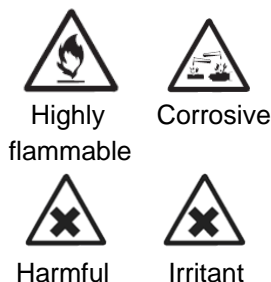


Activity 23: Making esters from alcohols and carboxylic acids**Objective**

- Be able to carry out esterification reactions safely.
- Appreciate the range of smells produced by different esters.

Safety

- Alcohols are flammable.
- Butan-1-ol is harmful and irritant.
- Conc sulfuric acid is corrosive.
- Liquid carboxylic acids are corrosive.
- Wear goggles

**Equipment/materials**

- Conc sulfuric acid
- A range of alcohols
- A range of carboxylic acids
- 3 x boiling tubes
- Large beaker to act as a water bath
- 250cm³ beaker for the cold water
- 0-100 °C thermometer
- 10cm³ measuring cylinder
- Stirring rod
- Spatula
- Access to kettle
- Mass balance
- Dropping pipette

Procedure

1. Place 1 cm³ of methanol and 3g of salicylic acid in a boiling tube. Mix well and *carefully* add a few drops of conc sulfuric acid.
2. Place the boiling tube in a water bath at about 80°C for five minutes.
3. Pour the contents of the boiling tube into a beaker of cold water.
4. Carefully smell the ester floating on the water.
5. Place 1 cm³ of ethanol and 1 cm³ of ethanoic acid in a boiling tube. Mix well and *carefully* add a few drops of conc sulfuric acid.
6. Repeat steps 2 – 4.
7. Try other alcohol/carboxylic acid combinations.

Data

Methyl salicylate is also known as *oil of wintergreen* and is found in wintergreen, GermoleneTM and RalgexTM ointments.

Ethyl ethanoate is a solvent used in modelling paints and glue.

Analysis of results

- Record your observations in an appropriate form.
- Write an equation for each reaction.

From the examiner...

- You should be able to draw the ester produced from a particular alcohol/carboxylic acid combination.
- You should be able to name the esters correctly.
- You should appreciate that the conc sulfuric acts as a catalyst.
- Know some uses for esters.

Questions

1. In these reactions the OH in the carboxylic acid is lost to water. Suggest how this could be proved using ¹⁸O.
2. Draw displayed formulae for ethanol and propanoic acid and ring the atoms which produce the water molecule.
3. Describe the flavours/smells for the esters you have made – two are already described in the data section.

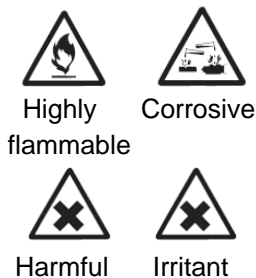
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7. Try other alcohol/carboxylic acid combinations.

Notes

- Conc sulfuric acid should be dispensed from a fume cupboard.
- The students should be instructed *not* to add water to a spillage of conc sulfuric acid on the skin.
- If time is restricted, the teacher may wish to dictate the alcohol/carboxylic acid combinations.

From the examiner...

- You should be able to draw the ester produced from a particular alcohol/carboxylic acid combination.
- You should be able to name the esters correctly.
- You should appreciate that the conc sulfuric acts as a catalyst.
- Know some uses for esters.

Answers

1. If ethanoic acid with the isotope ¹⁸O incorporated into it is used, the water molecules formed will also contain the ¹⁸O isotope as H₂¹⁸O. A peak at 20 in a mass spectrometer will be obtained.
2. CH₃CH₂O-H H-O-CO.CH₂CH₃
3. Butyl butanoate: pineapple
Ethyl butanoate: banana; pineapple; strawberry
Ethyl cinnamate: cinnamon
Methyl ethanoate: peppermint
Methyl butanoate: pineapple; apple
Methyl cinnamate: strawberry
Pentyl ethanoate: apple; banana
Pentyl butanoate: apricot; pear; pineapple
Propyl ethanoate: pear
4. Alcohols react with carboxylic acids to make long chain compounds with ester functional groups.
5. n HOCH₂-CH₂-CO.OH = [OCH₂-CH₂-CO.O]_n

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Requirements per student*/group of students	Notes
Conc sulfuric acid	Dispensed from a fume cupboard
A range of alcohols	Methanol, ethanol, propan-1-ol, propan-2-ol, butan-1-ol, pentan-1-ol
A range of carboxylic acids	Ethanoic acid, butanoic acid, salicylic acid, cinnamic acid
3 x boiling tubes	
Large beaker to act as a water bath	Kettles
250cm ³ beaker for the cold water	
0–100°C thermometer	
Stirring rod	
1 x 10cm ³ measuring cylinder per liquid chemical	Or graduated dropping pipette with pipette filler to measure 1 cm ³
Spatula	
Mass balance accurate to at least 0.01 g	
Dropping pipette for sulfuric acid	

Notes

Butanoic acid has a very unpleasant smell which will linger in the laboratory and the teacher may wish not to use this carboxylic acid. Propanoic acid is a possible substitute.