InkChemistry

QUESTION WORKBOOK

Free-radical substitution

Alkanes and halogenoalkanes · Unit C17

AQA 3.3.2.4 · OCR A 4.1.2 (f), 4.1.2 (g)

18 questions · 58 marks

NAVY SCREEN EDITION

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SECTION A · Short, 1 to 2 marks

A1 FR-Q3

Explain why ultraviolet light starts the reaction by breaking the Cl–Cl bond rather than a C–H bond. [2]

A2 FR-Q9

Suggest how the proportion of chloromethane in the product could be increased, and explain why your change works. [2]

A3 FR-Q14

Calculate the percentage of the monochlorinated product of butane, $CH_3CH_2CH_2CH_3$, that would be 1-chlorobutane if every hydrogen atom were equally likely to be replaced. [2]

A4 FR-Q15

Suggest why the measured percentage of 1-chlorobutane in the monochlorinated product of butane, about 28%, is lower than the figure predicted by counting hydrogen atoms. [2]

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A5 FR-Q17 Explain why the reaction between methane and chlorine stops almost at once when the ultraviolet lamp is switched off. [2]

SECTION B · Standard, 3 to 5 marks

B1 FR-Q1 State the condition needed for methane to react with chlorine and name the type of mechanism, then state what is meant by a radical and describe how homolytic fission forms one. [4]

B2 FR-Q2 Outline the mechanism for the reaction of methane with chlorine to form chloromethane, using equations. [4]

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B3 FR-Q11

Give the two propagation steps by which chloromethane is converted into dichloromethane, and the termination step that forms a hydrocarbon with two carbon atoms, and identify what that hydrocarbon shows about the mechanism. [4]

B4 FR-Q16

Evaluate free-radical substitution as a method for making pure 1-chloropropane from propane. [4]

B5 FR-Q21

Draw the initiation step and the first propagation step of the reaction of methane with chlorine, using fishhook arrows to show the movement of single electrons. [4]

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B6 FR-Q22 Draw the second propagation step of the reaction of methane with chlorine, and the termination step that forms ethane, using fishhook arrows. [4]

B7 FR-Q5 Explain why the reaction of methane with chlorine is described as a chain reaction. [3]

B8 FR-Q7 Calculate the percentage atom economy for making dichloromethane by the reaction $CH_4 + 2Cl_2 \rightarrow CH_2Cl_2 + 2HCl$. Ar: H 1.0, C 12.0, Cl 35.5. [3]

B9 FR-Q8 Explain why the reaction of methane with chlorine gives a mixture of products. [3]

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B10 FR-Q10 Suggest, using the bond enthalpies C–H 413 and C–Br 290 kJ mol^{-1}, why a bromine radical does not react with methane by the step Br• + CH_4 → CH_3Br + H•. [3]

B11 FR-Q13 Suggest equations for the initiation step and the two propagation steps in the reaction of propane with bromine in ultraviolet light to form 2-bromopropane. [3]

B12 FR-Q19 Explain, using the bond enthalpies C–H 413 and H–I 299 kJ mol^{-1}, why iodine does not react usefully with methane in ultraviolet light. [3]

SECTION C · Long, 6 marks or more

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C1
FR-Q23

Outline the mechanism by which propane reacts with chlorine in ultraviolet light to form 1-chloropropane, and explain why 1-chloropropane is only one of many products. [6]

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