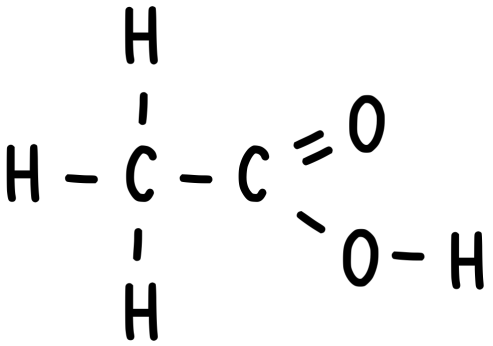
CAIE IGCSE Chemistry

11.7 Carboxylic acids

Notes

Describe the reaction of ethanoic acid with… including names and formulae of the salts produced

- Ethanoic acid is a type of carboxylic acid with the formula CH_3COOH and displayed formula:



- Ethanoic acid (aq) is a colourless liquid and is also known commonly as vinegar

(a) Ethanoic acid and metals

- Ethanoic acid will react with metals to form a salt and hydrogen gas
- This acid-metal reaction occurs as the metal displaces the hydrogen in ethanoic acid to form the salt.
- But only metals above hydrogen in the reactivity series will react with ethanoic acid, to be able to displace the hydrogen
- The name of the salt is generally: Metal ethanoate
- General equation for this reaction:
  Metal + Ethanoic acid -> Metal ethanoate + Hydrogen
- E.g. Write the word and balanced chemical equation for the reaction between sodium and ethanoic acid:
  Sodium + Ethanoic acid -> Sodium ethanoate + Hydrogen
  $2Na + 2CH_3COOH \rightarrow 2CH_3COONa + H_2$

(b) Ethanoic acid and bases

- Ethanoic acid will react with bases to form a salt and water
- This is a neutralisation reaction as water is formed as a product
- The name of the salt is generally: Metal ethanoate
- General equation for this reaction:
  Base + Ethanoic acid -> Metal ethanoate + Water
- E.g. Write the word and balanced chemical equation for the reaction between potassium hydroxide and ethanoic acid:
  Potassium hydroxide + Ethanoic acid -> Potassium ethanoate +Water
  $KOH + CH_3COOH \rightarrow CH_3COOK + H_2O$

(c) Ethanoic acid and carbonates

- Ethanoic acid will react with metal carbonates to form a salt, carbon dioxide and water
- The name of the salt is generally: Metal ethanoate
- General equation for this reaction:
  Base + Ethanoic acid -> Metal ethanoate + Carbon dioxide + Water
- E.g. Write the word and balanced chemical equation for the reaction between calcium carbonate and ethanoic acid:
  Calcium carbonate + Ethanoic acid -> Calcium ethanoate + Carbon dioxide + Water
  $CaCO_3 + 2CH_3COOH \rightarrow (CH_3COO)_2Ca + H_2O + CO_2$

(Extended only) Describe the formation of ethanoic acid by the oxidation of ethanol:

(a) With acidified aqueous potassium manganate(VII)

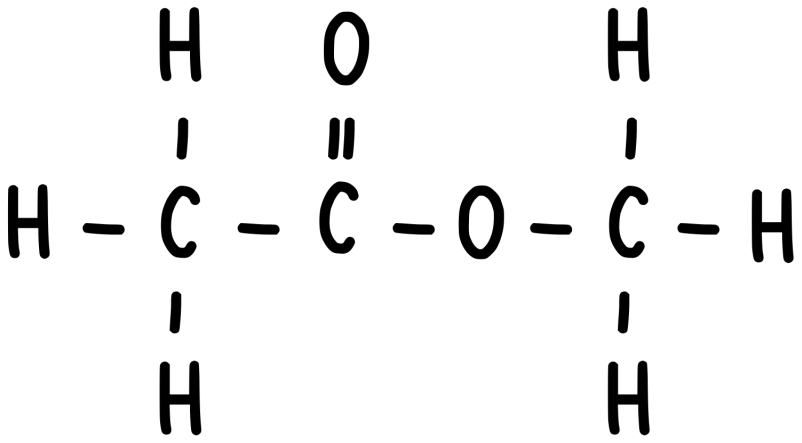
- Ethanol is heated with acidified potassium manganate(VII) to form ethanoic acid in an oxidation reaction, in the presence of an acid catalyst.
- There is a visible colour change in the solution from purple to colourless
- This reaction is done under reflux (heated with a condenser upright)
- Acidified aqueous potassium manganate(VII) is an oxidising agent (brings about oxidation whilst being reduced itself) and is represented in equations as [O]
- The chemical equation for this reaction is:
  $CH_3CH_2OH + 2[O] \rightarrow CH_3COOH + H_2O$

(b) By bacterial oxidation during vinegar production

- Ethanoic acid can also be formed through the bacterial oxidation (fermentation) of ethanol.
- This reaction occurs when a wine bottle (ethanol is in wine) is left open.
- Bacteria in the air will use atmospheric oxygen to oxidise ethanol, producing a weak solution of ethanoic acid (vinegar) over time.
- The chemical equation for this reaction is:
  $CH_3CH_2OH + O_2 \rightarrow CH_3COOH + H_2O$

(Extended only) Describe the reaction of a carboxylic acid with an alcohol using an acid catalyst to form an ester

- Esters have the functional group -COO (known as an ester bond/linkage)
- Esters are formed when a carboxylic acid is reacted with an alcohol using an acid catalyst, in a reaction known as esterification.
- A reversible sign ⇌ is used in esterification reactions
- Naming esters: First name comes from the alcohol. Second name comes from the carboxylic acid. E.g. Propanoic acid and ethanol makes ethyl propanoate.
- The general equation for esterification is:
  Carboxylic acid + Alcohol ⇌ Ester + Water
- E.g. Ethanoic acid is reacted with methanol, in the presence of an acid catalyst, what is produced?
  Ethanoic acid + Methanol ⇌ Methyl ethanoate + Water
  $CH_3COOH + CH_3OH \rightleftharpoons CH_3COOCH_3 + H_2O$



methyl ethanoate