Aromatic chemistry

OCR A H432 · 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

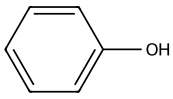
Write an equation for the formation of the electrophile when concentrated nitric acid and concentrated sulfuric acid are used to nitrate benzene. Identify the electrophile.

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. Compare two observations

Compound A is shown. A gives a white precipitate when shaken with bromine water under the usual test conditions. Benzene gives no such precipitate in the same test. Name A and the precipitate, then explain the different reactivity.

A 

8. Compare two carbon sources

Benzene reacts separately with chloroethane and ethanoyl chloride. Name a suitable halogen carrier. Give both structures and identify which carbon of each reagent bonds to the ring.

9. Extra challenge · Choose the order of substitution

Start with benzene and make 1-bromo-3-nitrobenzene in two substitutions. Choose the order, give the two sets of reagents or conditions and explain the position of the second group.

Draw the ring mechanism for the second reaction using Br^+ as the electrophile.

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