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scanner for code UTF-8 installed.
[primary] (0,0) rect (1.1); [white, right] at (0.3, 0.55) **ExamBhai.com** | *PremiumStudyMaterial*; $[white, left] at(, 0.55) Organic Chemistry Ultimate$

1. Fundamentals & Nomenclature

Priority of Functional Groups: Carboxylic Acid > Anhydride > Ester > Acid Halide > Amide > Nitrile > Aldehyde > Ketone > Alcohol > Amine > Alkene > Alkyne.

Isomerism Summary:

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- **Enantiomers:** Non-superimposable mirror images (R/S). Equal physical props, opposite $[\alpha]_D$.
- **Diastereomers:** Non-mirror image stereoisomers. Diff. physical/chemical properties.
- **Meso Compounds:** Internal plane of symmetry (C_i/C_s), optically inactive despite chiral centers.

Degree of Unsaturation (DoU / IHD):

$$\text{DoU} = C + 1 - \frac{H}{2} - \frac{X}{2} + \frac{N}{2}$$

2. Reaction Intermediates

Carbocation Stability:

$$\text{Benzylic} \approx \text{Allylic} > 3^\circ > 2^\circ > 1^\circ > \text{Methyl}$$

Stabilized by +I (inductive) and hyperconjugation ($3 \times \alpha$-H per methyl).

Carbanion Stability:

$$\text{sp} > \text{sp}^2 > \text{sp}^3 \quad | \quad \text{Methyl} > 1^\circ > 2^\circ > 3^\circ$$

Stabilized by electron-withdrawing groups (-I, -M).

Radical Stability:

$$\text{Allylic} \approx \text{Benzylic} > 3^\circ > 2^\circ > 1^\circ > \text{Methyl}$$

3. Nucleophilic Substitution

Property	S_N1	S_N2
Kinetics	First Order: $r = k[RX]$	Second Order: $r = k[RX][Nu]$
Steps	2-step (C+ intermed.)	1-step (Concerted TS)
Substrate	$3^\circ > 2^\circ \gg 1^\circ$	$\text{Me} > 1^\circ > 2^\circ \gg 3^\circ$
Stereo	Racemization	Inversion (180° attack)
Solvent	Polar Protic	Polar Aprotic

Solvents:

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- **Polar Protic (S_N1):** H_2O, MeOH, EtOH, AcOH.
- **Polar Aprotic (S_N2):** Acetone, DMSO, DMF, ACN, THF.

4. Elimination Reactions

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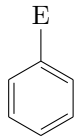
- **E1:** 2-step via carbocation. Favored by weak bases, high temp, 3° substrates.
- **E2:** 1-step concerted. Requires **anti-periplanar** geometry of H and LG. Favored by strong bases.
- **Zaitsev vs. Hofmann:**

  – *Zaitsev (More substituted alkene):* Small unhindered base (e.g., NaOEt, NaOH).

  – *Hofmann (Less substituted alkene):* Bulky base (e.g., *t*-BuOK, LDA).

5. Electrophilic Aromatic Substitution (EAS)

Basic mechanism involving arenium ion intermediate:



(Regioselectivity below)

Directing Groups:

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- **Ortho/Para Directors (Activating):**

  $-O^-, -NH_2, -OH, -OR, -NHCOR, -R$

- **Ortho/Para Directors (Deactivating):**

  $-F, -Cl, -Br, -I$ (Inductive -I ¿ Resonance +M)

- **Meta Directors (Deactivating):**

  $-NO_2, -CF_3, -CN, -SO_3H, -CHO, -COR, -COOH$

6. Key Organic Reactions

Alkene Additions:

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- **Hydroboration-Oxidation:** 1. $BH_3 \cdot THF$/2. $H_2O_2, NaOH arrow$ Anti-Markovnikov, Syn-addition alcohol.
- **Oxymercuration-Demercuration:** 1. $Hg(OAc)_2, H_2O$/2. $NaBH_4 arrow$ Markovnikov, No rearrangement.
- **Ozonolysis:** 1. O_3/2. Zn, AcOH (Reductive)$arrow$ Aldehydes/Ketones.

Carbonyl Chemistry:

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- **Aldol Condensation:** Base-catalyzed enolate formation + addition to carbonyl $arrow \beta$-hydroxy carbonyl $\xrightarrow{\Delta} \alpha, \beta$-unsaturated carbonyl.
- **Grignard Reaction:** R-MgX + Carbonyl$arrow$ Alcohol ($1^\circ, 2^\circ, 3^\circ$ depending on formaldehyde, aldehyde, or ketone).
- **Fisher Esterification:** RCOOH + R'OH $\xrightarrow{H^+}$ RCOOR' + H_2O.

7. Reagent Reference Guide

Reagent	Primary Function
PCC	Mild oxidation (1° Alc$arrow$Aldehyde)
$KMnO_4/CrO_3$	Strong oxidation (1° Alc$arrow$Carboxylic Acid)
$LiAlH_4$	Strong reducer (Esters, Acids, Carbonyls $arrow$ Alcohols)
$NaBH_4$	Mild reducer (Only Aldehydes/Ketones $arrow$ Alcohols)
$SOCl_2/PCl_5$	Converts $-OH$ to $-Cl$ with inversion
DIBAL-H	Reduces Esters/Nitriles to Aldehydes (at low temp)

8. Spectroscopy Quick Guide

IR Absorptions (cm^{-1}):

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- **O–H (Alcohol):** $3200 - 3600$ (Broad, strong)
- **N–H (Amine):** $3300 - 3500$ (Medium, sharp)
- **C=O (Carbonyl):** $1700 - 1750$ (Strong, sharp)
- **C$\equiv$** $N(Nitrile)$:**2200-2250**$(Medium)$
- **C=C (Alkene):** $1620 - 1680$ **(Variable)**

^{1}H-NMR Chemical Shifts (ppm):

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- Alkyl (R-CH_3): $0.9 - 1.5$
- Allylic/Alkynyl: $1.8 - 2.5$
- Heteroatom-adjacent (-CH_2-O-): $3.3 - 4.5$
- Vinylic (C=C-H): $4.5 - 6.5$
- Aromatic (Ar-H): $6.5 - 8.5$
- Aldehyde (-CHO): $9.5 - 10.0$
- Carboxylic Acid (-COOH): $10.5 - 12.0$