

Alcohols, Carboxylic Acids and Esters Notes

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Alcohols, carboxylic acids, and esters are important groups of organic compounds, each with their own structures, properties, and uses. Let's look at alcohols first.

Alcohols

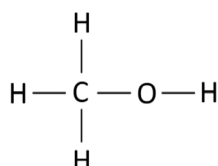
An alcohol: a homologous series of compounds that all contain -OH functional group.

The general formula of an alcohol is $\text{C}_n\text{H}_{2n+1}\text{OH}$.

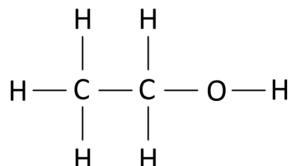
That's a single O. The 2 belongs to the H. All alcohols have names that end in **-ol**.

A quick reminder that a homologous series of compounds is a group of compounds with the same general formula, that have similar chemical properties meaning that they react the same way as each other and that they show a gradual variation in their physical properties.

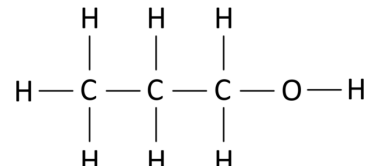
1. Methanol, CH_3OH



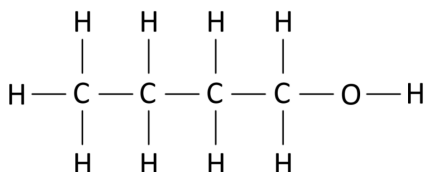
2. Ethanol, $\text{C}_2\text{H}_5\text{OH}$



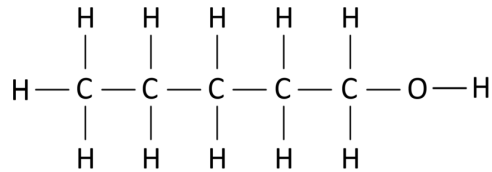
3. Propanol, $\text{C}_3\text{H}_7\text{OH}$



4. Butanol, $\text{C}_4\text{H}_9\text{OH}$



5. Pentanol, $\text{C}_5\text{H}_{11}\text{OH}$



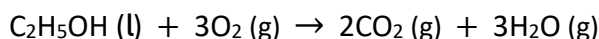
Reactions of Alcohols

We could see exam questions on the reactions of alcohols. We are required to know two reactions involving alcohols, the reaction with sodium, combustion, addition of water and oxidation of alcohols. Let's look at each in detail.

Combustion of Alcohols

Like most organic compounds, alcohols can burn in air. Check out the example of the combustion of ethanol below.

ethanol + oxygen $\rightarrow$ carbon dioxide + water



This is complete combustion. There are two types of combustion, **complete combustion** and **incomplete combustion**.

Complete combustion – occurs when a fuel fully reacts with a sufficient supply of oxygen. It results in the formation of two main products, carbon dioxide, CO_2 and water, H_2O .

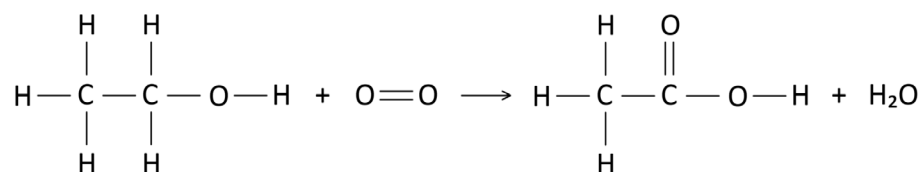
Incomplete combustion – occurs when a fuel burns in an insufficient supply of oxygen. As a result, the fuel is not fully oxidised. This leads to the formation of harmful products, such as carbon monoxide, CO and soot (carbon particles), in addition to water, H_2O .

Oxidation of Alcohols

If a solution of ethanol is left to stand in air it is oxidised by oxygen. This is why wine turns into vinegar if left in contact with air. When alcohols are oxidised they are converted into carboxylic acids.

Check out the reaction shown below.

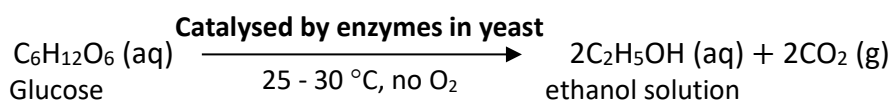
ethanol + oxygen → ethanoic acid + water



What is this reaction used for? To produce ethanoic acid (vinegar) which is used to flavour food and as a preservative in other foods like pickled eggs for example. Pickled means conserved in vinegar.

Fermentation

Fermentation is a process where microorganisms, like yeast, break down sugars to make ethanol and carbon dioxide. Ethanol is used in making drinks and fuels. The equation below shows the fermentation reaction.



Conditions:

- **Catalyst is the enzymes present in the yeast.**
- **Room temperature is best. The reaction will take place above 10°C.**

The reaction must be anaerobic (there must be no O₂ present) otherwise the ethanol will be oxidised to ethanoic acid.

Fermentation gives a solution of ethanol. Fractional distillation can be used to give pure ethanol.

Fermentation is used to make all alcoholic drinks. But if hydration of ethene gives a pure product that doesn't need any separation processes, why would people use fermentation?

1. Fermentation is a cheap process as we don't need to have a complicated infrastructure to do it.
2. We don't have to heat the reaction it as it happens at room temperature.
3. Fermentation doesn't need to be pressurised, so complicated infrastructure isn't needed.

Carboxylic Acids

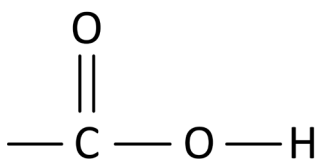
Carboxylic acids: are a homologous series of compounds that all contain the **–COOH** functional group.

They all have names that end in **–anoic acid**. Carboxylic acids are weak acids and partially dissociate in solution.

What is a functional group? It can be an atom, or a group of atoms, that determines the chemical properties and reactions of an organic compound. In simpler terms it's the reactive part of a compound that gives the compound its specific chemical properties 😊

A quick reminder about weak acids. A weak acid will only partially dissociate when they are dissolved in water. For example ethanoic acid, CH_3COOH .

Dissociate means to split up and you **must** use this key word, though the exam board will also accept ionise instead. We could be asked to draw the **–COOH** functional group in the exam. The figure below shows this functional group.

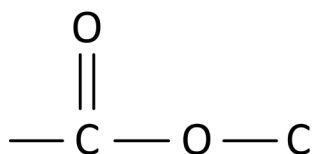


Esters

Esters themselves are not covered in depth for the GCSE specification anymore, which is a shame, there is some wonderful chemistry involving esters. I have included them in this booklet because esters are cool and if you're going on to A level chemistry it's not bad to have a bit of an introduction prior to that.

An ester: a homologous series of compounds that all contain the **–COOC** functional group.

The **–COOC** functional group is drawn as follows:



As we saw in the previous section esters are formed by the reaction of a carboxylic acid with an alcohol.

That's it 😊 That's all we need to know about esters for the GCSE 😊