CBSE Class 9 Science

Revision Notes

CHAPTER – 3

Atoms and Molecules

1. Laws of Chemical Combination

Law of Conservation of mass:
proposed by the French chemist Antoine Lavoisier (1774)

Mass can neither be created nor destroyed in a chemical reaction.

OR

For any chemical process in a closed system, the mass of the reactants must be equal the mass of the products.

$C + O_2 = CO_2$

$12g + 32g = 44g$

Law of definite proportion:
proposed by Louis Proust (1799)

'A chemical compound always consists of the same elements combined together in the same ratio,

irrespective of the method of preparation or the source from where it is taken'.

One molecule of a compound water always contains same ratio of Hydrogen and Oxygen by mass i.e.

$H_2O = 2 : 16 = 1 : 8$

Limitation of "Law of definite proportion"

This law does not hold good when the compound is obtained by using different isotopes of the combining elements.

2. John Daltons Atomic Theory

Using his theory, Dalton rationalized the various laws of chemical combination which were in existence at that time. However, he assumed that the simplest compound of two elements must be binary.

3. Atoms, Molecules, Ions & Chemical Formula

Atom

An atom is the smallest particle of an element which can take part in a chemical reaction. It may or may not exist freely.

↓

Each atom of an element shows all the properties of the element.

Molecule

The smallest particle of matter (element or compound) which can exist in a free state.

↓

The properties of a substance are the properties of its molecules.

- **MOLECULES OF ELEMENT** : The molecules of an element are constituted by the same type of atoms.
- **MOLECULES OF COMPOUND**: Atoms of different elements join together in definite proportions to form molecules of compounds. (hetero atomic molecules)
- **ATOMICITY**: The number of atoms contained in a molecule of a substance (element or compound) is called its atomic

Element	Formula	Atomicity
Ozone	O_3	3
Phosphorus	P_4	4
Sulphur	S_8	8
Oxygen	O_2	2

- Based upon atomicity molecules can be classified as follows.
- **Monoatomic molecules**: Noble gases helium, neon and argon exist as He Ne and Ar respectively.

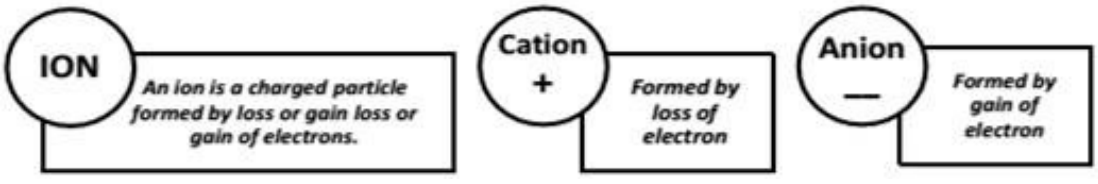
Diatomic molecules: H_2, O_2, N_2, Cl_2, CO, HCl.
Triatomic molecules: O_3, CO_2, NO_2

SYMBOLS

- The abbreviation used to represent an element is generally the first letter in capital of the English name of element.
  Oxygen $\rightarrow$ O Nitrogen $\rightarrow$ N
- When the names of two or more elements begin with the same initial letter, the initial letter followed by the letter appearing later in the name is used to symbolize the element
  Barium $\rightarrow$ Ba Bismuth $\rightarrow$ Bi

Symbols of some elements are derived from their Latin names

ELEMENT	LATIN NAME	SYMBOL
Sodium	Natrium	Na
Copper	Cuprum	Cu
Potassium	Kalium	K
Iron	Ferrum	Fe
Mercury	Hydragyrum	Hg
Tungsten	Wolfram	W



Polyatomic Ion : A group of atoms carrying a charge is as polyatomic ion.
Eg. $NH_4^+ - Ammoniumlon : CO_3^{2-} - Carbonate\ ion$

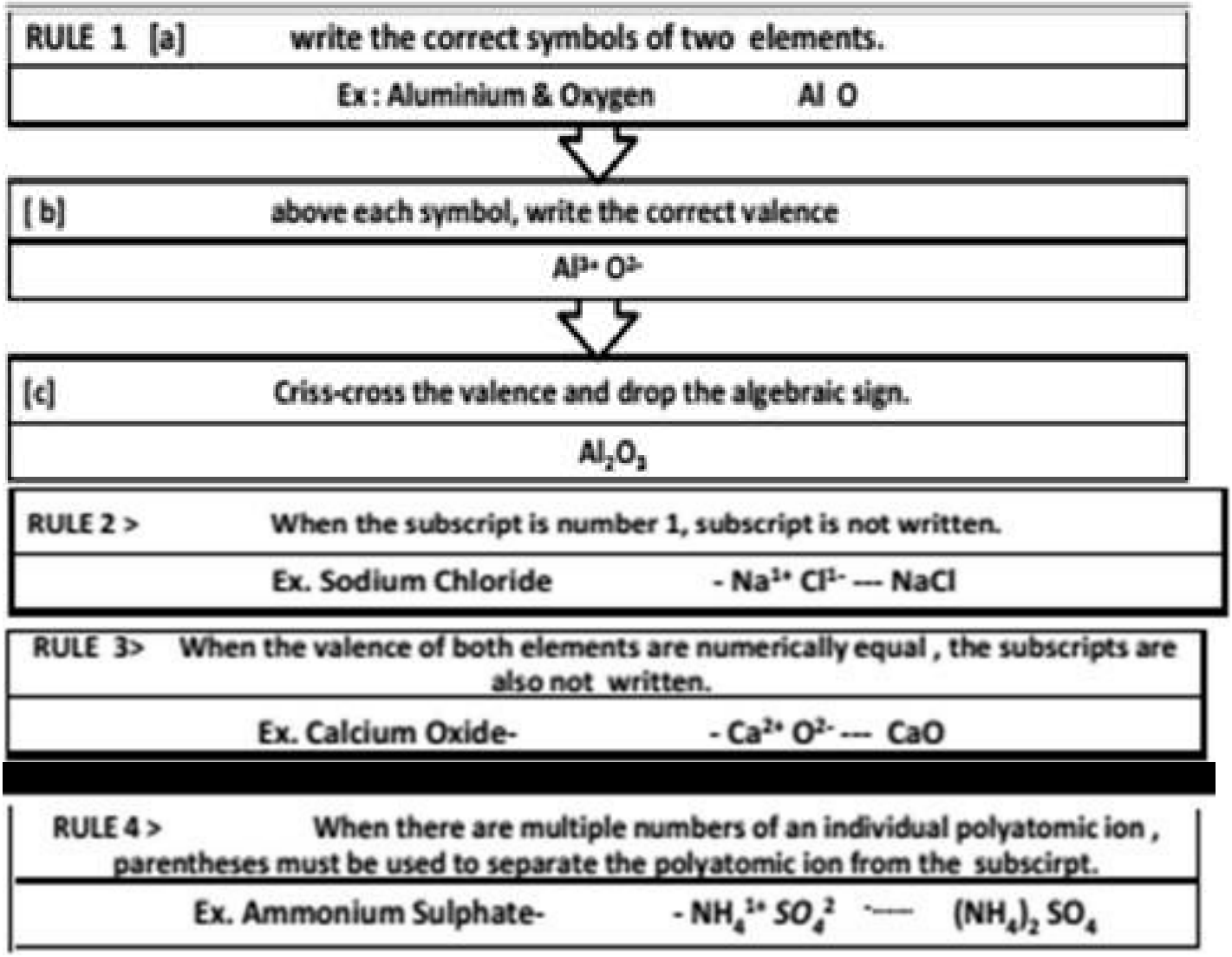
Valency : The number of electrons which an atom can lose , gain or share to form a bond.

OR

It is the combining capacity of an atom of the element.

- **Chemical Formula** : A chemical formula is a short method of representing chemical elements and compounds.

Writing a Chemical Formula -CRISS-CROSS rule



RULES > All subscripts must be reduced to lowest term (except for molecular or

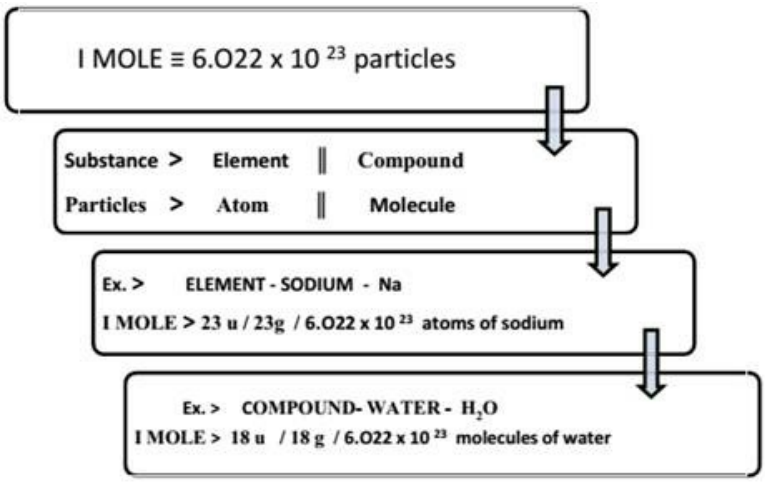
Examples

CATION	ANION	FORMULA	NAME
Al^{3+}	${SO_4}^{2-}$	$Al_2(SO_4)_3$	Aluminium sulphate
Ca	${HCO_3}^-$	$Ca(HCO_3)_2$	Calcium bicarbonate
${NH_4}^+$	Cl^-	NH_4Cl	Ammonium chloride
Na^+	${CO_3}^{2-}$	${HCO_3}^-$	Sodium carbonate
Mg^{2+}	OH^-	$Mg(OH)_2$	Magnesium hydroxide
Na^+	${PO_4}^{3-}$	Na_3PO_4	Sodium phosphate

4. Mole Concept

The mole (mol) is the amount of a substance that contains as many elementary entities as there are atoms in exactly 12.00 grams of ${}^{12}C$

The Avogadro constant is named after the early nineteenth century Italian scientist Amedeo Avogadro.



S.No.	Symbol / formula of atom / molecule	Atomic / molecular mass (u)	1mole (in g)	Avogadro no.	Molar mass (g mol $^{-1}$)
1.	O	16 u	16 g	6.022 x 10^{23} atoms	16 g mol $^{-1}$
2.	N_2	28 u	28 g	6.022 x 10^{23} molecules	28 g mol $^{-1}$
3.	HCl	36.5 u	36.5 g	6.022 x 10^{23} molecules	36.5 g mol $^{-1}$

GRAM MOLECULAR MASS

Gram molecular mass is the mass in grams of one mole of a molecular substance.

Ex: The molecular mass of N_2 is 28, so the gram molecular mass of N_2 is 28 g.

ATOMIC MASS UNIT

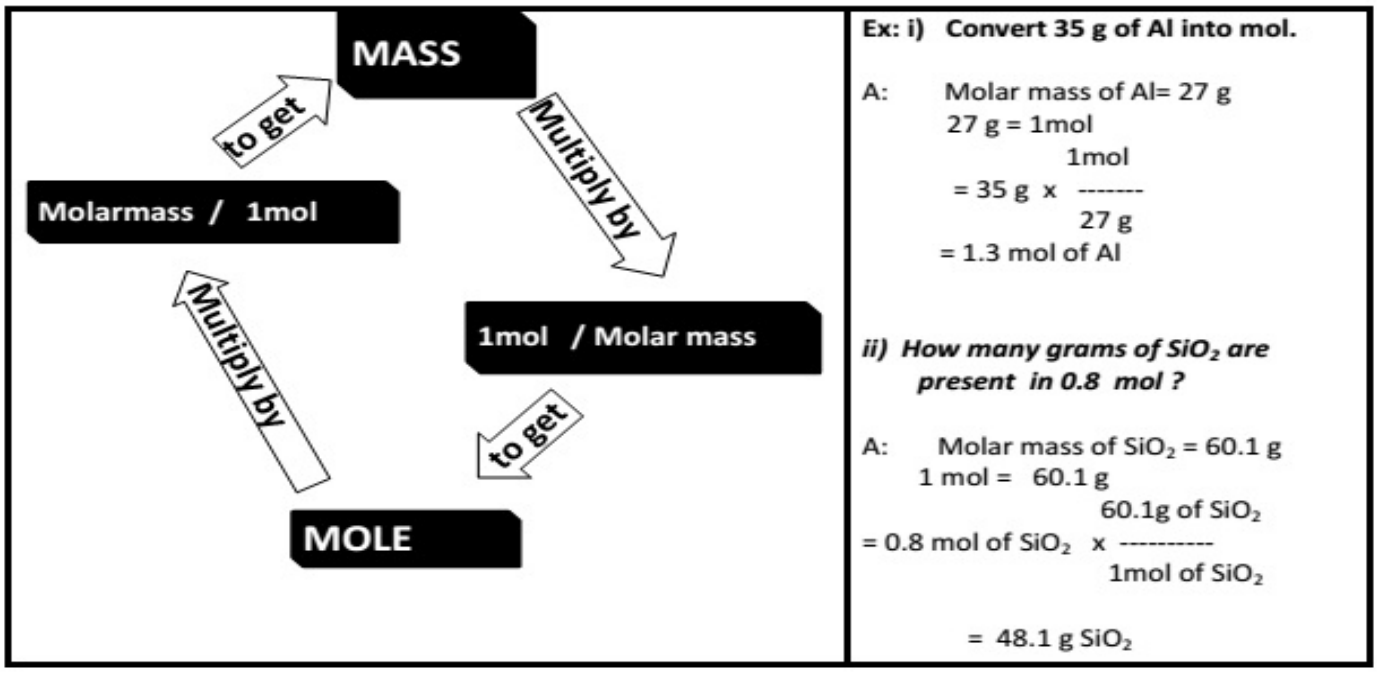
An atomic mass unit or amu is one twelfth of the mass of an unbound atom of carbon-12. It is a unit of mass used to express atomic masses and molecular masses.

Also Known As: Unified Atomic Mass Unit (u).

MOLECULAR MASS : A number equal to the sum of the atomic masses of the atoms in a molecule. The molecular mass gives the mass of a molecule relative to that of the 12 C atom, which is taken to have a mass of 12.

Examples: The molecular mass of C_2H_6 is approximately 30 or $[(2 \times 12) + (6 \times 1)]$. Therefore the molecule is about 2.5 times as heavy as the 12C atom or about the same mass as the NO atom with a molecular mass of 30 or (14 +16).

5. Molar Mass & Avogadro Constant



Ex: i) Convert 35 g of Al into mol.

A: Molar mass of Al= 27 g

27 g = 1mol

$$= 35 \text{ g} \times \frac{1 \text{ mol}}{27 \text{ g}}$$

= 1.3 mol of Al

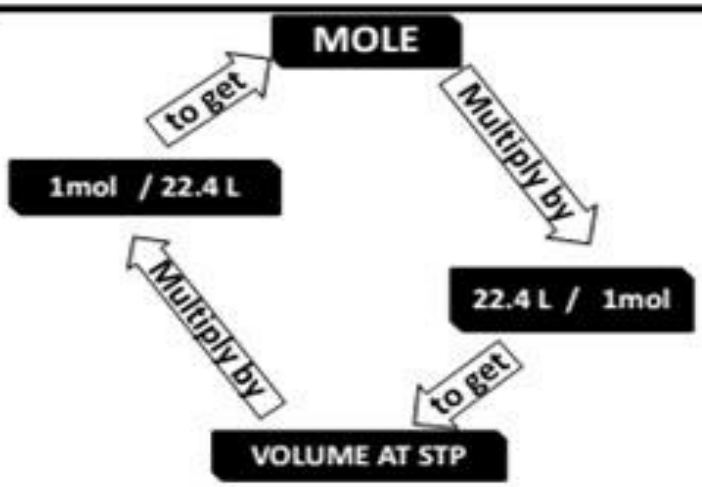
ii) How many grams of SiO_2 are present in 0.8 mol ?

A: Molar mass of SiO_2 = 60.1 g

1 mol = 60.1 g

$$= 0.8 \text{ mol of } SiO_2 \times \frac{60.1 \text{ g of } SiO_2}{1 \text{ mol of } SiO_2}$$

= 48.1 g SiO_2

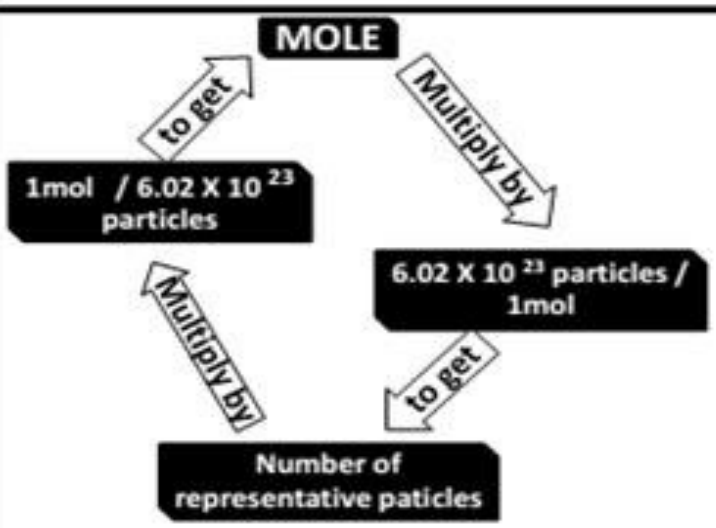


Ex . How many mol of CO_2 are present in 55.5 L ?

A: 22.4 L = 1mol

$$= 55.5\ L \times \frac{1\ mol}{22.4\ L}$$

$$= 2.48 \text{ mol of } CO_2.$$



Ex Calculate number of molecules in 200 g of N_2O.

Molar mass of N_2O = 44 g

i) to find number of moles:-

44 g = 1 mol

$$= 200\ g \times \frac{1\ mol}{44.0\ g}$$

$$= 4.55 \text{ mol of } N_2O$$

ii) to find number of molecules

1 mol = 6.02×10^{23} molecules

$$= \frac{6.02 \times 10^{23} \text{ molecules } N_2O}{1/4.55}$$

$$= 2.74 \times 10^{24} \text{ molecules } N_2O$$