PiXL KnowIT!

GCSE Chemistry

AQA Topic – Organic Chemistry

(Alkenes, Alcohols, Carboxylic Acids, Esters, Polymers)

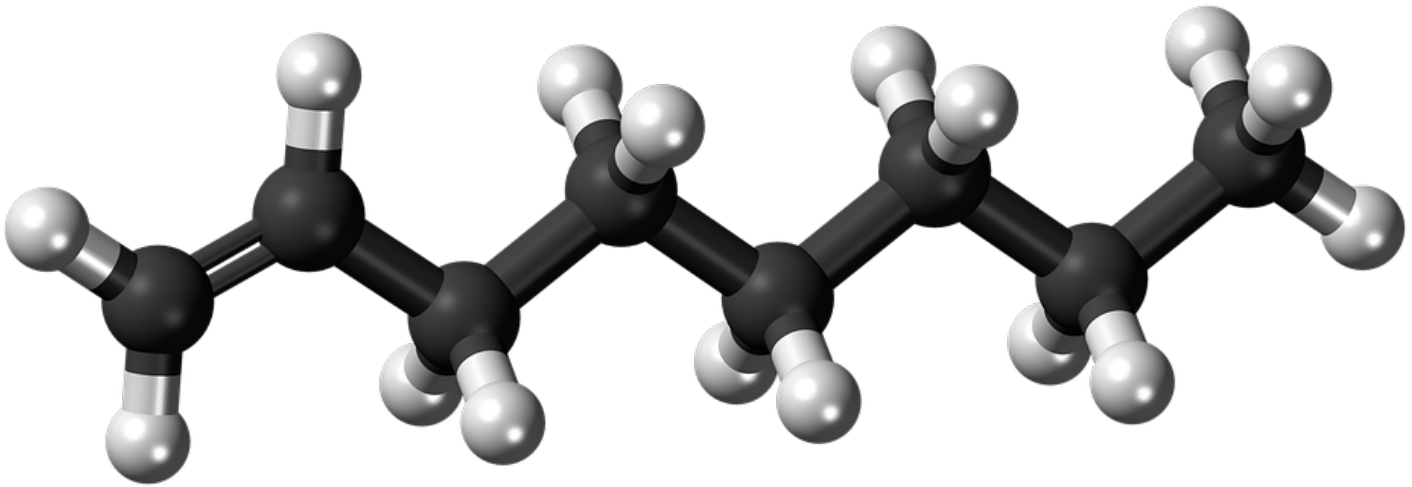
Structure and formulae of alkenes (Chemistry only)

We already know that alk**anes** have the general formulae C_nH_{2n+2}

Alk**enes** are hydrocarbons with a **double carbon-carbon bond**. The general formula for the homologous series of alkenes is C_nH_{2n}

The first four members of the alkanes are ethene, propene, butene and pentene.

There is no chemical called methene, as the double bond must be between two carbons. Any hydrocarbon starting with meth- can only have one carbon.



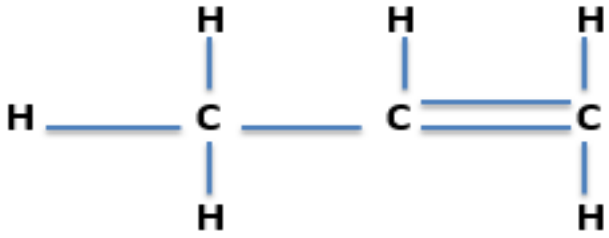
Structure and formulae of alkenes (Chemistry only)

Worked examples

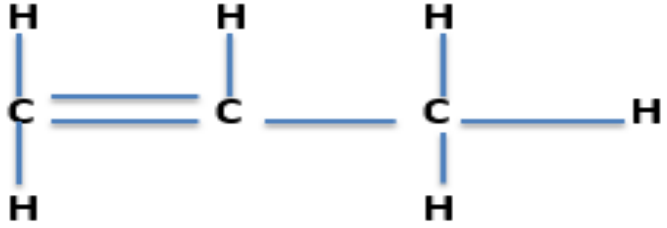
Ethene has two carbon atoms so it's formula will be $C_2H_{(2x2)}$ this gives C_2H_4
Propene has three carbon atoms so it's formula will be $C_3H_{(2x3)}$ this gives C_3H_6
Butene has four carbon atoms so it's formula will be $C_4H_{(2x4)}$ this gives C_4H_8
Propene has five carbon atoms so it's formula will be $C_5H_{(2x5)}$ this gives C_5H_{10}

You will be expected to know the names and formulae of these first four alkenes, you will be expected to calculate the formulae of alkenes with more than five carbons

Where the double bond is placed is not important at this stage so for propene we can draw it in one of two ways e.g.



Or



Both are C_3H_6

Reaction of alkenes (Chemistry only)

Alkenes are hydrocarbons with the functional group C=C. This is the **carbon-carbon double bond**.

Alkenes react with oxygen in combustion reactions in the same way as other hydrocarbons, but they tend to burn in air with **smoky flames** because of **incomplete combustion**.

Alkenes can therefore react as alkanes do e.g.

butene + oxygen → carbon dioxide + water

$$C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$$

Incomplete combustion however produces either carbon monoxide CO or carbon C i.e.

$$C_4H_8 + 4O_2 \rightarrow 4CO + 4H_2O$$

Or

$$C_4H_8 + 2O_2 \rightarrow 4C + 4H_2O$$

Alkenes react with hydrogen, water and the halogens (chlorine, bromine and iodine) by the addition of atoms across the carbon-carbon double bond so that the double bond becomes a single carbon-carbon bond.

Propene + hydrogen → propane

Propene + water → propanol

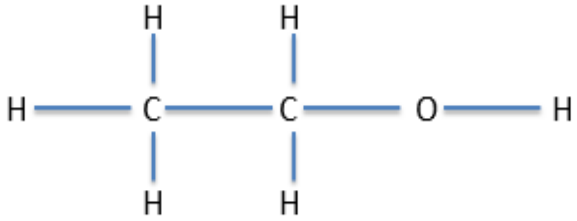
Propene + chlorine → dichloropropane

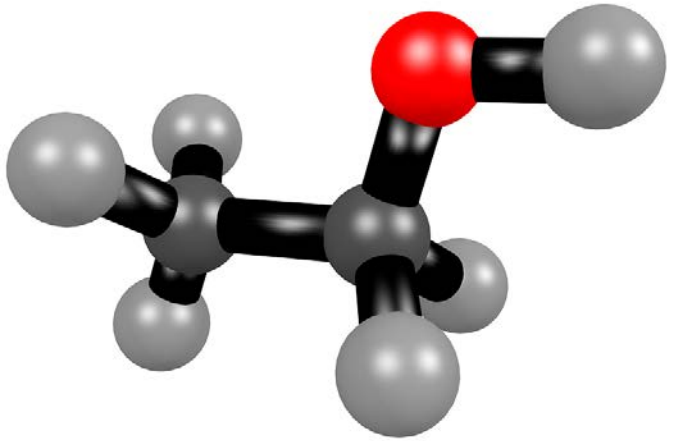
Reactions of alcohols (Chemistry only)

Alcohols contain the functional group **-OH**

Methanol has the formula CH_3OH
Ethanol has the formula CH_3CH_2OH or C_2H_5OH
Propanol has the formula $CH_3CH_2CH_2OH$ or C_3H_7OH
Butanol has the formula $CH_3CH_2CH_2CH_2OH$ or C_4H_9OH

An alternative way to show the alcohol structure is:





Reactions of alcohols (Chemistry only)

Alcohols have a number of important reactions:

- When **ethanol reacts with sodium,** bubbles of **hydrogen gas** are given off and colourless **sodium ethoxide** solution is left

Sodium + ethanol → sodium ethoxide + hydrogen

- All the alcohols **dissolve in water** to give **colourless solutions** with a **pH of 7**.
- Alcohols can react with an **oxidising reagent** to make the **carboxylic acid** e.g. **ethanol** will oxidise to make **ethanoic acid**.
- Alcohols also undergo **combustion** reactions with oxygen e.g.

Propanol + oxygen → carbon dioxide + water

$$C_3H_7OH + 5O_2 \rightarrow 3CO_2 + 4H_20$$

Aqueous solutions of ethanol are produced when sugar solutions are fermented using yeast.

The conditions needed for **fermentation** to happen are:

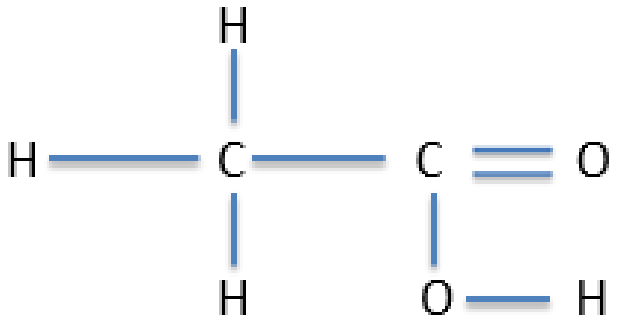
- A **temperature** between **25^{O}C and 45^{O}C**
- **Water** but **no oxygen**

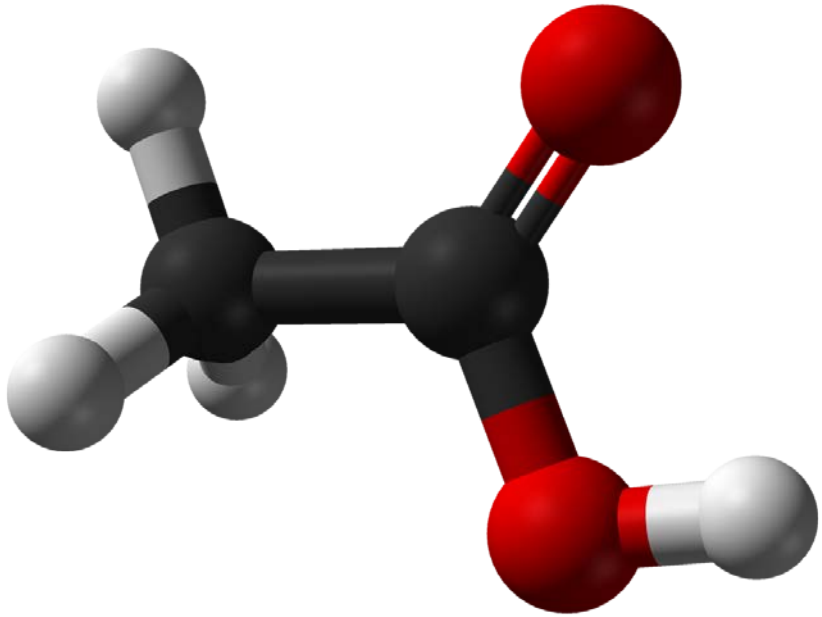
Reactions of carboxylic acids (Chemistry only)

Carboxylic acids have the functional group **-COOH**

Methanoic acid has the formula CHOOH
Ethanoic acid has the formula CH_3COOH
Propanoic acid has the formula C_2H_5COOH
Butanoic acid has the formula C_3H_7COOH

An alternative way to show the carboxylic acid structure is:





Reactions of carboxylic acids (Chemistry only)

Carboxylic acids have a number of important reactions:

- When we react carboxylic acids with a **metal carbonate** a **salt, carbon dioxide** and **water** are produced e.g.

  Sodium carbonate + propanoic acid → sodium propanoate + carbon dioxide + water

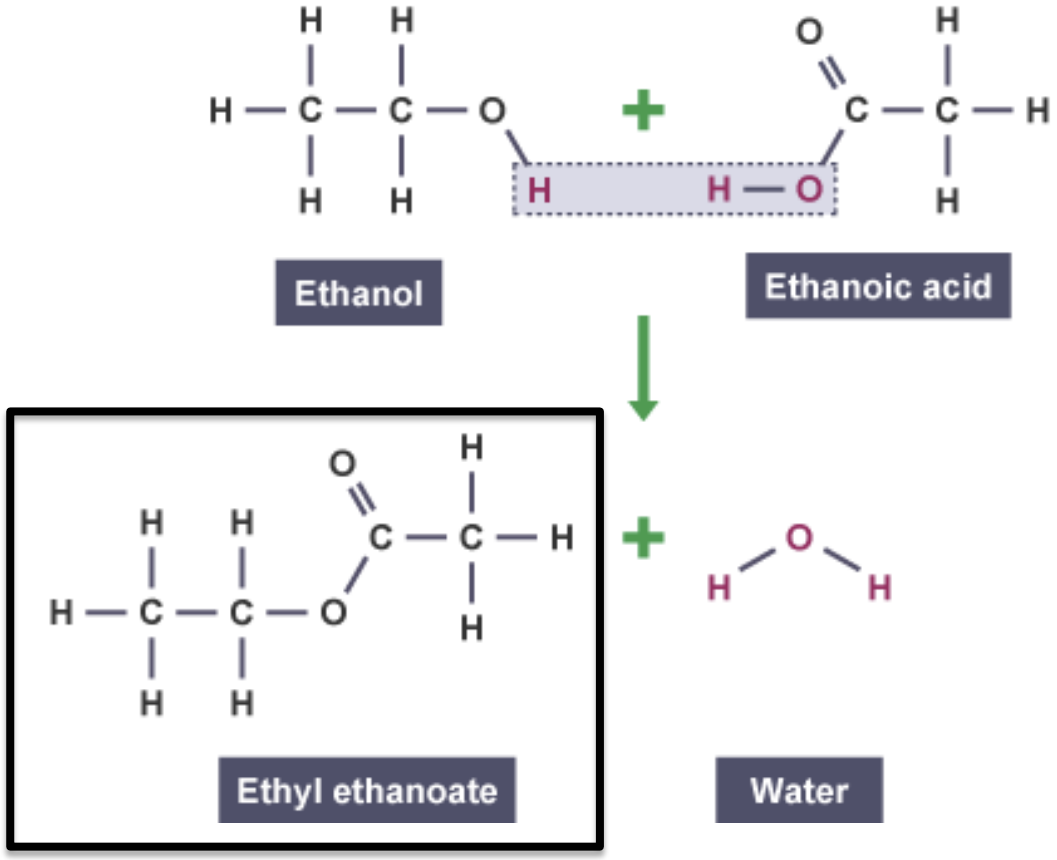
- Carboxylic acids with **five or less carbons dissolve in water.** Carboxylic acids with **more than five carbons in them are less soluble**.
- Carboxylic acids will **react with alcohols** to make an **ester and water**, an **acid catalyst** is needed (ethyl ethanoate is the ester below)

  Ethanoic acid + ethanol → ethyl ethanoate + water

(HT only)

Carboxylic acids are described as **weak acids** as they are only **partially ionised**, therefore they give off relatively **few hydrogen ions** in comparison to strong acids and have a **higher pH** than strong acids.

Esters: made when alcohols and carboxylic acids react together



You only need to learn this one example at GCSE!

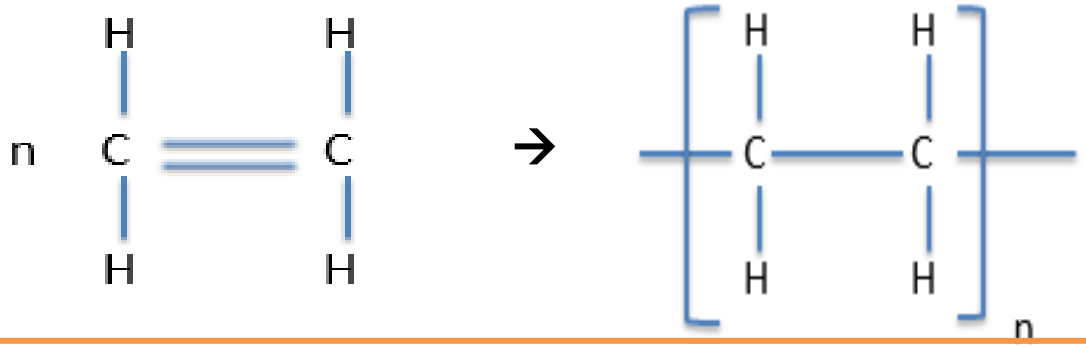
Addition polymerisation (Chemistry only)

Alkenes can be used to make **polymers** such as poly(ethane) and poly(propene) by **addition polymerisation.**

In addition polymerisation reactions, **many small molecules** (monomers) **join together** to form **very large molecules** (polymers).

Polythene has many uses.

An example of this is



One of the double bonds in the monomer breaks to form a single bond with other monomers. This leads to a very long polymer.

In **addition polymers** the repeating unit, **n,** has the **same atoms as the monomer** because no other molecule is formed in the reaction.

You must be able to move from the monomer to the polymer or polymer to the monomer

Condensation, polymerisation and amino acids (Chemistry HT only)

Condensation polymerisation involves **monomers with two functional groups**. When these types of monomers react they join together, usually **losing small molecules** such as **water**, and so the reactions are called **condensation reactions.**

The simplest polymers are produced from **two different monomers** with two of **the same functional groups** on each monomer.

An example of this is:

Ethane diol (this is ethane with two –di – alcohol – ol groups at either end)

$HO – CH_2 – CH_2 – OH$ **or** HO - □ - OH

And

Hexanedioic acid (this is hexane with two carboxylic acid groups at the end)

$HOOC - CH_2 - CH_2 - CH_2 - CH_2 – COOH$ **or** HOOC - □ - COOH

Polymerise to produce a polyester

n HO - □ -OH + n HOOC - □ - COOH → [- □ - OOC - □ - COO -]$_n$ + $2nH_2O$