Atoms and Molecules

Role of Indian Philosophers:

1. Maharishi Kanad postulated that the division of the matter (padarth) is possible to a level as they reach the smallest particles that couldn't be divided further than he named Parmanu.
2. Pakudha Katyayama, elaborated the doctrine by Mahrishi Kanad and said that Parmanu normally exist in a combined form which gives us various forms of matter.

Role of Greek Philosophers:

1. Democritus and Leucippus suggested that if we go on dividing matter, stage will come when particles obtained cannot be divided further. Democritus called these indivisible particles atoms.

Laws of Chemical Combination: Lavoisier and Joseph L. Proust established these laws after much experimentation.

1. **LAW OF CONSERVATION OF MASS:**
   It states that mass can neither be created nor destroyed in a chemical reaction.
2. **LAW OF CONSTANT PROPORTIONS:**
   It states in a chemical substance the elements are always present in definite proportions by mass.

Dalton's Atomic Theory:

British chemist John Dalton provided the basic theory about the nature of matter that was based on the laws of chemical combination. This theory explained the brief explanation for the law of conservation of mass and the law of definite proportions.

The Postulates of Dalton's Atomic Theory:

(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.

- **What is an Atom?**

The smallest electrical charged particles that can't be seen from naked eyes are called atoms. These atoms are the building blocks of chemistry, everything is made from atoms.

Atomic radius is measured in nanometres.

$$1/10^{9}\ m = 1\ nm$$

$$1\ m = 10^{9}\ nm$$

- **IUPAC:**

- International Union of Pure and Applied Chemistry approves names of elements. The symbols of the elements are given on the basis of the one or two letters of its name. The first letter must be always in a capital letter followed by small letter. Example: Nitrogen – N, Cobalt – Co, etc.
- Other symbols have been taken from the names of elements in Latin, German or Greek. For example, the symbol of iron is Fe from it Latin name ferrum, sodium is Na from natrium, potassium is K from kalium.

- **Atomic Mass:**

One atomic mass unit is compared to exactly one-twelfth (1/12th) the mass of one atom of carbon-12. The relative atomic masses of all elements have been found with respect to an atom of carbon-12.

- **Molecules:** it is the smallest particle of an element that shows all the properties of a substance and can exist independently.
    - **Molecules of an element:** In this same type of element's atoms are taken together. Example: Oxygen –O_2.

The number of atoms constituting a molecule is known as its atomicity.

- **Molecules of Compounds:** In this the atoms of more than one element are combined in a fixed ratio. Example: Water - H:O=1:8
- **Ion:** The charged atoms are called ions. The negatively charged ions are called **anions** example: **Na^+** whereas the positively charged are termed as **cations** example: **Cl^-** . Group of atoms carrying a charge is termed as a **polyatomic** ion.

➢ **<u>Chemical Formulae:</u>**

The symbolic representation of the chemical compounds is its chemical formulae.

The combining capacity of an atom is called its Valency.

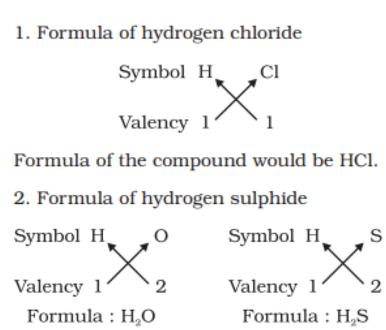
Rules to be followed up while writing chemical formulas:

1. The name or the symbol of a metal is written first when it consists of a metal and a non-metal.
2. The valencies must be balanced.
3. In compounds formed with polyatomic ions, the ion is enclosed in a bracket before writing the number to indicate the ratio.

➢ **<u>Formulae of Simple Compounds:</u>**

- Binary compounds are those compounds which are made up of 2 elements.
- The valencies of the compounds are written just below their symbols. After this the valancies of the combining elements are crossed over.

<u>Example</u>:



- **Molecular Mass:**

When the sum of all the atoms present in a molecule is taken up as a whole then it is termed as the molecular mass of that substance.

Example: **H_2O**

Atomic mass of H = 1 u

Atomic mass of O = 16u

H_2O = H x 2 + O x 1

(1 x 2) + (16 x 1)

2 +16 = 18u

Molecular Mass of ***H_2O = 18 u***

- **Formula Unit Mass:**

It's just similar to that of molecular mass. It is the sum of all the atomic masses of all atoms that are present in a formula unit of a compound.

The difference between both of them is that word formula unit is used for the substance whose constitutes particles are ions.

Ex: $CaCl_2$

1 x 40 + 2 x 35.5 = 111 u

- **Mole Concept:**

Single mole of any species (it can be atoms, molecules, ions or particles) represents the quantity in number that has a mass equal to its atomic or molecular mass in grams.

- **Avogadro Number(N_0):** it's the fixed number obtained after an experiment. It represents a fixed value of 1 mole that is 6.022×10^{23} .
- **Molar Mass:** The mass of single mole is called it's molar mass or gram atomic mass. Ex: atomic mass of 1 hydrogen – 1 u whereas its molar mass or gram atomic mass is – 1g.

Number of Moles could be found using two formulas:

- **Number of moles using masses(n) :** given mass**(m) /** molar mass **(M)**

$$n = m/M$$

- **Number of moles using numbers(n) :** given numbers of particles**(N) /** Avogadro numbers **(N_0)**

$$n = N/ N_0$$

Calculate the number of moles for the following:

1. No. of moles = n
2. Given mass = m
3. Molar mass = M
4. Given number of particles = N
5. Avogadro number of particles = N_0

(i) 52 g of He (finding mole from mass)

Solutions:

Atomic mass of He = 4 u

Molar mass of He = 4g

Thus, the number of moles = given mass / molar mass

⇒ **n = m / M** = 52 / 13 = **4**

(ii) 12.044 × 10^{23} number of He atoms (finding mole from number of particles).

Solutions:

We know, 1 mole = 6.022 × 10^{23}

The number of moles = given number of particles / Avogadro number

⇒ **n = N / N_0** = 12.044 x 10^{23}/ 6.022 x 10^{23}= **2**