

Oxygen-Containing Functional Groups: one-page cheat sheet

1 · Alcohols

- b.p.** acids > alcohols > aldehydes, ketones > ethers > alkanes
- Branching** butan-1-ol 390 K > butan-2-ol 373 K > 2-methylpropan-2-ol 356 K
- Hydroboration** BH_3 , then $\text{H}_2\text{O}_2 / \text{OH}^-$: anti-Markovnikov, no rearrangement
- NaBH_4** reduces aldehydes and ketones only
- LiAlH_4** also esters and acids
- Grignard** $\text{HCHO} \rightarrow 1^\circ$; $\text{RCHO} \rightarrow 2^\circ$; ketone $\rightarrow 3^\circ$
- Lucas** 3° turbid at once; 2° in about 5 min; 1° none

2 · Phenols

Compound	$\text{p}K_a$
2,4,6-trinitrophenol (picric acid)	0.38
4-nitrophenol	7.1
2-nitrophenol	7.2
phenol	10.0
ethanol	15.9

- Cumene** air oxidation, then dil. H_2SO_4 : phenol + acetone
- Kolbe** $\text{PhONa} + \text{CO}_2$ (400 K, 4–7 atm) $\rightarrow$ salicylic acid
- Reimer–Tiemann** CHCl_3 + aq. NaOH via $:\text{CCl}_2 \rightarrow$ salicylaldehyde
- Br_2 water** gives white 2,4,6-tribromophenol
- Nitration** dil. HNO_3 gives o- and p-nitrophenol; conc. gives picric acid
- Tests** neutral FeCl_3 gives violet; phthalein dye test gives pink

3 · Ethers

- Williamson** $\text{RX} + \text{R'ONa}$; RX must be 1° , else elimination
- HI cleavage** $1^\circ/2^\circ$: $\text{S}_{\text{N}}2$ at the **smaller** alkyl group
- 3° alkyl** $\text{S}_{\text{N}}1$: tertiary iodide forms
- Anisole** $\text{C}_6\text{H}_5\text{OCH}_3 + \text{HI} \rightarrow$ phenol + CH_3I

4 · Carbonyl: nucleophilic addition

Reactivity $\text{HCHO} > \text{RCHO} > \text{ketone}$

Reagent	Product
HCN	cyanohydrin
NaHSO_3	bisulphite adduct
ROH , dry HCl	hemiacetal, acetal
NH_2OH	oxime
NH_2NH_2	hydrazone
2,4-DNP	orange-red ppt
semicarbazide	semicarbazone

5 · Named reactions

- Rosenmund** $\text{RCOCl} + \text{H}_2 / \text{Pd-BaSO}_4 \rightarrow \text{RCHO}$
- Stephen** $\text{RCN} + \text{SnCl}_2 / \text{HCl}$, then $\text{H}_2\text{O} \rightarrow \text{RCHO}$
- DIBAL-H** ester or nitrile $\rightarrow$ aldehyde
- Etard** toluene + $\text{CrO}_2\text{Cl}_2 \rightarrow$ benzaldehyde
- Clemmensen** $\text{Zn-Hg} / \text{HCl}$: $\text{C=O} \rightarrow \text{CH}_2$
- Wolff–Kishner** $\text{NH}_2\text{NH}_2 / \text{KOH}$: $\text{C=O} \rightarrow \text{CH}_2$
- PCC** 1° alcohol stops at the aldehyde

6 · Aldol & Cannizzaro

- Aldol** needs α -H; dilute NaOH ; gives β -hydroxy carbonyl, then enal
- $$2\text{CH}_3\text{CHO} \xrightarrow{\text{dil. NaOH}} \text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CHO} \xrightarrow{-\text{H}_2\text{O}} \text{CH}_3\text{CH}=\text{CHCHO}$$
- Cannizzaro** no α -H (HCHO , PhCHO); conc. NaOH ; alcohol + acid salt

7 · Tests

- Tollens'** aldehydes: silver mirror
- Fehling's** **aliphatic** aldehydes: red Cu_2O ; not benzaldehyde
- Iodoform** $\text{CH}_3\text{CO}-$ or $\text{CH}_3\text{CH}(\text{OH})-$: yellow CHI_3
- NaHCO_3** acids give CO_2 ; phenols do not

8 · Carboxylic acids

- $\text{CF}_3\text{COOH} > \text{CCl}_3\text{COOH} > \text{CHCl}_2\text{COOH} > \text{NO}_2\text{CH}_2\text{COOH}$
 $\text{NO}_2\text{CH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{HCOOH} > \text{CH}_3\text{COOH}$
- HVZ** $\text{RCH}_2\text{COOH} + \text{X}_2 / \text{red P} \rightarrow \alpha$ -halo acid
- Derivatives** reactivity $\text{RCOCl} > \text{anhydride} > \text{ester} > \text{amide}$

Seen in NEET 2024

- Propene, then $\text{BH}_3 / \text{H}_2\text{O}_2$, OH^- , then PCC.
- Propan-1-ol is oxidised only as far as **propanal**.

Seen in NEET 2021

- Acetone + $\text{C}_2\text{H}_5\text{MgBr}$, then H_3O^+ : tertiary alcohol **2-methylbutan-2-ol**.

Seen in NEET 2025, 2020

- Ester to aldehyde: **DIBAL-H**, then H_2O .
- Anisole + conc. HI : **phenol + CH_3I** .

Seen in NEET 2026

- $\text{C}_8\text{H}_8\text{O}$: 2,4-DNP positive, Fehling's negative, oxidises to benzoic acid.
- A ketone: **acetophenone**, $\text{C}_6\text{H}_5\text{COCH}_3$ (it also gives the iodoform test).

Seen in NEET 2023

- Cyclohexanone + HCN , then conc. H_2SO_4 , then H_3O^+ :
- cyclohex-1-enecarboxylic acid** (cyanohydrin, dehydration, nitrile hydrolysis).

Six traps to remember

- Hydroboration–oxidation gives the anti-Markovnikov alcohol.
- Williamson synthesis needs a primary alkyl halide.
- Anisole with HI gives phenol and CH_3I , never iodobenzene.
- Fehling's test is negative for benzaldehyde.
- Cannizzaro needs no α -hydrogen; aldol needs at least one.
- Electron-withdrawing groups raise acidity; alkyl groups lower it.