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QUESTION WORKBOOK

Electrophilic substitution: nitration and Friedel–Crafts acylation

Aromatic chemistry and amines · Unit C21

AQA 3.3.10.2 · OCR A 6.1.1 (d), 6.1.1 (e), 6.1.1 (g), 6.1.1 (i) to (l), 6.2.4 (d)

18 questions · 63 marks

NAVY SCREEN EDITION

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SECTION A · Short, 1 to 2 marks

A1 ESN-Q22

Suggest the main organic product when nitrobenzene reacts with bromine and iron(III) bromide, and explain the position of the bromine. [2]

SECTION B · Standard, 3 to 5 marks

B1 ESN-Q2

Explain, with equations, how the nitronium ion forms in the nitrating mixture, and why concentrated sulfuric acid is described as a catalyst. [4]

B2 ESN-Q7

Identify the electrophile and the role of the aluminium chloride when a student heats benzene under reflux with ethanoyl chloride and anhydrous aluminium chloride, and give the equations that show the electrophile forming and the catalyst re-forming. [4]

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B3 ESN-Q9 Outline the mechanism for the reaction of benzene with ethanoyl chloride and aluminium chloride, including an equation for the formation of the electrophile. [4]

B4 ESN-Q24 Show that the overall equation for the nitration of benzene is $C_6H_6 + HNO_3 \rightarrow C_6H_5NO_2 + H_2O$, by combining the equations for the formation of the electrophile, the substitution step and the regeneration of the catalyst, and state what the result shows about the sulfuric acid. [4]

B5 ESN-Q15 Compare the reaction of ethene with hydrogen bromide and the nitration of benzene, in terms of the electrophile, the intermediate and the type of reaction. [4]

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B6 ESN-Q17 Suggest a two-step synthesis of phenylamine from benzene, giving the reagents and conditions for each step and naming the intermediate. [4]

B7 ESN-Q19 Outline the mechanism for the bromination of benzene with bromine and iron(III) bromide, including equations for the formation of the electrophile and the regeneration of the catalyst. [4]

B8 ESN-Q1 State the reagents and conditions for the nitration of benzene. [3]

B9 ESN-Q4 Explain why benzene reacts with electrophiles by substitution rather than by addition. [3]

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B10 ESN-Q12 Calculate the percentage atom economy for making phenylethanone by the reaction $C_6H_6 + CH_3COCl \rightarrow C_6H_5COCH_3 + HCl$. Mr: C_6H_6 78.0, CH_3COCl 78.5, $C_6H_5COCH_3$ 120.0. [3]

B11 ESN-Q13 Suggest why little phenylethanone forms when a student uses aluminium chloride from a bottle that had been left open, and what the student would have seen when the bottle was opened. [3]

B12 ESN-Q14 Suggest the electrophile, an equation for its formation, and the organic product when benzene is heated with benzoyl chloride, C_6H_5COCl, and aluminium chloride. [3]

B13 ESN-Q16 Explain why benzene needs a positive ion such as NO_2^+ as an electrophile, when ethene reacts with neutral bromine. [3]

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B14 ESN-Q20 Explain why phenol reacts with bromine water at room temperature, whereas benzene reacts with bromine only when a halogen carrier is present. [3]

B15 ESN-Q21 Explain why Friedel–Crafts alkylation of benzene gives some disubstituted product, whereas acylation stops after one group, and how the alkylation is run to limit it. [3]

B16 ESN-Q23 Suggest the organic product when methylbenzene reacts with chlorine in ultraviolet light, with chlorine and aluminium chloride, and with hot alkaline potassium manganate(VII) followed by acid. [3]

SECTION C · Long, 6 marks or more

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C1
ESN-Q3

Draw the mechanism for the nitration of benzene, including an equation for the formation of the electrophile, and explain why the reaction is a substitution and not an addition. [6]

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