

# Class 12 Chemistry – Aldehydes, Ketones & Carboxylic Acids | Study Guide

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## 1. Theory in Simple Words with Visuals

### 1.1 What are Aldehydes, Ketones, and Carboxylic Acids?

Compound	General Formula	Structure	Example	Analogy
Aldehydes	R-CHO	Carbonyl (C=O) at end of chain	CH <sub>3</sub> CHO (Ethanal)	"C=O = front door of carbon street"
Ketones	R-CO-R	Carbonyl (C=O) inside chain	CH <sub>3</sub> COCH <sub>3</sub> (Propanone)	"C=O = middle bridge connecting carbons"
Carboxylic Acids	R-COOH	Carbonyl + -OH	CH <sub>3</sub> COOH (Acetic acid)	"C=O + OH = sour lemon flag"

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### 1.2 Physical Properties

Property	Aldehydes	Ketones	Carboxylic Acids
Boiling Point	Moderate	Moderate	High (H-bonding)
Solubility	Soluble in water (small molecules)	Soluble in water (small molecules)	Highly soluble (H-bonding)
Odor	Pungent / fruity	Sweet / fragrant	Sour smell

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### 1.3 Important Functional Group Reactions

#### Aldehydes & Ketones:

- Nucleophilic addition reactions (C=O is reactive)
- Tollens' test: Aldehydes → Silver mirror
- Fehling's test: Aldehydes → Red precipitate
- Ketones usually **do not give Tollens'/Fehling's test**

#### Carboxylic Acids:

- Acidic nature:  $\text{R-COOH} + \text{NaOH} \rightarrow \text{R-COONa} + \text{H}_2\text{O}$

- **Esterification:**  $\text{R-COOH} + \text{R}'\text{-OH} \rightarrow \text{R-COOR}' + \text{H}_2\text{O}$  (acid catalyst)
  - **Reduction:**  $\text{R-COOH} \rightarrow \text{R-CH}_2\text{OH}$
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## 1.4 Classification

Type	Example	Notes
Aldehyde	Formaldehyde, Acetaldehyde	C=O at end
Ketone	Acetone, Butanone	C=O inside chain
Carboxylic Acid	Formic acid, Acetic acid	Contains -COOH

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## 2. Key Concepts & Formulas

Concept	Formula / Key Points	Mnemonics / Tips
Oxidation	Aldehyde $\rightarrow$ Carboxylic acid	"Aldehyde can be oxidized, Ketone cannot"
Reduction	Aldehyde $\rightarrow$ Alcohol, Ketone $\rightarrow$ Alcohol, Carboxylic acid $\rightarrow$ Alcohol	"C=O + H $\rightarrow$ CH-OH"
Nucleophilic Addition	$\text{R-CHO} + \text{Nu}^- \rightarrow \text{R-CHNu-OH}$	Focus on carbonyl carbon being $\delta^+$
Acid-base	$\text{R-COOH} + \text{Base} \rightarrow \text{Salt} + \text{H}_2\text{O}$	$\text{H}^+$ donor = acidic
Esterification	$\text{R-COOH} + \text{R}'\text{-OH} \rightarrow \text{Ester} + \text{H}_2\text{O}$	Acid catalyzed

**Mnemonic for Oxidation Tests:**

"Aldehydes react, Ketones rest"  $\rightarrow$  Tollens' / Fehling's test.

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## 3. Solved Numerical / Reaction Problems

### Example 1: Identify Reaction Product

**Problem:**  $\text{CH}_3\text{CHO} + [\text{O}] \rightarrow ?$

**Solution:**

- Aldehyde oxidation:  $\text{CH}_3\text{CHO} \rightarrow \text{CH}_3\text{COOH}$  (Acetic acid)
- Tip:** Remember: Only aldehydes oxidize easily.
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## Example 2: Ester Formation

**Problem:**  $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \rightarrow ?$

**Solution:**

- Esterification:  $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \rightarrow \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$   
**Mnemonic:** "Acid + Alcohol  $\rightarrow$  Ester + Water"
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## Example 3: Tollens' Test

**Problem:** Identify aldehyde by Tollens' reagent

**Solution:**

- $\text{R-CHO} + \text{Ag}(\text{NH}_3)_2^+ \rightarrow \text{R-COOH} + 2\text{Ag}$  (silver mirror)

**Tip:** Ketones do NOT give this test.

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## 4. Previous Years' Board Questions

- High-weightage topics:**
  - Oxidation/reduction of aldehydes & ketones
  - Esterification reactions
  - Identification tests for aldehydes, ketones, acids
  - Nucleophilic addition reactions

**Trends:** Mechanism-based reactions, reaction products, comparison of aldehyde vs ketone reactivity.

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## 5. Quick Revision Notes / Important Points

- Functional groups:**
  - Aldehyde =  $-\text{CHO}$
  - Ketone =  $-\text{CO}-$
  - Carboxylic acid =  $-\text{COOH}$
- Key reactions:**
  - Nucleophilic addition ( $\text{C}=\text{O}$ )
  - Oxidation (aldehyde  $\rightarrow$  acid)
  - Reduction ( $\text{C}=\text{O} \rightarrow -\text{CH}-\text{OH}$ )
  - Esterification (acid + alcohol  $\rightarrow$  ester)
  - Acid-base ( $\text{COOH} + \text{base} \rightarrow \text{salt} + \text{water}$ )

**Color-coded visual table:**

Compound	Key Reaction	Test / Observation
Aldehyde	Oxidation	Silver mirror (Tollens')

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Compound	Key Reaction	Test / Observation
Ketone	Nucleophilic addition	No Tollens', forms alcohol on reduction
Carboxylic acid	Esterification / Neutralization	Acidic reactions, salts

## 6. Predicted / Likely Questions

1. Oxidation products of aldehydes
2. Reactions of ketones with Grignard reagents
3. Preparation of carboxylic acids from alcohols / aldehydes
4. Esterification reactions and mechanism
5. Identification of functional groups via chemical tests
6. Comparison: Aldehyde vs Ketone reactivity

## 7. Exam Tips & Tricks

- Mark C=O carbon  $\delta^+$  for addition reactions
- Remember Tollens' test only for aldehydes
- Esterification is acid-catalyzed, reversible
- Color coding: Carbonyl = red, alcohol = blue, acid = green
- Draw flowcharts for: oxidation, reduction, esterification

## 8. Visual & Kid-Friendly Learning Style

- Picture C=O as a carbon "door" → easy for nucleophiles to attack
- Acid = sour flag → reacts with base to make salt
- Ester = sweet perfume → product of acid + alcohol
- Use flowcharts for reactions:
  - Aldehyde → Oxidation → Acid
  - Alcohol → Oxidation → Aldehyde → Acid
  - Acid + Alcohol → Ester + Water