

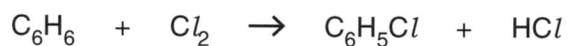
②

June 2011

2

Answer **all** the questions.

- 1 Benzene and other arenes can be chlorinated to produce chloroarenes which are used in the manufacture of pesticides, drugs and dyes.
- (a) Chlorobenzene, $\text{C}_6\text{H}_5\text{Cl}$, is formed by the reaction of benzene and chlorine in the presence of a suitable catalyst, such as AlCl_3 .



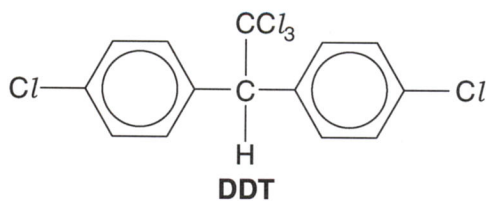
Outline the mechanism for the formation of chlorobenzene from benzene.

Show how AlCl_3 behaves as a catalyst.

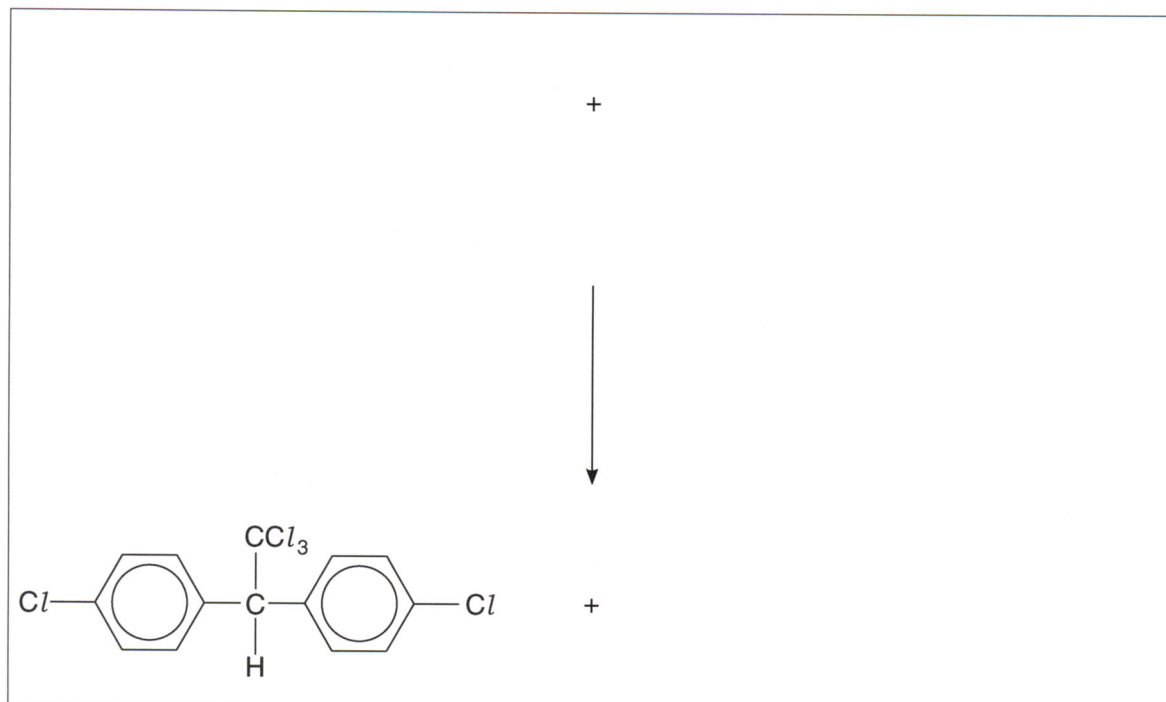
[6]

3

- (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]



[3]

[Total: 13]

2 A student was investigating the reactions and uses of organic amines.

- (a) The student found that amines such as ethylamine, $\text{C}_2\text{H}_5\text{NH}_2$, and phenylamine, $\text{C}_6\text{H}_5\text{NH}_2$, both behave as bases.

(i) Explain why amines can behave as bases.

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

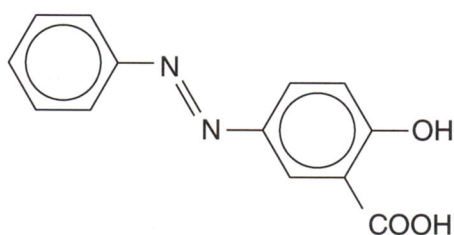
(ii) The student reacted an excess of $\text{C}_2\text{H}_5\text{NH}_2$ with two different acids.

Write the formulae of the salts that would be formed when an **excess** of $\text{C}_2\text{H}_5\text{NH}_2$ reacts with:

sulfuric acid,

ethanoic acid. [2]

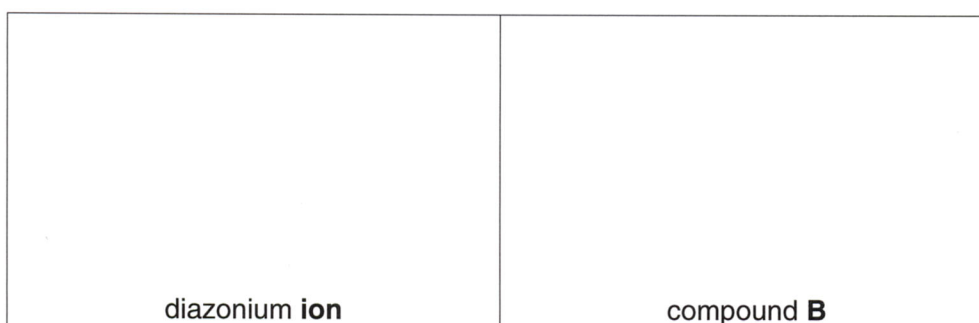
- (b) The student reacted phenylamine with a mixture of $\text{NaNO}_2(\text{aq})$ and $\text{HCl}(\text{aq})$ whilst keeping the temperature below 10°C . A diazonium ion was formed. The student then reacted the diazonium ion with compound **B**. After neutralisation, compound **A** was formed.



compound **A**

(i) Draw the structures of the diazonium **ion** and compound **B**.

Display the functional group in the diazonium ion.



[2]

(ii) State the conditions required for the reaction of the diazonium ion with compound **B** and state a possible use for compound **A**.

conditions

possible use for compound **A**. [1]

- (iii) The student added Na_2CO_3 to a solution of compound **A**.

Draw the structure of the organic product and state the formulae of any other products from this reaction.

[2]

- (c) The student repeated the experiment in part (b) but allowed the temperature to rise above 10°C .

Under these conditions, the diazonium **ion** in (b)(i) reacts with water to produce phenol. A gas with molar mass of 28.0 g mol^{-1} and one other product are also formed.

Construct an equation for this reaction.

[1]

[Total: 9]

Answer **all** the questions.

- 1 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.

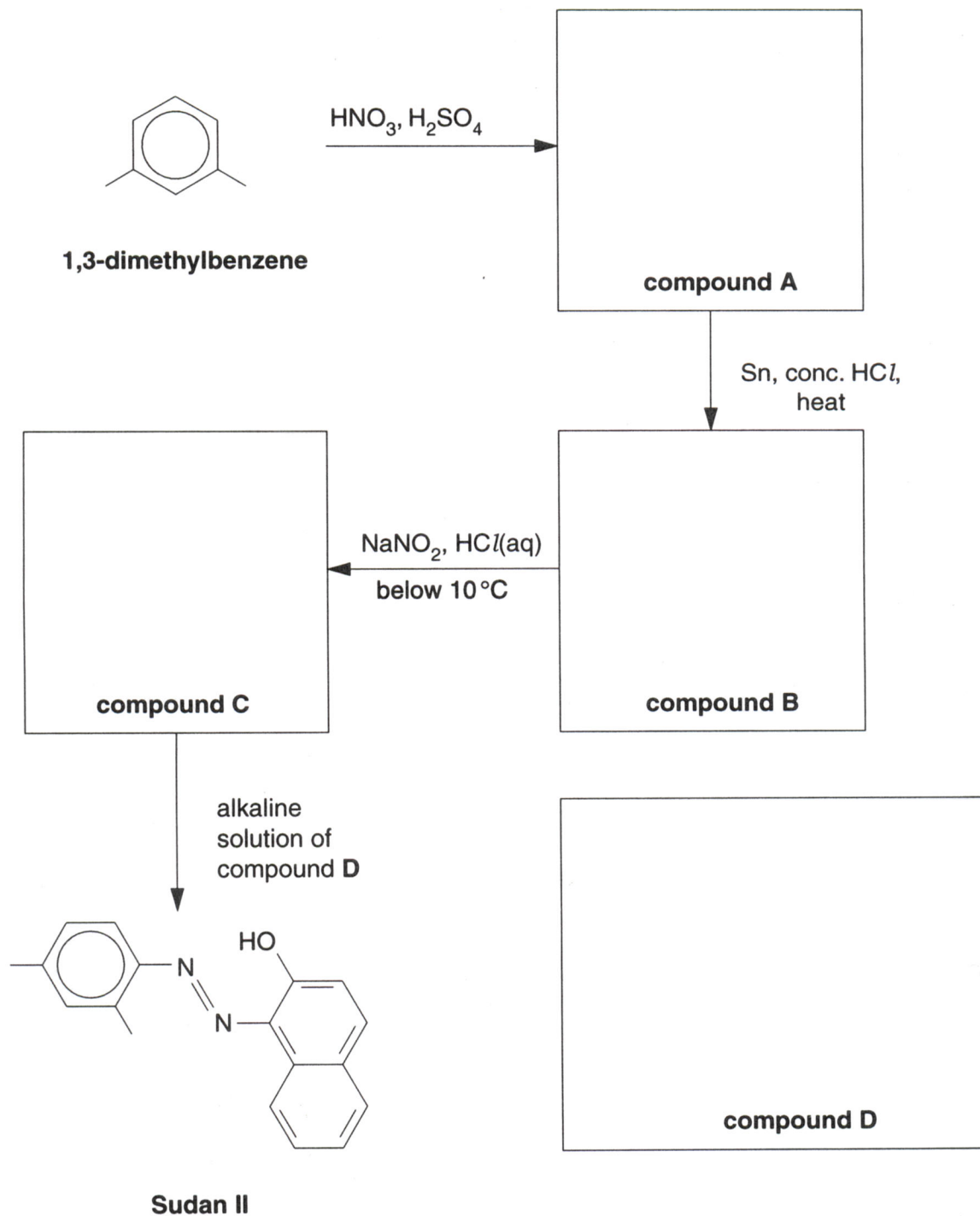
..... [3]



- (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**.



- (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]



2

Answer **all** the questions.

- 1 A chemist was investigating the reactions of benzene, phenol and cyclohexene with bromine. She found that they all reacted with bromine but under different conditions.

- (a) The chemist found that when benzene reacts with bromine, a halogen carrier is required as a catalyst.

Write an equation for this reaction.

You do **not** need to show the halogen carrier in your equation.

[1]

- (b) The chemist also found that when phenol or cyclohexene reacts with bromine, a halogen carrier is **not** required.

- (i) The chemist observed that bromine decolourises when it reacts with phenol.

What other observation would she have made?

Draw the structure of the organic product formed.

Observation

Organic product:

[2]

- (ii) Cyclohexene also decolourises bromine.

Name the organic product formed.

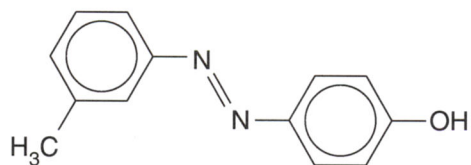
..... [1]



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

[5]

- (c) Compound **A**, shown below, is being considered as an azo dye by a chemical company. A chemist planned a two-stage synthesis of compound **A** starting from an aromatic amine.



compound A

The aromatic amine is first converted into a diazonium ion.

- Draw the displayed formula of the aromatic amine **and** of the diazonium ion.
- State the reagents and conditions for each stage in the synthesis of compound **A** from an aromatic amine.

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..... [5]

[Total: 14]