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QUESTION WORKBOOK

Benzene: its structure and the evidence for delocalisation

Aromatic chemistry and amines · Unit C21

AQA 3.3.10.1 · OCR A 6.1.1 (a) to (c), 6.1.1 (h)

18 questions · 61 marks

NAVY SCREEN EDITION

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SECTION A · Short, 1 to 2 marks

A1 BSE-Q2
Give the systematic name of the structure Kekulé proposed for benzene, and give the number of delocalised electrons in one benzene molecule. [2]

A2 BSE-Q4
Explain why all of the carbon–carbon bonds in benzene are the same length. [2]

SECTION B · Standard, 3 to 5 marks

B1 BSE-Q1
Describe the shape of a benzene molecule and the lengths of its carbon–carbon bonds, as X-ray diffraction shows them, and state how each differs from what the Kekulé structure predicts. [4]

B2 BSE-Q3
Describe the bonding in a benzene molecule using the delocalised model. [4]

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B3 BSE-Q9 Name the compounds $C_6H_5CH_3$, C_6H_5COOH and $C_6H_5NH_2$, and a benzene ring with chlorine atoms on two opposite carbons. [4]

B4 BSE-Q14 Compare the reactions of cyclohexene and benzene with bromine, and with hydrogen over a nickel catalyst, explaining the differences. [4]

B5 BSE-Q18 Explain, in terms of the anion each forms, why the pKa values of ethanol, phenol and ethanoic acid are about 16, 10.0 and 4.8. [4]

B6 BSE-Q22 Compare the reactions of benzene and of phenol with bromine, giving the conditions, the organic product and the reason for the difference. [4]

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B7 BSE-Q5 Explain why cyclohexene decolourises bromine water at room temperature but benzene does not. [3]

B8 BSE-Q6 Calculate the delocalisation energy of benzene from these data-book values for the enthalpy of hydrogenation: cyclohexene −120 kJ mol^{-1}, benzene −208 kJ mol^{-1}. [3]

B9 BSE-Q12 Suggest what the following data show about the bonding and the reactions of cyclooctatetraene, C_8H_8, a ring of eight carbons: it decolourises bromine water rapidly, and its carbon–carbon bonds are 133 pm and 146 pm long, in turn. [3]

B10 BSE-Q13 Suggest how the number of isomers of dichlorobenzene, $C_6H_4Cl_2$, that can be made supports the delocalised model over the Kekulé structure. Only three isomers exist. [3]

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B11 BSE-Q15 Explain, in terms of energy, why benzene is more stable than the Kekulé structure would be. [3]

B12 BSE-Q17 Evaluate the claim that benzene has three double bonds which swap places too quickly for the two forms to be separated. [3]

B13 BSE-Q19 Explain why chlorobenzene is not hydrolysed when boiled with aqueous sodium hydroxide, whereas 1-chlorobutane is hydrolysed on heating under reflux. [3]

B14 BSE-Q20 Suggest a chemical test that distinguishes phenol from benzoic acid, giving the observation for each compound. [3]

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B15 Calculate the pH of a 0.0250 mol dm^{-3} solution of phenol, whose pKa is 10.0. [3]
BSE-Q21

SECTION C · Long, 6 marks or more

C1 Discuss the evidence that the Kekulé structure of benzene is wrong, and explain how the delocalised model accounts for each piece of evidence. [6]
BSE-Q7

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