

17.1 Aldehydes and ketones

Name: _____ Class: _____ Date: _____

Total: 13 marks

KEY WORDS nucleophilic addition 亲核加成 • tollens' reagent 托伦试剂 • carbonyl 羰基 • aldehyde 醛
• ketone 酮

Objective

Build the skills to answer exam questions on **aldehydes and ketones** 醛和酮 — making them, **nucleophilic addition** 亲核加成 of HCN, and the tests that tell an aldehyde from a ketone.

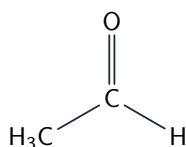
You must be able to:

- describe how aldehydes and ketones are made and reduced
- describe the nucleophilic addition mechanism of HCN
- use 2,4-DNPH, Fehling's and Tollens' tests, and the iodoform test

1 Worked examples

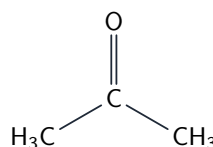
■ Carbonyl compounds

aldehyde



C=O carbon on the end
(also carries an H): -CHO

ketone

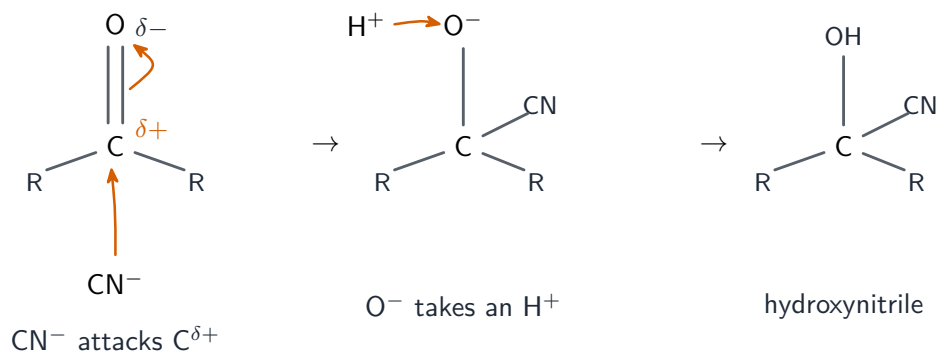


C=O carbon in the middle,
between two carbons

Both have the C=O carbonyl group: aldehyde = on the end (-CHO); ketone = in the middle

Made by oxidising alcohols: primary (distil) → **aldehyde**; secondary → **ketone**.
Reduced back by NaBH₄/LiAlH₄. With HCN (KCN catalyst) → a **hydroxynitrile** (+1 carbon).

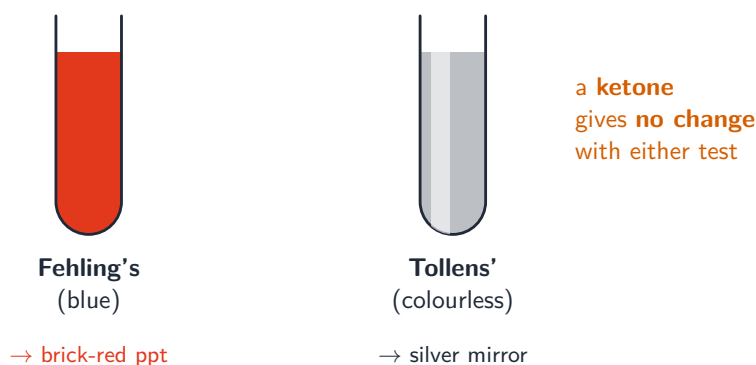
■ Nucleophilic addition of HCN



CN^- attacks the δ^+ carbon; the $\text{C}=\text{O}$ breaks to O^- ; O^- takes an H^+ to give the hydroxynitrile

■ Tests

tell an aldehyde from a ketone



2,4-DNPH (orange ppt) detects any carbonyl. Aldehyde: Fehling's $\rightarrow$ brick-red, Tollens' $\rightarrow$ silver mirror. Ketone: no change

The **iodoform test** (alkaline I_2) gives a yellow CHI_3 precipitate for a $\text{CH}_3\text{CO}-$ group.

2 Practice

2.1 State the difference in structure between an aldehyde and a ketone. [2]

2.2 Name the reagent used to detect the presence of any carbonyl compound. [1]

3 Exam-style questions

3.1 Which reagent gives a silver mirror with an aldehyde but no change with a ketone?[1]

- **A** 2,4-DNPH
 - **B** Tollens' reagent
 - **C** bromine water
 - **D** NaBH_4
-

3.2 The reaction of HCN with a ketone is classified as: [1]

- **A** electrophilic addition
 - **B** nucleophilic addition
 - **C** free-radical substitution
 - **D** elimination
-

3.3 (a) Describe the mechanism of the nucleophilic addition of HCN to ethanal. [3]

(b) State the reagent and condition to reduce propanone to an alcohol, and name the alcohol formed. [2]

3.4 Describe how you would use chemical tests to distinguish between propanal (an aldehyde) and propanone (a ketone). [3]

Solutions

2.1 in an aldehyde the C=O is on the end of the chain (carries an H, -CHO); in a ketone the C=O is in the middle, between two carbons.

2.2 2,4-dinitrophenylhydrazine (2,4-DNPH).

3.1 B. Tollens' reagent gives a silver mirror with an aldehyde only.

3.2 B. Addition of HCN to a carbonyl is nucleophilic addition.

3.3 (a) the CN^- nucleophile attacks the $\delta+$ carbonyl carbon (curly arrow from the lone pair); the C=O π bond breaks, the electrons going to the oxygen to give O^- ; the O^- takes an H^+ (from HCN) to form the hydroxynitrile.

(b) NaBH_4 (or LiAlH_4); propan-2-ol (a secondary alcohol).

3.4 add Tollens' reagent (or Fehling's) and warm; propanal (aldehyde) gives a silver mirror (or brick-red precipitate); propanone (ketone) gives no change.