GRADE 10 SECTION

Introduction to Chemistry

1. **What is Chemistry?**
    - The study of the particles that make up matter and the changes the particles can undergo.
2. **Classify the branches of chemistry.**
    - Branches such as:
    - **Analytical,** this branch of chemistry investigates what substances are made of. It helps chemists to identify chemicals that are present is the sample and measure their quantity
    - **Biochemistry**, this is the field of chemistry that deals with the study of the chemical nature of the living matter. It investigates the chemical compounds and energy changes in living system.
    - **Inorganic** is the study of compounds that do not contain carbon except carbonates.
    - **Physical Chemistry** is the study of physical characteristics of materials and how they react to each other.
    - **Organic chemistry** is the study of substances that contains carbon.
3. **Explain the importance of chemistry.**

    Agriculture
    - Farmers use fertilizers made from chemical elements such as nitrogen, phosphorous to improve soil quality.

    Industry

    e.g Mining chemistry is applied in the extraction of metals such as copper from copper ores.

    Plastics

Plastics are made from crude oil or coal.

Medicine

In the manufacture of drugs from plants, chemical processes are used.

HOME

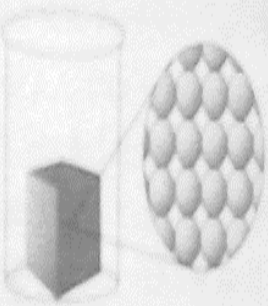
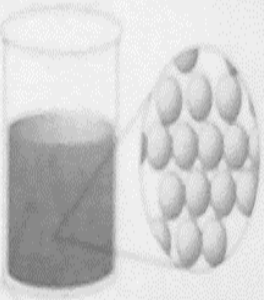
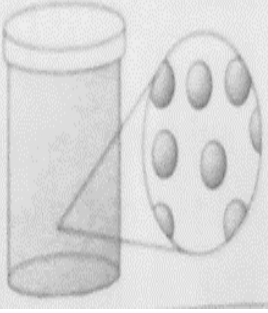
e.g detergents and household soaps are designed to do the best job possible.

4. **Describe the challenges of chemical industrial activities**
    - Production of undesired harmful by-products such as sulfur dioxide, carbon monoxide carbon dioxide harm environment.
5. **How can you demonstrate an appreciation of safety in the laboratory?**
    - By following Safety rules in the lab

The Particulate nature of matter

Matter and the Kinetic theory

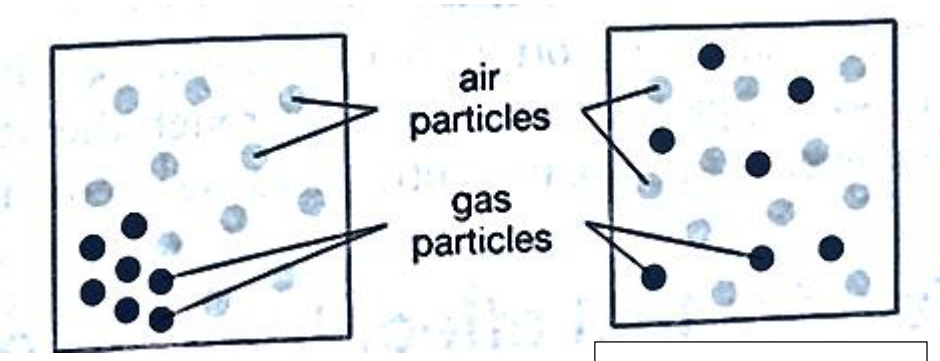
6. **Describe matter**.
    - Matter is anything that has **mass** and occupies space
7. **Classify the basic units of matter**
    - Atoms ,molecules ,ions
8. **Classify the states of matter in terms of particle arrangement and movement**
    - Solid,>> particles of a solid are closely packed and in constant vibration in their fixed position
    - Liquid>> distance between particle of a liquid are far apart from each other as compared to the distance between solid particle and move about randomly
    - Gas >> the particles that make up a gas are very far from each other when compared to the distance of particle in liquids. This is the why gas is easily compressed.

State	Characteristics	How are the particles arranged?	Examples
Solid	Solids have fixed volume and shape. To change the shape of a solid requires force, such as when it is broken or cut with an instrument.		stones, wood and table salt
Liquid	Liquids have fixed volume, but not fixed shape. A liquid can change its shape and take on the shape of the container that it is in.		water, paraffin and cooking oil
Gas	Gases do not have fixed volume or shape. A gas will expand to take up the full volume of the container that it is in.		oxygen, carbon dioxide and chlorine gas

9. **Illustrate changes of states of matter.**
    - **Melting is** the change of state from solid to liquid as a result of increase in temperature. The distance between particles increase
    - **Freezing point**, is the change of state from liquid to solid. the distance between particles of the liquid reduce until solid state is achieved.
    - **Boiling point**, is the temperature at which liquid changes to gas. The temperature remains constant at this point until all the liquid has changed to gas. The energy supplied to the liquid is used to increase the distance between the particles of the liquid.
    - **Condensation**, is the change of state from gas to liquid.
    - **Sublimation, is the** change of state from solid to gas or gas to solid

10. **Describe the absorption of heat and release of heat during changes of states of matter**
    - Changing states of matter, exothermic-release of heat during a reaction, endothermic-absorption of heat during a reaction.
11. **Define diffusion**
    - Is the movement of particles from region of higher concentration to region of lower concentration?
12. **How can you demonstrate diffusion in fluids**
    - Perfume sprayed in one corner of the classroom eventually is detected in all parts of the room.

- A coloured juice poured in water eventually distribute itself uniformly in water until all parts have the colour



The concentration of particles in one region

The particles are evenly distributed throughout the volume of air.

13. Describe the factors that affect the rate of diffusion.

- **Molecular mass**, the bigger the molecular mass the slower the rate of diffusion. The smaller the mass the faster the rate of diffusion.
- **Temperature**, at higher temperature particles move faster hence faster rate of diffusion. At low temperature particles move slower hence the slower rate of diffusion. Therefore we can state that the rate of diffusion is directly proportional to temperature.
- **Concentration**. The higher the difference in concentration the faster the rate of diffusions. The lower the difference in concentration of the two substances the lower the rate of diffusion.

Experimental Techniques

Measuring of quantities.

14. Demonstrate how different quantities are measured.

- Time is measured using a stop watch by determining the period elapsed between the start and ending of an event e.g. time taken for a liquid to reach boiling point.
- Temperature is recorded by putting a thermometer in a vessel to determine the heat released or absorbed, the melting point or melting point of a liquid.
- Mass is recorded by putting a substance to be measured on an electronic balance.
- Volume is measure using measuring cylinder, by pouring the desired liquid into the cylinder and taking the reading

15. Identify different measuring apparatus used in chemistry.

Some of the Measuring apparatus are

- **Stopwatch or stop clock**- for time
- **thermometers**,- for temperature
- **electronic/beam balances**, for mass
- **Burettes, pipettes, volumetric flask, measuring cylinder, and gas syringes** for recording volume.

16. Identify various measuring instrument and other apparatus used in chemistry

- **Stopwatch or stop clock**- for time
- **thermometers**,- for temperature
- **electronic/beam balances**, for mass
- **Burettes, pipettes, volumetric flask, measuring cylinder**, **and gas syringes**- for recording volume.

  Other apparatus are

  Spatula, stands and clamp, test-tubes, burners, glass rods, evaporating dish, funnel beaker, conical flask etc.

CRITERIA F PURITY

17. Describe the differences between a pure substance and a mixture.

- A pure substance has a sharp melting point and fixed density while an impure substance has melt or boil over a range of temperatures.

18. Demonstrate how to determine the purity of a substance.

- Put a thermometer into an ice or a liquid and apply heat. For a pure substance the temperature will remain at the at the same at boiling or melting point until complete change of state take place as the liquid change its state to gas or ice change state to liquid at melting or boiling points while a mixture melt or boil at a range of temperature.

19. Explain the importance of purity of a substance.

- purity in substances such as foodstuffs, medicines, drinks is very important because impurities can affect the health of animals eg human
- In industry, the computer processor chip must be in purest of silicon otherwise it will not work.

20. Distinguish between physical and chemical changes

Physical change

- No new substances formed
- Is reversible
- No absorption release of energy

Chemical change

- New substances are formed
- Not reversible by simple means
- Energy is released or absorbed

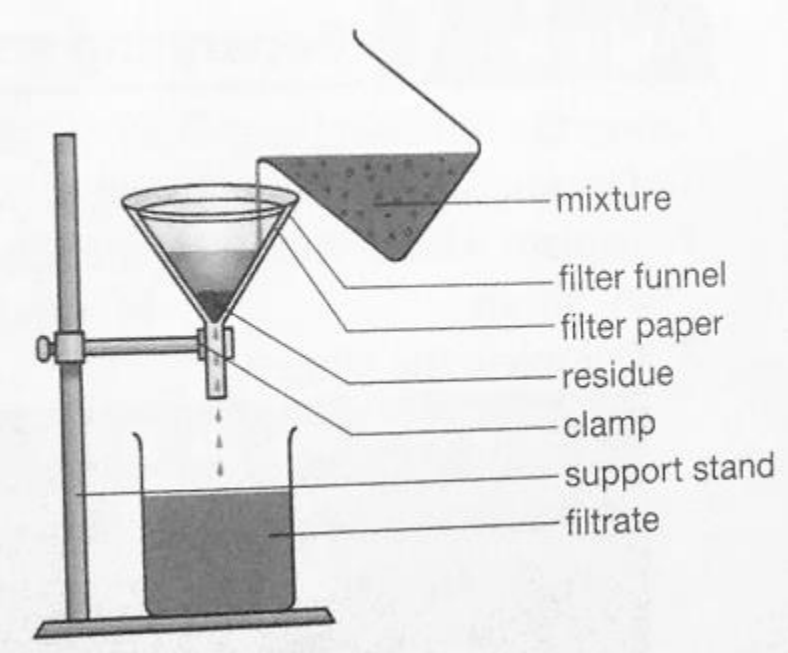
21. **Demonstrate different methods of separating mixtures**.

- **Decantation:**

  If a mixture contains solid particles solid particle that can be seen, and that will settle to the bottom of the container, if left to stand ' it can be separated be decantation. You can. Carefully pour off the all the quid so that the solid substance remains

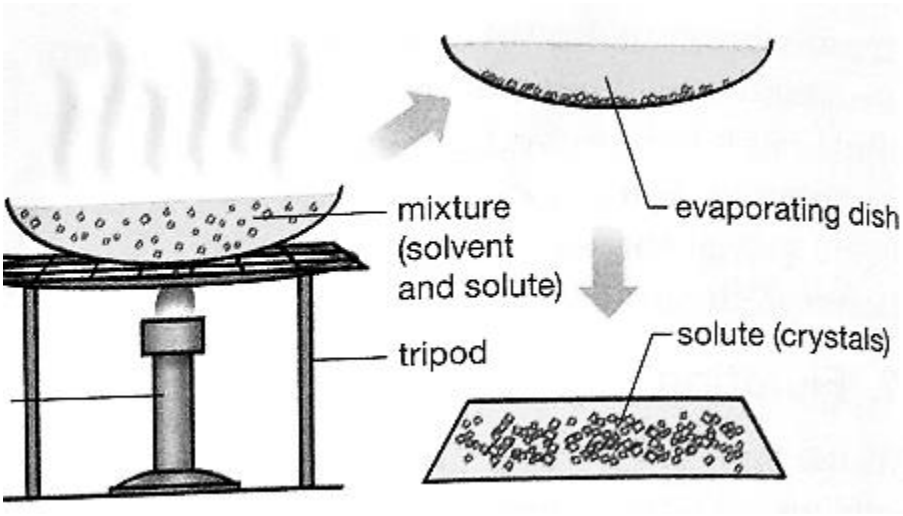
- **Filtration:**

  The act or process of filtering, especially the process of passing a liquid or gas, such as air, through a filter in order to remove solid particles, is used to separate soluble and insoluble substances. A mixture of soluble and insoluble substances is dissolved in water and thereafter filtered to remove the insoluble substance. The filtrate can evaporated and crystallized to recover the solute.

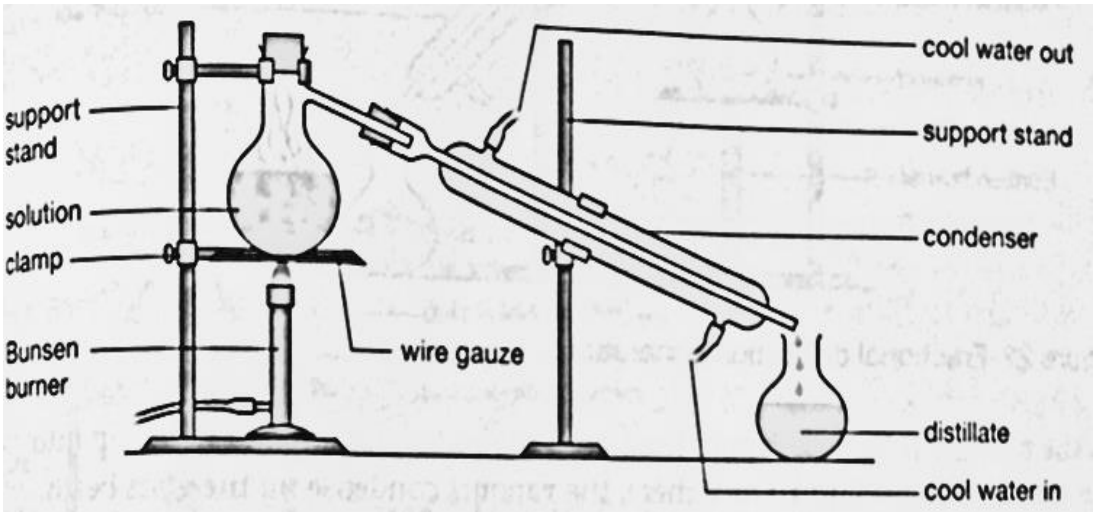


- Crystallization is the process used to recover a solute from. A solution is heated to saturate it and is later let to cool down. When a solution becomes saturated, it means that the solvent cannot ‘‘hold’, any more solute in solution at that

temperature, so the solute is forced out of the solution in the form of solid crystals.

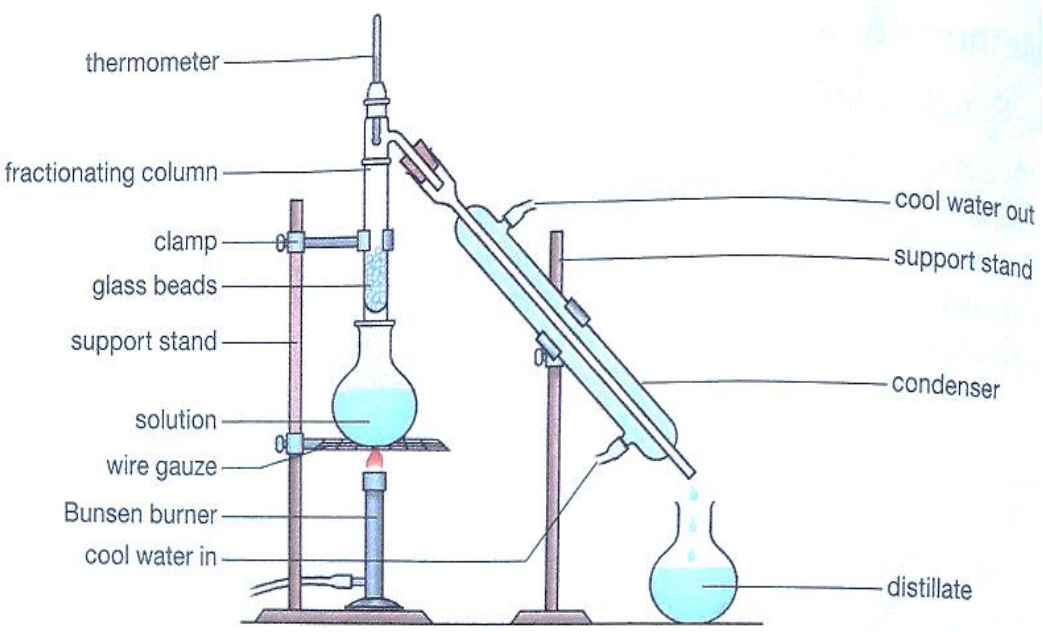


- **Simple distillation** is the process used to separate a liquid from a solution by evaporating the mixture and condensing the mixture back to liquid.

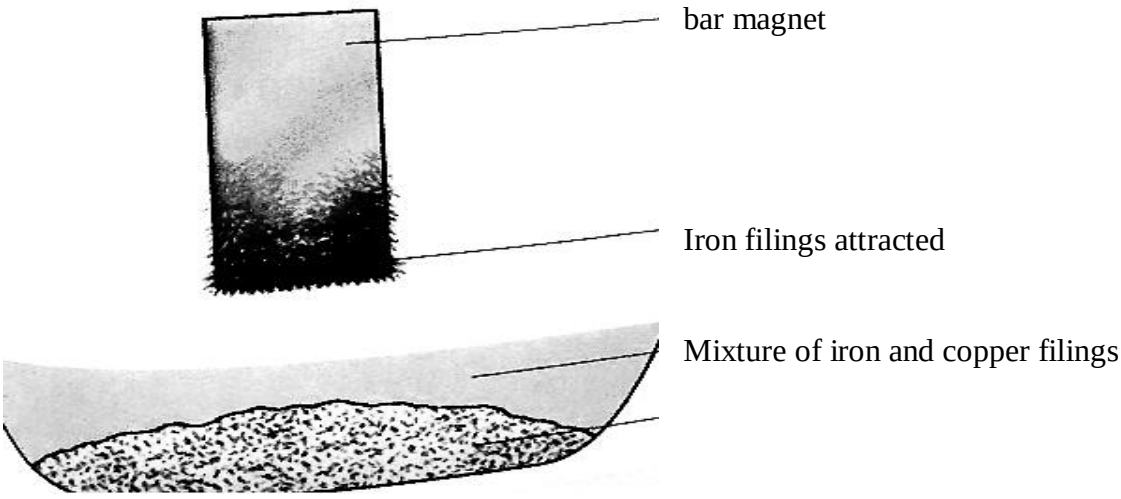


- **Fractional distillation**, is the process used to separate mixtures with different boiling point. e.g pure water, boiling point 100℃ and ethanol with boiling point 73℃ are heated to 100℃ and 73℃ repectively at the temperature is let to at

constant until all the ethanol evaporate and the raised to 100℃

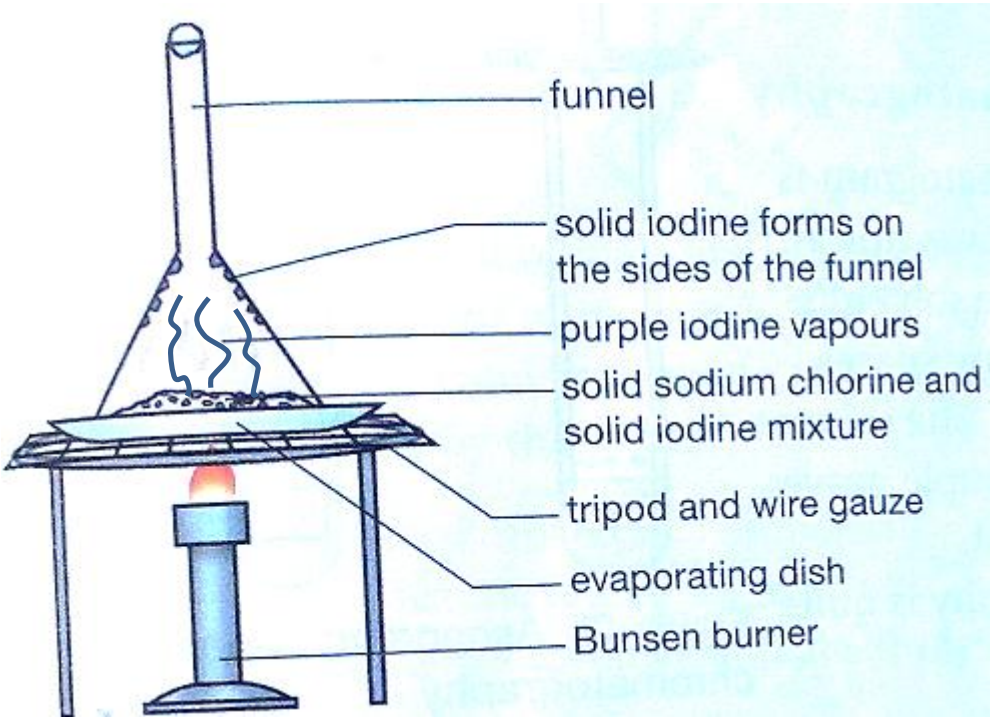


- Magnetism, is used to separate magnetic materials from non-magnetic material. Iron metal can be separated from a mixture of sand, stones copper e.t.c using a magnet.



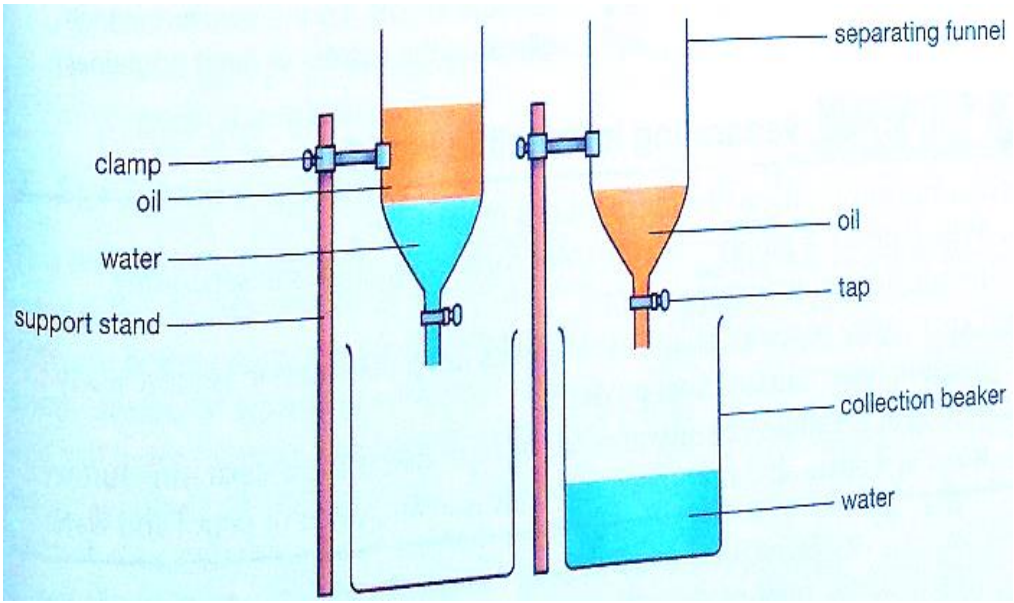
- **Evaporation,** is the process used to recover a solvent from a solution. Salt crystals can be recovered from a solution water and salt by evaporating the mixture.

- **Sublimation** is the change of state from gas to solid or solid to gas directly. It is a technique used to separate substances that undergo sublimation. It works well when a non-sublimating substance has a high melting point.



Separating funnel

Is use to separate liquids that are immiscible, they quickly separate into layers once poured into the funnel. The tap at the bottom of the funnel is opened to pour off the bottom layer, leaving the upper layer or layers. Immiscible



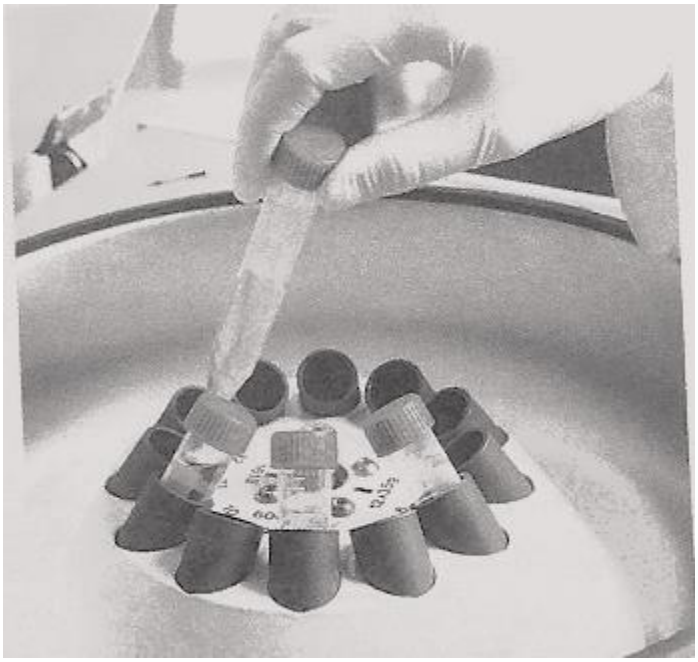
Using a separating funnel makes it easier to see exactly where the oil layer starts. Therefore you can turn off the tap just before any oil contaminates the water sample. You can discard a small amount of oil to make sure that all the water particles have been removed from the funnel, before you collect the pure oil in another container.

Centrifugation

Use a centrifuge

it is another method that can separate two or more immiscible liquids. This method uses a piece of apparatus known as a centrifuge,

which rotates the container holding the sample liquid around a fixed axis, but at an angle to the vertical. As the centrifuge rotates, the more dense liquids are pushed outwards and towards the bottom of the container, while the less dense liquids are pulled inwards and upwards. The liquid on top can be poured off or using a pipette too remove it.



A laboratory centrifuge: As the rotor rotates, the more dense substance collects at the bottom of each container

Chromatography.

This is a separating technique in which a mixture is separated as it moves across porous surface, carried by an appropriate developing solvent. Different substance in the mixture will interact differently with both the solvent and the surface, therefore they will separate. The substance that dissolves more readily and is least attracted to the surface, moves the fastest. It therefore travels furthest from the starting line, separating itself from the other substances in the mixture.

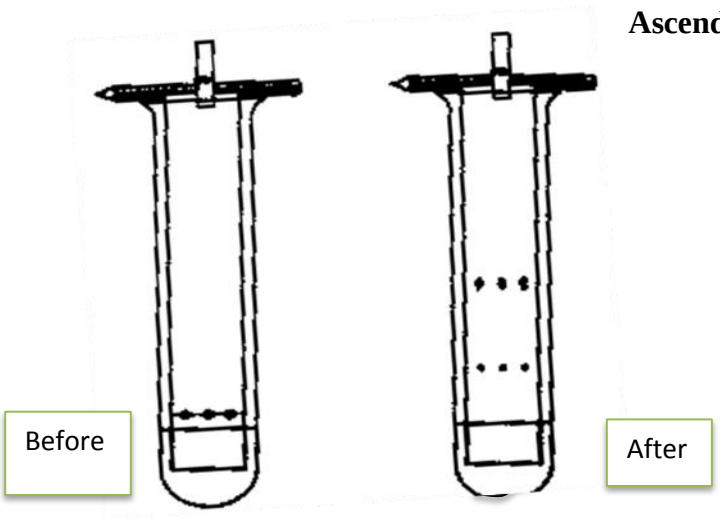
22. Interpret simple paper chromatograms.

Types of paper chromatography.

1. **Ascending paper chromatography.**

The bottom edge of the chromatogram is in the solvent. The solvent moves upwards through the paper, because the solvent's particles are attracted to the tiny spaces between the particles of paper. The solvent dissolves the sample, so the sample

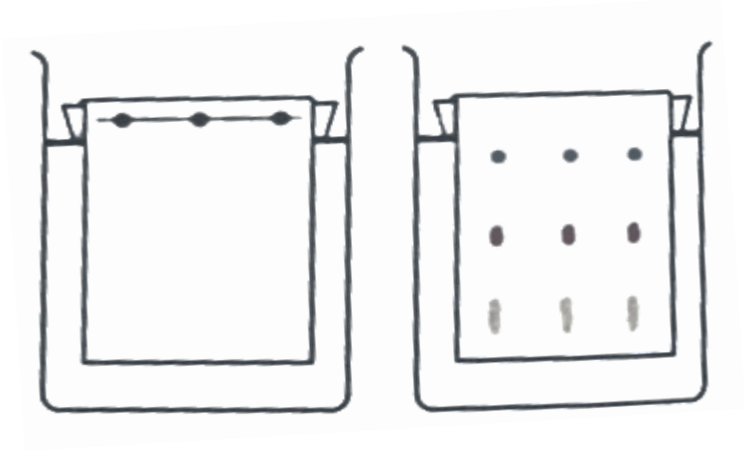
moves upwards along with the solvent. Ascending paper chromatography is quite a slow process.



Ascending paper chromatography

2. Descending paper chromatography

The moving solvent moves vertically downwards as the mixture separates. The chromatography paper is saturated with the solvent beforehand, and more is kept in a chamber at the top of the apparatus. The separation of the mixture occurs faster than in ascending paper chromatography, because the moving solvent is helped by gravity.



Descending paper chromatography

3. Radial chromatography

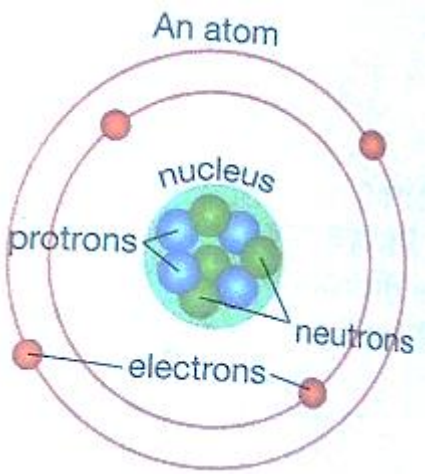
The moving solvent moves outwards from a central point and separates the mixture into concentric circles (rings). The end result looks like this:

Atoms, elements, compounds and molecules

23. Describe an atom and its structure.

- An atom is the smallest particle of an element which takes part in a chemical reaction.
- All atoms are made up of three sub-atomic particles: protons, neutrons and electrons. The protons and neutrons are found in the nucleus

- Structure: nucleus at the centre surrounded by electron shells. The nucleus consist of electrons and neutrons



24. Describe the relative charges and approximate relative masses of protons, neutrons and electrons

Sub-atomic particle	Approximate mass in atomic mass units (amu)	Charge	Location in an atom
proton	1	+1	nucleus
neutron	1	0	nucleus
electron	$\frac{1}{1\,840}$	−1	shells

25. Describe the proton (atomic)number and nucleon(mass) number and nuclide notations

- Number of protons: Z, Number of nucleons: A (protons + neutrons)and nuclide notation ${}^{A}_{Z}\mathrm{X}$ where X represent symbol of an element,

  A represent the atomic mass or nucleon number or mass number

  Z. represent the atomic number.

Atomic number (Z) is the number of protons.

Atomic mass (A) is the sum of protons and neutrons.

26. Describe an element

- Is substance made up of same chemical atoms.

27. Identify elements using their chemical symbols

The first 20 elements of the Periodic Table: Names, symbols and important numbers

	Element	Symbol	Proton number (Z)	Nucleon number (A)
1	hydrogen	H	1	1
2	helium	He	2	4
3	lithium	Li	3	7
4	beryllium	Be	4	9
5	boron	B	5	11
6	carbon	C	6	12
7	nitrogen	N	7	14
8	oxygen	O	8	16
9	fluorine	F	9	19
10	neon	Ne	10	20
11	sodium	Na	11	23
12	magnesium	Mg	12	24
13	aluminium	Al	13	27
14	silicon	Si	14	28
15	phosphorus	P	15	31
16	sulphur	S	16	32
17	chlorine	Cl	17	35
18	argon	Ar	18	40
19	potassium	K	19	39
20	calcium	Ca	20	40

28. Describe the basis of the Periodic Table. The periodic has periods and groups.

- Group determined by valence electrons
- Period determined by number of shells

29. Describe isotopes

- Isotopes are atoms of the same element having the same number of protons bt different number of neutrons. Including radioactive and non-radioactive isotopes.

Example of isotopes

Oxygen atoms have 8 protons and 8 electrons. The majority of naturally occurring oxygen atoms have 8 neutrons, but a small percentage have 9 neutrons, while others have 10 neutrons

Name of isotope	Proton number(Z)	Neutron (N)	Atomic Mass(A)
Oxygen-16	8	8	16
Oxygen-17	8	9	17
Oxygen – 18	8	10	18
Chlorine-35	17	18	35
Chlorine-37	17	20	37

30. **Describe the use of radioactive isotope**

Medical and health-related use

- Cobalt-60 is used to treat cancer. This radioisotope gives off rays named gamma rays as it decay. Gamma rays are effective at targeting and killing cancer cells, so a cancer patient has a beam of gamma rays from a sample of cobalt-60 directed to the part of the body where the cancerous cells are located. This type of treatment is called radiotherapy

31. **Cobalt-60 is also commonly used to treat food. Gamma rays kill dangerous bacteria and parasite**.

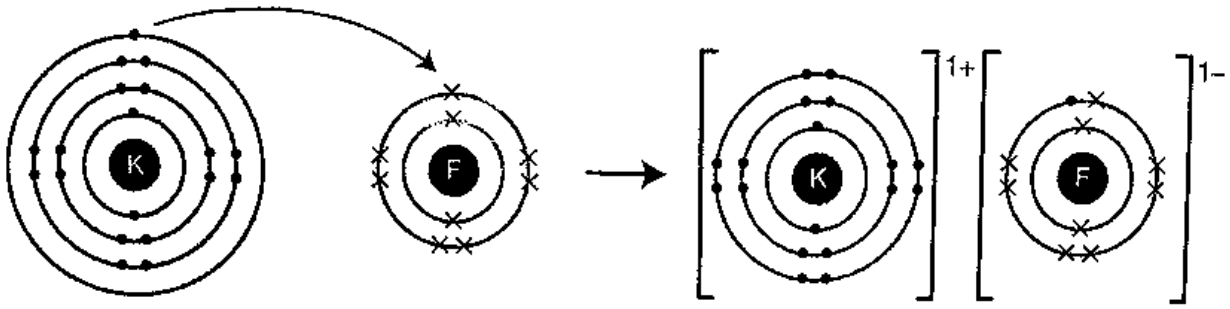
Demonstrate the build-up of electrons in shells

- The number of shells are drawn according to the period where an element is found. If an element is found in period 3, the element has three shells. The first shell must have a maximum number of two electrons. The next shell must have maximum number of 8 electrons. The remaining electron are spilled into the next shell until all electrons are filled into the shell.

32. Describe a compound

A compound is a substance that, consists of two or more different types of elements that have been chemically, combined. The ratio of elements in a compound is, always held. The process of Forming a, compound from two or more different elements is called **synthesis**. Energy is either given out or absorbed in compound synthesis. The newly-formed compound has entirely new chemical properties. For example, hydrogen reacts with oxygen to form water

33. **Describe the formation of ions (radicals**).



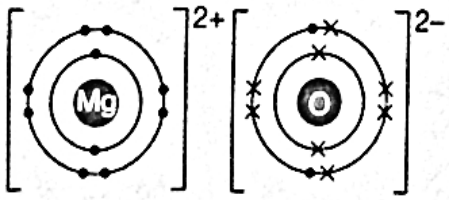
K, 2:8:8:1 F, 2:8:1 KF

Show, using a dot and cross diagram, how atoms are bonded in:

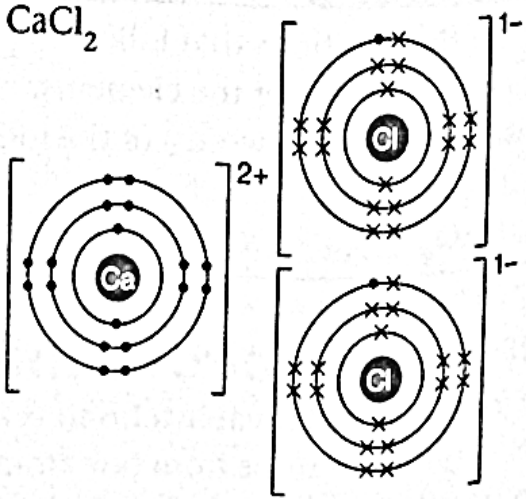
1. magnesium oxide (MgO)
2. calcium chloride ($CaCl_2$).

Answers

1. MgO



2. $CaCl_2$



Ions are of two kinds namely cations and anions.

- Cations by electron loss, eg $Cu - 2e \rightarrow Cu^{2+}$ Anions by electron gain of electrons e.g.

  $O + 2e \rightarrow O^{2-}$

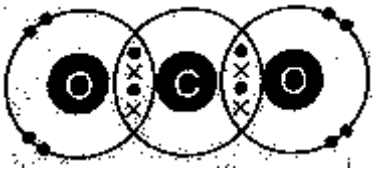
34. **Describe the formation of ionic (electrovalent) bonds**.

- Electrovalent bonds are formed by loss and gain of electrons between metallic and non-metallic atoms. an ionic bond is electrostatic force between cations and anions. Such as NaCl, $CaCl_2$ and MgO

35. Describe the formation of covalent bonds

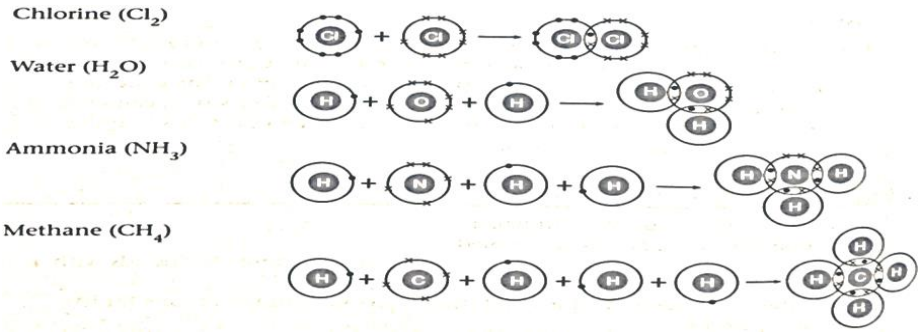
This type of bonding involves the sharing of electrons between non-metallic atoms when their shells overlap. In Figure 13, two non-metal atoms that each need one more electron to achieve noble gas configuration, can share a valence electron from each atom, so that both end up with full outer shell. The result is a very.

Covalent bonding involves the sharing of electrons between non-metallic atoms when their shells overlap. In the figure, two non-metal atoms that each need one more electron to achieve noble. Covalent bonds are formed by sharing of electrons between non-metallic atoms.



Covalent bonds as shared pairs of electrons. Such as H_2O, Cl_2, NH_3, CH_4,

Examples of covalent bonds



36. Describe the electronic arrangement in simple multiple covalent molecules

A pair of shared electrons form a one make one bond.

- double bonds in O_2 ,C_2H_4 and CO_2, Triple bond in $N_2$and C_2H_2

  Example in CO_2

  $\mathbf{O = C = O}$: There are two pairs of electrons shared between any of the oxygen atom and carbon atom.

In C_2H_2, there are three pairs of electrons shared between carbon to carbon and one pair of electrons shared between carbon and hydrogen atoms

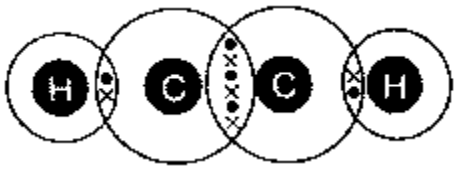
$$\mathbf{H - C \equiv C - H}$$

one bond is equal to two electrons. Therefore, there are two electron shared between hydrogen and carbon and 6 electrons shared between carbon and carbon

37. Describe the uses of ionic and covalent compounds

Uses of ionic compounds

- Because ionic compounds have such high melting points, they can keep their strength and stability at very high temperatures. This means that they are very good refractory materials, which play an important role in some industries. Industries that make use of furnaces need to have linings in those furnaces that can withstand the extremely high temperatures. Some of these are:



- Metals: Whenever metals are processed and formed into products, the metal usually has to be melted down first. Steel mills contain blast furnaces where this happens, and those are often lined with magnesium oxide (MgO).
- Glass and cement: Furnaces used in glass- and cement making are often lined with aluminum oxide (Al_2O_3)

Uses covalent compounds

- Alcohol: Ethanol is an organic, covalent compound that we know as alcohol. Apart from alcoholic beverages, alcohol is used in medical science as a preservative and an antiseptic, and it is used in some cleaning agents and fuels.
- Glass: The main ingredient of glass is silicon dioxide (SiO_2)

38. Describe a molecule

- An element is the smallest particle of an element or compound which exists independently

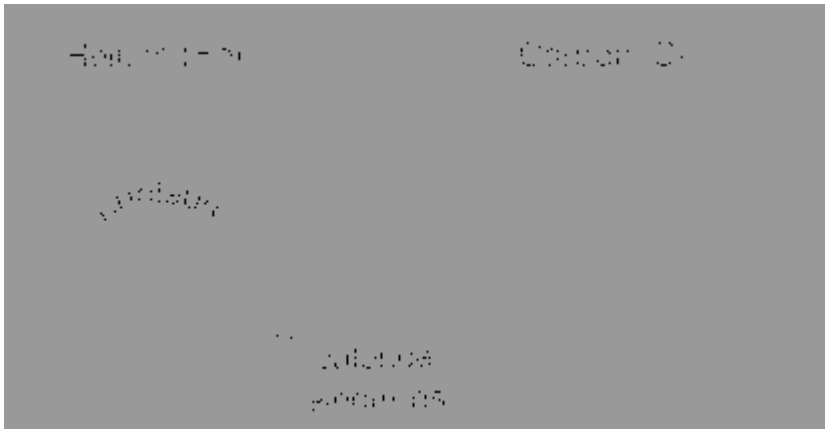
39. Describe valence and valence electrons. Demonstrate how to deduce valence of an element.

- Valence is combining power of an atom or radical.

  The number of electrons that an atom of any element loses or gains to form the stable structure of a noble gas, is called its valence number, or combining power. Elements that have: • 1 to 3 valence electrons tend to lose those electrons (aluminum's valence number is 3)

  • 4 valence electrons tend to share those electrons (carbon's valence number is 4)

  • 5 to 7 valence electrons tend to gain electrons to complete the noble gas
- Valence electrons is the number of electrons in the outer most shell of an atom



40. Identify the differences in properties of ionic and covalent compounds.

Covalent compounds

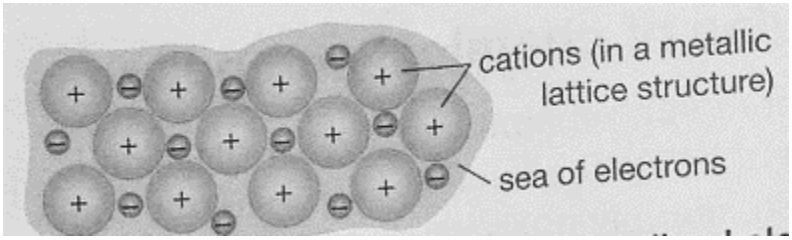
Ionic compounds	Covalent compound
Most ionic compounds are not volatile They are made up of ions. (they do not easily evaporate at room temperature and pressure)	Most covalent compounds are volatile. that is why they usually have distinctive smells
When melted or in solution, ionic Compounds conduct electricity.	They do not conduct electricity
Ionic compounds are usually solids at Room temperature and pressure.	Covalent compounds are usually gases or liquids at room temperature and pressure
Ionic compounds have high boiling points and high melting points,	They vaporize easily. This is because of the very weak electrostatic forces of Attraction between the molecules.
They do not vaporize easily. This is because of the very strong electrostatic Forces of attraction between the oppositely charged ions.	Many covalent compounds are insoluble in water, but soluble in other covalent liquids such as alcohol and Tetra chloromethane.
Many ionic compounds are soluble in water	Generally, covalent compounds have Lower densities than ionic compounds.

41. **Describe metallic bonding**.

This type of bonding involves the force of attraction between cat ions (positive ions) and electrons in a metallic lattice structure. In other words, when metal

Atoms are packed together tightly in a metal lattice, their valence electrons break

Free from the shells and move around the structure. The electrons become localized and form a sea" of electrons, which then acts as a glue that hold the lattice together.



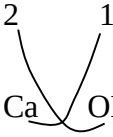
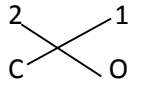
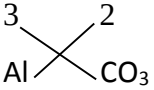
42. **Describe the electrical and thermal conductivity of metals**.

Metals are good conductors of heat.They have very high melting points because very much heat is required to break the lattice structure. They conduct electricity because electrons are free to move around the lattice. The electrons can carry electrical charge throughout the lattice structure. They conduct heat because the electrons both absorb and transfer heat to the cations very well. Metals are ductile (they can be drawn into a wire) and malleable (they can be hammered into a new shape). This is because the positive ions are able to slide over each other, without breaking the bond is he electrical conductivity of free electron movement/delocalized electrons

43. Demonstrate how to deduce a chemical formulae from valences.

	Zinc chloride	Ammonia	Aluminium oxide
Step 1: write the symbols	Zn Cl	N H	Al O
Step 2: write the valencies	2 1	3 1	3 2
Step 3: balance the valencies	(multiply the valency of Cl by 2)	(multiply the valency of H by 3)	(multiply the valency of Al by 2 AND multiply the valency of O by 3
Chemical formula	$ZnCl_2$	NH_3	Al_2O_3

Other examples

Name of a compound	Step 1	Step 2	Step 3	Chemical formulae
Calcium hydroxide	Ca OH	2 1 Ca OH	2 1  Ca OH	$Ca(OH)_2$
Carbon dioxide	C O	4 2 C O	~~4~~ 2 ~~2~~ 1  2 1 C O	CO_2
Aluminium carbonate	Al CO_3	3 2 Al CO_3	3 2  Al CO_3	$Al_2(CO_3)_3$

44. Demonstrate how to construct word equations.

Steps for writing chemical equations

Step 1: Write the names of the reactants and products in a word equation.

Step 2: Below the word equation, write the chemical formulae for each reactant and product.

Step 3: Balance the equation to make sure that the number of a certain type of atom on the left hand side is the same as the number of the same type of atom on me right side. You can do this by

- multiplying the formulae (which represent atoms ·of that chemical the equation) by whole numbers until the two sides are balanced

Example

Mixing Calcium carbonate and hydrochloric acid produce calcium chloride salt, water and carbon dioxide.

Word equation

Calcium carbonate + hydrochloric acid $\longrightarrow$ Calcium chloride + water + Carbon dioxide

Chemical equation

$$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2\,(aq)} + H_2O_{(l)} + CO_{2\,(g)}$$

45. Construct net ionic equations from balanced chemical equations

Write the net ionic equation for this reaction:

$2AgNO_3\,(aq) + ZnCl_2\,(aq) \rightarrow 2AgCl\,(s) + Zn(NO_3)_2\,(aq)$

Answer

$2Ag^+\,(aq) + 2\cancel{NO_3^-\,(aq)} + \cancel{Zn^{2+}\,(aq)} + 2Cl^-\,(aq) \rightarrow 2AgCl\,(s) + \cancel{Zn^{2+}\,(aq)} + 2\cancel{NO_3^-\,(a}$

$2Ag^+\,(aq) + 2Cl^-\,(aq) \rightarrow 2AgCl\,(s)$

$Ag^+\,(aq) + Cl^-\,(aq) \rightarrow AgCl\,(s)$

GRADE 11 CHEMISTRY 5124/5070

ACIDS, BASES AND SALTS

Characteristic properties of acids and bases

1. **Describe acids, bases or alkalis in terms of ions they contain or produce in aqueous solution**.

Answer

- **Acid** are compound that produces hydrogen ions as the only positively charged ions in aqueous solutions,
- **Base** is an oxide or hydroxide of a metal including ammonium hydroxide
- **Alkalis** are soluble bases that produce hydroxide ions in aqueous solution as the only negatively charged ions.

2. **Describe the meaning of weak, strong, dilute and concentrated acids and alkalis**

Answer

ACIDS

- Weak acids are acids that partially ionize in water.
- Strong acids are acids that completely ionize in water to form hydronium ions.
- Dilute acids is one where a pure acid is mixed with significant percentage of water.
- Concentrated acids is the amount of acid dissolved in $1dm^3$ of a solution.

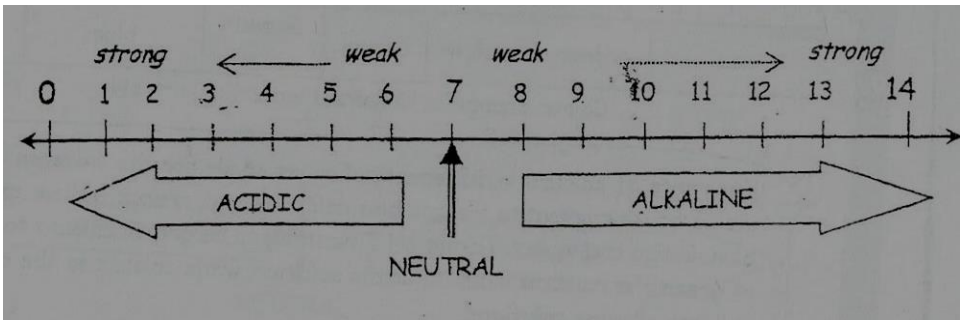
ALKALIS

- Weak alkalis. A weak alkali partially disassociate in water.
- Strong alkalis – A strong alkali dissociates completely in water.
- Dilute alkalis – is an alkali that is not very strong it has a P^H OF 8,9,10…
- Concentrated alkalis – The amount of acid or alkali dissolved in $1dm^3$ of a solution.

3. Describe the P^H scale (*P^H is an abbreviation "potential hydrogen").

Answer

- **P^H scale** is scale ranging from 0 to 14 showing the degree of acidity and alkalinity.



4. Describe neutrality, acidity and alkalinity in terms of P^H value

Answer

- **Neutrality ;** The P^H of 7 indicates a neutral solution
  (The P^H values: 7 for neutrality)
- **Acidity;** Solution that have a P^H less than 7 are acidic.
  Below 7 for acidity (from 0 to 6.9 is acidity)
- **Alkalinity;** solutions that have a P^H more than 7 are alkaline. ***(P^H ranging from 8 to 14)***

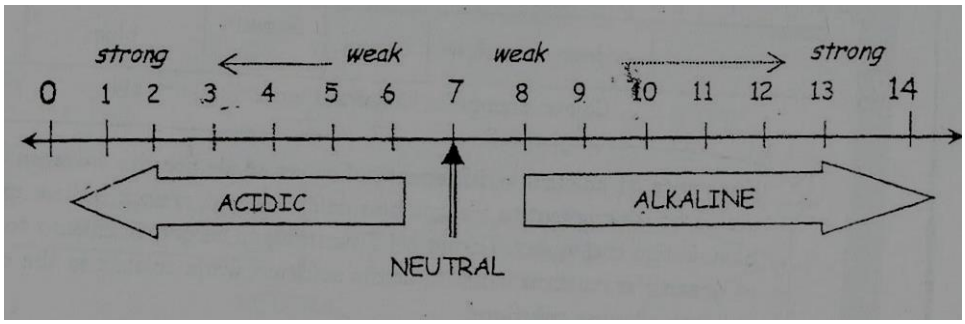


Figure 1 P^H scale

5. **Determine the P^H value of a solution**.

Answer

- **Using universal indicator**: which gives different colours at different P^H values.
- **Using P^H meter**: which gives precise values are given

6. Demonstrate the characteristic properties of acids

Answer

Characteristic properties of acids

- Acids have a sour taste
- Acids are corrosive (strong acids are dangerous and can burn the skin)
- Acids are neutralized by bases.
- Acids turn dump blue litmus paper red

7. Demonstrate the characteristic properties of acids

Answer

- **acids reacts with a metal to form a salt and hydrogen gas**

  Acid + metal $\longrightarrow$ salt +hydrogen gas

  $HCl_{(aq)} + Mg_{(s)} \longrightarrow MgCl_{2\,(aq)} + H_2$

- **Acid react with base**

- **A**cid react with base to form salt and water only,

  Acid + base $\longrightarrow$ Salt +water

  $HCl_{(aq)} + NaOH_{(AQ)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

- **Acids react with metal carbonate, and hydrogen carbonate to produce salt, water and carbon dioxide**

  Acid + carbonate $\longrightarrow$ Salt +water +carbon dioxide

  $HCl_{(aq)} + CaCO_{3\,(S)} \longrightarrow CaCl_{2\,(aq)} + H_2O_{(l)} + CO_{2(g)}$

8. **State the effect of acids on indicators;**

Answer

Acids turn;

- blue litmus paper turn red,
- methyl orange change red
- Bromethymol blue change yellow
- Phenolphthalein change colourless,

9. **Demonstrate the characteristic properties of bases.**

Answer

Properties of bases

- Have a bitter taste
- Have a soapy or slippery feel.
- Are corrosive
- Are neutralized by acids.

10. **Illustrate the importance of acid- base reactions**

Answer

Importance of acid- base reactions

- **Used in controlling the acidity in the soil** – The quality of a crop depends on the quality of the soil. Acidity in soils comes from the build-up of H^+ in the soil solution. For example, acid comes from:
- air pollution that mixes with water vapour and eventually comes back down to earth in the form of rain (in particular, acidic gases from mines and other industrial activities)

- **Treatment of indigestion** – some cells in your stomach produce an acid to help with the digestion of food, while others produce a base to neutralize the acid. Sometimes there is too much acid in the stomach. This acid travels up the oestophagus (food pipe) causing heartburn. The symptoms of heartburn can be relieved by taking antacids (bases or basic salts). Baking soda can also be used to neutralize the excess acid in the stomach.
- **Brushing teeth with toothpaste** – Tooth decay is usually caused by the bacteria in our mouths which converts sugars into lactic acid. It is the build-up of this acid that dissolves the enamel, or outer surface of our teeth. Toothpaste contains sodium bicarbonate (baking soda), which removes stains, provides the foaming action and neutralizes acids.

11. **State the uses of acids and bases.**

- Used in control of P^H in agriculture,

- making of soap,
- in car batteries

PREPARATION OF SALTS

1. **Describe a salt**

   Answer

- A **salt is** a compound formed when the hydrogen ions of an acid are fully or partially replaced by a metal or ammonium ions.
- Or **a salt is** compound made of positive metallic/ammonium ions and any negative ion of an acid.

2. **Classify salts according to their nature and solubility in water**

   Answer

   Types of salts;

- acid,
- basic and
- Normal salts.

Table 1; SOLUBILITY RULES OF SALTS

SOLUBLE SALTS	**INSOLUBLE SALTS**
All nitrates are soluble	
Carbonates of sodium, potassium, ammonium are soluble (all Carbonates Group I elements)	All other Carbonates are insoluble.
Most sulphate are soluble	Lead (II)sulphate,barium sulphate,calcium sulphate
Most chlorides are soluble	Silver chloride, lead (II) chloride,mercury (I) chloride
Hydroxides and oxides of alkali metals and ammonium	All other oxides and hydroxides are insoluble
All salts of alkali metals and ammonium	

3. **Demonstrate the preparation of an insoluble salt.**

These are the step for obtaining the Barium sulphate;

Step 1; Mix solutions of barium chloride and magnesium sulphate. A white precipitate of barium sulphate forms at once.

Step 2; the mixture is filtered.the barium sulphate gets trapped in the filter paper. (Barium sulphate remains on the filter paper as a residue).

Step 3; It is rinsed with distilled water.

Step 4; then it is put in a warm oven or porous filter paper to dry.

4. **Demonstrate the preparation of a soluble salts.**

Step 1; Pipette 25.0cm^3 of 1.0 mol/dm^3 hydrochloric acid into a conical flask.

Step 2; Add 2 droppers of phenolphalthalein indicator into the flask and swirl.

Step 3; slowly release from the burette aqueous sodium hydroxide of a known concentration it flask and swirl the flask constantly to mix the contents.

Step 4; when the pink colour first appears in the flask,stop the addition of sodium hydroxide and note the volume of alikali used.

Step 5; repeat the titration steps,this time without addition of indicator,adding the noted volume of alikali into the flask of 25.0cm^3 of 1.0 mol/dm^3acid.

Step 6; the solution found will be neutral solution of sodium chloride.

Step 7; heat the solution so that the water will evaporate and the solution become saturated.

Step 8 ; crystallise the cooled saturated solution.

Step 9; filter out the pure sodium chloride crystals.

The steps can be used in the preparation of other such as, Zinc sulphate, copper (II) sulphate

5. **Demonstrate the existence of hydrated salts and differentiate from anhydrous salts**

- Hydrated salts as salts containing water of crystallisation.
- Anhydrous salts as salts not containing water of crystallisation.

6. **Describe the behaviour of salts with reference to the atmosphere.**

- Salt is hygroscopic, efflorescent, deliquescent.

TYPES OF OXIDES

1. **Describe the various types of oxides.**

- **Acidic oxides**; are oxides with acidic properties such as SO_2 and CO_2.
- **Basic oxide**s; are oxides of Group I and Group II metals such as K_2O and MgO.
- **Neutral oxides**; are oxides some non-metals with neither acidic nor basic properties such as CO, H_2O.
- **Amphoteric oxide**s; are oxides with both acidic and basic properties such as ZnO, Al_2O_3 and PbO.

3. **Demonstrate the identity of aqueous cations and anion.**

   Cations using aqueous sodium hydroxide and aqueous ammonia being

Table 2; Test for aqueous cations

Cations	**Effect of aqueous sodium hydroxide**	**Effect of aqueous ammonia**
Aluminium ions (Al^{3+})	White ppt.soluble in excess giving a colourless solution	White ppt., insoluble in excess
Ammonium ions (NH_4^+)	Ammonia produced on warming	-
Calcium ions (Ca^{2+})	White ppt., insoluble in excess	No change
Copper ions (Cu^{2+})	Light blue ppt., insoluble in excess	Light blue ppt., soluble in excess, giving a dark blue solution
Iron(II) ions (Fe^{2+})	Green ppt., insoluble in excess	Green ppt., insoluble in excess, turns reddish-brown on standing
Iron (III) ions (Fe^{3+})	Red-brown ppt., insoluble in excess	Red-brown ppt., insoluble in excess
Zinc ions (Zn^{2+})	White ppt.,soluble in excess giving a colourless solution	White ppt. soluble in excess giving a colourless solution.

Anions being using various reagents.

- carbonate,
- chloride,
- iodide,
- nitrate
- sulphate

Table 3; Test for anions

Anions	**Test**	**Test result**
Carbonate (CO_3^{2-})	Add dilute acid	Effervescence occurs, carbon dioxide produced
Chloride (Cl^-) [in solution]	Acidify with dilute nitric acid , then add aqueous silver nitrate	White ppt.
Iodide (I^-)[in solution]	Acidify with dilute nitric acid , then add aqueous lead (II) nitrate	Yellow ppt.
Nitrate (NO_3^-)[in solution]	Add aqueous sodium hydroxide, then aluminum foil, warm carefully.	Ammonia produced
Sulphate (SO_4^{2-}) [in solution]	Acidify with dilute nitric acid, then add aqueous barium nitrate	White ppt.

3. **Demonstrate the identity of gases.**

- **Gases being ammonia,**
- Place damp universal indicator paper in the gas
- It will turn blue (ammonia gas is alkaline).
- A sharp, pungent smell of ammonia is notice.
- **Carbon dioxide,**
- bubble the gas through limewater(an aqueous solution of calcium hydroxide),

- The limewater will turn milky (CO_2 is slightly acidic, so it reacts with $Ca(OH)_2$ to produce a white precipitate of $CaCO_3$).

➢ **Chlorine gas,**

- place damp universal indicator paper in the gas
- The indicator paper will first turn red (because chlorine gas is the only gas that has a bleaching effect).

➢ **Hydrogen gas,**

- Collect some hydrogen gas in attest tube, then hold a burning match in the mouth of the test tube
- Hydrogen puts off a burning flame with a pop sound.

➢ **Oxygen gas**

- Collect some of the gas in a test tube, then hold a glowing splint in the mouth of the test tube.
- The splint will ignite spontaneously

➢ **sulphur dioxide.**

- bubble the gas through an acidified potassium (V) dichromate ($K_2Cr_2O_7$) solution
- the orange solution will react with $K_2Cr_2O_7$ to produce the green precipitate, $Cr_2(SO_4)_3$.

Table 4; Test for gases

Gas	Test	Test result
Ammonia	Introduce damp red litmus paper to the gas	Turns damp red litmus paper blue
Carbon dioxide	Bubble the gas through limewater	White precipitate formed
Chlorine (Cl_2)	Introduce damp blue litmus paper to the gas	Turns litmus paper red then bleaches it
Hydrogen (H_2)	Introduce a lighted splint into the gas	Puts out the lighted splint with a 'pop'sound
Oxygen (O_2)	Introduce a glowing splint into the gas	Glowing splint relighted
Sulphur dioxide (SO_2)	Bubble the gas through acidified potassium dichromate (VI)	Turns orange potassium dichromate green.

THE MOLE CONCEPT

1. **Describe Relative Atomic Mass and relative molecular mass**

- **Relative Atomic Mass-** the average mass of one atom of a given element compared to $\frac{1}{12}$ the mass of one atom of carbon -12.
- **Relative molecular mass-** the average mass of one molecule of a substance compared with $\frac{1}{12}$ the mass of one atom of carbon -12

2. **Calculate the relative formula mass of a compound**

- **Relative formula mass**-the sum of all relative atomic mass of the ions that make up that one formula unit of a compound.

Example. Calculate the relative formula mass of calcium carbonate $CaCO_3$.

Answer

A_r (Ca) =40 X 1 atom of ca

=40

A_r (C) =12 X 1 atom of C

=12

A_r (O_3) =16 X 3 atoms of O

=48

M_r for **$CaCO_3$** =40+12+48

= 100

MOLE

1. **Describe a mole.**

   Answer

- Amount of substance contained the same number of particles as the number of carbon-12 atoms in exactly 12g of carbon -12

2. **Determine the physical masses (m) of any substance using the molar mass (M_r) and the physical volume (v) of any gas at r.t.p (room temperature and pressure) and vice versa.**

Answer

- Apply n = $\frac{m}{M_r}$ and $n\frac{V}{V_m}$

Where n = number of moles

(a) (i)Find the number of moles in 20g of calcium.

(ii)Find the mass of 3.5 moles of water

Answer

(a) (i) **Data**

N=?

A_r =40

m=20

n= $\frac{m}{A_r} = \frac{20g}{40g/mol}$

= 0.5mol

Answer

(a) (ii)**Data**

n= $\frac{m}{M_r}$

m=?

n=3.5

M_r=18g/mol

n=$\frac{m}{M_r}$

3.5= $\frac{m}{18}$

m=3.5mol X 18g/mol

=63g

(b)Calculate the number of moles in

(i) 3.01 X 10^{23} atoms of Na.

Answer

Data

n=? n= $\frac{particles}{L}$

L= 6.02 X 10^{23} n= $\frac{3.01 \text{ X } 1023}{6.02 \text{ X } 1023}$

Particles=3.01 X 10^{23} = 0.5mol

(c)A gas cylinder has a capacity of 200cm^3 .calculate;

(i) the moles of CO_2 that can fully occupy it at rtp

(ii) the moles of CO_2 that can fully occupy it at stp

Answer

(C) (i) Data

n=? n= $\frac{V}{V_m}$

v=200cm^3 = $\frac{0.2 \text{ dm3}}{24 \text{ dm3}}$

=0.2dm^3 =0.0083mol

V_m=24 dm^3 (r.t.p)

Answer

(C) (ii) Data

n=? n= $\frac{V}{V_m}$

v=200cm^3 = $\frac{0.2dm^3}{22.4dm^3}$

=0.2dm^3 =0.0089mol

V_m=22.4 dm^3 (s.t.p)

3. **Describe the relationship of Avogadro's law to reacting moles and volumes of gases at r.t.p and s.t.p.**

The Molar gas volume (V_m) of any gas at rtp is 24dm^3 or 22.4 dm^3 at stp.

Answer

Avogadro's Law states that equal volumes of gases under the same conditions of temperature and pressure contain the same number of molecules.

- This means equal amounts of moles of gases occupy the same volume under the same conditions of temperature and pressure.
- So the volumes have equal moles of separate particles (molecules or individual atoms) in them.
- Therefore one mole of any gas (formula mass in g), at the same temperature and pressure occupies the same volume.
- This is **24 dm^3** (24 litres) or **24000 cm^3**, at room temperature of 25^oC/298K and normal pressure of 101.3 kPa/1 atmosphere (such conditions are often referred to as r.t.p).
- The molar volume for s.t.p is 22.4 dm^3 (22.4 litres) at 0^oC and 1atmosphere pressure.

4. **Determine the concentration of a solution and apply dilution law. (Concentration as mol/dm^3 or g/$dm^{3)}$.**

- Concentration: it is amount of substance dissolved in a unit volume of a solution.
- Concentration: It is the amount of substance per unit volume of a solution. Concentration can be expressed in two ways: **(i)Mass concentration and**

(ii)Mole concentration

(i) **Mass concentration**: it is the mass per unit volume of solution.it therefore follows

Mass concentration=$\frac{mass(g)}{volume(dm^3)}$. The units are g/$dm^3$

Example

(i) Calculate the concentration of the solution containing 20 g of sodium hydroxide in 250cm^3 of the solution.

Answer

Volume=250$cm^{3;}$ convert to dm^3 by dividing by 1000 giving as 0.25dm^3

Than substitute variable in the formula

$$\text{conc} = \frac{\text{mass(g)}}{\text{volume}(dm^3)}$$

$$\text{Conc} = \frac{20g}{0.25dm^3}$$

Conc =<u>80g/dm^3</u>

(ii) **Mole concentration** (molality): it is moles per unit volume of a solution.

$$\text{Molarity} = \frac{\text{mole (mol)}}{\text{volume } (dm^3)}$$

Example

(i)What is the concentration of a solution made d by dissolving 60 g of sodium chloride (NaCl) in half a liter of a solution**?**

Answer

Convent the mass of sodium chloride into moles.

$$\text{Mole} = \frac{\text{mass}}{\text{molar mass}}$$

$$\text{Mole} = \frac{60g}{58.5}$$

Mole=<u>1.0256</u>

$$\text{Therefore; Molarity} = \frac{\text{mole}}{\text{volume}}$$

$$= \frac{1.0256}{0.5}$$

= <u>2.0513mol/dm^3</u>

Note; The number of moles of solute before dilution is the same as after dilution, $M_1V_1 = M_2V_2$.

5. **Illustrate calculations involving stoichiometric reacting moles and volumes of gases and solutions**.

- Using molar mass and molar volume of a gas using the mole concept. (Questions on gas laws and conversions of gaseous volumes to different temperatures and pressures will **not** be required). Proportional stoichiometric masses and the given quantities

6. Describe and calculate the percentage yield in a reaction and the percentage purity of a substance

Answer

Percentage yield is the ratio of the actual mass of product to that of expected mass expressed as a percentage. It is calculated as follows;

Percentage yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100$

Example

Consider the reaction between carbon and oxygen $C_{(s)} + O_{2\,(g)} \longrightarrow CO_{2\,(g)}$. If 60g of carbon was burned in oxygen and 160g of carbon dioxide was produced .what was the percentage yield of carbon dioxide in the experiment.

Answer

First calculate the theoretical mass of Carbon dioxide that can be obtained from the equation

1 mol of C: 1 mol of CO_2

Therefore;

12g/ mol C: 44g/mol CO_2

60g of C: m (CO_2)

$$M(CO_2) = \frac{(44G\ g/molCO_2 \times 60g\ of\ C)}{12\ g/_{mol}\ of\ C}$$

M (CO_2) =<u>220g</u>

Therefore 60g C should yield 220g of CO_2, but only 60g was produced.

Percentage yield= $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100$

$= \frac{160g}{220g} \times 100$

Percentage yield =**<u>73%</u>**

C $_{(s)}$ + $O_{2\,(g)}$ ⟶ $CO_{2\,(g)}$

Actual yield is the actual amount of product produced by a reaction

Theoretical yield is the expected amount of products produced by ta reaction based on calculations involved the amounts of reagents

Percentage purity as amount of substance divided by total amount of the mixture x 100%

Example

Manganese (IV) oxide reacts with concentrated HCl according to the following equation.

$MnO_{2(S)}$ +4HCl $_{(aq)}$ ⟶ $MnCl_{2\,(aq)}$ +2H_2O $_{(l)}$ +$Cl_{2\,(g)}$

A 4.325g sample of Manganese (IV) oxide was added to 1.0mol/dm^3 HCl.48cm^3 of the acid was needed to react Manganese (IV) oxide in a given sample. Calculate the percentage purity of Manganese (IV) oxide.

Answer

Number of moles of HC l= 1.0mol/dm^3x$(\frac{48}{1000})dm^3$

=<u>0.048moles</u>

The balanced equation; $MnO_{2(S)}$ +4HCl $_{(aq)}$ ⟶ $MnCl_{2\,(aq)}$ +2H_2O $_{(l)}$ +$Cl_{2\,(g)}$

Mole ratio from the equation is, 1mole MnO_2 :4 moles of HCl

Calculation of number of moles of pure MnO_2 ; 0.048 mol HCl used,

Hence $\frac{0.048}{4}$ =0.012 mol MnO_2 present

Mass pure MnO_2 = 0.012 x M_r of MnO_2

= 0.012x 87

=1.044g.

Percentage purity = $(\frac{\text{mas of pure MnO2}}{\text{mass of impure MnO2}})$ x100

= (1.044/4.35) x100

= <u>24%</u>

7. Determine limiting reagent in a given reaction.

Using proportional stoichiometric masses and the given quantities.

Silicon is a semi-conductor that is used in computer chips and solar cell.it is made by the following reaction

$SiCl_{4\,(l)} + 2Mg_{(s)} \longrightarrow Si_{(s)} + 2MgCl_{2(s)}$

If 225g of $SiCl_4$, and 225g of magnesium is used to prepare the silicon, which reagent is the limiting reagent.

Answer

Given the equation below

Step 1.write a balanced chemical equation

$SiCl_{4\,(l)} + 2Mg_{(s)} \longrightarrow Si_{(s)} + 2MgCl_{2(s)}$

From the periodic table mass of $SiCl_4$ =28+ (4x35.5)

=<u>170g/mol</u>

Step2. (c)

Convent all given masses, volumes, concentration or number of particles to moles

From the periodic table mass of Mg=24g/mol

n ($SiCl_4$)= $\frac{225g}{170g/mol}$

=<u>1.324mol</u>

n (Mg) = $\frac{225g}{24\ g/mol}$

=<u>9.375mol</u>

Step 3.calculate the required mole ratio from a balance equation

From the balanced equation mole ratio= $\frac{n\ (SiCl4)}{n\ (Mg)}$

=1/2

=0.5

Step 4.compare the required mole ratio to the available mole ratio.

From the calculated number of moles $\frac{n\ (SiCl4)}{n\ (Mg)}$

n = $\frac{1.324}{9.375}$

n =<u>0.141moles</u>

Therefore, <u>$SiCl_4$ is limiting reagent</u>

8. **Demonstrate calculations involving different types of acid–base titration reactions.**

Titration is a procedure that is often used to determine the concentration of a solution.

Example

25cm3of hydrochloric acid of concentration 0.12 mol/dm^3reacts with 28.4 $cm^3$of sodium hydroxide solution to form water and sodium chloride. Calculate the concentration of sodium hydroxide solution.

Answer

$n_a = 1$ $\quad HCl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + H_20_{(l)}$

$n_b = 1$ $\quad \frac{n_a}{n_b} = \frac{C_a \times V_a}{C_b \times V_b}$ (check that both volume have the same units)

$C_a = 0.12 mol/dm^3$ $\quad \frac{1}{1} = \frac{0.12 mol/dm^3 \times 25 cm^3}{C_b \times 28.4 cm^3}$

$C_b = ?$ $\quad C_b = \underline{0.11 mol/\ dm^3}$

$V_a = 25\ cm^3$

$V_b = 28.4\ cm^3$

CHEMICAL REACTIONS

Rates of chemical reactions

1. **Describe rate of a chemical reaction.**

   Answer

- **Chemical reaction** is a chemical change that occurs when two or more substances combine to form a new substance.
- The **rate of reaction** is the rate of change of an amount or concentration of a particular reactant or product per unit time.

2. **Demonstrate the factors that affect the rates of chemical reactions and Interpret data on the rate of chemical reactions.**

   Answer

- Factors that affect the rate of reactions are; temperature, concentration, surface area, catalyst, pressure and light intensity.
- **(I) Temperatur**e – At higher temperatures, the reactant particles will have greater kinetic energy, resulting in a higher speed of movement and more frequent effective collisions. Hence, the increase in temperature of reaction will lead to a higher speed of reaction.

Example

Reaction of sodium thiosulphate and dilute hydrochloric acid:

Chemical equation:

$Na_2S_2O_{3\,(aq)} + 2HCl_{\,(aq)} \longrightarrow 2NaCl_{\,(aq)} + S_{(s)} + H_2O_{\,(l)} + SO_{2(g)}$

Procedure:

1. An experiment is set up as shown below*:*

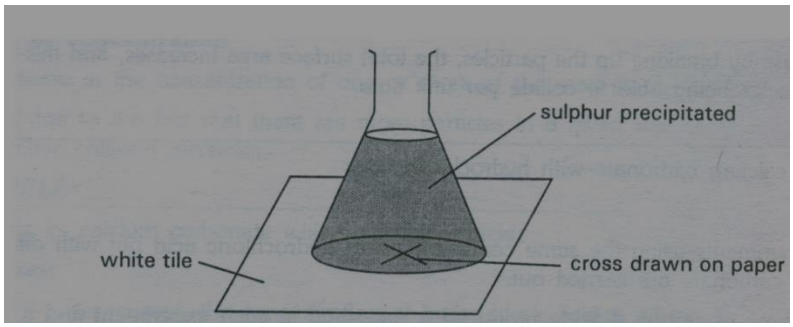


Figure 2 showing effect of temperature on speed of reaction

2. The temperature of the reading solution is changed, keeping the concentration of sodium thiosulphate at 0.01 mol/dm^3 and using a volume of 50cm^3.
3. For experiment 1, all the reactants were heated to 30°C in a water bath.
4. 50cm^3 of sodium thiosulphate was put into a conical flask and the flask with contents placed on a piece of white paper (or a white tile) marked with a blue cross (x).

5. $5cm^3$ of hydrochloric acid was added into the flask and the contents shaken to mix and react.
6. A stop watch was started at the point of addition of acid and the time taken for the cross to disappear was recorded and tabulated.
7. The experiment was repeated for different temperatures and recorded

Experiment	**Volume of 0.01 mol/dm^3 sodium thiosulphate/cm^3**	**Volume of 1 mol/dm^3 HCl/cm^3**	**Temperature of mixture /°C**	**Time taken for cross to disappear/s**
1	50	5	30	79
2	50	5	35	61
3	50	5	40	47
4	50	5	45	37
5	50	5	50	30

Table 3 showing a graph plotted and is as shown below

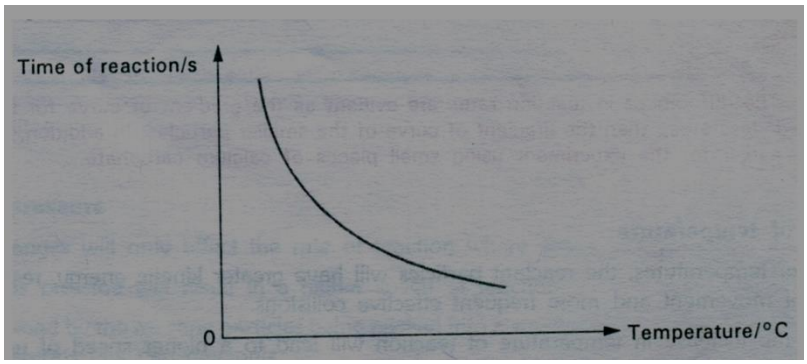


Figure 3 showing a Graph of time of reaction against temperature/°C

Observations:

The higher the temperature, the shorter the reaction. This also means that the speed of reaction is faster at a higher temperature.

- **(II) Concentration** – An increase in the concentration of one or more of the reactants increases the speed of reaction. This is due to the fact that there are more particles in a given volume and hence, the frequency of effective collision increases.

Example

Reaction of calcium carbonate with hydrochloric acid is altered in the second experiment, keeping all other factors constant.

Experiment 1	**Experiment 2**
$50cm^3$ of 0.5 mol/dm^3 HCL solution	$50cm^3$ of 1 mol/dm^3 HCL solution
0.2g of marble chips	0.2g of marble chips

The volume of carbon dioxide that was given off was recorded at every 3 min interval for each experiment.

A graph for the two sets of readings was plotted and interpreted.

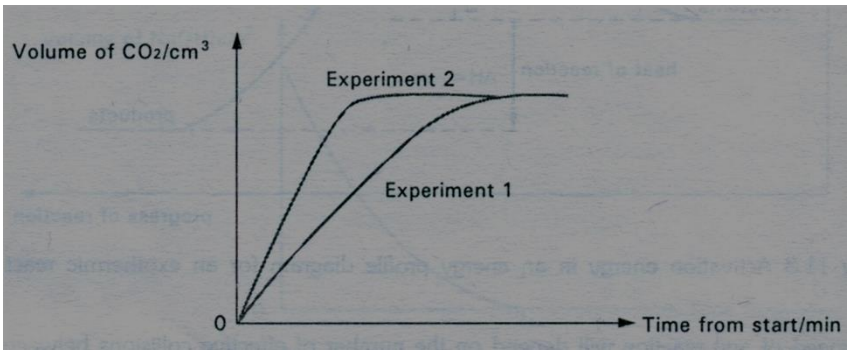


Figure 4 showing graph of volume of carbon dioxide produced/cm^3 against time from start/min

Observations:

The speed of reaction is faster in experiment 2 as the concentration of HCL is higher, with all other factors being kept constant.

- **(III) Surface Area (effect of particle size)** – Decreasing the particle size of the reactant particles will increase the speed of reaction. This is because by breaking up the particles,

the total surface area increases, and this in turn results in more particles being able to collide per unit time.

Example

Reaction of calcium carbonate with hydrochloric acid:

Procedure:

1. Two experiments using the same concentration of hydrochloric acid but with different sizes of calcium carbonate are carried out.
2. The volume of carbon dioxide produced is measured in each experiment and a graph plotted as shown below.

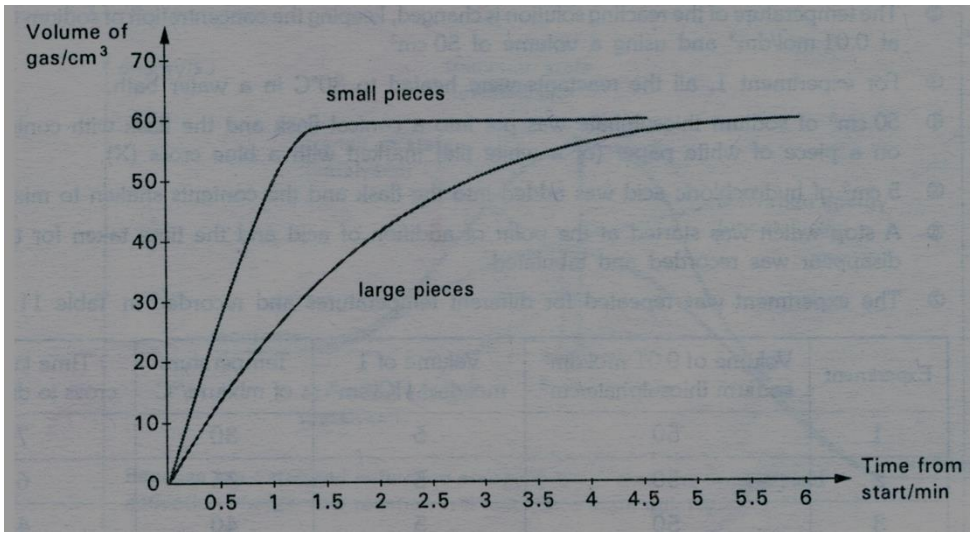


Figure 5 showing graph of volume of CO_2 per cm^3 against time /min

Observations:

The experiment with larger pieces of calcium carbonate was slower in speed while the experiment with the smaller pieces of calcium carbonate was faster.

- **(IV) Catalyst** – A catalyst is a substance which changes the rate of reaction, but itself is unchanged chemically at the end of the reaction. A catalyst changes the rate of reaction by lowering the activation energy of a reaction.
  Particles react through collissions with each other. When a catalyst is present, the particles can collide with the catalyst as well, causing the particles to react with a lower activation energy.

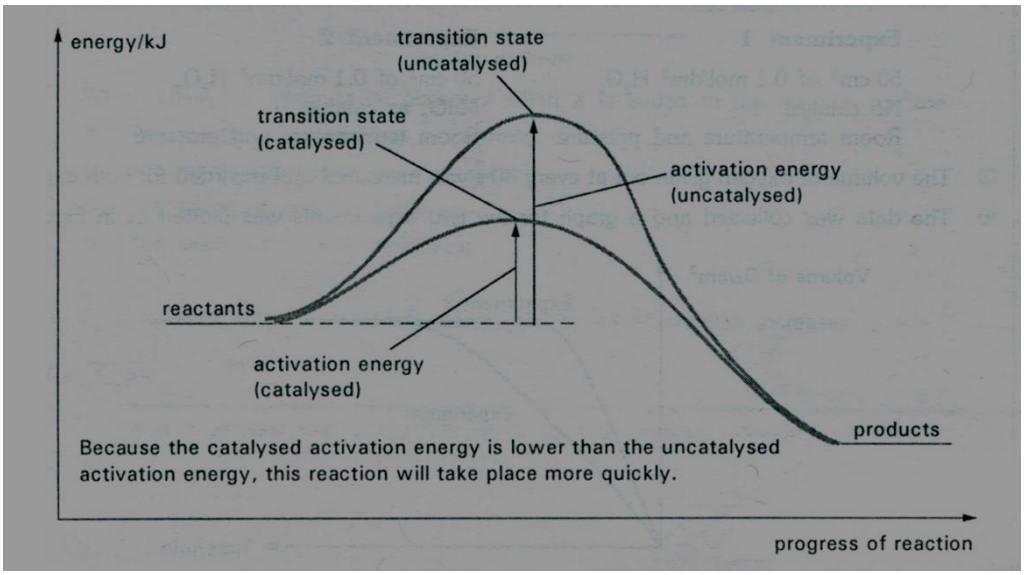


Figure 6 showing catalyzed and non –catalyzed reaction

1. Different reactions will require different types of catalysts, i.e. each catalyst is specific to a particular reaction.
2. Enzymes, however are biological catalysts found in living cells. With them, reactions involve the breakdown of giant molecules (such as proteins and starch) into simpler ones like amino acids and sugars can take place.
3. A catalyst does not change the amount of products obtained in a reaction. It only speeds up the chemical reaction. (Note: ΔH is the same for both catalyzed and non-catalyzed reaction).

   Example 2

   Decomposition of hydrogen peroxide:

   Chemical equation:

   $2H_2O_{2\,(aq)} \longrightarrow 2H_2O_{(l)} + O_{2(g)}$

   Procedure:

   1. The experiment is set up as shown.

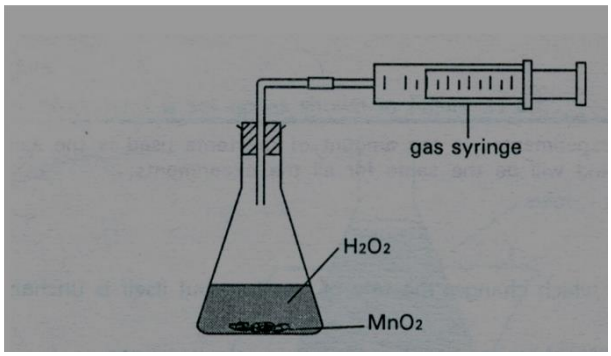


Figure 7 showing decomposition of hydrogen peroxide using manganese (IV) oxide as catalyst.

2. One experiment was carried out without a catalyst and the other with a catalyst.

Experiment 1	**Experiment 2**
50cm3 of 0.1 mol/dm3 H2O2	50cm3 of 0.1 mol/dm3 H2O2
No catalyst	NbO2 as catalyst
Room temperature and pressure	Room temperature and pressure

3. The volume of oxygen given out at every 30 s was measured and recorded for both experiments.
4. The data was collected and a graph for the two experiments was plotted.

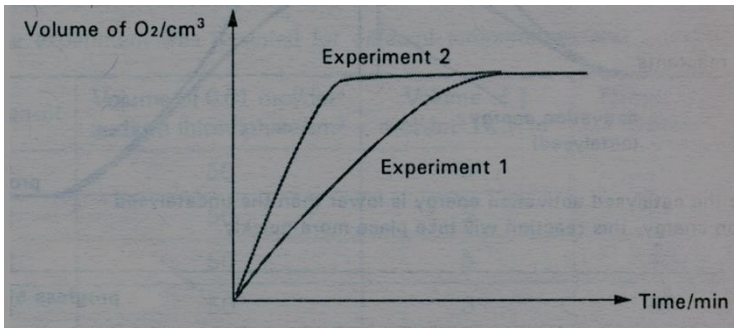


Figure 8 showing a graph of volume of O_2 formed per cm^3against tim/ min

Observations

1. Same volume of oxygen was collected in both experiments.

2. The speed of reaction is higher in experiment 2 as it was a catalyzed reaction.

- **(V) Pressure** – Pressure changes will only affect the rate of reaction where gases are involved. A higher gas pressure will result in a higher speed of reaction.

This is explained by the reacting particles being packed into a smaller volume, resulting in more frequent effective collisions between reactants.

- **(VI) Light Intensity** – light (when viewed as an electromagnetic wave) is considered to be an energy source and has sufficient impact energy to break chemical bonds. This energy is more than enough to overcome the activation energy. The greater the intensity or energy of light, the more reactant molecules are likely to gain kinetic energy, so the faster the reaction should be. Methane reacts very slowly with chlorine in the dark, but the rate of reaction is much faster in the presence of ultraviolet light.

3. Describe methods of controlling the rate of chemical reactions.
    - Reducing the frequency of collisions between reacting particles such as explosions in flour mills or coal mines when ignited to surface area
4. Describe the effect of a catalyst on the activation energy
    - Catalyst lowers the activation energy thus increasing the rate of a chemical reaction.

THE PERIODIC TABLE

Groups and Periods

1. Describe the Period Table
    - The periodic table is an arrangement of elements by order of their atomic number.

The periodic table is a way of arranging and classifying elements according to their Atomic numbers. The table consists of a number of rows called **periods** and a number of columns called **groups.** There three other blocks of elements, namely the transition metals, the lantnthanides and the actinides. The various section of the periodic table are summarized in the figure below.

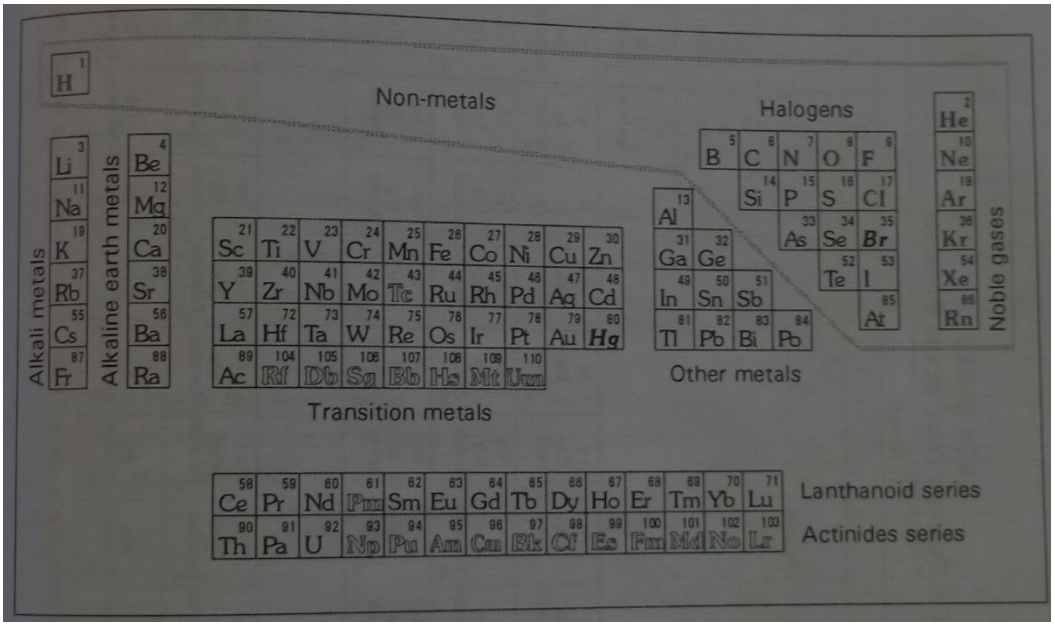


Figure 9 showing the periodic table of elements

2. Identify vertical columns and horizontal rows.

- **Vertical columns** of elements on the Periodic Table are **Groups.** There eight groups in total .The group to which an element belongs depends on the valence electrons of the element.
- **Horizontal rows** of elements on the Periodic Table are **Periods.** There seven period in total. The period to which an element belongs depends on the number of occupied shells it has in its electronic structure.

3. Demonstrate how to use the Periodic Table to classify elements.

Elements are classified as non- metals, metals and metalloids. All the metals are found to the left of the thick line in the figure below the non-metals are found on either side of the line as shown below

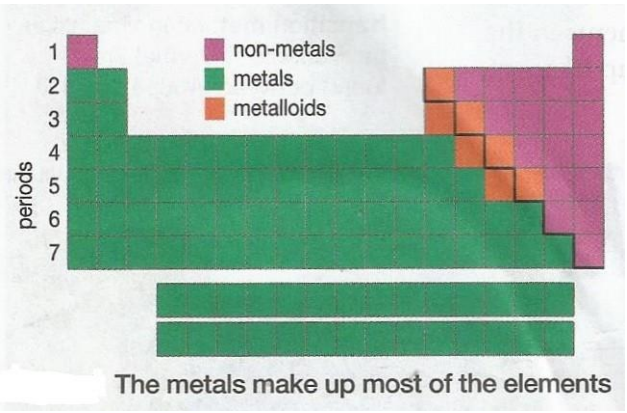


Figure 10 shows classification of elements on the periodic table

4. Describe trends in various Groups given information about the elements

GROUPS AND PERIODIC TRENDS

- **GROUPS TRENDS**
  Elements in the same group;
  - Have the same number of electrons in the outermost shell
  - Form ions with similar formulae
  - Form compounds with similar chemical properties
  - Have similar physical and chemical properties

- **PERIODIC TRENDS**
  - The period to which an element belongs depends on the number of occupied shells it has in its electronic structure.
  - Elements are arranged in order of increasing proton number (atomic number).

5. Describe the physical and chemical properties of elements in Group I, II, VII and VIII.

Answer

GROUP I

Group I elements are known as the alkali metals.

Physical properties

- Are soft and easy to cut with a knife
- Are silvery when freshly cut

- Float on water because of their low density
- Have low melting points and boiling points
- Are good conductor of heat and electricity because they are metals
- React spontaneously and vigorously with water and oxygen ,so they must be stored under oil

Chemical properties

- These elements all have one valence electron, so, they react by losing electron to form a single positive ion.
- They are the most reactive metals and their reactivity increase down the group.

Group II

Group II elements are known as alkaline earth metals.

Physical properties

- Are soft and can easily be cut with a knife (although they are slightly harder than the alkali metals)
- Show a silvery colour when freshly cut
- Are low- density metals.
- Have higher melting points and boiling points
- Are good conductor of both heat and electricity

Chemical properties

- These elements all have two valence electrons, so, they react by losing two electrons to form an ion with a charge $2^{+.}$
- Their reactivity increase down the group, but they are less reactive than the alkali metals.

Group VII

Physical properties

- They are non-metals
- Exist as diatomic molecules e.g. F_2, Cl_2, Br_2 and I_2.
- Have a high melting and boiling point
- Are poisonous
- Are poor conductors of both heat and electricity

Chemical properties

- These elements all have seven valence electrons. So they react by gaining one electron to form a single negatively charged ion.
- Their reactivity decrease as you go down the group
- Halogens undergo displacement reactions; the more reactive halogen will displace the less reactive halide ion from its salt in a solution.

6. Describe the importance of halogens

Importance of halogens

- Fluorine is used as fluoride in toothpaste,
- chlorine in water treatment, antiseptic,
- bromide in photographic film
- Small amounts of iodine are needed in our bodies to prevent the swelling of the thyroid gland.
- Chlorine is used to bleach wood pulp to make white paper. (used as bleaching agent)

7. Describe the harmful effects of halides.

- When used in drugs may have negative effect on man,
- Used in Pesticides which has negative effect on environment when used in excess,
- CFCs cause ozone layer depletion (CFCs)

8. Describe the use of the noble gases

- providing an inert atmosphere in bulbs
- The significance of their non- reactivity in providing an inert atmosphere. Such as argon in electrical lamps, helium in balloons

Transition metals

9. Describe transition metals.

Answer

- **Transition metals** are a block elements between Group II and Group III of the Periodic Table

10. Describe general properties of transition metals.

Answer

General properties of transition metals.

- have variable valencies,
- high densities,
- high melting points,
- form coloured compounds,
- Are catalysts.

Note: Electronic configuration of transition metals will **not** be required

3. Describe the uses of transition metals

Answer

Uses of transition metals

They are used;

- as catalysts in industries in order to speed up reactions

  E.g. an iron catalysis is used in the manufacturing of ammonia.

  A nickel catalyst is used in the manufacturing of margarine
- to make alloys, because they combine readily with themselves and other elements e.g.
  - mirrors are made with copper –tin alloy.
  - Brass is a copper – zinc alloy.
  - Steel is an iron and carbon alloy.
- As conductors of electricity and heat e.g.
  - Copper is used in electrical wiring
  - Aluminum is used to make pots and pans for cooking
- To manufacture paint

NB: Heavy metals are no longer used to make paint for health reasons

GRADE 12 CHEMISTRY 5124/5070

CHEMISTRY AND ELECTRICITY

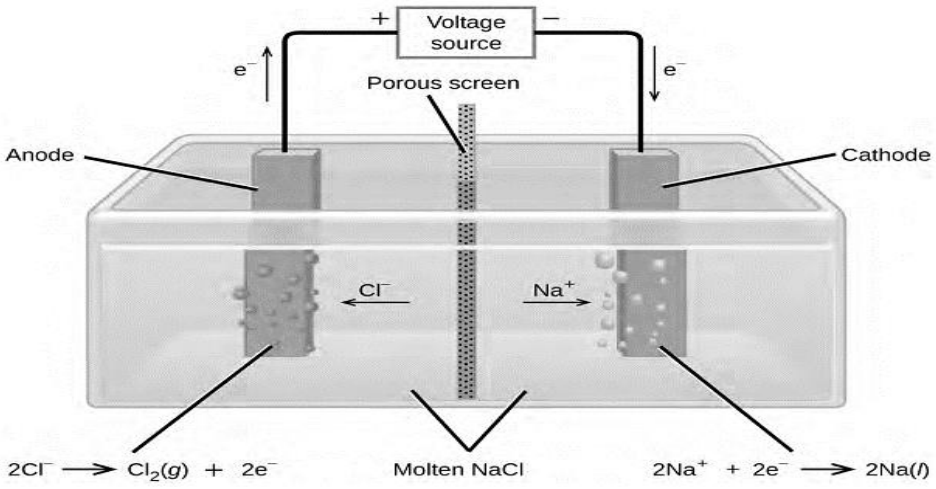
Conductors

1. Classify conductors and non- conductors
    - Conductors are metals such as copper, aluminium, silver and Non-conductors being non-metals such as sulphur, phosphorus, except carbon in form of graphite.

Electrolysis

2. Classify electrolytes and non-electrolytes

    Difference between electrolytes and non-electrolytes:
    - Electrolytes as ionic compounds while non- electrolytes as covalent compounds.
3. Describe what electrolysis is
    - Electrolysis: As decomposition of electrolyte using electricity in an electrolytic
4. Describe the products at the electrodes during electrolysis of molten binary ionic compounds cell.
    - Products by electrolysis of molten binary ionic compounds: metals are discharged at the cathode by reduction, non- metals at the anode by oxidation



Passing an electric current through molten sodium chloride decomposes the material into sodium metal and chlorine gas. Care must be taken to keep the products separated to prevent the spontaneous formation of sodium chloride.

5. **Describe the products at the electrodes during electrolysis of aqueous ionic solutions**
    - Products by electrolysis of aqueous ionic solutions: Refer to selective discharge of ions given conditions. Electrolytes include molten lead (II) bromide, molten aluminium oxide, dilute sulphuric acid (acidified water), concentrated hydrochloric acid, concentrated aqueous sodium chloride (brine) using carbon electrodes, and aqueous copper (II) sulphate using carbon and copper electrodes.
6. **Describe the industrial applications of electrolysis**
    - Applications of electrolysis: Such as extraction of aluminium from its oxide, copper refinery and electroplating
7. **Calculate the quantity of electrolytic products.**

    Quantitative Aspects of Electrolysis

    The amount of current that is allowed to flow in an electrolytic cell is related to the number of moles of electrons. The number of moles of electrons can be related to the reactants and products using stoichiometry. Recall that the SI unit for current (I) is the ampere (A), which is the equivalent of 1 coulomb per second (1 A = 1C in coulombs) is given by

    $Q = I \times t = n \times Fs$). The total charge (Q,

Where t is the time in seconds, n the number of moles of electrons, and F is the Faraday constant. Moles of electrons can be used in stoichiometry problems. The time required to deposit a specified amount of metal might also be requested, as in the following examples.

Converting Current to Moles of Electrons

In one process used for electroplating silver, a current of 10.23 A was passed through an electrolytic cell for exactly 1 hour. How many moles of electrons passed through the cell? What mass of silver was deposited at the cathode from the silver nitrate solution?

Solution

Faraday's constant can be used to convert the charge (Q) into moles of electrons (n). The charge is the current (I) multiplied by the time

$$n = \frac{Q}{F} = \frac{\frac{10.23\ \text{C}}{\text{s}} \times 1\ \text{hr} \times \frac{60\ \text{min}}{\text{hr}} \times \frac{60\ \text{s}}{\text{min}}}{96{,}485\ \text{C/mol e}^-} = \frac{36{,}830\ \text{C}}{96{,}485\ \text{C/mol e}^-} = 0.3817\ \text{mol e}^-$$

From the problem, the solution contains $AgNO_3$, so the reaction at the cathode involves 1 mole of electrons for each mole of silver

$$\text{cathode: } Ag^+(aq) + e^- \longrightarrow Ag(s)$$

The atomic mass of silver is 107.9 g/mol, so

$$\text{mass Ag} = 0.3817\ \text{mol e}^- \times \frac{1\ \text{mol Ag}}{1\ \text{mol e}^-} \times \frac{107.9\ \text{g Ag}}{1\ \text{mol Ag}} = 41.19\ \text{g Ag}$$

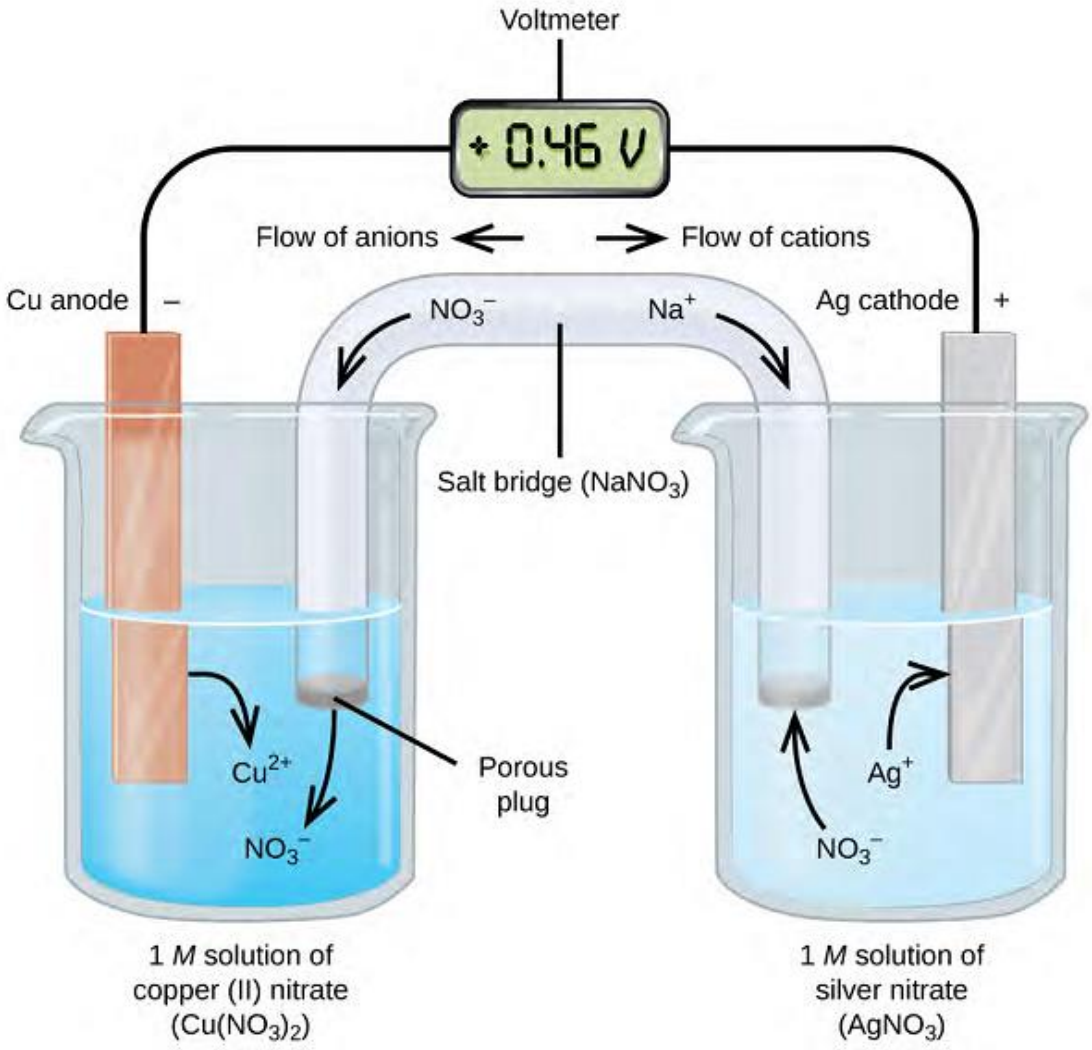
Check your answer: From the stoichiometry, 1 mole of electrons would produce 1 mole of silver. Less than one-half a mole of electrons was involved and less than one-half a mole of silver was produced.

Check Your Learning

Aluminum metal can be made from aluminum ions by electrolysis. What is the half-reaction at the cathode? What mass of aluminum metal would be recovered if a current of 2.50×10^3 A passed through the solution for 15.0 minutes? Assume the yield is 100%.

8. Describe what a chemical cell is

A chemical cell: Two different metals connected together and dipped in an electrolyte to produce electricity.



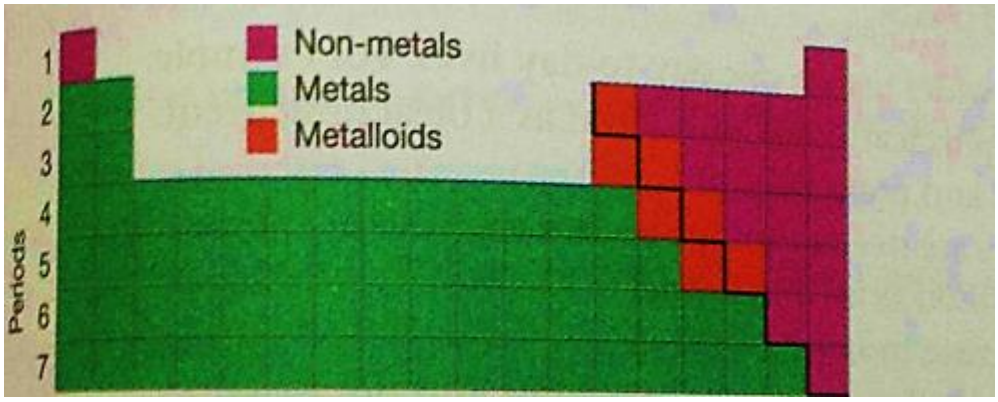
9. Compare electrolytic cells and simple cells

- Types of cells: Similarities are oxidation at the anode and reduction at the cathode.
- Differences are cathode being negative in electrolytic cell while positive in simple cell and vice versa for the anode. Simple cell **must** use two different electrodes while electrolytic cell can use any.

METALS

1. Describe the physical properties of metal

- They are strong
- They are malleable
- They are ductile
- They are sonorous
- They are shiny
- They are good conductors of heat and electricity
- They have high melting and boiling point
- They have a high densities

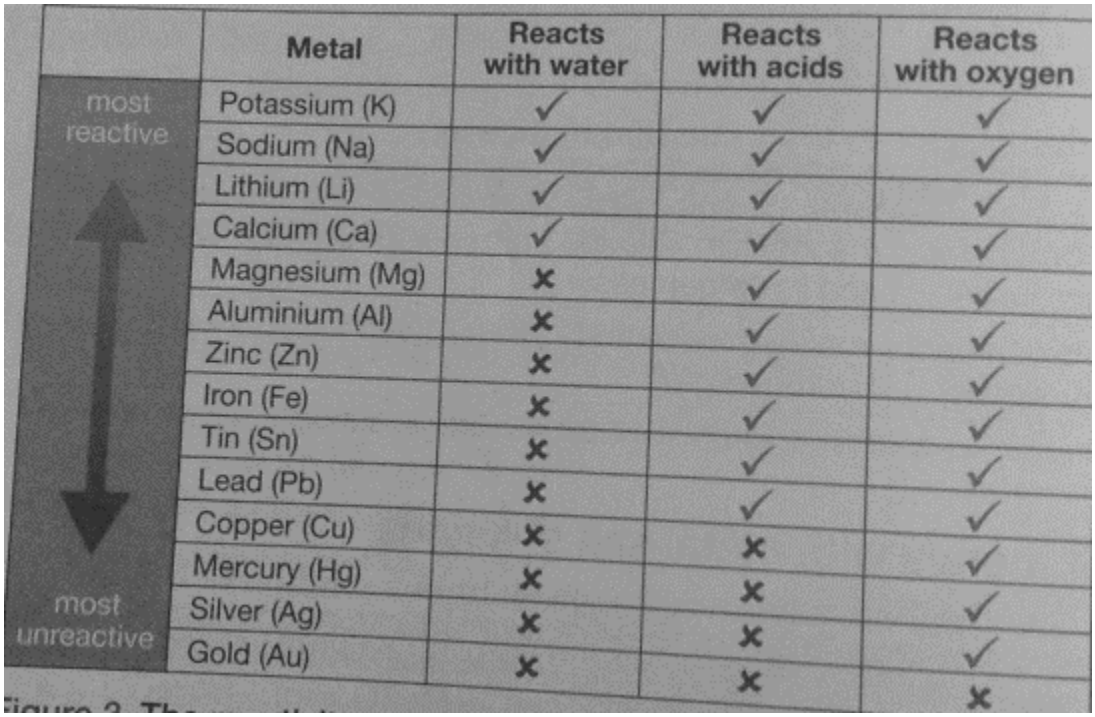


2. Describe the chemical properties of metals.

- All metals are electropositive as illustrated in the reaction with air, water/steam, dilute non-oxidizing acids, aqueous solution of other metal ions

3. Describe the reactivity series of metals

- As arrangement of metals in order of either their increasing or decreasing order of reactivity as being potassium, sodium, calcium, magnesium, aluminum, zinc, ion, lead,)hydrogen), copper and silver



	Metal	Reacts with water	Reacts with acids	Reacts with oxygen
most reactive	Potassium (K)	✓	✓	✓
	Sodium (Na)	✓	✓	✓
	Lithium (Li)	✓	✓	✓
	Calcium (Ca)	✓	✓	✓
	Magnesium (Mg)	✗	✓	✓
	Aluminium (Al)	✗	✓	✓
	Zinc (Zn)	✗	✓	✓
	Iron (Fe)	✗	✓	✓
	Tin (Sn)	✗	✓	✓
	Lead (Pb)	✗	✓	✓
	Copper (Cu)	✗	✗	✓
	Mercury (Hg)	✗	✗	✓
	Silver (Ag)	✗	✗	✓
most unreactive	Gold (Au)	✗	✗	✗

4. Explain the apparent non reactivity of aluminum due to adhesive coat.

- Due to the presence of adhesive oxide or coat. The non-reactivity of aluminum is due to adhesive coat

5. Demonstrate an order of reactivity.

   ……..

6. Describe the effects of heat on hydroxides, carbonate, nitrate of metals and ammonium compounds.

Effect of heat;

Carbonate, metals that are above sodium are generally very reactive and form stable carbonates.they are decomposed by heat.

Metals below sodium form carbonates that can be decomposed by heat into metal oxide and carbon dioxide. In some cases, the metal oxide further decompose to form the metal and oxygen gas.

Example;

Metal carbonate $\longrightarrow$ metal oxide +carbon dioxide

$CaCO_{3(S)} \longrightarrow CaO_{(S)} + CO_{2(g)}$

7. Describe the extraction of copper, iron and zinc from their ores.

(I) EXTRACTION OF ZINC

Extraction is done from the respective common ores i.e. zinc blend (for Zinc) and galena (for lead) concentration of the ores is done through filtration. The concentration ores are first roasted in air to convert them into oxides.

$2ZnS\ (s) + 3O_2\ (g) \longrightarrow 2ZnO\ (s) + 2\ SO2\ (g)$

If zinc carbonate is used, ores are decomposed as:

$Zn\ CO_3\ (s) \longrightarrow ZnO\ (s) + CO_2\ (g)$

Zinc oxide and lead oxide if mixed with coke and is led into a furnace.

The following reactions occur:

$2C\ (s) + O_2\ (g) \longrightarrow 2CO\ (g)$

Oxides in the furnace are reduced as follows:

$ZnO\ (s) + C\ (g) \longrightarrow Z\ n\ (g) + CO\ (g)$

Overall reaction;

$2ZnO_{(s)} + C_{(S)} \longrightarrow 2Zn_{(s)} + CO_{2(g)}$

(II) EXTRACTION OF Copper

Copper is extracted from its common ore copper pyrite ($ufes_2$), concentration is done by froth floatation. The concentration ore are roasted in air.

$2\ Cu\ FeS_2 + 4O_2\ (g) \longrightarrow Cu_2S\ (g) + 2F\ e\ O\ (g) + 3SO_{2(g)}$

Roasted ore is mixed with silicon (IV) oxide in furnace to remove $FeO_{(s)}$

$FeO\ (s) + SO_2\ (g) \longrightarrow FeSiO_3\ (l)$

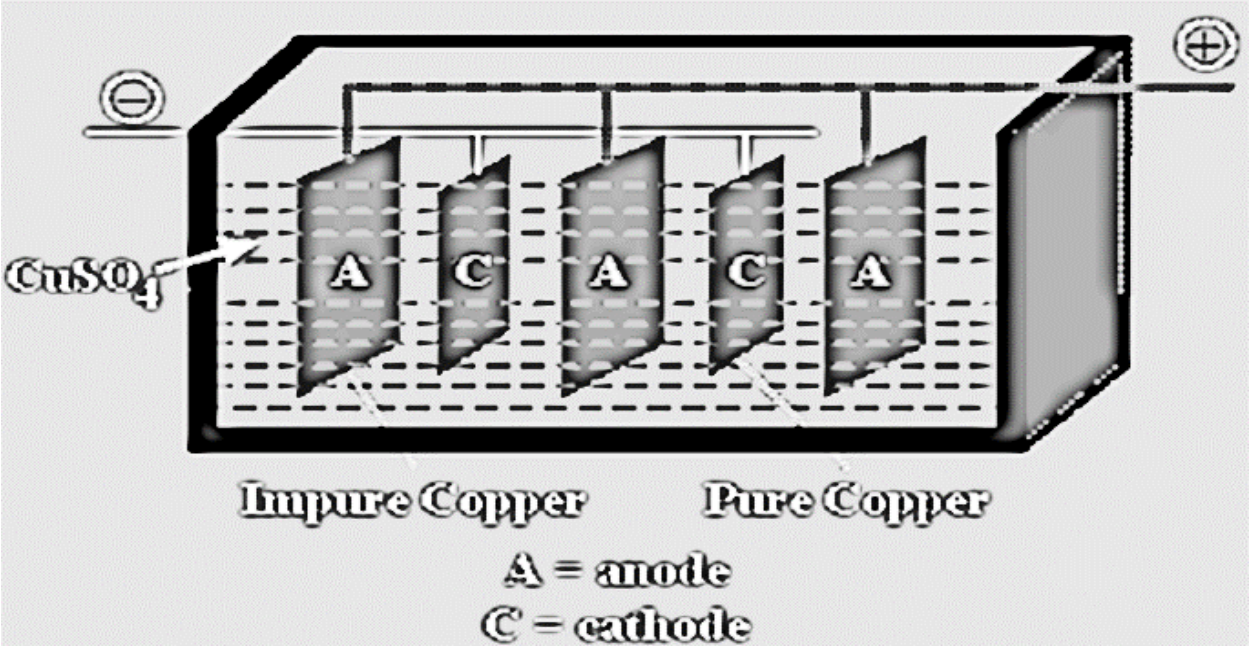
Impure copper (l) sulphide is heated in limited supply of air in converter where it partially converts to copper (i) oxide

$Cu_2S\ (g) + O_2\ (g) \longrightarrow 2Cu(s) + SO_2\ (g)$

The supply of air is then stopped and supply of heat to converter raised. Resulting to reduction of copper sulphide to copper metal

$2Cu_2O\ (s) + Cu_2S \longrightarrow 6Cu\ (l) + 2SO_2(g)$

Purification of copper



Uses of copper

- In electrical wires because it is a perfect electrical conductor and very ductile, malleable and cheap.
- Making alloys such as bronze and brass
- Cooking utensils because it conducts heat and it has high melting and boiling points and also resists corrosion.
- Electrodes because it is a good conductor of electricity.
- Water pipes because it is resistant to corrosion.

(III) EXTRACTION OF IRON

Iron is extracted from haemitide and magnetite.

Extraction takes place in two stages

Stage 1

Removal of water and other impurities of low melting points

Stage ii

Reduction of oxide to iron in the blast furnace

- Coke burns in lower part of furnace exothermically

  $$C(s) + O2\ (g) \longrightarrow CO_2(g)$$

- Carbon (iv) oxide is reduced to carbon (ii) oxide with more coke as it rises up the furnace endothemically

  $CO_2\ (g) + C(s) \longrightarrow CO_2\ (g)$

- Carbon (ii) oxide reduces iron ore to iron at temperature between 600-700^{0}C

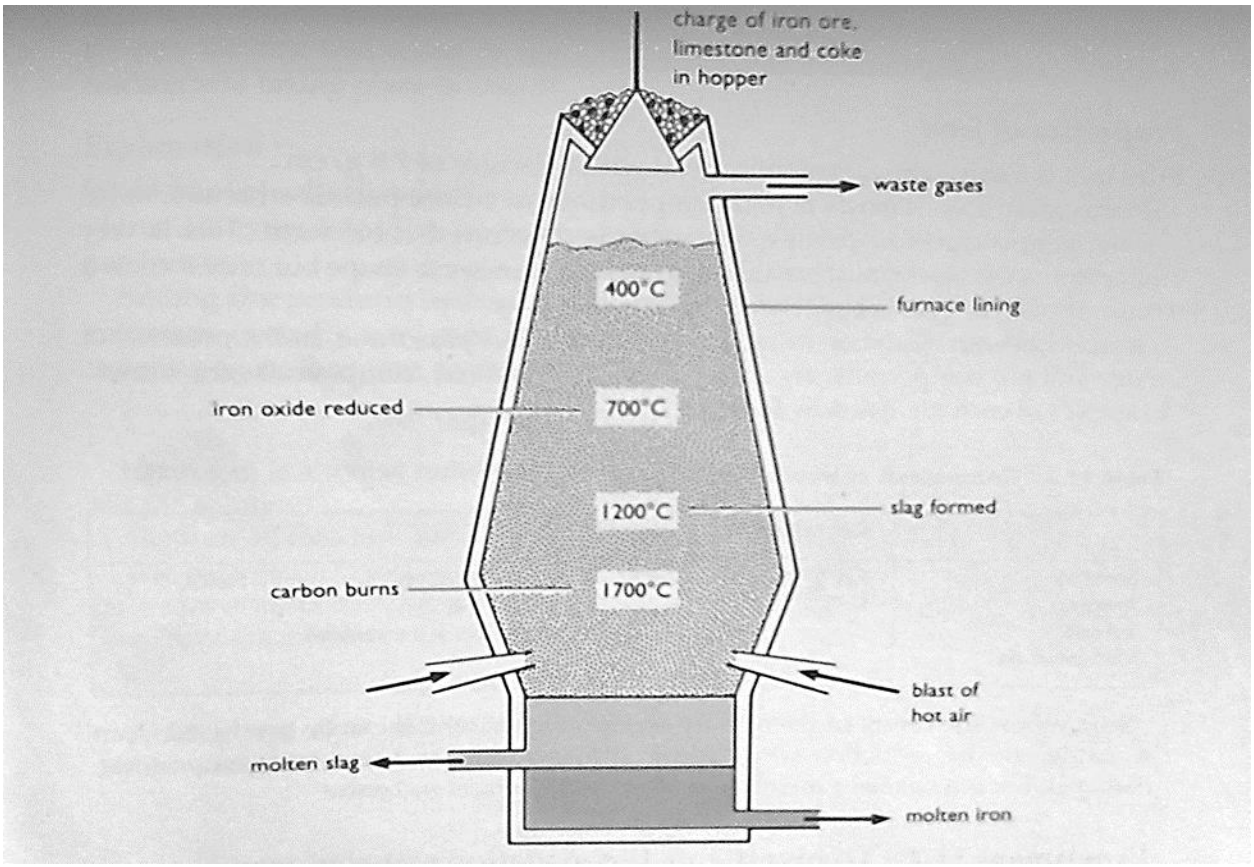
  $$Fe_2O_3(s) + 3CO(g) \xrightarrow{800^oC\text{-}700^oC} 2Fe\ (s) + 3\ CO_2\ (g)$$

- Limestone undergoes thermal decomposition to yield calcium oxide which reacts with impurities to form slag 800^{0}C

  $CaCO_3(g) \xrightarrow{800^0C} CaO\ (g) + CO_2\ (g)$

  $CaO(g) + SiO_2(g) \longrightarrow Ca\ SiO_3\ (l)$

  $Al_2O_3 + CaO\ (g) \longrightarrow Ca\ Al_2O_4\ (s)$



Uses of iron

7. Explain the harmful effects of some metals.

- Lead poisoning (brain damaging), sodium ions in raising high blood pressure, alzehermia by aluminium.

8. Describe alloys

- An alloy is a uniform mixture of two or more metals. Or it is a solid solution of two or more metals. carbon examples of alloys are, steel, brass, bronze e.t c

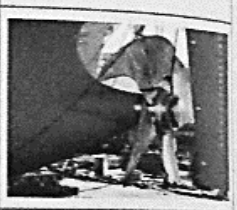
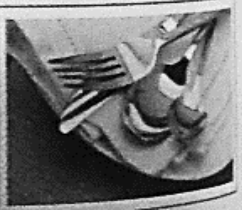
9. Explain the advantages of using alloys over pure metals

- Alloys exhibit better properties compound to a pure metal-conductor, such as high tensile strength, weight ratio, are hard, are resistance to corrosion.

10. Identify common uses of alloys

- Silver is used for making coins
- Stainless is used for making car parts, kitchen sinks and cutlery
- Duralium is used for making aircraft parts
- Bronze is used for making statues, ornaments, church bells
- Solders used for joining wires and pipes
- Brass used for making musical instruments

Advantages and uses of alloys

Alloy	Advantages	Uses	
steel (99.8% iron and 0.2% carbon)	• hard • strong	• large building and bridge construction • household appliances	
brass (75% copper and 25% zinc)	• hard • malleable • corrosion-resistant	• musical instruments • ornaments • doorknobs and other fittings • household appliances	
bronze (88% copper and 12% tin)	• very hard • malleable • corrosion-resistant • non-magnetic	• propellers of huge ships • decorative ornaments and trophies	
aluminium alloys (90.25% aluminium, 6% zinc, 2.5% magnesium and 1.25% copper)	• light but very strong • corrosion-resistant	• aircraft parts (fuselage, wings, tails etc.)	
stainless steel (74% iron, 18% chrome and 8% nickel)	• strong • shiny • corrosion-resistant	• cutlery • hospital and medical apparatus • car parts	

12 Describe corrosion

- Chemical; wearing of metal resulting from attack by atmospheric oxygen in pressure of moisture

13 Relate corrosion to the reactivity of metals

- More reactive metals easily corrode while less reactive metals do not easily corrode

14 Describe the different methods of preventing corrosion

- Sacrificial protection
- Paining
- Greasing/oiling
- Alloying and galvanizing

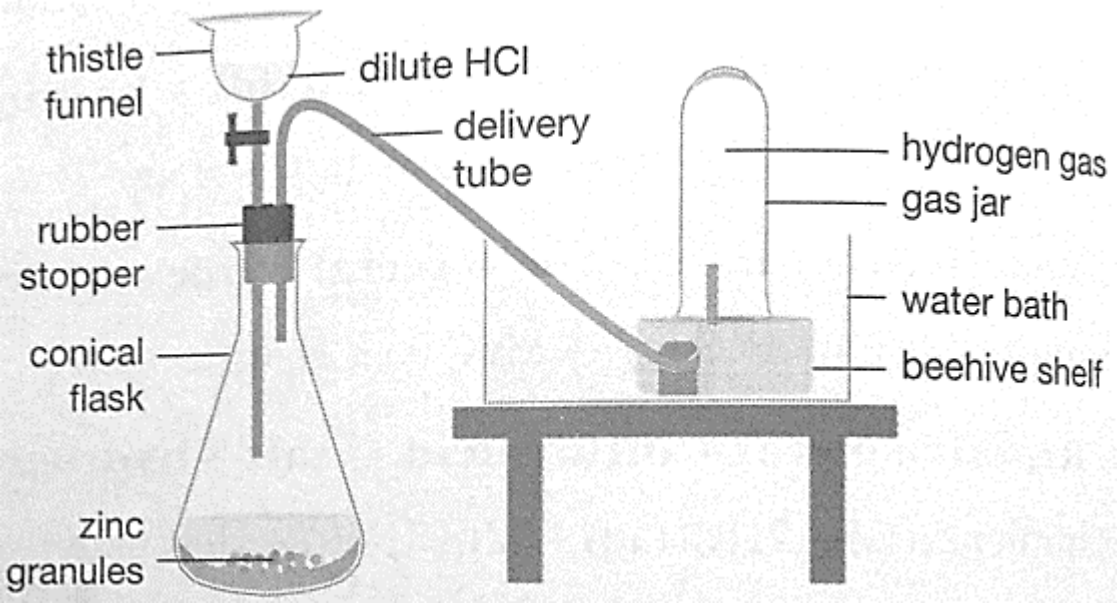
NON METALS

1. Describe the physical and chemical properties of non-metals

- They are not strong, or malleable, or ductile, or sonorous
- They have lower melting and boiling points that metals
- They are poor conductors of electricity; graphite (carbon) is the only exception. They are also poor conductors of heat
- They have low densities
- Like metals, most of them react with oxygen to form oxides
- When they form ions, the ions are negative

2. Demonstrate the laboratory preparation, collection and test for hydrogen

- By action of moderate reactive metals on water/steam and dilute acids and collect by upward delivery method, puts out a lighted splint with a 'pop' sound



3. **Describe the physical and chemical properties of hydrogen**

   Physical

   - It is colorless, odorless and tasteless gas
   - No effect both blue and red litmus paper
   - It is less than air

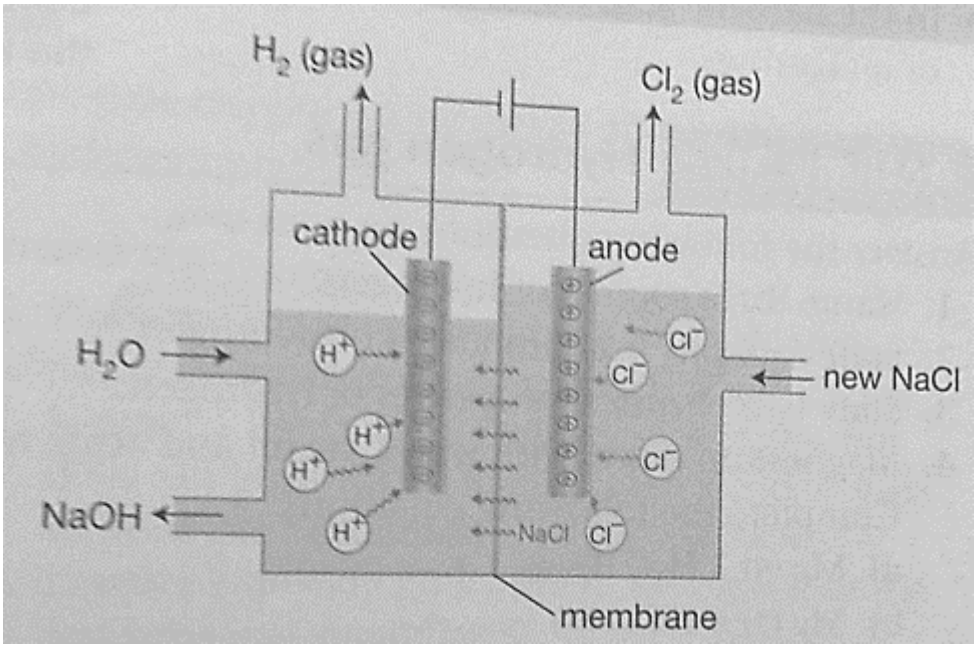
   Chemical

   - It is inflammable

4. **Describe industrial manufacture of hydrogen**

   - It is manufactured by cracking, electrolysis of brine (salt water) and from natural gas

Electrolysis of brine (salt water)



5. **Describe the uses of hydrogen**
   - In Haber process for manufacture of ammonia gas
   - In metalogical balloon because it is lighter than air
   - Used in welding process
   - Used in hardening of oils to form fat
   - Used as rockets fuel because hydrogen liberates a lot of energy when burned
6. **Demonstrate the laboratory preparation, collection and test for oxygen**
   - By catalytic decomposition of hydrogen peroxide and catalytic decomposition of potassium chlorate, collected above water and re-lights the glowing splint

7. **Describe the physical and chemical properties of oxygen**

   Physical properties of oxygen
   - It is colorless gas
   - Tasteless and odorless
   - Insoluble in water
   - As dense as air

Chemical properties of oxygen

- It relights a glowing splint
- It reacts with metals to form metal oxides
- Reacts with non-metals

8. **Describe the industrial preparation of oxygen**
   - By fractional distillation of liquid air. The air is distilled into fractions of varying temperature within the tower. The tower is coolest at the top. The air separates into fractions as nitrogen separates first at -190^0C followed by argon at -186^0C than oxygen at -163^0C.
   - By so doing oxygen will have been prepared.
9. **Describe the uses of oxygen in industry and in natural processes**
   - It is used for burning
   - It is used for welding
   - It is in blast furnace
   - It is used for respiration
10. **Demonstrate the chemical test for water.**
    - Using white anhydrous copper (ii) sulphate which turns blue
11. **Explain the importance of ozone layer and dangers of its depletion**
    - It traps radiation, if depleted by CFC's causes skin cancer, respiratory diseases
12. **Describe the importance of water**
    - For laundry, drinking
13. **Describe the industrial manufacture of nitrogen**
    - By fractional distillation of liquid air. The air is distilled into fractions of varying temperatures within the tower. The tower is coolest at the top. The air separates into fractions as nitrogen separates, first at -190^0C followed by argon at -186^0C then oxygen at -163^0C
14. **Explain the characteristics and importance of nitrogen as a gas**
    - It is a non-reactive insoluble gas hence used as refrigerant, food packaging. Manufactures of ammonia

15. Demonstrate preparations collection and test for ammonia in the laboratory.

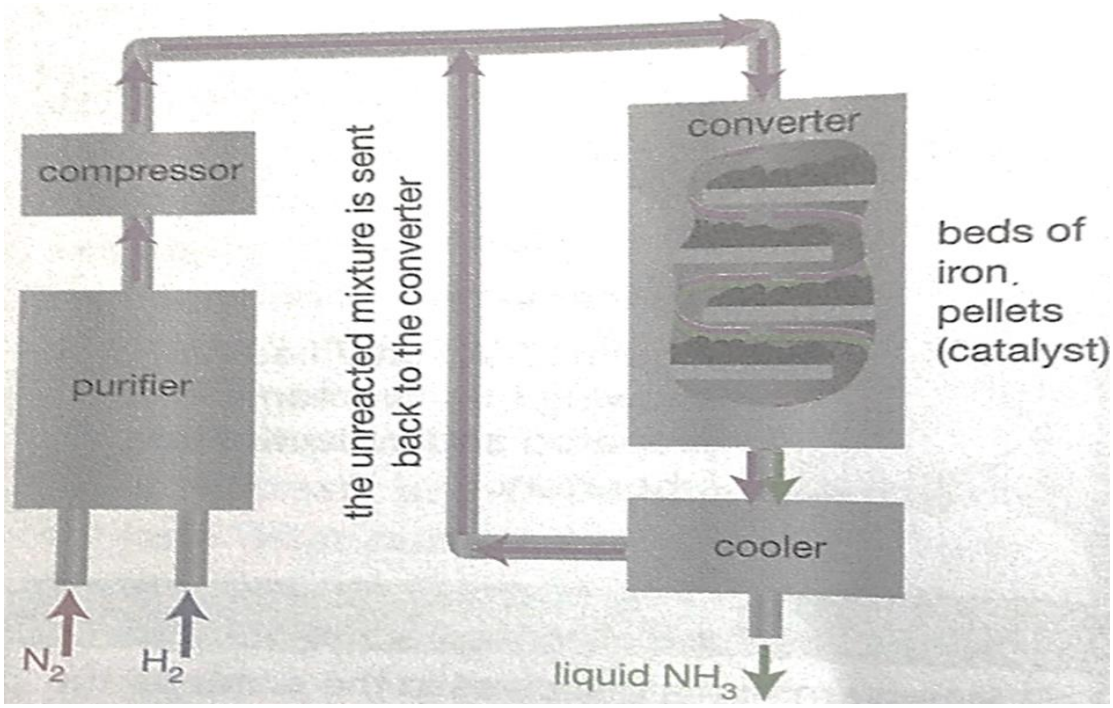
- Action of a base on ammonium salt and collected by upward delivery method, turns damp red litmus paper blue.

16. Describe the manufacture of ammonia

- Hydrogen and nitrogen gas are purified to remove impurities such as carbon (iv) oxide, oxygen sulphure (iv) oxide etc that would poison catalyst, hydrogen and nitrogen are mixed in ration of 1:3 and compressed to 350 atm pressure and heated to 540^0C. The hot compressed gases are passed over finely divided iron catalyst mixed with aluminium (iii) oxide promoter. The equation of the reaction is"

  N_2 (g) + 3H (g) $\rightleftharpoons$ 2NH3 (g)

  Ammonia is condensed out as liquids.



17. Describe the uses of ammonia

- In the manufacture of fertilizers, explosive, nitric acid

18. Describe the manufacture of nitric acid, manufacture of nitric acid by the Ostwald process

Step (i): catalyst oxidation of ammonia at 900^0C

$4NH_{3(g)} + SO_{2(g)} \xrightarrow{\text{Pt catalyst}} 4NO + 6H_2O_{(l)}$

This reaction is exothermic and sustains itself once started.

Step (ii): Nitrogen (ii) oxide is cooled and reacted with excess air to form nitrogen (iv) oxide

$2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$

Step (iii): absorption of nitrogen (iv) oxide in water to form nitric acid

$4NO_2(g) + 2H_2O(g)\ g + O_2(g) \longrightarrow 4HNO_2(aq)$

- Percentage of nitric acid can be concentrated from 60% to 68% by distillation

19. Explain the importance of nitrogenous fertilizers

- Nitrogen for growth,
- phosphorous for root development and
- potassium for seed formation (NPK)

20. Describe the effects of nitrogenous fertilizer on the environment

- The form acid rain
- Some nitrogen (IV) oxide in air absorbs solar energy and dissociates into nitrogen atoms combines with oxygen in air forming ozone which combines with hydrocarbons producing poisonous compounds.
- If fertilizers are not used correctly, they reach rivers and storms encouraging growth of algae and other marine plants that deprive water of oxygen leading to death of marine animals.

21. Describe allatropes

- When an element exist in several physical forms of the same state, it is said to exhibit allotrope. Each form of this element is an allotrope. Lots of elements exhibit allotropy. Carbon has two very popular allotropes, diamond and graphite. Diamond and graphite are both made of carbon only. However, they look very different and have different physical properties. They are both giant molecular structures.

22. Describe the formation and properties of carbon monoxide

Formation

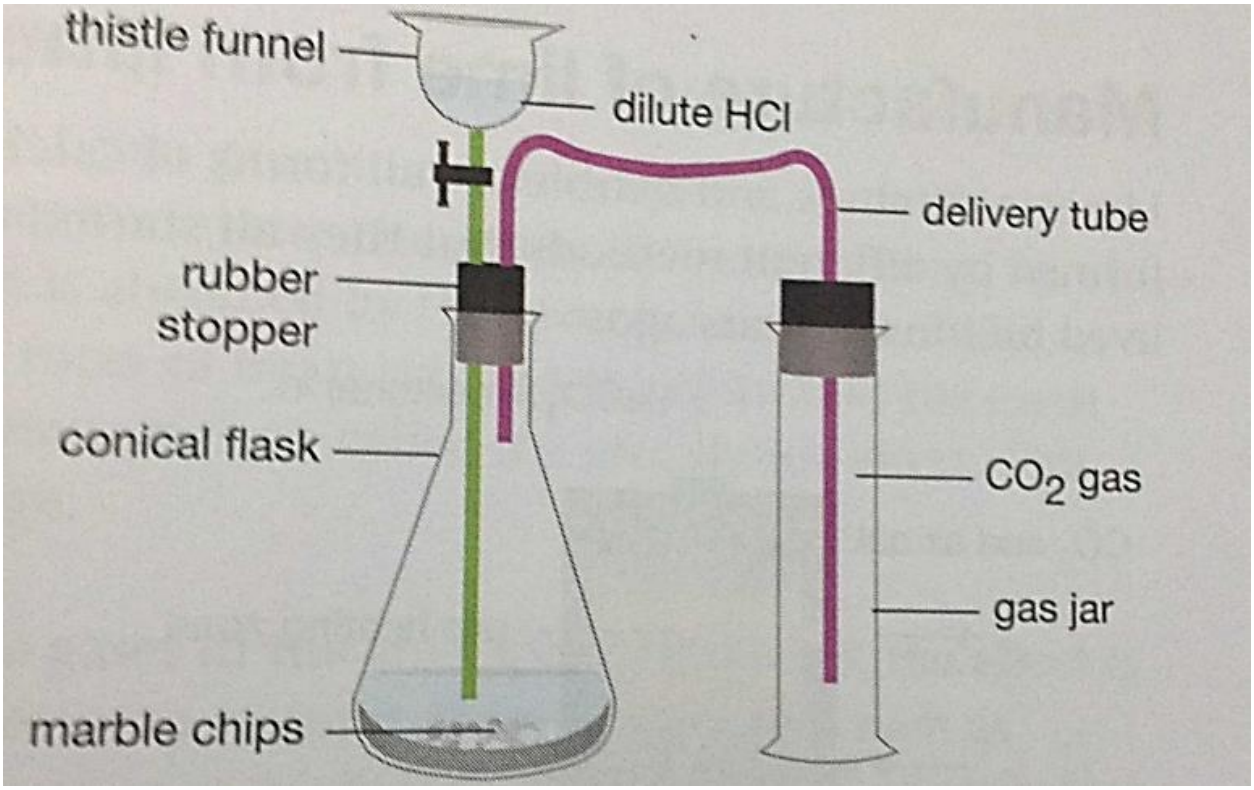
- By incomplete combustion of carbon and carbon compounds,
- reduction of carbon dioxide by carbon.

Properties of carbon monoxide

- In terms of colour, odours, density,
- It is insulibility in water,
- It is very poisonous,
- It act as reducing agent.

23. Demonstrate the laboratory preparation, collection and the test for carbon dioxide

- By reaction of dilute acids with carbonate or bi-carbonate, collection by downward delivery method/above water, forms white precipitate with lime water.



24. Describe the physical and chemical properties of carbon dioxide.

Physical properties of carbon dioxide

- It is a colourless, odourless, tasteless gas
- It is much heavier than air
- It is slightly soluble in water, its solubility increases with pressure
- If carbon dioxide is cooled and pressurized, it turns straight into a solid, which is called dry ice.

Chemical properties of carbon dioxide

-

25. Describe the uses of carbon dioxide

- Used in fire extinguishers,
- Carbonated drinks,

- dry ice,
- baking and
- Photosynthesis

26. Describe the uses of lime and slaked lime

- In neutralizing acidic soil,
- lime as a drying agent for ammonia

27. Describe the uses of limestone

- Used in manufacturing of lime,
- cement,
- Glass, and
- iron

28. Describe the greenhouse effect

- In the day, heat from the sun (in the form of infrared) passes through the atmosphere heating up the earth. At night, the earth radiates heat, to the outer space. Some atmospheric gases trap heat from the sun, thus preventing the loss of heat. This is called greenhouse effect(which is essential or else the earth will be too cooled for life.
- Global warming due to increase of carbon dioxide in atmosphere

ORGANIC CHEMISTRY

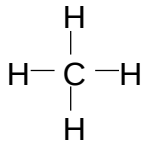
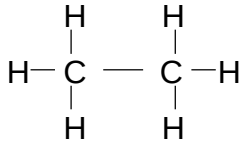
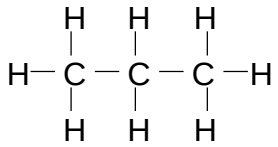
1. Describe an organic compound

- A compound of carbon other than oxides and carbonates.

2. Describe hydrocarbon

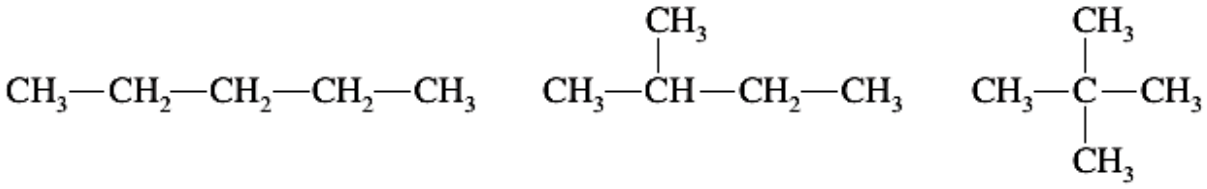
- A binary compound of carbon and hydrogen in there molecules.

3. **Illustrate and name the structures of the aliphatic alkane up to five carbon atoms.**

NUMBER OF CARBPON ATOMS	NAME	MOLECULAR FORMULA	STRUCTURAL FORMULA
N=1	METHANE	CH_4	
N=2	ETHANE	C_2H_6	
N=3	PROPANE	C_3H_8	
N=4	BUTANE	C_4H_{10}	
N=5	PENTANE	C_5H_{12}	complete ……

4. **Demonstrate the structures of Isomers and their name**

Pentane



n-pentane isopentane neopentane

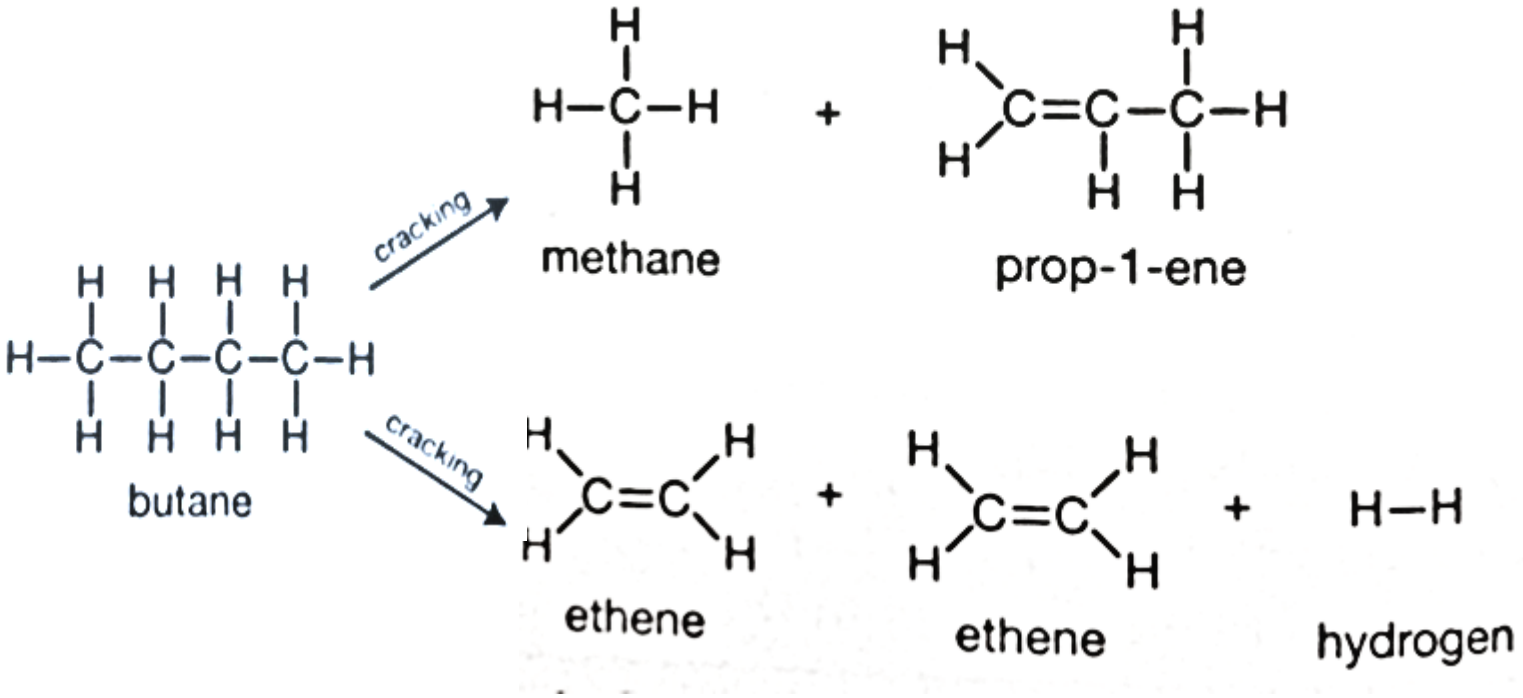
5. **Describe fractional distillation of petroleum (crude oil)**
   - Crude oil contains a mixture of hydrocarbon most of them being alkanes. Some of the compounds of crude oil can be separated by fractional distillation of crude oil. Solids such as sand are separated by filtration. The crude oil layer is pumped into furnace at about 400^0C to vaporize it. The hot vapour is pumped into a fractionating column near the bottom. The tower contains perforated horizontal plates at temperature ranges that are same as boiling range of reaction at that point.
6. **Describe the uses of the fractions of crude oil**
   - Used as domestic fuel, road construction
   - Used as combustion, cracking, substitutions, steam reforming
7. **Describe the chemical properties of alkanes**
   - Burn in excess air (oxygen) with a pale blue flame forming carbon (iv) oxide plus water vapours

     $CH_4(g) + 6\ 202\ (g) \longrightarrow CO_2\ (g) + 2H_2O\ (l)$
   - In the presence of sunlight or uvlight, alkanes react with halogen forming series of products depending on the amount of halogen

     $CH_4 + Cl_2\ (g) \xrightarrow{\text{uvlight}} CH_3Cl\ (g) + HCl\ (g)$
   - Cracking is the decomposition of high boiling hydrocarbons of high molecular-weight into simpler, low boiling hydrocarbons of molecular weight.

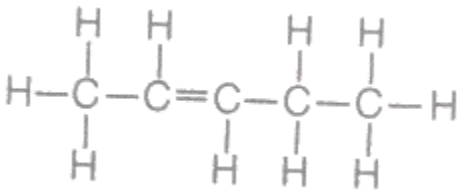
     $C_{10}H_{22} \longrightarrow C_5H_{22} + C_5H_{10}$

     decane n-pentane pentene



8. Illustrate unsaturated in alkenes

- Alkenes are unsaturated hydrocarbons with general molecular formula $C_n H_{2n}$



C_5H_{10}

9. Describe and name the structures of the alkenes up to 5 carbon atoms

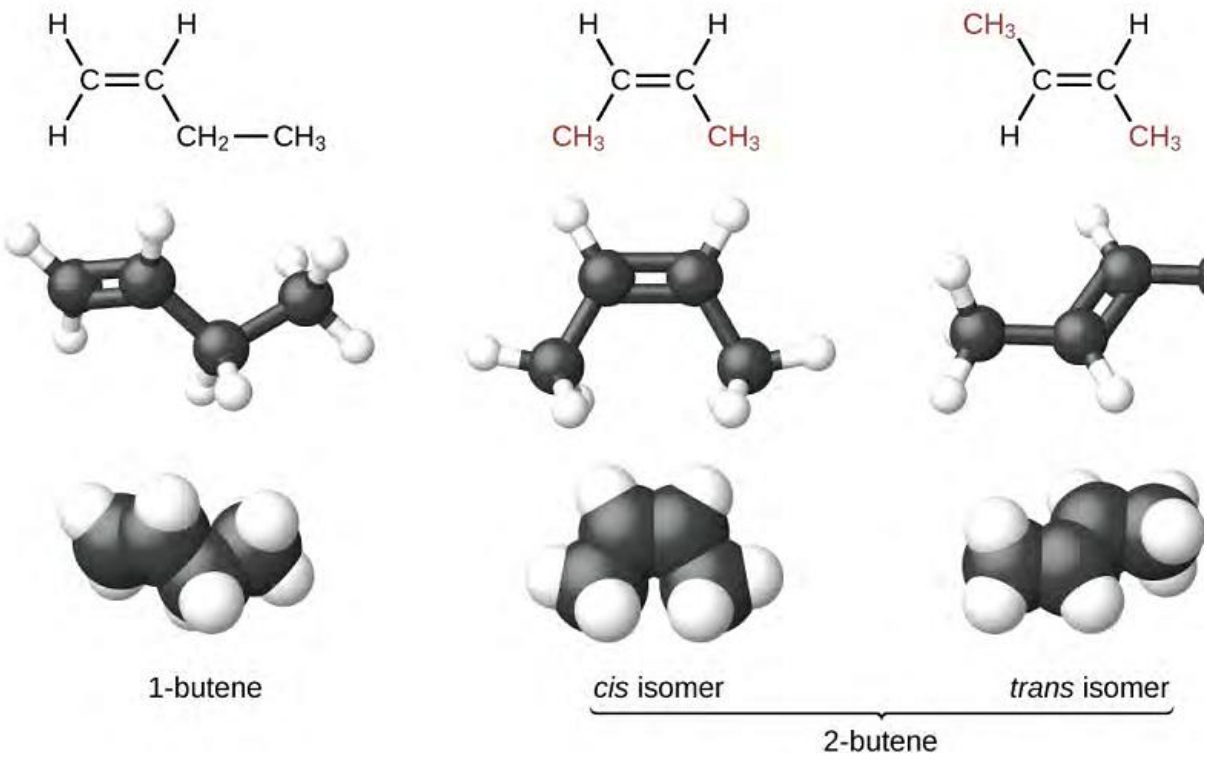
- Alkenes are unsaturated hydrocarbons with general molecular formula $C_2 H_{2n}$. Names are derived from those of corresponding alkanes by replacing ending – ane by – ene.

  ethene, propene, butane, pentene, Hexane

  but-l-ene pent-l-ene, Hex-l-ene

Name	Condensed formula	C_nH_{2n}
ethene	$H_2C{=}CH_2$	C_2H_4
propene	$H_2C{=}CH{-}CH_3$	C_3H_6
but-1-ene	$H_2C{=}CH{-}CH_2{-}CH_3$	C_4H_8
but-2-ene	$H_3C{-}CH{=}CH{-}CH_3$	C_4H_8
pent-1-ene	$H_2C{=}CH{-}CH_2{-}CH_2{-}CH_3$	C_5H_{10}
pent-2-ene	$H_3C{-}CH{=}CH{-}CH_2{-}CH_3$	C_5H_{10}

10. Demonstrate the Isomers of alkenes



11. Describe the chemical properties of alkene

- burn in excess air with luminous flame forming carbon (iv) 0xide and water

  $C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(l)$

- is one which two or more molecules combine to yield a single molecule of product

  Additional reaction

  $C_2H_4(g) + H_2(g) \xrightarrow{\text{nickel catalyst}} C_2H_6(g)$

  Ethane

  $C_2H_4(g) + H_2(g) \xrightarrow{\text{room temperature}} CH_2BrCH_2Br$

  (Red- brown dish) — 2di broom ethane (colourless)

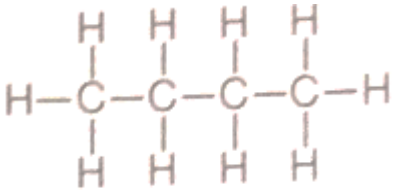
  $CH_2 = CH_2(g) + HCl(aq) \xrightarrow{\text{room temperature}} CH_3CH_2Cl(g)$

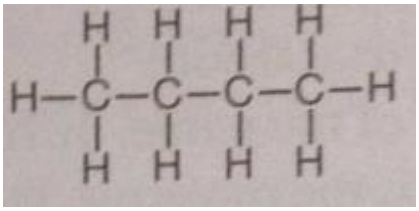
  chloroethane

12. Illustrate the differences and similarities between saturated and unsaturated hydrocarbons.

Saturated hydrocarbons

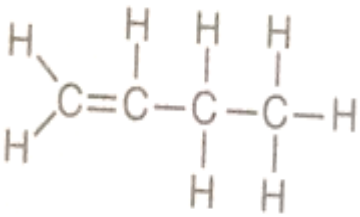
- Alkanes all have a Carbon bonds which are single



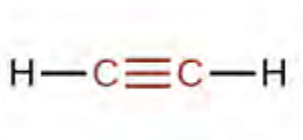


unsaturated hydrocarbons

alkenes or alkynes have carbon which is double or triple bond



Triple bond



- Unsaturated compounds such as alknesdecolourise acidified potassium manganate (vii) and bromine water

13. Describe the chemical tests for unsaturated hydrocarbons (alkenes)
    - Alkenes decolourise bromine solution rapidly

14. Describe the uses of alkenes

- Ethane is used in manufacturing of polythene which is used for making bags, water pipes etc
- Ethane in low concentration is used to ripen fruits
- Propene is used in manufacture of poly Propene which is used to make ropes

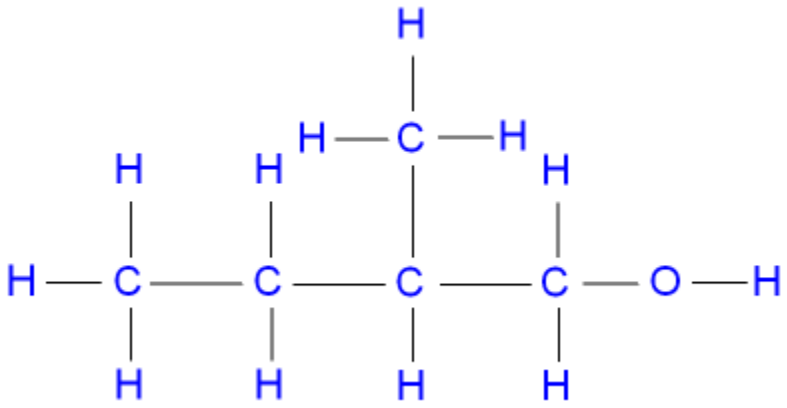
15. Describe the chemical composition of an alcohol

- Alcohol is an organic compound with hydroxyl group (OH) as a functional group. They have a general formula R-OH. Group and its name is derived from corresponding alkane by replacing ending e by ol.

16. Describe and name structures of primary alcohols up to five carbon atoms

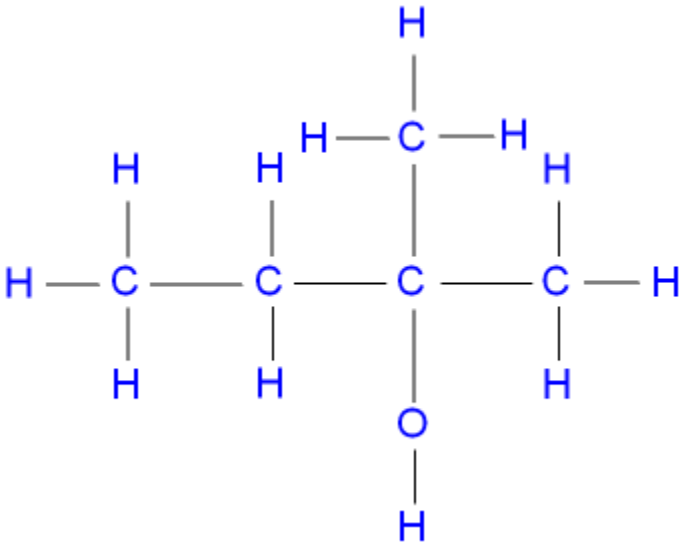
- Parent structure is longest continuous chain of carbon atoms carrying the hydroxyl (OH) group and its name is derived from corresponding alkane by replacing ending e by ol.

17. Demonstrate Isomerism in alcohols



3-methylbutan-1-ol, a primary alcohol,

Represented below by the structural formula



2, 2-dimethylpropanol, a primary alcohol,

Represented above by the structural formula

18. Describe the formulation of alcohols

(i) Alkene is absorbed in 98% sulphuric acid at 80% under 25 atmosphere pressure to form an alkyl hydrogen sulphate which is hydrolysed by boiling water to form an alkanol

$C_2H_4 + H_2SO_4 \longrightarrow C_2H_5HSO_4$

$C_2H_5SO_4 + H_2O \longrightarrow C_2H_5OH + H_2SO_4$ (aq)

(ii) Fermentation of carbohydrates

Various carbohydrates such as maize, potatoes and barley are pressure cooked to release starch grain. The mixture is then treated for an hour at 60^0C with malt which supplies enzymes diastate that hydrolyse it to maltose

$(C_5H_{10}O_5)n + nH_2O \longrightarrow C_{12}H_{22}O_{11}$

Yeast is added at room temperature. Its enzyme maltase hydrolyses maltose to glucose.

$C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{maltatse}} 2C_6H_{12}O_6$
glucose

Another enzyme of yeast, zymase, converts glucose to ethanol.

$C_6H_{12}O_6$ (g) $\xrightarrow{\text{yeast}}$ $2CO_2$ (H) + $2C_2H_5OH$ (g)
Zymase

19. Describe the properties (chemical) of alcohols.

(i) Combustion

- Burn in excess oxygen to form water and carbon (iv) oxide

C_2H_5OH (i) + $3O_2$ (g) $\longrightarrow$ $2CO_2$ (g) + $3H_2O$ (l)

(ii) Reaction with sodium metal to evolve hydrogen gas and form an alkoxide

CnH_{2n} + l OH + 2Na $\xrightarrow{\text{room temperature}}$ 2Cn H_2 n + l ONa + H 2 (g)

Alkanol sodium alkoxide

(iii) Dehydration

Alcohol are dehydrated by excess concentrated sulphuric acid at 170^0C to form alkene

$C_2H_5OH \xrightarrow{\text{conc H2 SO4}}$ C2 $H_4 + H_2O$

(iv) Reaction with alkanoic acid (esterification)

When alkanol is boiled with alkanoic acid in presence of concentratedsulphuric acid ester is formed.

$CH_3COOH + C_2H_5OH \xrightarrow{\text{conc } H_2SO_4} CH_3COOC_2H_5 + H_2O$
Ethanoic acid ethanol (esther)

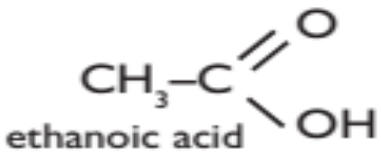
(v) Oxidation of alkanols

Are oxidized in excess of oxidizing agent such as acidifies potassium manganate (vi) or potassium dichromate (vi) in two distinct stages first to alkano and then alkanoic acid with no loss of carbon.

20. Describe and name structure of carboxyl

- Acids up to five carbon atoms
- Carboxyl acids have a general formula RCOOH where the carboxyl group (COOH) is the functional group. General molecular formula is Cn H_{2n} + 1 COOH

3



21. Describe the formation carboxylic acid

- Carboxylic acids are formed by oxidation of alcohols. The general equation is:

  $RCH_2OH + [O] \longrightarrow RCHO + H_2$

  Alcohol
- By hydrolysis of alkenes

  Alkene is absorbed in 98% sulphuric acid at 80^0C under 25 atmosphere pressures to form an alkyl hydrogen sulphate which is hydrolysed by boiling water to form an alcohol.

22. Demonstrate the chemical properties of carboxylic acid

- They react with a base forming a salt and water only
- Liberate hydrogen with active metals\react with carbonate and hydrogen carbonate to form salt, water and carbon (iv) oxide

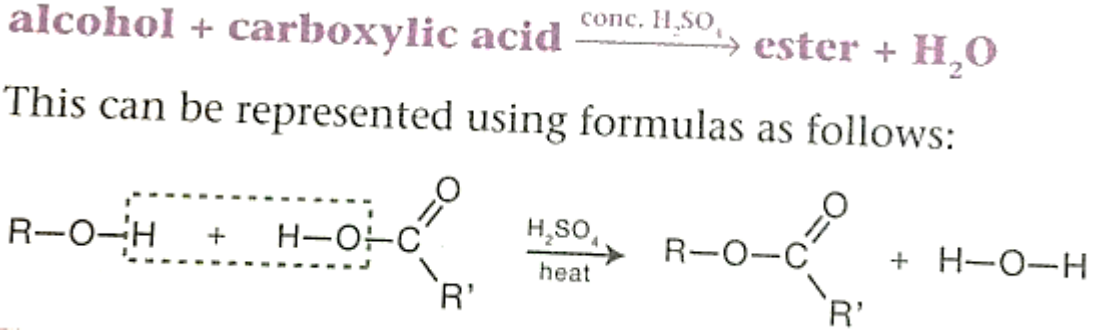
23. Describe the uses of carboxylic acids

- Preservative tenderizer for food
- For flavouring food stuff

- As a solvent for many organic chemicals especially in textile, paint and colour making industry
- Alcohol react with carboxylic acid to form esters

24. Describe and name the structure of easter up to five carbon atoms

- They react with alcohols in the presence of an acid to form easters, easters are named by first identify the group on the caborxylate oxygen, then identification of the carboxylic acids and replacing the –oic acid with –ate



25. Describe the chemical properties of ester

- Reaction of an ester with sodium hydroxide result in the formation of sodium carbohylate and an alcohol

26. Describe the uses of esters and relate the uses to properties

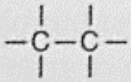
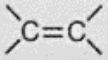
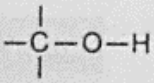
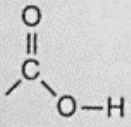
- Ester are used in making perfumes, food flavourants because of having pleasant smell

27. Describe homologous series

- It is a collection of organic compounds belonging to the same family with the same general formula (consider alkanes, alkenes, alcohols, acids, esters)

28. Describe the general characteristics of homologous (members)

- Members of each homologous series have the same general formula and similar chemical properties. Physical properties (state, melting point, boiling point, density solubility) of members above gradually changes as molecular mass changes. Adjacent members differ by CH_2 and have a method of preparing members

Homologous series	Functional group	General formula	Naming convention
alkanes		C_nH_{2n+2}	name ends in -ane
alkenes		C_nH_{2n}	name ends in -ene
alcohols		$C_nH_{2n+1}OH$	name ends in -ol
carboxylic acids		$C_nH_{2n}O_2$	name ends in -oic acid

29. Describe macromolecu;es (polymers)

- A giant molecule formed by combination of many small molecules (monomers)

30. Describe synthetic macromolecules

- These are human made giant molecules (polymers)

31. Describe the formation of polyalkanes

- By addition of polymerization e.e polythene, polyvinyl chloride, polypropane, polystyrene

32. Classify plastics

- Thermoplastics- these get soft runny when they are heated, but become hard when they are cooled
- Thermosetting plastics- these become permanently hard once they are heated

33. Describe the formation of nylon and terylene

- Nylon id formed by condensation polymerization- this is where monomers (identical or different combine to form long chain molecules (polymers) with loss of a small molecule like water, ammonia or hydrogen chloride) from a diamine and diotic acid structure represented as:
- Terylene formed from diol and dioic acid structures

34. Differentiate between the structure of Nylon and Terylene

- Nylon is a polyamide and Terylene is a polyster

35. Describe the typical uses of plastics and synthetic fibres

- Plastics are used a s carrier bags, buckets, pipes
- Nylon and terylene in making clothes, tents, strings, ropes, carpets, rubber reinforcement, sewing thread

36. Describe the biodegradability of synthetic fibres

- Biodegradable synthetic fibres are fibres that can be broken down by micro organisms
- Non- biodegradable are synthetic fibres that can not be broken down by micro-organism e.g. plastics

37. Describe natural macromolecules

- Natural macromolecules are molecules that are made by God. Examples are:
  - (i) Cellulose materials whose monomer is glucose e.g. wood, cotton
  - (ii) Used in making clothes and paper respectively
  - (iii) Natural rubber whose number is 2 methy l buta-1,3 – dine (Isoprene) used for making types
  - (iv) Protein whose number monomer units are amino acids. Used for making clothes threads and ropes
  - (v) Fats and oils whose monomer are fatty acids and glycerol, used in soap making
  - (vi) Starch whose monomer is glucose

38. Describe composition of carbohydrates

- carbohydrates contain carbon, hydrogen and oxygen in the form $Cx\ H_{2y}\ O_y$where x is a multiple of six