Revision Notes On Chemistry

- **Matter in Our Surrounding**
- **Is Matter Around Us Pure**
- **Atoms and Molecules**
- **Structure of Atom**

Matter in Our Surrounding

- Matter is anything that occupies space and has mass.
- Fundamental states of matter are-

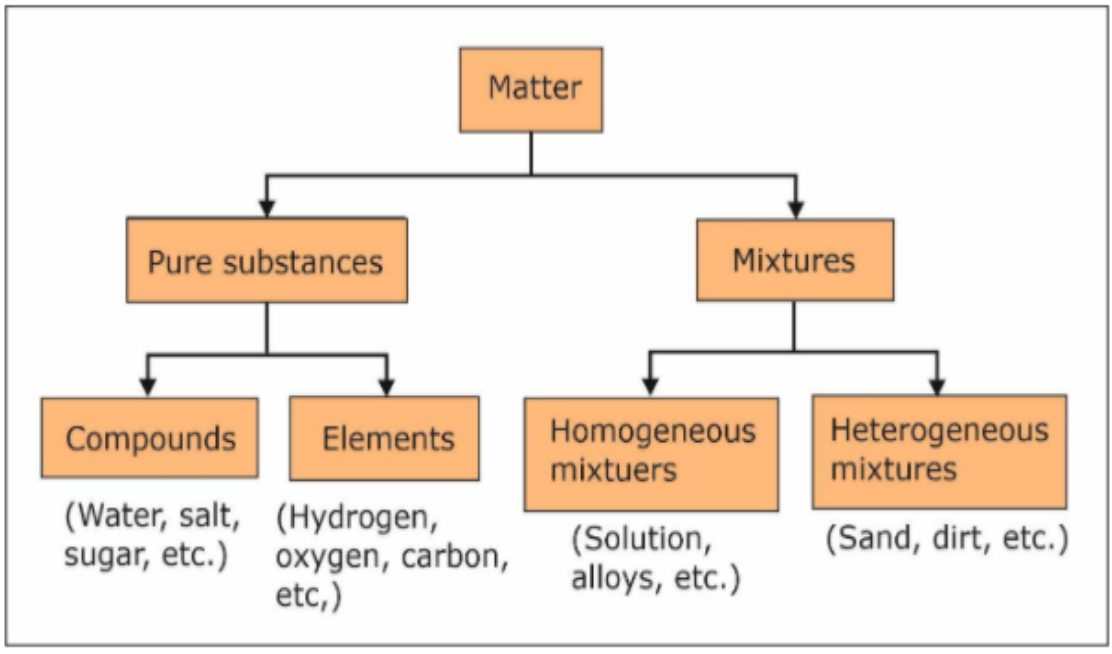
1. Solid
2. liquid
3. Gas
4. Plasma

PROPERTIES OF MATTER

The particle of matter also posses some characteristic features which are as follows-

1. Particles of Matter are very, very small.
2. Particles of Matter Have Space between them
3. Particles of Matter Are Continuously Moving
4. Particles of Matter Attract Each Other

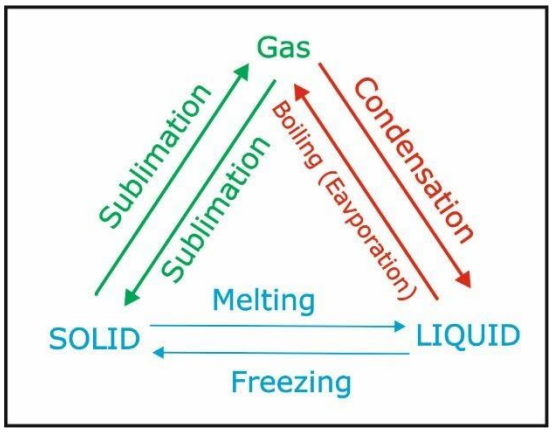
On the basis of chemical properties matter can be divided as follows-



PROPERTIES OF STATES OF MATTER ARE-

	Property	Solids	Liquids	Gases
1	**Shape**	Definite	Take the shape of the container, but do not necessarily occupy all of it.	Take the shape of the container by occupying the whole of the space available to them.
2	**Volume**	Definite	Definite	Take the volume of the container
3	**Compressibility**	Almost nil	Almost nil	Very large
4	**Fluidity or Rigidity**	Rigid	Fluid	Fluid
5	**Density**	Large	Large	Very small
6	**Diffusion**	Generally do not diffuse	Diffuse slowly	Diffuse rapidly

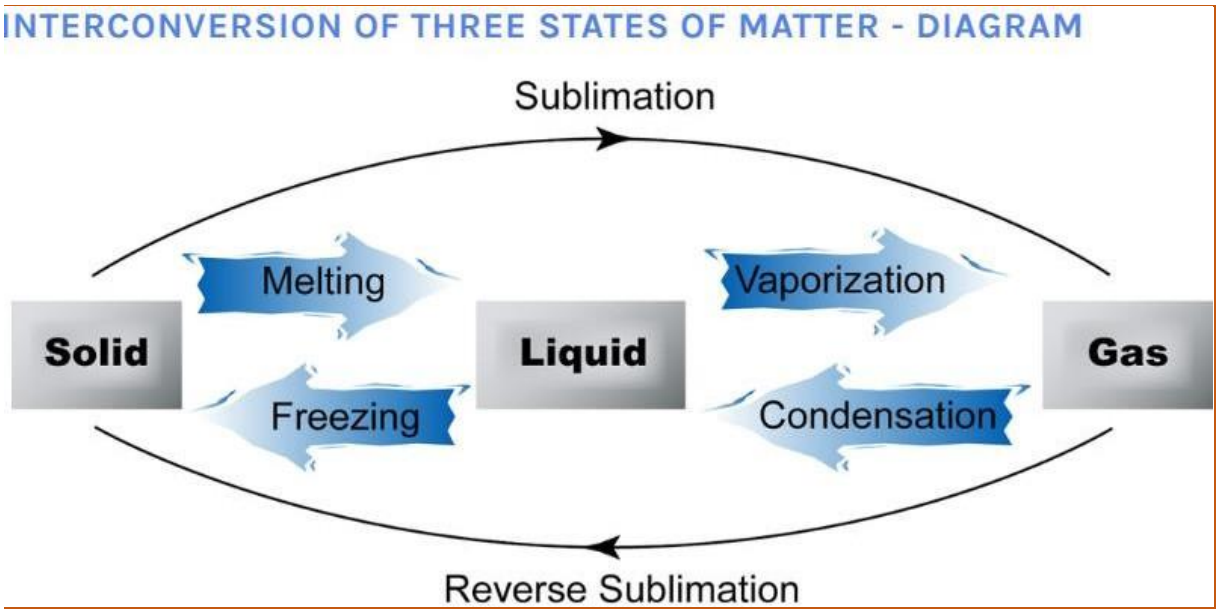
INTERCONVERSION OF STATE OF MATTER



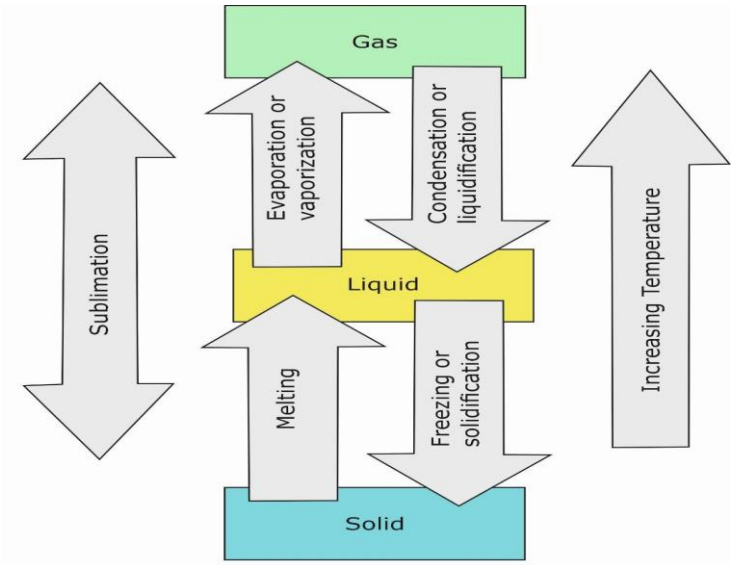
- Change from solid to liquid at a constant temperature is known as Melting. The temperature is known as melting point.
- Change from liquid to solid at a constant temperature is known as Freezing. The temperature is known as freezing point.
- Change from liquid to gas over a range of temperature is known as vaporization and the process is known as evaporation.

- Change from gas to liquid over a range of temperature is known as condensation.
- Change from liquid to gas at a constant temperature is known as boiling.
- Change from gas to liquid at a constant temperature is known as condensation.
- Change from solid to gas without going into the liquid state is known as sublimation
- Change from gas to solid without going into the liquid state is also known as sublimation.
- Latent heat- The heat energy which has to be supplied to change the state of a substance is called its latent heat.
- Latent heat is of two types-

LATENT HEAT OF FUSION: The heat required to convert a solid into the liquid state is called latent heat of fusion. In other word 'The latent heat of fusion of a solid is the quantity of heat in joules required to convert 1 kilogram of the solid to liquid, wit out any change in temperature.
Ex. The latent heat of fusion of ice = 3.34 × 105 J/kg
LATENT HEAT OF VAPORIZATION: The heat required to convert a liquid into the vapour state is called the latent heat of vaporization.



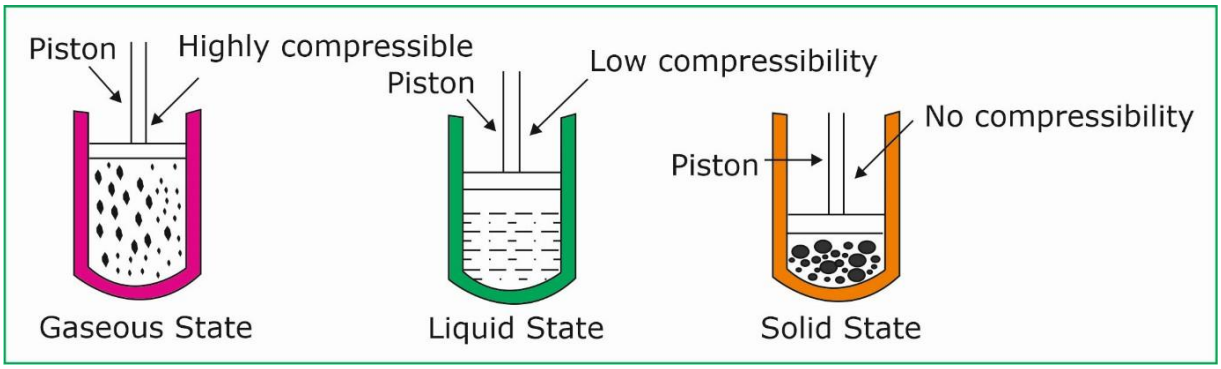
EFFECT OF TEMPERATURE



Effect of temperature on the physical state of a substance

EFFECT OF PRESSURE

- Solid: There is no effect of pressure on solids.
- Solids are non compressible, i.e. solids cannot be compressed as there is no space between their particles which could allow compression.
- When the pressure is increased on a solid, it is deformed and finally broken.
- Liquid: There is no effect on pressure on liquid.
- Liquids are non-compressible, i.e. liquids cannot be compressed since there is not enough space between their particles to get compressed.
- Gas: The volume of gas decreases with increase in pressure.



Is Matter Around Us Pure

MIXTURE

A mixture is a blend of two or more elements and / or compounds which are not chemically combined together.

TYPES OF MIXTURES

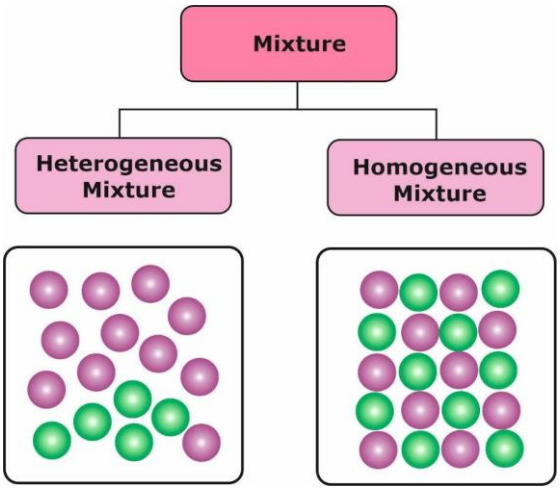
- Homogeneous Mixtures
- Heterogeneous Mixtures

HOMOGENEOUS MIXTURES

mixtures in which the components are completely mixed together and are indistinguishable from one another are called Homogeneous Mixtures.

HETEROGENEOUS MIXTURES

The components in a heterogeneous mixture do not completely dissolve in each other and we can separate them by physical means. In other words, the composition of such mixtures is not uniform.



DIFFERENCES BETWEEN HOMOGENEOUS AND HETEROGENEOUS MIXTURES

Homogeneous mixture	Heterogeneous mixture
They have uniform composition throughout the mixture.	They have composition which may vary from point to point.
The whole mixture is in the same phase.	Substances can be of two phases and layers may separate.
Components are not visible to the naked eye.	Components of the mixture can be seen easily.
Components cannot be separated easily.	Components can be separated easily.
Sugar and water →Sugar solution	Salt and sand

SOLUTIONS

A solution is a homogeneous mixture of two or more substances. The substances like salt, sugar, etc. which dissolve completely in water are said to be 'soluble' in water.

TYPES OF SOLUTIONS

- Liquid into liquid: Water and ink
- Solid into solid: Alloys
- Gas into gas: Air
- Solid into liquid: Sugar in water, tincture of iodine (dissolved iodine in alcohol)
- Gas into liquid: Soda water is a solution of carbon dioxide and water.

SOLVENT – The substance in which another substance is mixed is called the Solvent. For Example, Water is a solvent in which we can mix different substances such as salt or sugar.

SOLUTE – The substance that is added to the solvent to form a solution is called a Solute. For Example, Salt, when mixed in water, acts as a solute for the mixture.

SOLUBILITY- The maximum amount of a solute which can be dissolved in 100 grams of a solvent at a specified temperature is known as solubility of that solute in that solvent.

FACTORS AFFECTING SOLUBILITY-

- Temperature- The solubility of solids in liquids increases on increasing the temperature and decreases on decreasing the temperature.
- Pressure-
  - The solubility of solids in liquids remains unaffected by the changes in pressure.
  - The solubility of gases in liquid increases on increasing the pressure and decreases on decreasing the pressure.

SUSPENSION AND COILLOIDS

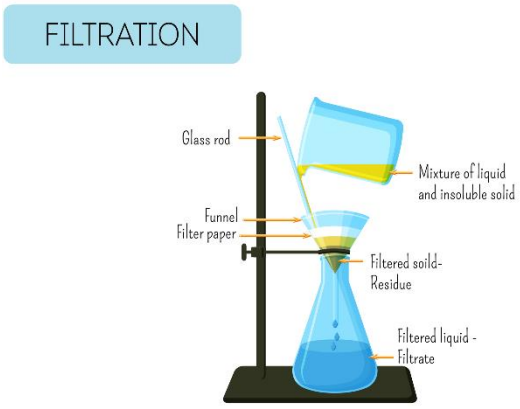
- Suspensions and colloids are heterogeneous mixtures.
- A suspension is a heterogeneous mixture in which the small particles are spread throughout the liquid without dissolving in it.
- For example- Muddy water, milk of magnesia.
- A colloid is a heterogeneous mixture of two substances in which minute particles of one substance are dispersed in another substance.

- For example- Soap solution, blood.
- Difference between Suspensions and colloids is listed as under-

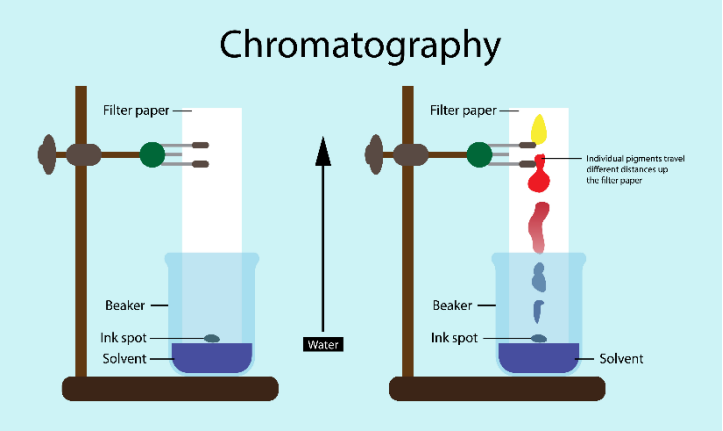
Suspension	Colloids
Heterogeneous solution	Homogeneous solution
Particle size is greater than 100nm in diameter.	Particle sizes range from 1 and 100nm in diameter.
Particles settle down.	Particles do not separate.
May scatter light.	Shows tyndall effect.
Opaque	Translucent
Easily visible through naked eye.	Not visible through naked eye.
Muddy water, flour in water	Milk, Ink

SEPARATING THE COMPONENTS OF A MIXTURE

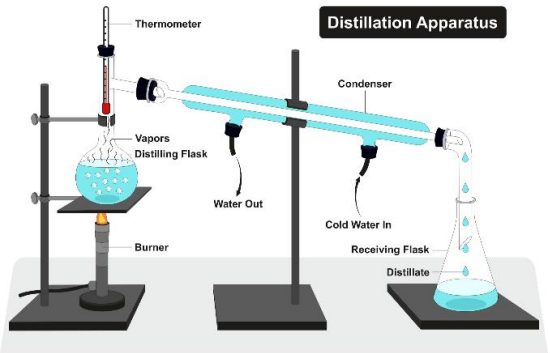
- **SEDIMENTATION AND DECANTATION-** Sedimentation is defined as the separation process in which solids are separated from the liquid. Decantation is the process of separation of liquid from solid and other immiscible (non-mixing) liquids, by removing the liquid layer at the top from the layer of solid or liquid below
- **FILTRATION-** It is the technique of removing insoluble solids from a liquid by using a filter paper. For example: Mixture of chalk and water is separated by filtration.

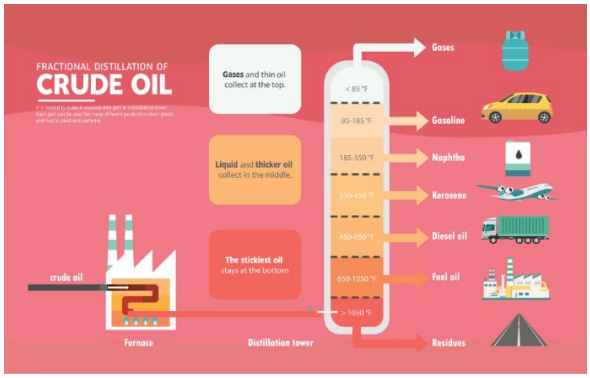


- **EVAPORATION-** It is the technique used to separate solid substance that has dissolved in water or any other liquid.
- **CHROMATOGRAPHY-** It is a technique of separating two or more dissolved solids present in a solution in very small quantities. This separation is based on the fact that though two or more substances are soluble in the same solvent but their solubilities may be different. There are many types of chromatography but paper chromatography is the simplest form. For example, Black ink is a mixture of several coloured substances which can be separated by paper chromatography.



- **CRYSTALLISATION-** The process of cooling a hot, concentrated solution of a substance to obtain crystal is called crystallisation. It is used for obtaining a pure solid substance from impure substance.
- **DISTILLATION AND FRACTIONAL DISTILLATION-** Distillation process involves heating a liquid to its boiling point such that the liquid passes into its vapour state. The vapours are condensed in a condenser and transformed into liquid form. The pure liquid is collected from the condenser in a receiver.
  Fractional distillation is done when the difference in boiling points of the components of miscible liquids is less than 25K.





- **CENTRIFUGATION-** It is a method for separating the suspended particles of a substance from a liquid in which the mixture is rotated at a high speed in a centrifuge.
- **SUBLIMATION-** Sublimation is the technique used to separate those substances which sublime on heating.
- **SEPARATING FUNNEL-** Separating funnel is used to separate a mixture of two immiscible liquids. This separation is based on the difference in the densities of immiscible liquids.

Atoms And Molecules

- **LAWS OF CHEMICAL COMBINATION-**

- **LAW OF CONSERVATION OF MASS-** According to the law of conservation of mass: Matter can neither be created nor destroyed in a chemical reaction. The substances which combine together in a chemical reaction are known as 'reactants' whereas the new substances formed as a result of chemical reaction are called 'products'. The law of conservation of mass means that in a chemical reaction, the total mass of products is equal to the total mass of reactants. There is no change in mass during a chemical reaction.
- **LAW OF CONSTANT PROPORTIONS-** This law was discovered by the french chemists, A. Lavoisier and Joseph Proust. A pure chemical compound always contains same elements combined together in same proportion by mass.

- **LIMITING REAGENT: -** In a reaction having more than one reactant we must identify the limiting reagent "Reagent which is finished early is known as limiting reagent ".

ATOMS

- An atom can be defined as the smallest constituent particle of an element which showcases independent existence. All the matter is made up of atoms. An atom is the smallest particle of an element that can take part in a chemical reaction. Atoms of most of the elements are very reactive and do not exist in the free state. They exist in combination with the atoms of the same element of another element.

MOLECULES

- A combination of atoms is called a molecule. The forces which hold the atoms together in a molecule are called covalent bonds.
- A molecule is the smallest particle of a substance which has the properties of that substance and can exist in the free state.
  For example- O_2, HCl

ELEMENTS

- Substances that is made of only one element and cannot be divided into simpler substances are called elements, such as hydrogen, carbon, oxygen, silver, gold, etc.

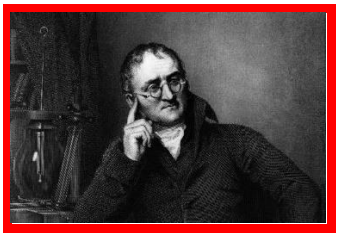
COMPOUNDS

- Substances that is made of one or more elements by chemical combination are called compounds, such as water, carbon dioxide, copper oxide, hydrochloric acid, etc.

DIFFERENCE BETWEEN ATOMS AND MOLECULES

	Atoms	Molecules
Definition	Most fundamental and smallest part that can exist of an element.	Two or more atoms chemically bonded together.
Example	Oxygen – O Phosphorus – P Sulphur – S Hydrogen – H	Oxygen – O_2 Phosphorus – P_4 Sulphur – S_8 Water – H_2O
Structure	Smallest particle with properties of an element.	Combination of two or more atoms.
Stability	An atom may not always be stable in nature due to the presence of electrons in the outer shells.	Molecules are formed to attain stability.
Constituents	Protons, Electrons & Neutrons	Two or more atoms of the same or different elements
Reactivity	Except for the noble elements, atoms of all elements showcase a certain level of reactivity.	Compared to a molecule, the level of reactivity is less as some of the valence points are filled by electrons of combined elements.

DALTON'S ATOMIC THEORY



Postulates of Dalton's atomic theory which he proposed in 1808 are-

- All the matter is made up of very small particles called "atoms".
- Atoms cannot be divided.
- Atoms can neither be created nor destroyed.

- Atoms are of various kinds. There are as many kinds of atoms as are elements.
- All the atoms of a given element are identical in every respect, having the same mass, size and chemical properties.
- Atoms of different elements differ in mass, size and chemical properties.
- Law of Chemical combination between two (or more) elements consists in the joining together of atoms of these elements to form molecules of compounds.
- The "number" and "kind" of atoms in a given compound is fixed.
- During chemical combination, atoms of different elements combine in small whole numbers to form compounds.
- Atoms of the same elements can combine in more than one ratio to form more than one compounds.

DRAWBACKS OF DALTON'S ATOMIC THEORY

- One of the major drawbacks of Dalton's atomic theory of matter is that atoms were thought to be indivisible (which cannot be divided). We now know that under special circumstances, atoms can be further divided into still smaller particles called electrons, protons and neutrons. So, atoms are themselves made up of three particles: electrons, protons and neutrons.
- Dalton's atomic theory says that all the atoms of an element have exactly the same mass. It is, however, now known that atoms of the same element can have slightly different masses.
- Dalton's atomic theory said that atoms of different elements have different masses. it is, however, now known that even atoms of different elements can have the same mass.
- It failed to explain how atoms of different elements differ from each other, i.e., it did not tell anything about internal structure of the atom.
- It could not explain how and why atoms of different elements combine with each other to form compound atoms or molecules.
- It failed to explain the nature of forces that hold together different atoms in a molecule.
- It did not make any distinction between ultimate particle of an element that takes part in reactions (atom) and ultimate particle that has independent existence (molecule).

RULE TO WRITE THE CHEMICAL SYMBOLS

- Dalton was the first scientist to use the symbols to represent elements in a short way.

Element	Dalton's symbol
Hydrogen	⊙
Carbon	●
Oxygen	○
Phosphorus	✇
Sulphur	⊕
Platinum	Ⓟ
Iron	Ⓘ
Copper	Ⓒ
Silver	Ⓢ
Gold	◍
Lead	Ⓛ
Mercury	✪

- Modern symbol of Elements- IUPAC (International Union of Pure and Applied Chemistry) approves names of elements. The symbols of elements are generally either the first letter or the first two letters or the first and the third letters of the name of the elements. The symbols of the following elements are the first letter of the name of that elements.

Element	Symbol
Hydrogen	H
Carbon	C
Nitrogen	N
Oxygen	O
Fluorine	F
Phosphorus	P
Sulphur	S
Iodine	I

ATOMICITY

- The number of atoms present in one molecule of an element is called its atomicity.
- Atomicity of some common elements are shown in the table below-

Type of element	Name	Symbol	Atomicity
Non-metal	Helium	He	Monoatomic
	Argon	Ar	Monoatomic
	Neon	Ne	Monoatomic
	Hydrogen	H_2	Diatomic
	Chlorine	Cl_2	Diatomic
	Nitrogen	N_2	Diatomic
	Oxygen	O_2	Diatomic
	Phosphorus	P_4	Tetratomic
	Sulphur	S_8	Polyatomic
Metals	Sodium	Na	Monoatomic
	Iron	Fe	Monoatomic
	Aluminium	Al	Monoatomic
	Copper	Cu	Monoatomic

WRITING THE CHEMICAL FORMULA OF THE COMPOUNDS

- Step-1: Write the symbols of formulae of the ions of the compound side by side with positive ion on the left-hand side and negative ion on right hand side.
- Step-2: Enclose the polyatomic ion in a bracket.
- Step-3: Write the valency of each ion below its symbol.
- Step-4: Reduce the valency numerals to a simple ratio by dividing with a common factor, if any.
- Step-5: Cross the valencies. Do not write the charges positive or negative of the ions.

MOLE CONCEPT

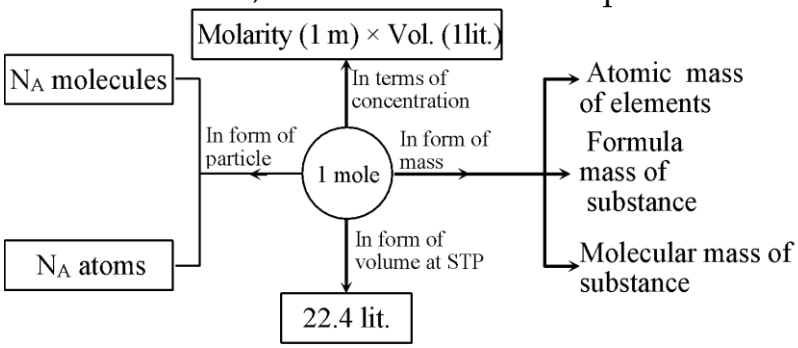
- Atoms and molecules are so smaller size that they cannot be counted individually. The chemists use the unit mole for counting atoms, molecules or ions. It is represented by n. A mole represents 6.022 × 1023 particles. This number is called Avogadro constant or Avogadro number. it is represented by N_A.
- 1 mole of atoms = 6.022×10^{23} atoms = Gram atomic mass or Molar mass of element
- Number of moles= $\frac{\text{Mass of element}}{\text{Molar mass}}$

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

- Number of moles= $\frac{\text{Given number of atoms}}{\text{Avogadro number}}$

  $n = \frac{N}{N_0}$

  No. of moles = n
  Given mass = m
  Molar mass = M
  Given number of particles = N
  Avogadro number of particles = N0
  These relations can be interchanged as
  Mass of element, m = n × M or No. of particles of element, N = n × N_0

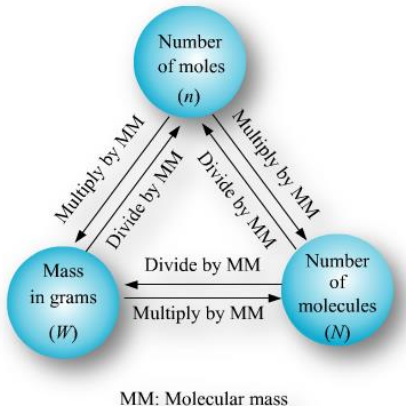


MOLAR MASS

- Molar mass: The mass of one mole of the substance is called its molar mass. Its units are g mol^{-1}. Thus, it can be equal to gram atomic mass or gram molecular mass or gram formula mass depending upon whether the substance is atomic, molecular or ionic.

MOLAR VOLUME

- The volume occupied by one mole of a gas under standard conditions of temperature and pressure (STP conditions, i.e., 25^0C and 1 atmosphere pressure) is called molar volume. It is equal to 22.4 liters.



- $\text{Vapour Density (V.D)} = \frac{\text{Mass of 'x' volume of a gas}}{\text{Mass of equal volume of hydrogen}}$

Sturcture of Atom

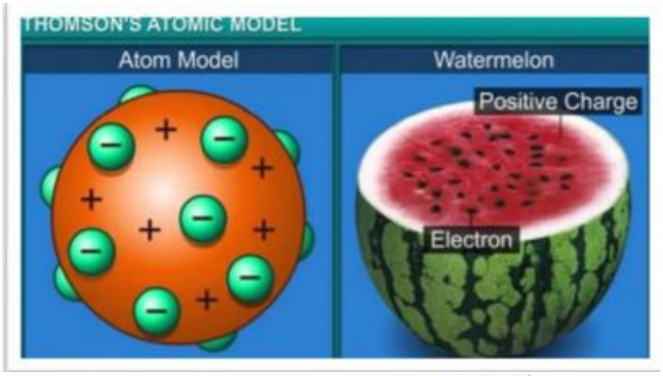
SUBATOMIC PARTICLE AND THEIR DISCOVERIES

- Fundamental subatomic particles are- electrons, protons and neutrons.
- Electron were discovered by J.J Thomson in Cathode Ray Experiment.
- Protons were discovered by Goldstein.
- Neutrons were discovered by Rutherford.
- The charge on the electrons or protons were found out to be 1.6×10^{-19} C.
- Mass of an electron is 9.1×10^{-31} kg or 9.1×10^{-27} g.
- Mass of a proton and neutron are almost the same and are taken as 1.67×10^{-27}kg or 1.66×10^{-24} g.

THOMSON MODEL OF ATOM

POSTULATES

- An atom is considered to be a sphere of uniform positive charge and electrons are embedded into it.
- The total positive charge is equal to the total negative charge so that an atom as a whole is electrically neutral.
- The mass of an atom is considered to be uniformly distributed.
- A watermelon is a common analogy of Thomson's atomic model where he considered:
  - Watermelon seeds embedded as negatively charged particles.
  - The red stuff of the watermelon as positively charged.



PLUM PUDDING MODEL

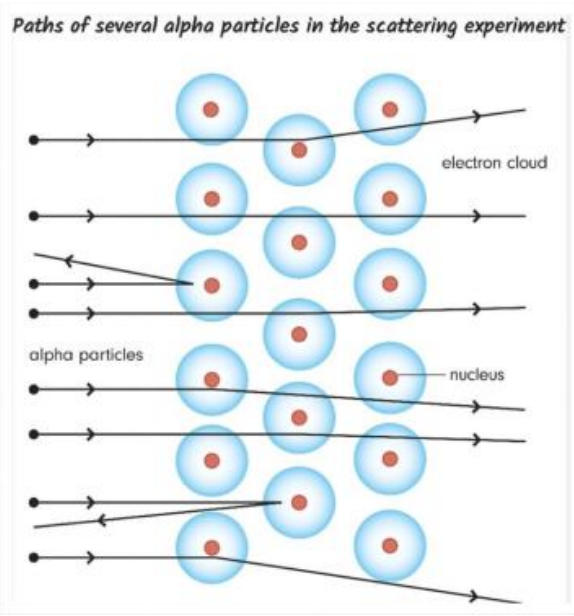
MERITS OF THOMSON MODEL OF ATOM-

- The model accounted for the electrically neutral nature of the atom. The model gave a clue that the mass of the atom is uniformly spread over the atom.

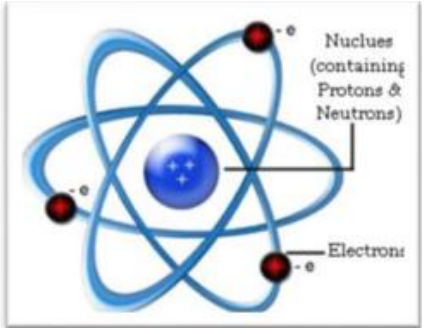
DRAWBACK OF THOMSON MODEL OF ATOM-

- The model was not satisfying because it was not useful in predicting and explaining the chemical properties of atoms.
- The model failed to explain how a positive charge holds the negatively charged electrons in an atom. Therefore, failed to explain the stability of atom.
- The model also failed to account for the position of the nucleus in an atom.
- Thomson's model of the atom had to be abandoned in 1911 when Ernest Rutherford performed the α- scattering experiments.

RUTHERFORD MODEL OF ATOM



- Most of the space in an atom is empty.
- Positive charge in an atom is not uniformly distributed and concentrated in a very small volume.
- The volume occupied by positive charge is very small as compared to the total volume occupied by an atom.
- The positively charged particles called protons and most of the mass was concentrated in a very small volume at the centre of the atom. This region of atom called as nucleus.



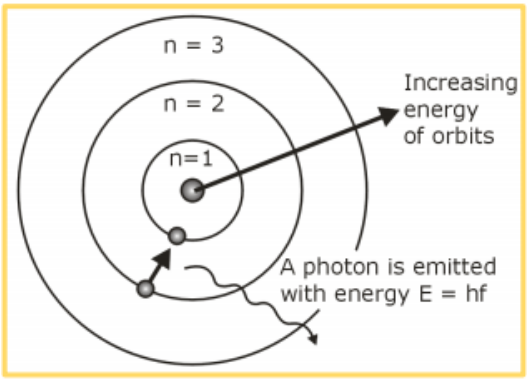
- The negatively charged particles called electrons are revolved around the nucleus in close circular orbits called orbits. Just as in the solar system, the sun is at the centre and the plants revolve around it.
- The atom is stable because the electrons and nucleus is held together by electrostatic force of attraction.

DEFECTS OF RUTHERFORD'S MODEL OF ATOM

- Rutherford proposed that the electrons revolve around the nucleus in paths called orbits. According to classic law of mechanics and electrodynamics, if an electrically charged particle is in motion, it emits electromagnetic radiations. Thus, an electron revolving around the nucleus should emit electromagnetic radiation, i.e. loses energy. As a result, it should be gradually pulled towards the nucleus and would end up with the collision. This would collapse of the atom. If it was so, the atom should be highly unstable. Thus, Rutherford model failed to explain the stability of an atom.
- Rutherford's atomic model did not mention anything about the arrangement of electrons in the orbit.

BOHR, MODEL OF ATOM

- In an atom, electrons (negatively charged) revolve around the positively charged nucleus in a definite circular path called as orbits or shells.
- Each orbit or shell has a fixed energy and these circular orbits are known as orbital shells.
- The energy levels are represented by an integer (n=1, 2, 3…) known as the quantum number. This range of quantum number starts from nucleus side with n=1 having the lowest energy level. The orbits n=1,2, 3, 4… are assigned as K, L, M, N…. shells and when an electron attains the lowest energy level it is said to be in the ground state.
- The electrons in an atom move from a lower energy level to a higher energy level by gaining the required energy and an electron moves from a higher energy level to lower energy level by losing energy.



LIMITATIONS OF BOHR MODEL OF ATOM

- It does not explain the spectra of atoms having more than one electron.
- Bohr's atomic model failed to account for the effect of magnetic field (Zeeman Effect) or electric field (Stark effect) on the spectra of atoms or

ions. It was observed that when the source of a spectrum is placed in a strong magnetic or electric field, each spectral line further splits into a number of lines. This observation could not be explained on the basis of Bohr's model.

RULES TO WRITE THE ELECTRONIC CONFIGURATION OF AN ELEMENT

- Maximum number of electrons in an orbit is calculated by $2n^2$, where 'n' is number of orbit and may be equal to 1, 2, 3, …..
- Electrons occupy the next orbit only after filling the inner orbit completely.
- Electronic configuration of some common elements are given as under-

ELEMENT	ELECTRONIC CONFIGURATION
H_1	1
He_2	2
Li_3	2, 1
Be_4	2,2
B_5	2,3
C_6	2,4
N_7	2,5
O_8	2,6
F_9	2,7
Ne_{10}	2,8

ATOMIC NUMBER AND MASS NUMBER

- Atomic number (Z) = Number of proton = Number of electron (in a neutral atom).
- Mass Number(A) = No. of protons + No. of neutrons
- Number of neutrons = A-Z

ISOTOPES, ISOBARS, ISOTONES AND ISOELECTRONIC SPECIES

- Atoms with the same atomic number but different mass numbers are called isotopes. For example - ^{12}C, ^{13}C and ^{14}C. Carbon-12 (^{12}C) has six protons and six neutrons, 13C has six protons and seven neutrons, and ^{14}C has six protons and eight neutrons.
- Isobars definition- Isobars are atoms of different elements that have the mass number (sum of protons and neutrons). For example- $^{54}Cr_{24}$ and $^{54}Fe_{26}$ Here, both chromium and iron have same mass number i.e., 54, sum of protons and neutrons) but contains different number of protons.

- Isotones are atoms of different elements that have the same number of neutron number but have different number of protons. For example- $^{36}S_{16}$, $^{37}Cl_{17}$, $^{38}Ar_{18}$, $^{39}K_{19}$ and $^{40}Ca_{20}$.
- Isoelectronic- Isoelectronic species refers to two atoms, ions or molecules that have the same electronic structure and the same number of valence electrons term means "equal electric" or "equal charge". Isoelectronic chemical species typically display similar chemical properties. Atoms or ions with the same electronic configurations are said to be isoelectronic to each other. For example-Examples of isoelectronic species with 10 electrons: N^{3-},O^{2-},F^{-}.

***