

## 4.5.2 Carbonyl tests, reduction and cyanide addition

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_ Total: 20 marks

**KEY WORDS** nucleophilic addition

### Objective

Combine test results and reaction conditions to identify and transform carbonyls. Questions and marking guidance are original.

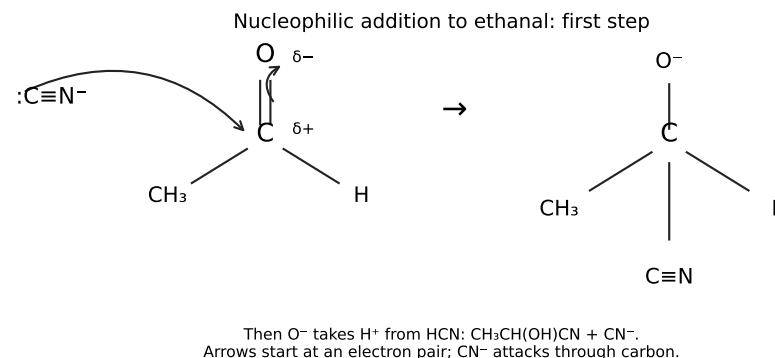
### 1 Key knowledge and worked examples

Aldehydes have terminal  $\text{-CHO}$ ; ketones have carbon groups on both sides of  $\text{C=O}$ . Both give a 2,4-DNPH precipitate. Warm Tollens' gives silver with an aldehyde; warm Fehling's/Benedict's gives brick-red  $\text{Cu}_2\text{O}$ . Ordinary ketones do not give these reducing tests. An isolated positive 2,4-DNPH result does not distinguish them.

#### ■ Worked identification

$\text{C}_3\text{H}_6\text{O}$  with  $\text{C=O}$ , positive Tollens' and three carbon-13 environments fits propanal,  $\text{CH}_3\text{CH}_2\text{CHO}$ . Propanone fits the formula but fails the other two observations.  $\text{LiAlH}_4$  in dry ether reduces propanal to propan-1-ol after suitable work-up.

$\text{HCN}$  with  $\text{CN}^-$  catalyst adds across  $\text{C=O}$ : a carbon lone pair of  $\text{CN}^-$  attacks carbonyl carbon and the  $\pi$  pair moves to O. The  $\text{O}^-$  intermediate gains  $\text{H}^+$  from  $\text{HCN}$ . Propanal gives  $\text{CH}_3\text{CH}_2\text{CH(OH)CN}$ , a racemate in achiral conditions because either face of the planar carbonyl is available. Propanone's product has identical methyl groups and is achiral. Cyanide/Tollens' chemistry requires approved controlled handling.



### 2 Practice

**2.1** Give one test that distinguishes propanal from propanone and both observations. [3]

---



---



---



---

**2.2** Give product and reagent conditions for reduction of propanone. [2]

---



---



---

**2.3** State the observation with 2,4-DNPH and explain its identification limit. [2]

---



---



---

### 3 Exam-style questions

---

**3.1** An unknown  $\text{C}_3\text{H}_6\text{O}$  gives 2,4-DNPH and iodoform precipitates, no Tollens' silver and two carbon-13 signals. Identify it, explain all evidence, and predict whether its HCN product is chiral. [5]

---

---

---

---

---

---

**3.2** Describe the electron-pair movements for  $\text{CN}^-$  addition to ethanal and the following proton transfer. State why a racemate results under achiral conditions. [4]

---

---

---

---

---

**3.3** Draw the first-step electron-pair arrows for  $\text{CN}^-$  addition to ethanal and the charged intermediate. [4]

---

---

---

---

---

---