Class 9th

CHEMISTRY

CHAPTER - 03

ATOMS AND MOLECULES

Laws of Chemical Combination:

1. Law of conservation of mass (Antoine Lavoisier)

The law of conservation of mass states that mass can neither be created nor be destroyed in a chemical reaction. The law of conservation of mass means that in a chemical reaction, the total mass of products is equal to the total mass of reactants. There is no change in the mass during a chemical reaction.

Suppose a chemical reaction takes place between substances A and B and if the products formed are C and D as:

$$A + B \longrightarrow C + D$$

If 'a' g of A and 'b' g of B react to produce 'c' g if C and 'd' g of D. Then according to law of conservation of mass, we have

$$a + b = c + d.$$

2. Law of constant proportions (Joseph L. Proust.)

"In a chemical substance, the elements are always present in definite proportions by their mass". The chemical composition of pure substance is not dependent on the source from which it is obtained.

3. Dalton's atomic theory

- All matter is made of very tiny particles called atoms, which participate in chemical reactions.
- Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction.
- Atoms of a given element are identical in mass and chemical properties.
- Atoms of different elements have different masses and chemical properties.
- Atoms combine in the ratio of small whole numbers to form compounds.
- The relative number and kinds of atoms are constant in a given compound.

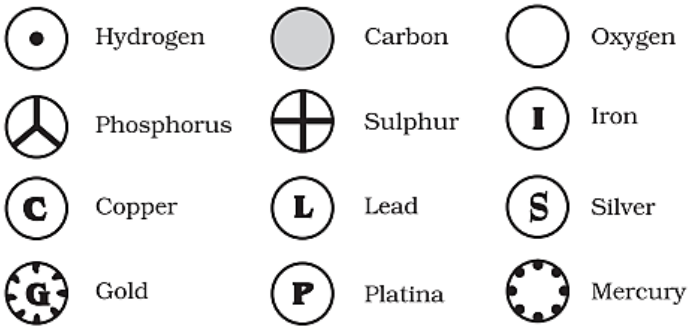
4. Atom: Atoms are defined as ***"the basic building blocks of matter"***.

Atomic radius is measured in nanometre.

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

5. Dalton's atomic symbols:

Dalton was the first scientist to use the symbols for elements in a very specific sense.



6. **Berzelius's atomic symbols:**
Berzelius uses first one or two letters of the element's name in English. The first letter of a symbol is always written as a capital letter (uppercase) and the second letter as a small letter (lowercase).
For example: (i) hydrogen, H (ii) aluminium, Al and not AL (iii) cobalt, Co and not CO.

7. **Atomic mass unit (amu):** One atomic mass unit is the mass equal to exactly one-twelfth (1/12th) of the mass of one atom of carbon-12.

8. **Molecules:** A molecule can be defined as the smallest particle of an element or a compound that is capable of an independent existence and shows all the properties of that substance. For example diatomic molecule, O_2 and triatomic molecule,O_3. Atoms of different elements join together in definite proportions to form molecules of compounds.

9. **Molecular mass:** The molecular mass of a substance is the sum of the atomic masses of all the atoms in a molecule of the substance.
For example:
The molecular mass of H_2O
$= 2 \times 1u + 1 \times 16u$
$= 18$ u

10. **Atomicity:** The number of atoms constituting a molecule is known as its atomicity.
Phosphorus (P_4) – Tetra-atomic
Sulphur (S_8) – Polyatomic

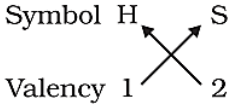
11. **Ion:** An ion can be a negatively or positively charged particle. A negatively charged ion is called an 'anion' and the positively charged ion is called a 'cation'.
For example: Na^+ is a cation and Cl^- is an anion

12. **Polyatomic ion:** A group of atoms carrying a charge is known as a polyatomic ion.

13. **Chemical formula:** The chemical formula of a compound is a symbolic representation of its composition.

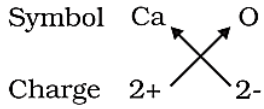
14. **Valency:** The combining power (or capacity) of an element is known as its valency. Some elements show more than one valency.

(a) Formula of hydrogen sulphide



Formula: H_2S

(b) Formula for calcium oxide:



Here, the valencies of the two elements are the same. You may arrive at the formula Ca_2O_2. But we simplify the formula as CaO.

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^-		
			Iodide	I^-	Hydrogen carbonate	HCO_3^-
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+}				

15. Formula unit mass

The formula unit mass of a substance is the sum of the atomic masses of all atoms in a formula unit of a compound. For example, sodium chloride has a formula unit NaCl. Its formula unit mass can be calculated as:

23u + 35.5u = 58.5u

16. Mole concept

Mole is the Latin word meaning heap or pile. The SI unit of the amount of a substance is mole.

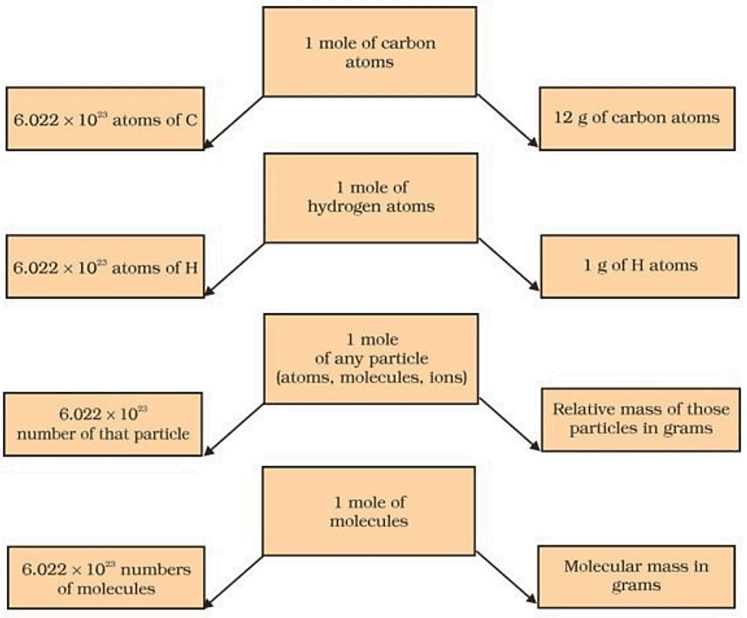
One mole contains exactly $6.02214076 \times 10^{23}$ elementary entities. The number, 6.022×10^{23} is known as Avogadro's constant (N_A).

1. The number of moles

$$= \frac{\text{given mass}}{\text{molar mass}} \Rightarrow n = \frac{m}{M}$$

2. The number of moles

$$= \frac{\text{given number of particles}}{\text{Avogadro number}} \Rightarrow n = \frac{N}{N_A}$$



The number of particles in each of the following:

(i) 46 g of sodium

(ii) 8 g O_2 of oxygen

(i) The number of atoms

$$= \frac{\text{given mass}}{\text{Atomic mass}} \times \text{Avogadro number}$$

$$\Rightarrow N = \frac{m}{M} \times N_A$$

$$\Rightarrow N = \frac{46}{23} \times 6.022 \times 10^{23}$$

$$\Rightarrow N = 12.044 \times 10^{23} \text{ Na atoms.}$$

(ii) The number of molecules

$$= \frac{\text{given mass}}{\text{molar mass}} \times \text{Avogadro number}$$

$$\Rightarrow N = \frac{m}{M} \times N_A$$

Atomic mass of oxygen = 16g

$\therefore$ Molar mass of O_2 molecules

$= 16 \times 2 = 32$ g

$$\Rightarrow N = \frac{8}{32} \times 6.022 \times 10^{23}$$

$$\Rightarrow N = 1.5055 \times 10^{23}$$

1.51×10^{23} molecules of O_2

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