

Carbonyl Compounds

A-Level Chemistry • Topic 17

A-Level Chemistry



Carbonyl Compounds

What we will cover

- 1 Aldehydes vs ketones
- 2 Nucleophilic addition
- 3 Tests for carbonyls
- 4 Silver mirror & iodoform



propanone, a ketone

1

Structure and mechanism

Carbonyl Compounds

Structure and mechanism

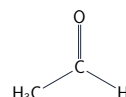
Aldehydes vs ketones

Both have the **carbonyl** 羰基 ($\text{C}=\text{O}$) group:

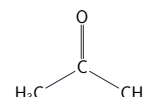
- an **aldehyde** 醛 ($-\text{CHO}$) – $\text{C}=\text{O}$ on the end
- a **ketone** 酮 – $\text{C}=\text{O}$ in the middle

Made by oxidising primary / secondary alcohols.

aldehyde



ketone

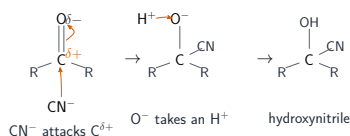


$\text{C}=\text{O}$ carbon on the end $\text{C}=\text{O}$ carbon in the middle,
(also carries an H): $-\text{CHO}$ between two carbons

Carbonyl Compounds

Structure and mechanism

Nucleophilic addition



HCN adds across the $\text{C}=\text{O}$ by **nucleophilic addition** 亲核加成:

- CN^- attacks the δ^+ carbon
- $\text{C}=\text{O}$ breaks to O^-
- O^- takes an H^+ → a **hydroxynitrile** 羟基腈

Reduction 还原 (NaBH_4) gives back an alcohol.

2

Tests

Tests for carbonyls

tell an aldehyde from a ketone

Fehling's
(blue)
→ brick-red ppt

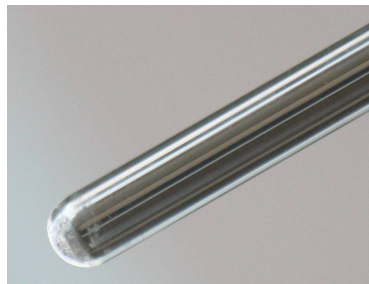
Tollens'
(colourless)
→ silver mirror

a **ketone**
gives **no change**
with either test

2,4-DNPH 2,4-二硝基苯肼 gives an orange precipitate → any carbonyl.

To tell them apart (aldehydes oxidise, ketones don't):
Fehling's 斐林试剂 → brick-red; **Tollens'** 托伦试剂 → silver mirror – only with an aldehyde.

Silver mirror and iodoform



A positive **Tollens'** 托伦试剂 test coats the tube with a shiny silver mirror – the aldehyde reduces Ag^+ to silver. The **iodoform test** 碘仿试验 (alkaline I_2) detects the $\text{CH}_3\text{CO}-$ group, giving yellow CHI_3 .

3

Recap

Worked example – aldehyde or ketone?

Propanal and propanone are in unlabelled tubes. Give one test that tells them apart.

- Both give an orange precipitate with **2,4-DNPH** – that only proves a $\text{C}=\text{O}$ is present.
- So 2,4-DNPH **cannot** separate them. Use an **oxidising** 氧化的 test instead.
- Add Tollens' reagent and warm: propanal (aldehyde) reduces Ag^+ to a **silver mirror**.
- Propanone gives **no change** – a ketone has no H on the carbonyl carbon to lose.

2,4-DNPH proves $\text{C}=\text{O}$ **present**. Tollens' or Fehling's then splits aldehyde (positive) from ketone (negative).

Topic 17 – key takeaways

1 Carbonyl

aldehyde ($-\text{CHO}$) vs ketone (middle)

2 Mechanism

nucleophilic addition of HCN

3 Detect

2,4-DNPH gives an orange precipitate

4 Distinguish

Fehling's & Tollens' react with aldehydes

Check yourself

- Where is the $\text{C}=\text{O}$ in a ketone?
- What attacks the carbonyl carbon in the HCN mechanism?
- What reagent confirms any carbonyl?
- What does Tollens' give with an aldehyde?



Answers 1. in the middle of the chain 2. the cyanide ion CN^- 3. 2,4-DNPH 4. a silver mirror