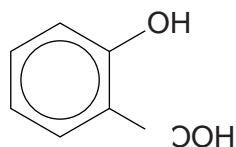


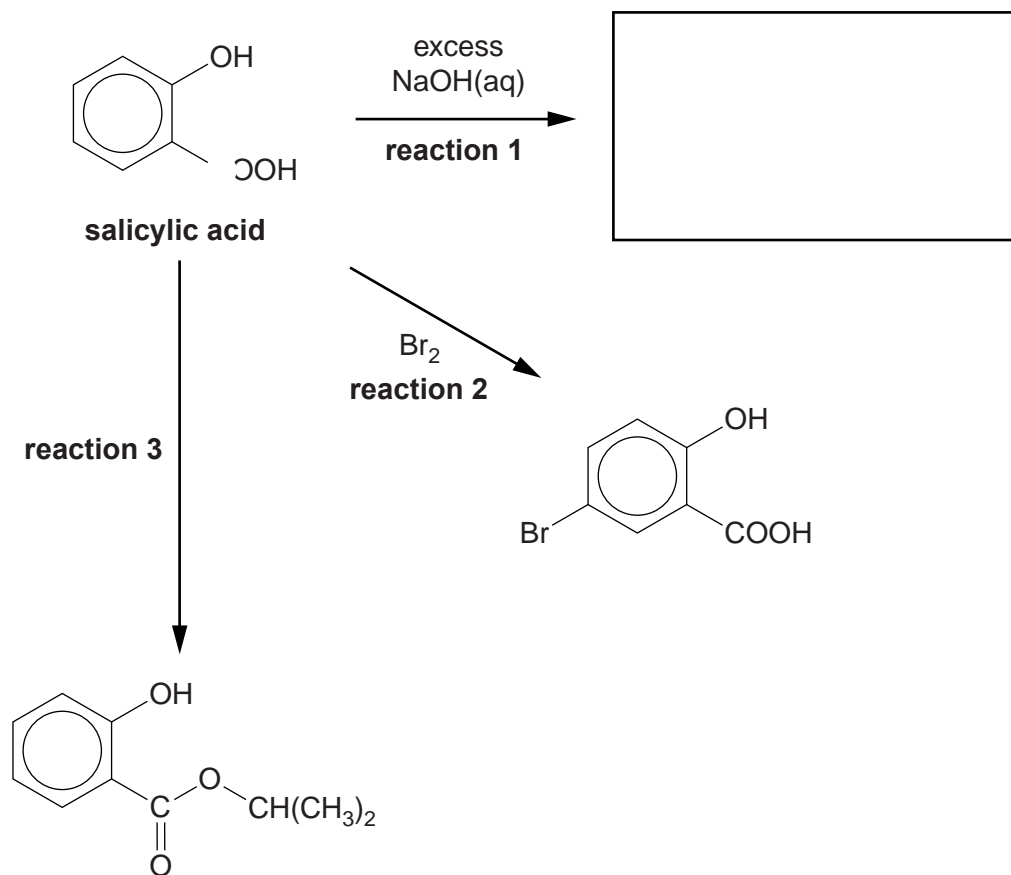
1 Salicylic acid is a naturally occurring carboxylic acid, widely used in organic synthesis.



salicylic acid

(a) The flowchart below shows some reactions of salicylic acid.

(i) In the box below, draw the structure of the organic compound formed by **reaction 1**. [1]



(ii) Describe what would be **observed** during **reaction 2**.

.....
..... [1]

(iii) Write a chemical equation to represent **reaction 2**.

[1]

(iv) State the reagents and conditions in **reaction 3**.

.....
..... [1]

(b) Bromine reacts more readily with salicylic acid than with benzene.

(i) Outline the mechanism for the bromination of salicylic acid shown in **reaction 2** in the flowchart.

A halogen carrier is not required for this reaction.

The electrophile is Br₂.

[4]

(ii) Explain why bromine reacts more readily with salicylic acid than with benzene.



In your answer, you should use appropriate technical terms, spelled correctly.

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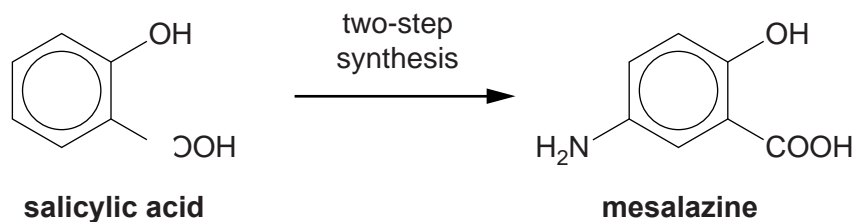
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[3]

(c) Mesalazine is a drug that can be synthesised from salicylic acid in two steps.



(i) Suggest a **two-step** synthesis to prepare mesalazine from salicylic acid.

For **each** step

- state the reagents used,
- write a chemical equation.

[4]

(ii) Mesalazine reacts with acids to form salts.

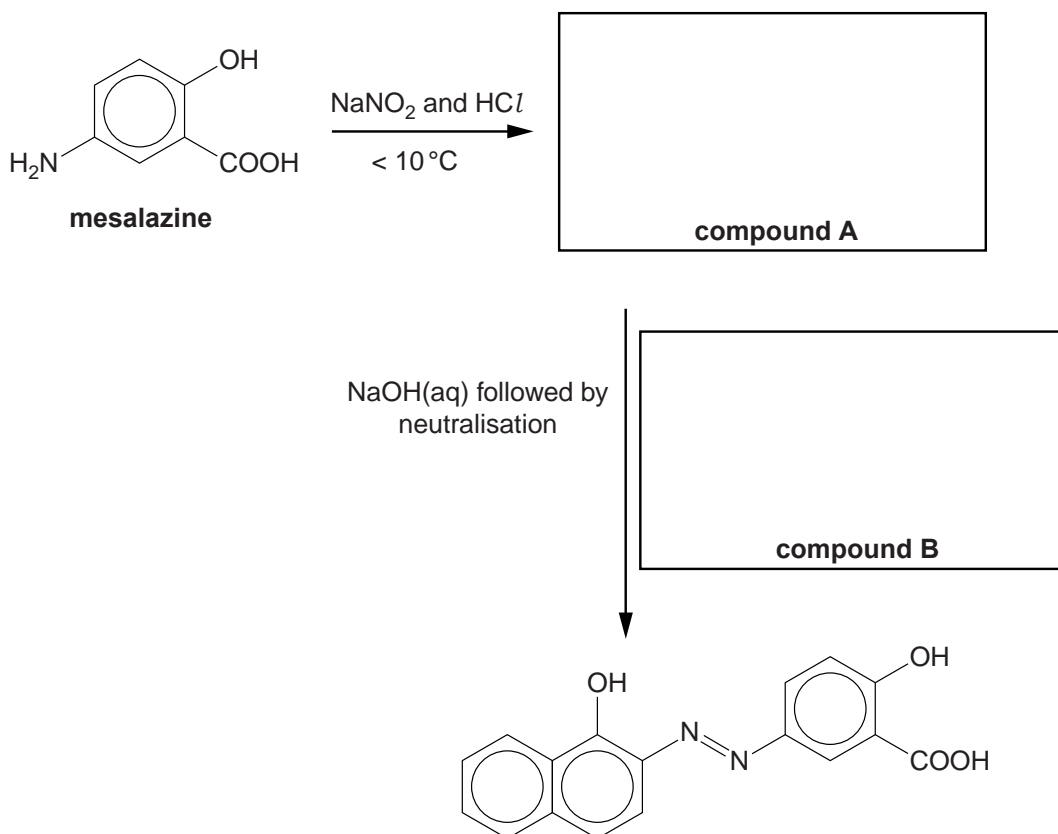
Explain how mesalazine is able to react with acids.

.....
.....
..... [1]

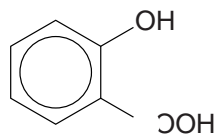
(iii) Mesalazine reacts in another two-stage process as shown below.

In the boxes, draw the structures of organic compounds **A** and **B**.

[2]



(d) Salicylic acid can be used to form a condensation polymer similar to Terylene®.

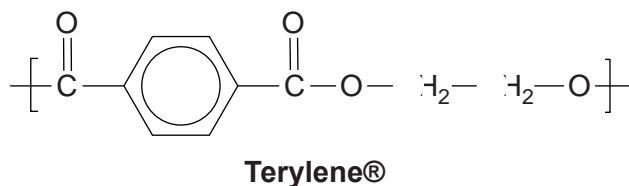


salicylic acid

(i) Explain what is meant by the term *condensation polymer*.

.....
..... [1]

(ii) The repeat unit of Terylene® is shown below.



Draw the skeletal formulae of **two** monomers that can be used to form Terylene®.

[2]

(iii) Salicylic acid reacts with 3-hydroxypropanoic acid to form a mixture of condensation polymers.

To form one polymer, the two monomers react in equal quantities.

Draw the repeat unit of this polymer, displaying the link between the monomer units.

[1]

[Total: 22]

2 Alkenes and benzene both react with bromine but alkenes are much more reactive.

(a) Explain the relative resistance to bromination of benzene compared with alkenes.



In your answer, you should use appropriate technical terms, spelled correctly.

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[4]

(b) A student investigates two reactions of bromine with phenylethene, $C_6H_5CH=CH_2$.

Reaction 1

The student first mixes phenylethene with excess bromine at room temperature. An organic compound forms with the molecular formula $C_8H_8Br_2$.

Reaction 2

The student then adds a halogen carrier to the mixture obtained from **reaction 1**. A mixture of isomers forms. Each isomer has the molecular formula $C_8H_7Br_3$.

(i) Draw the structure of the organic compound formed in **reaction 1**.

[1]

(ii) Predict the number of peaks in the carbon-13 NMR spectrum of the organic compound formed in **reaction 1**.

..... [1]

(iii) Draw the structures of two of the isomers of $C_8H_7Br_3$ formed in **reaction 2**.

isomer 1	isomer 2
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[2]

(iv) State the types of mechanism that take place in **reaction 1** and **reaction 2**.

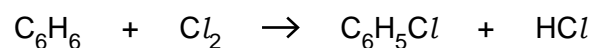
reaction 1

reaction 2 [2]

[Total: 10]

3 Benzene and other arenes can be chlorinated to produce chloroarenes which are used in the manufacture of pesticides, drugs and dyes.

(a) Chlorobenzene, C_6H_5Cl , is formed by the reaction of benzene and chlorine in the presence of a suitable catalyst, such as $AlCl_3$.

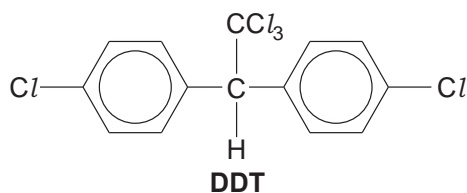


Outline the mechanism for the formation of chlorobenzene from benzene.

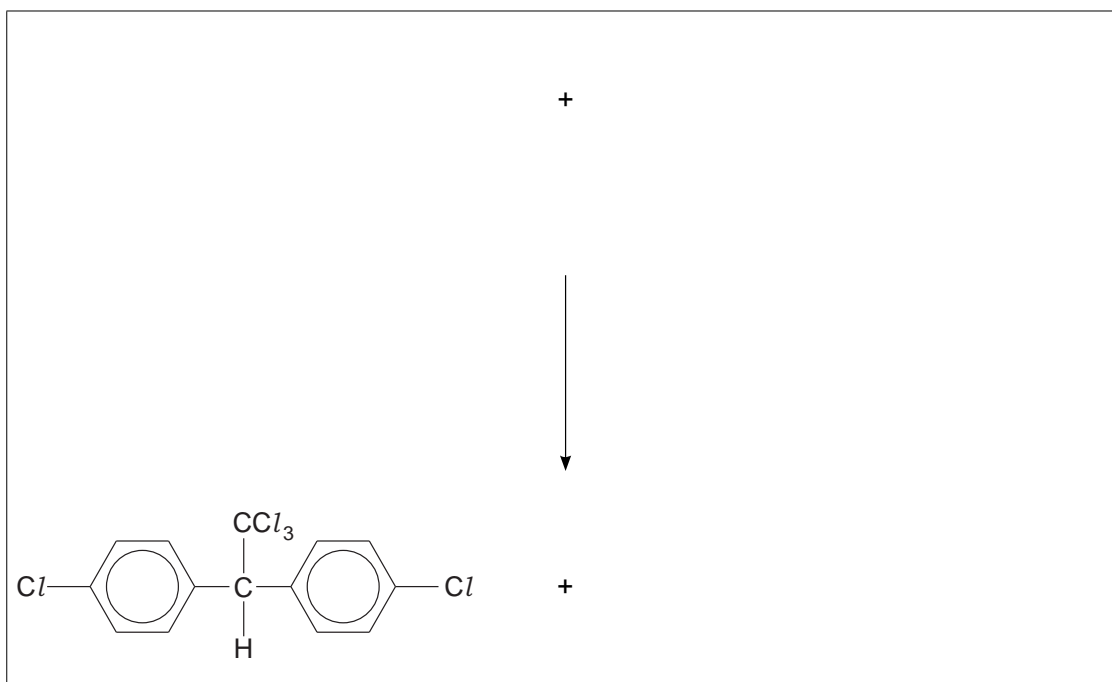
Show how $AlCl_3$ behaves as a catalyst.

[6]

(b) Chlorobenzene reacts with trichloroethanal, Cl_3CCHO , to produce the pesticide DDT.



(i) Construct an equation for the reaction of chlorobenzene with trichloroethanal to form DDT.



[2]

(ii) Predict the number of peaks in the ^{13}C NMR spectrum of DDT.

..... [1]

(c) Chlorobenzene can be nitrated to form a mixture of products.

Suggest why the reaction forms a mixture of products.

.....
.....
..... [1]

- 4** Benzene is an important industrial chemical and is used in a wide range of manufacturing processes. Over time our understanding of the structure and bonding of benzene has changed and various models have been proposed.
- (a)** In 1865, Kekulé proposed a model for the structure and bonding of benzene, but there is considerable evidence to suggest that Kekulé's model may not be correct. Scientists have proposed alternative models for the structure and bonding of benzene.

Explain the evidence that led scientists to doubt the model proposed by Kekulé.

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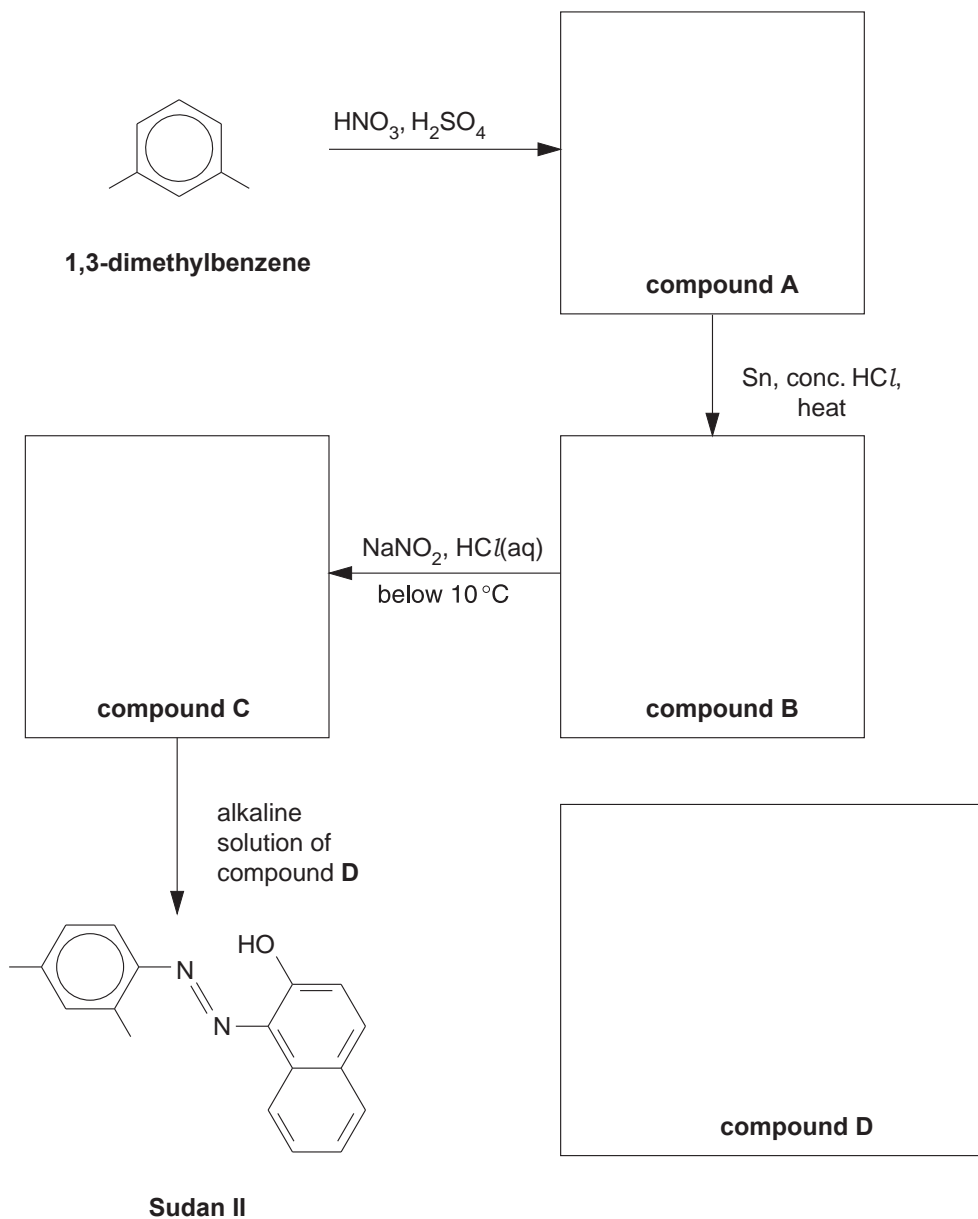
.....

[3]

- (b) Sudan II is an azo dye which was used as a colourant in chilli powder. However, scientists advised the Food Standards Agency that Sudan II was linked to an increased risk of cancer and it is now no longer used as a food colourant.

The flowchart below shows how Sudan II could be prepared in the laboratory from 1,3-dimethylbenzene.

- (i) Draw the structures of the organic compounds **A**, **B**, **C** and **D** in the boxes below. Display the functional group in compound **C**.



[4]

(ii) Compound **A** is formed by reacting 1,3-dimethylbenzene with HNO_3 and H_2SO_4

Explain, with the aid of curly arrows, the mechanism for the formation of compound **A**.

Your answer should clearly show the role of H_2SO_4 as a catalyst.

[5]

(iii) Deduce how many **other** structural isomers of compound **A** could have been formed from the mononitration of 1,3-dimethylbenzene.

..... [1]

[Total: 13]