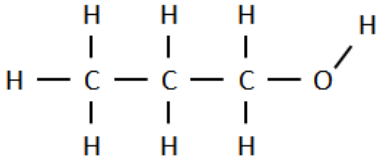
CHEM 9.3.5 ESTERS

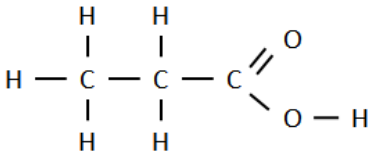
Esterification is a naturally occurring process which can be performed in the laboratory

5.1 Describe the differences between the **alkanol and alkanoic acid functional groups** in carbon compounds

- **Alkanols** are compounds that replace –H with **–OH** (alcohol group) in any alkane
  - E.g. $CH_3 - CH_2 - CH_2 - OH$ is **1-propanol**
- **Alkanoic acids** have a **–COOH** (carboxylic acid group) ending,
  - E.g. $CH_3 - CH_2 - COOH$ is **propanoic acid**
- **Formic acid and acetic acid** for methanoic



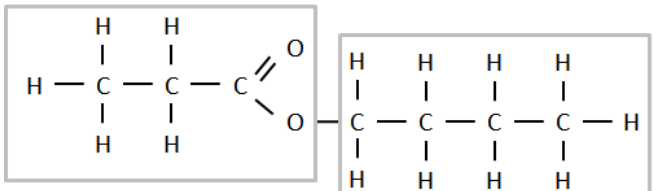
1-propanol



propanoic acid

5.2 Identify the **IUPAC nomenclature** for describing the **esters produced by reactants** of straight-chained **alkanoic acids** from C1 to C8 and straight-chained **primary alkanols** from C1 to C8

- Esters formed from alkanoic acids and alkanols are **alkyl alkanoates**
- (Alkanol Prefix)-yl (alkanoic acid)-anoate, e.g.:

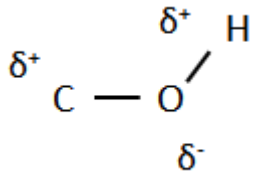


butyl propanoate

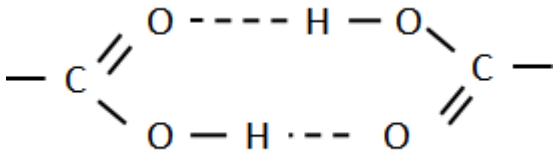
- IUPAC preferred: **methanoate** as **formate**, **ethanoate** as **acetate**

5.3 Explain the **difference in melting point and boiling point** caused by straight-chained **alkanoic acid** and straight-chained primary **alkanol** structures

- **Alkanoic acids** have **higher MP/BP** than alkanols
- Alkanols are **polar (OH)** and can form **hydrogen bonds**
- Alkanoic acids are **polar (COOH)** between alkanoic acid molecules, **two hydrogen bonds** as 2 O atoms



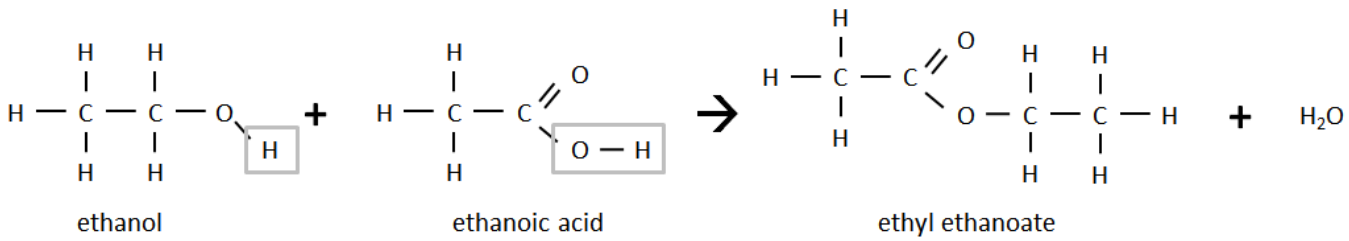
alkanol



alkanoic acids

5.4 Identify esterification as the **reaction between an acid and an alkanol** and describe, using equations, **examples of esterification**

- Esters form when **alkanoic acids react with alkanols**, e.g. ethanoic acid and ethanol:
  - $CH_3COOH_{(aq)} + CH_3CH_2OH_{(l)} \rightarrow CH_3COOCH_2CH_{3\,(l)} + H_2O_{(l)}$



- It is a **condensation reaction** – water molecule condenses out

5.5 Describe the purpose of using **acid** in esterification for **catalysis**

- Acid (**sulphuric acid**) used as it absorbs water
- Esterification goes to equilibrium, if water is removed, equilibrium **shifts to the right**

5.6 Explain the need for **refluxing** during esterification

- Temperature often close to BP of alcohol
- Refluxing (**condenser to cool vapour rising from reaction**) used to prevent losing alcohol + runs back down

5.7 Outline some examples of **occurrence, production** and **uses** of esters

- Esters found in **nature** – e.g. fats, oils and natural waxes , and **manufactured**
- **Lubricants** for **jet engines** due to low viscosity at low temperature, highly biodegradable
- **Solvents and coatings** due to strong attraction to metal objects, have high volatility due to low mol. Weight
- **Fragrances:**
  - Butanoates: **methyl** (apple), **ethyl** (pineapple)
  - Acetates: **1-pentyl** (fruity – banana/pear), **1-octyl** (orange)
- Can also be used as **plasticisers** and **alternative fuels**