# Cambridge (CIE) A Level Chemistry

Your notes

## Nitriles & Hydroxynitriles

### Contents

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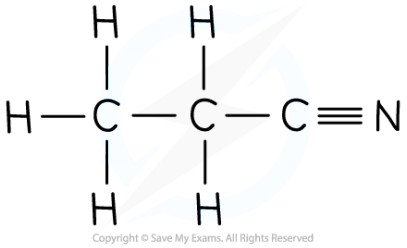
# Production of Nitriles

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

## Propanenitrile, an example of a nitrile



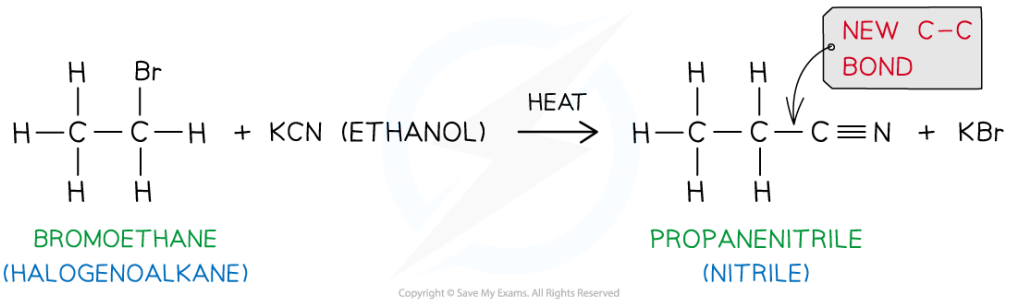



*There are 2 alkyl type carbon atoms and the nitrile carbon for a total of 3 carbon atoms in propanenitrile*

## Reaction with KCN

- The **nucleophile** in this reaction is the **cyanide**, $CN^-$ ion
- **Ethanolic 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 (KCN (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

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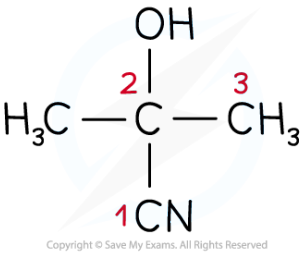
# Production of Hydroxynitriles

- **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



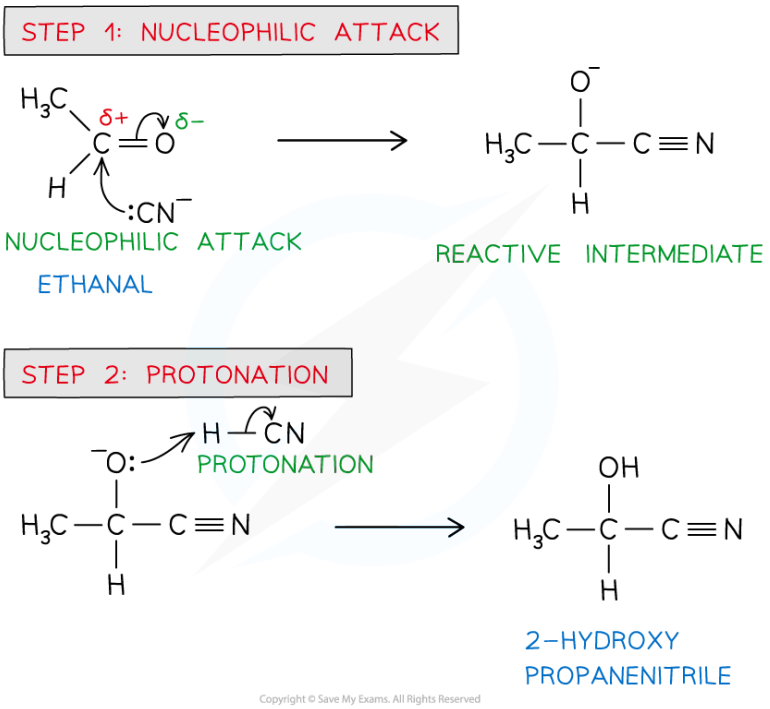


***Hydroxynitriles contain an OH and a CN group, typically attached to the same carbon atom***

## 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





***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

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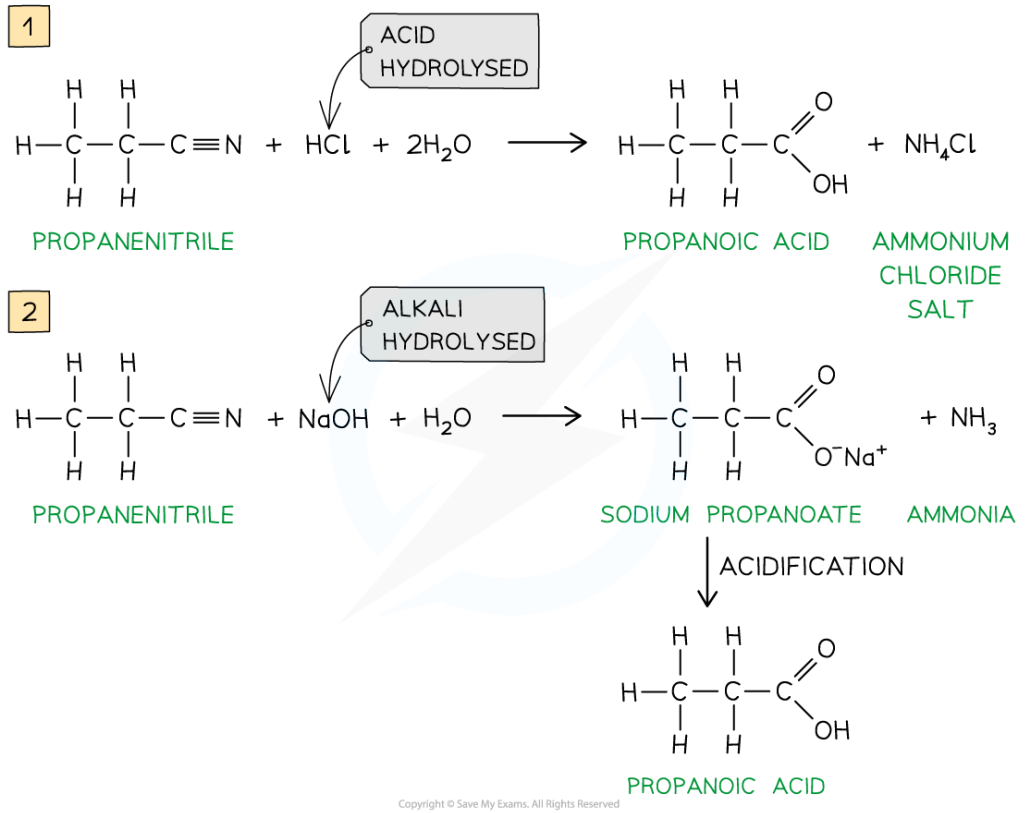
## Hydrolysis of nitriles





*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

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