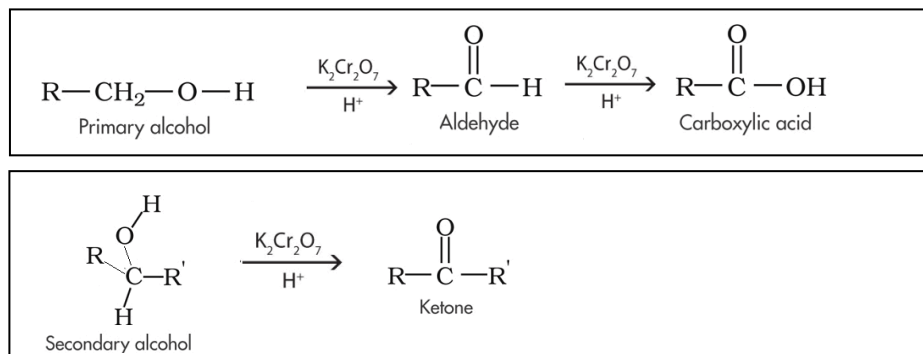


## Lesson 10 Chemical reactions with alcohols carboxylic acids and esters.

[Click](#) to revise reaction pathways for the oxidation of alcohols

[Click](#) to revise the naming of esters

Below is a summary of the oxidation pathways of primary and secondary alcohols.

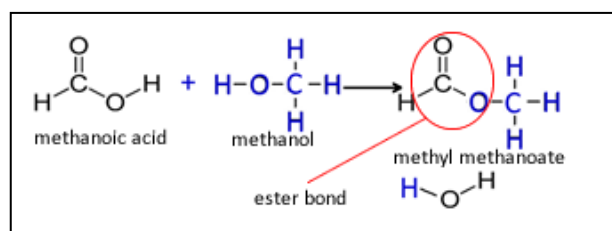


Keep in mind :

- tertiary alcohols do not undergo oxidation.
- $\text{KMnO}_4 / \text{H}^+$  can also be used as an oxidant in place of  $\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}^+$

### Esters

An ester is synthesised from a carboxylic acid and an alcohol using an acid catalyst ( $\text{H}_2\text{SO}_4$ ). The reaction that forms an ester is referred to as an **esterification reaction**. This type of reaction is generally called a **condensation reaction**. A condensation reaction is one where a small molecule is given off when two molecules form a covalent bond between each other.



To name an ester follow the steps below

- i. Place the alcohol that formed the ester first in the name followed by the acid.  
**ethanol propanoic acid**
- ii. Replace the **anol** of the alcohol with **yl** and the **ic** of the acid with **oate**.  
**ethyl propanoate**

1) Name the esters formed from the following

- a) **ethyl propanoate**  
Propanoic acid + ethanol  $\xrightarrow[\text{catalyst}]{\text{H}_2\text{SO}_4}$
- b) **methyl ethanoate**  
methanol + ethanoic acid  $\xrightarrow[\text{catalyst}]{\text{H}_2\text{SO}_4}$
- c) **propyl methanoate**  
propanol + methanoic acid  $\xrightarrow[\text{catalyst}]{\text{H}_2\text{SO}_4}$
- d) **pentyl methanoate**  
methanoic acid + pentanol  $\xrightarrow[\text{catalyst}]{\text{H}_2\text{SO}_4}$

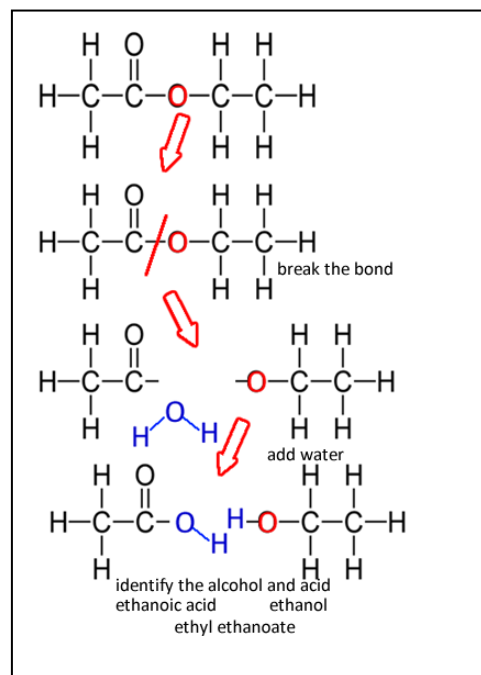
2) When faced with a structural formula of an ester and asked to name it, it is important you can identify the alcohol and acid that formed it. Take the ester shown on the right.

The C=O bonded carbon belongs to the acid while the C-O bonded carbon belongs to the alcohol.

In this case the alcohol is ethanol and the acid is ethanoic acid

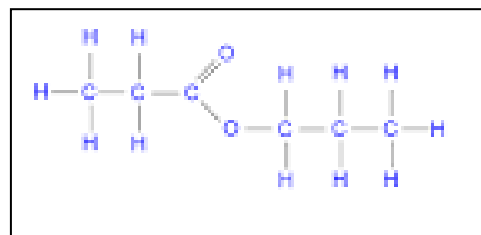
The ester is therefore named ethyl ethanoate.

**Hydrolysis** reactions involve the breaking of bonds by the addition of water. Esters undergo hydrolysis to yield an alcohol and a carboxylic acid, as shown on the right.

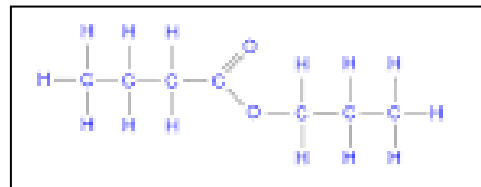


Identify the acid and alcohol that formed the esters shown on the right and name each ester.

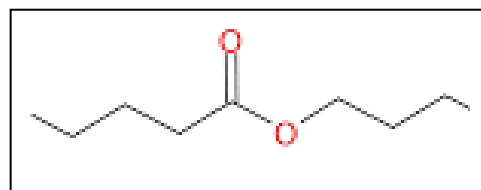
a) *propanoic acid and propanol, propyl propanoate*



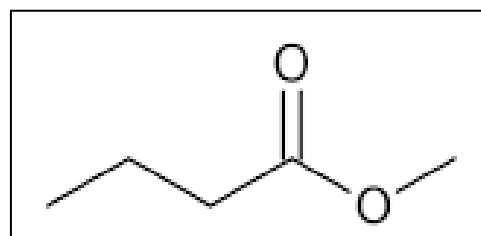
b) *butanoic acid and propanol, propyl butanoate*



c) *Pentanoic acid and butanol, butyl pentanoate*



d) *Butanoic acid and methanol, methyl butanoate*

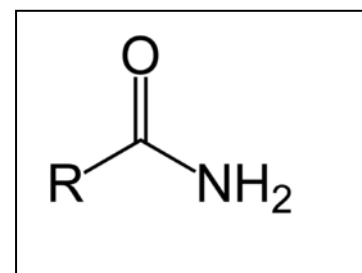


- 2) Explain why ethyl ethanoate has a boiling temperature of 77 °C while butanoic acid, which has the same formula mass as ethyl ethanoate, boils at 164 °C.

*Ethyl ethanoate has intermolecular forces composed of weak dispersion forces and dipole-dipole bonding, whereas butanoic acid has weak dispersion forces as well as stronger hydrogen bonding.*

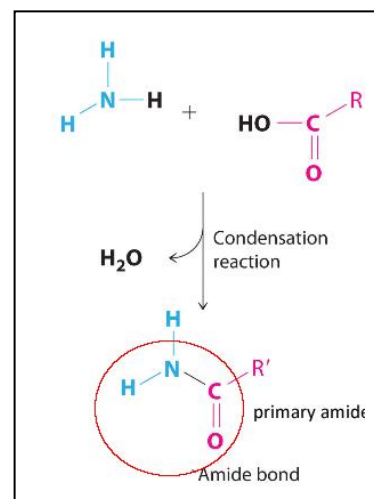
Amides - Reactions between carboxylic acids and amines.

A primary amide has a characteristic CONH<sub>2</sub> ending, as shown on the right.

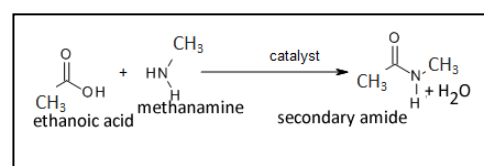


It comes about when a carboxylic acid reacts with ammonia in a condensation reaction, as shown on the right. Note how the OH from the acid combines with a H from the ammonia to produce a water molecule.

A secondary amide is produced by a carboxylic acid and an alkylamine and has the general formula RCONHR', where R and R' represent alkyl groups.

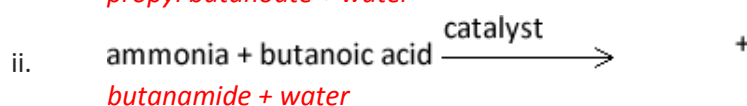
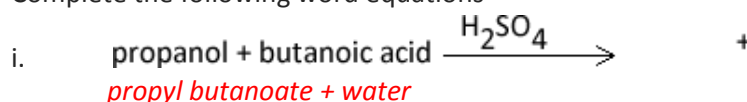


Example 1 Consider the condensation reaction between ethanoic acid and methanamine, shown on the right. A secondary amide is formed and water is given off.



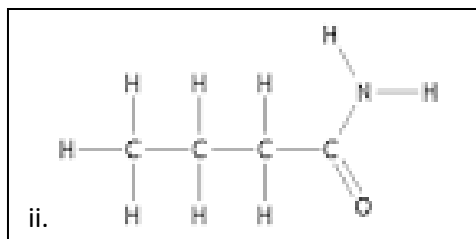
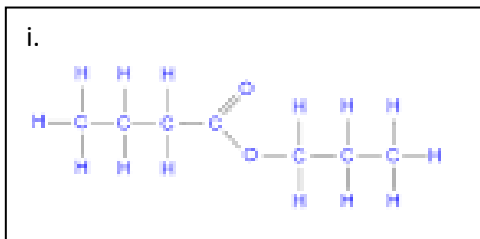
- 3) What type of functional group is produced when:
- Propanamine reacts with ethanoic acid *amide*
  - Propanoic acid and pentanol *ester*

4) Complete the following word equations



*Note -Naming of aldehydes, ketones and amides is not required in this course.*

5) Draw the structural formulae of the products formed in each reaction in 4) above.



6) Complete the following word equations and identify the type of reaction taking place.

- i. *Ethyl ethanoate* +  $\text{H}_2\text{O}$   $\rightarrow$  ethanoic acid + ethanol = *Hydrolysis reaction*
- ii. Propanol + methanoic acid  $\rightarrow$  *propyl methanoate* +  $\text{H}_2\text{O}$  = *esterification reaction*
- iii. Propanoic acid + ammonia  $\rightarrow$  propanamide +  $\text{H}_2\text{O}$  = *condensation reaction*