What Are Addition Reactions?

Worksheet

In electrophilic addition, an electrophile attacks the -electrons of an alkene, forming a carbocation intermediate. A nucleophile then adds to the carbocation. Markovnikov's rule states the electrophile adds to the carbon with more hydrogens, placing the nucleophile (or negative part) on the more substituted carbon.

Questions

1. HCl + CHCH=CH major product?

A) CHCClCH
B) CHCHClCH
C) CHClCHCH
D) No reaction

2. Rank carbocation stability: 1, 2, 3

A) 1 > 2 > 3
B) 3 > 2 > 1
C) 2 > 1 > 3
D) All equal

3. HBr + cyclohexene major product's position of Br?

A) C1
B) C2
C) C3
D) Both equally

4. Why does HBr + peroxides give anti-Markovnikov?

A) Peroxides change the substrate
B) Free radical mechanism (different pathway)
C) Temperature effect
D) Solvent effect

5. Draw the mechanism for HBr adding to propene (CHCH=CH). What is the major product?

6. Predict the product of HBr + 2-methylpropene. Does rearrangement occur?

7. What is the product of HO adding to 1-methylcyclohexene? Does carbocation rearrangement occur?

8. Define: What is Markovnikov's rule?

9. Define: What is a carbocation intermediate?

10. Define: Stability order of carbocations?

Answer Key

1. B) CHCHClCH - H forms the secondary carbocation (CHCHCH), Cl attacks CHCHClCH (Markovnikov).

2. B) 3 > 2 > 1 - Tertiary > secondary > primary. More alkyl substitution stabilizes the positive charge.

3. B) C2 - Symmetrical ring; either C (C1 or C2 in tautomeric sense) gives same 2 carbocation HBr adds forming cyclohexyl bromide (2).

4. B) Free radical mechanism (different pathway) - Peroxides initiate free-radical mechanism: Br-addition is to less substituted C (radical stability order opposite to carbocation).

5. Step 1: H attacks the -bond. Two possible carbocations: - Primary carbocation (less stable) - Secondary carbocation from CH-CH-CH (more stable formed) Step 2: Br attacks the secondary carbocation Product: CHCHBrCH (2-bromopropane, major) Minor: CHCHCHBr (1-bromopropane, very minor)

6. Substrate: (CH)C=CH (2-methylpropene) H attack forms a carbocation. Initially secondary (CH-C-CH-CH from). No rearrangement needed - secondary is already favorable. Br attacks product: (CH)C-Br (tert-butyl bromide, 2-bromo-2-methylpropane) Follows Markovnikov.

7. Substrate: cyclohexene ring with CH at position 1 H attacks C=C forming a secondary benzylic-like carbocation. HO attacks product: major is the secondary alcohol (Markovnikov). No rearrangement; secondary carbocation is stable enough. Minor: primary alcohol from alternative attack.

8. In asymmetric alkene + HX addition, H adds to the C with more hydrogens, X adds to the more substituted C.

9. A carbon atom with only 6 electrons (positively charged); forms in two-step additions.

10. 3 (tertiary) > 2 (secondary) > 1 (primary) > methyl; more substitution = more stability.