

Chapter: I

Fundamentals Of Chemistry (Mureed Abbas)

Chemistry: A branch of science, which deals with the composition, properties, chemical changes in a matter and those laws which govern these changes.

Branches of Chemistry

Following are the main branches of chemistry (eight).

- (1) **Organic Chemistry:** It is the study of organic compounds (carbon containing compounds). But some compounds such as CO_2 , CO , HCO_3^- , CO_3^{2-} are not included in organic.
- (2) **Inorganic Chemistry:** It deals with elements and compounds except organic compounds.
- (3) **Biochemistry** (Bio = life/living things), It deals with chemical changes that occur in living things.
- (4) **Physical Chemistry:** It deals with the laws and theories for understanding structure of matter.
- (5) **Industrial Chemistry:** It deals with methods and use of technology in the large scale production of useful things.
- (6) **Nuclear Chemistry:** It deals with changes that occur in the atomic nuclei.
- (7) **Analytical Chemistry:** It deals with methods and instruments to determine the composition of matter.

Matter: Anything that occupies space and has mass.

Substance: Any matter that has a particular set of characteristics that differ from the characteristics of another kind of matter.

Examples: Iron, water, Carbon dioxide, glucose.

Element: An element is a substance whose all the atoms have the same atomic number.

Examples: Oxygen, Hydrogen, Iron, Copper etc are elements.

Compound: A compound is a pure substance that consists of two or more elements held together in fixed proportions by natural forces (chemical bonds).

Examples: water, carbon dioxide, Sodium chloride are all compounds.

Mixture: An impure substance that contains two or more pure substances that retain their individual chemical characteristics is called a mixture.

Examples: 1) Air

2) Table salt in sand

3) Water containing dissolved oxygen.

Types of Mixture: There are two types of mixture

(1) **Homogeneous mixture:** A mixture consists of only one phase is called homogeneous mixture.

Examples: Sugar mixed in water, salt dissolved in water.

What is an ION?

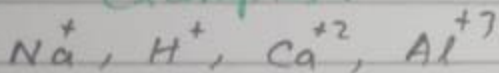
" Ion is a charged specie formed from an atom or chemically bonded groups of atoms by adding or removing electrons."

Types of ION?

Cations

- (i) These are positively charged
- (ii) Metal atoms lose one or more electrons and form cation.

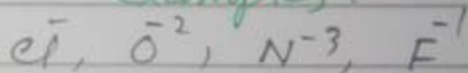
Examples:



Anions

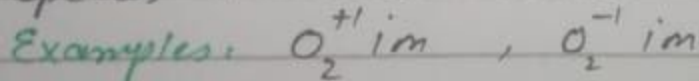
- (i) These are negatively charged.
- (ii) Non-metal atoms gain one or more electrons and form anion.

Examples:



What is a molecular ion?

" When a molecule loses or gain electrons, the resulting species is called molecular ion."



Free Radical?

" A free radical is an atom which has an unpaired electron and bears no electrical charge."

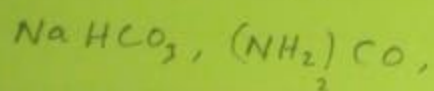
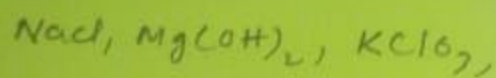


Formula Mass?

"The sum of the atomic masses of all the atoms in the formula unit of a substance is called formula mass."

Examples: Following are main examples.

Examples of formula units



$$\text{(i) NaCl} = (1 \times \text{atomic mass of Na} + 1 \times \text{atomic mass of Cl})$$

$$= (1 \times 23 + 1 \times 35.5)$$

$$= 23 + 35.5$$

$$= 58.5 \text{ amu}$$

$$\text{(ii) Mg(OH)}_2 = (24 + 16 \times 2 + 1 \times 2)$$

$$= 24 + 32 + 2$$

$$= 58 \text{ amu}$$

*

Note: The term formula mass is used for ionic compounds. An ionic compound is represented by formula unit. A formula unit represents simplest ratio b/w cations and anions in an ionic compound.

Molecular Mass?

"It is the sum of atomic masses of all the atoms present in the molecule."

Examples:

$$\text{(i) H}_2\text{O} : (2 \times 1) + 16$$

$$= 18 \text{ amu}$$

$$\text{(ii) C}_6\text{H}_6 : (6 \times 12) + (6 \times 1)$$

$$= 72 + 6$$

$$= 78 \text{ amu}$$

(8) **Environmental Chemistry**: It deals with toxic materials that pollute the environment and their adverse effects on human beings.

Chemical Formula

It is the symbolic representation of elements present in a compound.

Types of Chemical Formula

There are two main types of chemical formula.

(1) **Molecular Formula**: It tells about the actual number of atoms present in a compound.

Examples: Glucose $C_6H_{12}O_6$

Hydrogen Peroxide H_2O_2

Benzene C_6H_6

Sucrose $C_{12}H_{22}O_{11}$

(2) **Empirical Formula**: It tells about the simplest ratio of atoms in a compound.

Examples: Glucose CH_2O

Hydrogen peroxide HO

Benzene CH

Sucrose $C_{12}H_{22}O_{11}$

Note: Many compounds have same empirical as well as molecular formula.

Examples: Sucrose $C_{12}H_{22}O_{11}$

Carbon dioxide CO_2

Water H_2O

Ammonia NH_3

Relative Atomic Mass: The mass of an atom of an element relative to the mass of an atom of C-12 is called relative atomic mass.

But How??

An isotope of C-12 has been chosen as a standard. C-12 was assigned a mass of exactly 12 a.m.u (atomic mass unit). This value was determined accurately by mass spectrometry. The mass of atoms of all other elements are compared to the mass of C-12.

What is atomic mass unit? "It is mass exactly equal to $\frac{1}{12}$ th the mass of one C-12 atom."

$$\begin{aligned} \text{mass of one C-12 atom} &= 12 \text{ amu} \\ 1 \text{ amu} &= \frac{\text{mass of one C-12 atom}}{12} \end{aligned}$$

Example: A hydrogen atom is 8.40% as massive as the standard C-12 atom. Therefore, relative atomic mass of hydrogen is

$$\begin{aligned} &= \frac{8.40}{100} \times 12 \text{ amu} \\ &= 1.008 \text{ amu} \end{aligned}$$

(2) **Heterogeneous mixture:** A mixture that contains two or more visibly different compounds (components) is called a heterogeneous mixture.

Examples: Sand + Salt, oil in water etc.

Atomic Number (Z): The number of protons in the nucleus of an atom is called atomic number.

Examples: H: 1 (one proton)
Na: 11 (Eleven protons)
C: 6 (Six protons)
N: 7 (Seven protons)

Atomic Mass (A): It is the number of protons and neutrons in an atom is called atomic mass or mass number.
Mass^{OR} Number

Examples: H: 1 (one proton + zero neutrons)
Na: 23 (Eleven protons + Twelve neutrons)
C: 12 (Six protons + Six neutrons).
N: 14 (Seven protons + Seven neutrons).