Chemical Formula and Equations

COMPOUND

pure substance composed of 2 or more elements that are chemically combined in a definite proportion by mass.

smallest unit **molecule**

FORMULA - represents compound

NaCl - sodium chloride

H_2O - water

$CaCl_2$ - calcium chloride

subscripts denote # of atoms

Molecular Mass - sum of all atomic masses in molecule

Formula Mass - sum of all atomic masses in formula

more general. e.g. NaCl not a molecule

% Composition of compound

% = (Total Mass of Element) / (Formula Mass) × 100%

examples: H_2O $C_9H_8O_4$ (aspirin)

Amadeo Avogadro (1776-1856)

Equal volumes of ALL gasses at same T and P contain the same number of molecules.

GRAM-ATOMIC MASS - mass of element in grams

equal to atomic mass. H = 1.0 g, N = 14.0 g

Contains same number of atoms for all elements.

GRAM-MOLECULAR MASS or **GRAM-FORMULA MASS**

molecular/formula mass in grams

Contains same number of molecules for all compounds.

MOLE - used for any of the above

Refers to the same number of atoms/molecules ⇒

AVOGADRO'S NUMBER (N_A) = 6.02×10^{23}

= number of atoms/molecules in 1 Mole

= number of atoms/molecules in 22.4 liter of a gas at 0°C and 1 Atmosphere pressure.

36 g of H_2O contains

how many H_2O molecules?

how many H atoms?

how many O atoms?

H_2O formula mass = 18.0 amu, gram-formula mass = 18 g = 1 mole

36 g = 2 mole = 2 × N_A = 12.04×10^{23} H_2O molecules

each H_2O molecule has 2 H and 1 O ⇒ 24.08×10^{23} H atoms, 12.04×10^{23} O atoms

Information carried by Chemical Symbols and Formula

Ni

1. the element nickel
2. one atom of nickel
3. one atomic mass of nickel: 58.7 amu
4. one gram-atom (gram-atomic mass) of nickel: 58.7 g
5. one mole of nickel atoms = N_A = 6.02×10^{23} atoms

CO_2

1. carbon dioxide
2. one molecule of carbon dioxide
3. one molecular mass of carbon dioxide: 44.0 amu
4. one gram-molecular mass of carbon dioxide: 44.0 g
5. one mole of carbon dioxide molecules
   = N_A = 6.02×10^{23} molecules

CHEMICAL EQUATIONS

Reactants → Products

$Al + Fe_2O_3 \rightarrow Al_2O_3 + Fe$ unbalanced equation

symbol	meaning
+	plus
→	yields, produces
⇔	reversible reaction
=	equilibrium

Law of Conservation of Mass

in a chemical reaction bonds are made or broken,
atoms are rearranged
atoms are not created or destroyed
must have the same number of atoms of each element
before and after the reaction
requires ⇒

Balanced Equation

equal numbers of atoms of each element on each side

1. Adjust coefficients
2. Reduce to lowest whole numbers (common denominator)

balance:

$$H_2O_2 \rightarrow H_2O + O_2$$

$$Zn + H_3PO_4 \rightarrow Zn_3(PO_4)_2 + H_2$$

$$N_2 + H_2 \rightarrow NH_3$$