Exercise walk-through

Aldehydes and ketones ▪ 17.1

eXercise

You must be able to

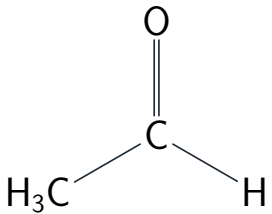
- describe how aldehydes and ketones are made and reduced
- describe the nucleophilic addition mechanism of HCN
- use 2,4-DNPH, Fehling's and Tollens' tests, and the iodoform test

Method — Carbonyl compounds

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

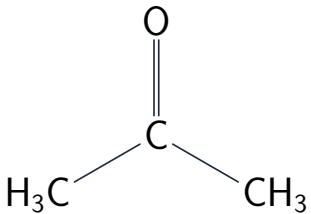
Method — Carbonyl compounds

aldehyde



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

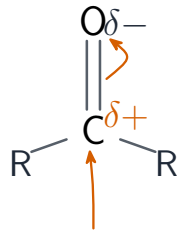
ketone



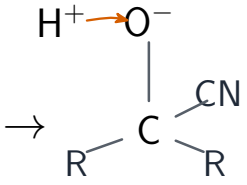
C=O carbon in the middle, between two carbons

Ethanal with C=O on the end (–CHO); propanone with C=O in the middle

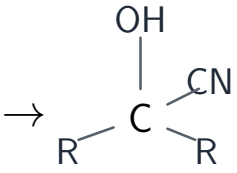
Method — Nucleophilic addition of HCN



CN^- attacks $C^{\delta+}$



O^- takes an H^+



hydroxynitrile

CN attacking the $\delta+$ carbonyl carbon, C=O breaking to O , then O taking a proton

Method — Tests

The **iodoform test** (alkaline I) gives a yellow CHI precipitate for a CH_3CO- group.

tell an aldehyde from a ketone

Fehling's
(blue)
→ brick-red ppt

Tollens'
(colourless)
→ silver mirror

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

Practice 2.1 ▪ 2 marks

State the difference in structure between an aldehyde and a ketone.

Solution 2.1

Worked steps

in an aldehyde the C=O is on the end of the chain (carries an H, –CHO) B1; in a ketone the C=O is in the middle, between two carbons B1.

Practice 2.2 ▪ 1 mark

Name the reagent used to detect the presence of any carbonyl compound.

Solution 2.2

Worked steps

2,4-dinitrophenylhydrazine (2,4-DNPH) B1.

Exam-style 3.1 ▪ 1 mark

Which reagent gives a silver mirror with an aldehyde but no change with a ketone?

A 2,4-DNPH

B Tollens' reagent

C bromine water

D NaBH

Solution 3.1

Method: Tests

A 2,4-DNPH

B Tollens' reagent ✓

C bromine water

D NaBH

Worked steps

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

Exam-style 3.2 ▪ 1 mark

The reaction of HCN with a ketone is classified as:

A electrophilic addition

B nucleophilic addition

C free-radical substitution

D elimination

Solution 3.2

A electrophilic addition

B nucleophilic addition ✓

C free-radical substitution

D elimination

Worked steps

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

Exam-style 3.3 ▪ 3 marks

(a) Describe the mechanism of the nucleophilic addition of HCN to ethanal.
(b) State the reagent and condition to reduce propanone to an alcohol, and name the alcohol formed.

Solution 3.3

Worked steps

(a) the CN nucleophile attacks the $\delta+$ carbonyl carbon (curly arrow from the lone pair) M1; the C=O π bond breaks, the electrons going to the oxygen to give O M1; the O takes an H (from HCN) to form the hydroxynitrile A1.
(b) NaBH (or LiAlH) B1; propan-2-ol (a secondary alcohol) B1.

Exam-style 3.4 ▪ 3 marks

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

Solution 3.4

Worked steps

add Tollens' reagent (or Fehling's) and warm M1; propanal (aldehyde) gives a silver mirror (or brick-red precipitate) M1; propanone (ketone) gives no change A1.