



Nitriles & Hydroxynitriles

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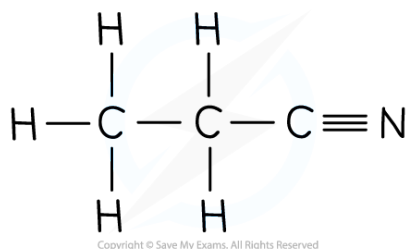
- * Nitriles & Hydroxynitriles



Production of Nitriles

- **Nitriles** are compounds with a -CN functional group
- They can be prepared from the **nucleophilic substitution** of halogenoalkanes

Propanenitrile, an example of a nitrile

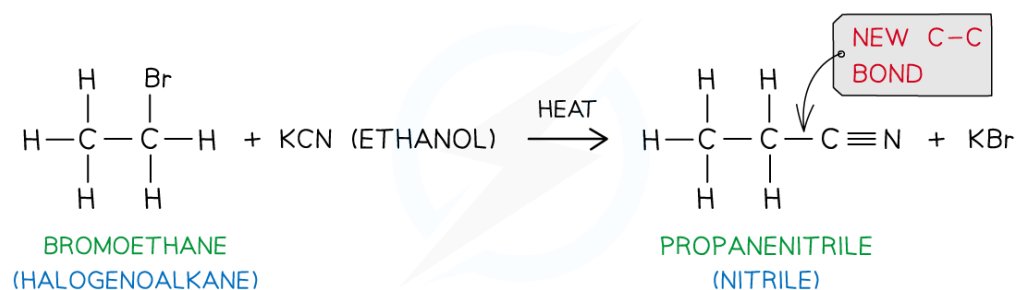


There are 2 alkyl type carbon atoms and the nitrile carbon for a total of 3 carbon atoms in propanenitrile

Reaction with KCN

- The **nucleophile** in this reaction is the **cyanide**, CN^- ion
- **Ethanol solution** of **potassium cyanide** (KCN in ethanol) is **heated under reflux** with the halogenoalkane
- The product is a **nitrile**
 - If an **aqueous** solution of potassium cyanide ($\text{KCN}(\text{aq})$) is heated under reflux with the halogenoalkane, an alcohol can be formed instead of the nitrile

The reaction of bromoethane with ethanolic KCN



Bromoethane reacts with ethanolic potassium cyanide when heated under reflux to form propanenitrile



Examiner Tips and Tricks

The nucleophilic substitution of halogenoalkanes with KCN adds an **extra** carbon atom to the carbon chain

This reaction can therefore be used by chemists to make a compound with one more carbon atom than the best available organic starting material

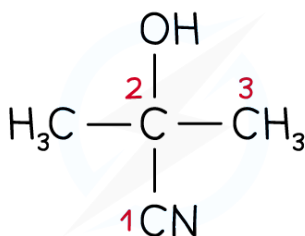


Your notes

Production of Hydroxynitriles

- **Hydroxynitriles** are compounds with both a hydroxy (-OH) and cyanide (-CN) functional group
- They can be prepared from the **nucleophilic addition** of **aldehydes** and **ketones**

2-hydroxy-2-methylpropanenitrile, an example of a hydroxynitrile compound



Hydroxynitriles contain an OH and a CN group, typically attached to the same carbon atom

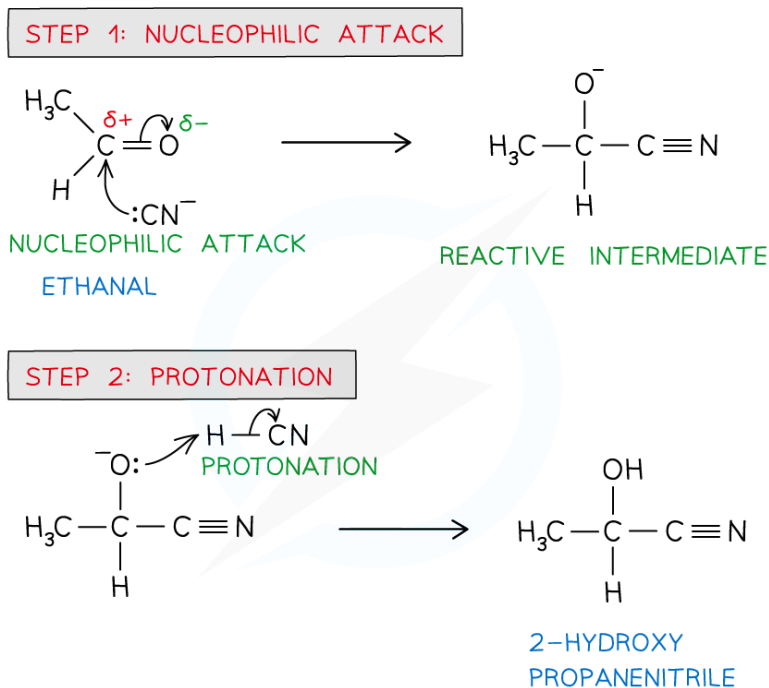
Reaction with HCN

- The nucleophilic addition of hydrogen cyanide to carbonyl compounds is a two-step process
- In **step 1**, the cyanide ion attacks the carbonyl carbon to form a negatively charged intermediate
- In **step 2**, the negatively charged oxygen atom in the reactive intermediate quickly reacts with aqueous H^+ (either from HCN, water or dilute acid) to form a 2-hydroxynitrile

Nucleophilic addition of HCN to carbonyl compounds



Your notes



The cyanide ion attacks the carbonyl carbon to form a negatively charged intermediate which quickly reacts with a proton to form a 2-hydroxynitrile compound



Examiner Tips and Tricks

The actual negative charge on the cyanide ion is on the **carbon atom** and not on the **nitrogen atom**

Hydrolysis of Nitriles

- **Nitriles** are hydrolysed by either **dilute acid** or **dilute alkali** followed by **acidification** to give a carboxylic acid
 - Hydrolysis is the breakdown of a compound using water

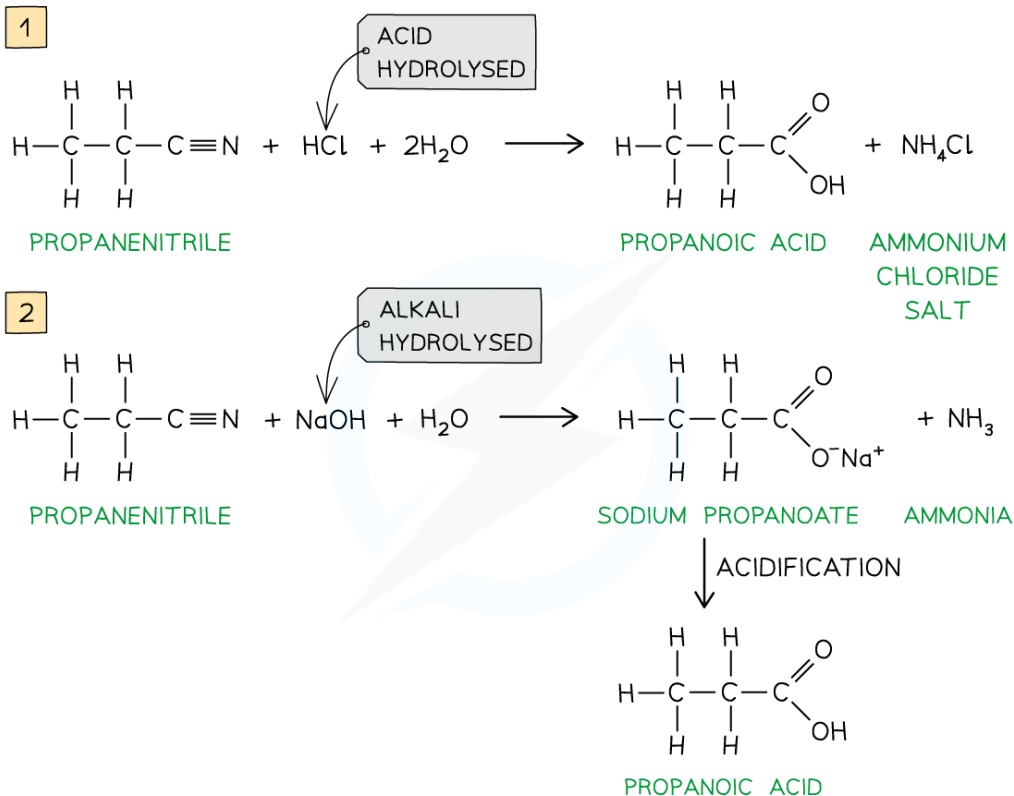
Hydrolysis of nitriles

- Nitriles are **hydrolysed by** 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



Your notes



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



Examiner Tips and Tricks

Unlike the **formation** of nitriles which add an extra carbon atom to the carbon chain, **hydrolysis** doesn't change the number of carbon atoms