

NCERT Chemistry Formula Book
Classes 11 & 12

Compiled from NCERT Textbooks

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Chemical Constants and Values

Fundamental Constants

Constant	Symbol	Value
Avogadro's number	N_A	$6.022 \times 10^{23} \text{ mol}^{-1}$
Gas constant	R	$8.314 \text{ J/mol} \cdot \text{K}$
Faraday constant	F	96485 C/mol
Planck's constant	h	$6.626 \times 10^{-34} \text{ J} \cdot \text{s}$
Speed of light	c	$3 \times 10^8 \text{ m/s}$
Boltzmann constant	k_B	$1.381 \times 10^{-23} \text{ J/K}$
Electronic charge	e	$1.602 \times 10^{-19} \text{ C}$

Common Conversion Factors

Conversion	Value
1 atm	101.325 kPa
1 bar	100 kPa
1 calorie	4.184 J
1 eV	$1.602 \times 10^{-19} \text{ J}$
1 Debye	$3.336 \times 10^{-30} \text{ C} \cdot \text{m}$

Chapter 1

Physical Chemistry Formulas

1.1 Some Basic Concepts of Chemistry

Mole Concept: Number of moles = $\frac{\text{Mass}}{\text{Molar mass}}$

Definition: Fundamental concept relating mass to number of particles. 1 mole contains 6.022×10^{23} entities.

Percentage Composition: % of element = $\frac{\text{Mass of element in compound}}{\text{Molar mass of compound}} \times 100$

Definition: Mass percentage of each element in a compound.

Empirical Formula: Simplest whole number ratio of atoms

Definition: Derived from percentage composition data.

Molecular Formula: Actual number of atoms of each element

Definition: Multiple of empirical formula.

Stoichiometry: Calculation of reactants and products

Definition: Based on balanced chemical equations.

1.2 States of Matter: Gases and Liquids

Ideal Gas Law: $PV = nRT$

Definition: Relationship between pressure, volume, temperature and moles of ideal gas. Applies to gases at high temperature and low pressure.

Combined Gas Law: $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

Definition: For fixed amount of gas, PV/T is constant.

Dalton's Law: $P_{\text{total}} = P_1 + P_2 + P_3 + \dots$

Definition: Total pressure equals sum of partial pressures in gas mixture.

Graham's Law: $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

Definition: Rate of effusion/diffusion inversely proportional to square root of molar mass.

Kinetic Gas Equation: $PV = \frac{1}{3}mN\bar{c}^2$

Definition: Relates pressure to molecular speed and mass.

Van der Waals Equation: $\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$

Definition: Modified gas equation for real gases accounting for molecular size and intermolecular forces.

1.3 Thermodynamics

First Law: $\Delta U = q + W$

Definition: Law of conservation of energy. Change in internal energy equals heat added to system plus work done on system.

Work: $W = -P_{\text{ext}}\Delta V$

Definition: Work done in expansion/compression at constant pressure.

Enthalpy: $H = U + PV$

Definition: Heat content at constant pressure.

Entropy: $\Delta S = \frac{q_{\text{rev}}}{T}$

Definition: Measure of disorder or randomness in system.

Gibbs Free Energy: $\Delta G = \Delta H - T\Delta S$

Definition: Predicts spontaneity of process. Negative ΔG indicates spontaneous process.

1.4 Chemical Equilibrium

Equilibrium Constant: $K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$ for $aA + bB \rightleftharpoons cC + dD$

Definition: Ratio of product concentrations to reactant concentrations at equilibrium.

Relationship: $K_p = K_c(RT)^{\Delta n_g}$

Definition: Relates concentration and pressure equilibrium constants.

Le Chatelier's Principle

Definition: System at equilibrium responds to counteract applied stress.

1.5 Electrochemistry

Ohm's Law: $V = IR$

Definition: Voltage equals current times resistance.

Conductivity: $\kappa = G \frac{l}{A}$

Definition: Measure of ability to conduct electric current.

Nernst Equation: $E = E^0 - \frac{RT}{nF} \ln Q$

Definition: Electrode potential under non-standard conditions.

Faraday's Laws:

First Law: $m = ZIt$

Second Law: $\frac{m_1}{m_2} = \frac{E_1}{E_2}$

Definition: Quantitative relationships in electrolysis.

Chapter 2

Organic Chemistry - Named Reactions

2.1 Alkyl Halides

Wurtz Reaction: $2\text{R-X} + 2\text{Na} \longrightarrow \text{R-R} + 2\text{NaX}$

Definition: Coupling of two alkyl halides with sodium metal to form alkane. Used for preparation of symmetrical alkanes.

Finkelstein Reaction: $\text{R-X} + \text{NaI} \longrightarrow \text{R-I} + \text{NaX}$

Definition: Halogen exchange reaction in acetone. Iodides prepared from chlorides/bromides.

Swarts Reaction: $\text{R-X} + \text{AgF} \longrightarrow \text{R-F} + \text{AgX}$

Definition: Preparation of fluorides from alkyl halides.

2.2 Aromatic Compounds

Friedel-Crafts Alkylation: $\text{Ar-H} + \text{R-X} \longrightarrow \text{Ar-R} + \text{HX}$ (with AlCl_3)

Definition: Introduction of alkyl group on aromatic ring using alkyl halide and Lewis acid catalyst.

Friedel-Crafts Acylation: $\text{Ar-H} + \text{RCOX} \longrightarrow \text{Ar-COR} + \text{HX}$ (with AlCl_3)

Definition: Introduction of acyl group on aromatic ring using acid chloride and Lewis acid catalyst.

Reimer-Tiemann Reaction: $\text{Ar-OH} + \text{CHCl}_3 + \text{NaOH} \longrightarrow \text{Ar-CHO}$

Definition: Formylation of phenols to produce salicylaldehyde.

2.3 Carbonyl Compounds

Cannizzaro Reaction: $2\text{Ar-CHO} + \text{NaOH} \longrightarrow \text{Ar-CH}_2\text{OH} + \text{Ar-COONa}$

Definition: Disproportionation of aldehydes lacking alpha-hydrogen in presence of strong base.

Clemmensen Reduction: $\text{Ar-COR} + 4[\text{H}] \longrightarrow \text{Ar-CH}_2\text{-R} + \text{H}_2\text{O}$ (with Zn-Hg/HCl)

Definition: Reduction of carbonyl to methylene group using zinc amalgam and hydrochloric acid.

Wolff-Kishner Reduction: $\text{Ar-COR} \longrightarrow \text{Ar-CH}_2\text{-R}$ (with $\text{NH}_2\text{NH}_2/\text{KOH}$)

Definition: Alternative method for carbonyl to methylene reduction using hydrazine and base.

Aldol Condensation: $2\text{R-CH}_2\text{-CHO} \longrightarrow \text{R-CH}_2\text{-CH(OH)-CH(R)-CHO}$

Definition: Carbon-carbon bond formation between carbonyl compounds having alpha-hydrogen.

Perkin Reaction: $\text{Ar-CHO} + (\text{CH}_3\text{CO})_2\text{O} \longrightarrow \text{Ar-CH=CH-COOH}$ (with CH_3COONa)

Definition: Synthesis of cinnamic acids from aromatic aldehydes and acid anhydrides.

2.4 Carboxylic Acids and Derivatives

Hell-Volhard-Zelinsky Reaction: $\text{R-COOH} \longrightarrow \text{R-CH}_2\text{-COOH}$ (with P, Br_2)

Definition: Alpha-bromination of carboxylic acids.

Claisen Condensation: $2\text{R-CH}_2\text{-COOR}' \longrightarrow \text{R-CH}_2\text{-CO-CH(R)-COOR}'$

Definition: Ester analogue of aldol condensation producing beta-keto esters.

Dieckmann Condensation: Intramolecular Claisen condensation

Definition: Cyclization via intramolecular ester condensation forming cyclic beta-keto esters.

2.5 Amines

Hofmann Bromamide Reaction: $\text{R-CONH}_2 + \text{Br}_2 + 4\text{NaOH} \longrightarrow \text{R-NH}_2 + 2\text{NaBr} + \text{Na}_2\text{CO}_3 + 2\text{H}_2\text{O}$

Definition: Conversion of amides to amines with one less carbon atom using bromine and sodium hydroxide.

Carbylamine Reaction: $\text{R-NH}_2 + \text{CHCl}_3 + 3\text{KOH} \longrightarrow \text{R-NC} + 3\text{KCl} + 3\text{H}_2\text{O}$

Definition: Test for primary amines producing isocyanides (bad smelling compounds).

Hinsberg Test: Distinguishes between 1°, 2°, and 3° amines

Definition: Reaction with benzenesulfonyl chloride for amine classification.

2.6 Important Tests

Tollens' Test: $\text{R-CHO} + 2[\text{Ag}(\text{NH}_3)_2]^+ + 3\text{OH}^- \longrightarrow \text{R-COO}^- + 2\text{Ag} + 4\text{NH}_3 + 2\text{H}_2\text{O}$

Definition: Test for aldehydes producing silver mirror. Aldehydes reduce Tollens' reagent to metallic silver.

Fehling's Test: $\text{R-CHO} + 2\text{Cu}^{2+} + 5\text{OH}^- \longrightarrow \text{R-COO}^- + \text{Cu}_2\text{O} + 3\text{H}_2\text{O}$

Definition: Test for aldehydes producing red precipitate of cuprous oxide.

Iodoform Test: $\text{CH}_3\text{-CH(OH)-R} + 4\text{I}_2 + 6\text{NaOH} \longrightarrow \text{CHI}_3 + \text{R-COONa} + 5\text{NaI} + 5\text{H}_2\text{O}$

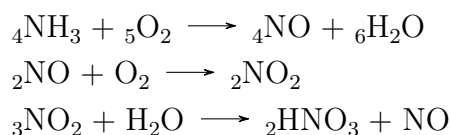
Definition: Test for methyl ketones and alcohols producing yellow precipitate of iodoform.

Chapter 3

Inorganic Chemistry - Important Processes

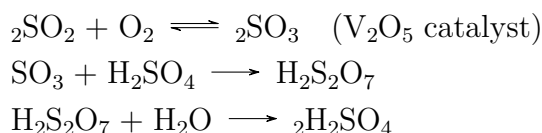
3.1 Industrial Processes

Ostwald Process:



Definition: Industrial production of nitric acid from ammonia through catalytic oxidation.

Contact Process:



Definition: Industrial production of sulfuric acid from sulfur dioxide.

Haber Process: $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$

Definition: Industrial synthesis of ammonia from nitrogen and hydrogen using iron catalyst at high pressure and temperature.

Down's Process: Electrolysis of molten NaCl for sodium metal

Definition: Industrial production of sodium metal by electrolysis of molten sodium chloride.

Castner-Kellner Process: Electrolysis of brine for NaOH

Definition: Industrial production of sodium hydroxide by electrolysis of brine using mercury cathode.

3.2 Extraction Processes

Mond Process: $\text{Ni} + 4\text{CO} \longrightarrow \text{Ni}(\text{CO})_4 \longrightarrow \text{Ni} + 4\text{CO}$

Definition: Purification of nickel via formation and decomposition of volatile nickel carbonyl.

Van Arkel Method: Purification of titanium and zirconium

Definition: Using iodine transport method to form volatile iodides which decompose to pure metal.

Thermite Process: $\text{Fe}_2\text{O}_3 + 2\text{Al} \longrightarrow 2\text{Fe} + \text{Al}_2\text{O}_3$

Definition: Reduction of metal oxides using aluminum as reducing agent, producing molten metal.

3.3 Coordination Compounds

Werner's Theory: Primary and secondary valences

Definition: Foundation of coordination chemistry proposing central metal atom with primary (ionizable) and secondary (non-ionizable) valences.

Valence Bond Theory: Hybridization in complexes

Definition: Explains geometry of complexes using hybridization concept.

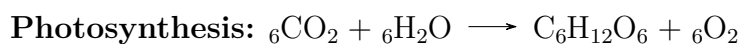
Crystal Field Theory: Splitting of d-orbitals

Definition: Explains color and magnetic properties of complexes based on d-orbital splitting in ligand field.

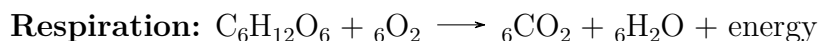
Chapter 4

Biomolecules and Polymers

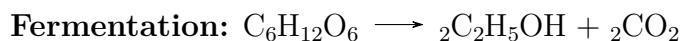
4.1 Biomolecules



Definition: Process by which plants convert light energy to chemical energy using chlorophyll.



Definition: Cellular process of energy production through oxidation of glucose.



Definition: Anaerobic breakdown of glucose to ethanol and carbon dioxide by microorganisms.

4.2 Analytical Chemistry

Beer-Lambert Law: $A = \epsilon cl$

Definition: Relationship between absorbance and concentration in spectrophotometry.

Raoult's Law: $P = P^0x$

Definition: Vapor pressure of ideal solutions is proportional to mole fraction of solvent.

Henry's Law: $P = K_Hx$

Definition: Solubility of gases in liquids proportional to pressure of gas over solution.