AQA A-LEVEL CHEMISTRY · 7405

CHEMISTRY



EXAM QUESTION PACK

3.3.10 AROMATIC CHEMISTRY

SCORE	PERCENTAGE
/76	%

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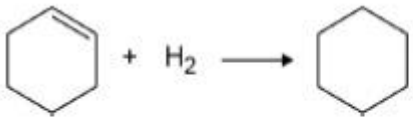
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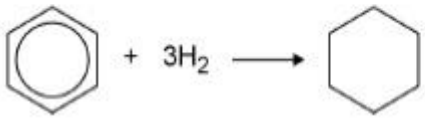
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Q1.

Data about the hydrogenation of cyclohexene and of benzene are given.



$\Delta H^{\ominus} = -120 \text{ kJ mol}^{-1}$



$\Delta H^{\ominus} = -208 \text{ kJ mol}^{-1}$

(a) Explain the bonding in and the shape of a benzene molecule.
Compare the stability of benzene with that of the hypothetical cyclohexa-1,3,5-triene molecule.
Use the data in your answer.

(6)

(b) The enthalpy of hydrogenation of cyclohexa-1,3-diene is **not** exactly double that of cyclohexene.

Suggest a value for the enthalpy of hydrogenation of cyclohexa-1,3-diene and justify your value.

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(3)

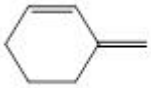
(Total 9 marks)

Q2.

Use your understanding of the bonding in benzene to identify the compound that has the most exothermic enthalpy of hydrogenation.

A  

B  

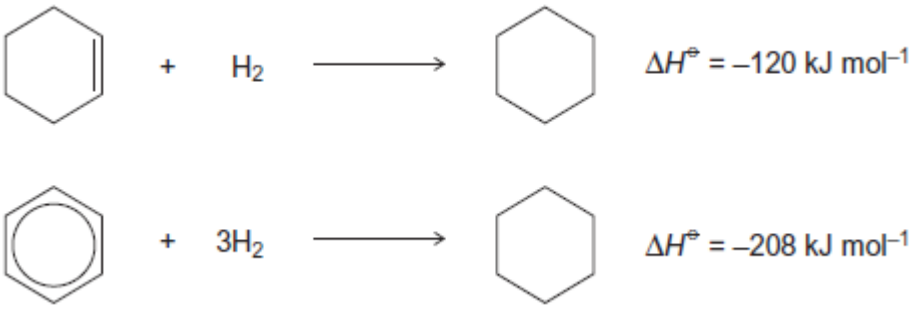
C  

D  

(Total 1 mark)

Q3.

Equations for the hydrogenation of cyclohexene and of benzene, together with the enthalpies of hydrogenation, are shown.



(a) (i) Use these data to show that benzene is 152 kJ mol^{-1} more stable than the hypothetical compound cyclohexa−1,3,5−triene.

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(1)

(ii) State, in terms of its bonding, why benzene is more stable than cyclohexa−1,3,5−triene.

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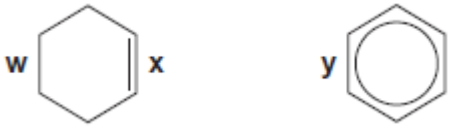
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(1)

(b) Three carbon−carbon bonds are labelled on the structures shown.
These bonds are of different lengths.

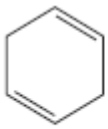


Write the letters **w**, **x** and **y** in order of **increasing** bond length.

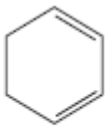
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(1)

(c) The structures of two cyclic dienes are shown.



cyclohexa-1,4-diene



cyclohexa-1,3-diene

(i) Use the enthalpy of hydrogenation data given opposite to calculate a value for the enthalpy of hydrogenation of cyclohexa−1,4−diene.

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(1)

(ii) Predict a value for the enthalpy of hydrogenation of cyclohexa−1,3−diene.

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(1)

(iii) Explain your answers to part (i) and part (ii) in terms of the bonding in these two dienes.

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(3)

(Total 8 marks)

Q4.

Each of the following conversions involves reduction of the starting material.

(a) Consider the following conversion.



Identify a reducing agent for this conversion.

Write a balanced equation for the reaction using molecular formulae for the nitrogen-containing compounds and [H] for the reducing agent.

Draw the repeating unit of the polymer formed by the product of this reaction with benzene-1,4-dicarboxylic acid.

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(5)

(b) Consider the following conversion.



Identify a reducing agent for this conversion.

State the empirical formula of the product.

State the bond angle between the carbon atoms in the starting material and the bond angle between the carbon atoms in the product.

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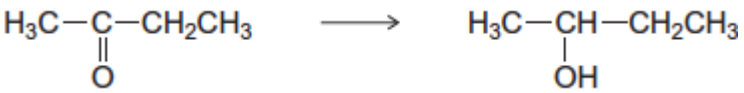
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(4)

(c) The reducing agent in the following conversion is $NaBH_4$



(i) Name and outline a mechanism for the reaction.

Name of mechanism _____

Mechanism

(5)

(ii) By considering the mechanism of this reaction, explain why the product formed is optically inactive.

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(3)

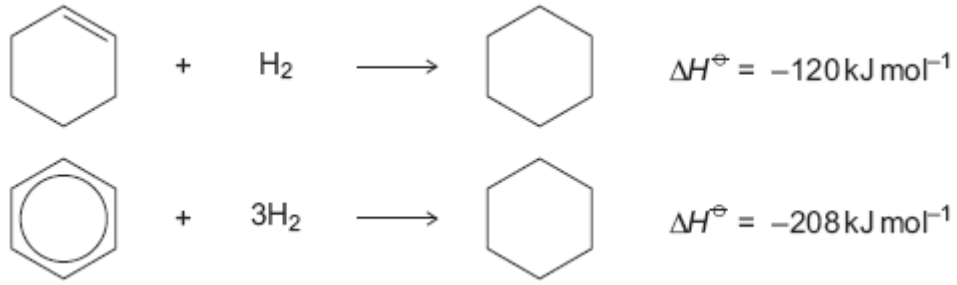
(Total 17 marks)

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Q5.

The hydrocarbons benzene and cyclohexene are both unsaturated compounds.
Benzene normally undergoes substitution reactions, but cyclohexene normally undergoes addition reactions.

(a) The molecule cyclohexatriene does not exist and is described as hypothetical.
Use the following data to state and explain the stability of benzene compared with the hypothetical cyclohexatriene.



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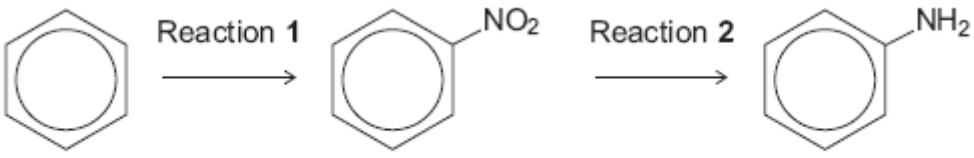
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(4)

(b) Benzene can be converted into amine **U** by the two-step synthesis shown below.



U

The mechanism of Reaction **1** involves attack by an electrophile.

Give the reagents used to produce the electrophile needed in Reaction **1**.

Write an equation showing the formation of this electrophile.

Outline a mechanism for the reaction of this electrophile with benzene.

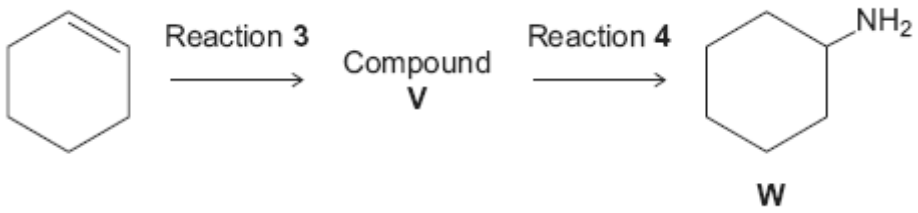
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(6)

(c) Cyclohexene can be converted into amine **W** by the two-step synthesis shown below.



Suggest an identity for compound **V**.

For Reaction **3**, give the reagent used and name the mechanism.

For Reaction **4**, give the reagent and condition used and name the mechanism.

Equations and mechanisms with curly arrows are **not** required.

(6)

(d) Explain why amine **U** is a weaker base than amine **W**.

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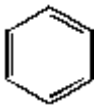
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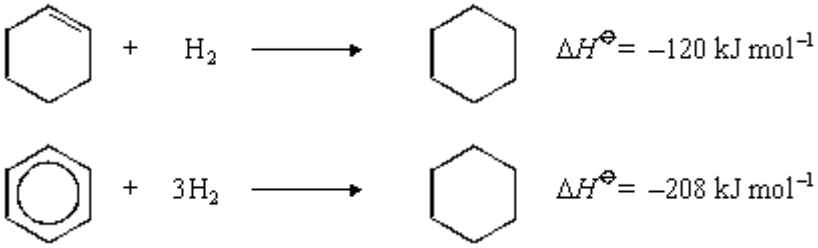
(Total 19 marks)

Q6.

(a) Use the following data to show the stability of benzene relative to the hypothetical cyclohexa-1,3,5-triene.



Give a reason for this difference in stability.



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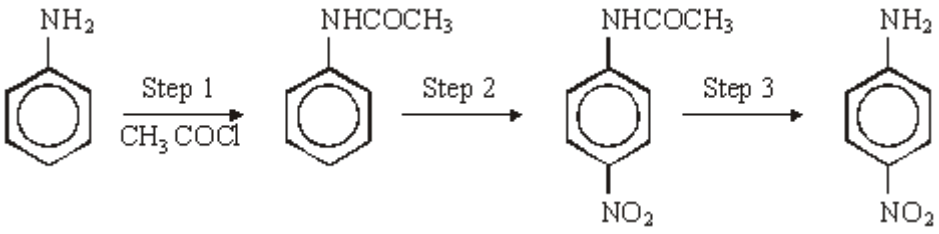
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(4)

(b) Consider the following reaction sequence which starts from phenylamine.



(i) State and explain the difference in base strength between phenylamine and ammonia.

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(3)

(ii) Name and outline a mechanism for the reaction in Step 1 and name the organic product of Step 1.

(6)

(iii) The mechanism of Step 2 involves attack by an electrophile. Give the reagents used in this step and write an equation showing the formation of the electrophile.
Outline a mechanism for the reaction of this electrophile with benzene.

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(6)

(iv) Name the type of linkage which is broken in Step 3 and suggest a suitable reagent for this reaction.

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(2)

(Total 21 marks)

Q7.

Which one of the following does **not** contain any delocalised electrons?

A poly(propene)

B benzene

C graphite

D sodium

(Total 1 mark)

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