The Language of Chemistry

Pure Substance

A pure substance is one which is made up of molecules containing same kind of atoms.

Pure Substance

- **Element**
  - An element is a simple and pure form of matter which cannot be decomposed into simpler substances.
  - For example: H, C, O etc.
- **Compound**
  - A compound is a substance formed by the chemical combination of two or more elements in a fixed proportion.
  - For example: H_2O, CO_2, NO_2 etc.

Molecule :

A molecule is the smallest particle that has the capability to exist independently.

For example: H_2, O_2, CO_2 etc.

Symbols of Elements

- **Dalton's Symbols**
  - Hydrogen ⊙
- **Berzilius Symbols**
  - Hydrogen H

Carbon	●	Carbon	C
Sulphur	⊕	Sulphur	S

Symbols of certain elements based on latin names:

Gold	Aurum
Silver	Argentum
Mercury	Hydrargyrum
Copper	Cuprum
Potassium	Kalium
Iron	Ferrum

Valency of Elements

The valency of an element is a measure of its combining power with other elements.

for example:

Ammonia (NH_3), Valency of N = 3

Methane (CH_4), Valency of C = 4

Modern defination:

The number of electrons that an atom can lose, gain or share during a chemical reaction is called its valency.

For example:

$Na \longrightarrow Na^{+} + 1e^{-}$ (Monovalent)

2,8,1 → 2,8

$N + 3e^{-} \longrightarrow N^{3-}$ (Trivalent)

2,5 → 2,8

Variable valency:

Certain elements exhibit more than one valency i.e, they show variable valency.

For example:

Iron Valency: 2,3 (Ferrous, Ferric)

Copper Valency: 1,2 (Cuprous, Cupric)

Radicals

A radical is an atom or a group of atoms of the same or of different elements that behaves as a single unit with a positive or negative charge.

Types of radicals:

1. Simple radical ⇒ Na^{+}, Mg^{2+} etc
2. Compound radical ⇒ SO_4^{2-}, NO_3^{-} etc
3. Acid radical ⇒ Cl^{-}, HCO_3^{-} etc
4. Basic radical ⇒ Ca^{2+}, K^{+} etc

Chemical Formula Writing

Based on the steps (Criss-cross method), formulae can be written in the following w

Compound	Symbols with valencies and charge	Exchange of valency	Formula
Magnesium chloride	Mg^{2+} Cl^-	Mg 2 ✕ Cl 1	$MgCl_2$
Calcium oxide	Ca^{2+} O^{2-}	Ca 2 ✕ O 2	$Ca_2O_2 \Rightarrow CaO$

Naming of Compounds

1. A metal and a non-metal

Non-metal ⇒ Prefix
Metal ⇒ Suffix

Calcium Nitride
Ca_3N_2

2. Two non-metals

Prefixes ⇒ tri = 3
tetra = 4
penta = 5

Phosphorous trichloride
PCl_3

3. Two elements and oxygen

Prefix ⇒ Hypo (Oxygen < 2)

Sodium hypochlorite
NaClO

Suffix ⇒ ite (Oxygen = 2)

Sodium chlorite

$NaClO_2$

Suffix ⇒ ate (Oxygen = 3) Sodium chlorate $NaClO_3$

Prefix ⇒ per (Oxygen > 3) Sodium perchlorate $NaClO_4$

4. Naming of acids

Prefix ⇒ Hydro Suffix ⇒ ic

Hydrochloric acid HCl

Hydrofluoric acid HF

Sulpuric acid H_2SO_4

Sulphurous acid H_2SO_3 (less oxygen)

5. Trivial names

Nitrogen trihydride NH_3

Dihydrogen oxide H_2O

Chemical Equation

A chemical equation is the symbolic representation of a chemical reaction using the symbols and formulae of the substances involved in the reaction.

Word Equation

Carbon + oxygen $\xrightarrow{\Delta}$ Carbon dioxide

Chemical Equation

$$C + O_2 \xrightarrow{\Delta} CO_2$$

Reactants — Product

Skeleton Equation

It is an equation that represents a chemical change but is unbalanced.

For example:

$$KNO_3 \longrightarrow KNO_2 + O_2$$

Balanced Equation

It is an equation in which the total number of atoms of each element in the reactants is equal to the number in the products.

For example:

$$2KNO_3 \longrightarrow 2KNO_2 + O_2$$

There are two methods of balancing an equation

1. Hit and Trial method
2. Partial equation method

For example:

$$Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$$

Element — Reactant — Product

Cu	1	1
H	4	4
S	2	2
O	8	8

Information conveyed by a balanced Equation

1. About the actual result of chemical change.
2. About the reactants involved and products formed.
3. About the chemical composition of each molecule.
4. It also proves the Law of conservation of mass.

Limitations of a chemical equation

A chemical equation does not tell us

1. the physical states of reactants and products.
2. the time taken for the completion of reaction.
3. the respective concentration of reactants and products.
4. the rate at which the reaction proceeds.

A chemical Equation can be made more informative

1. informing about temperature, pressure, catalyst etc.

$$N_2 + 3H_2 \xrightarrow[450^\circ C]{Fe + Mo} 2NH_3$$

200 - 900 atm

2. informing about physical states

$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

3. informing about precipite by downward arrow (↓).

$$AgNO_3(aq) + HCl(aq) \longrightarrow AgCl(\downarrow) + HNO_3(aq)$$

Relative atomic weight or mass (RAM)

$$\text{Relative atomic mass} = \frac{\text{Mass of 1 atom of element}}{\frac{1}{12}\text{th the mass of one C-12 atom}}$$

Atomic mass unit (amu)

It is defined as the $\frac{1}{12}$th the mass of C-12 atom.

1 amu or 1u = 1.66×10^{-24}g

Relative molecular mass

Relative molecular mass of an element or a compound is the number that represents how many times one molecule of the substance is heavier than 1/12 of the mass of an atom of carbon -12.

For example: Relative molecular mass of H_2SO_4
$= (2 \times 1) + 32 + (16 \times 4)$
$= 98$

Percentage composition

Percentage composition of a compound is the percentage by weight of each element present in it.

% composition of element in a compound

$$= \frac{\text{Total weight of element in one molecule}}{\text{Gram molecular weight of compound}} \times 100$$

Empirical formula of a compound

It is the formula which gives the simplest whole number ratio of atoms of different elements present in one molecule of the compound.

For example:
The empirical formula of hydrogen peroxide (H_2O_2) is 'HO'.

Molecular formula = n x Emperical formula

n = Molecular formula mass

$n = \frac{\text{Molecular formula mass}}{\text{Emperical formula mass}}$

Molecular mass = 2 × Vapour density