- **Metalloids or semi-metals:** They have intermediate properties between those of metals and non-metals.
- **Compound**: It is defined as a pure substance made up of two or more elements chemically combined in a fixed proportion by mass.
- **Mixtures:** A mixture contains two or more substances (elements or compounds) which are physically mixed in any proportion but not chemically combined.
- **Solution:** It is a homogeneous mixture of two or more substances. The major component of the solution is called the solvent and the minor component is called the solute.
- **Alloys:** They are homogeneous mixtures. They may also be regarded as solid in solid solution.
- **Concentration of a solution:** It is the amount of solute present per unit volume or per unit mass of the solution/ solvent.
- **Concentration of Solution:**

  1. Mass by mass percentage $= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$

  2. Mass by volume percentage $= \frac{\text{Mass of solute}}{\text{Volume of solution}} \times 100$

- **Saturated solution:** It is a solution which contains the maximum amount of the solute dissolved in a given quantity of the solvent at the given temperature and which cannot dissolve any more solute at that temperature.
- **Unsaturated solution:** It is a solution which can dissolve more amount of solute in it at the given temperature.
- **Supersaturated solustion:** It is a solution which temporarily contains more solute than the saturation level.
- **Suspension:** It is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium.
- **Colloids:** They are heterogenous mixtures in which the size of the particles lies in between those of true solutions and suspensions.

Example 1

A solution contains 60 g of common salt in 240 g of water. Calculate the concentration in terms of mass by mass percentage of solution.

Solution:

Step I: Concentration of solution

$$= \left(\frac{\text{Mass of solute}}{\text{Mass of solution}}\right) \times 100$$

Mass of common salt is 60 g.

Mass of water is 240 g.

Step II: Mass of solution = (60 + 240)g= 300 g.

Step III: Concentration of solution

$$= \left(\frac{60}{300}\right) \times 100 = 20\% \quad 2$$

CHAPTER-3

PARTICLE NATURE AND THEIR BASIC UNITS

Revision Notes

- **Laws of chemical combination :** There are two laws of chemical combination :
  - **(i) Law of conservation of mass :** Mass can neither be created nor be 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 a definite proportion by mass.
- **Postulates of Dalton's atomic theory :**
  - **(i)** Every matter is made up 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.

Atoms

- Atoms are building blocks of all matters.
- Atomic radius is measured in nanometers (1 m = 10^9 nm).

Elements and their naming

- Each element has a unique name and a unique symbol.
- IUPAC (International Union of Pure and Applied Chemistry) approves names of the elements.
- **Rules for assigning symbols for atoms of various elements are as follows :**

(i) The abbreviation used to represent an element is generally the first letter of the element's name in English.

English name of element	Symbol
Hydrogen	H
Boron	B
Oxygen	O
Nitrogen	N
Fluorine	F

(ii) When the names of two or more elements begins with the same initial letter, the initial letter is followed by the letter appearing later in the name :

Name of element	Symbol
Barium	Ba
Bismuth	Bi
Bromine	Br
Silicon	Si
Cadmium, Calcium	Cd, Ca

(iii) Symbols of some elements are derived from their Latin / German or Greek names :

Name of element	Latin/German/Greek name	Symbol
Sodium	Natrium	Na
Potassium	Kalium	K
Copper	Cuprum	Cu
Iron	Ferrum	Fe
Gold	Aurum	Au
Silver	Argentum	Ag

- **One atomic mass unit** is a mass unit exactly equal to $1/12^{th}$ the mass of one C-12 atom.
- Atoms of most elements are not able to exist independently. Atoms form molecules and ions.

Molecules

- Molecules of an element are formed by the atoms of the same type.
- Atoms of same or different elements join together in definite proportions to form molecules of compounds.
- The number of atoms constituting a molecule is known as its **atomicity**.

Ions

- An ion is a charged particle and can be negatively or positively charged.
- Ions may consist of a single charged atom or a group of atoms that have a net charge on them.
- Ionic compounds contain charged species called ions as their smallest unit.
- A group of atoms carrying a fixed charge on them are called polyatomic ions or radicals.
- The chemical formula of a compound is a symbolic representation of its composition.

Valency

- Valency is the combining capacity of an element.
- Valency can be used to find out how the atom(s) of an element will combine with the atom(s) of another element to form a chemical compound.
- **Names and symbols of some ions :**

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

* Some elements show variable valency which is represented by a roman numerical brackets.

- **Rules for writing the formula of a compound :**
  - **(i)** Formula of compound is given by writing side by side the symbols of constituent elements.
  - **(ii)** Symbol of the more metallic element is written first in the formula.
  - **(iii)** Number of atoms of each of the constituent element present in the molecule is indicated by subscript.
  - **(iv)** When either of the ions or both the ions are polyatomic and their valency is more than one, we enclose the polyatomic ions in brackets. No brackets are necessary if the valency(ies) of polyatomic ion (s) is (are) 1.
  - **(v)** While writing the formula of a compound if the valency numbers have a Highest Common Factor (H.C.F), divide the valency numbers by H.C.F so as to get the simplest ratio between the combining elements.
- The charges or valencies on the ion must be balanced.
- Formula of a binary compound is written by criss-crossing the valencies of elements present in a molecule of the compound.
- A chemical compound is always electrically neutral; hence the positive and negative valencies or charges of the ions in the compound must add upto zero.
- Scientists use the relative mass scale to compare the masses of different atoms of elements.
- Atoms of C-12 isotopes are assigned a relative atomic mass of 12 and the relative masses of all other atoms are obtained in comparison with the mass of a C-12 atom.
- Relative mass of a molecule is expressed in atomic mass unit (u).
- Atoms of different elements are of different sizes and masses.

Key Words

- **Atom :** Smallest particle of an element that shows all the properties of an element.
- **Atomic number :** Number of protons in an atom of an element.
- **Molecule :** Smallest particle of an element/compound that is capable of an independent existence and shows all the properties of that substance.
- **Anion :** Negatively charged ion.
- **Cation :** Positively charged ion.
- **Atomicity :** Number of atoms present in one molecule of an element.
- **Radical :** An atom or a group of atoms carrying positive or negative charge that behaves as a single unit in a chemical reaction.
- **Mole :** Amount of substance that contains the same number of units as there are atoms in exactly 12 g of carbon-12 isotope.
- **Chemical formula :** Expression of the composition of a substance by chemical symbols and numerical subscript.
- **Diatomic :** A molecule which contains two atoms.
- **Triatomic :** A molecule which contains three atoms.
- **Polyatomic :** A molecule which contains more atoms.
- **Valency :** Measure of combining capacity of an element with other atoms when it forms compounds or molecules.
- **Binary compound :** Simplest compounds made up of two different elements. e.g., HCl, H_2O.
- **Gram atomic mass :** Atomic mass of an element expressed in terms of grams.

- **Molecular mass :** Sum of the atomic masses of all the atoms in a molecule of the substance.
- **Formula unit mass :** Sum of the atomic masses of all the atoms in a formula unit of a compound.

Example 1

(a) A sample of vitamin C is known to contain 2.58×10^{24} oxygen atoms. How many moles of oxygen atoms are present in the sample ?

(b) Write one word for the following :

(i) In a balanced chemical equation, the sum of the masses of reactants and products remains unchanged.

(ii) A group of atoms carrying a fixed charge on them.

(c) Write chemical formulae of the following compounds :

(i) Sodium phosphate

(ii) Ammonium carbonate

Solution:

Step I: (a) Number of moles

$$= \frac{\text{Given no. of particles}}{\text{Avogadro number}}$$

$$= \frac{2.58 \times 10^{24}}{6.022 \times 10^{23}}$$

$$= 0.4284 \times 10$$

$$= 4.284 \text{ moles}$$

Step II: (b) (i) Law of conservation of mass.

(ii) Polyatomic Ion

Step III: (c) (i) Na_3PO_4

(ii) $(NH_4)_2CO_3$

(1 + 2 + 2 = 5)

CHAPTER-4

STRUCTURE OF ATOM

Revision Notes

- An atom is divisible and consists of charged particles.
- Ionization of gases in the discharge tube proved that atoms have sub-atomic particles.
- **Summary of characteristics of electrons, protons and neutrons:**

Characteristics	Electron	Proton	Neutron
Symbol	e	p	n
Relative charge	– 1	+ 1	0
Nature	Negatively charged	Positively charged	Neutral
Discovered by	J. J. Thomson	E. Goldstein	James Chadwick
Mass	1/2000 times mass of hydrogen atom	1 unit	Mass is nearly equal to that of proton

- **Thomson's model of atom:**

(i) An atom is a uniform sphere of positive charges (due to the presence of protons) as well as negative charges (due to the presence of electrons) which are embedded in it. This model is often called the 'Water Melon Model'.

(ii) An atom, as a whole, is electrically neutral because the negative and positive charges are equal in magnitude.

- **Limitations of Thomson's model of atom:** The model failed to explain how protons and electrons could be arranged in an atom so close to each other.
- α-particles are charged particles having two units of positive charge and four units of mass, i.e., they are double-charged helium ions (He^{2+}).
- **Observations predicted from α-particle scattering experiment by Rutherford based on Thomson's model of atom are:**