CLASS 11 CHEMISTRY — FORMULA SHEET

Chapter 8 : Organic Chemistry — Some Basic Principles & Techniques (NCERT)

8.1 Degree of Unsaturation (DoU / IHD)

Compound Type	Formula
Only C & H (C_nH_m)	DoU = (2n + 2 − m) ÷ 2
With nitrogen ($C_nH_mN_p$)	DoU = (2n + 2 + p − m) ÷ 2 (each N adds 1)
With halogen X ($C_nH_mX_x$)	DoU = (2n + 2 − m − x) ÷ 2 (halogen counts like H)
With O or S	DoU = (2n + 2 − m) ÷ 2 (O and S have NO effect)
Meaning of DoU	Each double bond OR ring = 1 ; each triple bond = 2
Benzene ring (C_6H_6)	DoU = 4 (3 double bonds + 1 ring)

8.2 IUPAC Nomenclature — Priority of Functional Groups

Priority (high → low)	Group & Suffix
1 (highest)	Carboxylic acid −COOH (-oic acid)
2	Sulphonic acid $-SO_3H$
3	Ester −COOR (-oate)
4	Acid halide −COX (-oyl halide)
5	Amide $-CONH_2$ (-amide)
6	Nitrile −CN (-nitrile)
7	Aldehyde −CHO (-al)
8	Ketone >C=O (-one)
9	Alcohol −OH (-ol)
10	Amine $-NH_2$ (-amine)
Lowest	Ethers, alkenes (-ene), alkynes (-yne); halo/alkyl/nitro are prefixes only

8.3 Quantitative Analysis — Estimation of Elements

Element / Method	Formula (% of element)
Carbon (combustion)	% C = (12/44) × (mass of CO_2 ÷ mass of compound) × 100
Hydrogen (combustion)	% H = (2/18) × (mass of H_2O ÷ mass of compound) × 100
Nitrogen (Dumas)	% N = (28/22400) × (volume of N_2 at STP ÷ mass of compound) × 100
Nitrogen (Kjeldahl)	% N = (1.4 × M_{acid} × basicity × V_{acid}) ÷ mass of compound
Halogen (Carius) — Cl	% Cl = (35.5/143.5) × (mass AgCl ÷ mass compound) × 100
Halogen (Carius) — Br	% Br = (80/188) × (mass AgBr ÷ mass compound) × 100
Halogen (Carius) — I	% I = (127/235) × (mass AgI ÷ mass compound) × 100
Sulphur (Carius)	% S = (32/233) × (mass $BaSO_4$ ÷ mass compound) × 100

Element / Method	Formula (% of element)
Phosphorus (Carius)	% P = (62/222) × (mass $Mg_2P_2O_7$ ÷ mass compound) × 100

8.4 Electronic Effects

Effect	Description & Examples
Inductive effect (−I)	Electron-withdrawing through σ-bonds: $-NO_2$ > −CN > −COOH > −F > −Cl > −Br > −I > −OH
Inductive effect (+I)	Electron-donating: $-C(CH_3)_3$ > $-CH(CH_3)_2$ > $-C_2H_5$ > $-CH_3$ > −H
Effect of −I / +I on acidity	−I groups INCREASE acid strength; +I groups DECREASE it
Mesomeric / Resonance (+M)	Electron-donating via lone pair: −OH, −OR, $-NH_2$, −NHR, $-NR_2$, halogens
Mesomeric / Resonance (−M)	Electron-withdrawing via π-bond: $-NO_2$, −CHO, −COR, −COOH, −COOR, −CN
Hyperconjugation	Delocalisation of σ(C−H) electrons into adjacent empty p / π orbital; more α-H → more stable
Electromeric effect (E)	Temporary, complete shift of π-electrons in presence of an attacking reagent

8.5 Stability of Reaction Intermediates

Intermediate	Stability Order (most → least)
Carbocation (C^+)	3° > 2° > 1° > CH_3^+ (stabilised by +I & hyperconjugation; benzylic/allylic by resonance)
Carbanion (C^-)	CH_3^- > 1° > 2° > 3° (opposite of carbocation; stabilised by −I groups)
Free radical	3° > 2° > 1° > CH_3• (like carbocation; hyperconjugation)
Resonance-stabilised	Allyl & benzyl cations/radicals are extra stable due to resonance

8.6 Bond Fission & Types of Reagents

Concept	Detail
Homolytic fission	Bond breaks evenly → free radicals (each atom keeps 1 e^-); shown by single-barbed arrows
Heterolytic fission	Bond breaks unevenly → ions (cation + anion); shown by double-barbed arrows
Electrophile (E^+)	Electron-deficient; accepts electron pair (e.g. H^+, NO_2^+, Cl^+, carbocation)
Nucleophile (Nu^-)	Electron-rich; donates electron pair (e.g. OH^-, CN^-, NH_3, H_2O)

8.7 Types of Organic Reactions & Isomerism

Type	Description / Example
Substitution	One atom/group replaces another: $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$
Addition	Atoms add across multiple bond: $CH_2{=}CH_2 + H_2 \rightarrow CH_3CH_3$
Elimination	Atoms removed; new π-bond forms: $C_2H_5OH \rightarrow CH_2{=}CH_2 + H_2O$
Rearrangement	Skeleton reorganises (e.g. 1° carbocation → 2°/3°)
Structural isomerism	Chain, position, functional, metamerism, tautomerism

Type	Description / Example
Stereoisomerism	Geometrical (cis-trans) & optical (mirror images)

8.8 Purification Techniques

Method	Used For
Crystallisation	Solids with different solubility from impurities
Sublimation	Solids that sublime (camphor, naphthalene)
Simple distillation	Liquids with large boiling-point difference
Fractional distillation	Liquids with close boiling points (e.g. petroleum fractions)
Steam distillation	Steam-volatile, water-immiscible liquids (e.g. aniline)
Distillation under reduced pressure	Liquids that decompose at their boiling point (e.g. glycerol)
Differential extraction	Separates compound from aqueous solution using a solvent
Chromatography	Separation & purification based on differential adsorption/partition

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DoU shortcut	$(2C + 2 + N - H - X) \div 2$. O & S ignored. Benzene = 4 (3 π + 1 ring).
Priority order	'COOH beats everything' → acid > ester > amide > nitrile > aldehyde > ketone > alcohol > amine.
Carbocation stability	3° > 2° > 1° > methyl. Carbanion is the EXACT reverse.
−I acidity	More −I (electron-withdrawing) groups → stronger acid (stabilises the conjugate base).
E vs Nu	Electrophile = Electron-loving (+) ; Nucleophile = Nucleus-loving / electron-rich (−).
Estimation fractions	C: 12/44, H: 2/18, S: 32/233, halogen via Ag salt mass ratios.
Hyperconjugation	'No-bond resonance' — more α-hydrogens means more stability.
Steam distillation needs	Compound must be volatile in steam AND immiscible with water (e.g. aniline).