Name:

Target grade: **Mark:** / **35**

Actual grade: **Percentage:**

Homework 1 – Benzene

1. In this question, one mark is available for the quality of spelling, punctuation and grammar.

Describe with the aid of suitable diagrams the bonding and structure of a benzene molecule.

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[6]

Quality of Written Communication [1]

[Total 7 marks]

Name:

2. The nitration of benzene is a very important industrial reaction.

(a) Name **two** types of commercially important material whose manufacture involves the nitration of benzene.

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(b) State the conditions required for the nitration of benzene using nitric acid and sulphuric acid.

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[2]

(c) Write a balanced equation for the nitration of benzene.

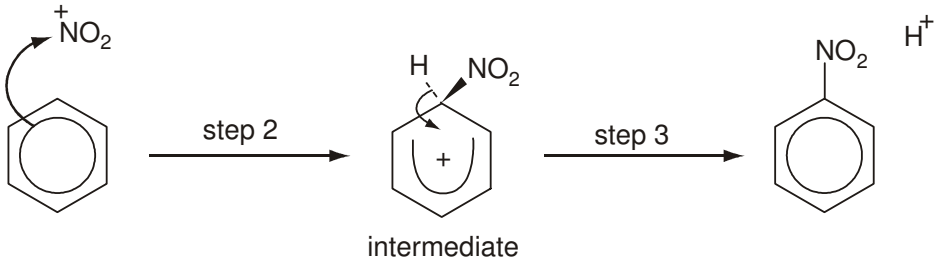
[2]

(d) The mechanism for the reaction is given below.

Step 1: formation of the electrophile, NO_2^+, from HNO_3 and H_2SO_4

$$HNO_3 + H_2SO4 \rightarrow H_2O + NO_2^+ + HSO_4^-$$

Steps 2 and 3: substitution of NO_2^+ into the benzene ring



intermediate

Step 4: protonation of the HSO_4^-

$$H^+ + HSO_4^- \rightarrow H_2SO_4$$

(i) Explain what a curly arrow  represents in this type of mechanism.

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(ii) State why the NO_2^+ is described as an electrophile in this mechanism.

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(iii) State why this mechanism is described as substitution.

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(iv) How does the mechanism show that the sulphuric acid is acting as a catalyst?

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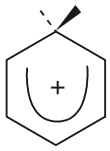
[1]

(e) In this question, one mark is available for the quality of spelling, punctuation and grammar.

The benzene ring and the ring in the intermediate formed after **step 2** have different structures shown below. Both structures have π-bonds.

benzene ring



ring in the intermediate

Deduce how many electrons are involved in the π-bonding in each structure and describe how their arrangements are different.

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Quality of Written Communication [1]

[Total 17 marks]

3. (a) In this question, one mark is available for the quality of use and organisation of technical terms.

Bromine is used in organic chemistry to carry out a variety of electrophilic reactions.

(i) Describe and explain how a molecule of bromine acts as an electrophile. Illustrate your answer with a diagram showing relevant dipoles and curly arrows.

(ii) Use your answer to (i) to explain why bromine reacts much more readily with cyclohexene than it does with benzene.

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Quality of Written Communication [1]

(b) The compound iodine monobromide, IBr, also reacts with benzene in an electrophilic reaction.

(i) Which compound would be the main product of this reaction, iodobenzene or bromobenzene? Explain your answer.

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[2]

(ii) Deduce an equation for the reaction of iodine monobromide with benzene.

[1]

[Total 11 marks]