Alcohols, Phenols and Ethers Class 12 Key Points

CBSE Class 12 Chemistry · NCERT · for boards, NEET and JEE revision

ChapterNotes

Three Oxygen Families

Alcohol R–OH · Phenol C_6H_5–OH (ring) · Ether R–O–R′

Phenol = –OH directly on a benzene ring; benzyl/allyl –OH on a side chain is still an alcohol.

- Alcohol: –OH on an sp^3 carbon (e.g. ethanol)
- Phenol: –OH bolted onto the aromatic ring carbon
- Ether: O bridges two carbons, no O–H at all

1° / 2° / 3° and IUPAC Names

alkane –e + –ol · $CH_3CH_2CH_2OH$ = propan-1-ol

Ethers: larger group = parent alkane, smaller –OR = alkoxy; CH_3–O–C_2H_5 = methoxyethane.

- 0-1 other C → 1°, two → 2°, three → 3° (count carbons, not H)
- Number the chain so –OH gets the lowest locant
- Glycols are dihydric (two –OH groups)

Preparing Alcohols

Grignard: HCHO→1° · other RCHO→2° · ketone→3°

$LiAlH_4$ reduces –COOH to 1° alcohol; mild $NaBH_4$ will not touch a carboxylic acid.

- Acid hydration of alkene → Markovnikov (OH on more substituted C)
- Hydroboration–oxidation → anti-Markovnikov 1° alcohol
- Aldehyde→1°, ketone→2° on reduction

Cumene Process & Williamson

$R–O^-Na^+ + R'–X \rightarrow R–O–R' + NaX$ (S_n2)

Cumene process gives phenol + acetone (not methanol). Diethyl ether: ethanol + conc. H_2SO_4 at 413 K.

- Williamson is S_n2 → use a 1° halide; 3° halides eliminate to alkene
- Unsymmetrical ether: hindered group as alkoxide, simple as 1° halide
- Cumene → cumene hydroperoxide → H^+ → phenol + acetone

Boiling Points & H-Bonding

B.p.: alcohol/phenol ≫ ether ≈ alkane (similar mass)

Ethers have no O–H → cannot self H-bond; b.p. rises with chain length, falls with branching.

- Alcohols/phenols self H-bond → high boiling points
- Diethyl ether b.p. ~35°C vs butan-1-ol ~118°C (similar mass)
- Branching = compact shape = less contact = lower b.p.

Acidic Character

Acidity: phenol > water > alcohol

Among alcohols 1° > 2° > 3° (alkyl +I destabilises alkoxide). This is opposite to the carbocation order.

- Phenol strongest: phenoxide resonance-stabilised into the ring
- EWG (–NO_2, o/p) raise phenol acidity; EDG (–CH_3, –OCH_3) lower it
- Both react with Na→H_2; only phenol reacts with NaOH

What Alcohols Do

HX / dehydration / Lucas reactivity: 3° > 2° > 1°

Lucas (conc. HCl + $ZnCl_2$): 3° turbid at once, 2° in ~5 min, 1° no reaction at RT.

- O–H cleavage: esterification (reversible) and Na → alkoxide + H_2
- Oxidation: 1°→aldehyde→acid, 2°→ketone, 3° resists; PCC stops 1° at aldehyde
- Dehydration (conc. H_2SO_4) follows Saytzeff → more substituted alkene

What Phenols Do

Br_2 water → 2,4,6-tribromophenol (white ppt)

Phenol's strong C–O bond means no Lucas/HX substitution like alcohols. $FeCl_3$ gives a violet colour.

- Kolbe: phenoxide + CO_2 then H^+ → salicylic acid (2-OH-benzoic acid)
- Reimer-Tiemann: phenol + $CHCl_3$ + NaOH → salicylaldehyde
- Conc. HNO_3 → picric acid (2,4,6-trinitrophenol); oxidation → benzoquinone

What Ethers Do

R–O–R′ + HX → R–X + R′–OH (HI > HBr > HCl)

S_n2 default: iodide hits the less-hindered carbon. If a group is 3°/allyl/benzyl → S_n1, stable cation takes the halide.

- CH_3–O–C_2H_5 + HI → CH_3I + C_2H_5OH (methyl less hindered)
- Anisole + HI → phenol + CH_3I (aryl C–O never cleaves)
- –OR is activating, o/p-directing in aromatic ethers

Quick revision

- Alcohols: 1° → aldehyde → acid; 2° → ketone; 3° → resistant to oxidation
- Dehydration ease: 3° > 2° > 1° (conc. H_2SO_4)
- Lucas test: 3° immediate, 2° in 5 min, 1° no reaction at RT
- Phenol: acidic (resonance-stabilised phenoxide), reacts with NaOH but not $NaHCO_3$
- Cumene process: benzene → cumene → phenol + acetone (industrial)
- Kolbe: PhONa + CO_2 → salicylic acid
- Reimer-Tiemann: PhOH + $CHCl_3$/NaOH → salicylaldehyde
- Williamson: RONa + R'X → ROR' (use 1° halide to avoid elimination)
- Ether cleavage (excess HI): R–O–R + 2HI → 2R–I + H_2O
- Distinction: phenol → violet with $FeCl_3$, white ppt with Br_2 water

Full chapter notes with solved examples and practice questions: https://chapternotes.in/cbse/class-12-chemistry/alcohols-phenols-and-ethers-class-12-notes/