Nitriles are compounds which contain -CN attached to a hydrocarbon group. Some common examples include:

\[
\begin{align*}
\text{CH}_3\text{-C}&\equiv\text{N} & \text{CH}_3\text{-CH}_2\text{-C}&\equiv\text{N} & \text{CH}_3\text{-CH}_2\text{CH}_2\text{-C}&\equiv\text{N} \\
\text{ethanenitrile} & & \text{propanenitrile} & & \text{2-hydroxypropanenitrile}
\end{align*}
\]

The name is based on the total number of carbons in the longest chain - including the one in the -CN group. Where you have things substituted into the chain (as in the third example), the -CN carbon counts as number 1. Nitriles are produced in two important reactions - both of which result in an increase in the length of the carbon chain because of the extra carbon in the -CN group. They are formed in the reaction between halogenoalkanes (haloalkanes or alkyl halides) and cyanide ions. For example:

\[ \text{CH}_3\text{CH}_2\text{Br} + \text{CN}^- \rightarrow \text{CH}_3\text{CH}_2\text{CN} + \text{Br}^- \]

or during the reaction between aldehydes or ketones and hydrogen cyanide. For example, the reaction between ethanal and hydrogen cyanide to make 2-hydroxypropanenitrile is:

\[ \text{CH}_3\text{CHO} + \text{HCN} \rightarrow \text{CH}_3\text{CH}_2\text{CN} \]

**Converting the nitrile into a carboxylic acid**

There are two ways of doing this, both of which involve reacting the carbon-nitrogen triple bond with water. This is described as hydrolysis. The two methods produce slightly different products - you just have to be careful to get this right.

**Acid hydrolysis**

The nitrile is heated under reflux with a dilute acid such as dilute hydrochloric acid. A carboxylic acid is formed. For example, starting from ethanenitrile you would get ethanoic acid. The ethanoic acid could be distilled off the mixture.

\[ \text{CH}_3\text{CN} + 2\text{H}_2\text{O} + \text{H}^+ \rightarrow \text{CH}_3\text{COOH} + \text{NH}_4^+ \]

**Alkaline hydrolysis**

The nitrile is heated under reflux with an alkali such as sodium hydroxide solution. This time you would not, of course, get a carboxylic acid produced - any acid formed would react with the sodium hydroxide present to give a salt. You also wouldn't get ammonium ions because they would react with sodium hydroxide to produce ammonia. Starting from ethanenitrile, you would therefore get a solution containing ethanoate ions (for example, sodium ethanoate if you used sodium hydroxide solution) and ammonia.

\[ \text{CH}_3\text{CN} + \text{H}_2\text{O} + \text{OH}^- \rightarrow \text{CH}_3\text{COO}^- + \text{NH}_3 \]
You have to remember to convert the ions into the free carboxylic acid, because that's what we are trying to make. To liberate the weak acid, ethanoic acid, you just have to supply hydrogen ions from a strong acid such as hydrochloric acid. You add enough hydrochloric acid to the mixture to make it acidic.

\[
\text{\[CH_3COO^- + H^+ \rightarrow CH_3COOH\]}\]

Now you can distil off the carboxylic acid.

Contributors

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