9th Standard Science

Atoms and Molecules

Law of Chemical Combination

Given by Lavoisier and Joseph L. Proust as follows:

1. **Law of conservation of mass:** Mass can neither be created nor destroyed in a chemical reaction. e.g., A + B → C + D Reactants → Products Mass of reactants = Mass of products

2. **Law of constant proportion:** In a chemical substance the elements are always present in definite proportions by mass.
E.g., in water, the ratio of the mass of hydrogen to the mass of oxygen is always 1 : 8 respectively.
These laws lacked explanation. Hence, John Dalton gave his theory about the matter. He said that the smallest particle of matter is called 'atom'.

Dalton's Atomic Theory

- Every matter is made up of very small or tiny particles called atoms.
- Atoms are not divisible and cannot be created or destroyed in a chemical reaction.
- All atoms of a given element are same in size, mass and chemical properties.

- Atoms of different elements are different in size, mass and chemical properties.
- Atoms combine in the ratio of a small whole number to form compounds.
- The relative number and kinds of atoms are constant in a given compound.

Atom

Atoms are the smallest particles of an element which can take part in a chemical reaction.

Size of an atom: Atomic radius is measured in nanometres.

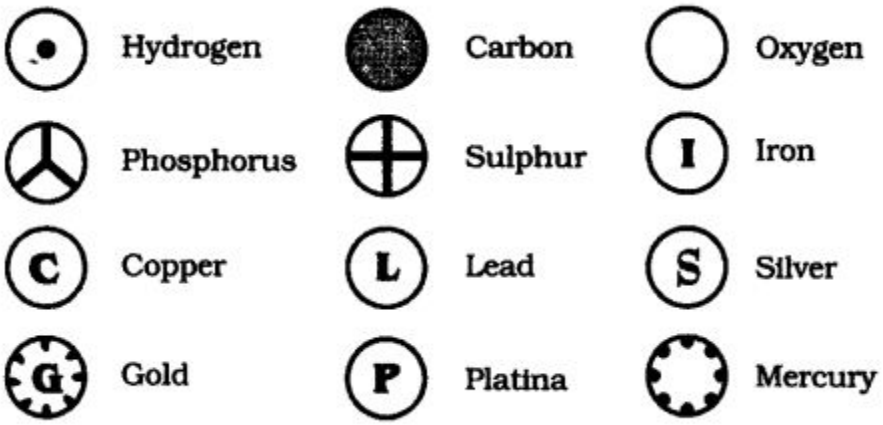
$$1\text{nm} = \frac{1}{10^9}\ \text{m}$$

$$\therefore \quad 1\text{m} = 10^9\ \text{nm}$$

Atomic radii of hydrogen atom = 1×10^{-10} m.

Symbols of atoms:

(a) Symbols for some elements as proposed by Dalton:



(b) Symbols of some common elements:

Name of the element	Latin name	Symbol
Hydrogen	–	H
Helium	–	He
Carbon	–	C
Copper	Cuprum	Cu
Cobalt		Co
Chlorine		Cl
Cadmium		Cd
Boron		B
Barium		Ba
Bromine		Br
Bismuth		Bi
Sodium	Natrium	Na
Potassium	Kalium	K
Iron	Ferrum	Fe
Gold	Aurum	Au
Silver	Argentum	Ag
Mercury	Hydragyrum	Hg

Molecule

It is the smallest particle of an element or a compound which can exist independently.

- Molecules of an element constitute the same type of atoms.
- Molecules may be monoatomic, diatomic or polyatomic.
- Molecules of compounds join together in definite proportions and constitute a different type of atoms.

Atomicity

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

Name of the element	Atomicity	Molecules formula
Helium	Monoatomic	He
Neon	,,	Ne
Argon	,,	Ar
Sodium	,,	Na
Iron	,,	Fe
Aluminium	,,	Al
Hydrogen	Di-atomic	H_2
Oxygen	,,	O_2
Chlorine	,,	Cl_2
Nitrogen	,,	N_2
Phosphorus	Polyatomic (Tetra)	P_4
Sulphur	Polyatomic (Octa)	S_8

Ions

The charged particles (atoms) are called ions, they are formed by attaining positive charge or negative charge on it.

Negatively charged ion is called anion (Cl^-).

Positively charged ion is called cation (Na^+).

Valency

The combining capacity of an element is known as its valency. Valency is used to find out how the atom of an element will combine with the atom of another element to form a chemical compound.

(Every atom wants to become stable, to do so it may lose, gain or share electrons.)

- If an atom consists of 1, 2 or 3 electrons in its valence shell then its valency is 1, 2 or 3 respectively,
- If an atom consists of 5, 6 or 7 electrons in the outermost shell, then it will gain 3, 2 or 1 electron respectively and its valency will be 3, 2 or 1 respectively.
- If an atom has 4 electrons in the outermost shell than it will share this electron and hence its valency will be 4.
- If an atom has 8 electrons in the outermost electron and hence its valency will be 0.

Name of the Element	Symbol	Valency	Ion.
Hydrogen	H	1	H^+
Helium	He	0	–
Lithium	Li	1	Li^+
Beryllium	Be	2	Be^{2+}
Boron	B	3	B^{3+}
Carbon	C	4 (Shares electrons)	–
Nitrogen	N	3	N^{3-}
Oxygen	O	2	O^{2-}
Fluorine	F	1	F^-
Neon	Ne	0	–
Sodium	Na	1	Na^+
Magnesium	Mg	2	Mg^{2+}
Aluminium	Al	3	Al^{3+}

Some elements show more than one valency,hence termed as variable valency.

e.g., Iron shows valency II – Fe^{2+}
and valency III – Fe^{3+}
Copper shows valency I – Cu^+
and valency II – Cu^{2+}

Chemical Formulae

Rules: (i) The valencies or charges on the ion must balance.

(ii) Metal and non-metal compound should show the name or symbol of the

metal first.

e.g., Na^{+} $Cl^{-} \rightarrow NaCl$

(ii) If a compound consists of polyatomic ions. The ion is enclosed in a bracket before writing the number to indicate the ratio.

e.g., $[SO_4]^{2-}$ → polyatomic radical

H^{1+} SO_4^{2-} → H_2SO_4

Chemical formula of some simple compounds

(*a*) Calcium hydroxide

Symbol → Ca OH

Valency → +2 −1

Criss-cross.

Formula → $Ca(OH)_2$

(*b*) Aluminium oxide

Symbol → Al O

Valency → +3 −2

Formula → Al_2O_3

Molecular Mass

It is the sum of the atomic masses of all the atoms in a molecule of the substance. It is expressed in atomic mass unit (u).

e.g., $2H^+ + O_2 \quad H_2O$ [H = 1, O = 16]

$1 \times 2 + 16 = 18$ u

Formula Unit Mass

It is the sum of the atomic masses of all atoms in a formula unit of a compound. The constituent particles are ions.

e.g., $Na^+ + Cl^- \rightarrow NaCl$

$1 \times 23 + 1 \times 35.5 = 58.5$ u

Mole Concept

Definition of mole: It is defined as one mole of any species (atoms, molecules, ions or particles) is that quantity in number having a mass equal to its atomic or molecular mass in grams.

1 mole = 6.022×10^{23} in number

Molar mass = mass of 1 mole → is always expressed in grams and is also known as gram atomic mass.

lu of hydrogen has → 1 atom of hydrogen 1g of hydrogen has → 1 mole of hydrogen

= 6.022×10^{23} atoms of hydrogen