

# CAIE Chemistry A-level

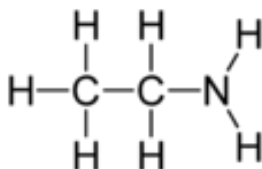
## 19: Nitrogen Compounds Notes

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## Primary Amines

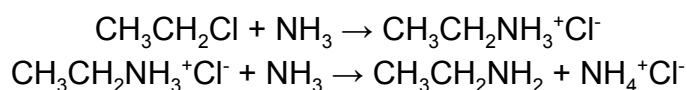
Primary amines have the formula  $\text{RNH}_2$  where R is an alkyl group. The structure of **ethylamine** is shown below:



### Formation of Alkyl Amines

**Alkyl amines** can be made from **halogenoalkanes**:

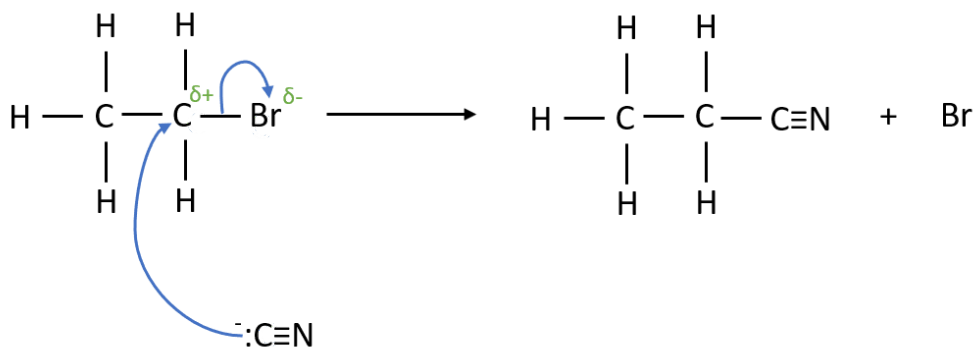
- Heat the halogenoalkane in a sealed tube with **concentrated ammonia** in an ethanol solvent (reflux cannot be used as ammonia is too volatile). To ensure that a **primary amine** is formed, rather than an ammonium salt, an **excess of ammonia** must be used.
- E.g. Using 1-chloroethane:



## Nitriles and Hydroxynitriles

### Formation of Nitriles

Nitriles are formed when a halogenoalkane reacts with **cyanide**. The reaction requires **warm, ethanolic potassium cyanide** (ethanolic means dissolved in ethanol).

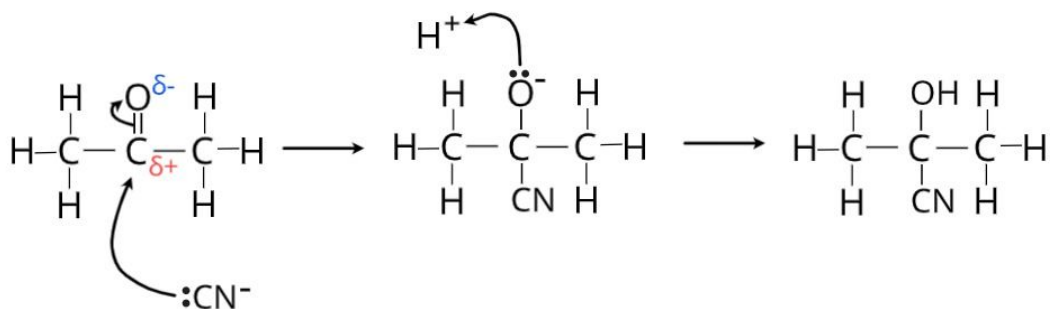


### Nucleophilic Addition

When aldehydes and ketones react with HCN to form **hydroxynitriles**, a **nucleophilic addition** reaction occurs.

The **carbonyl bond** ( $\text{C}=\text{O}$ ) is **highly polar**. The negative **cyanide ion** acts as a **nucleophile** and attacks the slightly positive carbon atom. The  $\text{C}=\text{O}$  bond breaks, leaving only a **single bond** between the **carbon and oxygen** atoms. The negatively charged oxygen then bonds to a **hydrogen ion** (from HCN or any added acid).





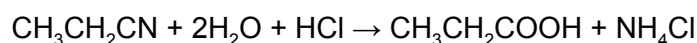
## Hydrolysis

**Nitriles** can undergo **hydrolysis** to form **carboxylic acids**. The  $C\equiv N$  nitrile bond reacts with water to produce the carboxylic acid.

- **Acid hydrolysis**

The nitrile is heated under **reflux** with a dilute acid (such as **hydrochloric acid**). A **carboxylic acid** and a **salt** are produced.

The reaction of propanenitrile with a dilute acid:



- **Alkaline hydrolysis**

The nitrile is heated under **reflux** with an alkali (such as **sodium hydroxide**). This produces a **carboxylic acid** and **ammonia**. The reaction takes place in two stages. First, carboxylate ions are produced (e.g. **sodium carboxylate** forms if sodium hydroxide is used). A **strong acid** must then be added to provide hydrogen ions to liberate the carboxylic acid. Hydrochloric acid is commonly used.

The formation of propanoic acid from propanenitrile:

