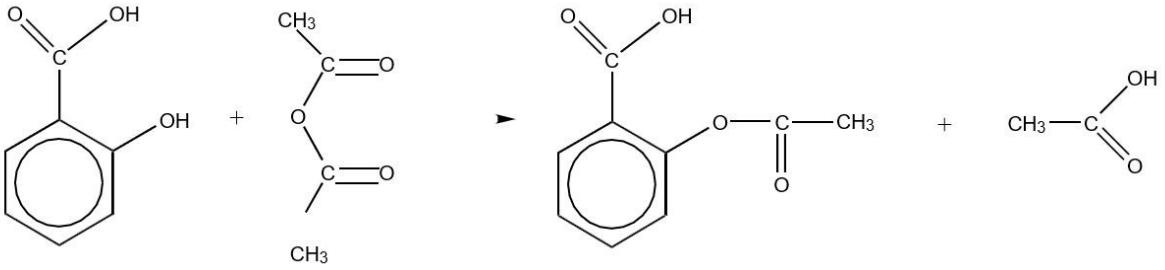
The preparation of aspirin – teacher notes

Introduction

In this activity you use ethanoic anhydride to convert 2-hydroxybenzoic acid into aspirin.



The reaction takes place easily in acidic solution but the product is formed as part of a mixture containing several other compounds. The product is formed in Stage 1 below and then separated from impurities in Stage 2.
Note that ethanoic anhydride reacts readily with water so all the apparatus must be dry.

Apparatus

- Access to a fume cupboard
- Pear shaped flask, 25 cm^3
- Hot water bath
- Measuring cylinder, 10 cm^3
- Bath of iced water
- Glass stirring rod
- Buchner funnel and suction apparatus
- Watch glass

Chemicals

- 2-Hydroxybenzoic acid, 1 g
- Ethanoic anhydride, 2 cm^3
- Eight drops of concentrated phosphoric acid

Health, safety and technical notes

- Read our standard health and safety guidance here https://rsc.li/3AlERrN
- Wear eye protection.
- Sulfuric acid can be used in place of phosphoric acid but may give lower yields.
- Some teachers have reported problems which were due to using ethanoic anhydride that had already been hydrolised to ethanoic acid. Add a drop to water to ensure it is still reactive.
- If no precipitate appears, scratch the inside of the beaker with a glass rod or add a seed crystal of aspirin.
- As much as 40% of the mass of product after filtering may be water. Overnight drying is preferable to oven drying.
- Students should obtain about 0.9 g of crude product from 1.0 g of 2-hydroxybenzoic acid.

Relative molecular masses are:

- 2-hydroxybenzoic acid: 138
- ethanoic anhydride: 102
- aspirin: 180

Further investigations

Vary the reaction conditions to investigate the effect on percentage yield of:

- type of acid catalyst;
- concentration or volume of acid used;
- time of heating/cooling; and
- relative amounts of reagents

Use thin-layer chromatography (tlc) to investigate the purity of the product, using commercial aspirin as a reference. Ensure that this aspirin sample is not 'soluble aspirin' (sodium or calcium salt).

Test for impurities

- Three test-tubes together with means of labelling them;
- A few crystals of the following substances:

a) Phenol (NB phenol is a toxic substance; avoid spillage and wash hands after use)
b) 2-Hydroxybenzoic acid (salicylic acid)
c) Crude product from Activity 3
d) Pure aspirin

- One per cent iron(III) chloride solution.

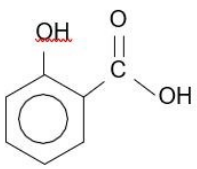
Results

Phenol + Fe^{3+} (aq)	Purple solution
2-Hydroxybenzoic acid + Fe^{3+}(aq)	Purple solution
Crude product + Fe^{3+}(aq)	May have a purple tinge due to unreacted 2-hydroxybenzoic acid
Pure product + Fe^{3+}(aq)	Very pale yellow

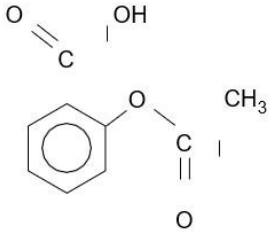
Answers

1) The crude product may contain 2-hydroxybenzoic acid, as well as water or ethanoic acid as impurities. 2-Hydroxybenzoic acid can be formed either from incomplete reaction or from hydrolysis of the product during its isolation.

Phenol



Salicylic acid
(2-Hydroxybenzoic acid)



Aspirin
(2-ethanoyloxybenzenecarboxylic acid)

2)

The OH group attached to the benzene ring produces a purple colour with Fe^{3+}(aq) ions. The OH group in aspirin is part of the carboxylic acid group and does not react in the same way.