# ORGANIC CHEMISTRY HIGH-YIELD CHEAT SHEET

## 1. Hybridization & Geometry

| Hybrid | Geometry | Angle | Bonds |
|---|---|---|---|
| $sp^3$ | Tetrahedral | 109.5° | 4 $\sigma$ |
| $sp^2$ | Trigonal Planar | 120° | 3 $\sigma$, 1 $\pi$ |
| $sp$ | Linear | 180° | 2 $\sigma$, 2 $\pi$ |

**Degree of Unsaturation (DoU/IHD):**

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

## 2. Stereochemistry

[leftmargin=*]

- **Enantiomers:** Non-superimposable mirror images ($R/S$ inverted at all centers).
- **Diastereomers:** Non-superimposable non-mirror images (at least one center differs).
- **Meso Compounds:** Multiple chiral centers + internal mirror plane = Achiral (Optically inactive).

**Cahn-Ingold-Prelog (CIP) Rules:** 1. Higher Atomic Number = Higher Priority. 2. In case of ties, compare attached atoms at first point of difference. 3. Double/Triple bonds counted as duplicate/triplicate atoms.

## 3. Intermediate Stability

**Carbocations ($3^\circ > 2^\circ > 1^\circ > CH_3^+$):** Stabilized by +I (inductive) and hyperconjugation.
**Carbanions ($CH_3^+ > 1^\circ > 2^\circ > 3^\circ$):** Stabilized by -I effect and electron-withdrawing groups.
**Free Radicals:** $3^\circ > 2^\circ > 1^\circ > CH_3^\bullet$ (Stabilized by hyperconjugation).
**Resonance / Aromaticity:**

[leftmargin=*]

- **Aromatic:** Cyclic, Planar, Fully Conjugated, $4n+2$ $\pi$ $e^-$ (Hückel Rule).
- **Anti-aromatic:** Cyclic, Planar, Fully Conjugated, $4n$ $\pi$ $e^-$ (Unstable).

## 4. Substitution vs. Elimination

| Rxn | Kinetics/Mechanism | Substrate/Solvent |
|---|---|---|
| $S_N1$ | Unimolecular, Carbocation | $3^\circ > 2^\circ$, Polar Protic |
| $S_N2$ | Bimolecular, Inversion | $1^\circ > 2^\circ$, Polar Aprotic |
| $E1$ | Carbocation, Zaitsev | $3^\circ > 2^\circ$, Heat/Weak Base |
| $E2$ | Concerted, Anti-periplanar | $3^\circ > 2^\circ > 1^\circ$, Strong Base |

## 5. Electrophilic Aromatic Substitution (EAS)

General Rxn: $Ar{-}H + E^+ \longrightarrow Ar{-}E + H^+$
**Directors / Directing Effects:**

[leftmargin=*]

- **Ortho/Para (Activating):** $-OH$, $-NH_2$, $-OR$, $-R$ (lone pairs / electron donors).
- **Ortho/Para (Deactivating):** $-F$, $-Cl$, $-Br$, $-I$ (halogens via inductive effect).
- **Meta (Deactivating):** $-NO_2$, $-CN$, $-CHO$, $-COOH$, $-SO_3H$ (strong electron-withdrawing).

## 6. Key Oxidation & Reduction Reagents

**Oxidizing Agents:**

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- **PCC / DMP:** 1° alc *arrow* Aldehyde; 2° alc *arrow* Ketone.
- **$KMnO_4$ / $CrO_3$ (Jones):** 1° alc *arrow* Carboxylic Acid.
- **$O_3$ / Zn or $Me_2S$:** Ozonolysis cleavage of alkenes.

**Reducing Agents:**

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- **$NaBH_4$:** Reduces aldehydes/ketones *arrow* alcohols (Ignores esters/acids).
- **$LiAlH_4$ (LAH):** Strong; reduces esters, acids, aldehydes, ketones *arrow* alcohols; nitriles *arrow* amines.
- **$H_2$ / Pd-C:** Alkene/Alkynyl hydrogenations.

## 7. Named Carbonyl Reactions

**Aldol Condensation:** Enolizable aldehyde/ketone + Base *arrow* $\alpha,\beta$-unsaturated carbonyl.
**Grignard Reaction:** $R-MgX + R'CHO \longrightarrow R-CH(OH)-R'$
**Wittig Reaction:** Ketone/Aldehyde + Phosphonium Ylide ($Ph_3P{=}CR_2$) *arrow* Alkene.