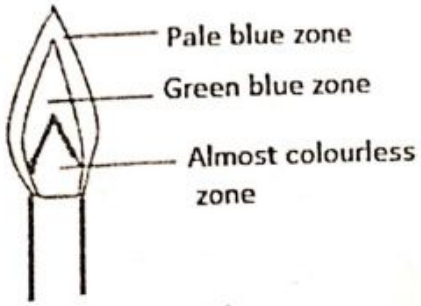
- **A flame** is a mass of burning gases to produce heat or light.

- A Bunsen burner produces two types of flames depending on the amount of air entering through the air holes.
- If the air holes are **fully open**, a **non luminous** flame is produced. If the air hole is **fully closed**, a **luminous flame** is produced.
- The outermost region is the hottest region due to complete combustion of air.
- The innermost region is the least hot as it contains unburnt gases



(a) Air hole closed

Luminous flame



(b) Air hole opened

non-Luminous flame

Characteristic differences between luminous and non-luminous flame

Luminous	*non-luminous*
Sooty	Not sooty
Quiet	Noisy/roaring sound
Has four regions	Has three regions
Moderate hot	Very hot
Does not burn back/No striking back	Burns back sometimes/ Striking back(sometimes)
Large and unsteady	Small and steady
yellow	Blue

If the air holes are partially opened or closed, the hybrid of non-luminous and luminous flame is produced.

NB; burning/striking/sucking back is the name given to a phenomenon where the flame goes down the chimney and goes off. It happens when the gas is being burnt faster than can be supplied.

Advantages of non-luminous flame

- ✓ Gives out a lot of heat hence very efficient in heating.
- ✓ It does not form soot hence it leaves apparatus clean even after experiments.

Disadvantages of non-luminous flame

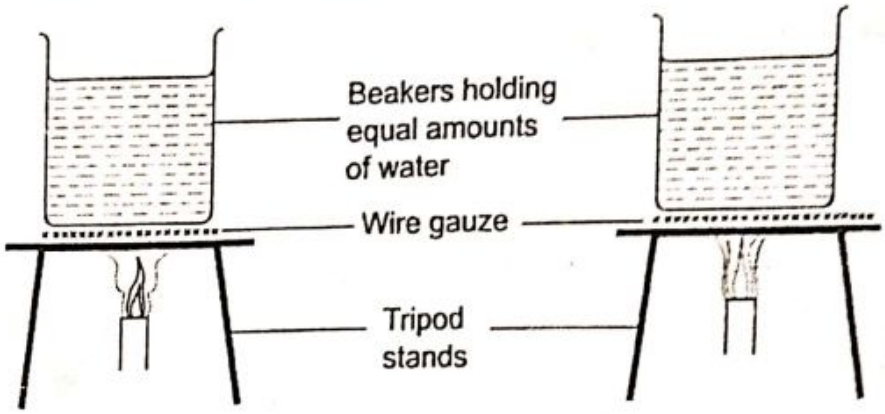
- ✓ It uses a lot of laboratory gas in burning.
- ✓ Cannot be used for lighting purposes since it produces very little light.

Experiments on a Bunsen burner flame

(a)To investigate the Heating Effects of the luminous and Non-Luminous Flame

Procedure

Pour 30cm^3 of water into a 100ml glass beaker and heat using the nonluminous flame. Record the time taken for the water to boil. Repeat the procedure using a luminous flame.



Water being heated using a luminous flame

Water being heated using a non-luminous flame

Observations

-water heated by non-luminous flame took a shorter time to boil than the one heated by luminous flame.
-the beaker heated by luminous flame was covered with soot while the one heated by non-luminous flame was clean.

Explanation

The non-luminous flame is hotter than luminous flame, hence boils the water faster.
Incomplete combustion of luminous flame. Leads to production of carbon particles which when hot glow yellow and on cooling forms black soot on the beakers.
Incomplete combustion in a non-luminous flame leads to production of carbon (IV) oxide and steam only, hence no soot formation.

Conclusion

- ✓ The non luminous flame is hotter than luminous flame.
- ✓ The non-luminous flame is cleaner than the luminous flame.

The non-luminous flame is preferably used for heating because;

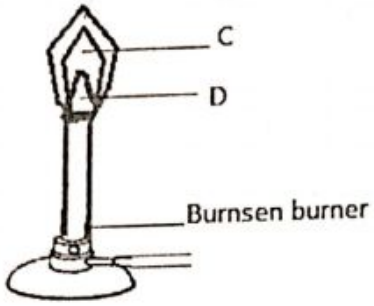
- ✓ It produces a lot of heat.
- ✓ It does not produce soot

Sample questions:

- ***What is the first aid in case of a burn by an acid in the laboratory?***
  - ✓ *Wash the burnt part with a lot of cold water.*
- ***State five laboratory rules.***
  - ✓ *Inflammable substances should be kept away from flames.*
  - ✓ *Flames that are not in use should be put off.*
  - ✓ *You should always hold tubes using test-tube holder while heating.*
  - ✓ *All chemicals should be labeled to avoid confusion.*
  - ✓ *You should never taste or eat anything in the laboratory.*
  - ✓ *You should always consult your teacher before trying anything new.*

- **State career opportunities in chemistry**
  - ✓ Pharmacist
  - ✓ Chemistry teacher
  - ✓ Hospital nurses
  - ✓ Analytical chemistry
  - ✓ Biochemistry
  - ✓ Medical doctors.

- **The diagram below shows a Bunsen burner when in use.**



- **Name the region labelled C and D.**
  C – Green blue zone D- Almost colourless zone
- **Which region is hotter than the other?**

Green blue is hotter due to complete combustion of gases

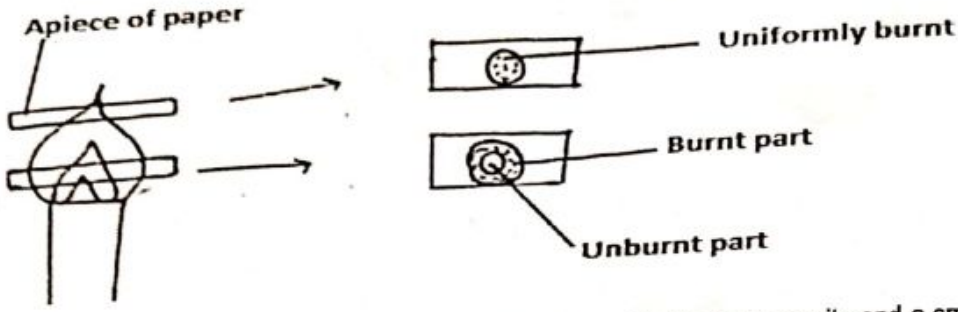
- **Why luminous flame burn with of yellow flame?**
  - ✓ It consist of partially burnt tiny particles of white hot carbon which give out bright yellow light

  N:B it is sooty due to presence of unburnt carbon particles which are black on cooling
- **Why is it advisable to turn non- luminous flame into luminous flame when not in use**
  - ✓ Luminous burns less than non-luminous hence less fuel used
  - ✓ Non-luminous flame is less visible due to its blue colour while luminous flame is large and brightly coloured which makes more visible and hence reduce fire accidents in the lab.
- **How can the hotness of a Bunsen burner be increased?**
  - ✓ By opening the air holes more
- **Why luminous flame is not used for heating?**
  - ✓ It is less hot
  - ✓ It produces soot
- **Uses of flame.**
  a. Luminous is usually used for lightning because it produces much light
  b. Non-luminous is used for heating because is very hot and does not produce soot

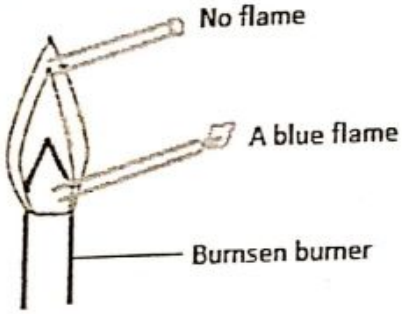
(b) to investigate the hottest part of a non luminous flame

- **Describe an experiment to show that the almost colorless region comprise of unburt gases using glass tube, sheet of paper or a match stick.**

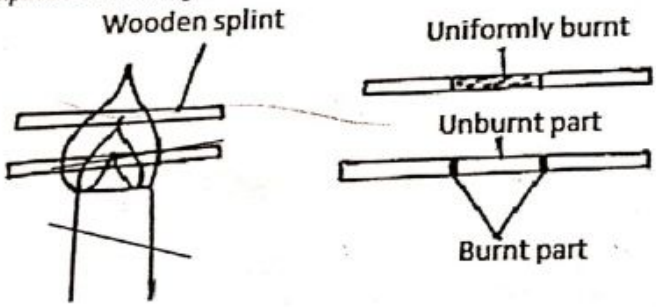
I. Slip a piece of paper/wooden splint through the non-luminous flame to be in contact with the inner most region, the central part in contact with the innermost region remain unburnt. Nb if the sheet of paper is placed at the outermost region it will burn uniformly



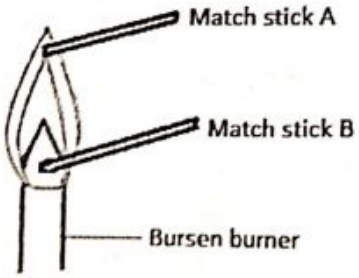
II. Insert a glass tube into the almost colourless region and ignite it at opposite end a small flame will be produced at the opposite end indicating that the almost colourless region comprise of unburnt gases



III. Slip a piece of wooden splint through the non-luminous flame to be in contact with the innermost region,the central part remain unburnt while the outer part is burnt indicating that the almost colourless region comprise of unburnt gases

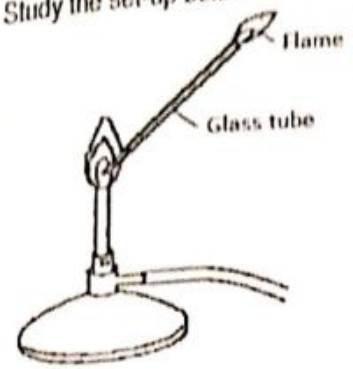


IV. Insert a matchstick to the almost colourless region point B, it will not ignite indicating that the almost colourless region comprise of unburnt gases, but if the matchstick is raised to then outer region, point A it ignites immediately



REVISION QUESTIONS

1. Study the set-up below and answer the questions that follow;



(a) What does the experiment demonstrate? (1mark)

(b) When is this type of Bunsen burner flame produced? (1mark)

2. (a) What is a drug?(1mk)

(b) Give two drugs that are commonly abused by the youth. (2marks)

3. The diagrams below are some common laboratory apparatus. Name each appáratus and State its use

Diagram	Name	Use
	(½mk)	(½mk)
	(½mk)	(½mk)

4. a) Define the term Chemistry. (1mark)

b) Name three major branches of chemistry (3marks)

5. Study the figure below and answer the questions that follow.

a) What name is given to the above type of flame? (1mark)

b) Indicate in the diagram the hottest region. (1mark)

c) Label the part of the flame that contains unburnt gases. (1mark)

6. State two reasons why most apparatus in the chemistry laboratory are made of glass. (2marks)

7 a) what is matter? (1mark)

b) Name the three states of matter? (3mks)

c) Draw the following apparatus (4 mks)

Beaker

Conical flask

Dropping funnel

Round bottomed flask

8. Write five careers related to chemistry (5mks)

i)

ii)

iii)

iv

v)

9. Which apparatus would you use to carry out the following? (6mks)

a) Measure accurate volume

b) Storing bench solutions and liquids

c) Heating solid substances that required strong heating

d) Separating immiscible liquids

e) Delivering liquids carefully into vessels

f) Adding controlled amounts of liquid into reaction vessels.

10. a)Name the structure in which experiments that produce poisonous gases are carried out. (1mk)

b) Why is this structure preferred?

(1mk)

11. State the differences between a luminous flame and a non-luminous flame. (5mks)

Non – luminous flame	Luminous flame
(i)	
(ii)	
(iii)	
(iv)	
(v)	

12. What action would you take in the following circumstances while in the laboratory doing experiments

a) A chemical accidentally spills on your hands. (1mk)

b) A fire outbreak during an experiment. (2mks)

13. List three harmful effects of drug abuse. (3mks)

14. Write down three differences between solids and gases in the table below.

Solids	Gases

15. Explain why does a luminous flame (2mks)
a. produce yellow light?

b.Produces more light than non-luminous flame

16. After use, a non-luminous flame should be put off or adjusted to a luminous flame. Explain. (1mk)

17. Name any other two apparatus that can be used for heating purposes in the laboratory apart from the Bunsen burner. (2mks).

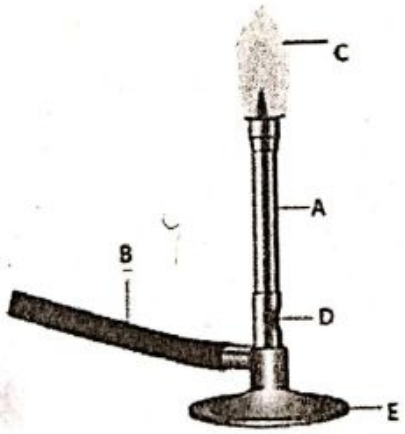
18. What do the following laboratory signs mean? (3 marks)

(a)

(b)

(c)

19. Study the following parts of a Bunsen burner.



a) Name the parts labeled A- E (5 mks)

A.	B.
C.	D.
E.	

b) State the functions of the parts labeled A,D and E (3 mks)

A_____

D_____

E_____

c) Define the term "strike back" as applied to a Bunsen burner. (1mk)

20. How can the hotness of a Bunsen burner be increased (2 mks)

21. Name two apparatus used for: (4mks)

a. Accurate measurement of volume

b. Accurate and fixed volume

c. Accurate but different measurement of volume

d. To measure different and approximate volume

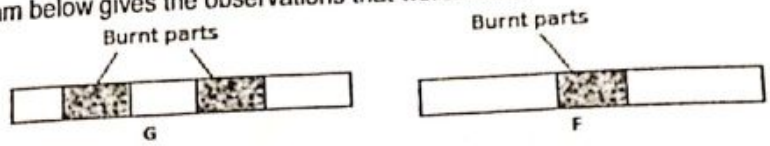
22 .Explain why luminous flame is sooty (2mk)

23. Name two apparatus used for accurate and specific measurement of volume. (2mk)

24. Name three apparatus used for delivering liquids carefully into vessels. (3mk)

25. State any four laboratory rules (4 marks)

26. Wooden splints F and G were placed in different zones of a Bunsen burner flame.
The diagram below gives the observations that were made

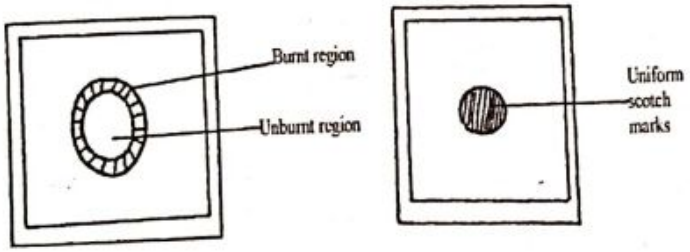


(a) Explain the difference between F and G (4marks)

27. (a) When the air-hole is fully opened, the Bunsen burner produces a non-luminous flame. Explain (1mk)

(b) Draw a labeled diagram of a non-luminous flame (4mks)

28. The diagram below shows the appearance of two pieces of paper placed in different parts of a Non-luminous flame of a Bunsen burner and removed quickly before the caught fire.



(a) What do the experiments show about the outer region of the flame? (1mk)

(b) From the above experiment, which part of the flame is better to use for heating? Give a reason (2mks)

29. Name the standard apparatus for measuring time. (1mk)

30. Distinguish between conductors and non-conductors of electricity giving two examples of each. (2mk)

31. State the uses of the following apparatus found in the laboratory. (2mks)

i. Pipette

ii. Boiling tube.

32. Describe an experiment that indicates that a Bunsen burner flame contains unburnt gases. (5marks)

33. Give four properties of a flame produced when an air hole of a Bunsen burner is closed. (4marks)

34. State three safety rules that a student should adhere when heating a substance in the laboratory. (3marks)

35. Name the apparatus used in the following: (3marks)

a) Measuring temperature of a mixture.

b) Burning solids in air.

c) Scooping solids in a container.

36. Draw a diagram of a Bunsen burner and label all the parts. (5marks)

(i) Which type of flame is preferred for heating substances in the laboratory? (1mark)

ii) Give two reasons why the above type of flame is preferred. (1mark)

37. What are the following drugs used for? (3marks)

i) Antibiotics _____

ii) Anaesthetic _____

iii) Antiseptic _____

38. State two properties of
(a) A solid - (2 marks)

(b) Liquids (2 marks)

39. List three scientific skills that can be acquired when performing chemistry experiments. (3mks)

40. Draw the following apparatus in the spaces provided.
Burette (I mark) Round bottomed flask (I mark)

Conical flask (1 mark)

Thermometer (1 mark)

Teat pipette (dropper) (1mark)

Gas jar (1 mark)

41. What is the use of the following apparatus?

(a) Test tube rack-

(b) Wash bottle -

(c) Spatula -

(d) Test tube holder-

(e) Pipette -

42. Mention five areas where the knowledge in chemistry is applied in our country (5 marks)

43. After use, a non-luminous flame should be put off or adjusted to a luminous flame. Explain. (1mk)

44. A Bunsen burner can produce two different types of flames under different conditions.

(a) Identify the most suitable Bunsen burner flame for heating in the laboratory (1mk)

(b) Give three reasons for your answer in (a) above. (3mks)

(c) Mention two main parts of a Bunsen burner (2mks)

45. a) Give two reasons why it is necessary to follow doctor's prescription when taking Medication (2mks).

b). Name the functions of the following parts of a Bunsen burner. (3mks).

i). Collar –

ii). Air hole-

iii). Base-

c). Name any other two apparatus that can be used for heating purposes in the laboratory apart from the Bunsen burner. (2mks).

46. Fill the table below.(4mks).

	APPARATUS	USES
I	Separating funnel	
Ii		Used to hold water for rinsing of vessels
Iii	Pestle and mortar	
Iv		Used for supporting test-tubes

47. Name any TWO industries that have benefited from the knowledge of chemistry. {2 marks}

48. Differentiate between Over the Counter (OTC) drugs and Prescription Drugs. {1 mark}

49. Mr. Rudisha went to a doctor who sent him to a pharmacy to pick some drugs. The pharmacist wrote on the medicine packaging 2X3.

a. Clearly state what 2X3 meant. (1mark)

b. State two reasons why it is important to adhere to the doctor's prescription (2 marks)

50. Define the following terms; (2marks)

(i) Medicine

(ii) Drug dependency

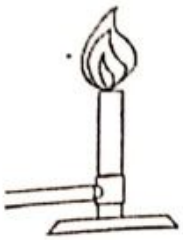
51. a) Name two apparatus used in a laboratory that are made up of plastic (2mks)

b) State two advantages of plastic apparatus (2mks)

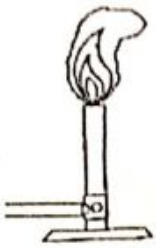
c) State two disadvantages of plastic apparatus (2mks)

52. Explain why some test tube holders have wooden handle (1mks)

53. The diagram below represents the flames of a Bunsen burner . use the diagrams to answer the questions that follow



Flame A



Flame B

i. Name flame (2mks)

A

B

ii.How can flame A be converted to flame B (1mk)

iii. State the difference between flame A and flame B (1mk)

54. Name and state the use of the following apparatus

A

B

C

D

CHAPTER TWO: SIMPLE CLASSIFICATION OF SUBSTANCES

Classification is the grouping of substances according to their physical properties.

Separation of mixtures

Substances are either pure or impure.

- ✓ A **pure** substance is one which contains only one substance.
- ✓ An **impure** substance is one which contains two or more substances. A **pure** substance is made up of a pure solid, liquid or gas.
- ✓ A **mixture** is a combination of two or more pure substances which can be separated by physical means. The three states of matter in nature appear mainly as mixtures of one with the other.

Types of mixtures

- A mixture must be made from at least two parts or components. They include:

1. Solid – solid mixture
2. Liquid – solid mixture
3. Liquid - liquid mixture
4. Gas- gas mixture

Basic concepts

- ***Solute***- a substance that dissolves in a liquid e.g. salt, glucose and sugar.
- ***Solvent***- the liquid in which a solute dissolve e.g. water.
- ***Solution***-the resulting uniform mixture of solute and solvent.e.g salt and water.
- ***Filtrate***-liquid that passes past the filter paper during filtration
- ***Solvent***-the liquid in which a solute dissolves.
- ***Saturated solution***- a solution in which no more solute can dissolve at a particular temperature.
- ***Crystallization***-process whereby crystals are formed from a hot saturated solution as it cools down.
- ***Miscible liquids***-liquids that can mix together completely. To form one layer.
- ***Immiscible liquids***-liquids that cannot mix together completely.

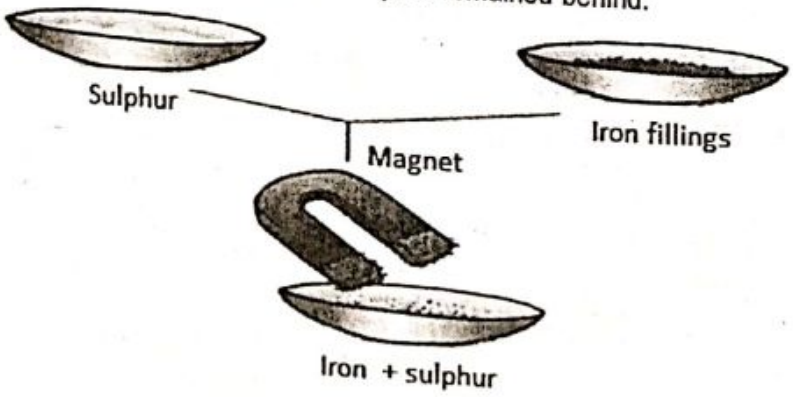
Methods of separating mixtures

Mixtures can be separated from applying the following methods: it is important to note that the differences in physical properties of substances in a mixture determine the method of separation.

1. Separation of Solid-Solid Mixture

a. Magnetic Separation

- Used to separate a mixture of solids whereby one of the solid is magnetic while the other solid is not e.g. iron fillings and sulphur, in this method a magnet is passed through the mixture, the iron sticks on the magnetic and the sulphur remained behind.

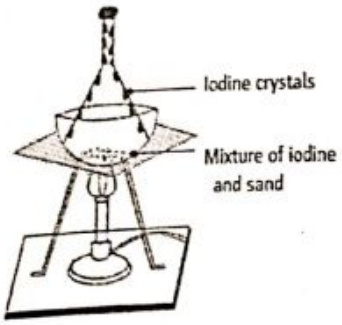


Application of magnetic separation

- ✓ In recycling plants e.g. used to separate scrap iron from other materials such as plastic and other nonmagnetic metals.
- ✓ In iron mining to separate magnetic iron ore from other materials in the crushed ore.

Sublimation

- This is the process by which a solid changes to a gas directly without passing through the liquid state.
- This method is used to separate a mixture of substances where one of the substances sublimes - e.g. a mixture of **salt and iodine** – the mixture is heated in a closed container or a container covered with evaporating dish with cold water. Where iodine sublimes forming a purple vapour which cools to form dark grey crystals of iodine leaving behind a white solid of sodium chloride.



Ammonium chloride undergoes thermal dissociation to form ammonia gas and hydrogen chloride gas which on cooling, the products of heated ammonium chloride recombine together to form the original substance. This process is called **thermal dissociation**. However, iodine sublimes when heated but it does not dissociate so the principle of sublimation can be used to separate a mixture containing ammonium chloride

During separation of mixure using sublimation mixture is heated a glass beaker covered with an evaporating dish containing cold water. The substance that sublimes will collect collects underneath the cold surface of the evaporating dish while the other component is left in the beaker. Scrap off the sublimate and place it in a different beaker.

Substances that sublime

- ✓ Iron (III) chloride
- ✓ Aluminium chloride
- ✓ Benzoic acid
- ✓ Dry ice (solid carbon (IV) oxide)
- ✓ iodine

Sublimation of iodine

- ♦ Solid iodine forms purple vapour, which **cools and deposits** on the colder part of the boiling tube to form a sublimate of pure iodine

Application of sublimation

Dry ice is used in cold boxes by ice cream vendors. It is preferred over ordinary ice *because it sublimes hence does not cause dampness/wetness and it is also a better coolant*

Sample questions

1. Describe how solid iron (III) chloride can be separated from a solid mixture of iron (III) chloride and anhydrous calcium chloride

Since iron (III) chloride sublimes but calcium chloride ***does not, sublimation process would do. Heat the Mixture in a container*** covered with evaporating dish with cold water, ***iron (III) chloride sublimes into vapour and collects/ gets deposited on the upper cooler parts of the test tube.*** ***$CaCl_2$ remains at the bottom of the heating tube***

2. Describe how Aluminium chloride can be separated from a mixture of Aluminium chloride and sodium chloride

Heat the mixture container covered with evaporating dish with cold water **Aluminum chloride sublime and collect be cooler part of the tube and sodium chloride left at bottom of the tube. Scratch the $AlCl_3$ and place it in a beaker**

3. Given a mixture of lead (II) oxide, Iron (III) Chloride and sodium chloride, describe how this mixture can be separated to obtain a sample of each

Heat the mixture Iron (III) Chloride sublimes and is collected on the cooler parts. Add water to the remaining mixture, stir and filter. Lead (II) Oxide remains as residue. Heat the filtrate to dryness to obtain sodium chloride.

4. State and explain the observations made when iodine crystals is heated in a boiling tube?

- Black crystals changes directly into purple vapour√1

- The iodine crystals (sublimes) changed directly into a purple vapour without passing liquid state and changed back to black iodine crystals on the upper cooler parts of boiling tube√ (Correct colour must be stated 2mks)

2. Separation of Solid –Liquid Mixture

There are two types of solid - liquid mixtures

i. **Soluble solid - liquid mixtures;** in this category, the solid dissolves in liquid. This mixture can be separated using the following methods. Evaporation, crystallization, simple distillation.

Separation of solid-liquid mixture where solid is soluble.eg

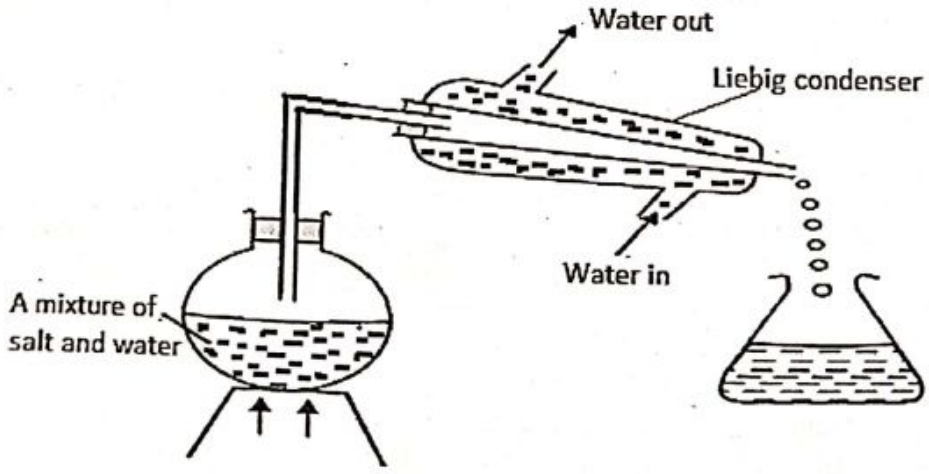
Describe how a solution of sodium chloride can be separated to obtain both the solvent (water) and the solute (sodium chloride)

This mixture can be separated by simple distillation using the set up below

The mixture is heated where the water (solvent) evaporates and is cooled by the liebigs condenser to form liquid water which is collected as filtrate. The sodium chloride is left left in the round bottomed flask.

Simple distillation,

- Method used to separate a mixture of solute and solvent.
- It is mainly used for purification of liquids containing dissolved substances.
- It is also useful in separating two miscible liquids with widely differing boiling points.
- The simple distillation diagram is shown below



The ***Liebig condenser*** is used to condense the vapours to liquid.

Note that the **water in** the lower part of condenser while the **water out** is on the upper part, this ensures there is **efficient condensation**

Application of simple distillation.

- ✓ Production of distilled water.
- ✓ Production of bottled pure water
- ✓ Desalinization of sea water to obtain pure water.
- ✓ Manufacture of wines and spirits.

ii. **Insoluble solid- liquid mixture;** in this category the solid does not dissolve in the liquid. This mixture can be separated using the following methods .Decantation , filtration

a.Filtration

Used to separate a mixture of soluble and insoluble solids/ a liquid and insoluble solid e.g. sand and water, lead (II) sulphate and sodium sulphate.it uses a filter paper with tiny pores through which liquid molecules can pass easily but solid particles cannot. The liquid that passes through the filter paper is called a **filtrate** while the solid that remains on the filter is called a **residue.**

The method involves three processes i.e.;

- Dissolving
- filtration
- evaporation

In case the mixture contains two solids where one is soluble, water is first added to the mixture followed by filtration e.g.

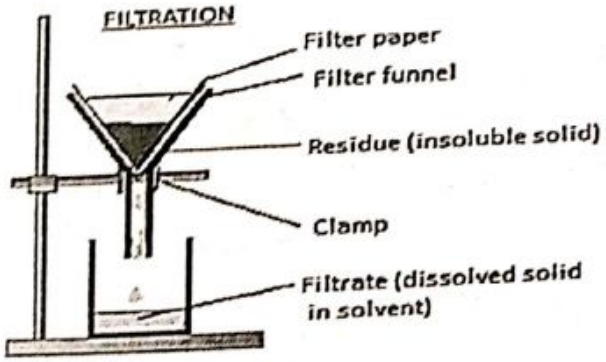
- ✓ When told to describe how to separate a mixture containing soluble and insoluble substance

Always start by adding distilled water to the mixture and stir, x dissolve, y does not dissolve, filter to obtain Y as residue, X solution as filtrate, evaporate the filtrate to saturation and allow it to cool for crystals to grow.

E.g. Describe how a mixture of sand and common salt are separated.

Add water to the mixture and stir, common salt dissolves while sand does not dissolve, filter to obtain sand as residue and common salt solution as filtrate, evaporate the filtrate to saturation and allow it to cool to crystallize.

NB; In the above question both filtration and evaporation are used to separate sand and salt

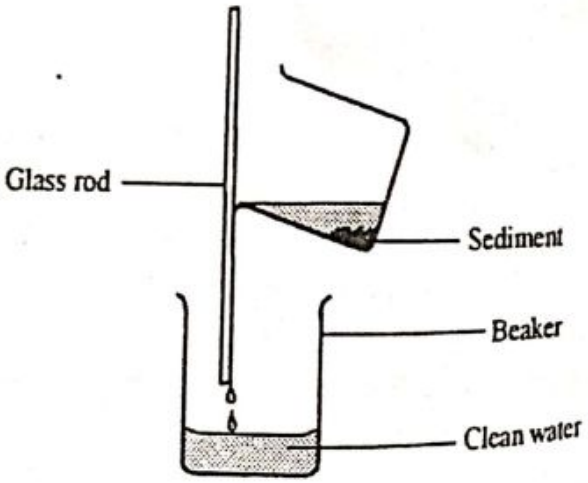


Application of filtration

- ✓ Large scale water purification to remove suspended solid particles from dirty water
- ✓ Also used in domestic water filters

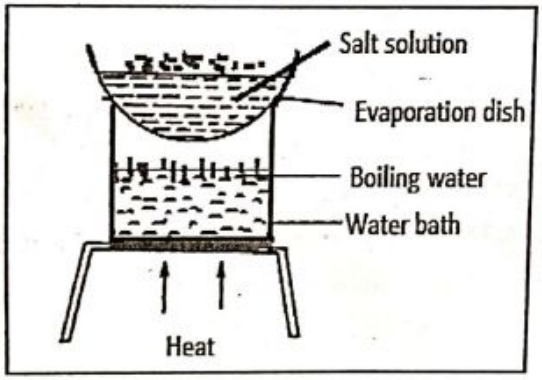
b. Decantation

An insoluble solid can be separated from a liquid by allowing the mixture to settle, and then carefully pouring off the solution into another container. This is called decantation. This is not an efficient method of separation because some solid comes out along with the solution.



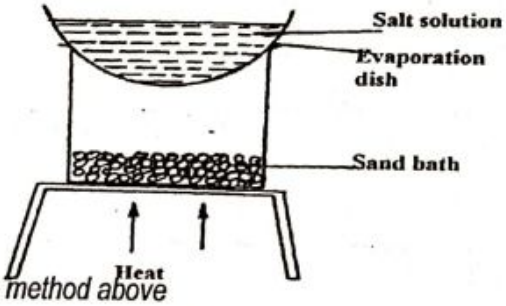
c. Evaporation

This method is used when you want to obtain a solute from a solution e.g. salt from sodium chloride solution. In this method the mixture is heated to evaporate the solvent and the solute is left as a residue. The evaporating dish is heated using a water birth so that the salt does not spit out of the basin as heating continues. This process is used to obtain salt from sea water.



Sample questions.

1. A form 1 student carried out the separation as shown in the set-up below: -



(i) Identify the method above

Evaporation

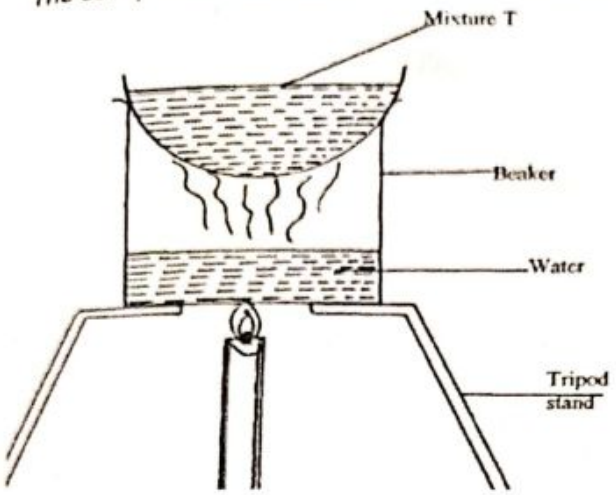
*(ii) Give **one** of its disadvantages*

- ✓ ***Only one of the components in a mixture is recovered as one of the substances vaporizes and is lost to the atmosphere.***

(iii)Name a mixture which can be separated by the set-up above

✓ ***Any soluble salt and water***

2 *The set-up below was used to separate a mixture: -*



(a) Name the apparatus missing in the set-up

✓ ***Wire gauze***

(b) Give one example of mixture T

✓ ***Sodium chloride solution (or any named soluble salt solution)***

(c) What is the name of this method of separation?

✓ ***Evaporation***

d.Crystallization

This is method used to obtain solute from a solution; the solution heated to evaporate water and form a saturated solution and then allowed to cool to form crystals.

E.g. used to obtain copper (II) sulphate crystals from copper (II) sulphate solution

Solution that contains a maximum amount of solute at a particular temperature is called a **saturated solution**. **Crystallization** is the process of obtaining crystals from a saturated solution.

Solute is the substance usually a solid that is dissolved in a solvent usually water.

✓ ***Fractional crystallization***

Is the method used to obtain two different solutes with different solubility from the same solution e.g. to separate sodium chloride and trona from the sea.e,g L. Magadi

What makes it possible to separate substances through this method?

✓ *Difference in solubility of the salts at different temperatures*

Application of crystallization

- ✓ *Extraction of salt from salty water lake Magadi and Ngomeni in Malindi*
- ✓ *Extraction of sugar from sugar cane*
- ✓ *Extraction of medicinal substances*

3.Liquid –liquid mixtures.

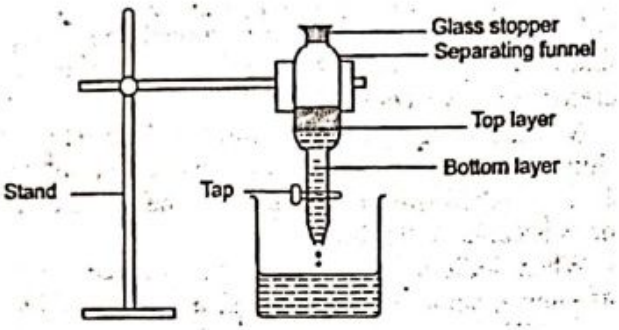
There are two categories;

I. **Immiscible liquids-** they do not mix. They form distinct layers. Example kerosene and water. They can be separated using a separating funnel,(use of a dropper, decantation- not efficient and inaccurate.)

II. **Miscible liquid** -they mix to form a homogenous solution .example water and milk. They can be separated through fractional distillation.

a. **Use of a separating funnel.**

Separating funnel is used to separate immiscible liquids which form two or more layers when put in the funnel,
This method is made possible due **to difference in densities of the liquids** e.g a mixture of paraffin and water -paraffin floats on water because it is less dense than water



How to separate a mixture of paraffin and water .The Stopper should be removed. Add the ,mixure of paraffin and water into the funnel,water forms bottom the layer and paraffin top layer.open the tap and draw out the bottom layer ,discard the interphase layer .paraffin remain the funnel

What makes it possible to separate substances through this method?

- ✓ *Difference in densities of the solutions*
- ✓ *Immiscibility of the liquids*

Application of separating funnel

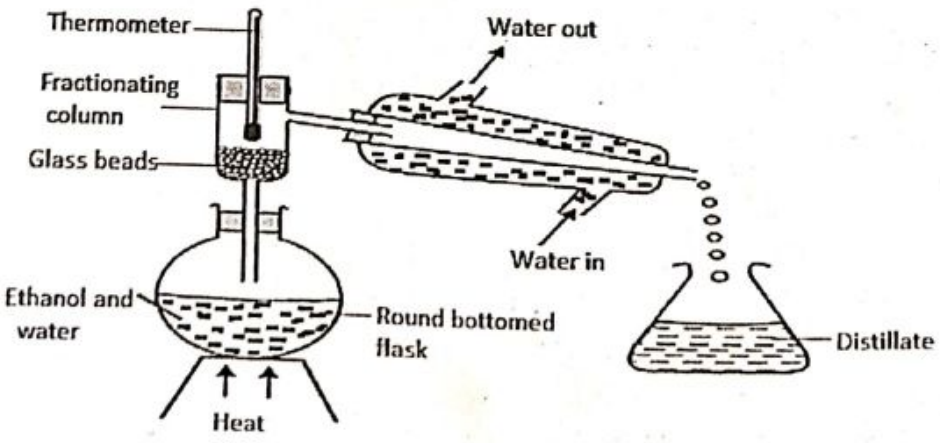
Extracting of useful substances from complex mixtures.

Distillation

- is normally a method to separate miscible liquid due to their difference in their boiling point
- There are two types of distillation. simple distillation and fractional distillation

Fractional distillation

- is used to separate miscible liquid with very close boiling point, the fractional distillation apparatus are similar to that of simple distillation but are modified to include, a **fractionating column** to enable vapour liquid with a higher boiling point to condense and flow back to the flask and Glass **beads** which are put in the fractionating column **increase the surface area for condensation.**
- the diagram below is used to separate ethanol boiling point (78°C) and water boiling point (100°)
- When the mixture is heated ,ethanol having a lower boiling point vaporizes first, rising to the top of fractionating column , it is then condensed in the Liebig's condenser and collected as a distillate



What makes it possible to separate substances through this method?

✓ Difference in the boiling point of the substances

The efficiency of fractional distillation so as to get purer components can also be done by:

- Increasing the length of fractionating column
- Making the fractionating column narrower
- Using more glass beads in the fractionating column

Precaution:

- Collection of fraction should be done in conical flasks or a narrow mouthed containers other than in a beaker to reduce the rate of evaporation of fraction especially the highly volatile ones.
- The thermometer bulb must be at the vapour outlet of the condenser.

Application of fractional distillation.

i. Obtaining nitrogen and oxygen from liquefied air in British oxygen company,(BOC)
ii. used in crude oil refinery at changamwe Mombasa
iii. Recycling of used oil in Athi river and kikuyu town
iv. Manufacture of wines and spirits

Other methods of separating mixture

❖ **Solvent Extraction**

- it a method used to extract a solute from its original solvent by using a second solvent in which it has a higher solubility.
- **e.g.** to obtain oil from ground nuts, simsim seeds etc. separation through this method is made possible due *difference in solubility of the substance*
- Solvent extraction can be used to *obtain oil from groundnuts/oil* from *coconut/oil* from *simsim seeds/elianto oil from maize seeds etc*
- Achieved by crushing a sample of nuts in a mortar with a pestle and then addition of a solvent e.g propanone(acetone).
- *The nuts are crushed in order to increase the surface area for extraction of oil. The resultant mixture is decanted to obtain oil- propanone mixture which is then exposed in the sun for propanone to evaporate.*

Procedure

- Crush the ground nuts in a mortar using a pestle; add propanone to dissolve the oil, filter and evaporate the filtrate using solar energy, propanone being more volatile will evaporate first leaving the oil behind.

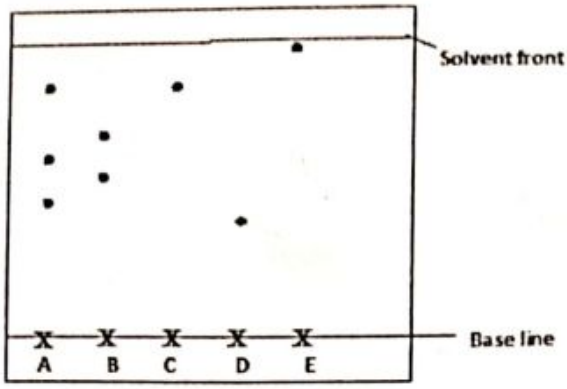
Application of solvent extraction

(a) Extraction of Natural dyes from plants
(b) Extraction of oil from nuts and seeds
(c) Extraction of some herbal medicines from plants
(d) Extraction of Caffeine from tea and coffee
(e) In dry cleaning to remove dirt/stains.

Separation of coloured mixture

Chromatography

- This is a method used to separate a mixture of coloured substances with different solubilities on a moving solvent(eluting solvent) e.g. a mixture of dyes; this method is made possible due to **difference in stickiness** of the dyes and **difference in solubility in the solvent.**
- The study of colours is called **chromatology. Chromatogram** is a visible record showing results of separating the components of a mixture by chromatography.



- ***What makes it possible to separate substances through this method?***
- *Difference in stickiness/viscosity of substances*
- *Difference in solubility on a moving solvent*
- *Difference in densities*
- ***Points to note about chromatography***
- Most soluble dye moves the furthest distance
- Least soluble dye moves the least distance
- Most sticky moves the least distance while the less sticky moves the furthest
- Pure substance makes only one spot in the chromatogram
- Identical substances will move equidistance from the base line
- Insoluble dye does not make any spot on the chromatogram paper
- The no of spots indicates the number of substances in the mixture
- Pure substance will make only one spot on the chromatogram
- Most dense moves the least distance

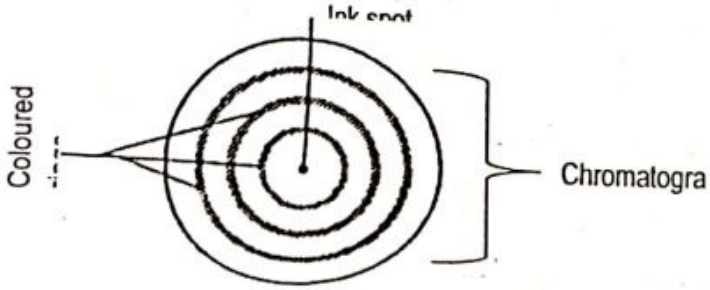
Basic concepts

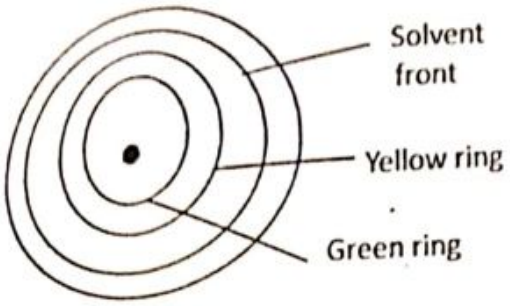
- **Solvent front**-the furthest distance reached by the eluting solvent.
- **Base line**-the point at which the dye to be separated is placed
- **Solubility**-the tendency of a substance to dissolve in a solvent.
- **adsorption**-the tendency of a substance to stick on an adsorbent material

Separation of coloured pigments in green leaves:

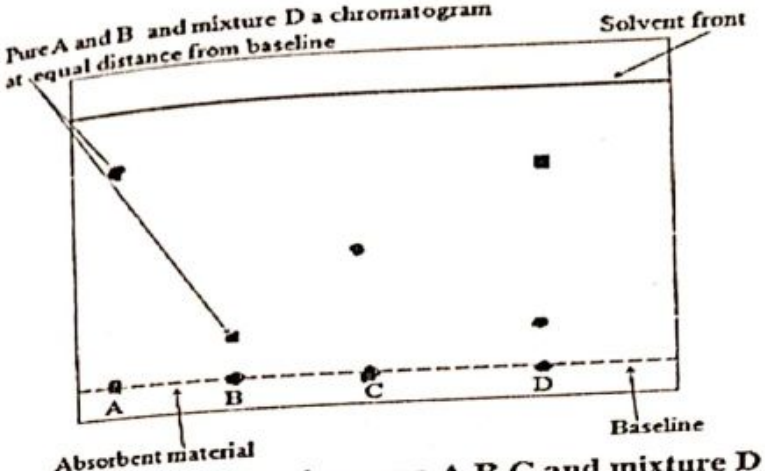
Procedure

Crush some green leaves in a mortar using a pestle. Add the solvent (propanone) as you continue crushing. Decant the extract in a clean beaker. Using a dropper, place one drop of the extract in the middle of a filter paper, leave the drop to dry and place another one on the same spot. Repeat this for the third drop. Using a clean dropper, add the solvent drop wise on the same spot each time allowing the solvent to spread.allow it to dry and make a diagram of the filter paper showing your results.





Two rings are observed. The yellow ring is due to xanthophyl's and green ring is due to chlorophyl. The xanthophyl is more soluble and less sticky so it moves the furthest distance than the chlorophyl.
The different rings can be cut off and put in a suitable solvent to obtain the colour from the chromatogram.
The solvent front is the furthest point reached by the solvent on the chromatogram.



Chromatogram showing pure A,B,C and mixture D

Note; D is a mixture of A and B

Applications of chromatography-

- In sports chromatography is used to identify use of banned substances e.g steroids in urine samples
- In food industry to identify contaminants in food and drinks
- In the cosmetic industry to identify harmful substances
- As a locating agent
- As an analyzation technique in both pharmacy and medicine to test purity of drugs.

NB: The physical properties of the components of the mixture determine the method of separation.

mixture	*Physical properties of the components*	*Examples*	*Method of separation*
Solid –solid mixture	Solid -solid one component sublimes	Sand and iodine	**Sublimation**
	Solid -solid one component is magnetic	Sulphur and iron fillings	**Use of magnet**
	Solid -solid one component is soluble and the other insoluble in water	Sand and salt	**Dissolve, filter then evaporate**
Liquid - solid mixture	The solid is soluble in the solvent	Salt and water/ sugar and water	**Crystallization/evaporation/ simple distillation**
	Two solids both soluble in the solvent	Sodium Chloride, Sodium Chlorate and Water	**Fractional crystallization**
	The solid is insoluble in the solvent	Sand and water	**Filtration**

Liquid-liquid mixture	Immiscible liquids	Paraffin and water	**Use of separating funnel**
	Miscible liquids	Water and ethanol	**Fractional distillation**
Gas –gas mixture	Gases have diff boiling points	Oxygen and nitrogen	**Fractional distillation of liquefied mixture**
Mix of coloured substances	The substances have different densities, solubility on moving solvent and difference in stickiness	Mixture of coloured dyes	**Paper chromatography**

Sample questions

1. *What makes it possible to separate substances through fractional crystallization?*
   - ✓ ***Difference in solubility of the substances and volatility***
2. *(i)What is solvent extraction?*
   - ***it a method used to extract a solute from its original solvent by using a second solvent in which it has a higher solubility.***

(ii)Why is propanone used as a solvent and not water?

- ✓ ***This is because oil dissolves in propanone but do not dissolve in water.***

(iii)Why is the solution left in sun?

- ✓ ***So that propanone can evaporate leaving oil behind. Oil having a higher boiling point than the solvent is left in the evaporating dish.***

3. *The table below shows liquids that are miscible and those that are immiscible*

Liquid	L_3	L_4
L_1	Miscible	Miscible
L_2	Miscible	Immiscible

Use the information given in the table to answer that questions that follow;

i) Name the method that can be used to separate L_1 and L_2 from a mixture of the two

- ✓ ***Fractional distillation***

ii) Describe how a mixture of L_2 and L_4 can be separated

Separating funnel method

Since the two liquids are immiscible pour the mixture into the separating funnel and allow settling. The denser liquid will settle down and the less dense one will form the second layer on top. Open the tap and run out the liquid in the bottom layer discard the interphase leaving the second layer in the separating funnel.

4. *Study the information below and answer the questions that follow:*

Solid	Cold water	Hot water
R	Soluble	Soluble
V	Insoluble	Soluble
S	Insoluble	Insoluble

*Describe how the mixture of solid **R, S,** and **V** can be separated*

Add cold water to the mixture, and stir to dissolve R. Filter to get solid S and V as residue. Heat the filtrate to evaporate to get R. Put the residue in hot water and stir to dissolve V and filter to get S as residue, Heat the filtrate to evaporate to get V

5. Study the information below and answer the following questions. A mixture contains three Solids **A, B,** and **C**. The solubility of these solids in different liquids is as shown below:-

Solid	Water	Alcohol	Ether
A	Soluble	Insoluble	Insoluble
B	Insoluble	Soluble	Very soluble
C	Soluble	Soluble	Insoluble

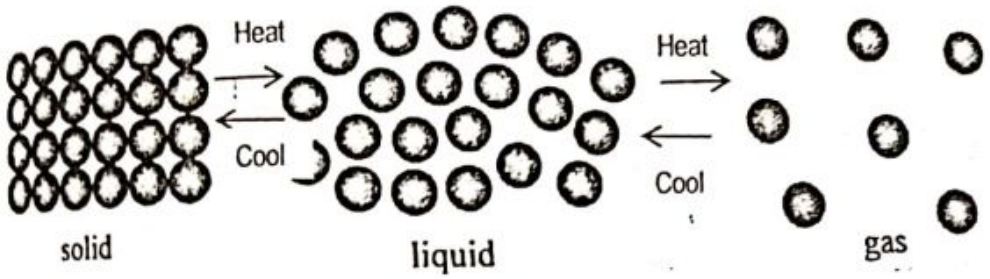
Explain how you will obtain sample **C** from the mixture

- **Add ether to the mixture. Stir and filter**
- **Add alcohol to the residue, stir and filter**
- **Evaporate the filtrate to obtain C**

Kinetic theory of matter

Its states that matter is made up of particles that are in continuous motion.

Theoretical model of matter



Particles are closely packed and held in fixed positions.

Particles are not closely packed they have a degree of freedom

Particles are widely apart. They move independently

- ✓ When a solid is heated, the kinetic energy of the particles increases and they begin to vibrate more vigorously. At certain fixed temperature **(melting point),** the forces holding the particles are weakened enough to allow the particles to change from solid state to liquid state.
- ✓ When a liquid is heated the particles move more rapidly as the forces of attraction are further weakened. The weakening continues until the particles gain enough energy to overcome the forces of attraction between them. At this point the temperature remains constant as the pure liquid boils.**(Boiling point).** The particles break free and enter the gaseous state.
- ✓ When a gas is cooled. the particles lose kinetic energy, slow down and easily attract each other to form a liquid. This process is known as **condensation.**
- ✓ When a liquid is cooled the kinetic energy of particles continue to decrease as particles take up fixed positions as the liquid solidifies through a process known as **freezing**

Effect of Heat on Substances

- Substances found in nature are made of matter.
- **Matter** *is anything that has mass and occupies space, matter exists in three interchangeable states;* ***solid, liquid and gas***
- It is classified into solids, liquids and gases

The following experiments illustrates illustrate what happens when ice is heated

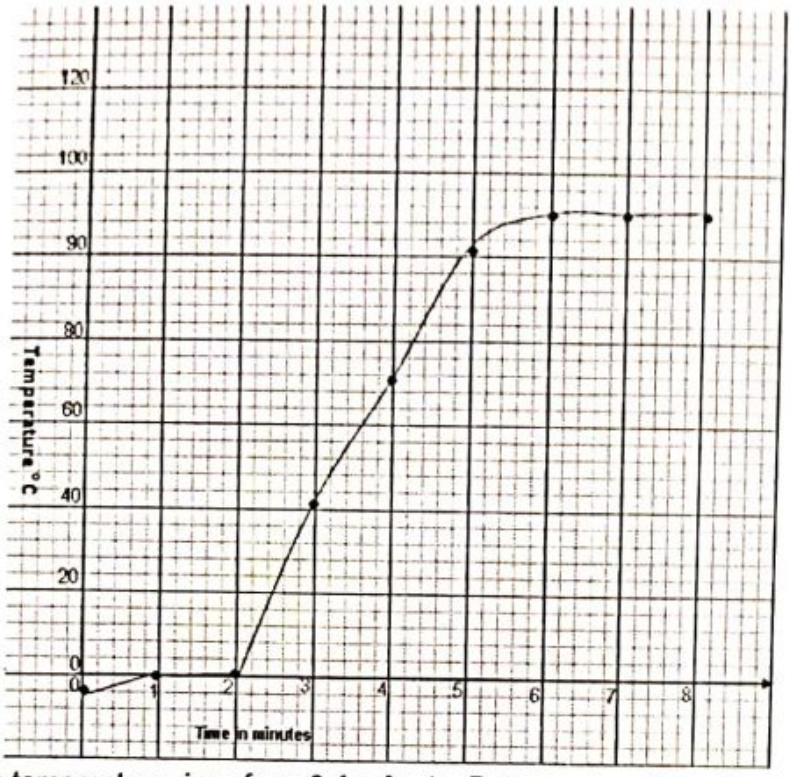
(a) *Heating ice*

- ❖ Place about 10g of pure ice in a beaker. Determine its temperature. Record it at time "0.0" in the table below. Heat the ice on a strong Bunsen flame and determine its temperature after every 60seconds/1minute to complete the table below:

Time/minutes	0	1	2	3	4	5	6	7	8

Temperature (°C)	-4.0	0.0	0.0	40.0	70.0	90.0	95.0	95.0	96.0

Plot a graph of Temperature (y-axes) against time.



The temperature rises from **0-1 minute**. Between **1 and 2 minutes** the temperature remains constant. This is because the ice is melting.

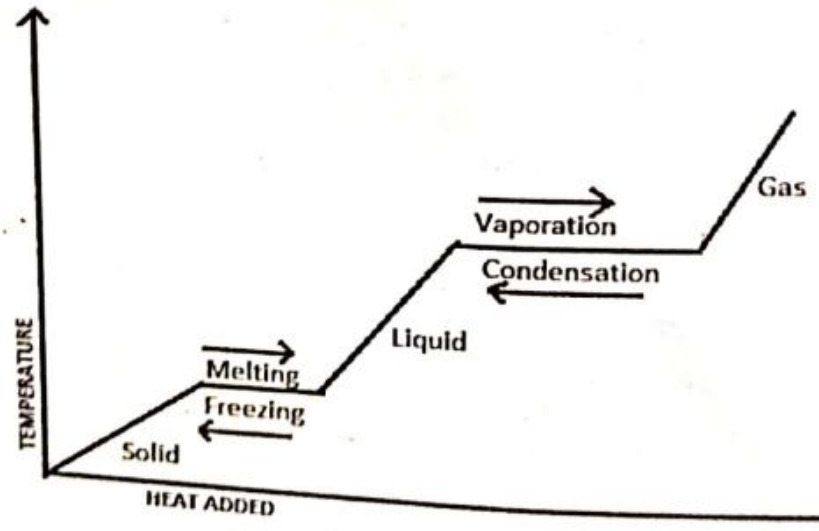
Melting point of a pure substance is a fixed or a constant temperature at which a solid changes into a liquid.

The temperature continues to rise steadily after **2 minutes** until the **6th minute**. This is due to increase in kinetic energy of the liquid particles.

Between **6th and 8th minute** the temperature remains constant. This is the boiling point.

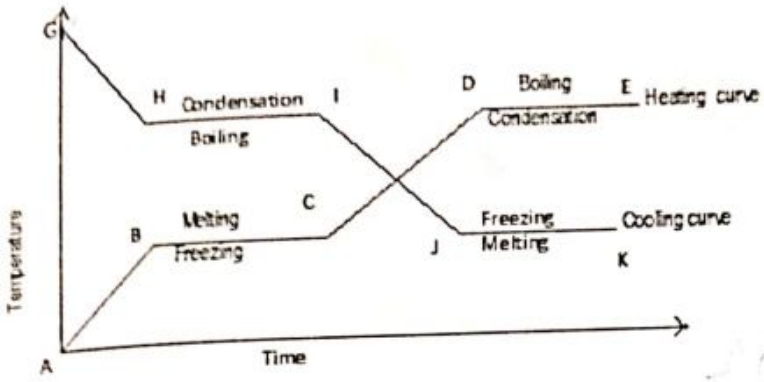
The **boiling point** of a substance is the fixed/ constant temperature at which a liquid changes in to a gas.

The curve obtained when substance is heated is called **heating curve** and the curve obtained when substance is cooled is called **cooling curve**



Heating and cooling curve.

Experiment- heating naphthalene



Discussion

Region AB- temperature increases steadily as the naphthalene absorbs heat energy. The heat absorbed increases the kinetic energy of the particles and they vibrate more vigorously.

Region BC-temperature remains constant until all naphthalene melts. This is because heat energy absorbed is used to weaken the bonds holding the particles of naphthalene together. Therefore, there is change of state from solid to liquid.

Region CD- temperature rises steadily as the liquid absorbs heat energy. The heat supplied increases further kinetic energy of the particles causing them to move faster. The rise stops at boiling point.

Region DE- temperature remains constant though heating goes on. This is because heat energy is used to break bonds to change liquid into vapour.

The change of state from solid to liquid and liquid to gas can be reversed by cooling. During cooling the gas condenses into liquid and finally liquid freezes into a soli

Define melting point and the boiling point

- ✓ *Melting point is the constant temperature at which the solid changes to Liquid*
- ✓ *Boiling point is the constant temperature at which a liquid changes to a gas*

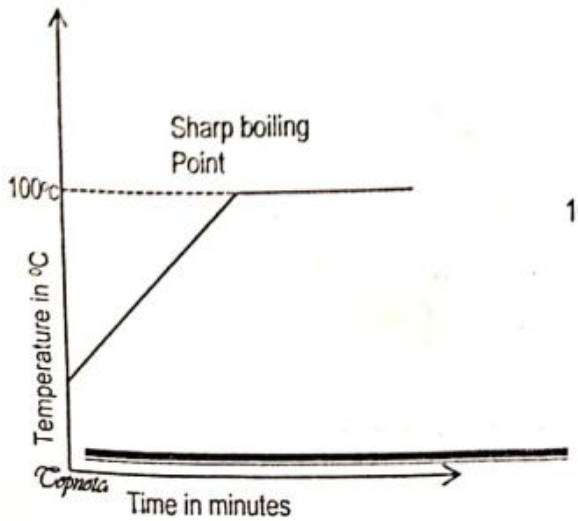
How do impurities affect the Melting Point and Boiling Point?

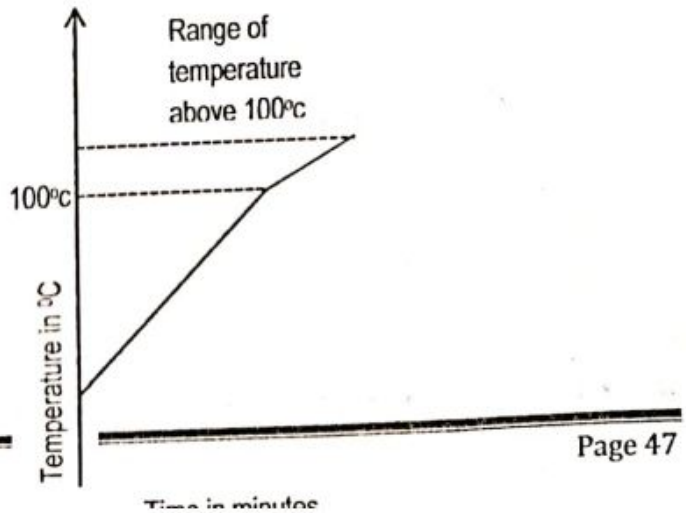
- ✓ *Impurities lower Melting Point and increase the Boiling Point*
- ✓ *Pure substance has a sharp transition temperature (Boiling Point and Melting Point)*

Sample question;

You are provided with two samples of water, pure sample and impure sample how can you differentiate the two?

- ✓ *Heat the samples. Pure water will boil at 100°c at sea level while impure water will boil at a range of temperature above 100°c at sea level*



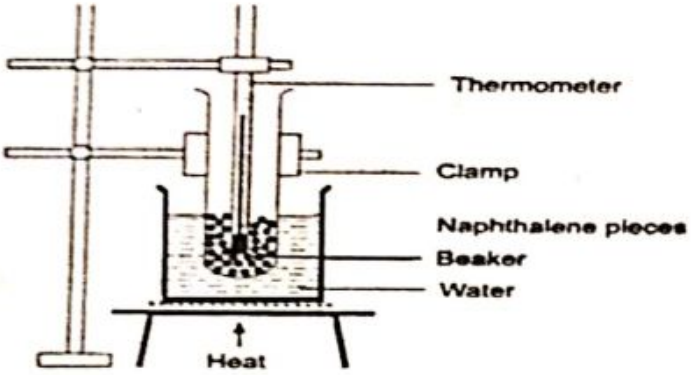


Application of effect of impurities on the Melting Point and Boiling Point

- ✓ *Salt is sprayed on roads to defrost and clear ice in temperate* **countries**, *the salt when added lowers the melting point of the ice so that it melts at a relatively lower temperature and consequently the ice is cleared*
- *The long term disadvantage of adding salt to clear ice is that salt accelerates rusting, Hence cause corrosion and destruction of machinery*
- *Temperature does not change when liquid is melting or when liquid is boiling – this is because the energy supplied is used to break the bonds holding the particles together.*

Determining the melting point of a solid.

- The melting point of a solid can be determined using the experiment shown below



Determining the Boiling point of a liquid

While the boiling point of a liquid can be determined using the experiment below

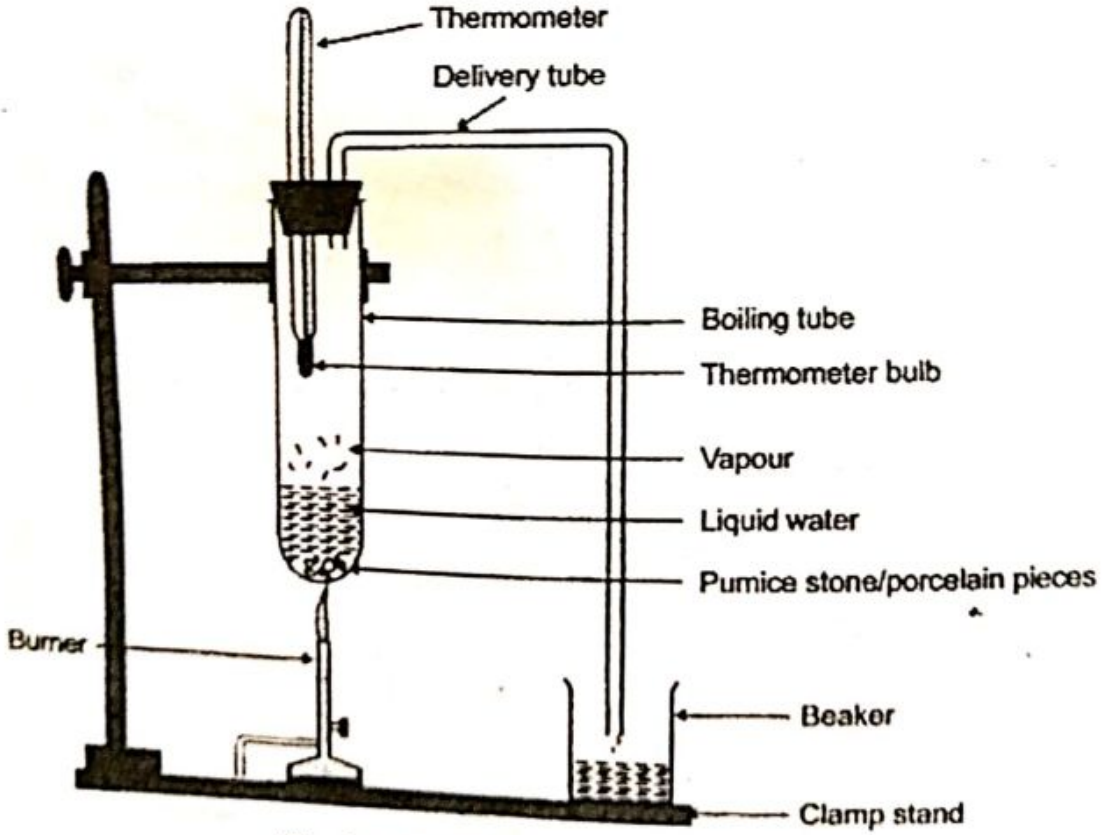


Fig. 8.2. Determination of boiling point of water

The thermometer is not immersed in the liquid but suspended above it. This is because boiling occurs off the surface of the liquid. The safety tube (glass tubing) allows the vapour formed to escape because pressure will build up to the tube leading to an explosion'. Flammable substances are not heated directly. We use a water bath /sand bath

- Altitude affects the Boiling Point in that the higher you go the cooler it becomes .This is because the higher you go the lower the atmospheric pressure the less the particles are compacted, making it easier to boil. That is why the Boiling Point of water is 100°c at sea level in one atmosphere pressure. But in Nairobi it's about 96°c.

The following are methods of determining purity.

- ✓ Boiling points and melting points
- ✓ Refractive index
- ✓ Using chromatography
- ✓ Using density

Chemical and physical changes

- Substances undergo many changes when subjected to different conditions of temperature and pressure. However, these changes can be classified as **temporary or permanent change.**

(a)Physical changes

These are changes that are easily reversible. They involve change in physical states and change in colour e,g boiling , melting and sublimation

Substances that undergo physical change

a. Heating Zinc oxide

Zinc oxide is **white** in colour when cold and **yellow** when hot.

When it is heated it changes its colour from white to yellow. When cooled the yellow solid turns white

$$Zinc\ oxide \underset{cool}{\overset{heat}{\rightleftharpoons}} zinc\ oxide$$

$$cool(White) \qquad hot(Yellow)$$

(White)

b. Heating solid wax

Wax melts when heated and when cooled, its changes back to a solid.

Heat

$$solid\ wax \underset{cool}{\overset{heat}{\rightleftharpoons}} liquid\ wax$$

Iodine when heated changes to purple vapour and when cooled it changes back to a black solid.

c. Heating iodine

$$solid\ iodine \underset{cool}{\overset{heat}{\rightleftharpoons}} iodine\ vapour$$

black purple vapour

d. Heating ice

$$ice \underset{cool}{\overset{heat}{\rightleftharpoons}} liquid \underset{cool}{\overset{heat}{\rightleftharpoons}} water\ vapour$$

solid liquid gas

The above substances do not form a new substance when heated; the changes are easily reversed when cooled. They are thus said to undergo **Temporary physical change.**

Characteristics of temporary physical change.

- ✓ Easily reversible
- ✓ No new substance is formed
- ✓ Usually no change in mass
- ✓ Not usually accompanied by great heat changes

(b) Chemical changes

There are two categories of chemical changes

- ✓ **Reversible chemical change** . Substances which undergo these changes are reversible and are accompanied by change in mass.
- ✓ **Permanent chemical change** Substances which undergo these changes are irreversible on cooling and accompanied by change in mass.

When heat is used to decompose a substance, the reaction is called **thermal decomposition.** These reactions are not reversible and thus permanent changes.

Examples of Reversible chemical change

I. heating hydrated copper (II) sulphate crystals

Hydrated copper (II) sulphate crystals are blue in colour. When heated, it decomposes and loses water of crystallization to form anhydrous copper (II) sulphate (white) and water. Upon cooling, the white hydrous Copper (II) Sulphate does not regain its original blue colour.

When water is added to the white hydrous Copper (II) Sulphate it regains its original blues colour.

Hydrated copper (II) sulphate $\xrightarrow{\text{Heat}}$ hydrous Copper (II) Sulphate + water

Blue **white**

Hydrous Copper (II) Sulphate + water $\longrightarrow$ Hydrated copper (II) sulphate

White **blue**

II. heating hydrated Cobalt (II) chloride

Pink Hydrated Cobalt (II) chloride decomposes when heated and loses water of crystallization to form **blue** anhydrous Cobalt (II) chloride and water.

Hydrated Cobalt (II) chloride $\xrightarrow{\text{Heat}}$ anhydrous Cobalt (II) chloride + water

Pink **blue**

Anhydrous Cobalt (II) chloride + water $\longrightarrow$ Hydrated Cobalt (II) chloride

Blue **Pink**

Hydrated means – with water of crystallization while **anhydrous** means without water of crystallization.

The above changes are known as **temporary chemical change. Characterized by the following**

- ✓ A new substance is formed
- ✓ Heat is evolved or absorbed
- ✓ There is change in mass
- ✓ The change is reversible

Permanent chemical change

Examples

a. heating copper (II) nitrate

When copper (II) Nitrate is heated it decomposes to form copper (II) Oxide (black), Nitrogen (IV) Oxide gas (brown) and oxygen gas (colourless)

The gaseous products ie. Nitrogen (IV) Oxide gas and oxygen gas escape into the atmosphere resulting to decrease in mass of copper (II) Oxide.

Copper (II) Nitrate $\xrightarrow{heat}$ *Copper (II) Oxide + Nitrogen (IV) Oxide + oxygen gas*

blue **black** **brown** *gas* *colourless*

b. **Heating purple Potassium Manganate (VII)**

Potassium Manganate (VII) decomposes when heated to form green solid of potassium manganate (VI), black manganese (IV) oxide and colourless oxygen gas. The mass of the black solid is less than the mass of original Potassium Manganate (VII) because oxygen gas escaped to the atmosphere.

$$\underset{\text{Potassium Manganate (VII)}}{\text{Potassium}} \xrightarrow{\text{heat}} \underset{\text{Manganate (VI)}}{\text{Potassium}} + \underset{\text{Oxide}}{\text{Manganese (IV)}} + \underset{\text{colourless}}{\text{oxygen gas}}$$

Purple green black

NB: The oxygen gas relights a glowing splint.

The above changes are examples of **permanent chemical changes**. They are characterized by the following.

- ✓ New substance is formed
- ✓ The change is irreversible
- ✓ The change is accompanied by change in mass
- ✓ Heat energy is released of absorbed

Difference between chemical and physical changes

Physical change	*Chemical change*
Not usually accompanied by great heat changes	Usually accompanied by great heat changes
Usually no change in mass	Usually there is change in mass
They are easily reversible	Usually irreversible
No new substance is formed	New substance is formed
No change in physical properties of the reactants	There is change in physical properties of the reactants

Sample questions.

1. *What is observed when the following substances are heated and cooled?*

a. *Wax* ***–wax melts on heating. It's cooled back to solid wax on cooling.***

b. *Naphthalene-****naphthalene melts on heating. It is cooled back to solid naphthalene on cooling.***

c. *Zinc oxide-****white zinc oxide changes colour to yellow zinc oxide on heating. On cooling yellow zinc oxide turns back to white zinc oxide.***

d. *Lead oxide-****yellow lead (II) oxide changes to orange lead (II) oxide on heating. On cooling , the orange lead (II) oxide turns back to yellow lead (II) oxide.***

e.*Ammonium chloride-****ammonium chloride changes directly to gaseous state when heated. On cooling it goes back to solid state. This process is called thermal dissociation***

- On cooling, the products of heated ammonium chloride combine together to form the original substance. The process is called **deposition**. The reaction is therefore reversible. However, iodine sublimes when heated but it does not dissociate since it is a **pure substance**.
- The above changes are temporary. They are characterized by ***physical change*** in state e.g. melting, boiling, evaporation and sublimation

2. *State what is observed when:*

a. *Copper (II) nitrate heated.*

- ***When crystals of copper (II) nitrate are heated, a brown gas (nitrogen (IV) oxide) and a colourless gas which rekindles a glowing splint (oxygen) are formed.***
- ***A black solid (copper (II) oxide) remains in the test-tube.***
-

b. *Copper turnings heated in air.*

- *When copper is heated in air; a black powder of copper (II) oxide is formed*

c. *Explain why there were changes in mass after heating in both cases.*

- *The mass of copper (II) oxide formed from the copper (II) nitrate was less than that of copper (II) nitrate. This is because some of the products are gaseous thus escapes.*
- *The mass of copper (II) oxide is greater than mass of original copper metal because copper combines with oxygen to form copper (II) oxide*

Elements, compounds and mixtures

Elements

- They are pure substances which cannot be split into simpler substance by chemical means. *Examples of elements:* ***oxygen, hydrogen, copper, sulphur, carbon and iron.***
- They are made up of atoms. **An atom is the smallest particle of an element, which can take part in a chemical change.**
- Atoms join together to form small groups of atoms called **molecules**. A molecule is the smallest particle of an element or a compound which can exist separately.

Chemical symbols of some elements

- This is usually the first letter or the first two letters of the elements name in English or Latin
- The first letter of a chemical symbol must always be a capital letter.

Element	Symbol	Element	symbol
Carbon	C	Magnesium	Mg
Nitrogen	N	Zinc	Zn
Oxygen	O	Calcium	Ca
Hydrogen	H	Beryllium	Be
Aluminum	Al	Lithium	Li
Phosphorus	P	Sulphur	S
Flourine	F	Silicon	Si
Bromine	Br	Barium	Ba
Iodine	I	Cobalt	Co
Boron	B	Chlorine	Cl
Manganese	Mn	Helium	He

- Finally in some cases, the symbol of the element is derived from the elements latin name as shown below:

Element	Latin name	symbol
Copper	Cuprum	Cu
Mercury	Hydragyrum	Hg
Lead	Plumbum	Pb
Gold	Aurum	Au
Silver	Argentum	Ag
Sodium	Natrium	Na
Potassium	Kalium	K
Iron	Ferrum	Fe

Compounds:-

- They are pure substances made up of two or more elements chemically combined together. *E.g sodium chloride is made up of sodium and chlorine. Water is made up of oxygen and hydrogen. Iron (ii) sulphide is made up of iron and sulphur.*

Mixtures:-

- They are made of two or more substances. They can be made by mixing two or more elements, two or more compounds or elements with compounds.
- The substances combined in mixtures are not chemically combined/ bonded together and can be separated by physical means. *Examples of mixtures: air, mixture of two compounds e.g sodium chloride and water*

Naming of compounds

The name of a compound is determined by the number and composition of elements making up the compounds. The following rules apply when naming compounds

1. ***Compounds made of only two elements ,their names end with –ide***

Compound	Elements present	Compound	Elements present
Sodium Oxide	*Sodium , oxygen*	Magnesium Oxide	
Sodium Chloride	*Sodium ,chlorine*	*Zinc Chloride*	
Sodium Flouride	*Sodium, fluorine*	Potassium Flouride	
Sodium Nitride	*Sodium, Nitrogen*	*Magnesium Nitride*	
Magnesium Sulphide	Magnesium, sulphur	*Sodium Sulphide*	
Copper (II) Oxide	*Copper ,oxygen*	*Zinc sulphide*	
Calcium Bromide		Carbon (IV) Oxide	
Calcium Nitride		*Potassium Nitride*	
Alluminium Chloride		Iron (III) Chloride	
Silicon (IV) Oxide		*Sulphur (IV) Oxide*	
Potassium Hydride		*Sodium Hydride*	

✓ ***Exception to this rule is hydroxide which contain three elements***

Compound	Elements present
Magnesium Hydroxide	Magnesium, Hydrogen and oxygen
Sodium Hydroxide	
Sodium Hydroxide	
Copper (II) Hydroxide	
Lead (II) Hydroxide	
Calcium Hydroxide	
Iron (III) Hydroxide	
Zinc (II) Hydroxide	
Aluminium Hydroxide	

2. ***Compounds whose names end with –ate or –ite are made of three elements with oxygen being the third element, but those with –ate have more oxygen content than those with –ite***

Compound	Elements present
Magnesium carbonate	Magnesium, carbon and oxygen
Sodium sulphate	
Sodium nitrate	
Copper (II) sulphate	
Lead (II) carbonate	
Calcium chlorate	
Iron (III) carbonate	
Zinc (II) carbonate	
Alluminium nitrate	
sodium chlorite	
Potassium nitrate	
Potassium permanganate	Potassium, manganese, oxygen
sodium sulphite	
Calcium perchlorate	Calcium, chlorine and oxygen
Sodium phosphate	

✓ ***Exception is hydrogen carbonates, hydrogen sulphates, hydrogen sulphites and hydrogen phosphates which contain 4 elements hydrogen being one of them***

Compound	Elements present
Magnesium hydrogen carbonate	Magnesium, hydrogen ,carbon and oxygen
Sodium hydrogen sulphate	
Sodium hydrogen sulphite	
Calcium hydrogen carbonate	
sodium hydrogen phosphate	

Simple word equations

When a chemical reaction takes place, we can represent it in form of a word equation. For example: when a mixture of iron and sulphur is heated, the two elements combine to form a compound called iron (ii) sulphide we can summarize this in a word equation as follows:-

Iron + sulphur ⟶ iron (II) sulphide

The plus sign (+) in chemistry means 'react with'.

The arrow ⟶ means to form the products shown

Hydrogen + oxygen ⟶ water

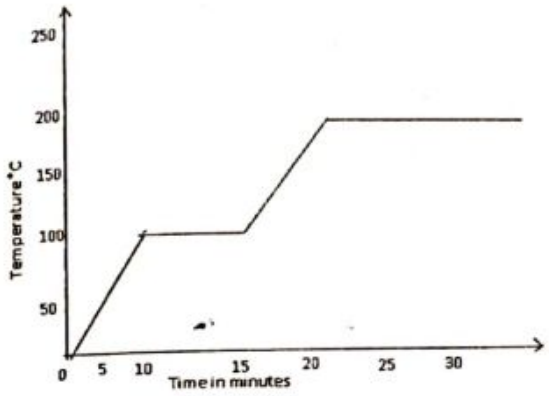
This means hydrogen reacts with oxygen to form water.

Copper + oxygen ⟶ copper (II) oxide
Zinc + oxygen ⟶ zinc oxide
Lead + oxygen ⟶ lead oxide

REVISION QUESTIONS

1. Sand was mixed with salt and you wanted to separate the mixture and recover salt and sand. Explain in steps how you would separate the mixture, make labeled diagram of apparatus you would use. (5mks)

2. The following graph shows what happens to a solid when it was heated steadily until it melted.



a) What is the:

i) Melting point of this substance in ^0C? (1mk)

ii) Boiling point ^0C (1mk)

b) How long did it take the substance to melt completely? (1mk)

c) Was the solid a pure substance? Explain your answer. (2mks)

3. a) Write the chemical symbols of the following elements (5mks)

i) Oxygen _____

ii) Copper _____

iii) Helium _____

iv) Magnesium _____

v) Lead _____

b) Write the names of the elements whose symbols are (5mks)

i) Na _____

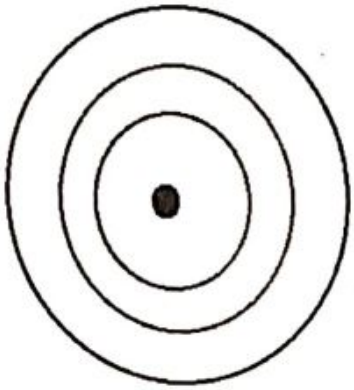
ii) Fe _____

iii) P _____

iv) Ag. _____

v) K _____

4. A green colouring material was placed at the centre of a circular piece of paper and allowed to dry. Drops of a solvent were added to the centre of the filter paper and eventually two circles were produced as shown below.



a. i) Name a process by which dilute extract could have been made more concentrated. (1mk)

ii) Name a suitable piece of apparatus for adding drops of the solvent to the centre at a controlled rate. (1mk)

iii) What is the name of the process by which the circles were produced? (1mk)

iv) What information does this experiment provide about the colouring matter in grass? (1mk)

v) Name a suitable solvent for the experiment. (1mk)

vi) Explain why water is not used to extract the green colour? (1mk)

5. a) A student mixed iron fillings with sulphur. Explain how he could separate the components of the mixture. (2mks)

b) He put the mixture in a test tube and heated using a non-luminous flame. Write a word equation for the reaction that took place. (2mks)

6. Define; (5mks)

a) A compound

b) A mixture

c) Element

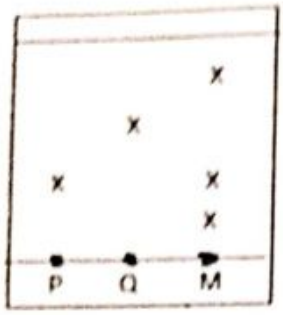
d) Melting point

e) A molecule

7. Give four differences between Temporary physical change and Permanent chemical change (8mks)

	Temporary Physical change	Permanent chemical change
1		
2		
3		
4		

8. Spots of pure pigment P and Q and a mixture M were placed on a filter paper and allowed to dry. The paper was then dipped in a solvent. The results obtained were as paper chromatogram.



a) Which is the

i) Baseline? (1mk)

ii) Solvent front? (1mk)

b) Circle the substances M made of? (1mk)

c) Which of the pure pigments was a component of M. Explain? (2mks)

d) i) Name a solvent that is used in paper chromatography. (1mk)

ii) Why is water not a suitable solvent in paper chromatography? (1mk)

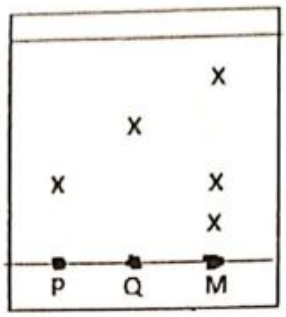
9. Name the elements present in the following compound (10mks)
a) Sodium nitride

b) Magnesium hydrogen carbonate

c) Copper sulphate

d) Sodium carbonate

8. Spots of pure pigment P and Q and a mixture M were placed on a filter paper and allowed to dry. The paper was then dipped in a solvent. The results obtained were as paper chromatogram.



a) Which is the

i) Baseline? (1mk)

ii) Solvent front? (1mk)

b) Circle the substances M made of? (1mk)

c) Which of the pure pigments was a component of M. Explain? (2mks)

d) i) Name a solvent that is used in paper chromatography. (1mk)

ii) Why is water not a suitable solvent in paper chromatography? (1mk)

9. Name the elements present in the following compound (10mks)

a) Sodium nitride

b) Magnesium hydrogen carbonate

c) Copper sulphate

d) Sodium carbonate

e) Iron (II) hydroxide

10. Draw a cooling curve of pure water. (4mks)

11. a)Describe how you can obtain Elianto oil from maize seeds (3mks)

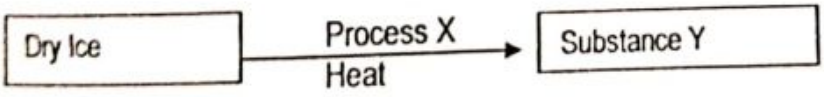
12. a) Describe an experiment that you would carry out to investigate the purity of water in chemistry laboratory. (3mks)

b) Give two laboratory safety rules that you would observe during your experiment. (2mks)

c) Define
i) A heating curve (1mk)

ii) A saturated solution (1mk)

13. Study the diagram below and answer the questions that follow.



a) Name process X (1mk)

b) Substance Y (1mk)

c) Why is dry ice preferred by ice cream vendors in their cold boxed over ordinary ice? (2mks)

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d) Name other two substances that undergo process X. (2mks)

14. a)Give one difference between a miscible liquid and an immiscible liquid (2mks)

b) Give one example of such liquids in each case. (2mks)

15. State the method that can be used to separate the following mixtures. (7mks)

	Mixture	Method
1	Ethanol and water	
2	Sand and aluminium chloride	
3	Sand and paraffin	
4	Salt and sugar	
5	Salt and ethanol	
6	Oil and water	
7	Xanophyll and chlorophyll	

16. Give the chemical symbols for the following elements. (5mks)

(a) Potassium

(b) Zinc

(c) Iron

(d) Oxygen

(e) Manganese

17. Complete the equations below (10mks)

a) Sulphur + oxygen ⟶

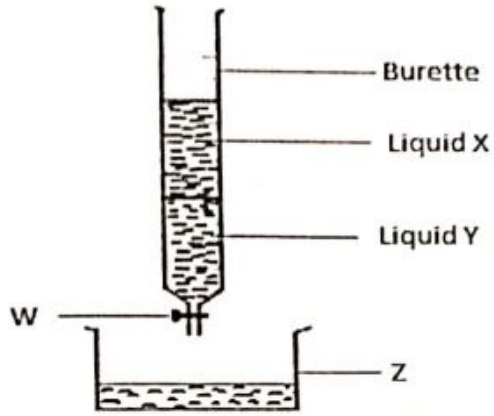
b) Magnesium +Carbon + oxygen ⟶

c) Magnesium + chlorine ⟶

d) Potassium + nitrogen ⟶

e) Copper + sulphur ⟶

18. A student set up the following apparatus to separate a mixture of oil and water.



a) i)Name the apparatus that would be suitable for use in the experiment instead of a burette. (1mk)

ii) What is the suitable function of a burette? (1 mk)

b) Name the following. (4 mks)

(i) W

(ii) Liquid X

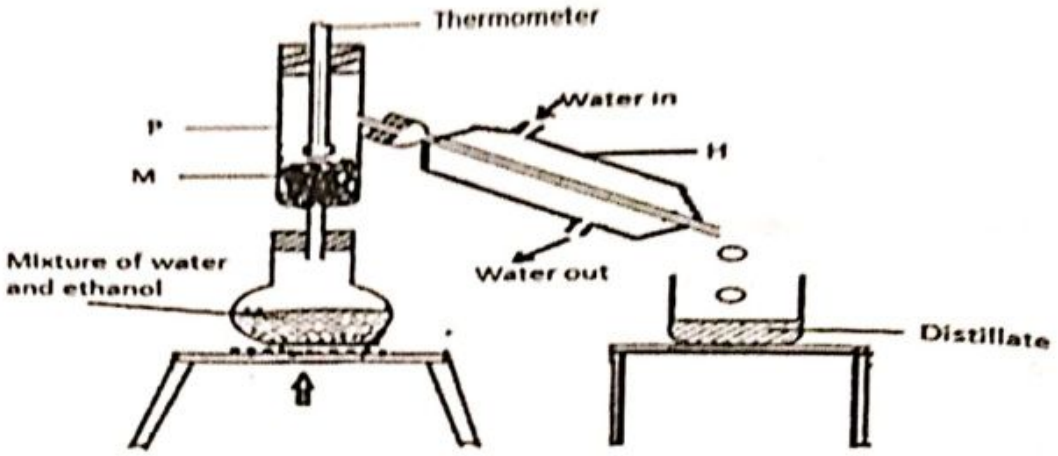
(iii) Liquid Y

(iv) Apparatus Z

c) Name two properties of liquid X and Y that enables them to be separated by the method above. (2 mks)

d) Give a brief description of how the above arrangement of apparatus could be used to achieve efficient separation of liquids X and Y. (4 mks)

19. A form one student set up the following apparatus to separate a mixture of water and ethanol. Study it and answer the questions that follow.



a) i) Identify 2 mistakes in the arrangement of apparatus. (2 mks)

ii) State a reason for each mistake you mention in a (i) above. (2mks)

b) I) Name the method of separation being used in this experiment. (1mk)

II) Identify apparatus P,M and H. (3mks)

(i) P

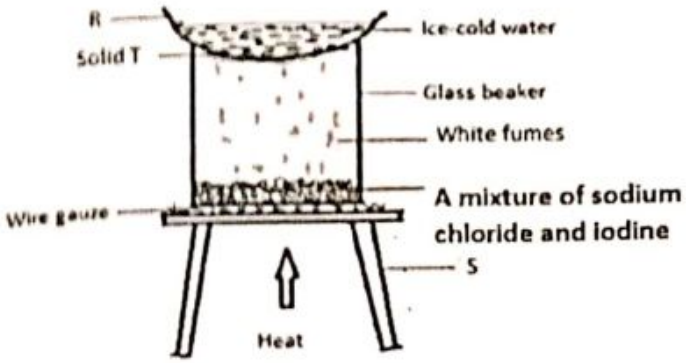
(ii) M

(iii) H

c) (i) Briefly explain how apparatus P functions to separate the mixture of water and ethanol. (2mks)

ii) What property of water and ethanol makes it possible to separate them from their mixture? (1mk)

20 The following apparatus were set up to separate a mixture of sodium chloride and iodine



a) Name the method used in this set up to separate the mixture of sodium chloride and iodine . (1mk)

b) Name the following: (1mk)

i) Apparatus R (1mk)

ii) Apparatus S (1mk)

iii) Solid T (1mk)

c) What is the purpose of ice cold water in the experiment? (1mk)

21. What is an atom

22. Write down the names of the element whose symbols are given below. (5mks)

(i) Fe

(ii) Pb

(iii) H

(iv) Ca

(v) Mg

23. Write down the symbols of the following elements. (5mks)

(a) Phosphorus

(b) Copper

(c) Gold

(d) Silver

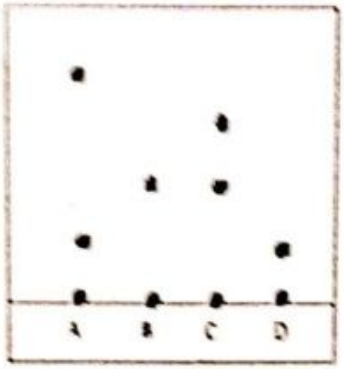
(e) Potassium

24. Illustrate the following information using word equations

(i) Carbon burns in oxygen to form carbon(IV) oxide. (1mk)

(ii) Calcium reacts with water to form calcium hydroxide and hydrogen gas. (1mk)

25. An analytical chemist working on food substances A, B, C and D suspected to contain trace elements that could boost the immune system of HIV –Aids patients kept peter, Mary, Jane and john on diets A , B C and D respectively. Jane showed remarkable improvement on her immune system. on the chromatogram of the food substances shown below, study it and answer the questions that follow.



(a) On the chromatogram above, circle the trace element responsible for improving Jane's health. (1mk)

(b) Circle the trace element found in Peter's diet only. (1mk)

(c) Indicate the solvent front, using a dotted line on the chromatogram (1mk)

26. Which process are involved in the following changes (3mks)

(a) Iodine solid to iodine

(b) Vapour ice to liquid water.

(c) Water to water vapour

27. Study the list of changes shown below and identify the charges that are chemical changes. (6mks)
(a) Adding sugar to water

(b) Lighting an electric bulb when the current is switched on

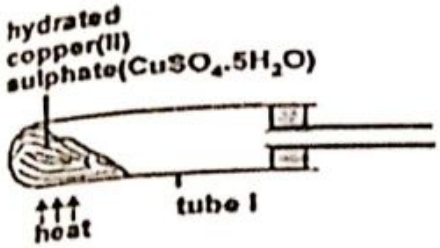
(c) The souring of milk

(d) Freezing of water

(e) Sticking a match stick

(f) Combustion of petrol in motor cars

28. Crystals of hydrated copper (II) sulphate were heated in a boiling tube as shown below



(a) Complete the diagram to show how you can collect the products formed when the solid crystals are heated. (3mks)

b) State one observable change that occurs on the crystals. (1mk)

29. State the method by which you can separate the following mixtures (5mks)

(a) Petrol and water (immiscible liquids)

(b) Common salt from a mixture of common salt and ammonium chloride

(c) Coloured pigments

(d) Copper (II) sulphate crystals from copper (II) sulphate solution

(e) Iron filings from a mixture of iron filling and sulphur.

30.(a) Mention three components of crude oil (petroleum). (3mks)

(b) State the method by which the components of crude oil may be separated. (1mk)

31. What observation is made when the following substances are heated in separate test tubes.

(a) Iodine crystals (1mk)

(b) Zinc oxide solid (1mk)

(c) Candle wax (1mk)

32. State the most suitable method of separating the following mixtures.

(i) Components found in green grass extract. (1mk)

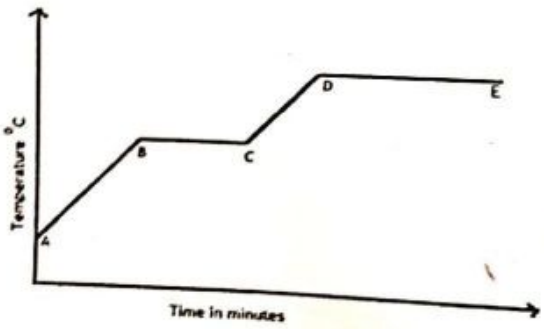
(ii) Corn oil and water (1mk)

(iii) Water and mud (1mk)

(iv) Copper (II) Sulphate dissolved in water (1mk)

(v) Common salt and iodine crystals (1mk)

33. The curve shown below was obtained when pure Naphthalene was heated to boiling.



(a) Which title do you give to the curve shown above ? (1mk)

(b) Explain in terms of kinetic theory, the process occurring in region BC. (2mks)

(c) Give one industrial application of the effect of impurities on substances. (1mk)

34. You are given samples of pure and impure water in beakers that are not labeled. Explain one simple experiment you can use to label the beakers correctly. (2mks)

35. Which of the following changes are physical or chemical changes. Put your answer in the table below.

CHANGE	TYPE OF CHANGE –PHYSICAL/CHEMICAL
Souring of milk	
Striking match	
Burning of a candle	
Heating candle wax	
Freezing of water	
Adding sugar to water	
Rusting of iron	
Boiling ethanol	
Heating lead (II) oxide	
Heating hydrated copper (II) sulphate	

(5mks)

36. Define the following terms.
(a) Classification

(b) Mixture

(c) Sublimation

(d) Filtrate –

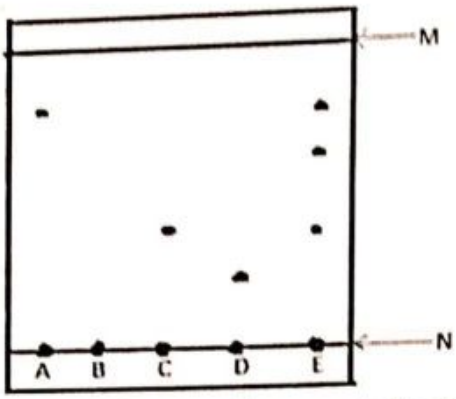
(e) Chromatography –

37 (a) Describe how you can carry out filtration process in the laboratory. (3mks)

(b) Explain why glass is usually used to make laboratory apparatus. (2 mks)

38 what is the use of a wire gauze in heating process. (1 mk)

39. Study the diagram below and use to answer the questions that follow



(a)Name the technique used to separate the dyes. (1mk)

(b)Which letters represent? (1mk)

(i) Baseline (origin) _____

(ii) Solvent path _____

c) Which chromatograms were present in dye E? (1mk)

(d)Which dye is insoluble? (1mk)

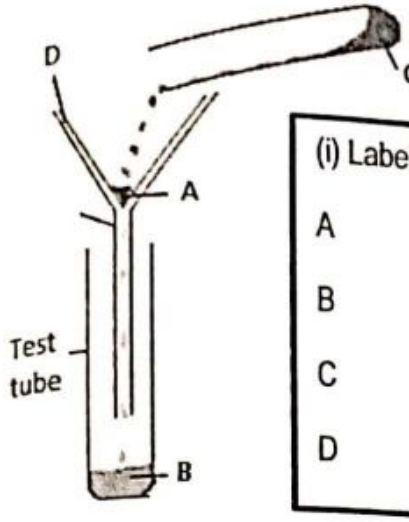
(e) Which dye is impure? Explain (1mk)

(f) Which chromatogram is most soluble? (1mk)

(g) What conditions are required to separate the chromatographs present in a dye? (1 mk)

40) Is air a mixture or a compound? Give a reason. (1 mk)

41. The diagram below shows apparatus set up to separate a mixture of soil and water.



(i) Label parts (4 mks)

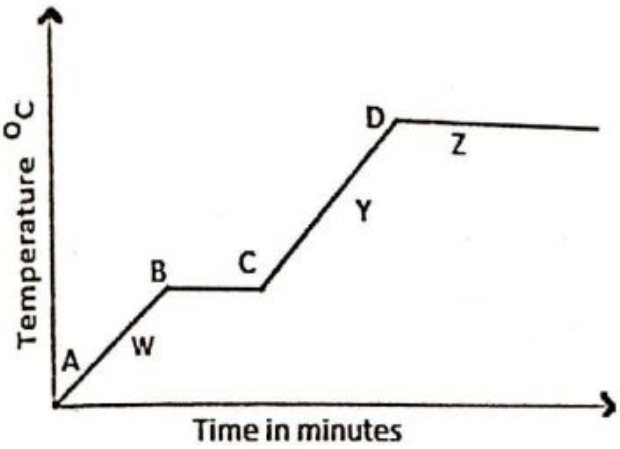
A

B

C

D

42. The diagram below shows the heating curve of a pure substance. Study it and answer the questions that follow.



(a) What are the physical states of the substance at points W, X and Y. (3mks)

(b) What happens to the temperature between points B and C (1mk)

(c) The substance under test is definitely not water. Give a reason for this. (1mk)

(d) What would happen to the melting point of this substance if it were contaminated with sodium chloride? (1mk)

43. State names of the elements making up the following compounds.

(i) $CuCO_3$ (1mk)

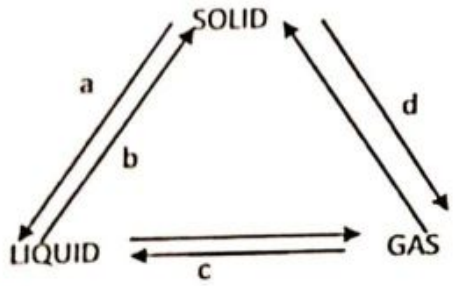
(ii) K_2SO_4 (1mk)

iii) H_2O (1mk)

iv) CO_2 (1mk)

44. Give three characteristics of a chemical change. (3mks)

45. The scheme below shows the behavior of solid W when heated.



(a) Name process

a) _____

b) _____

c) _____

d) _____

(b) In which state are the attractive forces between particles negligible? (1mk)

46. Give four differences between a compound and a mixture. (4mks)

47. State whether each of the following changes is temporary or permanent.

(i)Curdling of milk - (1mk)

(ii) Burning of a piece of paper - (1mk)

(iii) Cooling of water to ice - (1mk)

(iv) Melting of fat to oil - (1mk)

(v) Striking a match to burn - (1mk)

48. Identify the elements in the following compounds. (4mks)

(i)Sodium hydrogen carbonate-

(ii) Potassium sulphate-

(iii) Potassium sulphate-

(iv) Copper (II) Nitrate-

49. State whether the following are temporary or permanent changes. (5mks)

(i) Melting of candle wax-

(ii) Heating iodine-

(iii) Heating copper (II) Nitrate-

(iv) Heating zinc oxide-

(v) Lighting a match stick-

50. Write the word equation for the following reactions. (5mks)

(i) Heating magnesium in oxygen to form magnesium oxide.

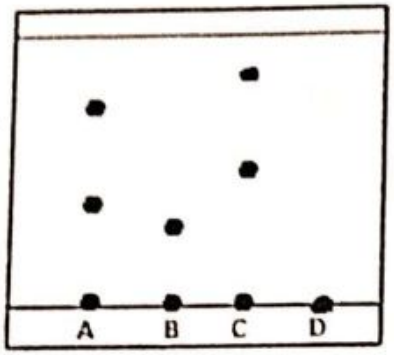
(ii) Heating copper (II) carbonate to form copper (II) oxide and carbon (IV) oxide.

(iii) Reacting hydrogen and oxygen to form water.

(iv) Heating Iron and sulphur to form Iron (II) Sulphide.

(v) Reacting sodium and chloride to form sodium chloride-

51 (a) The diagram below shows a paper chromatogram of substances A, B and C which are coloured.



(i)Indicate the solvent front and base-line on the chromatogram. (1mk)

(ii) Which substance is pure? Explain (1mk)

(iii) Name a possible organic solvent you can use for this experiment (1mk)

(iv) Substance D is a mixture of B and C, indicate its chromatogram in the diagram. (1 mk)

(v) Suggest two reasons why separations occur in this method (2mks)

(vi) Write four applications of Chromatography (4mks)

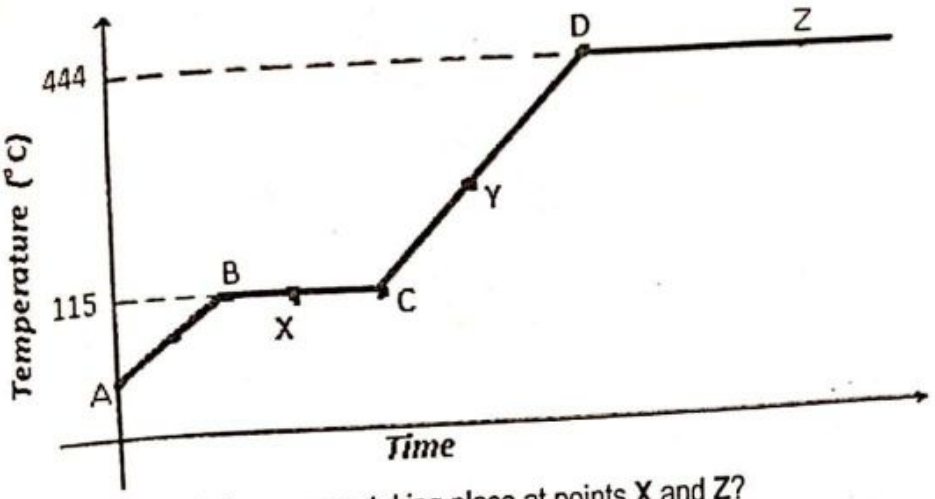
52. Two miscible liquids S and T whose boiling points are 60°c and 84°c respectively got mixed together accidentally.

(a) Suggest a method you would use to separate the two liquids. (1mk)

(b) Give two industrial application of the method you have suggested in (a) above (2mks)

53. State the kinetic theory of matter (1mk)

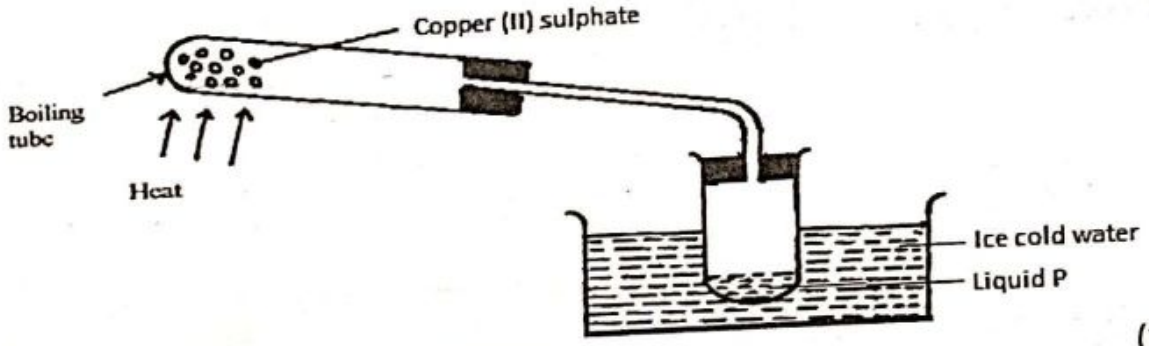
54. The diagram below shows the heating curve of a pure substance. Study it and answer the questions that follow:



(a) What physical changes are taking place at points X and Z? (1 mark)

(b)Explain what happens to the melting point if sodium chloride added to this substance (1mk)

55.The apparatus below were used by a student to study the effect of heat on hydrated copper (II) sulphate

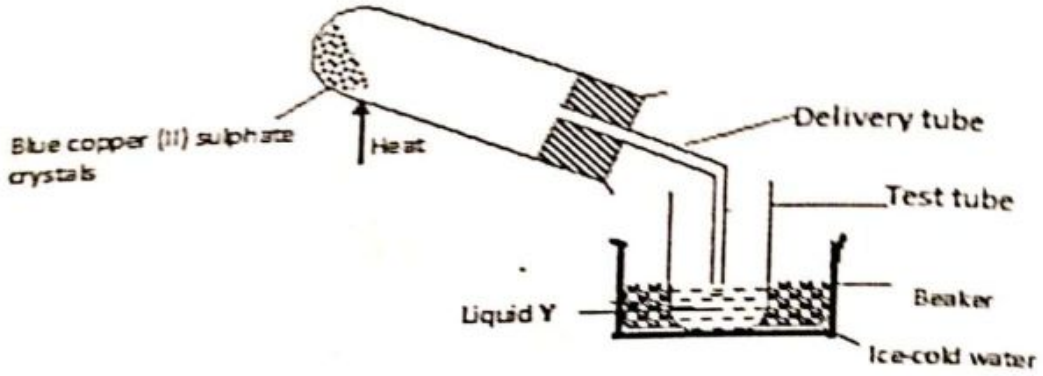


(a) What is the role of the ice cold water? (1 mk)

(b) Name liquid **P** (1 mk)

(c) What observation is made in the boiling tube (1mk)

56.a) The diagram below shows a set – up used by a student to find out what happens when Copper (II) sulphate crystals are heated.



(i) State the observations made when the blue copper (II) sulphate crystals are heated. (1mk)

(ii) Identify liquid Y and write an equation for its formation. (1mk)

57. The table below gives several samples of mixtures. Study the table and answer the questions that follow

Mixture 1 components	**Mixture 2 components**	**Mixture 3 components**	**Mixture 4 components**
Magnesium Sulphate	Water	Silver Chloride	Iron (III) Chloride
Water	Magnesium Sulphate	Lead Chloride	Iron (III) Oxide
Silver Chloride	Magnesium Nitrate	water	-

a). state **one** way in which the composition of a mixture differs from that of a compound (1mk)

b) Describe how **Mixture 1** and **Mixture 2** can be separated into its components

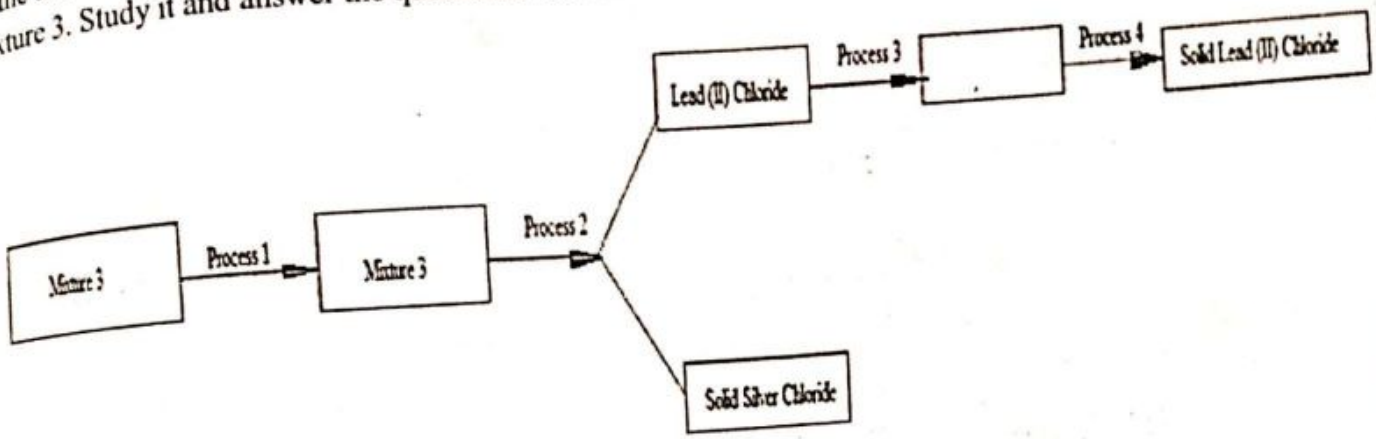
i. Mixture **1** (2mks)

ii. Mixture **2**

c). State the main property that makes components of **Mixture 3** separable (2mks) (1mk)

d). Draw a well labeled diagram of a simple laboratory set up which can be used to separate the components of **Mixture 4** (2mks)

e). the chart below gives a summary of steps which can be used to separate the components of mixture 3. Study it and answer the questions that follow



58. Identify the processes labeled 1,2,3,4 (1mk)

Process 1 (1mk)

Process 2 (1mk)

Process 3 (1mk)

Process 4

59. a) Complete table 1 by indicating the observations, type of permanent or temporary change and name of new compound formed.

Table 1

Experiment	observations	Type of change	Name of product
i) heat candle wax strongly in a test tube			
ii) anhydrous copper (II) sulphate is left exposed overnight			
iii) iron wool is soaked in tap water for two days			

CHAPTER THREE: ACIDS, BASES AND INDICATORS.

Indicators

An indicator is a substance that gives a definite colour in acids and a different definite colour in bases.

There are three types of indicators

- *Simple acid base indicators*
- *Commercial indicators*
- *Universal indicators*

Preparation of simple acid base indicators

Crush Coloured leaves, flowers or roots in a mortar using a pestle, add propanone, continue crushing and filter to obtain a thick colour paste. The resulting paste is a simple acid base indicator which can be confirmed by adding a few drops of it in a basic solution and other drops in a acidic solution, and it will give a distinct colour in base and a distinct colour in an acid

- ✓ *The disadvantage of this indicator is that they give inconsistent results.*
- ✓ *They expire within a short time*

Commercial indicators

- These are commercially prepared and they are the ones commonly used by school as they give consistent results and do not expire easily, the commonly used indicators are shown below
- Color of commercial indicators on acid and bases.

Indicator	Colour in acid	Colour in base	Colour in neutral
Phenolphthalein	Colourless	Pink	Colourless
Litmus	Red	Blue	Purple
Methyl orange	Pink	Yellow	Orange
Bromothymol blue	orange	blue	orange

The **advantages** of methyl orange over phenolphthalein indicator is that, it gives different distinct colours in and neutral solution while phenolphthalein does not.

pH scale and universal indicator

- *pH scale is a numeric scale ranging from 0-14 used to specify the acidity or basicity of an aqueous solution*
- universal indicator is a mixture of indicator and exhibits a range of colours in acids and in bases depending of strength of acid or base, when drops of universal indicator are added to a solution, the colour obtained is compared with that of universal indicator to determine the pH of the solution.
- The pH scale is shown in the figure bellow

Colour	Dark Red	Red	Red	Orange Red	Orange	Orange yellow	Greenish yellow	Green	Greenish blue	Blue	Navy blue	Purple	Dark purple	Violet	Violet
pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Advantage of universal indicator over other indicators

They are able to give information of whether a substance is a strong or a weak base/acid

How to determine pH of substances using universal indicator

You can also be told to describe how to test the pH of a solid or a liquid,the procedure below is used to determine the pH of a substance.

If it is solid

- *Dissolve the solid in distilled water and dip the universal paper or add 2 drops universal indicator solution to the resulting solution then match the colour with the universal indicator paper*

If it is liquid

- *If it is a liquid dip the universal paper or add 2 drops universal indicator solution to the liquid then match the colour with the universal indicator paper*

Experiment: To determine the pH value of some solutions.

(a) Place 5cm^3 of filtered wood ash, soap solution, ammonia solution, sodium hydroxide, hydrochloric acid, distilled water, sulphuric (VI) acid, sour milk, sodium chloride, toothpaste and calcium hydroxide into separate test tubes.

(b) Put about three drops of universal indicator solution or dip a portion of a piece of pH indicator paper into each. Record the observations made in each case.

(c) Compare the colour in each solution with the colours on the pH chart provided. Determine the pH value of each solution.

Sample observations

Solution mixture	Colour on the pH paper/adding universal indicator	pH value	Nature of solution
wood ash	Blue	12	Strongly alkaline
ammonia solution	**Blue**	10	weakly alkaline
sodium hydroxide	**Purple**	14	Strongly alkaline
hydrochloric acid	Red	1	Strongly acidic
distilled water	Green	7	Neutral
Tap water	Orange	5	Weakly acidic
Rain water	Orange	5	Weakly acidic
sulphuric(VI)acid	**Red**	1	Strongly acidic
sour milk	Orange	5	Weakly acidic
sodium chloride	Green	7	Neutral
Toothpaste	Blue	9	Weakly alkaline
calcium hydroxide	Blue	10	Weakly alkaline

- The pH values for acids range from 0 to just less than 7. Lemon juice, orange juice and ethanoic acids are ***weak acids*** and have pH range between ***4 - 6***
- ***Weak acids*** *are acids that does not dissociate completely in aqueous solution.*
- Solutions of sulphuric (VI) acid, hydrochloric acid and nitric (V) acid have pH which ranges between ***0- 3***. they are referred to as ***strong acids.***
- ***Strong acids,*** *this is an acid that dissociates completely to give out many hydrogen ions in aqueous solution.*
- The pH values of bases range between 8 -14. Soap solution, calcium hydroxide and tooth paste are ***weak bases*** and their pH ranges between ***8-10.***
- ***Weak bases*** are *bases which do not dissociate completely to give many hydroxyl ions.*
- ***Strong bases*** *are bases which dissociate completely to give many hydroxyl ions*, like solutions of sodium and potassium hydroxide have pH values ranges between ***11-14***
- As the pH values increase from 7 to 14, the strength of the bases increases.

Acids

Definition:-

- ***An acid*** **is** ***a substance that dissolves in water to form hydrogen ions as the only positive ions,***
- **Note,** this is the most suitable definition of an acid although at form one level an acid is simply defined *as a substance that reacts with a base to form salt and water.*
- An acid can also be defined as a *proton donor*
- ***Acidity*** if the measure of hydrogen ions in solution, hence hydrogen ions give a substance its acidic properties.

Properties of acids

a. Physical properties of acids

1. Acids have a characteristic sour taste
2. Most acids are colourless liquids
3. Mineral acids are odourless. Organic acids have characteristic smell
4. All acids have pH less than 7
5. All acids turn blue litmus paper red, methyl orange pink and phenolphthalein colourless.
6. All acids dissolve in water to form an acidic solution. Most do not dissolve in organic solvents like propanone, kerosene, tetra chloromethane, petrol.
7. Have scorching effect

Example of acids and where they are found

Acid	***Where found***
Citric acid	Lemon, oranges ,sodas
Butanoic acid	Beef fat
Hexandioc acid	palm oil and olive oil
Ethanoic/acetic acid	Vinegar
Tartaric acid	Graves ,baking powder
Methanoic acid	Nettle plant ,bee and ant stings

b. Chemical properties of acids

(i) Reaction with metals

- Acids react with metals to form *salt and hydrogen gas*. The reaction is accompanied by *effervescence due to the hydrogen gas produced*
- The name of the salt is derived from the acid used

Acid	***Salt produced***
Sulphuric(VI) acid	Sulphate
Nitric(V) acid	Nitrate
Carbonic acid	Carbonate
Phosphoric acid	Phosphate
Ethanoic/acetic acid	Acetate/ethanoate
Citric acid	Citrate
Hydrochloric acid	Chloride

Magnesium + Hydrochloric acid ⟶ Magnesium chloride + hydrogen gas

Calcium + Nitric (V) acid ⟶ calcium nitrate + hydrogen gas

Sodium + Ethanoic acid ⟶ Sodium ethanoate + hydrogen gas

Aluminium + hydrochloric acid ⟶ Aluminium Chloride + hydrogen gas

Complete the following word equations

1. Zinc + sulphuric (VI) acid ⟶
2. Calcium +Hydrochloric acid ⟶
3. Magnesium +Hydrochloric acid ⟶
4. Zinc +Sulphuric (VI) acid ⟶
5. Aluminium + Sulphuric (VI) acid ⟶
6. Lead + Nitric (V) acid ⟶

NB

- very reactive metals like **potassium** and **sodium** react violently with acids and should never be tried in a school experiments.
- The reaction between **calcium** and **lead** metals with **dilute sulphuric (VI) acid** slows down and eventually stops due to the formation of **insoluble Calcium sulphate** and Lead (II) sulphate respectively which coats the surface of the metal preventing further reaction between the acid and the metal.
- The reaction between **lead metal** and **hydrochloric acid** also slows down and eventually stops due to formation of insoluble **Lead (II) chloride** which coats the surface of the metal preventing further reaction between the acid and metal.
- **Copper** metal does not react with dilute acids because copper is below hydrogen in the reactivity series hence cannot displace hydrogen from an acid.

(ii)Reaction with bases

-Acids react with bases to form salt and water and reaction is known as **neutralization**

Sodium hydroxide + hydrochloric acid ⟶ sodium chloride + water

Sodium oxide + nitric (V) acid ⟶ sodium nitrate + water

Complete the following word equations

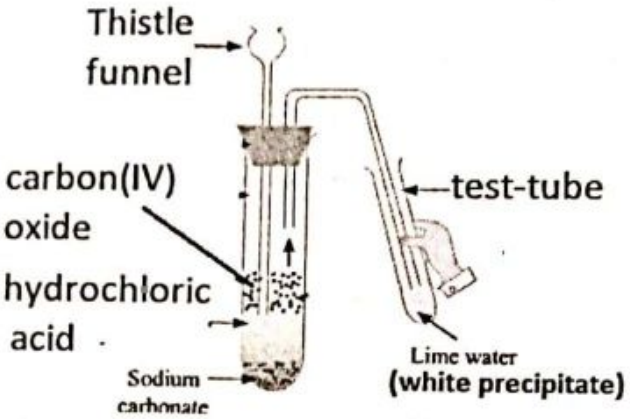
1. Sodium hydroxide +nitric (V) acid ⟶
2. Calcium oxide +Hydrochloric acid ⟶
3. Magnesium hydroxide + Hydrochloric acid ⟶
5. Copper (II) oxide + Sulphuric(VI) acid ⟶

6. Zinc oxide + Sulphuric (VI) acid ⟶

7. Magnesium hydroxide + Sulphuric (VI) acid ⟶

6. Potassium hydroxide + Sulphuric(VI) acid ⟶

(iii)Reaction with carbonates and hydrogen carbonates



- Acids reacts with carbonates/hydrogen carbonates to form *salt , carbon(IV) oxide and water*, the reaction is *accompanied by effervescence and evolution of a odourless gas that forms a white precipitate with lime water(calcium hydroxide solution)*

Sodium hydrogen + hydrochloric acid ⟶ sodium chloride + carbon (IV) oxide + water
Carbonate

sodium + Sulphuric (VI) acid ⟶ sodium sulphate + carbon (IV) oxide + water
Carbonate

Magnesium + Hydrochloric acid ⟶ Magnesium chloride + carbon (IV) oxide + water
Carbonate

Calcium + Nitric (V) acid ⟶ calcium nitrate + carbon (IV) oxide + water
Carbonate

Complete the word equations below:-

1. Sodium carbonate + Hydrochloric acid ⟶

2. Calcium carbonate + Hydrochloric acid ⟶

3. Magnesium carbonate + Hydrochloric acid ⟶

4. Copper carbonate + Hydrochloric acid ⟶

5. Copper carbonate + Sulphuric (VI) acid ⟶

6. Zinc carbonate + Sulphuric (VI) acid ⟶

7. Sodium hydrogen +Sulphuric (VI) acid
Carbonate ⟶

8. Potassium hydrogen + Sulphuric (VI) acid
Carbonate ⟶

7. Potassium hydrogen + Hydrochloric acid ⟶
Carbonate

10. Sodium hydrogen + Hydrochloric acid ⟶
Carbonate

Note;

- **Strong acids** completely ionize in solution. examples of strong acids: *hydrochloric acid, sulphuric(VI) acid and nitric(V) acid*
- **Weak acids** -partially ionize in solution. Examples of weak acids *Citric acid, Ethanoic acid (vinegar), methanoic acid*
- **Weakly acidic substances** :*lemon juice orange juice, sour milk, soda, sisal and nettle stings, most insect stings eg bee and ant sting ,tap water, rain water*
- Strong acids are more reactive than weak acids
- **NB;** distilled water and normal salts like sodium chloride, sodium sulphates are **neutral**
- However sodium carbonate ,sodium hydrogen carbonates, potassium carbonate, potassium hydrogen carbonate are **alkaline**
- Sodium hydrogen sulphate and potassium hydrogen sulphate are **acidic**

Uses of acids

- ✓ Sulphuric (VI) acid is used in car batteries as an electrolyte.
- ✓ Dilute Sulphuric (VI) acid and dilute hydrochloric acid is used to clean metal surfaces to remove the oxides
- ✓ Acids are used to treat insect stings e.g.; wasp bites
- ✓ Nitric (V) acid is used in making fertilizers and explosives
- ✓ Concentrated Sulphuric (VI) acid is used as a drying agent for gases

BASE

Definition-

A base is a substance that dissolves in water to form hydroxide (OH^-) as the only negative ions,

It is also defined as a proton acceptor

In form one a base is simply a substance that reacts with an acid to form salt and water as the only products

Alkali is a soluble base.

Properties of bases

Physical properties of bases

- ✓ They a slippery/soapy feel
- ✓ They have a bitter taste
- ✓ They turn red litmus paper blue
- ✓ Solutions are good conductors of electricity

Chemical properties of bases

- They react with acids to form salt and water as the only product. This reaction is called neutralization because the resulting solution is neutral

  Eg; sodium hydroxide + Hydrochloric acid ⟶ sodium Chloride + water

- Most metal hydroxides are decomposed by heat to form oxides and water

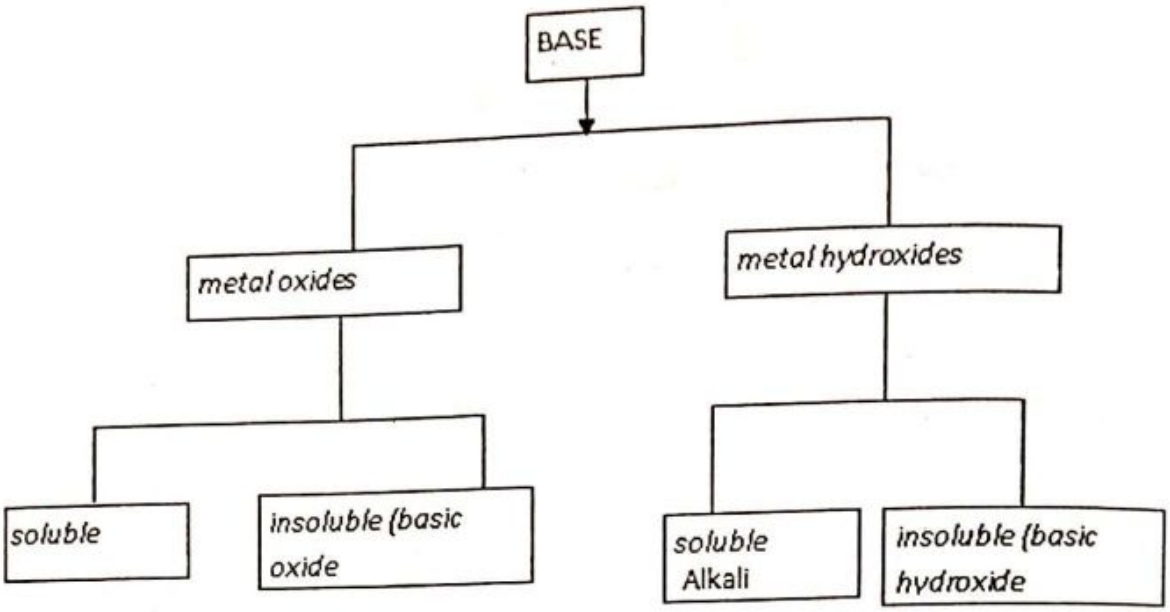
  Metal hydroxide $\xrightarrow{\text{heat}}$ metal oxide + water

  Zinc hydroxide ⟶ Zinc oxide + water

- Bases react with some soluble salts to form insoluble hydroxide known as a basic hydroxide

- Bases are usually oxides and hydroxides of metals, Ammonia and ammonium hydroxide are also bases

Classification of bases



NB: Most insect bites are acidic e.g. ant stings , bee sting ,also sisal sting .nettle plant stings are also acidic and therefore can be treated using weakly alkaline solutions like ammonia, sodium carbonate, sodium hydrogen carbonate, baking powder.

Use of bases

- *To manufacture toothpaste*
- *Used to manufacture anti-acid and indigestion tablets e.g magnesium hydroxide*
- *Sodium hydroxide is used to manufacture soap ,paper and cement*
- *Calcium oxide and hydroxide is used to reduce soil acidity and manufacture of cement.*
- *Bases are used to treat bee insect bites like ant and bee sting*

Nature of oxides

Nature of oxides- this refers to whether the oxide is acidic, neutral, basic or amphoteric

- ✓ ***Acidic oxides***- these are usually non-metal oxides that dissolves in water to form acidic solutions e.g.; Sulphur (IV) oxide, carbon (IV) oxide, Sulphur (VI) oxide, Nitrogen (IV) oxide etc
- ✓ ***Basic oxides***- these are usually metal oxides that react with dilute acids to form salt and water only e.g.; sodium oxide, magnesium oxide, potassium oxide, calcium oxide etc
- ✓ ***Neutral oxides*** – this are oxide that have no effect on red and blue litmus, and they don't react with acids or bases e.g. carbon(II) oxide, Nitrogen (I) oxide, Nitrogen(II) oxide, water (oxide of hydrogen)
- ✓ ***Amphoteric oxide***- these are oxides that have the characteristics of both acids and bases, e.g. Aluminium oxide, zinc (II) oxide and Lead (II) oxide, they react with both acids and bases

Sample questions.

1. The table below shows solutions **A, B** and **C** are tested and observations records as shown:

Solution	Observations on indicator
A	Methyl orange turns yellow
B	Phenolphthalein turns colourless
C	Litmus turns purple

(a) Using the table above, name an acid **B**

(b) How does the pH value of potassium hydroxide solution compare with that of aqueous ammonia? Explain

✓ ***PH of potassium hydroxide is higher than that of aqueous ammonia. potassium hydroxide dissociate fully while aqueous NH_3 dissociate partially .***

2. The information below gives PH values of solutions **V, W, X, Y Z**

Solution	PH values
V	2
W	6
X	11
Y	14
Z	4

(a) Which solution is likely to be?

(i) Calcium hydroxide? ***X***

(ii) Rain water? ***W***

(b) Which solution would react most vigorously with Zinc carbonate ***V***

3.) Complete the table below to show the colour of the given indicator in acidic and basic Solutions.

Indicator	Colour in	
	Acidic Solution	Basic Solution
Methyl Orange	Pink ✓½	Yellow
Phenolphthalein	Colourless	Pink ✓½

4. Use the information given below to answer the questions that follow:

Solution	G	H	I	J	K
pH	1.0	6.0	13.0	7.0	11.0

(a) Which of the solutions would be used to relieve a stomach upset caused by indigestion? **H**

(b) Which solution is likely to be:

(i) Dilute sulphuric acid?-**G**
(ii) Ammonia solution?-**K**
(iii) Distilled water -**J**
(iv) Wood ash- **I**

5. Solid copper (II) oxide is a base although it does not turn litmus paper to blue. Explain

✓ **Copper (II) oxide is insoluble in water hence there are no OH- ions in the mixture**

6. Below are the pH values of 4 types of medicine represented by letters **P, Q, R** and **S**

MEDICINE	pH VALUES
P	7.0
Q	5.0
R	8.0
S	6.0

a) It is not advisable to use **S** when a patient has stomach ulcers .Explain

✓ **S-is acidic and would make the situation worse √ ½**

b) What is the role of chemistry in drug manufacture

✓ **Chemistry is used in Discovery of drugs processing and testing of drugs √ ½**

7. Explain why very little Carbon (IV) oxide gas is evolved when dilute sulphuric (VI) acid is added to lead (II) carbonate

✓ **Its due to formation of insoluble Lead(II) carbonate which coats the metal carbonate hence preventing any further reaction**

8. State **one** commercial use of Calcium Oxide

✓ **CaO is used in correcting soil acidity. √**

9. The following data gives the **pH** values of some solutions

Solution	pH
P	14.0
Q	6.0
R	2.0

(a) What colour change would occur in solution **P** on addition of two drops of Phenolphthalein indicator? **-the indicator changes from orange to pink**

(b) State the pH value of a resulting solution when equal moles of solution **P** and **R** react **-7.0**

10. The table shows the colours obtained when some indicators are added to solutions:-

Solution	Blue litmus paper	Indicator W
Distilled water	**purple**	Colourless
Calcium hydroxide	Blue	Pink
Nitric (V) acid	Red	**colourless**

Complete the table by filling in the missing colours

(b) Identify indicator **W** - **Phenolphthalein**

11. Flower extracts can be used as Acid-base indicators. Give **two** limitations of such indicators

-give inconsistent results √ ½

-expire shortly √ ½

12. A beekeeper found that when stung by a bee, application of a little solution of Sodium hydrogen carbonate helped to relieve the irritation of the affected area. Explain

Sting of a bee is acidic √1 and is neutralized by sodium hydrogen carbonate √½ into a salt, carbon IV) oxide and water. This gives pain relief. √½

13. a)10g of sodium hydrogen carbonate were dissolved in 20cm^3 of water in a boiling tube. Lemon juice was then added drop wise with shaking until there was no further change. Explain the observation which was made in the boiling tube when the reaction was in progress

✓ **There was production of effervescence. The lemon juice contains an acid that reacts with the carbonate to produce carbon (IV) oxide.**

(b) What observations would be made if the lemon juice had been added to copper turning in a boiling tube?

No production of bubbles. Copper is below hydrogen in the reactivity

14. Define the term Universal Indicator

It is a mixture of indicators that exhibit a range of colours in acids and bases depending on the strength of the solution. It is used with a pH scale. √1

15. Describe how pH value of a sample of soil in playing field can be determined.

Put the soil sample in a beaker, add some pure water and stir the mixture. √1 Filter the mixture, to the solution obtained add some drops of universal indicator √1 and match the colour with that of PH chart to obtain the pH value √

REVISION QUESTIONS

1. Write word equations for the following reactions between hydrochloric acid and the following; (4 marks)
   a. Zinc
   b. Potassium hydroxide
   c. Magnesium oxide
   d. Calcium carbonate

2. The table below shows the pH value of solutions A,B,C and D.

Solution	A	B	C	D
pH	14.0	6.0	11.0	2.0

Which of the above solutions could be? (4 marks)

   a. Wood ash
   b. Acid rain
   c. Dilute hydrochloric acid
   d. Potassium hydroxide

3. Distinguish between a strong and a weak acid. Give an example of each. *(2 marks)*

4. A student tested the pH of five solutions using universal indicator and obtained the following results.

Solution	Colour	pH
P	Blue	10
Q	Violet	14
R	Red	1
S	Green	7
T	yellow	5

(4marks)

a) Identify a solution which is;

i) Strongly acidic _____

ii) Weakly acidic _____

iii) Strongly alkaline _____

iv) Weakly alkaline _____

b) Which of the solutions above is likely to be;

i) Potassium hydroxide _____ (1mk)

ii) Lactic acid _____ (1mk)

iii) Sulphuric (VI) acid _____ (1mk)

iv) Sodium chloride _____ (1mk)

v) Magnesium hydroxide _____ (1mk)

5. State three properties of an acid. (3mks)

6. .Define the following terms (2mks)

(i) Acids -

(ii)Indicators-

iii) Name three commercial indicators (3mks)

7. The table below shows pH values of solution A, B C, D, and E.

Solution	A	B	C	D	E
pH	6.0	2.0	8.0	11.0	4.0

(a)Which solution is likely to be (4mks)

(i)Tooth paste-

(ii)Rain water-

(iii) Hydrochloric acid-

(iv) Methanoic acid -

(b)Complete the following equation on reactions of acids. (6mks)

(i)Zinc + sulphuric acid ⟶

(ii) Sodium carbonate + Hydrochloric acid ⟶

(iii)Sodium hydroxide + Hydrochloric acid ⟶

8. Name the major component of air. (1mk)

9. Complete the table below. (4mks)

Indicator	colour in acid	colour in base
Litmus	Red	.....
Methyl orange	Pink	.....

Phenolphthalein	.....	Pink
Screened methyl orange	.....	Orange

10. The following data gives the pH value of solution P, Q, R, S and T.

Solution	pH value
P	13
Q	6
R	7
S	3
T	8

(5mks)

State which solution is;

(a) Strong acid -

(b) Strong base -

(c) Neutral-

(d) Weak base

(e) Weak acid -

11. The pH of a sample of soil was found to be 5.0. An agricultural officer recommended the addition of calcium oxide in the soil. State two functions of calcium oxide in the soil. (2 mks)

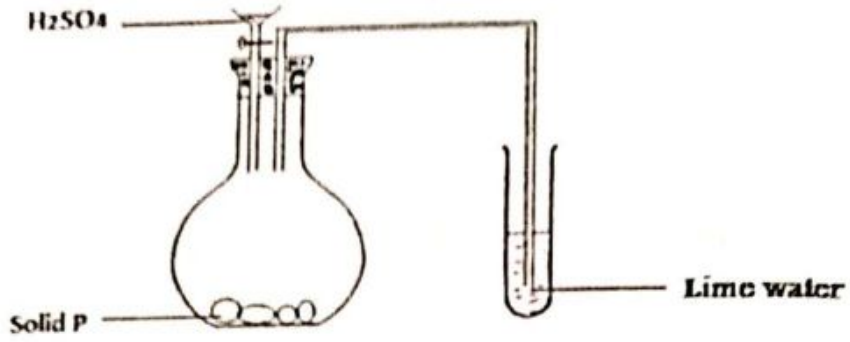
12. a) The following is a list of some pH values; 2, 4, 5, 7, 9 and 11. Complete the table below indicating the appropriate pH values. (2 mks)

Substance	pH Value
Dilute hydrochloric acid	
Wood ash Solution	
Orange juice	
Distilled water	

13. State one advantage of using the universal indicator over flower extracts indicators. (1mk)

14. What is a "neutralization reaction"? {1 mark}

15. in another experiment students reacted Sulphuric (VI) acid with solid P which is a compound of magnesium. A colourless solution Q was formed with production of a colourless gas Z.



When the colurless gas Z was bubbled in lime water, it formed a white precipitate.

i. Identify colourless gas Z. {1 mark}

ii. Identify compound P. {1 mark}

iii. Write the chemical formula of compound P. {1 mark}

iv. Name colourless solution Q. {1 mark}

16. Magnesium hydroxide is used as a medication to relieve stomach acidity:

(a) Write down the word equation for the reaction that occurs in the stomach when one takes in the medicine. (1mk)

(b) Explain why sodium hydroxide cannot be used for the same purpose. (1mk)

17. Explain what happens

a. when Lead(II) carbonate reacts with hydrochloric acid or sulphuric acid (2mks)

b. when calcium carbonate and barium carbonate are reacted with Sulphuric(VI) acid (2mks)

18. A certain indicator was added to a solution. The pH value on the scale that was used with the indicator was read as 8

a. Name the indicator (1mk)

b. Starting with beetroot , describe how its solution may be prepared and used as an indicator. (3mks)

19. A form one student was provided with the following apparatus and reagents, methyl orange indicator, a dropper, test tubes and test tube rack, a colourless solution. Describe how the student could test whether the colourless liquid is an acid. (3mks)

20. Give two examples in the following (2mks)

i. Basic oxides

(2mks)

ii.Acidic oxides

(2mks)

iii.Amphoteric oxides

CHAPTER FOUR: AIR AND COMBUSTION.

Specific Objectives

By the end of this topic, the learner should be able to:

- *State the percentage combustion of air by volume*
- *Carry out simple experiments to show that oxygen is the active part of air .*
- *Determine the percentage of oxygen in air using suitable methods*
- *Describe the combustion of specified elements in air and oxygen and name the products*
- *Explain how liquefied air can be separated into its components by fractional distillation*
- *Carry out experiments to investigate the conditions necessary for rusting, and state the composition of rust*
- *State methods of preventing rusting*
- *Prepare oxygen, investigate its properties and state its uses*
- *Arrange some elements in order of their reactivity with oxygen using experimental data*
- *Classify the products of burning elements in oxygen either as acidic or basic*
- *State pollution effects due to burning of substances in air*
- *State the uses of reactivity series.*

Air is a mixture of gases .which occur in the following composition,

Component of air	Approximate percentage by volume
Oxygen	20
Carbon(IV) oxide	0.03
Nitrogen	78
Water vapour	Variable
Noble gases	0.97
Dust particles	Variable

Experiments to determine the percentage of the active part of air

The active part of air is oxygen. The percentage of oxygen in the atmospheric air can be determined using the following experiments;

- *Using a burning candle*
- *Using smouldering phosphorous*
- *Burning copper metal in air*
- *Rusting of iron fillings.*

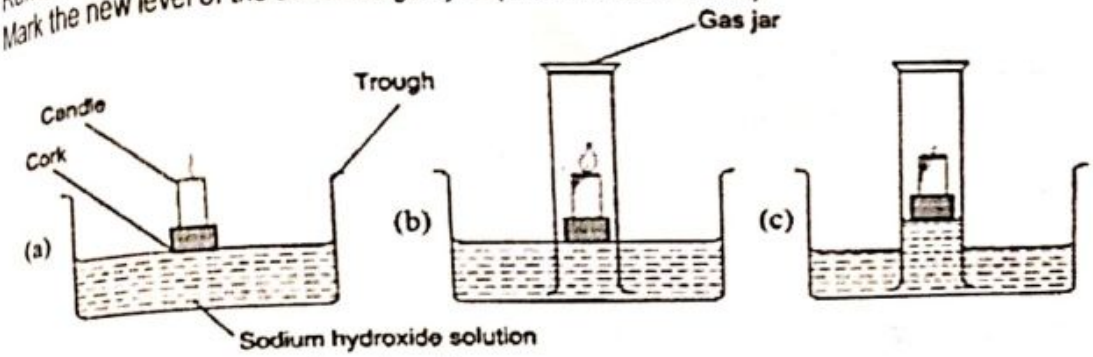
***Objectives**; by the end of the lesson/experiment the learner should be able to:*

1) *State and explain the Observations made during the experiments*
2) *Calculate the percentage of the active part air used in combustion.*
3) *Write a word equation for the reaction that took place*
4) *State the sources of errors in the experiment*
5) *State the precautions if any taken during the experiment*
6) *Draw a diagram of any of the experimental set up above above*

(a)To find the composition of air supporting combustion using a candle stick

Procedure

Measure the length of an empty gas jar. Place a candle stick on a trough Float it on sodium hydroxide in basin/trough. Cover it with the gas jar. Mark the level of the air in the gas jar. **(Initial volume of air)** Remove the gas jar. Light the candle stick. Carefully cover it with the gas jar. Observe for two minutes. Mark the new level of the air in the gas jar. **(Final volume of air)**



❖ **Observations and explanations**

✓ *Level of solution rises in the gas jar to occupy the space left by used up oxygen*

✓ *Candle burns for a while and then goes off after all the oxygen is used up.*

❖ **Calculation of percentage of air used by burning candle**

The formular for calculating the percentage of oxygen is shown below

✓ $\frac{initial\ volume\ of\ air\ in\ the\ gas\ jar(b) - final\ volume(c)}{initial\ volume\ (b)} \times 100$

The following are Sample results from a similar experiment:

Initial volume of air in the gas jar = 90 cm^3

Final volume of air in the gas jar = 75 cm^3

$\frac{90-75}{90} \times 100 = 16.6666667\%$

Equation

Candle is a hydrocarbon and burns in presence of air to form carbon (IV) oxide and water

Candle + oxygen ⟶ *carbon (IV) oxide + water*

Sources of errors

✓ *Candle may go off before all the oxygen is used up due to the build up of Carbon (IV) Oxide gas.*

✓ *The sodium hydroxide may not absorb all the Carbon (IV) Oxide produced*

- **Dilute Sodium hydroxide is preferably used instead of water because Carbon (IV) Oxide is slightly soluble in water but very soluble in Sodium hydroxide. Therefore,** *it absorbs most of the Carbon (IV) Oxide that was initially in the gas jar and that which is produced during combustion.*
- **The apparatus should be allowed to cool before final reading is taken** *because heat causes expansion of gases*

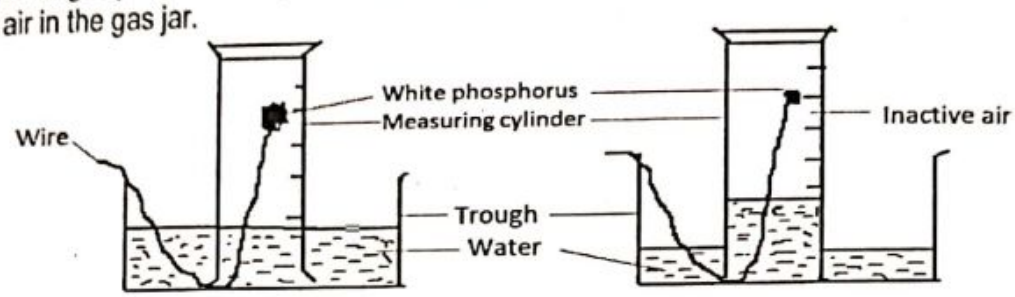
Name two non poisonous gases produced by a burning candle

- ✓ Carbon (IV) oxide
- ✓ Water vapour

b). *To find the composition of air supporting combustion using a white phosphorus.*

Procedure

Set up the experiment as shown. Invert a gas jar on a trough containing water; label the initial volume of air in gas jar ,insert the phosphorous using a nichrome wire, let it smolder and record the final volume of air in the gas jar.



Beginning of experiment After sometimes

Discussion of the experiment

- Red and white phosphorus smoulder in air. This is because phosphorus reacts spontaneously with oxygen to form a mixture of oxides. This explains why phosphorus is stored under water as **it does not react with water.**

Observations

- ✓ The level of water in the gas jar rose up to occupy space left by the used up oxygen
- ✓ The level of water in the trough dropped.
- ✓ The amount of phosphorous reduces in size
- ✓ Phosphorous smolders producing white fumes- the white fumes are due to reaction of phosphorous with air to form phosphorous (III) oxide and phosphorous (V) oxide

Chemical equations for the reaction involved

Phosphorous + oxygen gas ⟶ phosphorous (III) oxide

$P_{4s} + 3O_{2(g)} \longrightarrow 2P_2O_{3(g)}$

Phosphorous + oxygen gas ⟶ phosphorous (V) oxide

$P_{4(s)} + 5O_{2(g)} \longrightarrow 2P_2O_{5(g)}$

Calculation of percentage of air used by smouldering phosphorous

$$\frac{initialvolumeofairinthegasjar - finalvolume}{initialvolume} \times 100$$

Sample results

Initial volume of air in the gas jar = 80 cm³

Final volume of air in the gas jar = 66 cm³

$\frac{80-66}{80} X\ 100 = 17.5\%$

Sources of errors

- ✓ *Wrong readings from apparatus*
- ✓ *Phosphorous may not react with all the oxygen in the gas jar*

- After the phosphorous oxides are formed they react with water forming acidic solution, therefore if blue and red litmus is dipped into the resulting solution red litmus remains red while blue litmus turns red. **The solution gives a pH of 2 with universal indicator because phosphoric (V) acid is a strong acid.**

phosphorous (III) oxide + water ⟶ phosphoric (III) acid

$P_4O_{6(s)} + 3H_2O_{(l)} \longrightarrow 2H_3PO_{3(aq)}$

phosphorous (V) oxide + water ⟶ phosphoric (V) acid

$P_4O_{5(s)} + 3H_2O_{(l)} \longrightarrow 2\,H_3PO_{4(aq)}$

The apparatus should allowed to cool before final reading is taken because heat causes expansion of gases

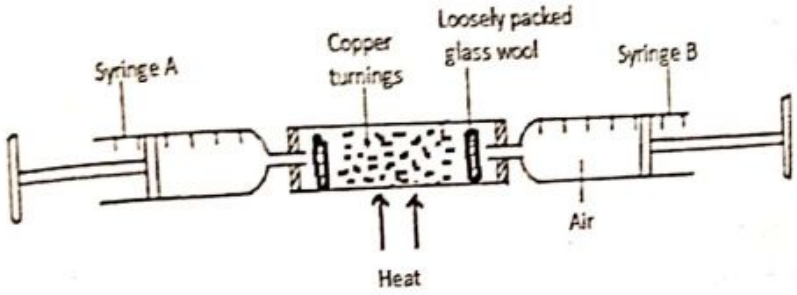
NB: phosphorous is suitable in this experiment because;

- *It does not react with water*
- *It smolders in air*

c) ***To determine the percentage of air used by burning copper metal.***

Procedure

Two syringes are used as shown in the diagram below ,syringe A is filled with air and initial volume of air in the syringe noted, while syringe B is empty, air is passed over heated copper turnings repeatedly until there no further change in volume, the apparatus are allowed to cool and the final volume is noted



Observations

- ✓ *The volume of air in syringe A decreases*
- ✓ *Brown copper metal changes colour into black due to reaction with oxygen to form black copper (II) oxide*

Chemical equation of reaction

Copper + oxygen gas ⟶ copper (II) oxide

(Brown) (Black)

$2Cu_{(s)} + O_{2(g)} \longrightarrow 2\,CuO_{(s)}$.

- **Calculation of percentage of air used by burning copper metal**

$$\frac{\textit{initial volume of air in syringeA} - \textit{final volume}}{\textit{initial volume}} \times 100$$

Sample results

Initial volume of air in the gas jar = 7.5cm³

Final volume of air in the gas jar = 6.0 cm³

$\frac{7.5-6.0}{7.5} \times 100 = 20\%$

Points to note

- *The apparatus are allowed to cool before taking the final readings* **because air expands when heated**
- *The air is passed repeatedly over heated copper* **to ensure that all oxygen is used up.**
- *The air is passed slowly over heated copper to* **allow enough time of contact between the reactants to ensure that all oxygen is used up.**
- *The glass wool plug is* **used to stop copper turnings from being sucked into the syringes.**
- *Excess copper turnings are* **used to ensure that all the oxygen reacts.**

Sources of errors

- ✓ The air initially in the combustion tube is not taken into account
- ✓ Copper may not react with all the oxygen in the syringe.
- ✓ There is possible leakage of air in syringes
- ✓ Wrong readings of volumes from the apparatus

NB

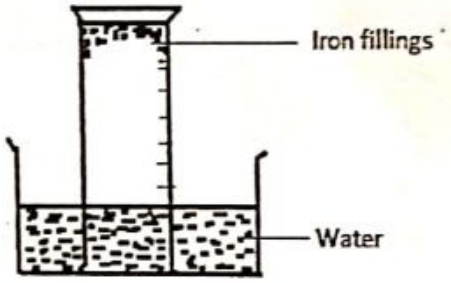
If copper turnings are replaced by magnesium shavings. The % of active part of air obtained is extra ordinarily high.

This is because magnesium is more reactive than copper. ***The reaction is highly exothermic. It generates enough heat for magnesium to react with both oxygen and nitrogen. This reduces the volume of air left.***

d) To determine the percentage of air used by rusting fillings.

Procedure

Sprinkle a measuring cylinder with water then add iron fillings into it, then invert the measuring cylinder into a trough containing water as shown in the diagram below. Note the initial volume of air in the measuring cylinder. Allow it to stand for four days. Then note the final volume of air in the measuring cylinder.



NB; the measuring cylinder is sprinkled with water for the iron fillings to stick on it.

Observations

- ✓ Iron fillings turned from grey to brown due to reaction between iron and oxygen in the measuring cylinder in presence of moisture to form rust.
- ✓ Level of water in the measuring cylinder rose to replace the space occupied by the air used up in rusting.

Chemical reaction

Iron + oxygen + water ⟶ *hydrated iron (III) oxide*

Calculation of percentage of air used by rusting iron fillings

$$\frac{initialvolumeofairinthegasjar - finalvolume}{initialvolume} \times 100$$

Sample results

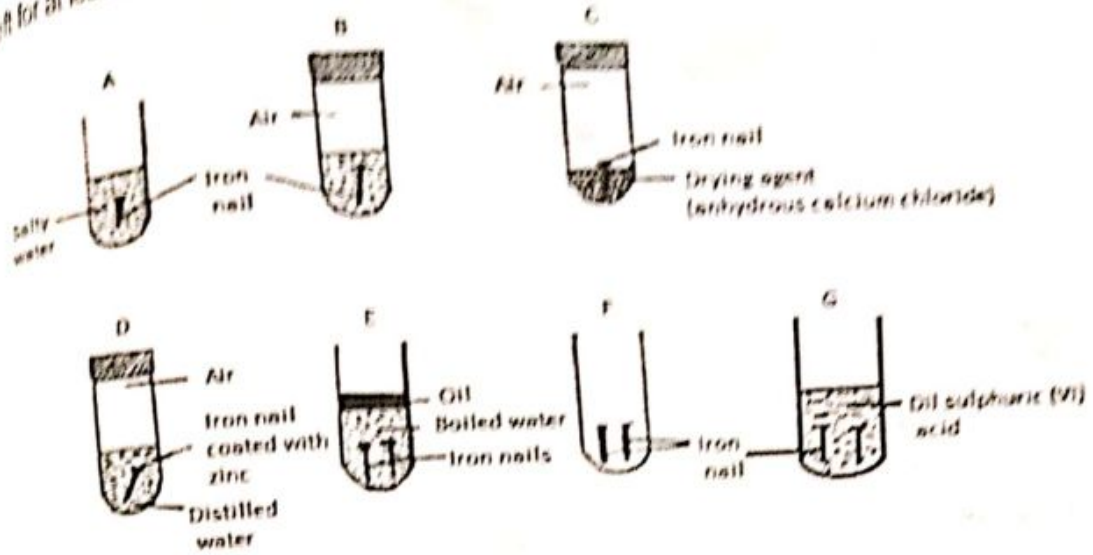
Initial volume of air in the gas jar = 18.0 cm³

Final volume of air in the gas jar = 14.7 cm³

$\frac{18-14.7}{18}$ *X 100 = 18.33%*

Describe an experiment to determine conditions necessary for rusting

Two iron nails are put Test –tubes A, B, C, D, E, F and G and set as shown in the diagrams below then left for at least four days.



Discussion of results

- In A and B rusting took place due to presence of air and water but rusting is more intense in A than B because salt accelerate rusting, in both A and B the iron nails will be covered with brown coat (rust) after four days
- In C rusting did not take place because the drying agent absorbs moisture in the test-tube, hence no moisture
- In D the iron is coated with zinc which prevents it from coming in contact with both air and moisture and therefore rusting did not occur
- In E rusting did not occur because boiling the water drove out dissolved oxygen and covering it with oil prevented reentry of oxygen.
- In F rusting occurred because oxygen is present and water vapour from air
- In G rusting occurred due to presence of water and dissolved oxygen but it is more intense as acid accelerate rusting

NB: **instead of boiling water pyrogallic acid can be used to absorb oxygen hence prevent rusting from taking place**

Conditions necessary for rusting

Water and air

Factors that accelerate rusting

Salty conditions

Acidic conditions

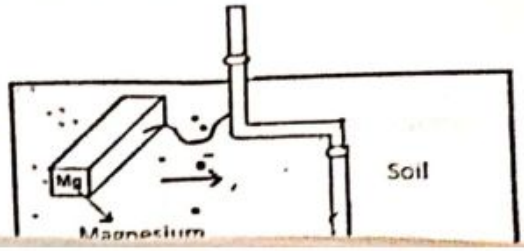
Chemical name and formula for rust.

Name –*hydrated iron (III) oxide*

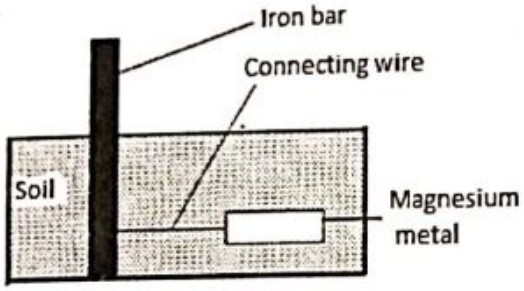
Formula- $Fe_2O_3.xH_2O$ where x is 1,2,or 3

Prevention of rusting.

- **Oiling and greasing** - *this keeps out water, it is used in moving engines parts where other methods cannot be used due to friction.*
- **Sacrificial protection**-*it is whereby blocks of a more reactive metal like magnesium is attached to iron object /*



structure using a conductor, whereby the more reactive metal corrode in place of iron. The method is applied in ships, water and oil pipes. See diagram below



- ***Painting***- *e.g. cars, roofs and marine vessels. Keeps out water and oxygen but if cracks occur rusting takes place*
- ***Alloying****-mixing iron with other metal which do not rust e.g. nickel*

Galvanizing-coating of iron with a thin layer of zinc, the advantage is that if there is crack zinc corrodes instead of iron.

Disadvantages of rusting

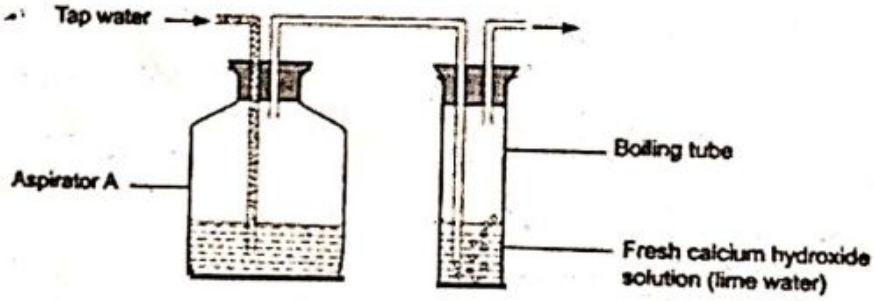
- ❖ Destroy machinery and equipments made of iron
- ❖ Destroy roofs made of iron etc

Advantages of rust

- ❖ Helps in decomposition of waste materials made of iron hence reducing environmental pollution
- ❖ Help to recycle iron into the soil which is essential mineral for plant growth,

Experiment to show presence of Carbon (IV) Oxide in air

Allow water to flow into aspirator A and into a boiling tube containing calcium hydroxide solution.

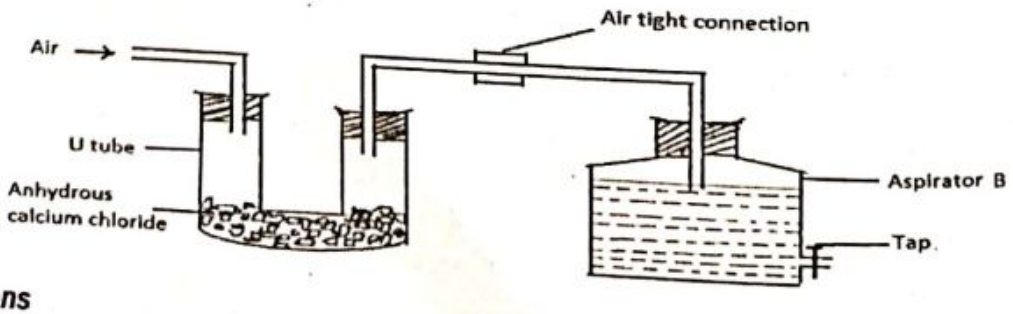


Observation

A white precipitate is formed in the boiling tube indicating presence of Carbon (IV) Oxide. This is because carbon (IV) oxide reacts with calcium hydroxide (lime water) forming insoluble Calcium carbonate (white precipitate

Experiment to show presence of water vapour in air

Water is allowed to flow out of aspirator B *creating a suction force which draws in air through the U-tube.*



Observations

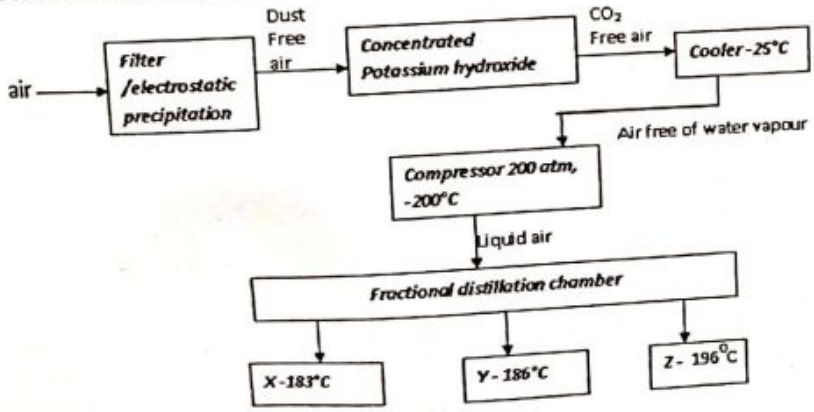
The white anhydrous calcium chloride will **absorb** water vapour from the atmospheric air forming a colourless solution. Substances, which absorb water (moisture) from the atmosphere to form a colourless solution, are called **deliquescent substances** and the process is called **deliquescence.** Other deliquescent substances include: - **Magnesium Chloride, Zinc Chloride, solid Sodium Hydroxide and Anhydrous Iron (III) Chloride**

Fractional distillation of liquefied air

- *Air is first purified by removing dust particles through* ***electrostatic precipitation*** *or by use of filters; electrostatic precipitation involves passing the air through chambers containing charged rubber sheets.* **Carbon (IV) Oxide** *is removed by bubbling the air through concentrated sodium hydroxide solution,*
- **Water vapour** *is removed by cooling the air to -25°C at the cooler whereby water solidifies as ice or by passing the air through concentrated Sulphuric (IV) acid solution.*
- *The remaining air is then taken to the* ***compressor at -200°C and 200atmosphere*** *pressure where the air is liquefied by repeated compression and sudden expansion.*
- *Water and carbon (IV) oxide are removed before compression because they solidify at lower temperatures hence clogging of pipes which will interfere with flow of the liquid gas,*

- *The liquid air is then led into a fractionating column where the components of air nitrogen, argon and oxygen are obtained according to their volatility/boiling point.*
- ***Nitrogen having a lower boiling point is collected first at -196°C followed by argon at -186°C then oxygen at -183°C***
- ***Other components of air obtained from this process are noble gases like neon, helium, and krypton.***

Fractional distillation liquid air

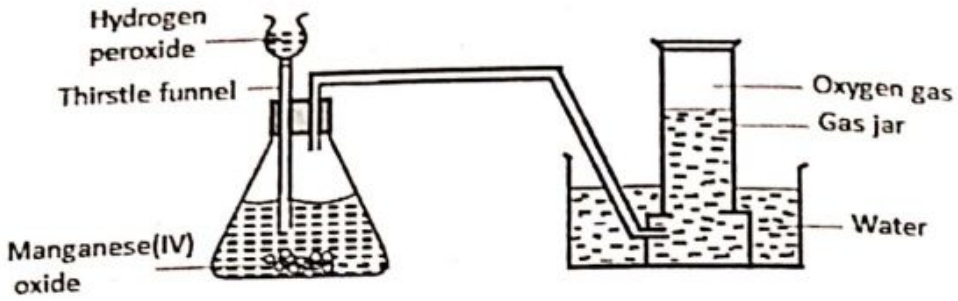


Oxygen

Laboratory preparation of oxygen gas

Preparation of oxygen in the laboratory can be done in the following ways

a) **Decomposition of hydrogen peroxide in presence of manganese (IV) oxide as catalyst**
Hydrogen peroxide decomposes slowly to produce oxygen and water under normal conditions. On adding Manganese (IV) Oxide the rate of decomposition is speeded up. Manganese (IV) Oxide acts as a **catalyst**. A **catalyst** is a substance that alters the rate of a chemical reaction.



Equation for the reaction

Hydrogen peroxide $\xrightarrow{\text{manganese (IV) oxide}}$ water + oxygen gas

$2H_2O_{2(l)} \xrightarrow{MnO_2} 2H_2O_{(l)} + O_{2(g)}$

- Oxygen is collected over water because it is **slightly** soluble in water.
- The first few bubbles of oxygen are not collected because the gas is mixed with air which was originally in the flask.

b) Adding cold water to sodium peroxide

The setup is as shown in (a) above

Sodium peroxide + water $\longrightarrow$ sodium hydroxide + oxygen

$2Na_2O_{2(s)} + 2H_2O_{(l)} \longrightarrow 4NaOH_{(aq)} + O_{2(g}$

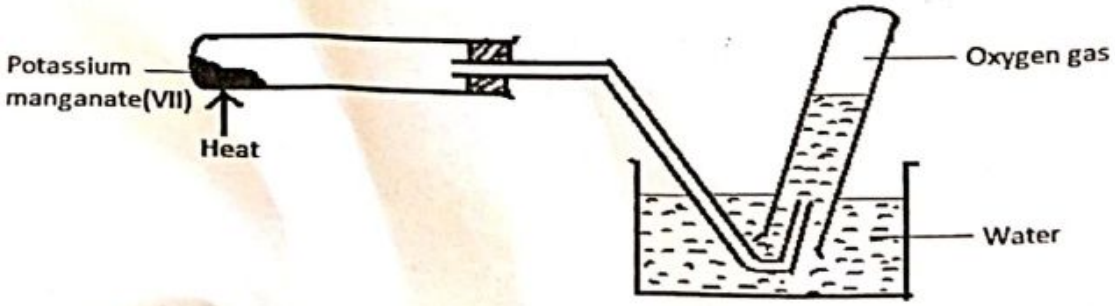
- Oxygen is collected over water because it is slightly soluble in water.
- The first few bubbles of oxygen are not collected because the gas is mixed with air which was originally in the flask.

c) heating Potassium manganate (VII)

potassium manganate(VII) decomposes on heating to form potassium manganate(VI), manganese (VI) oxide and oxygen.

Potassium manganate (VII) $\xrightarrow{\text{heat}}$ **Potassium manganate (VI)** + **Manganese (IV) Oxide** + **oxygen gas**

$2KMnO_{4(s)} \xrightarrow{\text{heat}} K_2MnO_{4(s)} + MnO_{2(s)} + O_{2(g)}$

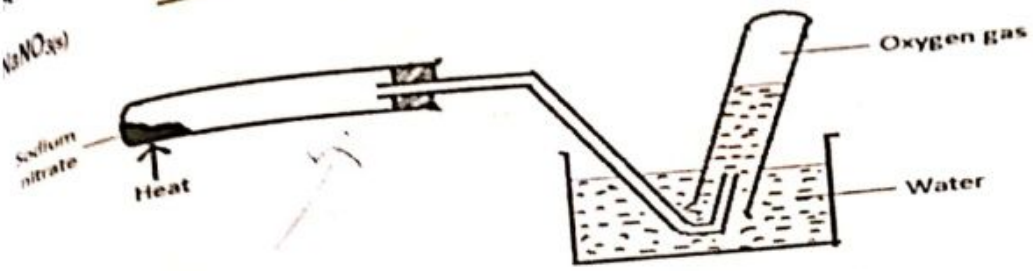


d) Heating sodium nitrate

Sodium nitrate decomposes on heating to form sodium nitrite and oxygen gas.

sodium nitrate → sodium nitrite + oxygen gas

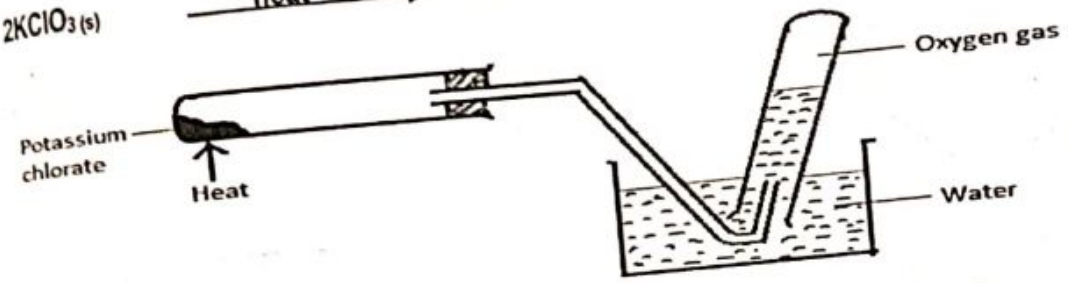
$NaNO_{3(s)}$ —heat→ $NaNO_{2(s)}$ + $O_{2(g)}$



e) Heating potassium chlorate(V)

Potassium chlorate —heat→ potassium chloride + oxygen gas

$2KClO_{3(s)}$ —heat→ $2KCl_{(s)}$ + $3O_{2(g)}$



Physical Properties of oxygen gas

- ✓ Odourless and colourless gas and tasteless gas.
- ✓ It has a low boiling point of -183°C
- ✓ Neutral gas
- ✓ Almost insoluble in water and that is why it is collected over water

Chemical test for oxygen gas

- Lower a glowing splint in a gas jar full of oxygen, oxygen relights the glowing splint.

Chemical properties of oxygen gas

(a)Burning of substances in air

Metals and non metals burn in presence of oxygen to form corresponding oxides

(i)Reaction of metals with Oxygen/air

The following experiments show the reaction of metals with Oxygen and air.

I. Burning Magnesium

Observations: *magnesium burns in air with a bright white flame forming a mixture of white and green solid. The white solid is magnesium oxide and green solid is magnesium nitride*

(a)In air

Magnesium + Oxygen → Magnesium Oxide

$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$ (white)

Magnesium + Nitrogen → Magnesium Nitride

$3Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$ (green)

When oxides react with water metal hydroxide is formed but when water is added to metal nitride, ammonia gas is evolved.

Magnesium Oxide + water ⟶ magnesium hydroxide

$MgO_{(s)} + H_2O_{(l)} \longrightarrow Mg(OH)_{2(s)}$

Magnesium Nitride + water ⟶ magnesium hydroxide + Ammonia

$Mg_3N_2\,(s) + 6H_2O_{(l)} \longrightarrow 3Mg(OH)_{2(g)} + 2NH_{3(g)}$

II. Burning Sodium

*Sodium burns with a **yellow** flame in air forming a **white** solid. Which is sodium oxide.*

Chemical equations

Sodium + Oxygen/air ⟶ Sodium Oxide

$4Na(s) + O_2(g) \longrightarrow 2Na_2O(s)$

Sodium Oxide dissolves in water to form a basic/alkaline solution of Sodium hydroxide. turns red litmus paper blue.

Chemical equations

Sodium Oxide + Water ⟶ Sodium hydroxide

$Na_2O(s) + H_2O\,(l) \longrightarrow Na\,OH(aq)$

*(b)Sodium burns in **pure oxygen** forming yellow **Sodium peroxide***

Chemical equations

Sodium + Oxygen ⟶ Sodium peroxide

$2Na(s) + O_2(g) \longrightarrow Na_2O_2\,(s)$

Sodium peroxide dissolves in water to form a basic/alkaline solution of Sodium hydroxide. Oxygen is produced.

Chemical equations

Sodium Oxide + Water ⟶ Sodium hydroxide + Oxygen

$2Na_2O_2\,(s) + 2H_2O\,(l) \longrightarrow 4NaOH(aq) + O_2\,(l)$

III. Burning Calcium

*Calcium burns with a **red** flame in air forming a **white** solid. Which is calcium oxide.*

Chemical equations

Calcium + Oxygen/air ⟶ calcium Oxide

$2Ca(s) + O_2(g) \longrightarrow 2CaO(s)$

Chemical equations

Calcium Oxide + Water ⟶ Calcium hydroxide

$CaO(s) + H_2O\,(l) \longrightarrow Ca(OH)_2\,(aq)$

IV. Burning Iron

When iron is heated in presence of oxygen it glows red with few sparks, forming red iron (III) oxide.

Chemical equations

Iron + Oxygen/air ⟶ Iron (III) Oxide

$4Fe(s) + 3O_2(g) \longrightarrow 2Fe_2O_3(s$

Iron (III)Oxide is insoluble in water hence it has no effect on red or blue litmus papers

V. Burning Copper

Copper burns in oxygen with a green flame forming black copper (II) oxide

Chemical equations

Copper + Oxygen/air ⟶ Copper(II) Oxide

$2Cu(s) + O_2(g) \longrightarrow 2CuO(s)$

Copper (II) oxide is insoluble in water hence it has no effect on red or blue litmus papers

Elements burn in air and oxygen at different rates; they burn faster in oxygen than in air. Nitrogen slows down the rate of burning.

Reactions of non-metals with oxygen

Carbon + Oxygen ⟶ Carbon (IV) Oxide

II. Burning Sulphur

Observations

*-Sulphur burns with a **blue** flame forming sulphur (IV) oxide*
-Gas produced that has pungent choking smell
-Solution formed turn blue litmus paper faint red.
Red litmus paper remains red.

Explanation

Sulphur burns in air and faster in Oxygen with a blue flame forming Sulphur (IV) oxide gas.
Sulphur (IV) oxide gas dissolve in water to form weak acidic solution of Sulphuric (IV)acid.

Chemical Equation

Sulphur + Oxygen ⟶ Sulphur (IV)oxide

$S(s) + O_2(g) \longrightarrow SO_2(g)$ *(in excess air)*

Sulphur(IV)oxide + Water ⟶ Sulphuric(IV)acid

$SO_2(g) + H_2O(l) \longrightarrow H_2SO_3(aq)$

III. Burning Phosphorus

Phosphorus burns in air with a white flame forming a mixture of Phosphorous (V)oxide and Phosphorous (III)oxide, the oxides dissolve in water forming acidic solutions.

Phosphorus + Oxygen ⟶ Phosphorous (V) oxide

$4P(s) + 5O_2(g) \longrightarrow 2P_2O_{5(s)}$

Phosphorus + Oxygen ⟶ Phosphorous (III) oxide

$4P(s) + 3O_2(g) \longrightarrow 2P_2O_{3(s)}$

Phosphorous (V)oxide + Water ⟶ Phosphoric(V)acid

$P_2O_{5(s)} + 3H_2O_{(l)} \longrightarrow 2H_3PO_{4(aq)}$

Phosphorous (III)oxide + Water ⟶ Phosphoric(III)acid

$P_2O_{3(s)} + 3H_2O_{(l)} \longrightarrow 2H_3PO_{3(aq)}$

Burning carbon in air

Carbon : carbon burns with a yellow flame to form a mixture of oxides

Carbon + Oxygen (excess air/oxygen) ⟶ Carbon(IV)oxide

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ (in excess air)

Carbon + Oxygen (limited air/oxygen) ⟶ Carbon(II)oxide

$2C(s) + O_{2(g)} \longrightarrow 2CO_{(g)}$ (in limited air)

Carbon(IV)oxide + Water ⟶ Carbonic(IV)acid

$CO_2(g) + H_2O(l) \longrightarrow H_2CO_3(aq)$ *(very weak acid)*

Summary of burning metals in oxygen

Metal	How it burns in air	How it burns in oxygen	Appearance of product	Name of product	Solubility of product in water	Effect on product on litmus
Sodium	Burns with yellow flame	Very vigorous yellow flame	White solid	Sodium oxide and sodium peroxide	Soluble Alkaline gas evolved	Turns blue
Calcium	Red flame	burns Very vigorous yellow flame	White solid	Calcium oxide and calcium nitride	Slightly soluble Alkaline gas evolved	Turns blue
magnesium	Burns with a bright white flame	Burns with more bright white flame	White powder	Magnesium oxide and magnesium nitride	Slightly soluble Alkaline gas evolved	Turns blue
Iron	No burning Glows red with few sparks	Glows more brightly and sparks	Red-brown solid	Iron (III) oxide	insoluble	No effect
Copper	No burning, surface turns black	Burns with a blue flame ,surface turns black	Black solid	Copper (II) oxide	insoluble	No effect

Summary of effect of burning non-metals in oxygen

Non-metal	How it burns in oxygen	Name of product	Appearance of product	Solubility of product in water	Effect on product on litmus
Sulphur	Burns with a blue flame	Sulpur(IV) oxide	white fumes	Soluble	Turns red
Carbon	Burns with a yellow flame	carbon(IV) oxide	White fumes	Soluble	Turns red
Phosphorous	Burns with a white flame	phosphorous (III) oxide, phosphorous (IV) oxide,	White fumes	Soluble	Turns red

Competition for oxygen and redox reactions

Reduction – this is removal of oxygen from a substance

Redox reaction – this is a reaction whereby both oxidation and reduction take place at the same time.

Oxidation- addition of oxygen to a substnce.

$$Mg_{(s)} + CuO_{(s)} \longrightarrow MgO_{(s)} + Cu_{(s)}$$

Explanation

Magnesium being more reactive than copper removes oxygen from it, hence **magnesium is oxidized** while **copper is reduced.**

Magnesium is the **reducing agent** while copper (II) oxide is the **oxidizing agent**

A substance to which oxygen is added is said to have been **oxidized**. The reactions in which elements combine with oxygen are referred to as **oxidation.**

Application of Redox reactions

- In extraction of metals from their ores using carbon and carbon (II) oxides as reducing agents.

- A more reactive element removes oxygen from a less reactive element but a less reactive element cannot remove oxygen from a more reactive element.

Memorizing Reactivity series- use mnemonic below

Popular-**Potassium**——— **-most reactive**

Scientist -**Sodium**

Can-**Calcium**

Make-**Magnesium**

A-**Aluminium**

Common-- carbon

Zoo-**Zinc decreasing reactivity**

In-**Iron**

Low-**Lead**

Humid-**Hydrogen**

Countryside –**Copper**

where

Most-**Mercury**

Students-**Silver**

Go-**Gold**————**least reactive**

NB metals form solid oxides while non-metals form gaseous oxides.

The metals can be arranged in order of their rates of reaction with oxygen from the most reactive to the least reactive. This arrangement is referred to as a **reactivity series of metals.**
Mercury, silver and gold are less reactive than copper and are not easily oxidized.

✓ **Oxidation**- refer to addition of oxygen

Uses of oxygen gas

- *When enriched with air it is used in hospitals by patients with breathing difficulties*
- *When mixed with helium it is used by mountain climbers*
- *Oxygen is used to burn fuels e.g. burning fuels for propelling rockets*
- *Its mixture with acetylene burns to produce a very hot flame used in welding and cutting metals e.g. in the oxy-acetylene torch*
- *During steelmaking it is used to remove iron impurities*
- *Is used as one of reactants in fuel cell*
- *Used together with hydrogen to form oxy-hydrogen flame used in welding*

Methods of gas collection

Gases can be collected using different method depending on the properties of the gases.
These properties include

- *Solubility*
- *Melting point and boiling point*
- *Density*
- *Volatility*
- *Toxicity*
- *purity*

a)Downward delivery/upward displacement of air

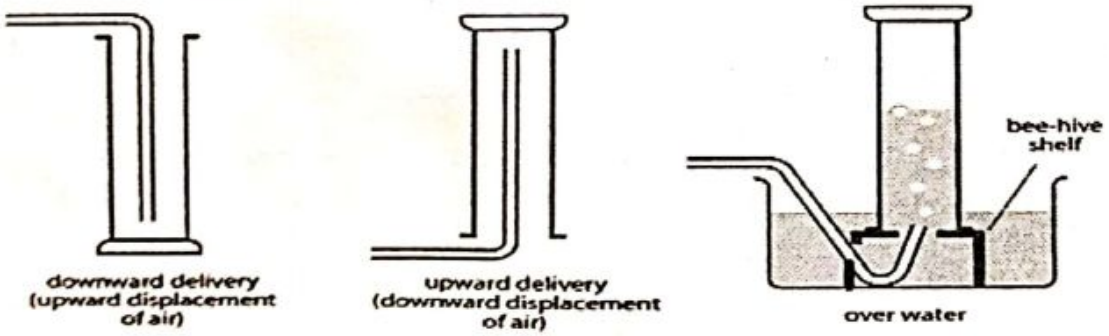
This method is used for gases denser than air and not required pure as it mixes with air e.g. *Carbon (IV) Oxide Gas (CO_2), Chlorine Gas (Cl_2), Sulphur (IV) Oxide (SO_2), Sulphur (VI) Oxide (SO_3), Nitrogen (IV) Oxide (NO_2), Hydrochloric Acid (HCl), Hydrogen Sulphide Gas (H_2S), And Nitrogen (I) Oxide(N_2 O)*

b) Downward displacement of water (over water)

This is used for gases insoluble in water and the gas is not required dry, e.g. *oxygen, nitrogen, . Nitrogen (I) oxide, nitrogen (II) oxide, carbon (II) oxide, methane, ethane. Ethene, ethyne and hydrogen.*

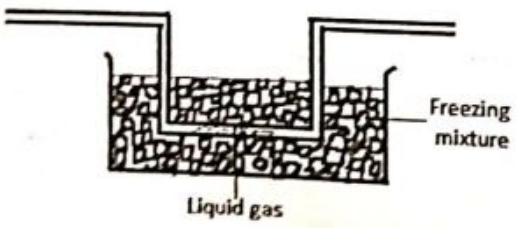
c) Upward delivery/ downward displacement of air

This method is used for gases less denser than air and it is not required pure as it mixes with air e.g. *hydrogen gas (H_2), ammonia gas (NH_3), methane,*

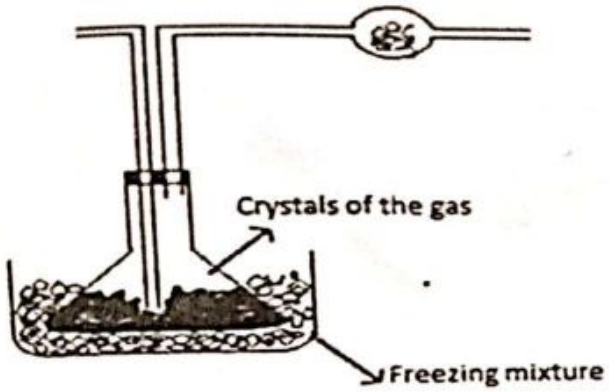


d) By liquefaction this is used for gases that is easily liquefied e.g

Nitrogen (IV) oxide.



(e) Freezing. This method is used to collect gases that solidify when cooled e.g sulphur (VI) oxide



f) Use of syringe

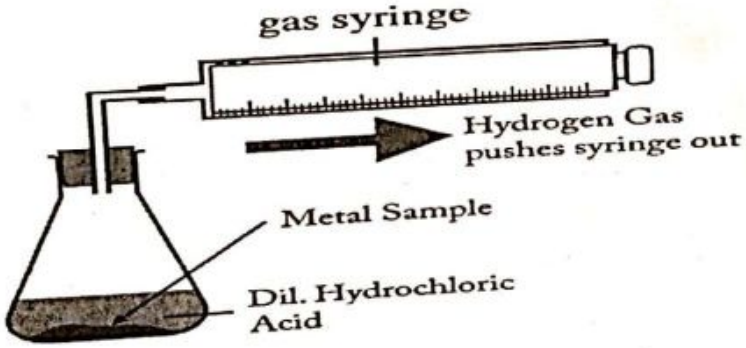
This method is used if the gas is required pure and also for gases that have almost density as air e.g. *CO, N_2, NO, O2, C_2H_4 and C2H6*

NB, the density of air is 30 so you can easily know whether the gas is denser than air by calculation the *RFM e.g. for CO_2 = 12 + (16 X 2)= 44 hence it is denser than air*

For NH_3= 14 + (1X3) =17 less dense than air

For HCl= 1+35.5 =36.5 denser than air etc

For gases whose density is between 28-32 eg CO, N_2, NO,O_2, C_2H_4 and C_2H_6 ,their density very close to that of air and they are either collected over water if not needed dry of by use of syringe if needed dry and pure



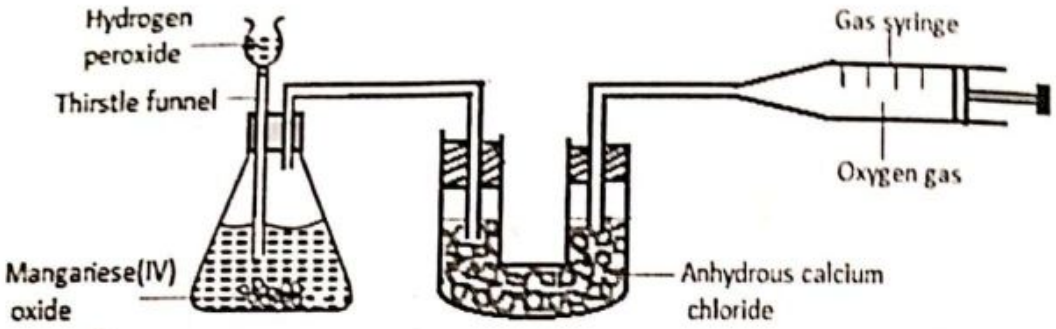
Drying of gases

Drying of gases- most gases are dried using fused $CaCl_2$ or anhydrous Calcium oxide in a U-tube or concentrated sulphuric (VI) acid in a wash bottle

Concentrated sulphuric (VI) acid cannot be used to dry an alkaline gas and that is why it is not used to dry ammonia

Calcium oxide is not used to dry acidic gases like Chlorine, sulphur (IV) oxide, Carbon (IV) oxide, Nitrogen (IV) oxide

Draw a diagram for preparation and collection of dry oxygen gas



Points to Note about Preparation of Gases

Note; in preparation of gases in many a times there will be drawn a diagram and be required to identify the mistakes made in preparation of certain gas. In such questions you look for;

- ✓ ***Method of collection in relation to the properties of that gas*** *i.e. is it soluble, denser than air*

Gases less denser than air like H_2, NH_3 should be collected by upward delivery/downward displacement of air, gases denser than air like chlorine, carbon (IV) oxide, sulphur (IV) 0xide ,H_2S, NO_2 etc should be collected by downward delivery, gases soluble in water like SO_2, HCl cannot be collected over water
Gases with almost the same density as air like O_2,N_2,CO, NO if needed dry should be collected using a syringe

***Reagents used**, look for formation of insoluble coat of insoluble salt which will interfere with preparation of the gas e.g. use of lead or calcium metal and dilute H_2SO_4 of hydrogen is wrong as this will lead to formation of insoluble coat of $PbSO_4$ and $CaSO_4$ which will prevent further reaction between the acid and the metal/use of $PbCO_3$ and sulphuric (VI) acid to prepare carbon (iv) oxide*

Thistle funnel should deep into the reaction mixture to avoid escape of the gas through it

Delivery tube should not deep into the reaction mixture

***Appropriate drying agent should be used** i.e. gas should not react with the drying agent*
Hydrogen cannot be prepared using copper metal and dilute acid because copper is less reactive than hydrogen hence cannot displace hydrogen from an acid
Nitric (V) acid cannot be used to prepare hydrogen because it is a strong oxidizing agent and it will oxidize the hydrogen produced into water

***Soluble gases** like CO_2, SO_2, NO2, HCl, Cl and NH_3 should never be collected over water*
when the gas is needed dry a drying agent is a must i.e conc. H_2SO_4 cannot be used to dry ammonia and hydrogen sulphide as it reacts with the gases, anhydrous calcium oxide should not be used to dry acidic gases like CO_2, SO_2,NO_2,HCl and Cl as it is basic and reacts with the gas

The complete reactivity series of metals/elements

Element/Metal	Symbol
Potassium	K
Sodium	Na
Calcium	Ca
Magnesium	Mg
Aluminium	Al
Zinc	Zn
Iron	Fe
Lead	Pb
Hydrogen	H
Copper	Cu
Mercury	Hg
Silver	Ag
Gold	Au
platinum	Pt

Most reactive

- Metals compete for combined Oxygen. A metal/element with higher affinity for oxygen removes Oxygen from a metal lower in the reactivity series/less affinity for Oxygen.
- When a metal/element gains/acquire Oxygen, the **process** is called **Oxidation**.
- When metal/element donate/lose Oxygen, the **process** is called **Reduction**.
- An element/metal/compound that undergoes Oxidation is called **Reducing agent**.
- An element/metal/compound that undergoes Reduction is called **Oxidizing agent**.
- A reaction in which **both** Oxidation and Reduction take place is called a **Redox** reaction.

Chemical equation

Reduction process

Oxidation

1. Copper (II) oxide + Magnesium → Magnesium oxide + Copper
   (Black) (White ash/solid) (Brown)
   CuO(s) + Mg(s) → MgO(s) + Cu(s)
   (Oxidizing Agent) (Reducing Agent)

2. Zinc (II) oxide + Magnesium → Magnesium oxide + Zinc
   (Yellow when hot) (White ash/solid) (Grey)
   ZnO(s) + Mg(s) → MgO(s) + Zn(s)
   (Oxidizing agent) (Reducing agent)

3. Zinc (II) oxide + Carbon → Carbon (IV) oxide gas + Zinc
   (Yellow when hot) (Colourless gas) (Grey)
   ZnO(s) + C(s) → CO_2 (g) + Zn(s)
   (Oxidizing agent) (Reducing agent)

NB: hydrogen is less reactive than lead but reduces the oxide of lead due to the high temperature that provides enough activation energy for the reaction.

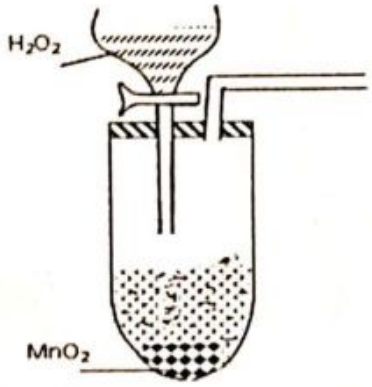
Atmospheric Pollution

A pollutant is a substance or a form of energy which has harmful effect to the environment
Combustion of fuel produces gases like sulphur (IV) oxide, phosphorous (V) oxide, carbon (II) oxide; carbon (IV) oxide which when released to the atmosphere causes harmful effects to both plants and animals

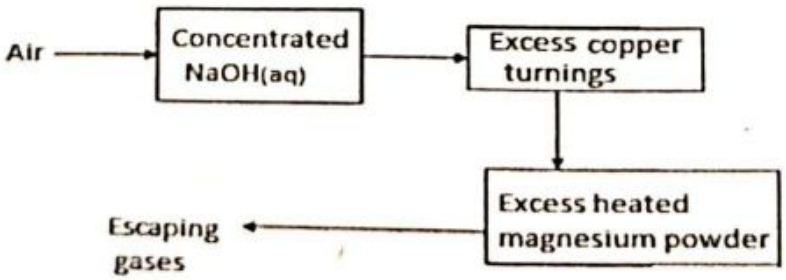
- Carbon (IV) oxide accumulates in the atmosphere causing greenhouse effect hence global warming.
- Sulphur (IV) oxide dissolve in rain water forming acidic rain which destroy chlorophyll in plants and also corrode iron sheets ,and stone work and cause leaching of soil nutrients.
- Carbon (II) oxide when inhaled causes death due to suffocation

SAMPLE QUESTIONS ON AIR AND COMBUSTION

1. The set-up below was used to prepare a sample of oxygen gas. Study it and answer the questions that follow. Complete the diagram to show how Oxygen can be collected



2. *Air was passed through several reagents as shown below:*



(a) Write an equation for the reaction which takes place in the chamber containing (1 mk)

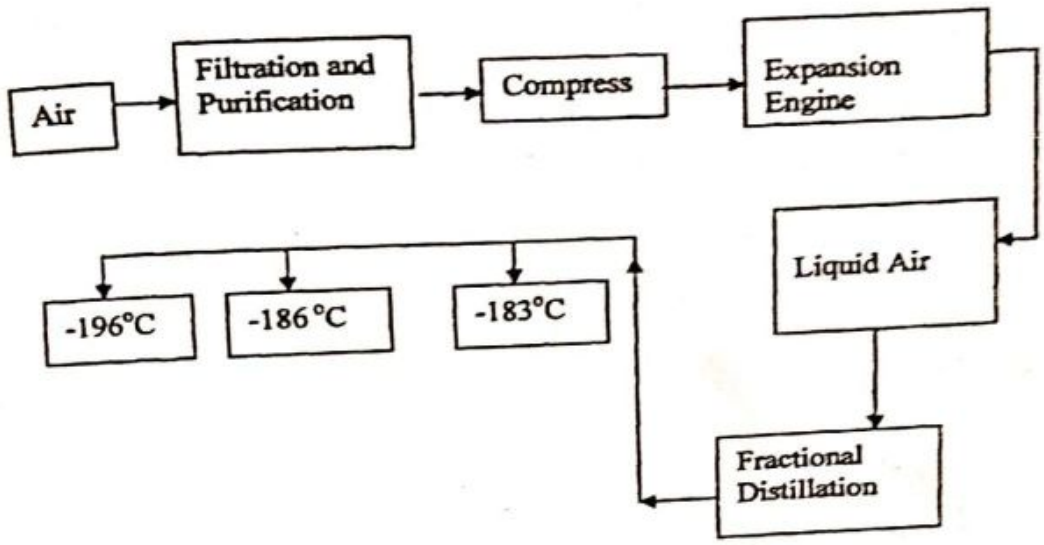
(b) Name **one** gas which escapes from the chamber containing magnesium powder. Give a reason for your answer (2mrks)

3. (a) What is rust? (1 mrk)

(b) Give **two** methods that can be used to prevent rusting (2 mks)

4. Name **one** substance which speeds up the rusting process (1 mrk)

5. Oxygen is obtained on large scale by the fractional distillation of air as shown on the flow chart below.

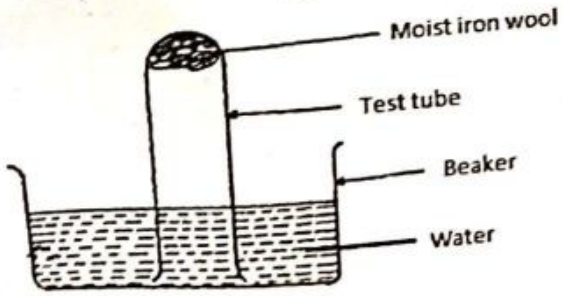


a.Identify the substance that is removed at the filtration stage (1 mrk)

b. Explain why Carbon (IV) oxide and water are removed before liquefaction of air (1 mrk)

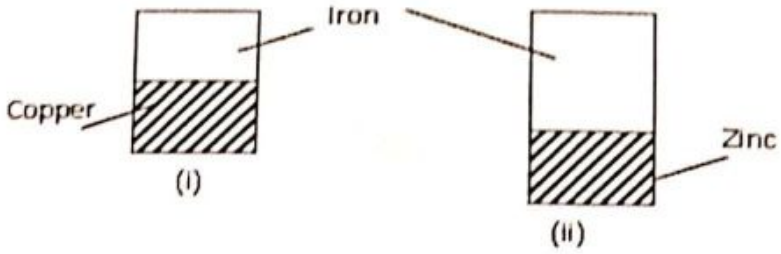
c Identify the component that is collected at -186°C (1 mrk)

6. The set-up below was used to study some properties of air.



a.State and explain **two** observations that would be made at the end of the experiment (2mks)

7. A form two student in an attempt to stop rusting put copper and Zinc in contact with iron as shown:-



(a) State whether rusting occurred after one week if the set-ups were left out (1 mrk)

(b) Explain your answer in **(a)** above (1 mrk)

8. In an experiment, a piece of magnesium ribbon was cleaned with steel wool. 2.4g of the clean magnesium ribbon was placed in a crucible and completely burnt in oxygen. After cooling the product weighed 4.0g

a. Explain why it is necessary to clean magnesium ribbon (1 mk)

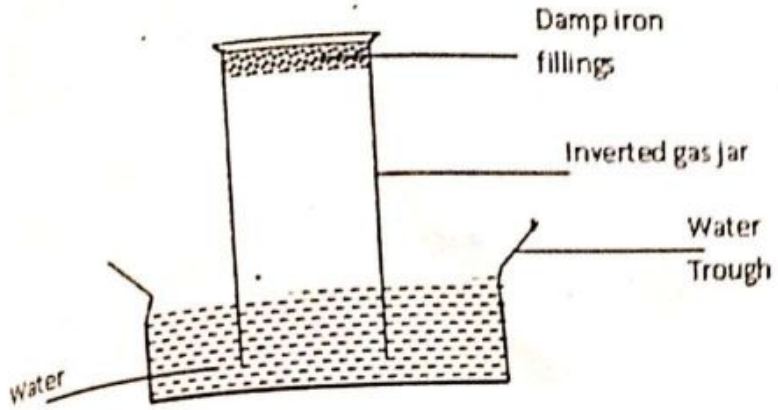
b. What observation was made in the crucible after burning magnesium ribbon? (1 mk)

c. Why was there an increase in mass? (1 mk)

d. Write an equation for the major chemical reaction which took place in the crucible (1mk)

e. The product in the crucible was shaken with water and filtered. State and explain observation which was made when red and blue litmus paper were dropped into the filtrate (1mk)

9. In an experiment a gas jar containing some damp iron fillings was inverted in a water trough containing some water as shown in the diagram below. The set-up was left un-disturbed for three days. Study it and answer the questions that follow:



a. Why was the iron filings moistened? (1 mk)

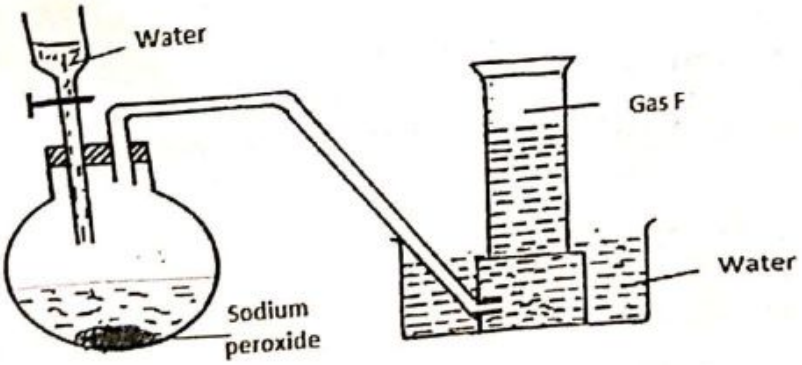
b. State and explain the observation made after three days. (2 mks)

c. State two conclusions made from the experiment. (2 mks)

d. Draw a labelled set-up of apparatus for the laboratory preparation of oxygen using Sodium Peroxide (2mks)

e. State two uses of oxygen (2 mks)

10. The set-up below was used to collect gas F produced by the reaction between sodium peroxide and water



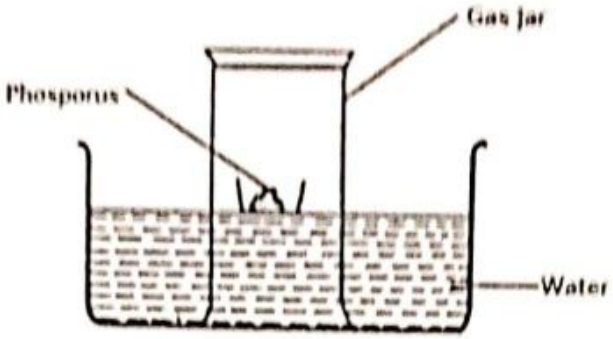
a) Name gas F (1 mk)

b) At the end of the experiment, the solution in the round bottomed flask was found to be a strong base. Explain why this was a strong base. Explain why this was so (2mks)

c) Which property of gas **F** makes it be collected by the method used in the set up? (1 mk)

d) Give **one** industrial use of gas **F** (1 mk)

12. The set-up below was used to investigate properties of the components of air;



a.State **two** observations made during the experiment (2 mks)

b.Write **two** word equations for the reactions which occurred (1 mk)

c. The experiment was repeated using burning magnesium in place of phosphorous. There was greater rise of water than in the first case. Explain this observation (1 mk)

d. After the two experiments, the water in each trough was tested using blue and red litmus papers. State and explain the observations of each case.

i.Phosphorous experiment (1 mk)

ii.magnesium experiment (1 mk)

e.Briefly explain how a sample of nitrogen gas can be isolated from air in the laboratory (1 mk)

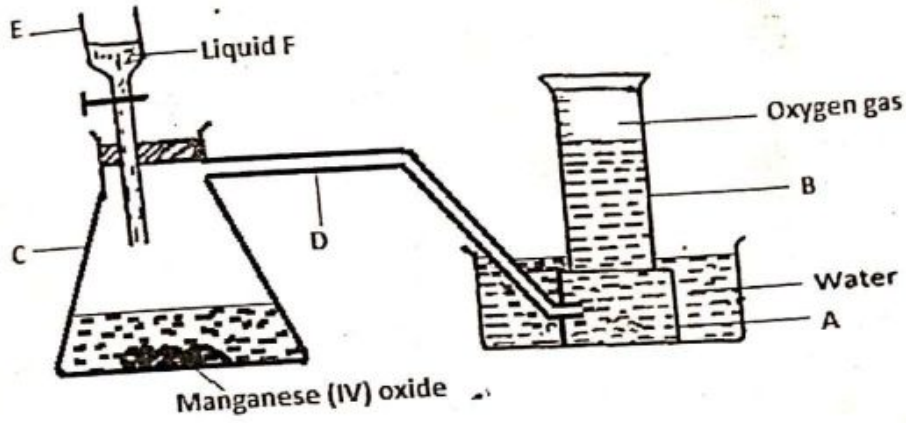
13. (i) A group of students burnt a piece of Mg ribbon in air and its ash collected in a Petri dish. The ash was found to comprise of magnesium Oxide and Magnesium nitride

(i) Write an equation for the reaction leading to formation of the magnesium nitride (1mk)

(ii) A little water was added to the products in the Petri dish. State and explain the observation made. (1 mk)

(iii) A piece of blue litmus paper was dipped into the solution formed in (b) above. State the observation made. (2 mks)

13. The diagram below shows the laboratory preparation of oxygen.



a) Identify the apparatus A to E and liquid F. (6mks)

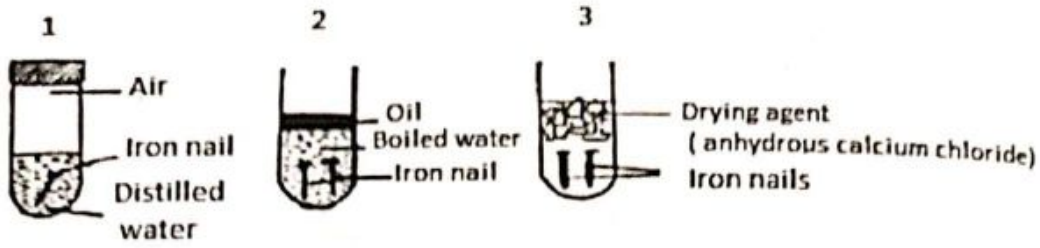
A.	B.
C.	D.
E.	F.

b) Write a word equation for the reaction producing oxygen. (2mks)

c) Describe the test you would perform to prove that the gas collected was oxygen. (2mks)

d) State two uses of oxygen. (2mks)

14. The following experiment was set-up to investigate the process of rusting.



a) State the conditions being tested in each tube (2mks)

2 _____

3 _____

b) In which tube would you expect rusting to occur? Explain (2mks)

c) Give two uses of preventing rusting? (2mks)

15. Metal W removes oxygen combined with X. Y reacts with an oxide of Z.
An oxide of X reacts with cold water but Y does not.

a) Which is the most reactive metal? (1mk)

b) Which is the least reactive metal? (1mk)

c) Arrange the metals in order of reactivity starting with the most reactive to the least react. (1mk)

16(a) Name the major component of air. (1mk)

(b) Complete the following table to show how the compound of air and their relative percentage abundance/composition. (4mks)

Component	% composition
(i)_____	20.9
(ii) Carbon (IV) oxide	_____
(iii) Nitrogen	_____
(iii)_____	0.97

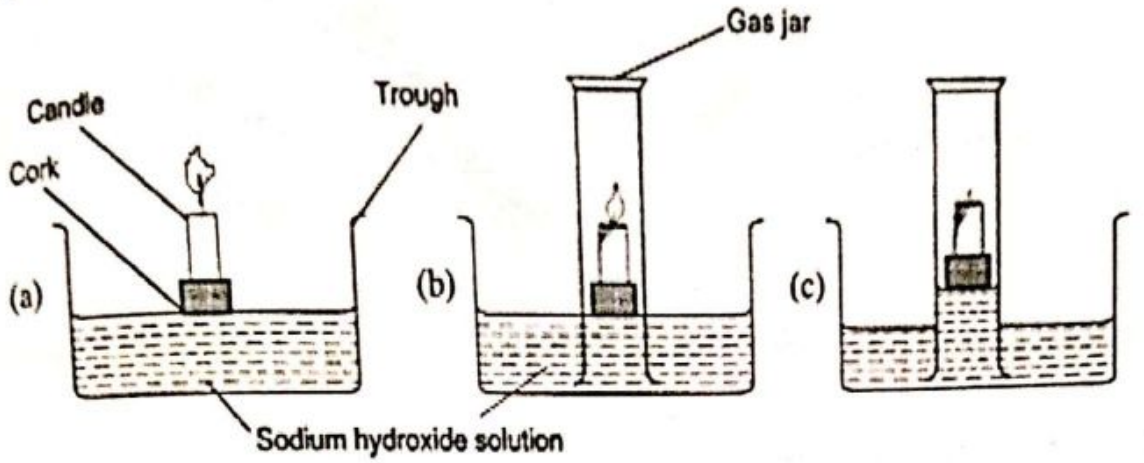
17.(a)Air is a mixture of several different gases. Identify the gas in air which: (3 mks)

(i)Put off a burning split_____

(ii)Make up almost 80% of air_____

(iii)Support combustion _____

(b) Below is an experiment set up to determine the percentage of oxygen in air. Use the set-up to answer the question that follow.



(i)Describe what happens when the burning candle is covered with a gas jar. (2 mks)

(ii)Explain why the lead of dilute sodium hydroxide rises in the gas jar. (1 mk)

(iii)Explain why sodium hydroxide is used instead of water. (1 mk)

(iv)Calculate the percentage of air in the experiment. (1 mk)

18 (a) State the condition necessary for rusting. (2mks)

(b) How can one prevent rusting? (2 mks)

19. Cars in Mombasa rust faster than in Kisumu. Explain. (1 mk)

20. (a)Define the following in terms of Oxygen
(i)Reduction-

(ii)Oxidation (2mks)

(b) Carbon reacts with copper (II) oxide in the equation shown below.

Carbon + Copper(II) oxide ⟶ Carbon (IV) oxide + Copper

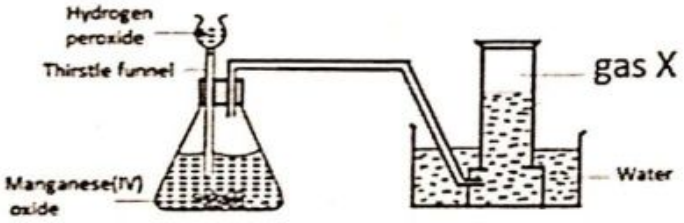
Which substance is

(i) Reduced-

(ii) Oxidized - (2mks)

(c) State two commercial uses of oxygen. (2mks)

21. The set up below shows preparation of certain gas X.



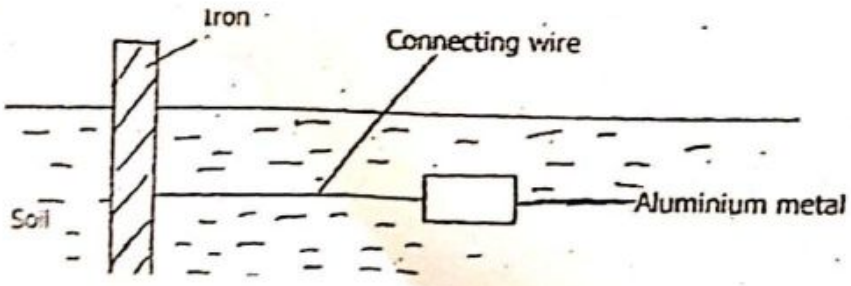
i) Name gas X (1 mk)

ii) Write word equation for preparation of gas X (1mk)

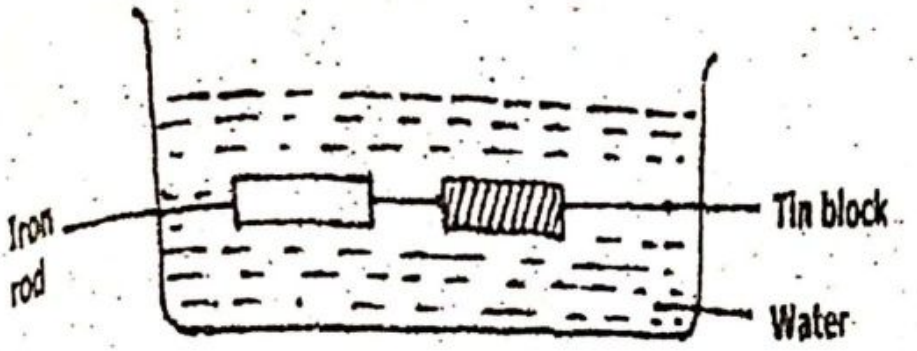
iii) What is the purpose of manganese (IV) oxide. (1mk)

iv) State two physical properties of oxygen gas (1mk)

22. The diagram below shows an iron bar which supports a bridge. The iron bar is connected to a piece of aluminum metal. Explain why it is necessary to connect the piece of aluminum metal to the iron. (2mks)



23. The set up below was used by students in preventing iron rod from rusting

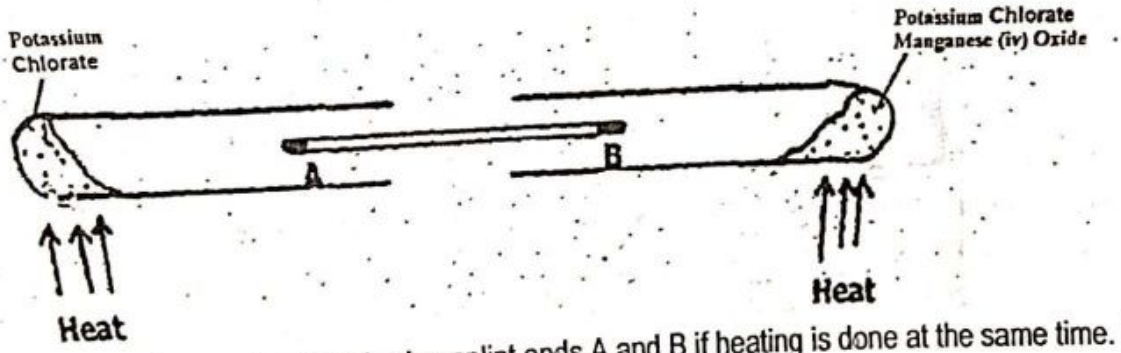


i. Did the students succeed in preventing the rusting of iron rod? Explain (2mks)

ii. Which method of preventing rust was the students investigating? (1mark)

iii. State other three methods of preventing rusting. (3mks)

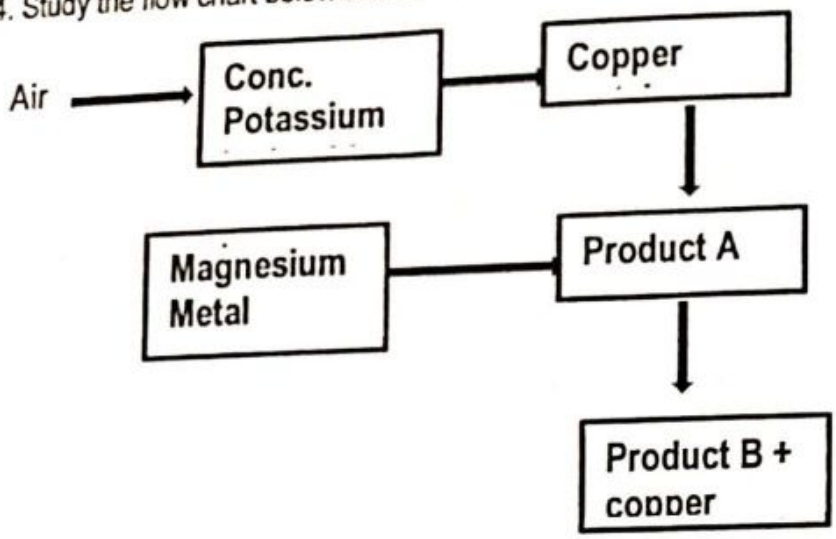
24. a wooden splint glowing on both ends was fixed as shown below . The experiment was carried out as indicated



a. what will be observed on the glowing splint ends A and B if heating is done at the same time. (2mks)

b. Explain the observation in a above (2mks)

24. Study the flow chart below and answer the questions that follow.



a. What was the purpose of passing Air through concentrated **Potassium hydroxide** (1mk)

b. Name
   i. Product A
   ii. Product B

c. Name the reaction taking place between Magnesium and product A (2mks)

25. Explain the observations made when the following salts are exposed to the atmosphere for three days (2mks)

a. anhydrous calcium chloride

b. anhydrous copper (II) sulphate

15. Describe an experiment to show that there is increase in mass when magnesium is burned in air. (3mks)

26. Is air a mixture or a compound. (3mks)

27. State two advantages of rusting (2mks)

28. List some industrial plants and indicate the gaseous pollutants they emit. (3mks)

29. Explain why phosphorous is stored under water in the laboratory (2mks)

30. State and explain the change in mass that occurs when the following substances are heated in open crucibles (2mks)

a. zinc metal

b. copper (II) Nitrate

31. State two products formed when phosphorous smoulders in air (2mks)

32. State two products formed when sodium burns in air (2mks)

33 Write an equation showing the products formed when Carbon reacts with

a. Excess oxygen (1mk)

b. Limited Oxygen supply (1mk)

34. Atmospheric air is used for breathing by normal human beings but is inadequate for patients with breathing problems. Explain (2mks)

35. Element s burns with a yellow flame forming white fumes which dissolve in water to form a solution that that turns blue litmus paper Red. (S is not the actual symbol of the element)

I. Is element S a metal or a nonmetal (1mk)

II. Give a reason for your answer in I above (1mk)

III. Suggest the possible identity of element T (1mk)

36.The following elements were newly discovered and named after the scientist who discovered them as follows ,Zeeal,Austron , kennual,syvenuer and kimely.Examine the table below and answer the questions that follow

Element	Burning oxygen	Solubility and pH of the solution
Zeeal	Burns vigorously with a white flame leaving a white solid	Dissolves to form a colourless solution with a pH of 14
Austron	Burns slowly with a green flame leaving a grey solid	Does not dissolve and the pH of the water remains 7
kennual	Burns slowly with white fumes forming a colourless gas	Dissolves to form a solution with a pH of 6
syvenue	Burns brightly with a yellow flame producing white fumes	Dissolves to form a solution with a pH of 3
kimely	Burns with a yellow flame leaving a white solid	Dissolves sparingly to form a solution with a pH of 10

I. Classify the element into metals and non metals (5mks)

II. Which of the elements burn in oxygen to give acidic oxide (2mks)

III. List the metallic element in a reactivity series starting from least reactive to the most reactive

(1 mk)

37. Explain why a mixture of magnesium powder and lead oxide will react vigorously when heated but no reaction occurs when a mixture of magnesium oxide and lead powder are heated. (2mks)

38. a. State two conditions that are known to accelerate rusting (2mks)

b. Explain why cooking pots made of Aluminium do not corrode easily when exposed to air (2mks)

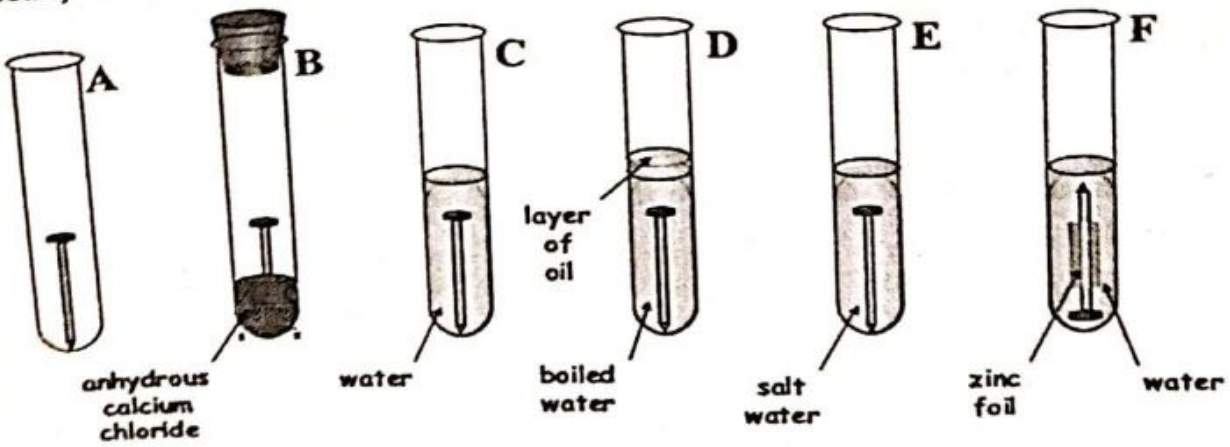
39. List three methods of preparation of oxygen in the laboratory (3mks)

40 a. define a catalyst (1mk)

b. Name the catalyst used in preparation of oxygen during decomposition of hydrogen peroxide. (1mk)

41. Giving examples, List four main types of oxides (4mks)

42. Study the diagram below and answer the question that follow



(a) Study and explains the made in each test-tube after two weeks. (12 marks)

(b) Give two reasons for electroplating iron spoon with silver. (2 marks)

(c) Give conditions necessary for rusting. (2 marks)

(d) Give two conditions that accelerate rusting. (2 marks)

(e) Explain how aluminium paint prevents rusting. (2 marks)

(f) Give the formula and chemical name for rust. (2 marks)

(g) Give two disadvantages and advantages of rusting. (4 marks)

WS

CHAPTER FIVE: WATER AND HYDROGEN

Specific objectives

By the end of the topic, the learner should be able to:

- ✓ *State the sources of water*
- ✓ *Describe an experiment to show that water is a product of burning organic matter*
- ✓ *Describe an experiment to show that water contains hydrogen*
- ✓ *State the products of reactions of cold water and steam with different metals.*
- ✓ *List the order of reactivity of metals as obtained from metal water reactions*
- ✓ *Prepare hydrogen, investigate its properties and state its uses*
- ✓ *Define oxidation as oxygen gain reduction as removal of oxygen.*
- ✓ *Explain metal oxide reactions with hydrogen in terms of reduction and oxidation*

Water

Water is a hydride of oxygen

Physical properties of water

- ✓ *colourless, odourless,*
- ✓ *neutral liquid*
- ✓ Water dissolves most solute/substances therefore referred as universal solvent
- ✓ Water naturally exists in three phases/states **solid** ice, **liquid** water and **gaseous** water vapour.
- ✓ The three states of water are naturally **interconvertible.**
- ✓ The natural inter conversion of the three phases/states of water forms the water cycle.

Sources of water

Natural sources of water

The natural sources of water are:

- **Rivers and lakes**
- **Rain water**
- **Oceans**

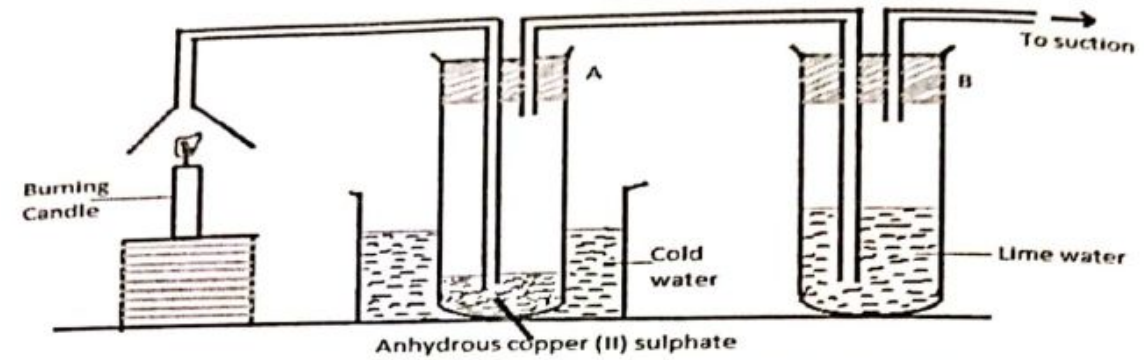
Chemical sources of water

- Water can be obtained when organic compounds like candle , biogas,paraffin, petrol are burnt in air to form carbon (IV) oxide and water vapour .
- Burning hydrogen in air to form water/water vapour
- Heating hydrated salts which lose the water of crystallization, which when condensed form water

  e.g hydrated Cobalt (II) chloride $\longrightarrow$ anhydrous Cobalt (II) chloride + water

  The water vapour can be identified by passing it through a freezing mixture to condense it to liquid and then adding a few drops of the liquid to **white anhydrous Copper (II) Sulphate** ,it will change to blue ,or if the colourless liquid is added to **blue anhydrous Cobalt** (II) Chloride it will change to **pink.**
- The carbon (IV) oxide gas is confirmed by bubbling the gas through lime water (calcium hydroxide) it forms a **white precipitate** due to formation of insoluble Calcium Carbonate

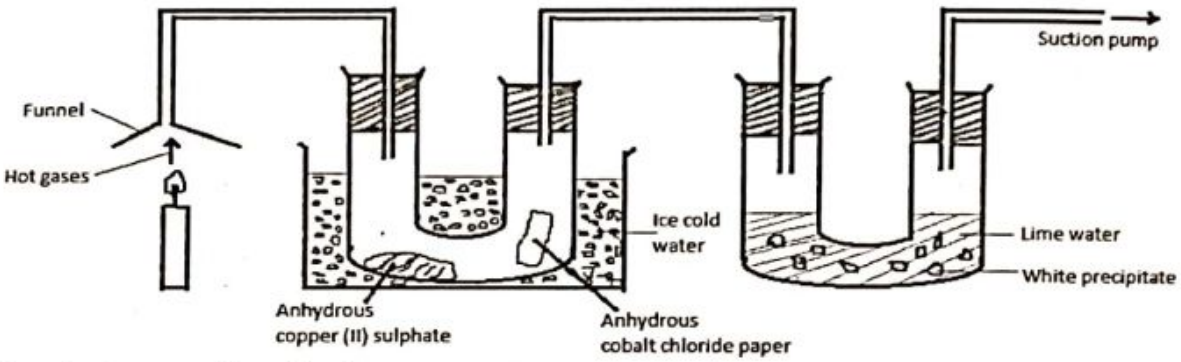
Candle is an hydrocarbon and contains carbon and hydrogen only, it burns in air to form carbon (IV) oxide and water.



To prove that water and carbon (IV) oxide are produced when a candle burns

Observation

- ✓ The anhydrous copper (II) sulphate turns from white to blue indicating presence of water.
- ✓ The anhydrous cobalt (II) chloride paper changes from blue to pink indicating presence of water.
- ✓ White precipitate is observed in lime water indicating the presence of carbon (IV) oxide.



Chemical properties of water

a. Reaction of metals with water

- Metals react with water to form metal hydroxide and hydrogen
- Reactive metals like **sodium and potassium** react vigorously with water producing hydrogen gas

i. Observations when sodium metal is reacted with water.

- When sodium is placed in a beaker containing **water it floats on the surface of water because it is less denser than water, it darts on the surface** due to propulsion by hydrogen gas, there is **effervescence** due to hydrogen gas produced, **it melts into silvery ball** as the reaction is highly exothermic, it **may burst into a yellow flame** because a mixture of hydrogen and air bursts into a flame and the resulting solution turns red litmus blue because it is alkaline.

Reaction

Sodium + water ⟶ sodium hydroxide + hydrogen

$$2Na_{(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)}$$

ii. Observations when potassium metal is reacted with water

The same observations are observed when a piece of potassium Is placed in water the only difference is that potassium reacts more vigorously with water than sodium and it **may burst into a purple flame**

The purple flame is as a result of hydrogen and air igniting but is purple due to presence of potassium vapour.

Reactions

Potassium + water ⟶ potassium hydroxide + hydrogen

$2K_{(s)} + 2H_2O_{(l)} \longrightarrow 2KOH_{(aq)} + H_{2(g)}$

iii. **Observations when Calcium metal is reacted with water**

- Calcium is not as reactive as potassium or **sodium and so it is not stored under oil or paraffin.** When a lump of calcium is put into water **it sinks into the water** showing that it is denser than water and reacts moderately producing a steady stream of bubbles. This results to a **white suspension** because calcium hydroxide is only slightly soluble in water. A water soluble base is called an **alkali.**

Calcium + water ⟶ **calcium hydroxide + hydrogen**

$Ca_{(s)} + 2H_2O_{(l)} \longrightarrow Ca(OH)_{2(aq)} + H_{2(g)}$

iii. **Observations when Magnesium metal is reacted with water**

Magnesium reacts with atmospheric oxygen to form a coat of magnesium oxide. The coating has to be removed so that the metal surface comes into contact with water. Reacts very slowly with cold water to form magnesium hydroxide and hydrogen gas. Bubbles are observed.

Magnesium + water ⟶ **magnesium hydroxide + hydrogen**

$Mg_{(s)} + 2H_2O_{(l)} \longrightarrow Mg(OH)_{2(aq)} + H_{2(g)}$

- Metals lower than magnesium in the reactivity series do not react with cold water

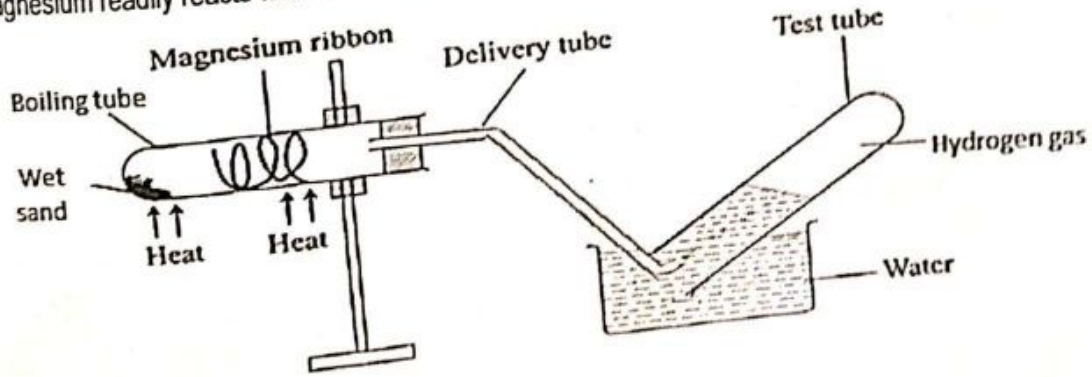
b. Reaction of metals with steam

Reaction of magnesium with steam

Metals react with steam to form metal oxide and hydrogen gas. The source of steam can be; heating water, wet sand, wet glass wool, or heating hydrated salt.

Metal + steam ⟶ metal oxide + hydrogen gas

Magnesium readily reacts with steam to form magnesium oxide and hydrogen gas.



Observations and explanations

- Magnesium burns with a bright white flame forming white solid which magnesium oxide.
- Bubbles of a gas are also seen in the test tube due to production of hydrogen gas.
- The wet sand is heated first to generate steam to react with magnesium and drive out the air initially in the boiling tube that might react with Magnesium.

Magnesium + steam ⟶ magnesium oxide + hydrogen gas

$Mg_{(s)} + H_2O_{(l)} \longrightarrow MgO_{(s)} + H_{2(l)}$

If magnesium ribbon is heated first it will react with air in the tube forming magnesium oxide which does not react with steam.

- Other metals like zinc, Aluminium, lithium, and iron also react with steam to form corresponding metal oxides and produce hydrogen gas
- Aluminium+ steam ⟶ Aluminium oxide + hydrogen gas

$2Al_{(s)} + 3H_2O_{(l)} \longrightarrow Al_2O_{3(s)} + 3H_{2(g)}$

Zinc + steam ⟶ Zinc oxide + hydrogen gas

$Zn_{(s)} + H_2O_{(l)} \longrightarrow ZnO_{(s)} + H_{2(g)}$

Iron + steam ⟶ Tri-iron tetroxide(black) + hydrogen gas

$3Fe_{(s)} + 4H_2O_{(l)} \longrightarrow Fe_3O_{4(s)} + 4H_{2(g)}$

- **N.B** Metals below lead in the reactivity series do not react with either steam or water. Sodium, potassium and calcium should not be reacted with steam as the reaction is very violent.

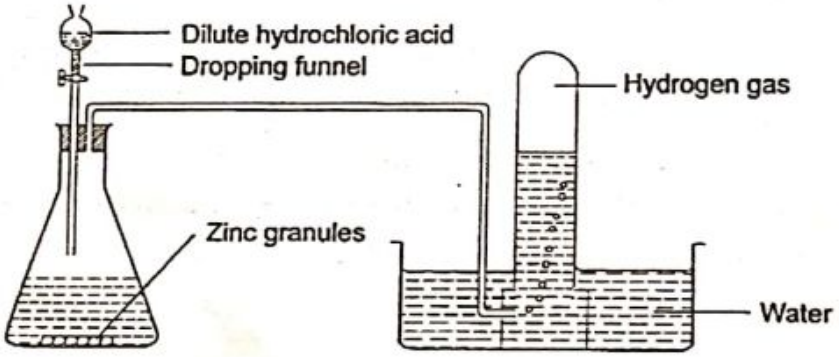
Preparation of hydrogen gas

Hydrogen is prepared by action of metals on suitable dilute acids. The reaction is accompanied by **effervescence due to production of hydrogen gas. Zinc metal and dilute hydrochloric acid is preferably used to prepare hydrogen in the laboratory.**

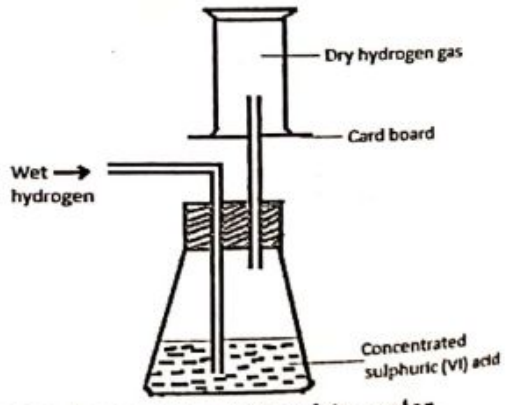
Zinc + Hydrochloric acid ⟶ Zinc Chloride + hydrogen gas

$Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnCl_{2(aq)} + H_{2(g)}$

A small amount of **Copper (II) Sulphate crystals** may be added to speed up the reaction. Copper (II) Sulphate acts as a catalyst.



If hydrogen gas is needed dry it is passed through **concentrated sulphuric (VI) acid** in a wash bottle or **anhydrous calcium chloride or calcium oxide in U-tube** and collected by **upward delivery** because it is less denser than air



Points to note about preparation of hydrogen gas

- Nitric(V) acid is not used to prepare hydrogen gas because it is **a strong oxidizing agent** hence the **hydrogen formed is oxidized to water.** However, very dilute nitric (V) acid liberates hydrogen with magnesium metal.
- Potassium, sodium, lithium and calcium **react explosively** with dilute acid hence must not be used.
- Magnesium can also be used to prepare hydrogen gas but it is very expensive.

- Aluminium forms a protective layer of Aluminium oxide, which should be removed using concentrated hydrochloric acid before the metal can react with dilute acids.
- Zinc is preferably used because it is cheap and reacts moderately with dilute acids.
- Impure iron gives a mixture of gases including the bad smelling hydrogen sulphide when it reacts with dilute acids.
- Hydrogen cannot be prepared using lead and dilute hydrochloric acid or dilute sulphuric (VI) acid due to formation of **insoluble of lead (II) sulphate /lead (II) Chloride** which coats the metal prevents further reaction between the acid and the metal
- Hydrogen can not be prepared by reacting copper metal and an acid because **copper is below hydrogen** in reactivity series and therefore **cannot displace hydrogen** from an acid

Physical properties of hydrogen gas

- Less dense than air hence collected by upward delivery.
- Insoluble in water so it can be collected over water.
- Neutral hence no effect on litmus papers.
- Colourless and odourless.

Describe the laboratory Test for hydrogen gas

- ✓ **Lower a burning splint in a gas jar full of hydrogen gas, the gas extinguishes the burning splint with a 'pop' sound**

NB; a mixture of hydrogen and air explodes when ignited

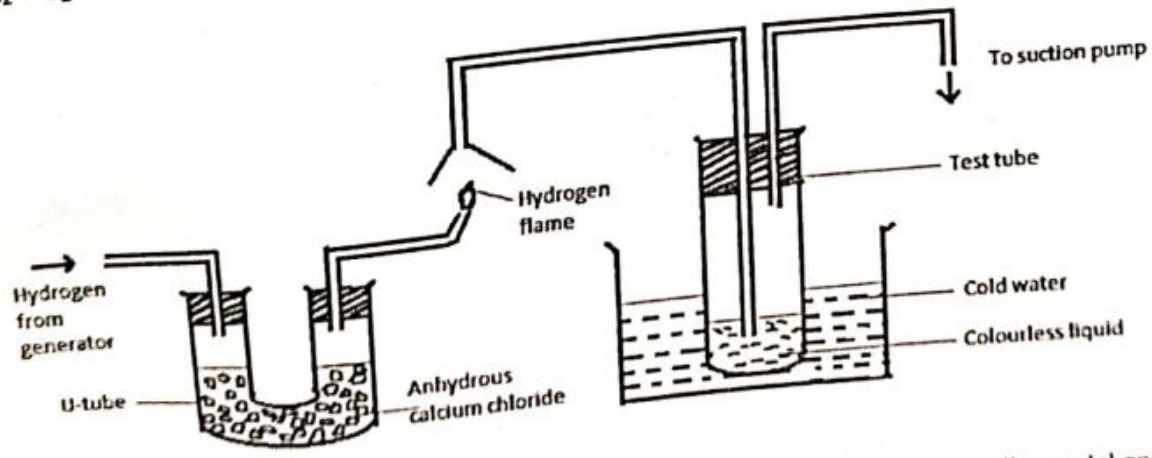
Chemical properties of hydrogen gas

What is formed when hydrogen burns in air?

When hydrogen burns in air , it burns **with a blue flame**, a colourless liquid which turns white anhydrous Copper(II) sulphate blue is formed. The liquid is water. Hydrogen combines with oxygen from the air to form water .water is therefore an oxide of hydrogen. **The role of suction pump is draw** the products of burning hydrogen gas into the test-tube. Anhydrous Calcium chloride dries the gas, the ice cold water condenses the steam to form liquid water.

Hydrogen + oxygen ⟶ water

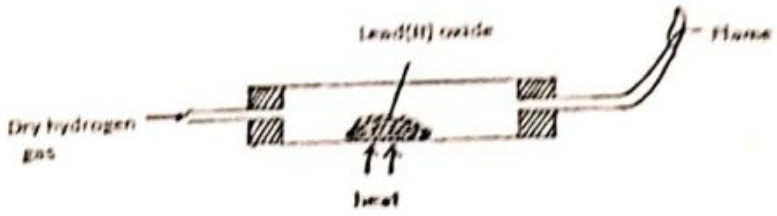
$2H_2 + O_2 \longrightarrow 2H_2O\ (l)$



Hydrogen as a reducing agent

Hydrogen reduces both hot copper (II) oxide and lead (II) oxide to form their corresponding metal and water

Reduction of Lead (II) Oxide.



Lead (II) Oxide + hydrogen ⟶ lead metal + water

$PbO_{(s)} + H_{2(g)} \longrightarrow Pb_{(s)} + H_2O_{(l)}$

Observations

- ✓ Lead (II) oxide changes colour from yellow to orange and finally to grey – this is because when lead (II) oxide is heated it changes colour from yellow to orange, and then the hot lead (II) oxide is reduced by hydrogen to lead metal which is grey in colour.
- ✓ Colourless droplets are formed on the cooler parts/ water vapour condenses on cooler parts of the apparatus.

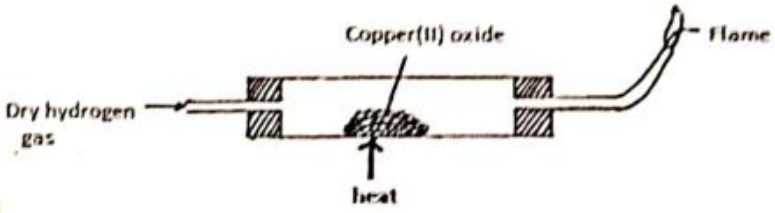
Reduction of Copper (II) Oxide.

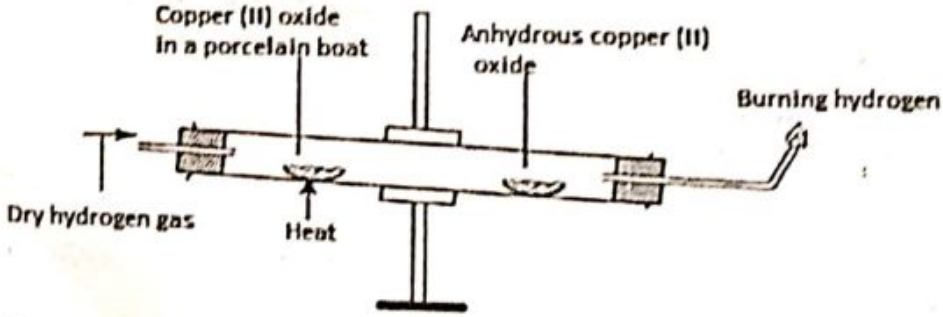
Copper (II) Oxide + hydrogen ⟶ copper metal + water

Black **brown**

$CuO_{(s)} + H_{2(g)} \longrightarrow Cu_{(s)} + H_2O_{(l)}$

Black **brown**





Observations made

- Black Copper (II) oxide turns to brown copper metal- due to reduction of black copper (II) oxide to copper metal which is brown
- Colourless droplets are formed on the cooler parts due to water formed when hydrogen reacts with oxygen from air.
- The white anhydrous copper (II) sulphate turns blue confirming the colourless liquid produced is water

NB

Air is **driven out of the apparatus to ensure that the hydrogen being burnt at the jet is** pure to avoid explosion when it mixes with air.

Removal of oxygen from a compound is known as **reduction** while addition of oxygen is known as **oxidation**. In this reaction Copper (II) Oxide is reduced to copper metal while hydrogen is oxidized to water.

The **supply of hydrogen gas is continued while apparatus cool** to avoid the re-oxidation of hot metal by oxygen from the air.

Excess hydrogen gas is burnt because its mixture with oxygen (air) is explosive when ignited. The excess gas is therefore not allowed to escape into the air for safety reasons.

Metal + water ⟶ **metal hydroxide + hydrogen gas**

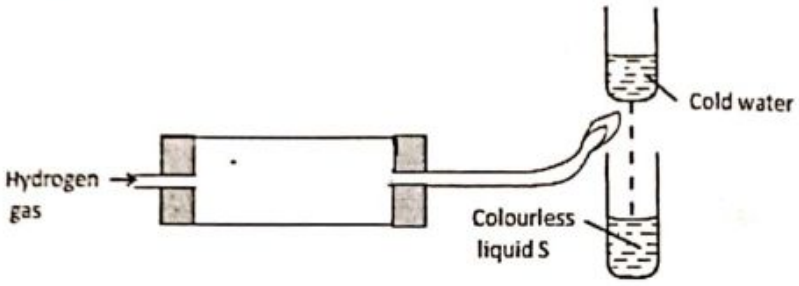
Metal + steam ⟶ **metal oxide**

Uses of hydrogen

- ✓ Used in large scale manufacture of ammonia
- ✓ Used in large scale manufacture of hydrochloric acid
- ✓ Used in manufacture of margarine
- ✓ Together with oxygen is used to produce oxy-hydrogen flame used in welding
- ✓ Hydrogen is used as a rocket fuel
- ✓ Used as a fuel in fuel cells

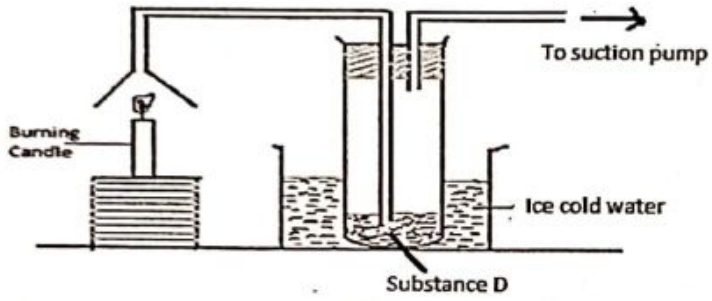
REVISION QUESTIONS ON WATER AND HYDROGEN

1. Study the diagram below and answer the question that follows.



Describe one chemical test that can be carried out to identify substance S. (2 marks)

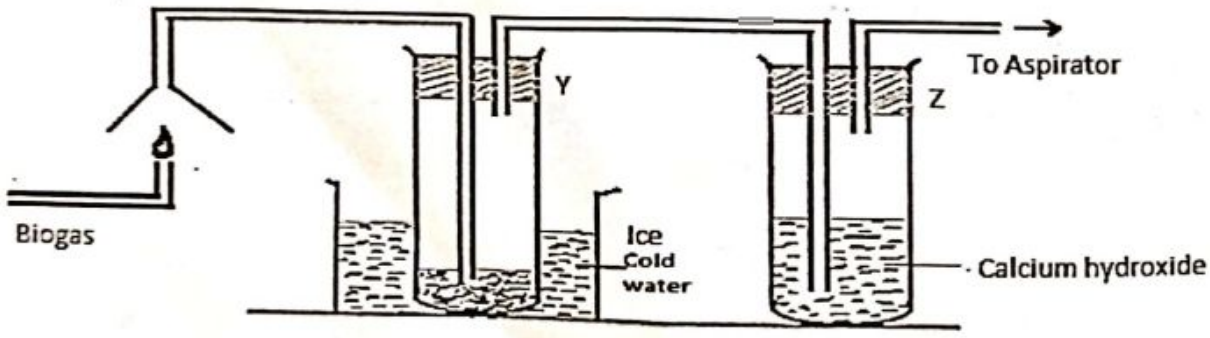
2. An experiment was set up as shown in the diagram below



(a) Identify substance D (1 mk)

(b) Describe how the other product of burning candle could be prevented from getting into the environment (2mks)

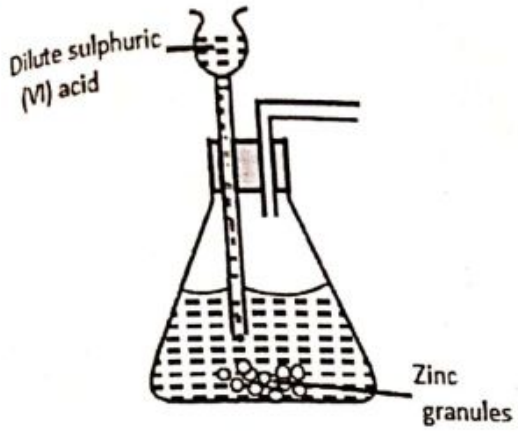
3. The set up below was used to investigate the products of burning biogas (methane).Study it and answer the questions that follow.



(a) What product will be formed in test tube Y (1mk)

(b)State and explain the observations which would be made in Z. (2mks)

4. The set up below was used to prepare hydrogen gas



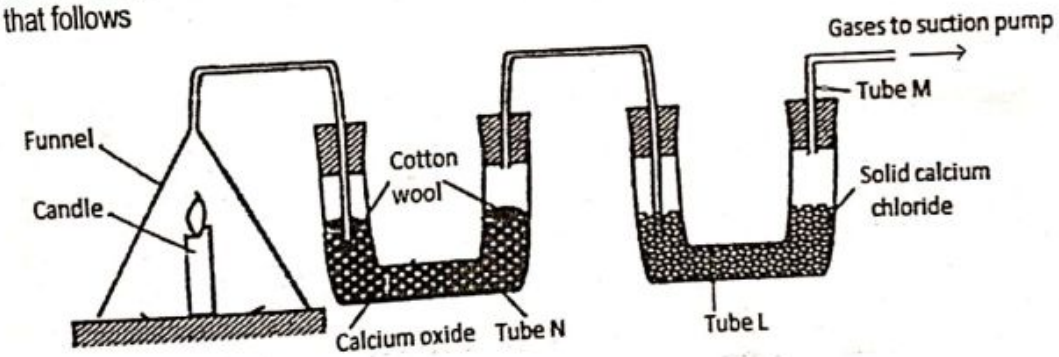
a) complete the diagram to show how a sample of hydrogen gas can be collected (3mks)

b) Write an equation for the reaction which takes place when hydrogen gas burns in air. (1mk)

c) State two industrial uses of hydrogen gas (2mks)

5. Candle wax is mainly a compound consisting of two elements. Name the two elements (2mks)

6. The set up below was used to investigate the burning of a candle. Study it and answer the question that follows



(i) What would happen to the burning candle if the pump was turned off? (3mks)

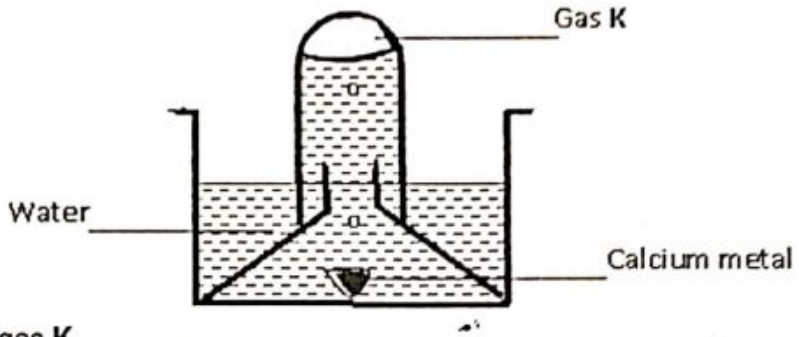
(ii) State and explain the changes in mass that are likely to occur in tube N by the end of the experiment. (3mks)

(iii) Name two gases that come out through tube M (2mks)

(iv) What is the purpose of calcium chloride in tube L (1mk)

(v) Name another substance that could be used in place of calcium oxide in tube N (1mk)

7. The set up below was used to collect gas K, produced by the reaction between water and calcium metal.

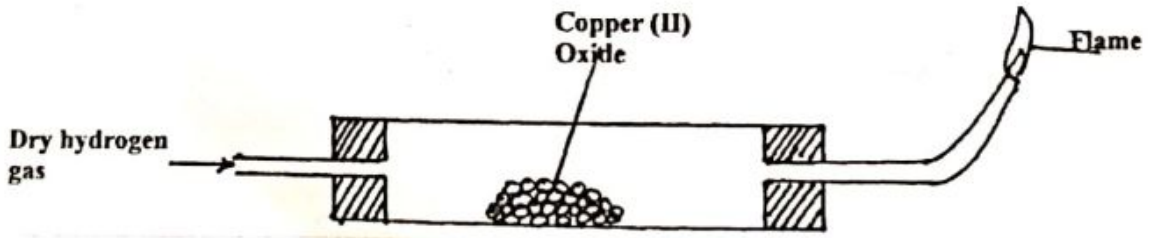


(a) Name gas **K** (1mk)

(b) At the end of the experiment, the solution in the beaker was found to be a weak base. Explain why the solution is a weak base (2mks)

(c) Give one laboratory use of the solution formed in the beaker. (1mk)

8. a) The set-up below is used to investigate the properties of hydrogen.



i) On the diagram, indicate what should be done for the reaction to occur (1mk)

ii) Hydrogen gas is allowed to pass through the tube for some time before it is lit. Explain (2mks)

iii) Write an equation for the reaction that occurs in the combustion tube (1mk)

iv) When the reaction is complete, hydrogen gas is passed through the apparatus until they Cool down. Explain (2mks)

iv) What property of hydrogen is being investigated? (1mk)

v) What observation confirms the property stated in (v) above? (1mk)

vii) Why is zinc oxide not used to investigate this property of hydrogen gas? (1mk)

9. Hydrogen can be prepared by reacting zinc with dilute hydrochloric acid. Write an equation for the reaction. (1mk)

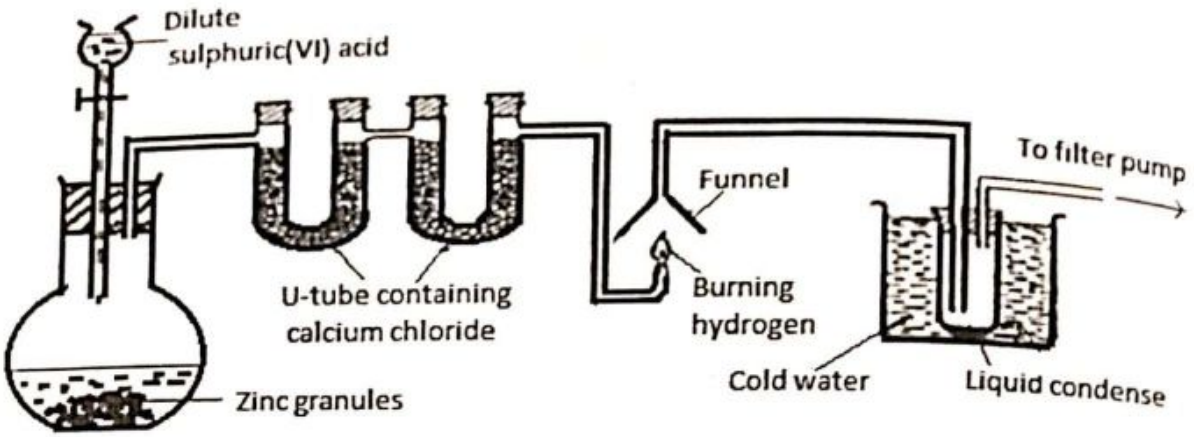
a) Hydrogen burns in oxygen to form an oxide

(i) Write an equation for the reaction. (1mk)

ii) State **two** precautions that must be taken before the combustion begins and at the end of the combustion. (2mks)

g) Element **Q** reacts with dilute acids but not with cold water. Element **R** does not react with dilute acids. Elements **S** displaces element **P** from its oxide. **P** reacts with cold water. Arrange the four elements in order of their reactivity, starting with the most reactive. (2mks)

10. Study the diagram below and answer the questions that follow



a) Write equation for the reactions taking place in the above set up (2mks)

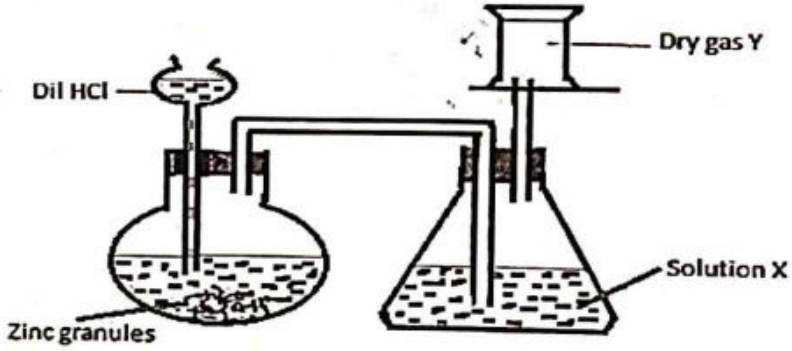
b) Explain how the identity of liquid in the test tube may be done (2mks)

c) Describe the purity the liquid can be determined (2mks)

d) With a similar arrangement ,name another substance that can used to replace calcium chloride (1mk)

e) What is the function of suction pump (1mk)

11. Study the diagram below and answer the questions that follow



(a) Justify the method of collection of the dry gas (1mk)

(b) Identify solution X and give its purpose (1mk)

c) Write a chemical equation for the reaction in the round bottomed flask (1mk)

12. Explain the following statements

i. copper does not react with dilute acids (2mks)

ii. Zinc is preferred to magnesium in preparation of hydrogen gas (2mks)

iii. Potassium, sodium, calcium and lithium should never be used to prepare hydrogen gas (2mks)

iii, Nitric (V) acid not used to prepare hydrogen gas (2mks)

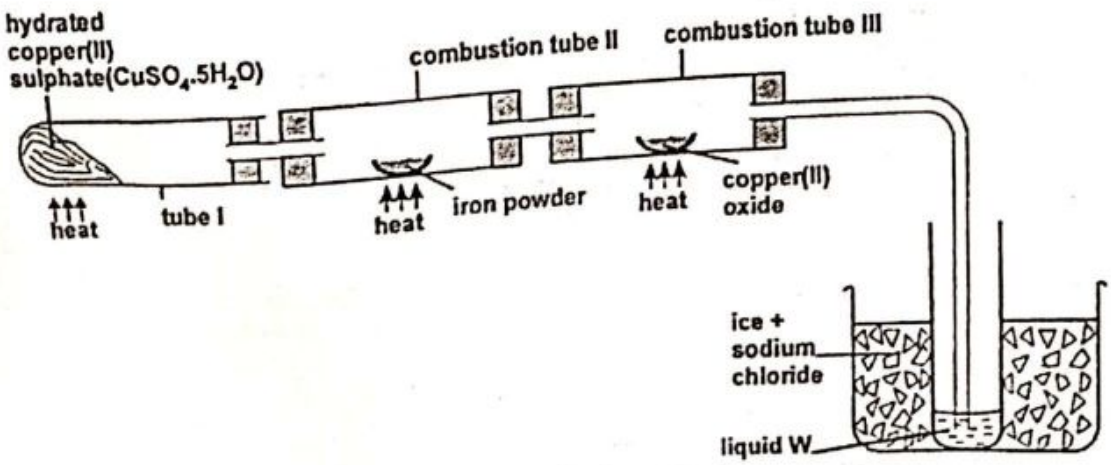
13. (a) Hydrogen can reduce coppers Oxide but not Aluminium oxide. Explain (2mks)

(b) When water reacts with potassium metal the hydrogen produced ignites explosively on the surface of water. (2mks)

(i) What causes this ignition? (1mk)

(ii) Write an equation to show how this ignition occur

14. Study the diagram below and answer the questions that follow.



a. State and explain the observations made the observations in tube 1,combustion tube II and combustion tube III (6mks)

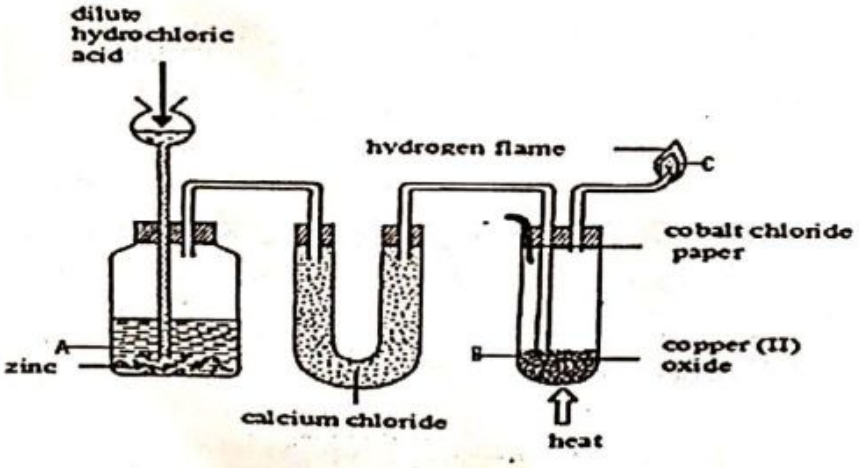
b. Write equation for the reaction for the reaction occurring at combustion tube II and III (1mk)

c. give a reason why ice is mixed with sodium chloride (1mk)

d. describe how the identity of substance W can be determined (1mk)

e. describe how you can determine if liquid W is pure (2mks)

15. Study the diagram below and answer the questions that follow



a) Write equations for the reactions that occur at A ,B and C (3mks)

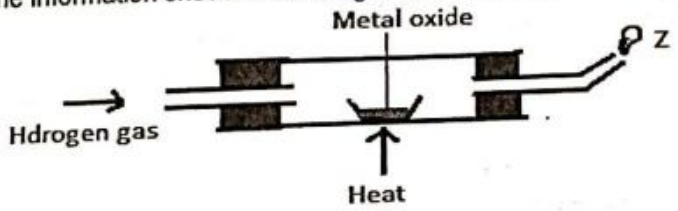
b) State the observations made at tube B (2mks)

c) Explain why excess hydrogen is burned (2mks)

d) Give three uses of hydrogen gas (3mks)

e) Give two reasons why hydrogen is not used as a fuel (2mks)

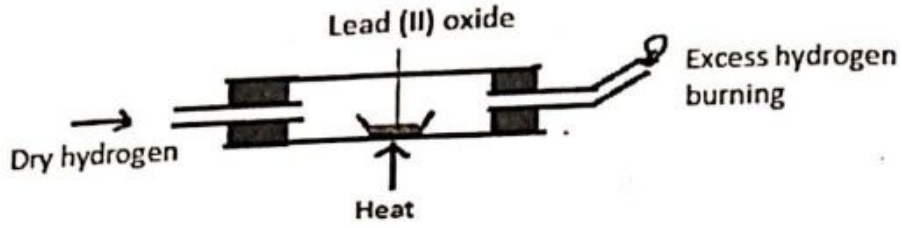
16. Use the information shown in the diagram below to answer the question that follows?



(i) Explain why it is important to pass the hydrogen for some time before lighting it at point Z. (1mk)

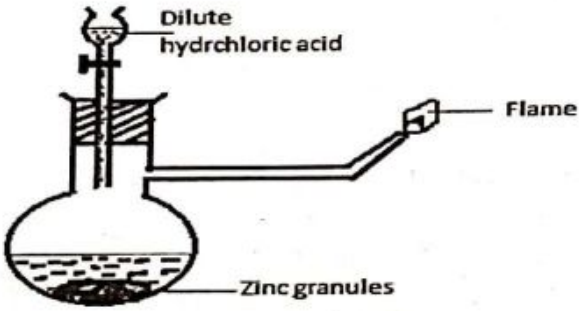
(ii) Write an equation for reaction that takes place when hydrogen burns at point Z .(1mk)

17. When hydrogen gas is passed over heated lead (II) oxide a reaction occurs. The diagram below shows a set up that could be used for this reaction.



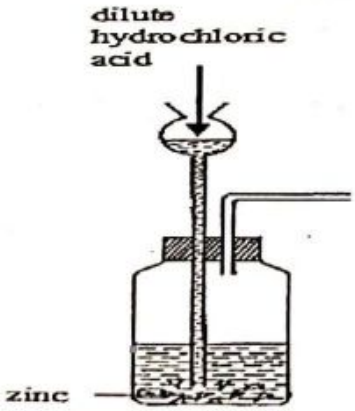
(a) What observation would be made in the combustion tube? (2mks)

18. Study the diagram below and answer the questions that follow.



Write an equation for each of the two reactions that take, place in the experiment represented by the diagram above (2mks)

19. The set – up below was used to prepare hydrogen gas



a) Complete the diagram to show how a dry sample of hydrogen gas can be collected (3mks)

b) Write an equation for the reaction, which takes place when hydrogen gas burns in air. (1mk)

20. A piece of phosphorous was heated in excess air. The product was shaken in a small amount of hot water to make a solution. The solution obtained was found to have a pH of 3. Give a reason for this observation. (2mks)

21. Sodium hydroxide can be prepared by the following methods; I and II.

I. Sodium metal $\xrightarrow{\text{cold water}}$ Sodium hydroxide + Hydrogen

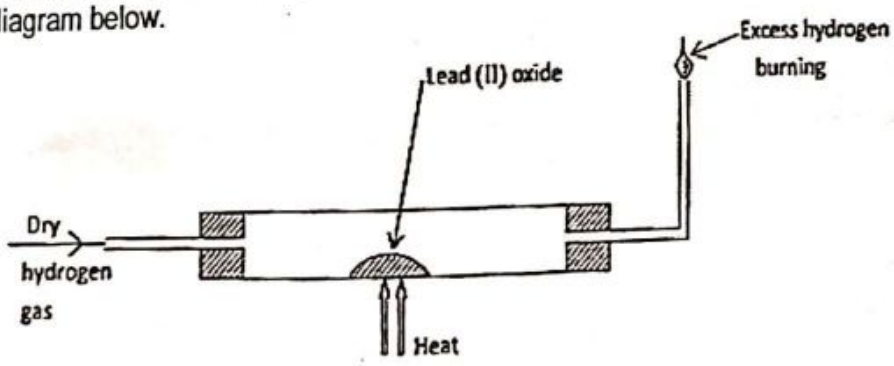
II. Concentrated Sodium chloride $\xrightarrow{\text{process A}}$ Sodium hydroxide + chlorine + hydrogen

a) Name one precaution that needs to be taken in method 1. (1mk)

b) Give the name of process A. (1mk)

c) Give one use of sodium hydroxide. (1mk)

22. In an experiment, dry hydrogen gas was passed over heated Lead (II) Oxide as shown in the diagram below.



State and explain the observations made in the combustion tube (3mks)

23. (a) Hydrogen can reduce coppers Oxide but not Aluminium oxide. Explain (2mks)

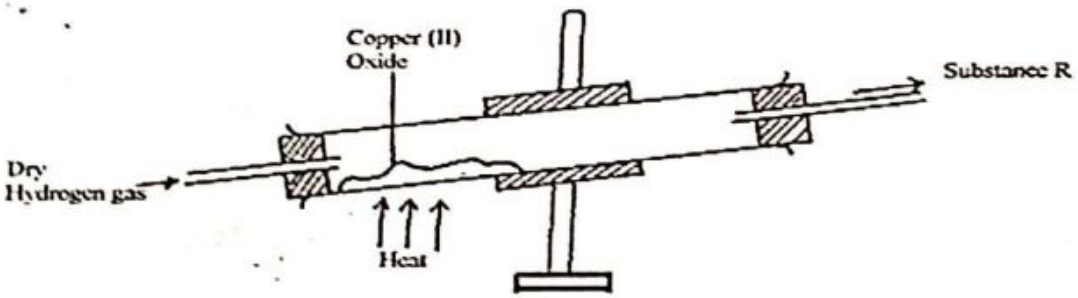
(b) When water reacts with potassium metal the hydrogen produced ignites explosively on the surface of water.

(i) What causes this ignition? (1mk)

(ii) Write an equation to show how this ignition occurs (1mk)

24. (a) Hydrogen can reduce coppers Oxide but not Aluminium oxide. Explain (2mks)

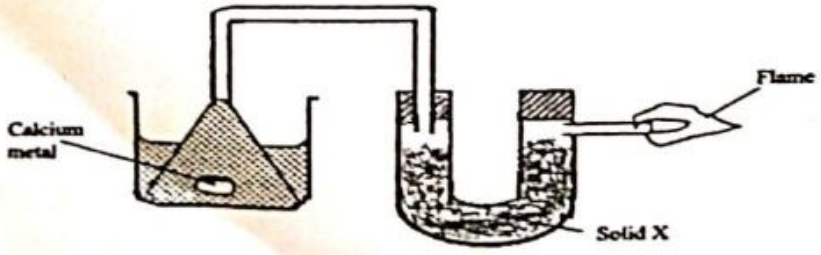
25. In an experiment, dry hydrogen gas was passed over hot copper (II) oxide in a combustion tube as shown in the diagram below:-



(a)Complete the diagram to show how the other product, substance **R** could be collected in the laboratory. (3mks)

(b) Describe how copper could be obtained from the mixture containing copper (II) oxide (3mks)

26. The setup below was used to investigate the reaction between metals and water.



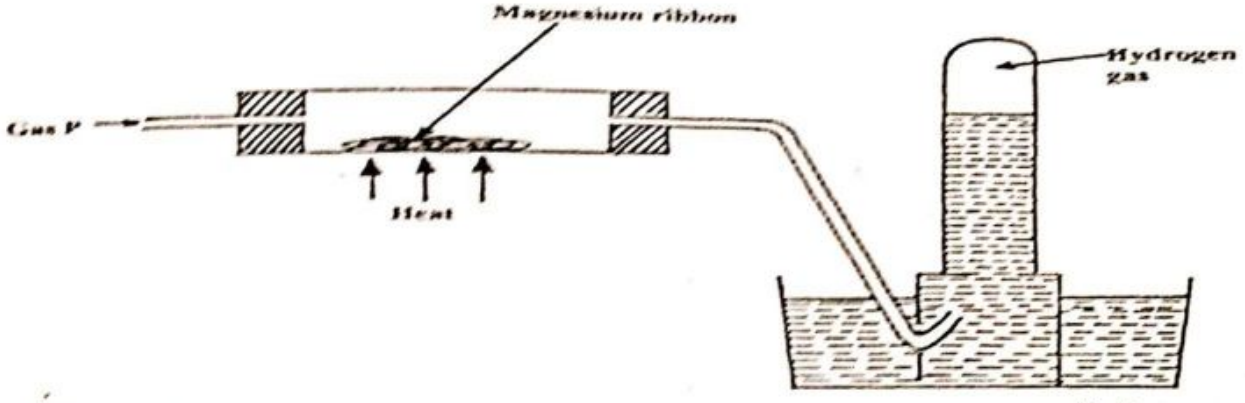
(a) Identify solid **X** and state its purpose (2mks)

(ii) Solid X.

(ii) Purpose

(b) Write a word equation for the reaction that produces the flame. (1mk)

27. Gas P was passed over heated magnesium ribbon and hydrogen gas was collected as shown in the diagram below.

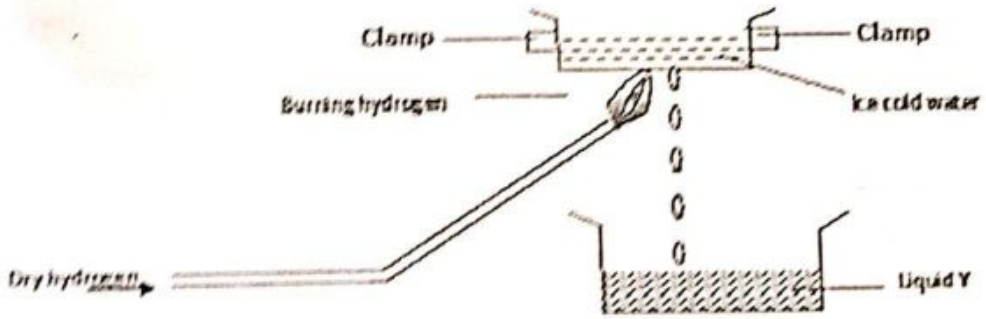


(i) Name gas P (1mk)

(ii) Write an equation of the reaction that takes place in the combustion tube (1mk)

(iii) State **one** precaution necessary at the end of this experiment (1mk)

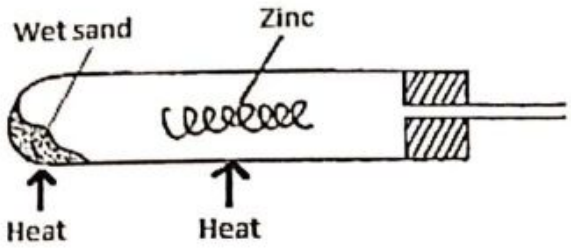
28. When hydrogen is burnt and the product cooled, the following results are obtained as shown in the diagram below.



(a) Write the equation for the formation of liquid Y (1mk)

(b) Give a chemical test for liquid Y (1mk)

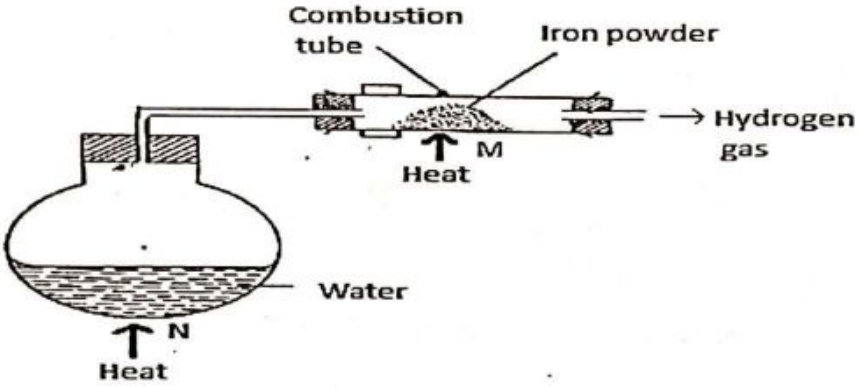
29. Jane set-up the experiment as shown below to collect a gas. The wet sand was heated before heating Zinc granules



a) Complete the diagram for the laboratory preparation of the gas (3marks)

(b) Why was it necessary to heat wet sand before heating Zinc granules? (2mks)

30. Study the diagram below and answer the questions that follow



(a) Between **N** and **M** which part should be heated first? Explain (2mks)

(b) Write an equation for the reaction occurring in the combustion tube. (1mk)

31. Hydrogen can be prepared by reacting zinc with dilute hydrochloric acid.

a) Write an equation for the reaction. (1mk)

b) Name an appropriate drying agent for hydrogen gas. (1mk)

c) Explain why copper metal cannot be used to prepare hydrogen gas. (1mk)

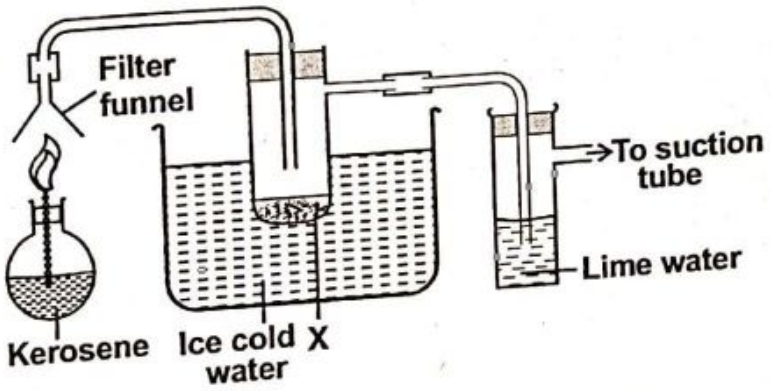
d) Hydrogen burns in oxygen to form an oxide.

(i) Write an equation for the reaction. (1mk)

(ii) State **two** precautions that must be taken before the combustion begins and at the end of the combustion. (2mks)

e) When zinc is heated to redness in a current of steam, hydrogen gas is obtained. Write an equation for the reaction. (1mk)

32. The diagram below shows an experiment to demonstrate the products formed when an organic compound burns in air. Study it and answer the questions that follow.



a) Identify liquid X (1mk)

b) Describe how liquid X would be tested to confirm its purity. (2mks)

c) State the role of ice-cold water in the experiment. (1mk)

d) State and explain the observation that would be made in the boiling tube containing lime water. (2mks)

33. What is the confirmatory test for hydrogen gas in the laboratory? (1mk)

34. A student was given a test tube with a liquid X. The teacher gave provided the student with anhydrous cobalt (II) chloride paper to help her identify liquid x. If the paper turned pink when added in liquid x, what is x? (1mk)

35. Write a word equation to show a reaction between:
(i) A metal and steam. (1mk)

(ii) A metal and water (1mk)

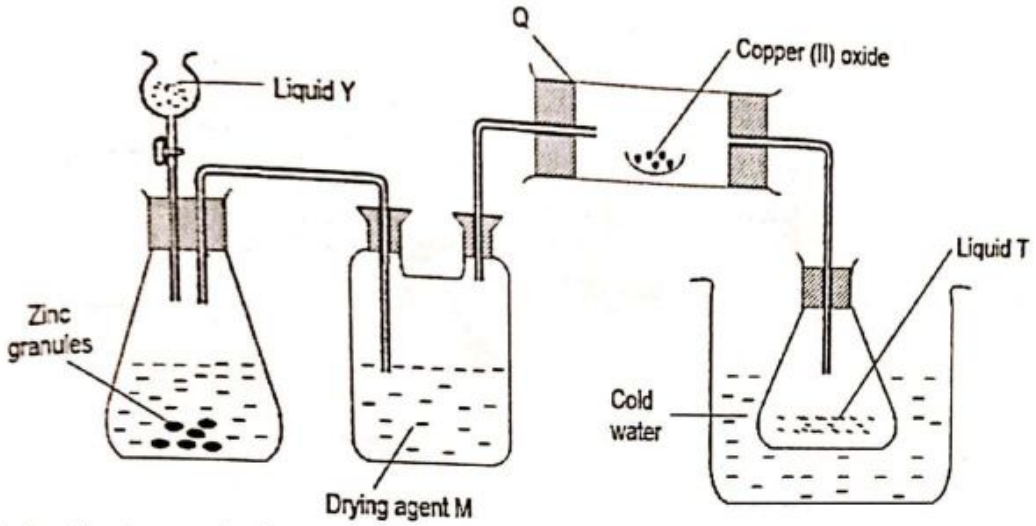
36. Draw a labeled diagram to show the laboratory preparation of dry hydrogen gas. (5mks)

37. Explain why the following combination of reagents is unsuitable for preparation of hydrogen gas
a. zinc and dilute Nitric (v) acid (1mk)

b. lead and dilute hydrochloric acid (1mk)

c. Potassium and dilute Sulphuric acid. (1mk)

38. Below is diagram showing how hydrogen can be prepared in the laboratory and the study of the reducing action of hydrogen.



(a) Define the term reduction. (1 mark)

(b) Identify apparatus **Q**. (1 mark)

(c) Identify **one** mistake in set up. (1 mark)

(d) Suggest a suitable drying agent M. (1 mark)

(e) What is liquid Y? (1 mark)

(f) Explain chemical reaction taking place in apparatus Q. (2 marks)

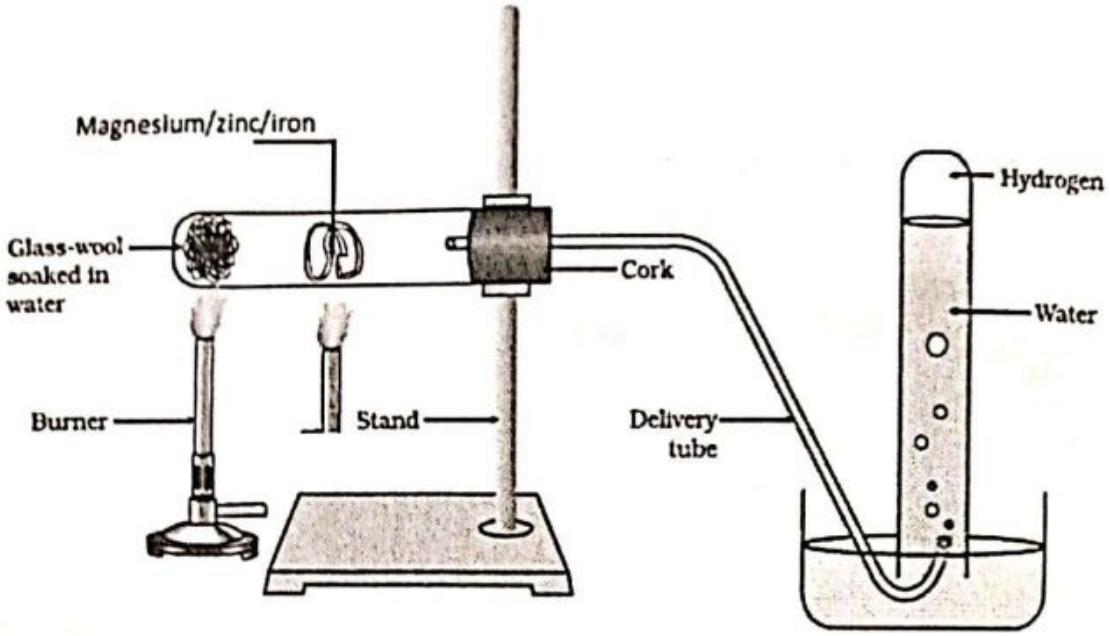
(g)

(i) Name liquid T. (1 mark)

(ii) Give **one** test of liquid T. (1 mark)

(h) State **two** uses of hydrogen gases. (2 marks)

39. The setup below was used to investigate the reaction between metals and steam.



(a) State and explain the observations made in the test tube and the gas jar. (2 marks)

(b) State two reasons why the glass wool is heated first before heating the metals. (2 marks)

(c) Write equations for the reactions that take place. (2 marks)

(d) Describe a test for the gas produced. (2 marks)

(e) Explain why sodium/calcium/potassium metals are not suitable for this experiment. (1 mark)

(f) State two commercial uses of oxygen. (2 marks)

(g) Explain why helium is preferred to hydrogen in weather balloons. (1 mark)

(h) Give two disadvantages of using hydrogen as a fuel. (1 mark)

(i) Give one advantage of using hydrogen as a fuel.

(j) Which property of hydrogen makes it possible to be collected using the above method? (1 mark)