Aromatic chemistry

AQA 7405 · A level

Answer on your own paper. Show your working where needed.

1. Benzene bonding

Describe the overlap of p orbitals in benzene. State how many electrons are delocalised and where the resulting electron density lies.

2. Measure the bonds

Diffraction gives six equal C-C bond lengths for benzene, each 139 pm. A typical C-C bond is 154 pm and a typical C=C bond is 134 pm. Explain which model the measurements support.

3. Use hydrogenation data

Hydrogenation of cyclohexene to cyclohexane gives −119 kJ mol^{-1}. Hydrogenation of benzene to cyclohexane gives −206 kJ mol^{-1}. Estimate the extra stability of benzene using the isolated-double-bond model.

4. Two ways a ring could react

Benzene can undergo electrophilic substitution. Compare the bonding in its substitution product with the bonding that would result from simple addition across two ring carbons.

5. Make the electrophile

Write an equation for the formation of the electrophile when concentrated nitric acid and concentrated sulfuric acid are used to nitrate benzene. Identify the electrophile.

6. The reaction of benzene with NO_2^+

Draw the mechanism for benzene reacting with NO_2^+. Include the ring intermediate and the step giving the organic product.

7. Interpret a bromine test

Benzene and cyclohexene are treated separately with bromine water without a halogen carrier. Predict the result for each and explain the difference.

8. Friedel-Crafts acylation

Explain how the catalyst is regenerated.

9. Extra challenge · Correct an acylation mechanism

Benzene reacts with propanoyl chloride in the presence of $AlCl_3$. A diagram shows the ring donating to the ethyl carbon and the product retaining two groups on a saturated ring.

Draw the correct mechanism from electrophile formation to the organic product. Write the equation that regenerates the catalyst.

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