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Chemistry form 2 Chapter 1

Elements and periodic table

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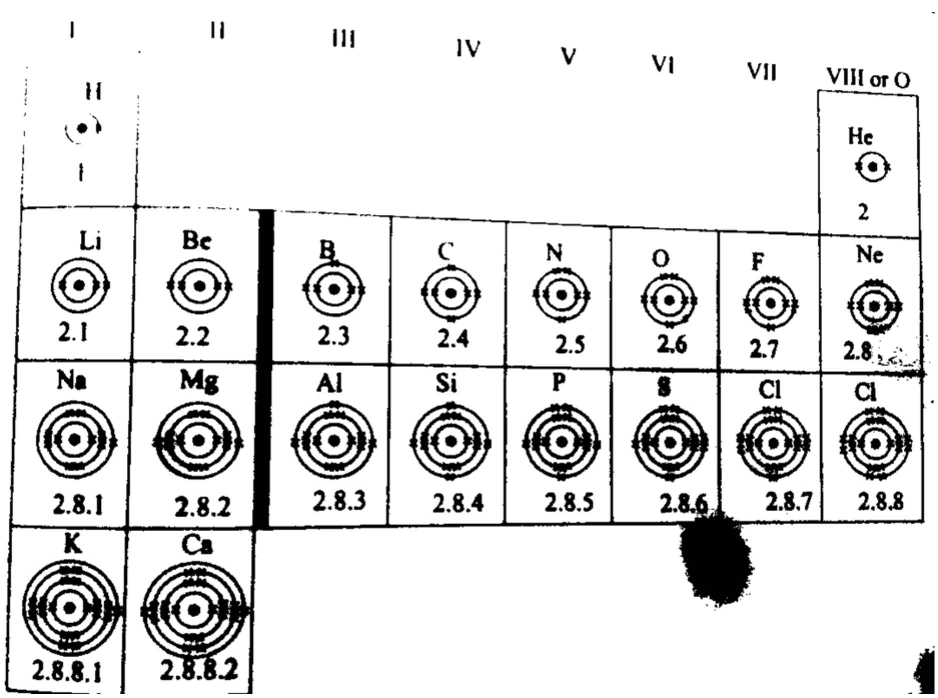
CHAPTER ONE: **Elements and The Periodic Table**

- Elements in the periodic table are metals (on the left), metalloids (in the middle), and non-metals on the right.

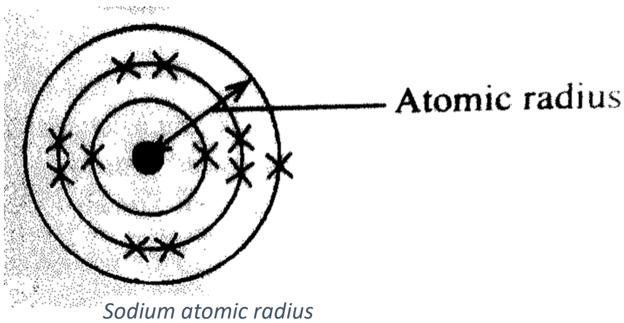
Periodic Trends

- A trend is a behavioural pattern that may occur repeatedly. Among the patterns in the periodic table are; atomic radius, electron affinity, electronegativity and ionisation energy.



a) Atomic Radii

- The radius of an atom is the distance from the centre of the atom to the farthest shell.
- Across the periodic table atomic radius of elements decrease. This is because of increased attraction between nucleus and outer electrons as the atomic number increases and electrons are being added to the same shell.
- Down the group the atomic radii increase due to decrease in attraction between nucleus and outer electrons because an extra shell is being added and the shells cause shielding of nuclear attraction.



Sodium atomic radius

b) Electron Affinity

- This is the ability of an element to accept electrons. This is the opposite of electronegativity.
- Effective nuclear charge (force of attraction) increases across the period due to increase in atomic number.
- Electron affinities, therefore, increase across the periodic table but decrease down the group due to increase in atomic radii.

c) Electronegativity

- This is the ability of an atom to attract electrons to itself.
- Across the period, electronegativity increases due to an increase in nuclear charge as the atomic number increases.
- Down the group, the electronegativity decreases due to increase in radius as the number of shells increases.

d) Ionisation Energy

- Ionisation energy is the minimum energy required to remove electrons from an atom.
- Down the group ionisation energy decreases because electrons in the outer shell are less attracted to the nucleus.

- Across the period ionisation energy increase because electrons in the outer shell increase and experience more attraction force.

Element	**Ionisation Energy (K)**	**Atomic radius**
Lithium (Li)	520	0.15
Sodium (Na)	496	0.19
Potassium (K)	479	0.23

NB: Valence Electrons are the outer electrons. Across the period, valence electrons increase, and down the group, valence electrons remains the same.

Properties of some Groups

A) **Alkali Metals – Group 1 elements**

- These include; Lithium, Sodium and Potassium.

Physical properties:

- They are soft
- They are shiny when freshly cut
- They float on water i.e. they have lower density than water

Chemical properties:

- They react with water to form a hydroxide and hydrogen gas.
  e.g. $2Na\ (s) + 2H_2O\ (l) \longrightarrow 2NaOH\ (aq) + H_2\ (g)$

- They are the most reactive metals
- They react with oxygen to form an oxide

  e.g. $Li\ (s) + O_2\ (g) \longrightarrow 2LiO\ (s)$

- They react vigorously with halogens producing metal halides in the process
  e.g. $2K\ (s) + Cl_2\ (g) \longrightarrow 2KCl\ (s)$

In group 1, reactivity increases down the group because atomic radii increases down the group so the valence electron is weakly attracted to the nucleus and the element can easily become an ion.

Uses of Alkali Metals

1. Lithium

- In glasses and ceramics that resist heat.
- Its alloys can be used in aircraft building.
- For making cellphone and computer batteries
- For making lubricating greases
- Its salts are used for making drugs for stabilising mood

2. Sodium

- As coolants in nuclear reactors.
- As a luster in metals.
- Its compounds are used in petroleum, textile and paper industries.
- In street lights and sodium vapour lamps.
- Its hydroxide is used in soap making.

3. Potassium

- Its nitrates are used for making explosives, fireworks and food preservatives.
- Its chromate is used for tanning leather and manufacture of inks, gun powder, dyes and safety matches.
- Its hydroxide is used for making soap.

B) Alkaline Earth Metals – Group 2 elements

- These include; Beryllium, Magnesium and Calcium.

Physical properties of Alkaline-earth metals

- They have high melting and boiling points. The melting and boiling points decrease down the group.
- They have grey silvery surface.
- They are good conductors of heat.
- They are good conductors of electricity.
- Density increase down the group due to increased mass of the atom.
- The atomic radii increase down the group. This is because down the group, the number of energy levels increases.
- Ionisation energy decreases down the group because as one goes down the group the radii of the atoms increase.

Chemical Properties of Alkaline-earth metals.

- They burn in air (oxygen) to form simple metal oxides

Metal + Oxygen $\longrightarrow$ Metal oxide
Magnesium + oxygen $\longrightarrow$ Magnesium oxide

- They react with water to form metal hydroxide and hydrogen gas.

Calcium + water $\longrightarrow$ Calcium hydroxide + hydrogen gas

- They react with chlorine to form chloride salts.

Magnesium + chlorine $\longrightarrow$ Magnesium chloride
$Mg\ (s) + Cl_2\ (g) \longrightarrow MgCl_2\ (s)$

- They react with dilute acids to form salt and hydrogen gas.

Uses of Alkaline Earth Metals

- **Beryllium** is used in high strength electrical insulators and semi-conductors.
- **Magnesium** is mixed with Aluminium or Zinc to alloys of more desirable qualities.
- **Calcium** is used in separating metals from their ores.

C) Halogens – Group 7 elements

- These include; Fluorine, Chlorine, Bromine and Iodine.

Physical Properties:

- Are made up of diatomic molecules, e.g. F_2, Cl_2.
- Have low melting and boiling points.
- Atomic radii increase down the group.
- Are poisonous and have different colours:
  - Fluorine – pale yellow gas
  - Chlorine – greenish yellow gas
  - Bromine – brown liquid
  - Iodine – blue, black shiny solid

Chemical properties:

- They are very reactive non-metals.
- They react with hydrogen to produce hydrogen halides.

$$H_2\,(g) + Br_2\,(l) \longrightarrow 2HBr\,(l)$$

- They react with alkali metals to form metal halides.

$$2Na\,(s) + Cl_2\,(g) \longrightarrow 2NaCl\,(s)$$

Reactivity decreases down the group because the atomic radii increases, hence smaller atoms can easily become ions.

Uses of Halogens

- Fluorine is used in the form of fluorides in drinking water and toothpaste to reduce tooth decay
- Chlorine is used to make plastic called polyvinyl-chloride (PVC) for electrical insulators and making household bleaches e.g. harpic.
- Chlorine can be used to kill bacteria and viruses in drinking water.
- Bromine is used in photography as silver bromide (AgBr) and medicine as potassium bromide (KBr).
- Bromine is used as flame retardant in fire extinguishers.

D) Inert (Noble) Gases

These do not take part in chemical reaction (they are unreactive) because they fill outermost shells. These are helium, neon, argon krypton and xenon.

Physical Properties:

- They are colourless gases.
- They are mono-atomic elements

Uses of Inert Gases

1. **Argon** is used to fill the bulbs to prevent the tungsten from reacting with air.

2**. Neon**

- Glows when electricity passes through it, hence used in advertising signs.
- It is used in Geiger-Muller tubes to detect radiation.
- It is also used together with helium-neon laser gas that is used in eye surgery.

3. Helium

- Used as a coolant in nuclear reactions.
- Used to inflate tyres of large aircraft to make them light enough.
- Used to fill airships and weather balloons to make them very light and cause them float on water and in air.

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Chemistry form 2 Chapter 2

CHEMICAL BONDING

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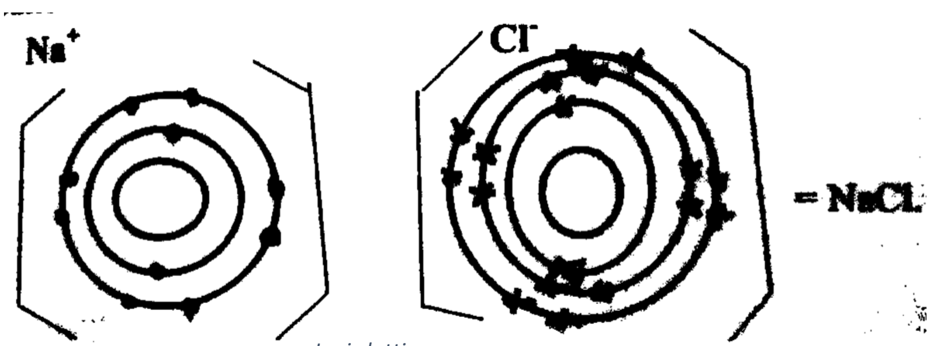
CHAPTER TWO: **Chemical Bonding**

- Chemical bonding is the joining of two or more atoms to form new products.
- Chemical bond is the force of attraction between atoms.
- Atoms bond in order to be stable and gain more ionisation energy.
- Atoms react (chemically bond) by gaining of electrons, loosing of electrons and sharing of electrons.

Types of Chemical Bonding

A) **Ionic Chemical Bonding**

- It is the type of chemical bonding that involves the transfer of electrons from metals to non-metals.
- It is formed when atoms either lose or gain atoms i.e. become ions. The positive ions are *cations* and negative ions are *anions*.
- The cations and anions attract to form a bond. For example, Na^+ and Cl^-.
- It is a type of bond that is also known as Electrovalent bond.



Ionic lattice

Ionic Lattice: This is an ionic crystal (grain). Ions in an ionic lattice are arranged side by side.

Formulae of Ionic Compounds

- The easier method of writing formulae of ionic compounds is to swap the charges between the ions and write them as subscripts of the atomic symbols leaving out signs. For example, the formula of magnesium chloride:

  Magnesium is Mg^{2+}, Chlorine is Cl^{-}, hence the formula is:

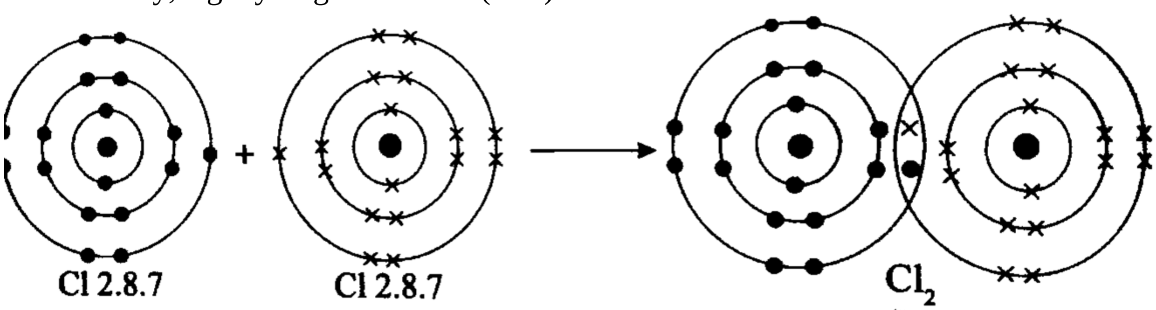
  $$Mg^{2+} \quad Cl^{-} = MgCl_2$$

Physical properties of Ionic compounds

- They have high melting and boiling points.
- They conduct electricity in their molten state because they have free ions.
- They are soluble in water to form aqueous solutions.

B) **Covalent (molecular) Chemical Bonding**

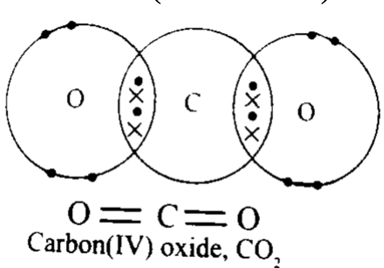
- These bonds are formed by sharing valence electrons. It is the reaction between non-metals only, e.g. hydrogen chloride (HCl).



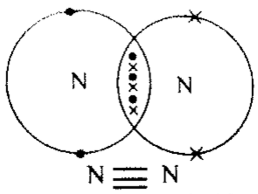
- The shared electrons are found where the outer-most shells overlap.
- When one pair of electrons is shared, then it is a *single bond*, when 2 pairs are shared, then it is a *double bond*, and when 3 pairs are shared, then it is a *triple bond*.

Example

Carbon dioxide (double bond)

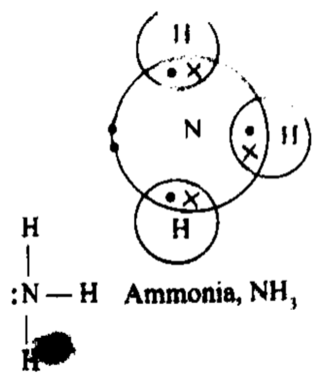


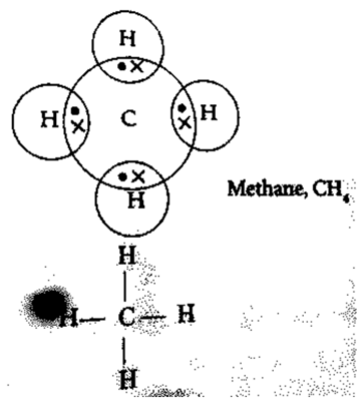
Nitrogen molecule (triple bond)



Nitrogen molecule, N_2

- **Dative (co-ordinate) bond** is a covalent bond in which the shared pair of electrons is provided by one of the bonded atoms.
- This pair of electrons is shared with an atom that has lost its electron(s) in the outer shell and has become ionised. The atom providing electrons is called a *donor* and the one receiving is called an *acceptor*.
- A dative bond is formed in ammonium ion.





Molecular compounds are formed when different non-metal atoms share electrons to form covalent bonds, such as hydrogen chloride, methane, glucose, etc.

Formulae of covalent (molecular) structures

This is possible when the valence electrons are known. For example:

Methane (CH_4) is: $C^4 \quad H^1 \longrightarrow CH_4$

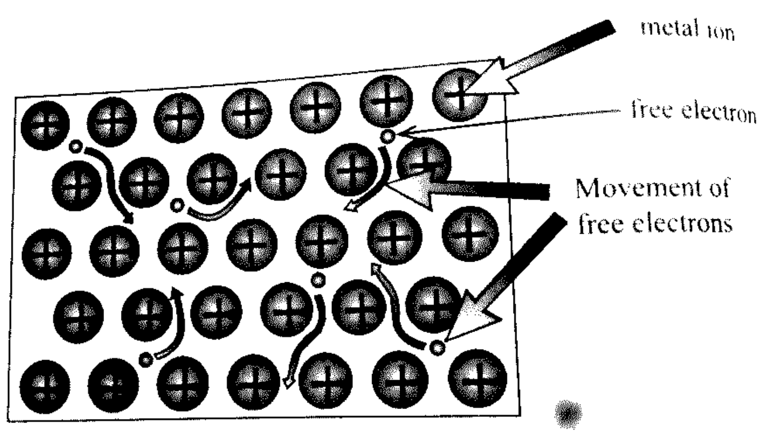
Ammonia (NH_3) is: $N^3 \quad H^1 \longrightarrow NH_3$

Physical properties of Molecular compounds

- They have low melting and boiling points.
- They do not conduct electricity
- They are insoluble in water but soluble in organic compounds.

C) **Matallic Chemical Bonding**

- These bonds are made between the stationary positive ions and free delocalised electrons. There is attraction between these ions.
- These are the strongest bonds because each free delocalised electron is attracted in their directions, hence forming a very strong bond.



Strength of Metallic Bond

➢ It occurs mainly due to:

a) Size of metal atoms

- The electrostatic force decreases going down the group. Hence substances from the upper part of the group will be having stronger electrostatic forces and they will be hard.

b) Number of valence electrons contributed to the 'sea' of electrons

- The melting and boiling points of metals across the periodic table increase because of increasing numbers of delocalised electrons. As the delocalised electrons increase, the electrostatic force of attraction between the electrons and nuclei increases.

Properties of metals

- They have high melting and boiling points; because they have very strong bonds.
- They expand when heated.
- Metals are good conductors of heat and electricity.
- They are malleable (can be beaten into various useful shapes e.g. sheets).
- Metals are ductile (they can be drawn into wires).
- They are sonorous (they produce a ringing sound).
- Metals are dense and strong

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Chemistry form 2 Chapter 3

ACIDS AND BASES

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CHAPTER THREE: **Acids and Bases**

Properties of Acids

- Acids have sour taste, such taste as lemons, vinegar, sour milk, etc. some acids are found in both plants and animals, and are referred to as *Organic acids*. While other acids are formed from reactions of chemicals, and they are called *inorganic* or *mineral acids.*
- Acids conduct electricity. When an acid is dissolved in water the resulting solution conducts an electric current.
- A number of mineral acids are corrosive. This means they can eat away skin, cloth and metals.
- Acids turn blue litmus paper red, and changes the colour of the universal indicator.

Organic acids

Name	**Where found**
Citric acid	Citrus fruits such as orange, lemons, malambe
Tartaric acid	Grapes, health salts, baking powder, bwemba
Lactic acid	Sour milk
Ethanoic acid	Vinegar
Methanoic acid	In ant, bee and nettle stings
Butanoic acid	Cheese
Tannic acid	Tea

Common mineral or inorganic acids

Name	**Where found**
Hydrochloric acid	In stomach, in chemicals used to clean metallic surfaces

Sulphuric acid	Car batteries, fertilisers, detergents.
Nitric acid	Fertilisers and explosives.

Properties of Bases

- Bases have a flat/ bitter taste e.g. drugs called anti-acids.
- Bases conduct electricity (they are electrolytes)
- Bases react with metals. Their concentrated solutions are corrosive.
- Bases change the colour of the universal indicator and red litmus paper to blue.

Acid / Base Indicators

- Indicators are used to distinguish acids from bases
- Indicators change into different colours when put in acids and bases.
- Examples of indicators are universal indicator, bromothymol blue indicator, phenolphthalein indicator and litmus paper.

Preparing Acid/Base indicators from local materials

- Indicators are usually dyes extracted from plants. The dyes are found in plant leaves and flowers. They can be exttacted from leaves of acacia, tomatoes and hibiscus flower.

Strength of Acids and Bases (pH scale)

- The strength of an acid or a base is determined by using *Electrical conductivity, a universal indicator or a pH scale.*
- The strength of a base or acid can be known by using a pH scale. The pH stands for power of hydrogen. The pH scale has corresponding colours as can be seen below:

Colour	**pH scale**
Red	1
Pink	2
Orange	3

Orange	4	*Increasing acid*
Yellow	5	
Light-green	6	
Green	7	*Neutral*
Dark-Green	8	
Dark-blue	9	
Blue	10	*Increasing alkalinity*
Violet	11	
Purple	12 /13 /14	

pH Scale chart

pH	0 & 1	2	3 & 4	5	6	7	8	9 & 10	11	12, 13 & 14
Colour	Dark red	Red	Orange	Yellow	Light Green	Green	Dark Green	Blue	Dark blue	Purple

- pH 0 to 6 means the solution is *acidic*.
- pH 7 means the solution is *neutral*.
- pH 8 to 14 means the solution is *alkaline or base.*
- If the pH value is very small then the solution is very *acidic*.
- If the pH value is very great then the solution is very *alkaline or basic*.

NB: *A universal indicator* is preferred when measuring pH of a solution because it provides a wide range of colour.

Examples of indicators and their colours

Name of indicator	**Basic colour**	**Acidic colour**
Litmus paper	Blue	Red
Phenolphthalein	Pink	Colourless
Bromothymol blue	Blue	Yellow
Universal indicator	Blue	Red

Uses of Acids and Bases

- Sulphuric acid (H_2SO_4) is used in car batteries and manufacturing industries producing paints, fertilisers and soap less detergents like surf.
- Ethanoic acid (acetic acid) is used as a food preservative and a solvent.
- Methanoic acid is used in dyeing and electroplating.
- Bases are used in food preparation e.g. okra (thelele).
- Bases are used to manufacture soap.
- Bases are used to neutralise acidic soils and acids are used to neutralise alkali soils.

Neutralisation

- This is a process of reducing acidity or basicity of a substance. All acid-base reactions are neutralisation process.
- It is a chemical reaction between a base and an acid to produce a salt and water only.

Neutralisation is applied in:

a) In digestion: the acidity in the stomach can be reduced by stomach powder such as drew liver salt, magnesium trisilicate and milk of magnesium.
b) Used in Agriculture: some crops do well in acid soils, others in neutral soils and basic soils. So acidic or alkaline soils have to be neutralised to accommodate crops which prefer neutral soils.
c) Used in cleaning teeth: acids produced by micro-organisms in the mouth are reduced by alkali bases.
d) Taking of ant-acids such as milk of magnesia and sodium bicarbonate (soda).
e) Insect bite neutralisation. Apply base on insect sting bite area

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Chemistry form 2 Chapter 4

HYDROCARBONS

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CHAPTER FOUR: **Hydrocarbons**

Hydrocarbons are organic compounds which contain carbon and hydrogen atoms only.

Organic compounds are substances which contain C-H bond. There are three classes of organic compounds, namely:

I. *Hydrocarbons:* substances which contain carbon and hydrogen atoms only; e.g. alkanes and alkenes.
II. *Oxycarbons:* substances which contain carbon, hydrogen and oxygen atoms e.g. alkanols.
III. *Nitrocarbons:* These contain carbon, hydrogen and nitrogen atoms e.g. CH_3NO_2.

Families of Hydrocarbons

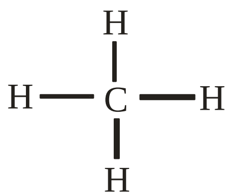
- There are several families of organic compounds each of which form a Homologous series with similar characteristics.
- *Homologous series* are series of compounds related by the same general formula and with similar properties.
- The two families or homologous series of hydrocarbons are *alkanes* and *alkenes*.

Sources of Hydrocarbons

- Alkanes and alkenes come from the remains of the dead pants and animals which give rise to:
- Fossil fuels (fractional distillation of petroleum)
- Cracking of long-chain alkanes
- Natural gas

Alkanes (paraffin)

- In this homologous series, each carbon atom forms 4 simple covalent bonds with other atoms.



- Alkanes are called saturated hydrocarbons because the carbon atoms have 4 single bonds and the carbon atom cannot take in anymore atoms.

General formula for alkanes

The general formula is $C_n H_{2n+2}$ where ***n*** stands for the number of carbons. If n = 1, then the formula is CH_4, and when n = 2 the formula is C_2H_6 etc.

Nomenclature of Alkanes

- Nomenclature is a naming system. Members that belong to a particular family have similar names.
- Alkanes are named by adding a suffix ***"-ane"*** to the common prefixes. The names of the first ten members of alkanes are:

Number of Carbons	**Common Prefix**	**Name of Alkane**
1	Meth-	Methane
2	Eth-	Ethane
3	Prop-	Propane
4	But-	Butane
5	Pent-	Pentane
6	Hex-	Hexane
7	Hept-	Heptane
8	Oct-	Octane
9	Non-	Nonane

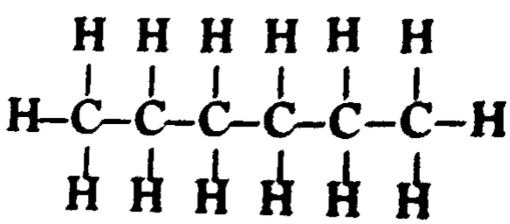
10	Dec-	Decane

For example, the chemical formula of butane will be:

$$\mathbf{C_n H_{2n+2} = C_4 H_{(2\times4)+2} = C_4 H_{8+2} = C_4 H_{10}}$$

Structural Formula and Skeletal formula

- *A structural formula* shows how the atoms are arranged and joined in a molecule.
- For example, Hexane



- *Skeletal formula* shows the carbon chains i.e. all hydrogens are removed.
- For example, Hexane

C – C – C – C – C – C

Condensed Formula: This formula shows both the carbon and hydrogen atoms and how many hydrogen atoms per each carbon atom.

For example, Hexane is $\mathbf{CH_3CH_2\ CH_2\ CH_2\ CH_2\ CH_3}$ or $\mathbf{CH_3\ (CH_2)_4\ CH_3}$

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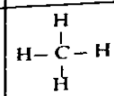
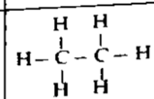
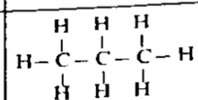
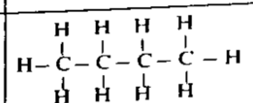
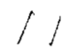
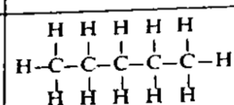
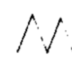
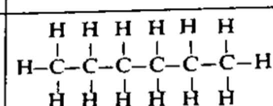
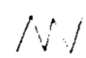
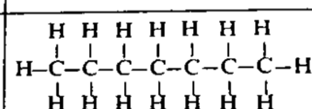
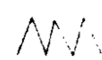
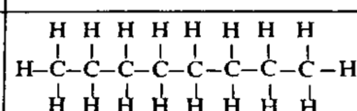
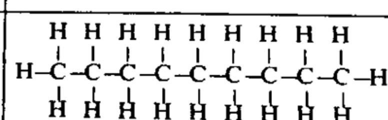
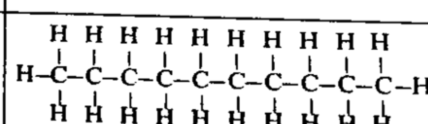
Table 4.3: Formu…

Number of carbon atoms	Name of alkane	Molecular formula	Structural formula	Condensed form of the structure	Skeletal formula
1	Methane	CH_4		CH_4	
2	Ethane	C_2H_6		CH_3CH_3	
3	Propane	C_3H_8		$CH_3CH_2CH_3$	
4	Butane	C_4H_{10}		$CH_3CH_2CH_2CH_3$	
5	Pentane	C_5H_{12}		$CH_3(CH_2)_3CH_3$	
6	Hexane	C_6H_{14}		$CH_3(CH_2)_4CH_3$	
7	Heptane	C_7H_{16}		$CH_3(CH_2)_5CH_3$	
8	Octane	C_8H_{18}		$CH_3(CH_2)_6CH_3$	
9	Nonane	C_9H_{20}		$CH_3(CH_2)_7CH_3$	
10	Decane	$C_{10}H_{22}$		$CH_3(CH_2)_8CH_3$	

Physical properties of Alkanes

- They are insoluble in water. They are hydrophobic (water-hating)
- At room temperature, alkenes with up to 4 carbon atoms are gases and those with 5 to 16 carbon atoms are liquids, and those with more than 16 carbon atoms are solids.
- Alkanes with larger molecules have higher melting and biling points because the longer the carbon chain the bigger the molecular and the greater the intermolecular forces (imf) and the more the heat required to weaken the force. Hence higher melting and boiling points.
- The bigger the molecule the greater the density.
- The larger the alkane, the more viscous it is. Viscosity is defined as the resistance of a liquid to flow.
- Alkanes do not conduct electricity. They are non-electrolyte.

Chemical properties of Alkanes

- They take part in combustion.
  For example: $CH_4\ (g) + 2O_2\ (g) \longrightarrow CO_2\ (g) + 2H_2O\ (l)$ + Heat Energy
- They take part in substitution reaction in which the hydrogen atoms can be substituted by another atom e.g. a halogen.
  Examples
  $CH_4\ (g) + Cl_2\ (g) \longrightarrow CH_3Cl + HCl$ [chloromethane]
  $CH_3Cl\ (g) + Cl_2\ (g) \longrightarrow CH_2Cl_2 + HCl$ [dichloromethane]
  $CH_2Cl_2 + Cl_2 \longrightarrow CHCl_3 + HCl$ [trichloromethane]
  $CHCl_3 + Cl_2 \longrightarrow CCl_4 + HCl$ [tetrachloromethane or Carbon tetrachloride]

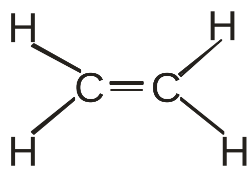
Uses of Alkanes

- For heating and cooking e.g. natural gas.
- Alkanes in form of bitumen, are used for surfacing the roads.
- They are used as fuels for vehicles, ships, geoplanes etc.
- They are also used to store the most the most reactive metals such as lithium, potassium etc.
- They are used as lubricating oil, where moving parts of a machine are lubricated to prevent rusting and reduce friction.

- They are used to produce other organic compounds such as alkenes.
- They are used as the solvent for other organic substances.

Alkenes

- Alkenes, unlike alkanes, are unsaturated compounds. The carbon atoms can accept more atoms. They also possess a *double bond* between a pair of carbon atoms.



- The double bond is called a *functional group*. A functional group is the group of atoms or bonds within a molecule that determines the properties of a compound.
- Alkenes are produced from alkanes through the process called *catalytic cracking*. This is the process where a long-chain alkane is split up, under high pressure and temperature and in the presence of aluminium and chromium as catalysts. For example,

$$C_{10}H_2 \xrightarrow[\text{Chromium oxides}]{\text{Aluminium}} C_5H_{12} + C_3H_6 + C_2H_4$$

- *Cracking* is subjecting larger hydrocarbon molecules to high pressure at high temperature to break them into smaller molecules in the presence of a catalyst.

$$\textbf{Pentane} \xrightarrow[\text{high pressure–high temperature}]{\text{catalyst}} \textbf{propane + ethene}$$

General formula of Alkenes

It **is C_nH_{2n}**, where *n* stands for the number of carbon atoms. The smallest alkene has 2 carbon atoms because of the double bond.

Nomenclature of Alkenes

The prefix is the same as those of alkanes. The suffix for alkenes is "-ene". The names of the first 9 alkenes are:

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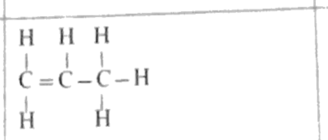
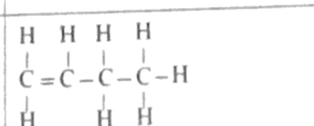
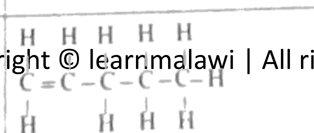
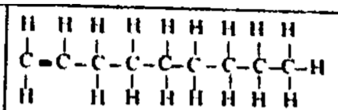
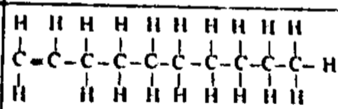
Number of Carbons	Common prefix	Name of Alkene
2	Eth-	Ethene (C_2H_4)
3	Pro-	Propene (C_3H_6)
4	But-	Butene (C_4H_8)
5	Pent-	Pentene (C_5H_{10})
6	Hex-	Hexene (C_6H_{12})
7	Hep-	Heptene (C_7H_{14})
8	Oct-	Octene (C_8H_{16})
9	Non-	Nonene (C_9H_{18})
10	Dec-	Decene ($C_{10}H_{20}$)

Number of carbon atoms (n)	Name	Molecular Formula C_nH_{2n}	Structural formula	Condensed formula of the structure	Skeletal formula
2	ethene	C_2H_4		$CH_2=CH_2$	
3	propene	C_3H_6		$CH_2=CHCH_3$	
4	butene	C_4H_8		$CH_2=CHCH_2CH_3$	
5	pentene	C_5H_{10}		$CH_2=CH(CH_2)_2CH_3$	
					

9	nonene	C_9H_{18}		$CH_2=CH(CH_2)_6CH_3$	
10	decene	$C_{10}H_{20}$		$CH_2=CH(CH_2)_7CH_3$	

The naming of alkenes follows the **IUPAC** system of naming where the position of the carbon-carbon bond is given.

a. $\underset{1}{C}-\underset{2}{C}=\underset{3}{C}-\underset{4}{C}-\underset{5}{C}$ Pent – 2 – ene or 2 – Pentene.

b. $\underset{7}{C}-\underset{6}{C}-\underset{5}{C}-\underset{4}{C}=\underset{3}{C}-\underset{2}{C}-\underset{1}{C}$ Hept – 3 – ene or 3 – Heptene.

The numbering of carbon atoms starts closer to the position of the double bond.

Physical Properties of Alkenes

- They are insoluble in water
- They exist in all states at room temperature
- Their melting and boiling points increase as the number of carbon atoms.
- The density of alkenes increases with increase in molecular size
- Viscosities follow the same trend as other organic compounds
- They do not conduct electricity

Chemical Properties of Alkenes

- They are more reactive than alkanes because of the presence of the double bond. They take part in combustion and addition reactions.

A) Combustion reaction

- They react with oxygen to produce CO_2, H_2O, and Heat Energy.
- For example: $C_2H_4\ (g) + 3O_2\ (g) \longrightarrow 2CO_2\ (g) + 2H_2O\ (l) + \text{Heat}$

B) Addition reaction

- In addition reactions, two or more molecules combine to form a larger molecule.

I. Addition of hydrogen (catalytic hydrogenation)
   - Ethene reacts with hydrogen in the presence of nickel catalyst to form ethane. A temperature of 150℃ is required.
   - For example: $CH_2 = CH_2 + H_2 \longrightarrow C_2H_6$ (ethane)

II. Halogenation reaction
   - Addition of halogens to ethane. Halogens readily add across a double bond of alkenes to form compounds called dihalides.
   - For example: $CH_2 = CH_2 + Br_2 \longrightarrow CH_2BrCH_2Br$ (bromoethene)

III. Hydration
   - Water is added to an alkene.
   - For example: $CH_2 = CH_2 + H_2O \longrightarrow C_2H_5OH$ (ethanol)

Uses of Alkenes

- Used to produce alkanols at industrial level; when they undergo process of hydration.

- Polymerisation alkenes are monomers. The monomer react to produce polymers e.g. in the formation of polythene (many ethane molecules).
- Some are used as plant hormones that regulate fruit ripening, flower maturity and seed germination e.g. ethane.
- Used in the production of halogen alkanes which are important industrial solvents.

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Chemistry form 2 Chapter 5

AIR

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CHAPTER FIVE: **Air**

- Air is composed of many kinds of gases. The gases are found in different percentages.

Component	**% by Volume**
Nitrogen	78.08
Oxygen	20.95
Argon	0.93
Carbon dioxide	0.03
Neon	0.002
Helium	0.0005
Methane	0.00017
Krypton	0.000114
Trace	0.000056

- In addition to these gases, air also contains water vapour, dust particles, smoke and ash.

Separation of components of Air

- Air is a mixture of gases. These are nitrogen, oxygen, carbon dioxide, noble gases, water vapour and dust particles.
- Fractional distillation is the best method used to obtain individual gases from air. This is possible because the gases have different boiling points. This means that the gases must condense first.

Gas	**Boiling Point C**

Xenon	-108
Krypton	-157
Oxygen	-183
Argon	-186
Nitrogen	-196
Neon	-246
Helium	-269

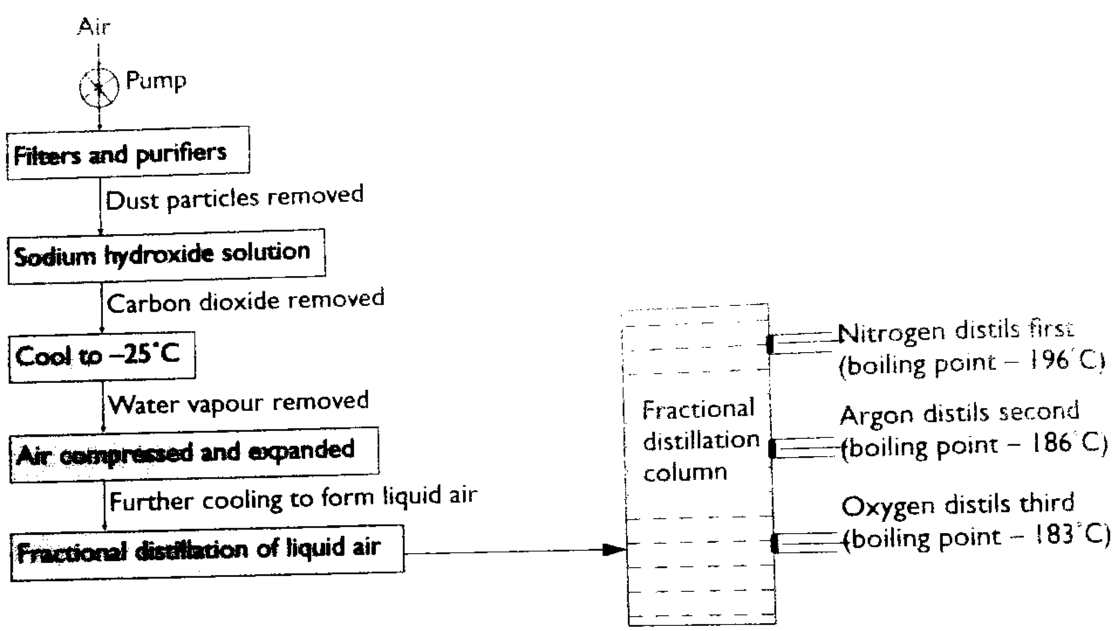

Fig. 5.1: Fractional distillation of liquid air

Properties and uses of Gases

a) Nitrogen gas

- Nitrogen is diatomic molecule where the two atoms are bonded by a triple bond [N≡N].
- The triple bond is very strong and cannot easily be broken. This property makes nitrogen to be a very unreactive gas.

Uses of Nitrogen Gas

- Food packaging: nitrogen prevents oil from reacting with oxygen and the food stays for a longer period.
- Fire extinguishing: Nitrogen stops oxygen from reaching the fire when it is spread onto the fire from the extinguisher.
- Freezing: Liquid nitrogen is used in refrigeration because at low temperature liquid N_2 can freeze foods quickly.
- Manufacturing of ammonia gas: This is done by the Haber process where nitrogen reacts with hydrogen.
- Preventing fires in oil tankers: When N_2 is put in fuel tankers it provides an inert atmosphere which prevents fires.

b) Oxygen

- This is a very reactive gas. It reacts with most compounds to form substances called Oxides. The reaction with oxygen is called a combustion reaction.
- Reaction of oxygen with metals
- This produces metal oxides.
- For example

$4Li\,(s) + O\,(g) \longrightarrow 2Li_2O$ (Lithium Oxides)

$Mg\,(s) + O_2\,(g) \longrightarrow MgO$ (magnesium oxide)

- The Reactivity series for oxygen

- This depends on the rate of reaction between oxygen and different metals. Some metals react quickly and others react slowly. For example:

K Na Ca Mg Al Zn Fe Sn Pb Cu Ag $\longrightarrow$

Decreasing reactivity

Test for reactivity

- The test for oxygen is that it can relight a burning splint.

Uses of oxygen

- For making oxides e.g. carbon dioxide.
- For combustion with fuels that provide energy for heating and driving vehicles.
- For welding. Oxygen can provide very high very high temperatures that can melt metals.
- For tissue respiration in living things.
- Used in iron blast furnaces.

c) Carbon dioxide

- Produced from the reaction between carbon and oxygen.
  $C\ (s) + O_2 \longrightarrow CO_2\ (g)$

Properties of CO_2

- An odourless and colourless gas.
- Not toxic gas.
- It is slightly soluble in water.
- It is denser than ordinary air.
- It is not for combustion.

Uses of CO_2

- Used in photosynthesis as a raw material.
- Put in fire extinguishers to fight fire.
- Put in fizzy drinks such as coke.

Test for Carbon dioxide gas

- It turns limewater milky.

Test for hydrogen gas

- It produces a pop sound once a burning splint is brought near.

d) Noble gases

- They are also called Inert gases. They are very unreactive gases because their outermost shells are full.

Properties of Noble gases

- They are all gases at room temperature (25^{o}C).
- They have very low melting and boiling points.

Air Pollution

- This means the introduction of undesirable elements into the atmosphere.
- These undesirable elements are called pollutants.

Sources of pollutants

- Burning fossil fuels. These produce CO_2, CO, SO_2, NO_2 and unburnt hydrocarbons which are not needed by living things.
- Motor vehicle exhausts gases. These include Nitrogen oxide (NO and NO_2) which are toxic gases.
- Ozone (O_3) produced from reaction between O_2 and O. It is very reactive but toxic to humans.
- Industrial chemicals processes. These may release SO_2 and ashes with soot which disturb the environment.
- Natural processes. Processes such as volcanic action, biological processes in the soil and water and lightning flashes releases such gases as CO, CO_2, CH_4 and other hydrocarbons which are dangerous.

Effects of Air pollutants on plants and animals

- ✓ Nitrogen oxides
- ✓ Inflammation of cells.
- ✓ Interference with O_2 transportation in the body as NO_2 is incorporated in the haemoglobin.
- ✓ Irritation of the lungs.
- ✓ Lowering of resistance of an individual to respiratory infections such as influenza.
- ✓ Particulates affect humans in that they get deposited into vital body organs and block their function.
- ✓ Sulphur dioxide causes irritation of the respiratory tract leading to high mucous secretion.
- ✓ Carbon monoxide is toxic if it is taken by haemoglobin instead of O_2.

Efforts to reduce atmospheric pollution

- Improved combustion of fuel in petrol and diesel engines.
- Introduction of better processing of fuels to make them free from sulphur compounds.
- Introduction of better and more efficient filter systems in industries.
- Introduction of smokeless solid fuels or fuels like hydrogen.

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Chemistry form 2 Chapter 6

soil

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CHAPTER SIX: **Soil**

- Soil is made up of soil particles, air, water, micro- and macro- organisms, and humans.
- Humus comes from dead remains of plant and animal matter and it is called Organic matter.
- Soil particles come from the process of weathering.

Chemical properties of Soil

Properties include soil pH cat ion exchange capacity (CEC), salinity and organic matter content.

1. Soil pH

- This measures the acidity or alkalinity of the soil.
- Knowledge of the soil pH determines the type of crops to be grown in a particular area.
- pH means power of hydrogen ions in a solution

Effects of soil pH

a. It affects the availability of plant nutrients. In acidic soils, mineral salts become soluble and are easily washed away.
b. Soil pH affects the availability of micro-organisms in the soil.

Factors that affect pH

- Application of acidifying fertilizers: phosphate and sulphate of ammonium add acid into the soil.
- Leaching: heavy rains cause Ca^{2+}, Na^{+}, Mg^{2+} and K^{+} to go down into the soil leaving the concentration of H^{+} to increase thereby making soil acidic.
- Parent material: sulphur parent material produces acidic soil. The acidity is caused by the H_2SO_4 (sulphuric acid) which is formed from sulphur. Limestone ($CaCOH_2$) releases alkaline soil.

- Drainage: sandy soils tend to have lower pH (acidic) while clay soils have higher pH (alkaline).

Importance of controlling soil acidity

- This is important because it creates a good environment for plant or crop production and availability of micro-organisms. Presence of micro-organisms improves aeration of the soil and they enrich the soil with their waste products.

2. Cation Exchange capacity (CEC)

- This is the ability of the soil to exchange ions at a given pH per unit weight. Sometimes ions are applied into the soil to take place of those present in it. A good example is the liming process. When liming, calcium oxide is applied to the acidic. Calcium ions replace the hydrogen ions in the acidic soil.

3. Soil Salinity

- This means the salt content of the soil.
- Salinity means the salt content of the soil. The accumulation of salts in the soil is called Soil Salination. Saline soil usually contains a lot of sulphate (NO_4^{2-}), nitrates (NO_3^-), carbonates (CO_3^{2-}) and chlorine (Cl^-).

Identification of saline soil

- Release of salty water from a borehole.
- Accumulation of white substances on the surface of the soil.
- Goats and cattle licking the soil.

Effects of saline soil

- It raises the pH of the soil (alkaline).

- Seed germination and plant growth usually fail because water is not available to plants and seeds due to high concentration of salts in the soils.
- It reduces the presence of moco-organisms in the soil.

4. Organic Matter

- This is the decaying plant and animal remains in the soil.

Importance of organic matter

- It binds soil particles together thereby improving drainage, aeration and reducing soil erosion.
- It improves soil structure and water holding capacity of the soil.
- It promotes the activity of the micro-organisms.

Soil Pollution

- Soil pollution is the introduction of substances that are harmful to the soil. It may be due to the human and industrial activities. Substances that encourage pollution are called pollutants.

Source of soil pollutants and degradation

The following are human activities which encourage soil pollution:

1) Poor farming methods; e.g. making ridges along the slope.
2) Application of inorganic fertilisers and pesticides. Inorganic fertilisers add acidity into the soil and some pesticides are non-biodegrable.
3) Car exhausts and industrial wastes such as CO_2, NO_2 and SO_2. When these dissolve in water they form acid rain which increases soil acidity.
4) The reactions are as follows:
   a. $CO_2\ (g) + H_2O\ (l) \longrightarrow H_2CO_3\ (aq)$ Carbonic acid
   b. $4NO_2\ (g) + 2H_2O\ (l) \longrightarrow 4HNO_2\ (aq)$ Nitric acid
   c. $SO_2\ (g) + H_2O\ (l) \longrightarrow H_2SO_4\ (aq)$ Sulphuric acid

5) Waste plastics and industrial effluent deposits. Waste plastic is non-biodegradable and remains in the soil for a long time while effluent kills marine organisms.
6) Lead compounds: these are released from exhaust pipes and when dumped into the soil, they kill soil organisms.

Prevention of soil pollution and degradation

- Several methods are used:
- Using electricity and solar power maintains soil cover.
- Using good farming methods or practices
- Afforestation and Re-afforestation.
- Recycling industrial and domestic wastes.
- Processing the wastes in fuels.
- Application of organic fertilisers like manure and animal dung.

Separation of Soil from water by Filtration

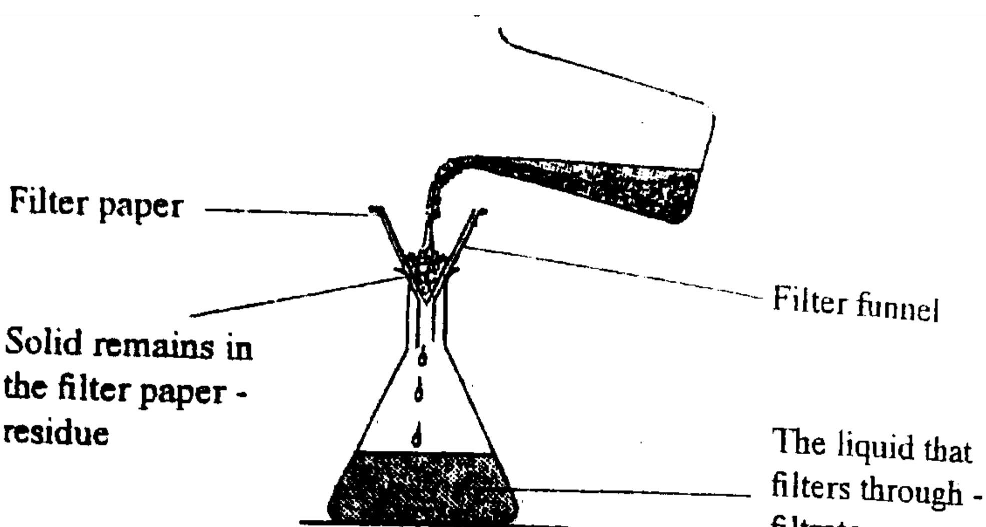

Fig. 3.34 Separation of soil from water by filtration

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