

Cambridge (CIE) A Level Chemistry



Your notes

Carboxylic Acids

Contents

* Carboxylic Acids



Production of Carboxylic Acids

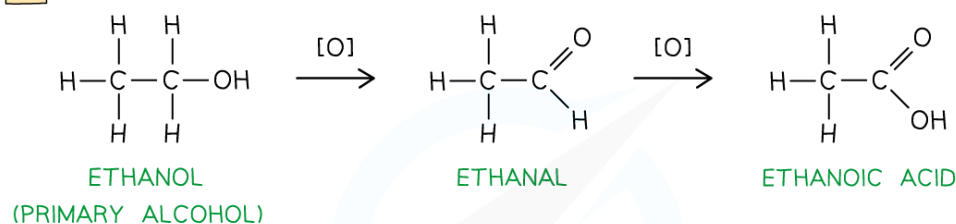
- Carboxylic acids are compounds with a -COOH functional group
- They can be prepared by a series of different reactions

Oxidation of primary alcohols & aldehydes

- Carboxylic acids can be formed from the **oxidation** of **primary alcohols** and **aldehydes** by either **acidified $\text{K}_2\text{Cr}_2\text{O}_7$** or **acidified KMnO_4** and **reflux**
- The oxidising agents themselves get reduced causing the solutions to change colour
 - In $\text{K}_2\text{Cr}_2\text{O}_7$ the orange dichromate ions ($\text{Cr}_2\text{O}_7^{2-}$) are reduced to green Cr^{3+} ions
 - In KMnO_4 the purple manganate ions (MnO_4^-) are reduced to colourless Mn^{2+} ions

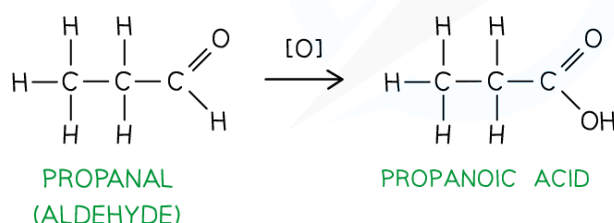
Oxidation of primary alcohols and aldehydes

1



[O] = ACIDIFIED $\text{K}_2\text{Cr}_2\text{O}_7$
OR
ACIDIFIED KMnO_4

2



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Oxidation of primary alcohols (1) and aldehydes (2) gives carboxylic acids

Hydrolysis of nitriles

- Carboxylic acids can also be prepared from the **hydrolysis** of **nitriles** using either **dilute acid** or **dilute alkali followed by acidification**
 - Hydrolysis by dilute acid results in the formation of a carboxylic acid and ammonium salt
 - Hydrolysis by dilute alkali results in the formation of a sodium carboxylate salt and ammonia; Acidification is required to change the carboxylate ion into a carboxylic

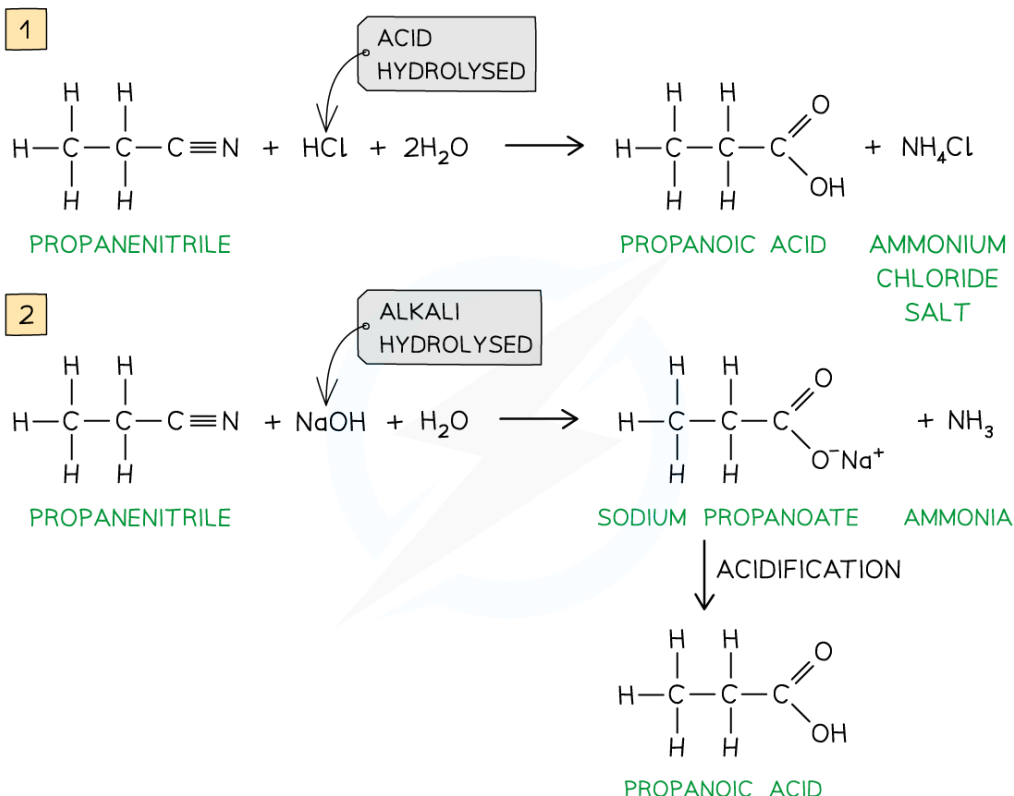
acid

- The -CN group at the end of the hydrocarbon chain is converted to a -COOH group

Hydrolysis of nitriles



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Hydrolysis of nitriles by either dilute acid (1) or dilute alkali and acidification (2) will form a carboxylic acid

Hydrolysis of esters

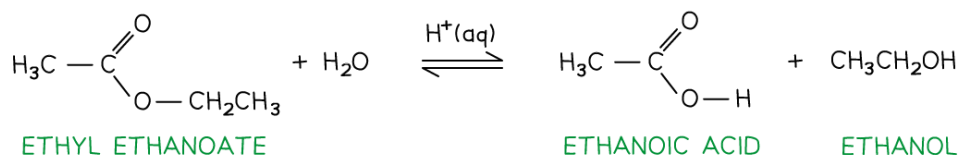
- Esters are formed from the condensation reaction between an alcohol and a carboxylic acid
- **Hydrolysis of esters by dilute acid or dilute alkali and heat followed by acidification** will reform the alcohol and the carboxylic acid
 - Hydrolysis by dilute acid is a **reversible reaction** where an equilibrium is established
 - Hydrolysis by dilute alkali is an **irreversible reaction** as all the ester is broken down to form a sodium carboxylate salt and an alcohol; acidification is required to change the carboxylate ion into a carboxylic acid

Hydrolysis of esters

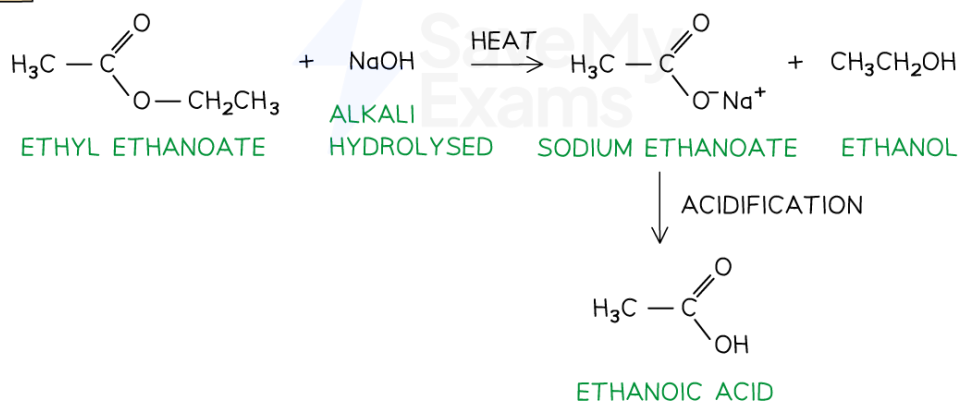


Your notes

1



2



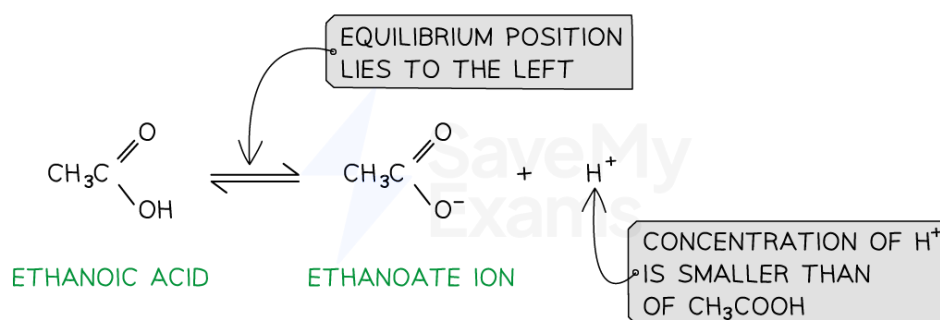
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Hydrolysis of esters by either dilute acid (1) or dilute alkali and heat followed acidification (2) will form a carboxylic acid

Reactions of Carboxylic Acids

- Carboxylic acids are **weak acids** as they do not completely **dissociate** in water
- This means that the position of the equilibrium lies to the left and that the concentration of H^+ is much smaller than the concentration of the carboxylic acid
- The solution has a pH value of less than 7

Example dissociation of a carboxylic acid



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Carboxylic acids are weak acids that do not fully dissociate in water, the position of the equilibrium lies to the left

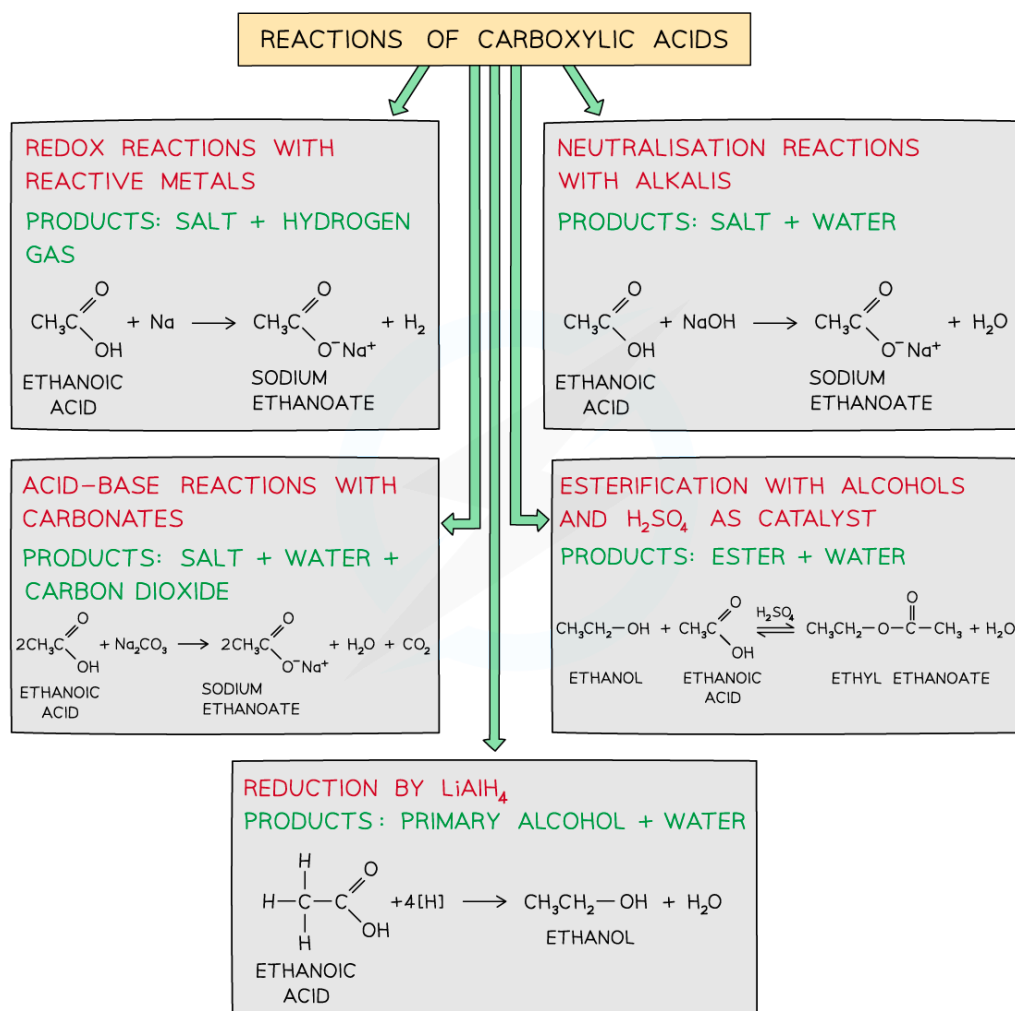
- Carboxylic acids are reactive compounds which can undergo many types of reactions including:

- Redox reactions with reactive metals
- Neutralisation reactions with alkali
- Acid-base reactions with carbonates
- Esterification with alcohols
- Reduction by LiAlH_4



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Different reactions of carboxylic acids



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Carboxylic acids undergo a wide variety of reactions