Class 12 Chemistry – Alcohols, Phenols & Ethers | Study Guide

1. Theory in Simple Words with Visuals

1.1 What are Alcohols, Phenols, and Ethers?

Compound	General Formula	Structure	Example	Analogy
Alcohols	R–OH	OH attached to saturated carbon	CH_3CH_2OH	"OH = water tap on a carbon road"
Phenols	Ar–OH	OH attached to aromatic ring	C_6H_5OH	"OH = flag on a benzene roundabout"
Ethers	R–O–R	Oxygen between 2 carbons	$CH_3–O–CH_3$	"Oxygen bridge connecting two carbons"

1.2 Classification

Alcohols:

- **Primary (1°):** –OH on 1° carbon (CH_3CH_2OH)
- **Secondary (2°):** –OH on 2° carbon ($CH_3CHOHCH_3$)
- **Tertiary (3°):** –OH on 3° carbon ($(CH_3)_3COH$)

Phenols:

- **Monohydroxy:** C_6H_5OH
- **Dihydroxy:** Catechol, Resorcinol, Hydroquinone

Ethers:

- Symmetrical: $CH_3–O–CH_3$
- Unsymmetrical: $CH_3–O–C_2H_5$

1.3 Physical Properties

Property	Alcohols	Phenols	Ethers
Boiling Point	Higher (H-bonding)	High (H-bonding)	Lower (no H-bond)
Solubility	Soluble in water	Soluble in water	Less soluble
Odor	Sweetish	Sweet, medicinal	Ether-like, pungent

1.4 Chemical Reactions

1.4.1 Reactions of Alcohols

1. **Acidic Reaction:** Alcohol + HX → Alkyl halide

$$CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$$

2. **Oxidation:**
   - 1° Alcohol → Aldehyde → Carboxylic acid
   - 2° Alcohol → Ketone
   - 3° Alcohol → No oxidation
3. **Dehydration:** Alcohol → Alkene (alc. H_2SO_4, 170°C)
   Example: $CH_3CH_2OH \rightarrow CH_2=CH_2 + H_2O$

1.4.2 Reactions of Phenols

1. **Acid-Base Reaction:** Phenol + NaOH → Sodium phenoxide + H_2O
2. **Electrophilic Substitution:**
   - Halogenation (Br_2) → Tribromophenol
   - Nitration (HNO_3) → Ortho/Para nitrophenol

Mnemonic: Phenol is **more reactive than benzene** → due to –OH activating effect.

1.4.3 Reactions of Ethers

1. **Cleavage by HX:**
   - $CH_3–O–CH_3$ + HI → CH_3I + CH_3OH
2. **Generally stable** → no oxidation like alcohols

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2. Key Concepts & Formulas

Concept	Formula / Key Points	Tips / Mnemonics
Alcohol Oxidation	1° → Aldehyde → Acid, 2° → Ketone	"1 step = aldehyde, 2 steps = acid"
Dehydration	ROH → Alkene + H_2O	Alc. H_2SO_4, heat
SN1 / SN2 in Alcohol → RX	Alcohol + HX → Alkyl halide	3° → SN1, 1° → SN2
Phenol Reactivity	Ortho/Para activator	OH group = electron donating
Ether Cleavage	R–O–R + HX → RX + ROH	Strong acid, heat needed

Mnemonic for Alcohol Oxidation:
"Primary → Aldehyde → Acid, Secondary → Ketone, Tertiary → None"

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3. Solved Numerical / Mechanism Problems

Example 1: Oxidation Product Prediction

Problem: Predict product of CH_3CH_2OH with [O]
Solution:
1° Alcohol → Aldehyde: CH_3CHO → Carboxylic acid: CH_3COOH

Example 2: Dehydration Mechanism

Problem: CH_3CH_2OH → ? (alc. H_2SO_4, 170°C)
Solution:

- Elimination → $CH_2=CH_2 + H_2O$

Tip: Mark β-Hydrogen → double bond forms there.

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4. Previous Years' Board Questions

- **Preparation reactions:** From alcohols to ethers, phenols from benzene
- **Reactivity & mechanism:** Oxidation, halogenation, nitration
- **Identification reactions:** iodoform, bromination, phenol tests

High-weightage areas: Oxidation products, substitution reactions, and phenol reactions.

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5. Quick Revision Notes / Important Points

- **Alcohol = ROH**, **Phenol = Ar–OH**, **Ether = R–O–R**
- **Oxidation:** 1° → Aldehyde → Acid, 2° → Ketone, 3° → None
- **Dehydration:** Alcohol → Alkene (alc. H_2SO_4)
- **Phenol reactions:** Halogenation, Nitration, Acid-base
- **Ethers:** Generally stable, cleaved by HX

Visual Table:

Compound	Reaction Type	Key Notes
Alcohol	Oxidation, Dehydration, Substitution	Check primary/secondary/tertiary
Phenol	Electrophilic substitution, Acid-base	Ortho/para activation

Compound	Reaction Type	Key Notes
Ether	Cleavage by HX	Stable otherwise

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6. Predicted / Likely Questions

1. Identify products of oxidation, dehydration
2. Distinguish alcohol, phenol, ether reactions
3. Electrophilic substitution reactions of phenols
4. Preparation of alcohols and ethers
5. Mechanism-based questions

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7. Exam Tips & Tricks

- Always **check degree of carbon** for alcohol reactions
- Use **color coding** for OH (blue), alkyl (green), aromatic (orange)
- For **electrophilic substitution**, remember **–OH activates ortho/para**
- **Mechanism arrows** fetch marks → practice flowchart style

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8. Visual & Kid-Friendly Learning Style

- Imagine **OH as a tap** → water or acid reactions
- Think **ether as a bridge** → connects two carbon islands
- Color-code reactions → H-bonding = blue, cleavage = red
- Draw **flowcharts for oxidation & substitution** → easy recall