CHEMISTRY

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01. Stoichiometry (Chemical Formulae and Equation)

In the discovery of a new chemical compound, the first question to answer is, what is the formula of the compound? The answer begins with stoichiometric calculation and analysis of the compound.

The percentage composition of a compound leads directly to its empirical formula. An **empirical formula** or simplest formula for a compound is the formula of a substance written with the smallest integer (whole number) subscripts.

The molecular formula of a compound is a multiple of its empirical formula.

Molecular mass = n × empirical formula mass.

Molecular formula = n × empirical formula

02. Stoichiometry : Quantitative Relations in Chemical Reactions

Stoichiometry is the calculation of the quantities of reactants and products involved in a chemical reaction.

It is based on the chemical equation and on the relationship between mass and moles.

1 molecule N_2 + 3 molecules H_2 → 2 molecules NH_3 (Molecular interpretation)

1 mole N_2 + 3 mole H_2 → 2 mole NH_3 (Molar interpretation)

28g N_2 + 6g H_2 → 34g NH_3 (Mass interpretation)

1 vol. N_2 + 3 vol. H_2 → 2 vol. NH_3 (Volume interpretation)

(i) Calculations based on mole-mole relationship.
(ii) Calculations based on mass-mass relationship.
(iii) Calculations based on mass-volume relationship.
(iv) Calculations based on volume-volume relationship.

Calculations based on mole-mole relationship

In such calculations, number of moles of reactants are given and those of products required. Conversely, if number of moles of products are given, then number of moles of reactants are required.

Q.1. $Mg(OH)_2$ in the form of milk of magnesia is used to neutralize excess stomach acid. How many moles of stomach acid can be neutralized by 1g of $Mg(OH)_2$? (Molar mass of $Mg(OH)_2$ = 58.33)

(a) 0.0171
(b) 0.0343
(c) 0.686
(d) 1.25

Calculations based on mass-mass relationship

In making necessary calculations, following steps are followed:

(a) Write down the balanced chemical equation.
(b) Write down the theoretical amount of reactants and products involved in the reaction.
(c) Calculate the unknown amount of substance using unitary method.

Q.1. *Calculate the mass of* (CaO) *that can be prepared by heating* 200*kg of limestone* $CaCO_3$ *which is* 95% *pure.*

Q.2. 1 g *of Mg is burnt in a closed vessel which contains* 0.5g *of* O_2.

(a) Which reactant is left in excess?

(b) Find the mass of the excess reactant.

Calculations involving percent yield.

$$\text{Percent yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$$

Q.1. For the reaction,

$CaO + 2HCl \rightarrow CaCl_2 + H_2O$

1.23 g of CaO is reacted with excess of hydrochloric acid and 1.85 g of $CaCl_2$ is formed. What is the percent yield?

Calculations involving percent purity

Depending upon the mass of the product, the equivalent amount of the reactant present can be determined with the help of a chemical equation. Knowing the actual amount of the reactant taken and the amount calculated with the help of a chemical equation the percentage purity can be determined.

Q.1. Chlorine evolved by the reaction of 45.31 g of pyrolusite (impure) and excess of HCl is found to combine completely with the hydrogen produced by the reaction of 10g of magnesium and excess of dilute hydrochloric acid. Fid the percentage of purity of MnO_2 in the given pyrolusite.

Calculations based on mass-volume relationship

In such calculations, masses of reactants are given and volume of the product is required and *vice-versa*.

1 mole of a gas occupies 22.4 litre volume at STP mass of a gas can be related to volume according to the following gas equation:

$$PV = nRT$$

$$PV = \frac{w}{m} RT$$

Q.1. What volume of $NH_3(g)$ at 27°C and 1 atm pressure will be obtained by thermal decomposition of 26.25g NH_4Cl?

Calculations based on volume-volume relationship

These calculations are based on two laws:

(a) Avogadro's law

(b) Gay-Lussac's law

Q.1. What volume of air containing 21% oxygen by volume is required to completely burn 1kg of carbon containing 100% combustible substances?

03. Cause of Radioactivity

Nuclide	$\frac{n}{p}$ Ratio	Nature of Emission
$^{35}_{16}S$	$\frac{19}{16} = 1.2$	β-emission $^{35}_{16}S \rightarrow ^{35}_{16}Cl + ^{0}_{-1}e$
$^{17}_{9}F$	$\frac{8}{9}\left(\frac{n}{p} < 1\right)$	Positron emission $^{17}_{9}F \rightarrow ^{17}_{8}O + ^{0}_{+1}e$
$^{105}_{47}Ag$	$\frac{n}{P} = \frac{58}{47} = 1.23$	Lies below stability belt, it has a heavy nucleus and it decays by K-electron capture. $^{105}_{47}Ag + ^{0}_{-1}e \rightarrow ^{105}_{46}Pd + hv$
$^{238}_{92}U$	$\frac{n}{P} = \frac{146}{92} = 1.59$	It is a neutron rich species. It undergoes decay by α-emission. $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He$

04. Important Relation

	Characteristics **Z = at. no., A = mass no., N = neutrons, P = protons**	**Examples**
Isotopes	Z = same, A = different	$^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$, $^{235}_{92}U$, $^{238}_{92}U$
Isobars	Z = different, A = same	$^{228}_{88}Ra$, $^{228}_{89}Ac$, $^{228}_{90}Th$
Isotones	N = same, nucleons = different, Z = different	$^{39}_{18}Ar$, $^{40}_{19}K$
Isomers	N = same, P = same, Z = same, A = same Nuclear energy levels = different	$U\text{-}X_2$, U-Z
Isoters	No. of atoms = same No. of electrons = same, physical properties = same.	CO_2, N_2O
Isodiapheres	Isotopic excess mass $(N—P)$ = same	$_{92}U^{235}$, $_{90}Th^{231}$
Isotopic no.	Isotopic no. = $(N—P)$	—
Isoelectronic species	species having same no. of electrons	Na^+, F^-, Ne

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05. General Trends of Some Properties In The Periodic Table

S. No.	Property	Variation from top to bottom in a group	Variation from left to right in a period
1.	Atomic radii	Increases	Decreases
2.	Ionisation enthalpy	Decreases	Increases
3.	Electron gain enthalpy	Decreases	Increases
4.	Electronegativity	Decreases	Increases
5.	Metallic character	Increases	Decreases
6.	Electropositive nature	Increases	Decreases
7.	Oxidising nature	Decreases	Increases
8.	Reducing agent	Increases	Decreases