

1.5.2 Electron arrows and addition mechanisms

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

KEY WORDS homolytic fission • electrophile • carbocation

Objective

Use the correct electron arrows in radical initiation and electrophilic addition. Show complete drawing answers, then explain evidence and limitations.

1 Key knowledge and worked examples

■ Match the arrow to the electrons moved

Homolytic breaking divides a bond pair: each curly half-arrow moves one electron. Heterolytic breaking transfers both electrons to one fragment: use an electron-pair curly arrow. An electrophile accepts an electron pair; a radical has an unpaired electron.

In HBr addition, draw a pair arrow from the alkene π bond to H and another from H–Br to Br. Br[–] then donates a lone pair to the carbocation. For propene, the major route forms a secondary rather than primary carbocation before bromide attacks.

2 Practice

2.1 Draw the UV initiation step for chlorine substitution, including curly half-arrows and radical dots. [3]

2.2 Write both propagation equations for substitution of methane by chlorine and one termination equation producing ethane. Explain why the propagation steps can continue a chain. [4]

2.3 Draw the simple electrophilic-addition mechanism of bromine to ethene. Include induced bond polarity, electron-pair arrows, the intermediate and final product. [5]

3 Exam-style questions

3.1 Explain why HBr addition to propene mainly gives 2-bromopropane rather than 1-bromopropane. Give the structural formula and class of each possible carbocation. [4]

3.2 A methane/chlorine reaction gives chloromethane, dichloromethane and small amounts of ethane. Explain the origin of the latter two products and why the process is unsuitable for obtaining only pure chloromethane directly. [3]

3.3 Draw the addition-polymerisation equation for propene, showing a complete repeat unit, continuation bonds, brackets and n. Explain why its empirical formula alone cannot distinguish the polymer from its monomer. [5]

3.4 Draw the electron-pair mechanism for hydrogen bromide adding to ethene. Show H–Br polarity, both arrows in the first step, the carbocation and bromide ion, the attack arrow and final organic product. Explain why ethene gives no choice between two different constitutional products. [6]
