CHAPTER 1 : Matter in Our Surroundings

Key Points and Concepts

- Anything that occupies space and has mass is called matter.
- Matter is made up of small particles called atoms.
- **Characteristics of particles of matter:**
  - Particles of matter are very small in size.
  - Particles of matter have spaces between them.
  - Particles of matter are continuously in motion.
  - Particles of matter attract each other.
- **Matter exists in three states :** Solid, liquid and gas.
- **Comparison between properties of three states of matter :**

S.No.	Property	Solid	Liquid	Gas
(a)	Shape	Definite shape.	No definite shape, takes the shape of container.	No definite shape, takes the shape of container.
(b)	Volume	Definite volume.	Definite volume.	No definite volume.
(c)	Compressibility	Non-compressible.	Slightly compressible.	Highly compressible.
(d)	Diffusion	Can diffuse in liquids.	Can diffuse in liquids.	Can diffuse in other gases.
(e)	Fluidity or rigidity	Are rigid.	Show fluidity.	Show fluidity.
(f)	Density	High.	Moderate.	Low.
(g)	Movement of particles	Do not move freely.	Move freely but confined within a boundary.	Move freely.
(h)	Interparticle force of attraction	Very strong.	Less strong.	Weak attraction.

- Water can exist in three states of matter – Solid (as ice), Liquid (as water) and Gas (as water vapour).
- The changing of solid directly into vapours on heating and vapours into solid on cooling is called **sublimation**. *e.g.* Ammonium chloride, camphor and iodine.
- The process in which a solid changes to liquid state by absorbing heat at constant temperature is called **fusion**.
- The temperature at which a solid melts to become a liquid at the atmospheric pressure is called **melting point**. The melting point of ice is 273.16 K.
- Solid carbon dioxide is stored under high pressure. Solid gets converted directly to gaseous state on decrease of pressure to 1 atmosphere without coming into liquid state. This is the reason that solid carbon dioxide is also known as dry ice.
- Boiling is a bulk phenomenon. Particles from the bulk (whole) of the liquid change into vapour state.
- Evaporation is a surface phenomenon. Particles from the surface gain enough energy to overcome the forces of attraction present in the liquid and change into the vapour state.
- $\text{Humidity} \propto \frac{1}{\text{evaporation}}$
- Temperature $\propto$ evaporation
- Wind Speed $\propto$ evaporation

- **Latent heat of vaporisation** is the heat energy required to change 1 kg of a liquid to gas at atmospheric pressure at its boiling point.
- **Latent heat of fusion** is the amount of heat energy required to change 1 kg of solid into liquid at its melting point.
- Kelvin is the SI unit of temperature,

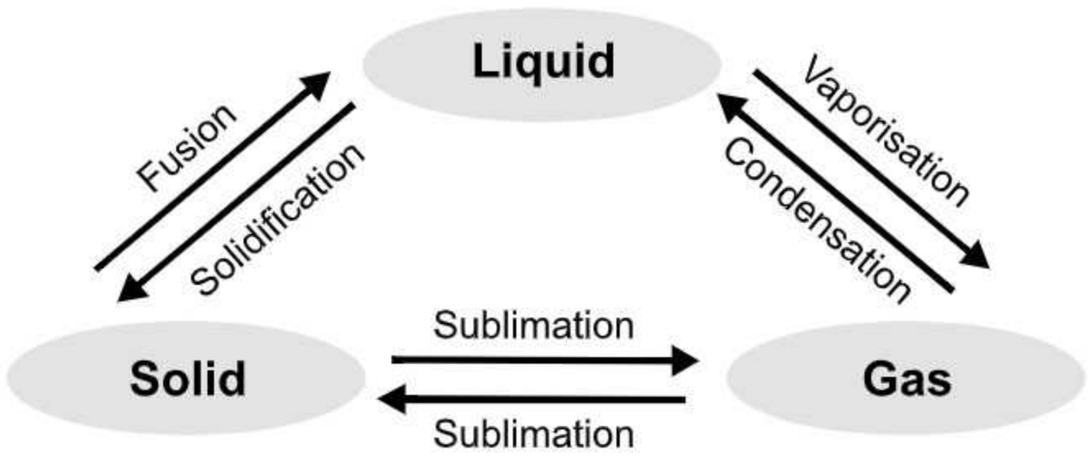
  $0°C = 273\ K$

  $T\ (K) = T°(C) + 273$
- Atmosphere (atm) is a unit of measuring pressure exerted by a gas.
- The SI unit of pressure is Pascal (Pa).
- **Quantities and Units**

Quantity	Unit	Symbol
Temperature	kelvin	K
Length	metre	m
Mass	kilogram	Kg
Weight	newton	N
Volume	cubic metre	m^3
Density	kilogram per cubic metre	$kg\ m^{-3}$
Pressure	pascal	Pa

Important Graphs and Diagrams

- **Inter-conversion of three states of matter :**



CHAPTER 2 : Is Matter Around Us Pure ?

Key Points and Concepts

- Pure substances can be elements or compounds.
- An element is a basic form of matter that cannot be broken down by physical or chemical methods into simpler substances.
- A compound is a substance composed of two or more types of elements, chemically combined in a fixed proportion.
- A mixture contains more than one substance (element and/or compound) mixed in any proportion.
- Alloys are mixtures of two or more metals or a metal and a non-metal and cannot be separated into their components by physical methods.
- An alloy is considered as a mixture because it shows the properties of its constituents and can have variable composition. For example, brass is a mixture of zinc and copper.

➢ **Difference between Mixtures and Compounds :**

S.No.	Mixtures	Compounds
1.	Two or more elements or compounds are mixed in any proportion.	Two or more elements combine and react in a fixed proportion.
2.	The new substance shows the properties of its constituents.	The new substance has totally different properties from its constituents.
3.	The composition of the new substance is variable.	The composition of the new substance is always fixed.
4.	The constituents of a mixture can be separated only by physical methods.	The constituents of a compound can be separated only by chemical reactions.
5.	The melting point and boiling point is not fixed.	The melting point and boiling point is fixed.

➢ **Difference between Homogeneous and Heterogeneous Mixture :**

S. No.	Homogeneous Mixture	Heterogeneous Mixture
1.	Uniform composition.	Non-uniform composition.
2.	No distinct boundaries of separation. *e.g.*, sugar + water.	Distinct boundaries of separation. *e.g.*, sand + water.

- A solution is a homogeneous mixture of two or more substances.
- A solution has a solvent and a solute as its components.
- The component of the solution that dissolves the other component in it (usually the component present in larger amount) is called the **solvent**. The component of the solution that is dissolved in the solvent (usually present in lesser quantity) is called the **solute**.
- The amount of the solute present in the saturated solution at this temperature is called its **solubility**.
- When further no more solute can be dissolved in a solution at a given temperature, it is called a **saturated solution**. If the amount of solute contained in a solution is less than the saturation level, it is called an **unsaturated solution**.
- Two methods to express concentration of solution:
  - Mass by mass percentage of a solution $= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$
  - Mass by volume percentage of a solution $= \frac{\text{Mass of solute}}{\text{Volume of solution}} \times 100$
- The component of colloid present in small amount is called **dispersed phase**. The medium in which colloidal particles disperse or suspend themselves is called **dispersion medium**.
- In a colloidal system, particles are always suspended and do not settle down. This constant colliding of the particles in continuous motion is called **Brownian movement**.
- Scattering of a beam of light when light is passed through a colloidal solution is called the **Tyndall effect**.

➢ **Types of solutions : On the basis of size of solute particles :**

S. No.	Solution	Colloids	Suspension
1.	A solution is a stable homogeneous mixture of solute and solvent.	A colloidal solution appears to be a homogeneous but actually it is a stable heterogeneous mixture of solute and solvent.	It is an unstable heterogeneous mixture.
2.	It is transparent.	It is translucent.	It is opaque.
3.	The solute particles are very small, *i.e.*, less than 1 nm.	The solute particles are between 1-100 nm.	The solute particles are quite large *i.e.* more than 100 nm.
4.	The particles are not visible even with a powerful microscope.	The particles are visible with the help of microscope.	The particles are visible with naked eye.
5.	The entire solution passes through filter paper as well as semi-permeable membrane.	The particles can pass through ordinary filter paper but not through a semi-permeable membrane.	The particles cannot pass through either a filter paper or through a semi-permeable membrane.
6.	The solute particles do not show Tyndall effect.	The particles show Tyndall effect.	The particles show Tyndall effect.
7.	The particles do not settle due to gravity. *e.g.*, salt in water solution.	The particles do not settle due to gravity. *e.g.*, blood.	The particles settle due to gravity. *e.g.*, chalk powder in water.

➢ **Separating techniques :**

1. **For heterogeneous mixtures:** Simple physical methods like -hand picking, sieving, and winnowing.
2. **Evaporation (To separate the volatile component (solvent) from its non-volatile solute) :** A mixture of salt and water or sugar and water.
3. **Centrifugation :** Butter from curd, fine mud particles suspended in water. **Principle:** The denser particles are forced to the bottom and the lighter particles stay at the top when spun rapidly.
4. **Decantation (Using separating funnel to separate two immiscible liquids) :** Oil from water. **Principle:** Immiscible liquids separate out in layers depending on their densities.
5. **Sublimation (For mixtures that contain a sublimable volatile component from a non-sublimable impurity) :** Camphor from salt. **Principle:** Solid changes directly into gaseous state on heating.
6. **Chromatography (For separation of those solutes that dissolve in the same solvent) :** Different pigments from an extract of flower petals. **Principle:** It is based on relative affinities of components towards stationary and mobile phases.
7. **Distillation and fractional distillation (To separate a mixture of miscible liquids) :** Separating components of petroleum. **Principle:** Difference in boiling point.
8. **Magnetic separation (To separate solids with magnetic properties from those with non-magnetic properties) :** Iron pins from sand.
9. **Crystallisation (To purify solids):** Salt from sea water. **Principle:** Difference in solubilities with increase in temperature.

➢ **Difference between Physical Change and Chemical Change :**

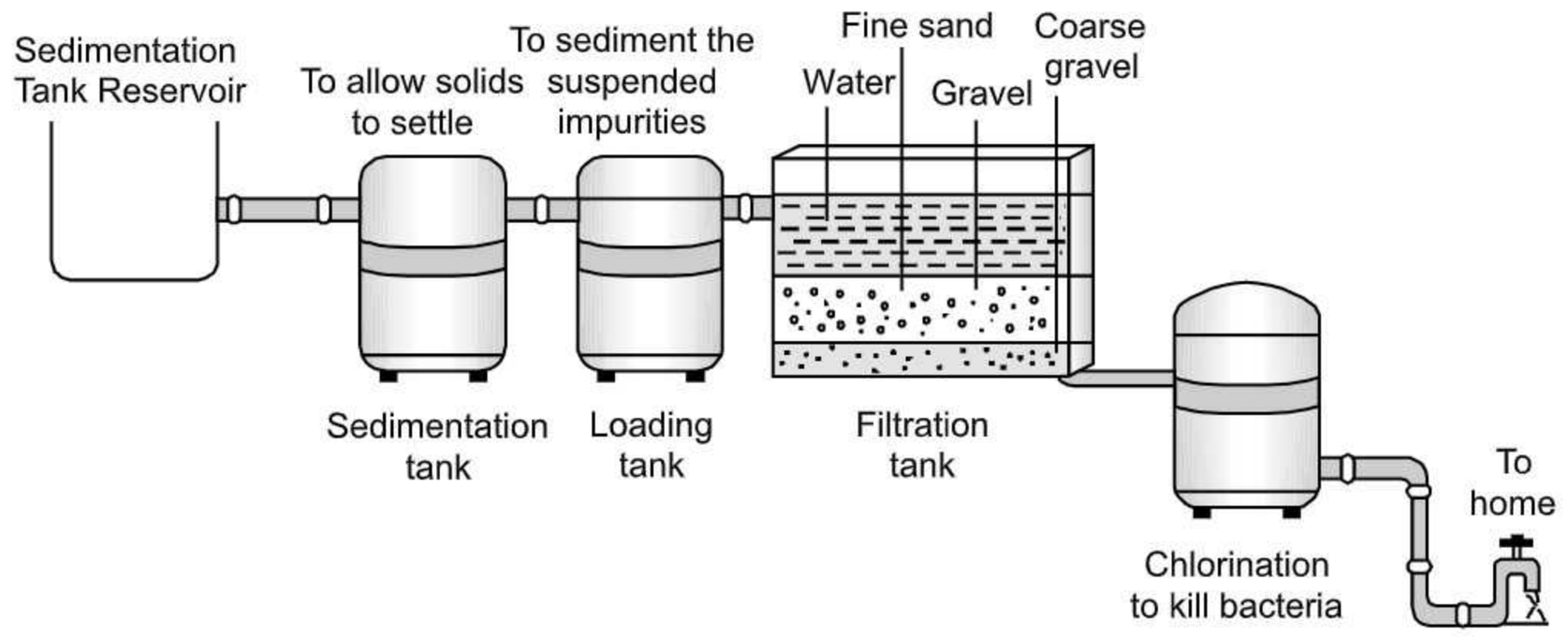
S. No.	Physical change	Chemical change
1.	These are reversible changes and their chemical composition do not change.	These are irreversible changes and the chemical composition also changes.
2.	No new substance is formed. *e.g.* Tearing of paper.	New substance is formed. *e.g.* Burning a match-stick.

Important Table

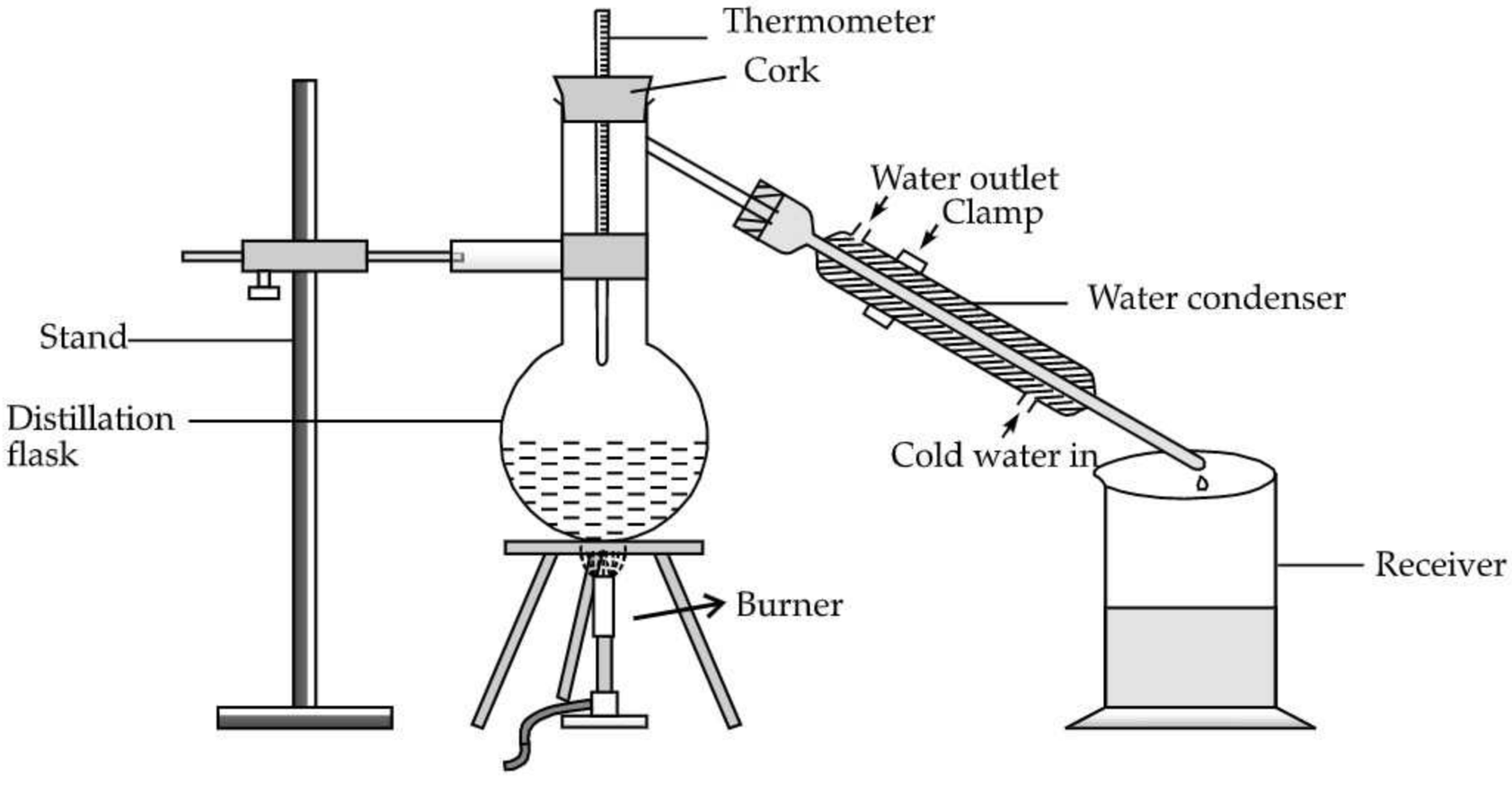
Dispersed phase	Dispersing medium	Type	Example
Liquid	Gas	Aerosol	Fog, clouds, mist
Solid	Gas	Aerosol	Smoke, automobile exhaust
Gas	Liquid	Foam	Shaving cream
Liquid	Liquid	Emulsion	Milk, face cream
Solid	Liquid	Sol	Milk of magnesia, mud
Gas	Solid	Foam	Foam, rubber, sponge, pumice
Liquid	Solid	Gel	Jelly, cheese, butter
Solid	Solid	Solid Sol	Coloured gemstone, milky glass

Important Diagrams

➢ How water purification works ?



➢ Fractional Distillation



➢ **Separation of Components of Air :**

Air

↓

Compress and cool by increasing pressure and decreasing temperature

↓

Liquid Air

↓

Allow to warm up slowly in fractional distillation column

↓

Gases get separated at different heights

↓

	Oxygen	**Argon**	**Nitrogen**
Boiling Point (°C)	–183	–186	–196
% Air by Volume	20.9	0.9	78.1

CHAPTER 3 : Atoms and Molecules

Key Points and Concepts

➢ **Laws of chemical combination :** They were given by Antoine L. Lavoisier.

(i) **Law of conservation of mass :** Mass can neither be created nor destroyed in a chemical reaction.

(ii) **Law of constant proportions or Law of definite proportions :** In a chemical substance, the elements are always present in definite proportions by mass.

➢ **The postulates of Dalton's theory are :**

(i) All matter is made of very tiny particles called atoms.

(ii) Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction.

(iii) Atoms of a given element are identical in mass and chemical properties.

(iv) Atoms of different elements have different masses and chemical properties.

(v) Atoms combine in the ratio of small whole numbers to form compounds.

(vi) The relative number and kinds of atoms are constant in a given compound.

➢ An atom is the smallest particle of an element which can take part in a chemical reaction. It may or may not exist freely. Each atom of an element shows all the properties of the element.

➢ IUPAC (International Union of Pure and Applied Chemistry) approves names of elements.

➢ The first letter of a symbol is always written as a capital letter (uppercase) and the second letter as a small letter (lowercase).

➢ **Molecule :** It is the smallest particle of matter (element or compound) which can exist in a free state. The properties of a substance are the properties of its molecules.

➢ **Atomicity :** It is the number of atoms constituting a molecule of a substance (element or compound).

- **Based upon atomicity, molecules can be classified as :**
  - Monoatomic molecules : *e.g.* He, Ne and Ar.
  - Diatomic molecules : *e.g.* H_2, O_2, N_2, HCl
  - Polyatomic molecules : *e.g.* O_3, CO_2, NO_2
- **Valency :** It is the combining capacity of an atom of the element.

- **Symbols of some elements :**

Element	Symbol	Atomic Number	Atomic Mass
Hydrogen	H	1	1
Boron	B	5	11
Carbon	C	6	12
Nitrogen	N	7	14
Oxygen	O	8	16
Sodium	Na	11	23
Magnesium	Mg	12	24
Phosphorus	P	15	31
Sulphur	S	16	32
Chlorine	Cl	17	35.5
Potassium	K	19	39
Calcium	Ca	20	40
Manganese	Mn	25	55
Iron	Fe	26	56
Cobalt	Co	27	59
Copper	Cu	29	63.5
Zinc	Zn	30	65
Molybdenum	Mo	42	96

- **Gram molecular mass :** It is the mass in grams of one mole of a molecular substance. *e.g.* : The molecular mass of N_2 is 28, so the gram molecular mass of N_2 is 28 g.
- **Atomic mass unit (amu) :** It is one twelfth of the mass of an unbound atom of carbon-12. It is a unit of mass used to express atomic masses and molecular masses.
- **Molecular mass :** It is a number equal to the sum of the atomic masses of the atoms in a molecule. The molecular mass gives the mass of a molecule relative to that of the C-12 atom, which is taken to have a mass of 12.
- The charged species are known as ions. A negatively charged ion is called an anion and the positively charged ion is called a cation.
- **Polyatomic ion :** A group of atoms carrying a charge is known as polyatomic ion. *e.g.* NH_4^+ (Ammonium ion).

➢ **Some Common Ions :**

Valency	Name of Ion	Symbol	Non-metallic element	Symbol	Polyatomic ions	Symbol
1	Sodium Potassium Silver Copper (I)*	Na^+ K^+ Ag^+ Cu^+	Hydrogen Hydride Chloride Bromide Iodide	H^+ H^- Cl^- Br^- I^-	Ammonium Hydroxide Nitrate Hydrogen–carbonate	NH_4^+ OH^- NO_3^- HCO_3^-
2	Magnesium Calcium Zinc Iron (II)* Copper (II)*	Mg^{2+} Ca^{2+} Zn^{2+} Fe^{2+} Cu^{2+}	Oxide Sulphide	O^{2-} S^{2-}	Carbonate Sulphite Sulphate	CO_3^{2-} SO_3^{2-} SO_4^{2-}
3	Aluminium Iron (III)*	Al^{3+} Fe^{3+}	Nitride	N^{3-}	Phosphate	PO_4^{3-}

➢ **Rules for writing a chemical formula:**

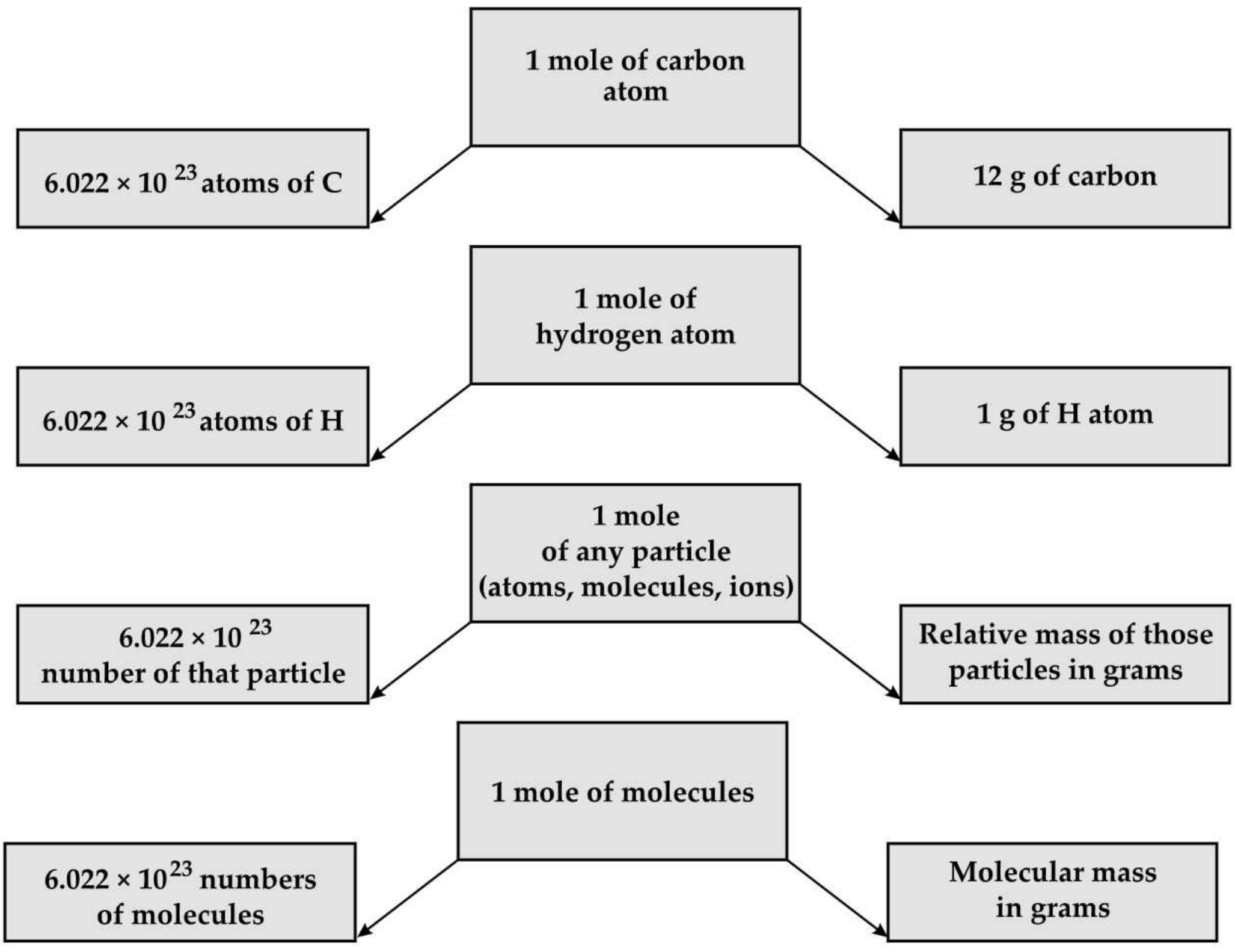
- The valencies or charges on the ion must balance.
- When a compound consists of a metal and a non-metal, the name or symbol of the metal is written first.
- In compounds formed with polyatomic ions, the ion is enclosed in a bracket before writing the number to indicate the ratio.

➢ **Some important formulae :**

Formula of hydrogen chloride : Symbol H Cl Valency 1 1 **Formula : HCl**	**Formula of hydrogen sulphide :** Symbol H S Valency 1 2 **Formula : H_2S**
Formula of carbon tetrachloride : Symbol C Cl Valency 4 1 **Formula : CCl_4**	**Formula of magnesium chloride :** Symbol Mg Cl Charge 2+ 1– **Formula : $MgCl_2$**
Formula of aluminium oxide : Symbol Al O Charge 3+ 2– **Formula : Al_2O_3**	**Formula of calcium oxide :** Symbol Ca O Charge 2+ 2– **Formula : CaO**

Formula of sodium nitrate : Symbol Na NO_3 Charge 1+ 1– **Formula : $NaNO_3$**	**Formula of calcium hydroxide :** Symbol Ca OH Charge 2+ 1– **Formula : $Ca(OH)_2$**
Formula of sodium carbonate : Symbol Na CO_3 Charge 1+ 2– **Formula : Na_2CO_3**	**Formula of ammonium sulphate :** Symbol NH_4 SO_4 Charge 1+ 2– **Formula : $(NH_4)_2SO_4$**

- **Formula unit mass:** Sum of the atomic masses of all atoms in a formula unit of a compound.
- **Avogadro constant,** (6.022×10^{23}) is defined as the number of atoms in exactly 12 g of carbon-12.
- One mole of any species (atoms, molecules, ions or particles) is that quantity in number having a mass equal to its atomic or molecular mass in grams.
- **Relationship between mole, Avogadro number and mass:**



- $$\text{Number of moles} = \frac{m}{M} = \frac{\text{Mass}}{\text{Molar mass}}$$
- $$\text{Number of moles} = \frac{N}{N_0} = \frac{\text{Given number of particles}}{\text{Avogadro number}}$$

CHAPTER 4 : Structure of Atoms

Key Points and Concepts

- **Canal rays :** Positively charged radiations discovered by Goldstein in a gas discharge tube at low pressure and high voltage.
- **J J Thomson Experiment :** He proposed that :
  - An atom is a uniform sphere of positive charges (due to presence of protons) as well as negative charges (due to presence of electrons) embedded in it
  - Atom as a whole is electrically neutral because the negative and positive charges are equal in magnitude.
- **Rutherford's Model of atom :** Rutherford took a thin gold foil and made fast moving alpha particles fall on it.

S.No.	Observation	Inference
1.	Most of the α- particles passed through the gold foil without getting deflected.	Most of the space inside the atom is empty.
2.	Very few particles were deflected.	Positive charge of the atom occupies very little space.
3.	A very few alpha particles, 1 in 12000 completely rebound on hitting the gold foil.	All the positive charge and mass of the gold atom were concentrated in a very small volume within the atom.

- **Rutherford's nuclear model of an atom :**

(i) There is a positively charged centre in an atom called the nucleus and the entire mass of atom resides in the nucleus.

(ii) Electrons revolve around the nucleus in well-defined circular orbits.

(iii) Size of the nucleus is very small as compared to the size of an atom.

- **Bohr's model of atom :** It states that
  - Only certain special orbits known as discrete orbits of electrons, are allowed inside the atom.
  - While revolving in discrete orbits, the electrons do not radiate energy.
- The orbits or shells in Bohr's model of atom are called energy levels.
- **Neutrons :** James Chadwick proved that the atomic nucleus contained a neutral particle, called neutrons. Neutrons had no charge and a mass nearly equal to that of a proton.
- Bohr and Bury suggested the distribution of electrons into different orbits of an atom.
- **Rules followed for writing the number of electrons in different energy levels or shells are :**
  - The maximum number of electrons present in a shell is given by the formula $2n^2$, where 'n' is the orbit number or energy level index, 1, 2, 3,…. Hence, the maximum number of electrons in different shells are as follows :
  - First orbit or K-shell will be $= 2 \times 1^2 = 2$,
  - Second orbit or L-shell will be $= 2 \times 2^2 = 8$, third orbit or M-shell will be $= 2 \times 3^2 = 18$, fourth orbit or N-shell will be $= 2 \times 4^2 = 32$, and so on.
  - The maximum number of electrons that can be accommodated in the outermost orbit is 8.
  - Electrons are not accommodated in a given shell, unless the inner shells are filled. That is, the shells are filled in a step-wise manner.
- **Atomic number :** Atomic number of an element is defined as the number of protons present in the nucleus.
- **Mass number :** It is defined as the sum of the number of protons and neutrons present in the nucleus of an atom.
- Mass Number = Mass of protons + Mass of neutrons

- In the notation for an atom, the atomic number, mass number and symbol of the element are written as :

  Mass Number

Symbol of element

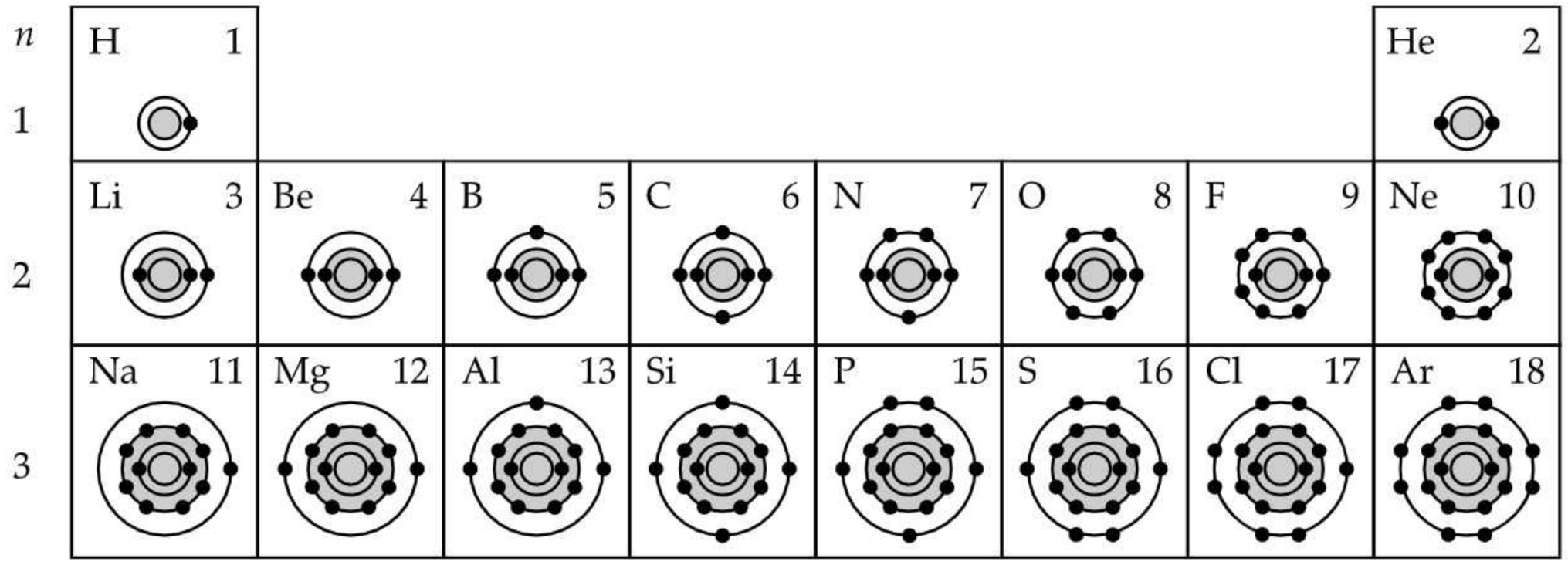
  Atomic Number

  or

  Mass Number / Atomic Number

- Valency is the combining capacity of an atom.

- **First 18 elements :**



- Isotopes are atoms of the same element, which have same atomic number but different mass numbers.

  (i) Carbon, $^{12}_{6}C$ and $^{14}_{6}C$,

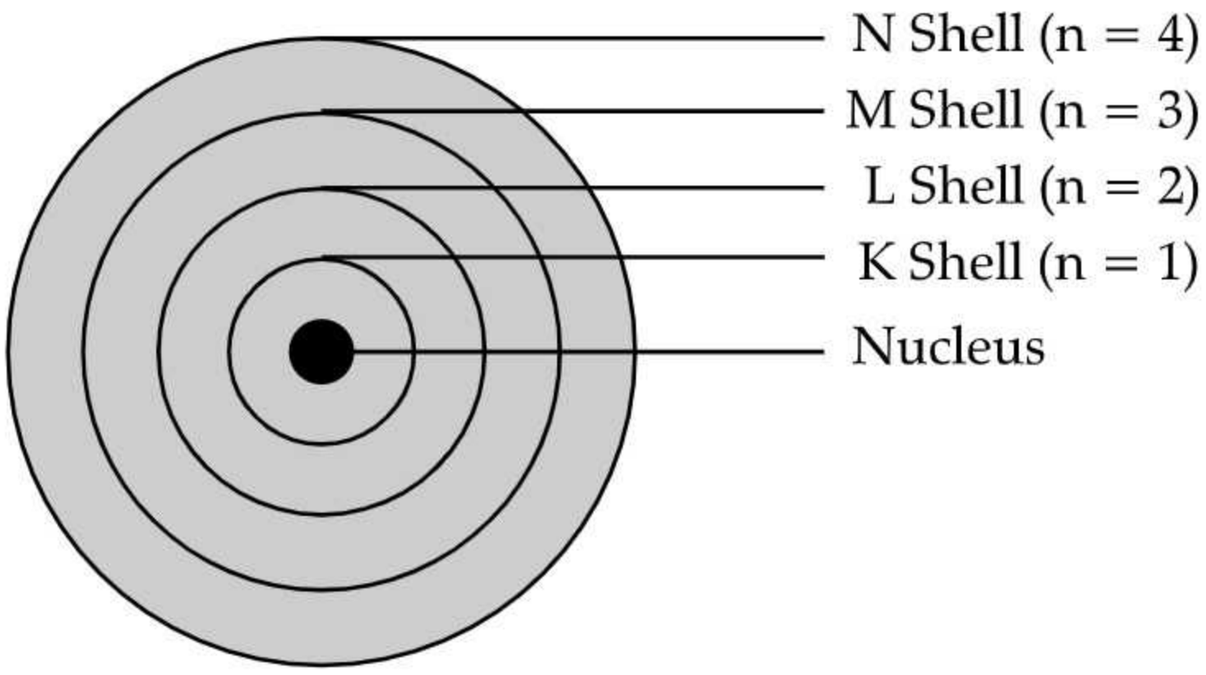
  (ii) Chlorine, $^{35}_{17}Cl$ and $^{37}_{17}Cl$, etc.

- Isobars are atoms having the same mass number but different atomic numbers.

  $^{76}_{32}Ge$ and $^{76}_{34}Se$ are isobars.

Important Graphs and Diagrams

- **Bohr's Model of an atom :**



- **Alpha particle scattering experiment by Rutherford :**