# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 1 : Solutions (NCERT)

## 1.1 Types of Solutions & Concentration Terms

| Concentration Term | Formula |
|---|---|
| **Mass percentage (w/w)** | = (mass of solute ÷ mass of solution) × 100 |
| **Volume percentage (v/v)** | = (volume of solute ÷ volume of solution) × 100 |
| **Mass by volume (w/v)** | = (mass of solute ÷ volume of solution) × 100 |
| **Parts per million (ppm)** | = (mass of solute ÷ mass of solution) × $10^6$ |
| **Mole fraction (x)** | $x_A = n_A \div (n_A + n_B)$ ; $x_A + x_B = 1$ |
| **Molarity (M)** | = moles of solute ÷ volume of solution (L) |
| **Molality (m)** | = moles of solute ÷ mass of solvent (kg) |
| **Normality (N)** | = gram equivalents of solute ÷ volume (L) |

## 1.2 Molarity vs Molality

| Concept | Detail |
|---|---|
| **Molarity depends on temperature** | Volume changes with temperature (M is temperature-dependent) |
| **Molality is temperature-independent** | Uses mass, which does not change with temperature |
| **Relation** | Molarity = (molality × density × 1000) ÷ (1000 + molality × $M_{solute}$) |
| **Dilution formula** | $M_1V_1 = M_2V_2$ |

## 1.3 Solubility & Henry's Law

| Concept | Formula / Statement |
|---|---|
| **Henry's law** | $p = K_H x$ (partial pressure ∝ mole fraction of gas) |
| **$K_H$ meaning** | Higher $K_H$ → lower solubility of the gas |
| **Effect of temperature** | Solubility of gas DECREASES with rise in temperature |
| **Effect of pressure (gas)** | Solubility of gas INCREASES with pressure |
| **Applications** | Soda bottles, scuba diving (bends), high-altitude breathing |

## 1.4 Raoult's Law & Vapour Pressure

| Concept | Formula |
|---|---|
| **Raoult's law (volatile solute)** | $p_A = p°_A x_A$ ; $p_B = p°_B x_B$ |
| **Total vapour pressure** | $p_{total} = p°_A x_A + p°_B x_B$ |
| **Raoult's law (non-volatile solute)** | $p_{solution} = p°_{solvent} \times x_{solvent}$ |
| **Relative lowering of VP** | $(p° - p) \div p° = x_{solute}$ |
| **Ideal solution** | Obeys Raoult's law ; $\Delta H_{mix} = 0$, $\Delta V_{mix} = 0$ |

| Concept | Formula |
|---|---|
| **Positive deviation** | p > Raoult ; weaker A-B forces (e.g. ethanol + acetone) |
| **Negative deviation** | p < Raoult ; stronger A-B forces (e.g. $HNO_3$ + water) |
| **Azeotropes** | Constant boiling mixtures (minimum or maximum boiling) |

## 1.5 Colligative Properties

| Property | Formula |
|---|---|
| **Relative lowering of VP** | $(p^\circ - p)/p^\circ = x_{solute} = (n_2)/(n_1 + n_2)$ |
| **Elevation of boiling point** | $\Delta T_b = K_b \times m$ |
| **Depression of freezing point** | $\Delta T_f = K_f \times m$ |
| **Molal elevation constant** | $K_b$ (ebullioscopic constant) |
| **Molal depression constant** | $K_f$ (cryoscopic constant) |
| **Osmotic pressure** | $\Pi = C\ R\ T = (n/V)\ R\ T$ |
| **Molar mass from osmotic pressure** | $M = (w\ R\ T) \div (\Pi\ V)$ |
| **Isotonic solutions** | Same osmotic pressure ($\Pi_1 = \Pi_2$) |

## 1.6 Van't Hoff Factor (i)

| Concept | Formula |
|---|---|
| **Van't Hoff factor** | i = (observed colligative property) ÷ (calculated) |
| **In terms of particles** | i = (actual particles after dissociation) ÷ (particles before) |
| **Modified formulas** | $\Delta T_b = i\ K_b\ m$ ; $\Delta T_f = i\ K_f\ m$ ; $\Pi = i\ C\ R\ T$ |
| **Dissociation (i > 1)** | Electrolytes split (e.g. NaCl → i ≈ 2) |
| **Association (i < 1)** | Molecules combine (e.g. benzoic acid in benzene → i ≈ 0.5) |
| **Degree of dissociation (α)** | $\alpha = (i - 1) \div (n - 1)$ |
| **Degree of association (α)** | $\alpha = (1 - i) \div (1 - 1/n)$ |



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|---|---|
| **Molarity vs molality** | Molarity uses solution VOLUME (temp-dependent) ; molality uses solvent MASS (temp-independent). |
| **Henry's law** | p = K_H x. High K_H → low solubility. Gas solubility falls as temperature rises. |
| **Raoult's law** | p = p°x. Relative lowering of VP = mole fraction of solute. |
| **Deviations** | Positive: weaker forces, p higher (ethanol+acetone). Negative: stronger, p lower ($HNO_3$+water). |
| **Colligative properties** | Depend on NUMBER of particles, not their nature. |
| **The four colligatives** | VP lowering, boiling pt elevation, freezing pt depression, osmotic pressure. |
| **Van't Hoff i** | i > 1 dissociation (NaCl ≈ 2) ; i < 1 association (benzoic acid ≈ 0.5). |

| | |
|---|---|
| **Osmotic pressure** | Π = CRT. Best method for finding molar mass of large molecules (polymers). |

# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 2 : Electrochemistry (NCERT)

## 2.1 Electrochemical Cells & Electrode Potential

| Concept | Detail |
|---|---|
| **Galvanic (voltaic) cell** | Chemical energy → electrical energy (spontaneous) |
| **Electrolytic cell** | Electrical energy → chemical reaction (non-spontaneous) |
| **Anode** | Oxidation occurs ; negative in galvanic, positive in electrolytic |
| **Cathode** | Reduction occurs ; positive in galvanic, negative in electrolytic |
| **Cell notation** | Anode \| anode soln \|\| cathode soln \| cathode |
| **Standard hydrogen electrode (SHE)** | Reference electrode ; $E^\circ = 0$ V |
| **EMF of cell** | $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$ (both as reduction potentials) |

## 2.2 Nernst Equation

| Concept | Formula |
|---|---|
| **Nernst equation (electrode)** | $E = E^\circ - (RT/nF) \ln Q$ |
| **At 298 K (simplified)** | $E = E^\circ - (0.0591/n) \log Q$ |
| **For a cell** | $E_{cell} = E^\circ_{cell} - (0.0591/n) \log Q$ |
| **At equilibrium** | $E_{cell} = 0$ ; $E^\circ_{cell} = (0.0591/n) \log K_c$ |
| **Relation E° and K** | $\log K_c = (n E^\circ_{cell}) \div 0.0591$ |
| **Gibbs energy & EMF** | $\Delta G^\circ = -n F E^\circ_{cell}$ |
| **F (Faraday constant)** | F = 96500 C/mol |

## 2.3 Conductance & Conductivity

| Quantity | Formula |
|---|---|
| **Resistance** | $R = \rho (l/A)$ ; unit ohm (Ω) |
| **Conductance** | $G = 1/R$ ; unit siemens (S) |
| **Conductivity (κ)** | $\kappa = 1/\rho = G \times (l/A)$ ; unit S $cm^{-1}$ |
| **Cell constant** | $G^* = l/A$ ; $\kappa = G \times$ cell constant |
| **Molar conductivity** | $\Lambda_m = (\kappa \times 1000) \div C$ ; unit S $cm^2$ $mol^{-1}$ |
| **Effect of dilution** | κ decreases ; $\Lambda_m$ increases on dilution |

## 2.4 Kohlrausch's Law

| Concept | Formula |
|---|---|
| **Limiting molar conductivity** | $\Lambda^\circ_m$ (at infinite dilution) |
| **Kohlrausch's law** | $\Lambda^\circ_m = \nu_+ \lambda^\circ_+ + \nu_- \lambda^\circ_-$ |

| Concept | Formula |
|---|---|
| **Degree of dissociation** | $\alpha = \Lambda_m \div \Lambda^\circ_m$ |
| **Dissociation constant (weak)** | $K_a = (C\,\alpha^2) \div (1 - \alpha)$ |
| **Application** | Find $\Lambda^\circ_m$ for weak electrolytes (e.g. $CH_3COOH$) |
| **Strong vs weak** | Strong: $\Lambda_m$ rises slightly on dilution ; Weak: rises sharply |

## 2.5 Faraday's Laws of Electrolysis

| Concept | Formula |
|---|---|
| **First law** | Mass deposited $m = Z \times Q = Z \times I \times t$ |
| **Electrochemical equivalent (Z)** | $Z = M \div (n\,F)$ |
| **Charge** | $Q = I \times t$ (current × time) |
| **Moles of electrons** | $= Q \div F = (I\,t) \div 96500$ |
| **Second law** | Masses deposited ∝ equivalent masses (same charge) |
| **Mass deposited** | $m = (M \times I \times t) \div (n \times 96500)$ |

## 2.6 Batteries & Corrosion

| Concept | Detail |
|---|---|
| **Primary cell** | Non-rechargeable (e.g. dry cell, mercury cell) |
| **Secondary cell** | Rechargeable (e.g. lead storage battery, Ni-Cd) |
| **Lead storage battery** | Anode: Pb ; Cathode: $PbO_2$ ; electrolyte: $H_2SO_4$ |
| **Fuel cell** | Converts fuel energy directly (e.g. $H_2$–$O_2$ fuel cell) |
| **Corrosion** | Oxidation of metal (e.g. rusting of iron) |
| **Rusting product** | Hydrated iron(III) oxide, $Fe_2O_3 \cdot xH_2O$ |
| **Prevention** | Galvanisation, painting, cathodic protection, alloying |

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|---|---|
| **Anode vs cathode** | Anode = oxidation, Cathode = reduction (always — 'An Ox, Red Cat'). |
| **Cell EMF** | $E^\circ cell = E^\circ cathode - E^\circ anode$ (both as reduction potentials). |
| **Nernst (298 K)** | $E = E^\circ - (0.0591/n) \log Q$. Concentration affects potential. |
| **ΔG & EMF** | $\Delta G^\circ = -nFE^\circ$. Positive $E^\circ$ → negative $\Delta G^\circ$ → spontaneous. |
| **Molar conductivity** | $\Lambda m = \kappa \times 1000/C$. Increases on dilution (more ionisation). |
| **Kohlrausch** | $\Lambda^\circ m$ = sum of ionic contributions ; $\alpha = \Lambda m/\Lambda^\circ m$. |
| **Faraday** | $m = MIt/(nF)$ ; $F = 96500$ C/mol = charge of 1 mole electrons. |
| **Lead battery** | Pb anode, $PbO_2$ cathode, $H_2SO_4$ electrolyte — rechargeable. |

# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 3 : Chemical Kinetics (NCERT)

## 3.1 Rate of Reaction

| Concept | Formula |
|---|---|
| **Average rate** | = ±(Δ[concentration]) ÷ Δt |
| **Instantaneous rate** | = ±(d[concentration]) ÷ dt |
| **For aA + bB → cC + dD** | rate = −(1/a)d[A]/dt = +(1/c)d[C]/dt |
| **Units of rate** | mol $L^{-1}$ $s^{-1}$ |
| **Reactant rate sign** | Negative (concentration decreases) |
| **Product rate sign** | Positive (concentration increases) |

## 3.2 Rate Law & Order

| Concept | Detail |
|---|---|
| **Rate law** | rate = k $[A]^x$ $[B]^y$ (x, y found experimentally) |
| **Order of reaction** | = x + y (sum of exponents) |
| **Molecularity** | Number of species in an elementary step (1, 2, 3) |
| **Order vs molecularity** | Order can be 0/fractional ; molecularity is a whole number |
| **Rate constant (k)** | Rate when all concentrations = 1 (specific rate) |
| **Units of k (order n)** | $(\text{mol } L^{-1})^{(1-n)}$ $s^{-1}$ |

## 3.3 Integrated Rate Equations

| Order | Integrated Equation & Half-life |
|---|---|
| **Zero order** | $[A] = [A]_0 - kt$ ; $k = ([A]_0 - [A]) \div t$ |
| **Zero order half-life** | $t_{1/2} = [A]_0 \div (2k)$ |
| **First order** | $k = (2.303/t) \log([A]_0/[A])$ |
| **First order (alt form)** | $\ln[A] = \ln[A]_0 - kt$ |
| **First order half-life** | $t_{1/2} = 0.693 \div k$ (independent of concentration) |
| **Units of k (zero order)** | mol $L^{-1}$ $s^{-1}$ |
| **Units of k (first order)** | $s^{-1}$ ($time^{-1}$) |

## 3.4 Half-life & Special Cases

| Concept | Formula |
|---|---|
| **Half-life (general, order n)** | $t_{1/2} \propto [A]_0^{(1-n)}$ |
| **Zero order: $t_{1/2}$** | $\propto [A]_0$ (directly proportional) |
| **First order: $t_{1/2}$** | Constant (independent of concentration) |

| Concept | Formula |
|---|---|
| **Pseudo first order** | Reaction appears first order (one reactant in excess, e.g. hydrolysis) |
| **Example** | Hydrolysis of ester / sucrose inversion (water in excess) |

## 3.5 Temperature Dependence — Arrhenius Equation

| Concept | Formula |
|---|---|
| **Arrhenius equation** | $k = A\, e^{(-Ea/RT)}$ |
| **Logarithmic form** | $\ln k = \ln A - (E_a \div RT)$ |
| **Two temperatures** | $\log(k_2/k_1) = (E_a/2.303R)[(T_2-T_1)/(T_1T_2)]$ |
| **A = frequency factor** | Total collision frequency (pre-exponential factor) |
| **$E_a$ = activation energy** | Minimum energy needed for reaction |
| **Temperature coefficient** | Rate roughly doubles for every 10°C rise |
| **Graph of ln k vs 1/T** | Straight line ; slope = $-E_a/R$ |

## 3.6 Collision Theory & Catalysis

| Concept | Detail |
|---|---|
| **Collision frequency (Z)** | Number of collisions per second per unit volume |
| **Effective collisions** | Need proper orientation + energy ≥ $E_a$ |
| **Rate (collision theory)** | rate = $P\, Z\, e^{(-Ea/RT)}$ (P = steric/probability factor) |
| **Threshold energy** | = activation energy + average energy of reactants |
| **Catalyst** | Provides an alternate path with LOWER $E_a$ |
| **Catalyst effect** | Speeds both forward & backward equally ; does not change ΔH or K |

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|---|---|
| **Rate basics** | Rate = −(1/a)d[A]/dt. Reactant: negative ; product: positive. |
| **Order vs molecularity** | Order: experimental, can be 0/fractional. Molecularity: whole number from mechanism. |
| **First order** | $k = (2.303/t)\log([A]_0/[A])$ ; $t½ = 0.693/k$ (concentration-independent). |
| **Zero order** | $[A] = [A]_0 - kt$ ; $t½ = [A]_0/2k$ (proportional to concentration). |
| **Units of k** | Zero: mol $L^{-1}s^{-1}$ ; First: $s^{-1}$. Units reveal the order. |
| **Arrhenius** | $k = Ae^{(-Ea/RT)}$. Higher T or lower Ea → faster reaction. |
| **Rate doubles** | Roughly doubles per 10°C rise (temperature coefficient ≈ 2). |
| **Catalyst** | Lowers Ea via a new path. Does NOT change ΔH or equilibrium constant. |

# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 4 : The d- and f-Block Elements (NCERT)

## 4.1 Position & General Introduction

| Concept | Detail |
|---|---|
| **d-block elements** | Groups 3–12 ; last electron enters d-orbital |
| **Transition element (definition)** | Has partially filled d-orbital in atom OR in a stable ion |
| **Four series** | 3d (Sc–Zn), 4d (Y–Cd), 5d (La, Hf–Hg), 6d (incomplete) |
| **General configuration** | $(n-1)d^{(1-10)}\ ns^{(1-2)}$ |
| **Zn, Cd, Hg** | Not typical transition metals ($d^{10}$, fully filled) |
| **f-block elements** | Lanthanoids (4f) and Actinoids (5f) ; inner transition |

## 4.2 General Properties of Transition Metals

| Property | Trend / Detail |
|---|---|
| **Metallic character** | All are metals ; hard, high m.p. & b.p. (strong metallic bonding) |
| **Atomic radius** | Decreases then nearly constant across a series |
| **Ionisation enthalpy** | Increases across the series (irregularly) |
| **Variable oxidation states** | Due to similar energy of $(n-1)d$ and ns electrons |
| **Common oxidation states** | Mn shows max range (+2 to +7) |
| **Catalytic property** | Variable states + surface adsorption (e.g. Fe, $V_2O_5$, Ni) |
| **Complex formation** | Small size, high charge, vacant d-orbitals |
| **Alloy formation** | Similar radii → readily form alloys |

## 4.3 Colour, Magnetism & Special Behaviour

| Property | Explanation / Formula |
|---|---|
| **Coloured ions** | d–d transition of electrons (absorb visible light) |
| **Colourless ions** | $d^0$ (e.g. $Sc^{3+}$) or $d^{10}$ (e.g. $Zn^{2+}$) → no d–d transition |
| **Magnetic moment (spin only)** | $\mu = \sqrt{n(n+2)}$ BM (n = unpaired electrons) |
| **Paramagnetic** | Has unpaired electrons (attracted to magnetic field) |
| **Diamagnetic** | All electrons paired |
| **Catalytic examples** | Fe (Haber), $V_2O_5$ (contact process), Ni (hydrogenation) |
| **Interstitial compounds** | Small atoms (H, C, N) occupy lattice gaps → hard, high m.p. |

## 4.4 Important Compounds

| Compound | Detail |
|---|---|
| **Potassium dichromate** | $K_2Cr_2O_7$ ; orange ; strong oxidising agent |

| Compound | Detail |
|---|---|
| **Dichromate–chromate equilibrium** | $Cr_2O_7^{2-} + 2OH^- \rightleftharpoons 2CrO_4^{2-} + H_2O$ (orange ⇌ yellow) |
| **Cr in dichromate** | Oxidation state +6 |
| **Potassium permanganate** | $KMnO_4$ ; purple ; strong oxidising agent |
| **Mn in permanganate** | Oxidation state +7 |
| **$KMnO_4$ in acidic medium** | $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ |
| **Preparation of $KMnO_4$** | From pyrolusite ($MnO_2$) → fuse → oxidise |

## 4.5 Lanthanoids & Actinoids

| Concept | Detail |
|---|---|
| **Lanthanoids** | Ce (58) to Lu (71) ; filling of 4f orbitals |
| **Lanthanoid contraction** | Steady decrease in size due to poor 4f shielding |
| **Consequences of contraction** | Similar size of 4d & 5d elements ; hard to separate lanthanoids |
| **Common oxidation state (Ln)** | +3 (most stable) |
| **Actinoids** | Th (90) to Lr (103) ; filling of 5f orbitals |
| **Actinoid features** | Radioactive ; show more oxidation states than lanthanoids |
| **Actinoid contraction** | Greater than lanthanoid (5f shields even more poorly) |

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|---|---|
| **Transition definition** | Partially filled d-orbital in ATOM or a stable ION (so Zn/Cd/Hg aren't typical). |
| **Variable oxidation** | (n−1)d and ns have close energy → many states. Mn: +2 to +7 (widest). |
| **Magnetic moment** | μ = √(n(n+2)) BM. n = number of unpaired electrons. |
| **Colour** | d–d transitions cause colour. $d^0$ and $d^{10}$ ions are colourless. |
| **Dichromate/chromate** | Orange $Cr_2O_7^{2-}$ (acidic) ⇌ yellow $CrO_4^{2-}$ (basic). Cr is +6. |
| **Permanganate** | $KMnO_4$ purple, Mn is +7 ; acidic medium → $Mn^{2+}$ (5 electrons). |
| **Lanthanoid contraction** | Poor 4f shielding shrinks size — makes 4d/5d elements similar. |
| **Lanthanoids vs actinoids** | Ln: mostly +3, non-radioactive. An: many states, radioactive. |

# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 5 : Coordination Compounds (NCERT)

## 5.1 Basic Terms

| Term | Definition |
|---|---|
| **Coordination compound** | Contains a central metal atom/ion bonded to ligands by coordinate bonds |
| **Central atom/ion** | Metal that accepts electron pairs (Lewis acid) |
| **Ligand** | Ion/molecule that donates an electron pair (Lewis base) |
| **Coordination number** | Number of ligand donor atoms bonded to the central metal |
| **Coordination sphere** | Central metal + ligands, written inside square brackets |
| **Counter ion** | Ion outside the coordination sphere |
| **Oxidation number of metal** | Charge on metal after removing ligands with their charges |

## 5.2 Types of Ligands

| Type | Detail / Example |
|---|---|
| **Monodentate** | One donor atom (e.g. $Cl^-$, $H_2O$, $NH_3$, $CN^-$) |
| **Bidentate** | Two donor atoms (e.g. ethylenediamine 'en', oxalate) |
| **Polydentate** | Many donor atoms (e.g. EDTA — hexadentate) |
| **Chelate ligand** | Bidentate/polydentate forming a ring → extra stability |
| **Ambidentate ligand** | Can attach via two different atoms (e.g. $NO_2^-$ / $ONO^-$, $SCN^-$ / $NCS^-$) |
| **Chelate effect** | Ring-forming ligands give more stable complexes |

## 5.3 IUPAC Nomenclature Rules

| Rule | Detail |
|---|---|
| **Order in formula** | Cation first, then anion ; metal before ligands inside brackets |
| **Order in naming** | Ligands (alphabetical) named first, then the metal |
| **Anionic ligands end in** | '-o' (chloro, cyano, hydroxo, sulphato) |
| **Neutral ligands** | aqua ($H_2O$), ammine ($NH_3$), carbonyl (CO), nitrosyl (NO) |
| **Number of ligands** | di, tri, tetra (or bis, tris for complex names) |
| **Metal in anionic complex** | ends in '-ate' (e.g. ferrate, cuprate, argentate) |
| **Oxidation state** | Roman numeral in brackets after the metal |

## 5.4 Isomerism in Coordination Compounds

| Isomerism | Detail |
|---|---|
| **Structural — Ionisation** | Different ions in solution (e.g. $SO_4$ vs Br exchange) |
| **Structural — Linkage** | Ambidentate ligand binds via different atoms ($NO_2$ / ONO) |

| Isomerism | Detail |
|---|---|
| **Structural — Coordination** | Ligand swap between cation & anion complex |
| **Structural — Hydrate** | Water inside vs outside coordination sphere |
| **Stereo — Geometrical** | cis / trans (and fac / mer) arrangements |
| **Stereo — Optical** | Non-superimposable mirror images (chiral, d & l forms) |

## 5.5 Werner's Theory & Valence Bond Theory

| Concept | Detail |
|---|---|
| **Primary valency** | Ionisable ; satisfied by negative ions (= oxidation state) |
| **Secondary valency** | Non-ionisable ; satisfied by ligands (= coordination number) |
| **VBT idea** | Metal uses hybrid orbitals to accept ligand electron pairs |
| **CN 6 (inner orbital)** | $d^2sp^3$ hybridisation → octahedral, low spin |
| **CN 6 (outer orbital)** | $sp^3d^2$ hybridisation → octahedral, high spin |
| **CN 4 (tetrahedral)** | $sp^3$ hybridisation |
| **CN 4 (square planar)** | $dsp^2$ hybridisation (e.g. $[Ni(CN)_4]^{2-}$) |

## 5.6 Crystal Field Theory (CFT)

| Concept | Detail / Formula |
|---|---|
| **CFT idea** | Ligands split d-orbitals into two energy levels |
| **Octahedral splitting** | $t_{2g}$ (lower) and $e_g$ (higher) ; gap = $\Delta_o$ |
| **Tetrahedral splitting** | e (lower) and $t_2$ (higher) ; $\Delta_t = (4/9)\Delta_o$ |
| **Spectrochemical series** | $I^- < Br^- < Cl^- < F^- < H_2O < NH_3 < en < CN^- < CO$ |
| **Strong field ligand** | Large Δ → low spin (electrons pair up) |
| **Weak field ligand** | Small Δ → high spin (electrons stay unpaired) |
| **CFSE** | Crystal field stabilisation energy (extra stability) |
| **Cause of colour** | d–d transition across the Δ gap |

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|---|---|
| **Coordination number** | Count ligand DONOR atoms, not ligands (bidentate counts as 2). |
| **Naming order** | Name ligands alphabetically first, then metal. Anion complex → '-ate'. |
| **Ambidentate** | Binds via different atoms: $NO_2^-$/$ONO^-$, $SCN^-$/$NCS^-$ → linkage isomerism. |
| **Chelate effect** | Ring-forming (poly)dentate ligands give EXTRA stability. |
| **Werner valencies** | Primary = oxidation state (ionisable) ; Secondary = coordination number. |
| **VBT hybridisation** | Octahedral: $d^2sp^3$ (inner) or $sp^3d^2$ (outer). Square planar: $dsp^2$. |
| **Spectrochemical series** | CO, $CN^-$ strong (low spin) ; $I^-$, $Br^-$ weak (high spin). |

| | |
|---|---|
| **Colour & CFT** | d–d transition across Δ. Strong field → larger Δ → different colour. |

# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 6 : Haloalkanes and Haloarenes (NCERT)

## 6.1 Classification & Nomenclature

| Concept | Detail |
|---|---|
| **Haloalkane (alkyl halide)** | Halogen attached to $sp^3$ carbon (R–X) |
| **Haloarene (aryl halide)** | Halogen attached to $sp^2$ carbon of an aromatic ring |
| **Primary (1°)** | Halogen on a carbon attached to one other carbon |
| **Secondary (2°)** | Halogen on a carbon attached to two carbons |
| **Tertiary (3°)** | Halogen on a carbon attached to three carbons |
| **Allylic halide** | X on carbon next to C=C double bond |
| **Benzylic halide** | X on carbon attached to benzene ring |
| **Vinylic / aryl halide** | X on $sp^2$ carbon (unreactive to substitution) |

## 6.2 Methods of Preparation

| Method | Reaction |
|---|---|
| **From alcohols (with HX)** | $R–OH + HX \rightarrow R–X + H_2O$ |
| **With $PCl_3$ / $PCl_5$ / $SOCl_2$** | $R–OH \rightarrow R–Cl$ ($SOCl_2$ gives purest product) |
| **Free radical halogenation** | Alkane + $X_2$ (UV light) → haloalkane + HX |
| **From alkenes (HX addition)** | Markovnikov addition gives the major product |
| **Finkelstein reaction** | $R–Cl + NaI \rightarrow R–I + NaCl$ (in dry acetone) |
| **Swarts reaction** | $R–X + AgF / Hg_2F_2 \rightarrow R–F$ |
| **Sandmeyer reaction** | Aryl diazonium salt + CuX → aryl halide |

## 6.3 Nucleophilic Substitution — SN1 vs SN2

| Feature | SN1 | SN2 |
|---|---|---|
| **Molecularity** | Unimolecular | Bimolecular |
| **Steps** | Two (carbocation intermediate) | One (concerted) |
| **Rate depends on** | [substrate] only | [substrate] and [nucleophile] |
| **Favoured by** | 3° halides | 1° halides |
| **Solvent** | Polar protic | Polar aprotic |
| **Stereochemistry** | Racemisation | Inversion (Walden) |
| **Reactivity order** | 3° > 2° > 1° | 1° > 2° > 3° |

## 6.4 Elimination & Other Reactions

| Reaction | Detail |
|---|---|
| **Dehydrohalogenation (β-elimination)** | R–X + alc. KOH → alkene + KX + $H_2O$ |
| **Saytzeff's rule** | More substituted (stable) alkene is the major product |
| **With aqueous KOH** | Gives alcohol (substitution), not alkene |
| **Wurtz reaction** | 2R–X + 2Na → R–R + 2NaX (alkane) |
| **Reaction with metals** | Grignard reagent: R–X + Mg (dry ether) → R–Mg–X |
| **Reduction** | R–X + $H_2$ / Zn-HCl → R–H (alkane) |

## 6.5 Haloarenes — Low Reactivity & Reactions

| Concept | Detail |
|---|---|
| **Why less reactive** | Resonance (partial double bond character of C–X) + $sp^2$ carbon |
| **C–X bond** | Shorter and stronger than in haloalkanes |
| **Nucleophilic substitution** | Needs harsh conditions (high T, P) or activating groups |
| **Effect of −$NO_2$ groups** | −$NO_2$ at ortho/para greatly increases reactivity |
| **Electrophilic substitution** | Halogen is o/p-directing but deactivating |
| **Wurtz–Fittig reaction** | Aryl + alkyl halide + Na → alkylarene |
| **Fittig reaction** | 2 Aryl halide + Na → biaryl |

## 6.6 Polyhalogen Compounds & Optical Activity

| Concept | Detail |
|---|---|
| **Chloroform ($CHCl_3$)** | Anaesthetic ; stored in dark (forms toxic phosgene in light) |
| **Carbon tetrachloride ($CCl_4$)** | Fire extinguisher (pyrene) ; harms ozone layer |
| **DDT** | Insecticide ; non-biodegradable, banned in many countries |
| **Freons (CFCs)** | Refrigerants ; deplete the ozone layer |
| **Chirality** | Carbon with 4 different groups is a chiral (stereo) centre |
| **Enantiomers** | Non-superimposable mirror images ; rotate plane-polarised light oppositely |
| **Racemic mixture** | 50:50 enantiomers ; optically inactive (net rotation 0) |

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|---|---|
| **SN1 vs SN2** | SN1: 3° halides, carbocation, racemisation. SN2: 1° halides, inversion. |
| **Reactivity orders** | SN1: 3°>2°>1° ; SN2: 1°>2°>3° (exactly opposite). |
| **Finkelstein** | R–Cl/Br + NaI in dry acetone → R–I (halide exchange). |
| **Saytzeff** | Elimination gives the MORE substituted (more stable) alkene. |
| **aq vs alc KOH** | Aqueous KOH → alcohol (substitution) ; alcoholic KOH → alkene (elimination). |
| **Haloarene low reactivity** | Resonance + $sp^2$ carbon shorten/strengthen the C–X bond. |

| | |
|---|---|
| **$-NO_2$ activates** | Nitro groups at ortho/para boost nucleophilic substitution in haloarenes. |
| **Chirality** | 4 different groups on a carbon → chiral. Equal enantiomers → racemic (inactive). |

# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 7 : Alcohols, Phenols and Ethers (NCERT)

## 7.1 Classification & Structure

| Concept | Detail |
|---|---|
| **Alcohol** | –OH attached to $sp^3$ carbon (R–OH) |
| **Phenol** | –OH attached directly to aromatic ring ($C_6H_5OH$) |
| **Ether** | R–O–R' (oxygen bonded to two carbons) |
| **1°, 2°, 3° alcohol** | Based on carbon bearing –OH (one, two, three C attached) |
| **Mono / di / trihydric** | Number of –OH groups present |
| **C–O–H bond angle** | Around 109° (alcohol) ; bent shape |

## 7.2 Preparation of Alcohols

| Method | Reaction |
|---|---|
| **Hydration of alkenes** | Alkene + $H_2O$ / $H^+$ → alcohol (Markovnikov) |
| **Hydroboration-oxidation** | Alkene → anti-Markovnikov alcohol ($B_2H_6$ then $H_2O_2/OH^-$) |
| **From haloalkanes** | R–X + aqueous KOH → R–OH |
| **Reduction of aldehyde/ketone** | Carbonyl + $H_2$ (or $NaBH_4/LiAlH_4$) → alcohol |
| **From Grignard reagent** | R–MgX + carbonyl → alcohol (after hydrolysis) |
| **Reduction of carboxylic acid** | RCOOH + $LiAlH_4$ → 1° alcohol |

## 7.3 Preparation of Phenols

| Method | Reaction |
|---|---|
| **From chlorobenzene (Dow process)** | $C_6H_5Cl$ + NaOH (high T, P) → phenol |
| **From benzene sulphonic acid** | Fuse with NaOH → sodium phenoxide → phenol |
| **From diazonium salt** | $C_6H_5N_2^+$ + $H_2O$ (warm) → phenol + $N_2$ |
| **From cumene** | Cumene + $O_2$ → cumene hydroperoxide → phenol + acetone |

## 7.4 Properties of Alcohols & Phenols

| Property | Detail |
|---|---|
| **Acidity order** | Phenol > water > alcohol (phenoxide ion is resonance-stabilised) |
| **Acidity among alcohols** | 1° > 2° > 3° (electron-donating groups lower acidity) |
| **Effect of $-NO_2$ on phenol** | Increases acidity (especially at ortho/para) |
| **Reaction with Na** | Both give alkoxide/phenoxide + $H_2$ gas |
| **Esterification** | Alcohol + acid → ester + water (acid catalysed) |
| **Oxidation of 1° alcohol** | → aldehyde → carboxylic acid |

| Property | Detail |
|---|---|
| **Oxidation of 2° alcohol** | → ketone |
| **3° alcohol** | Resistant to oxidation (no H on C–OH) |

## 7.5 Important Reactions

| Reaction | Detail |
|---|---|
| **Dehydration of alcohol** | Conc. $H_2SO_4$ → alkene (3° easiest, follows Saytzeff) |
| **Lucas test** | Distinguishes 1°/2°/3° alcohols (turbidity speed with Lucas reagent) |
| **Victor Meyer test** | Distinguishes 1°/2°/3° alcohols by colour |
| **Reimer-Tiemann (phenol)** | Phenol + $CHCl_3$/NaOH → salicylaldehyde |
| **Kolbe's reaction (phenol)** | Sodium phenoxide + $CO_2$ → salicylic acid |
| **Bromination of phenol** | With $Br_2$ water → 2,4,6-tribromophenol (white ppt) |
| **Phenol + $FeCl_3$** | Violet colour (test for phenol) |

## 7.6 Ethers — Preparation & Reactions

| Concept | Reaction / Detail |
|---|---|
| **Williamson synthesis** | R–X + R'–$O^-Na^+$ → R–O–R' (best for ethers) |
| **Best for Williamson** | Use 1° alkyl halide (avoids elimination) |
| **Dehydration of alcohol** | 2 R–OH + $H_2SO_4$ (413 K) → R–O–R (symmetrical ether) |
| **Cleavage by HX** | R–O–R' + HX → R–X + R'–OH (HI most reactive) |
| **Cleavage product rule** | Lower alkyl group forms the halide (3° forms alkene with HI) |
| **Anisole reactions** | Electrophilic substitution at ortho/para (–$OCH_3$ activates ring) |

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| | |
|---|---|
| **Acidity order** | Phenol > water > alcohol. Phenoxide is resonance-stabilised. |
| **Oxidation** | 1° → aldehyde → acid ; 2° → ketone ; 3° → resists oxidation. |
| **Dehydration ease** | 3° > 2° > 1° (more stable carbocation). Follows Saytzeff. |
| **Lucas test** | 3° turns turbid immediately, 2° in 5 min, 1° only on heating. |
| **Williamson** | R–X + alkoxide → ether. Use 1° halide to avoid elimination. |
| **Ether cleavage** | HI cleaves ethers ; lower alkyl group becomes the iodide. |
| **Phenol tests** | $FeCl_3$ → violet colour ; $Br_2$ water → white tribromophenol ppt. |
| **Hydroboration** | Gives anti-Markovnikov alcohol (opposite of acid hydration). |

# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 8 : Aldehydes, Ketones and Carboxylic Acids (NCERT)

## 8.1 Structure & Nomenclature

| Group | Detail |
|---|---|
| **Aldehyde** | –CHO (carbonyl at chain end) ; suffix -al |
| **Ketone** | C=O between two carbons ; suffix -one |
| **Carbonyl group** | C=O ; carbon is $sp^2$, planar, polar |
| **Carboxylic acid** | –COOH ; suffix -oic acid |
| **Carbonyl polarity** | C is δ+ (electrophilic), O is δ− |
| **Reactivity (nucleophilic addition)** | Aldehyde > ketone (less steric + more +ve C) |

## 8.2 Preparation of Aldehydes & Ketones

| Method | Reaction |
|---|---|
| **Oxidation of alcohols** | 1° → aldehyde ; 2° → ketone |
| **Ozonolysis of alkenes** | Alkene + $O_3$ → aldehydes/ketones |
| **Rosenmund reduction** | Acyl chloride + $H_2$/Pd-$BaSO_4$ → aldehyde |
| **Stephen reaction** | Nitrile + $SnCl_2$/HCl → aldehyde |
| **From nitriles (Grignard)** | RCN + R'MgX → ketone (after hydrolysis) |
| **Friedel-Crafts acylation** | Benzene + acyl chloride / anhydride → aryl ketone |
| **Gattermann-Koch** | Benzene + CO + HCl ($AlCl_3$) → benzaldehyde |

## 8.3 Nucleophilic Addition Reactions

| Reaction | Product |
|---|---|
| **With HCN** | Cyanohydrin |
| **With $NaHSO_3$** | Bisulphite addition product (used in purification) |
| **With alcohol** | Hemiacetal → acetal |
| **With ammonia derivatives** | Imines / oximes / hydrazones (condensation) |
| **With 2,4-DNP** | 2,4-dinitrophenylhydrazone (orange-yellow ppt ; test for C=O) |
| **Reduction ($NaBH_4$/$LiAlH_4$)** | Alcohol (1° from aldehyde, 2° from ketone) |
| **Clemmensen reduction** | C=O → $CH_2$ (Zn-Hg / HCl) |
| **Wolff-Kishner reduction** | C=O → $CH_2$ ($NH_2NH_2$ / KOH) |

## 8.4 Oxidation & Special Reactions

| Reaction | Detail |
|---|---|
| **Tollens' test** | Aldehyde + ammoniacal $AgNO_3$ → silver mirror |

| Reaction | Detail |
|---|---|
| **Fehling's test** | Aldehyde + Fehling's → red-brown $Cu_2O$ ppt |
| **Distinguishing test** | Aldehydes give both ; ketones do NOT |
| **Iodoform test** | $CH_3CO–$ group (or $CH_3CHOH–$) → yellow $CHI_3$ ppt |
| **Aldol condensation** | α-H aldehyde/ketone + base → β-hydroxy carbonyl |
| **Cannizzaro reaction** | Aldehyde with NO α-H + conc. NaOH → alcohol + acid salt |
| **Cross aldol** | Two different carbonyls with α-H |

## 8.5 Carboxylic Acids

| Concept | Detail |
|---|---|
| **Acidity** | Stronger than alcohols/phenols (resonance-stabilised carboxylate) |
| **Effect of −I groups** | Electron-withdrawing groups increase acidity (e.g. Cl) |
| **Effect of +I groups** | Alkyl groups decrease acidity |
| **Preparation (oxidation)** | 1° alcohol / aldehyde → carboxylic acid |
| **From nitriles** | $RCN + H_2O/H^+ \rightarrow RCOOH$ |
| **From Grignard** | $R–MgX + CO_2 \rightarrow RCOOH$ (after hydrolysis) |
| **HVZ reaction** | α-halogenation of acids (with $X_2$ / red P) |
| **Decarboxylation** | $RCOONa + NaOH\ (CaO) \rightarrow R–H + Na_2CO_3$ |

## 8.6 Acidity Comparison & Derivatives

| Concept | Detail |
|---|---|
| **Acid strength order** | $HCOOH > CH_3COOH$ > other higher acids |
| **Substituent effect** | $Cl\text{-}CH_2COOH > CH_3COOH$ (electron withdrawal helps) |
| **Position of halogen** | Closer to –COOH → stronger acid |
| **Reaction with $NaHCO_3$** | Carboxylic acids give $CO_2$ (phenols do not) — distinguishing test |
| **Esterification** | Acid + alcohol → ester + water (reversible, acid-catalysed) |
| **Acid derivatives** | Acid chloride, anhydride, ester, amide (decreasing reactivity) |

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| | |
|---|---|
| **Reactivity to nucleophiles** | Aldehyde > ketone (less steric hindrance, more +ve carbon). |
| **Tollens/Fehling** | Only ALDEHYDES give silver mirror / red $Cu_2O$. Ketones don't. |
| **Iodoform test** | Positive for $CH_3CO–$ group and $CH_3CHOH–$ → yellow $CHI_3$. |
| **Cannizzaro** | Aldehydes with NO α-H disproportionate (one oxidised, one reduced). |
| **Aldol needs α-H** | Aldol condensation requires an α-hydrogen ; Cannizzaro requires NONE. |
| **Acidity order** | Carboxylic acid > phenol > water > alcohol. |

| | |
|---|---|
| **$NaHCO_3$ test** | Acids release $CO_2$ with $NaHCO_3$ ; phenols do not — key distinction. |
| **Reductions** | Clemmensen (Zn-Hg/HCl) & Wolff-Kishner ($NH_2NH_2$/KOH): C=O → $CH_2$. |

# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 9 : Amines (NCERT)

## 9.1 Classification & Structure

| Concept | Detail |
|---|---|
| **Amine** | Derivative of ammonia ($NH_3$) ; one+ H replaced by alkyl/aryl |
| **Primary (1°)** | $R–NH_2$ (one carbon on N) |
| **Secondary (2°)** | $R_2NH$ (two carbons on N) |
| **Tertiary (3°)** | $R_3N$ (three carbons on N) |
| **Aliphatic amine** | N bonded to alkyl group(s) |
| **Aromatic amine** | N bonded directly to aromatic ring (e.g. aniline) |
| **Shape** | Pyramidal ($sp^3$ N with lone pair) |

## 9.2 Methods of Preparation

| Method | Reaction |
|---|---|
| **Reduction of nitro compounds** | $R–NO_2 + H_2/Ni$ (or Sn/HCl) → $R–NH_2$ |
| **Ammonolysis of haloalkanes** | $R–X + NH_3 \rightarrow R–NH_2$ (gives a mixture) |
| **Reduction of nitriles** | $RCN + H_2/Ni$ (or $LiAlH_4$) → $R–CH_2–NH_2$ |
| **Reduction of amides** | $RCONH_2 + LiAlH_4 \rightarrow R–CH_2–NH_2$ |
| **Gabriel phthalimide synthesis** | Gives pure 1° amine (not for aryl amines) |
| **Hoffmann bromamide degradation** | $RCONH_2 + Br_2/KOH \rightarrow R–NH_2$ (one C less) |

## 9.3 Basic Strength of Amines

| Concept | Detail |
|---|---|
| **Basicity reason** | Lone pair on N accepts a proton (Lewis base) |
| **In gas phase** | 3° > 2° > 1° > $NH_3$ (inductive effect) |
| **In aqueous (aliphatic)** | 2° > 1° > 3° > $NH_3$ (balance of +I, solvation, steric) |
| **Aromatic amines** | Weaker bases than ammonia (lone pair delocalised into ring) |
| **Aniline vs alkyl amine** | Aniline is much weaker (resonance stabilises lone pair) |
| **Electron-withdrawing groups** | Decrease basicity (e.g. nitroaniline) |
| **Electron-donating groups** | Increase basicity (e.g. toluidine) |

## 9.4 Chemical Reactions

| Reaction | Detail |
|---|---|
| **With acids** | Form salts ($R–NH_2 + HCl \rightarrow R–NH_3^+Cl^-$) |
| **Acylation** | Amine + acyl chloride → amide |

| Reaction | Detail |
|---|---|
| **Carbylamine reaction** | 1° amine + $CHCl_3$ + KOH → isocyanide (foul smell ; test for 1° amine) |
| **Hinsberg test** | Distinguishes 1°, 2°, 3° amines (with benzenesulphonyl chloride) |
| **Reaction with $HNO_2$ (1° aliphatic)** | → alcohol + $N_2$ gas |
| **Reaction with $HNO_2$ (1° aromatic)** | → diazonium salt (at 0-5°C) |
| **Bromination of aniline** | → 2,4,6-tribromoaniline (white ppt) with $Br_2$ water |

## 9.5 Diazonium Salts

| Reaction | Product |
|---|---|
| **Formation** | Aniline + $NaNO_2$/HCl (0-5°C) → benzenediazonium chloride |
| **Sandmeyer (–Cl, –Br)** | With CuCl/CuBr → chloro/bromo benzene |
| **Sandmeyer (–CN)** | With CuCN → benzonitrile |
| **Replacement by –I** | With KI → iodobenzene |
| **Replacement by –OH** | Warm with water → phenol |
| **Replacement by –H** | With $H_3PO_2$ → benzene |
| **Coupling reaction** | With phenol/aniline → azo dye (coloured) |

## ★ QUICK MEMORY AIDS & TRICKS

| | |
|---|---|
| **Basicity (aqueous)** | Aliphatic amines: 2° > 1° > 3° > $NH_3$. Aromatic amines are weaker than $NH_3$. |
| **Why aniline weak** | Lone pair delocalised into the ring → less available for protonation. |
| **Carbylamine test** | Only 1° amines give foul-smelling isocyanide (with $CHCl_3$/KOH). |
| **Hinsberg test** | Distinguishes 1°/2°/3° amines using benzenesulphonyl chloride. |
| **Gabriel synthesis** | Gives PURE 1° amine ; fails for aromatic amines. |
| **Hoffmann degradation** | Amide → amine with ONE carbon less ($Br_2$/KOH). |
| **Diazonium key** | Made at 0-5°C ; gateway to many aromatic compounds (Sandmeyer etc.). |
| **Coupling → dyes** | Diazonium + phenol/aniline → coloured azo dyes. |

# CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 10 : Biomolecules (NCERT)

## 10.1 Carbohydrates — Classification

| Type | Detail / Example |
|---|---|
| **Carbohydrates** | Polyhydroxy aldehydes/ketones or compounds giving them on hydrolysis |
| **Monosaccharides** | Cannot be hydrolysed further (glucose, fructose, ribose) |
| **Disaccharides** | Give 2 monosaccharides on hydrolysis (sucrose, maltose, lactose) |
| **Polysaccharides** | Many units (starch, cellulose, glycogen) |
| **Reducing sugars** | Reduce Tollens'/Fehling's (all monosaccharides, maltose, lactose) |
| **Non-reducing sugar** | Sucrose (no free aldehyde/ketone group) |
| **Aldose / Ketose** | Sugar with aldehyde (glucose) / ketone (fructose) group |

## 10.2 Glucose, Fructose & Sucrose

| Concept | Detail |
|---|---|
| **Glucose formula** | $C_6H_{12}O_6$ ; an aldohexose |
| **Glucose structure** | Six C, –CHO at C1, five –OH groups |
| **Glucose ring forms** | α and β pyranose (cyclic hemiacetal) |
| **Fructose** | Ketohexose (–C=O at C2) |
| **Sucrose** | Glucose + fructose ; non-reducing |
| **Invert sugar** | Hydrolysis of sucrose → glucose + fructose (rotation reverses) |
| **Starch** | Amylose (linear) + amylopectin (branched) ; α-glucose units |
| **Cellulose** | β-glucose units ; structural polysaccharide in plants |

## 10.3 Proteins & Amino Acids

| Concept | Detail |
|---|---|
| **Amino acid** | Contains $–NH_2$ and –COOH groups |
| **Essential amino acids** | Not made by body ; must come from diet |
| **Zwitterion** | Dipolar ion form ($–NH_3^+$ and $–COO^-$) |
| **Isoelectric point** | pH at which amino acid has no net charge |
| **Peptide bond** | –CO–NH– link between amino acids (amide bond) |
| **Primary structure** | Sequence of amino acids in the chain |
| **Secondary structure** | α-helix and β-pleated sheet (H-bonding) |
| **Tertiary structure** | 3D folding of the whole chain |
| **Denaturation** | Loss of 2°/3° structure (1° intact) ; protein loses function |

## 10.4 Enzymes, Vitamins & Hormones

| Concept | Detail |
|---|---|
| **Enzymes** | Biological catalysts (proteins) ; highly specific |
| **Fat-soluble vitamins** | A, D, E, K (stored in liver/fat) |
| **Water-soluble vitamins** | B-complex and C (not stored ; needed regularly) |
| **Vitamin C deficiency** | Scurvy |
| **Vitamin D deficiency** | Rickets |
| **Vitamin A deficiency** | Night blindness |
| **Hormones** | Chemical messengers (e.g. insulin, adrenaline) |

## 10.5 Nucleic Acids (DNA & RNA)

| Concept | Detail |
|---|---|
| **Nucleic acids** | Polymers of nucleotides (DNA, RNA) |
| **Nucleotide** | Base + sugar + phosphate |
| **Nucleoside** | Base + sugar (no phosphate) |
| **Sugar in DNA / RNA** | Deoxyribose / Ribose |
| **Purine bases** | Adenine (A), Guanine (G) |
| **Pyrimidine bases** | Cytosine (C), Thymine (T, DNA), Uracil (U, RNA) |
| **Base pairing (DNA)** | A=T and G≡C (complementary) |
| **DNA structure** | Double helix (Watson-Crick) ; carries genetic info |
| **RNA role** | Protein synthesis (mRNA, tRNA, rRNA) |

## ★ QUICK MEMORY AIDS & TRICKS

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|---|---|
| **Reducing sugars** | All monosaccharides + maltose + lactose reduce Tollens'/Fehling's. Sucrose does NOT. |
| **Glucose vs fructose** | Glucose = aldohexose (–CHO) ; Fructose = ketohexose (–C=O at C2). |
| **Starch vs cellulose** | Starch = α-glucose (digestible) ; cellulose = β-glucose (we can't digest). |
| **Invert sugar** | Sucrose hydrolysis flips optical rotation → glucose + fructose. |
| **Zwitterion** | Amino acids exist as dipolar ions: $–NH_3^+$ and $–COO^-$. |
| **Protein structures** | 1° sequence, 2° helix/sheet, 3° folding, 4° subunits. |
| **Vitamins** | Fat-soluble A,D,E,K ; rest are water-soluble. C→scurvy, D→rickets, A→night blindness. |
| **Base pairing** | A pairs with T (2 H-bonds), G pairs with C (3 H-bonds). RNA uses U instead of T. |