What Are E1 and E2 Elimination Reactions?

Worksheet

E1 is a two-step mechanism via a carbocation intermediate (first-order kinetics, favored by polar protic solvents and weak bases). E2 is a one-step, concerted mechanism (second-order kinetics, favored by strong bases and polar aprotic solvents). Zaitsev's rule predicts the major alkene product.

Questions

1. Which conditions favor E2 elimination?

A) Weak base, polar protic solvent
B) Strong base, polar aprotic solvent
C) Weak base, aprotic solvent
D) Carbocation stability

2. Zaitsev's rule predicts

A) The major substitution product
B) The more substituted alkene
C) The less substituted alkene
D) No reaction

3. E1 kinetics are

A) First-order in base
B) Second-order
C) First-order in RX only
D) Zero-order

4. Which substrate favors E1?

A) 1 alkyl halide
B) 2 alkyl halide
C) 3 alkyl halide
D) Primary alcohol

5. Predict the major alkene from 2-bromo-2-methylpropane (tert-butyl bromide) with KOH in ethanol.

6. What is the major product when 1-bromo-3-methylbutane reacts with tert-BuOK in DMSO?

7. With 2-bromobutane and KOH in EtOH, which elimination product is favored?

8. Define: What is the main difference between E1 and E2?

9. Define: What is Zaitsev's rule?

10. Define: Which mechanism is favored with a strong base and polar aprotic solvent?

Answer Key

1. B) Strong base, polar aprotic solvent - E2 requires a strong base (fast H removal) and aprotic solvent (no carbocation stabilization).

2. B) The more substituted alkene - Zaitsev = more stable, more substituted C=C is major.

3. C) First-order in RX only - E1 rate = k[RX] (first-order) - carbocation formation is rate-limiting, independent of base.

4. C) 3 alkyl halide - 3 alkyl halides form the most stable carbocation E1 preferred.

5. Substrate: tertiary alkyl halide (stable carbocation) Base: KOH (moderate strength) Solvent: ethanol (polar protic) E1 dominates. Carbocation forms, H removed from most substituted position (Zaitsev's rule). Product: 2-methylpropene (isobutylene), (CH)C=CH

6. Substrate: primary alkyl halide Base: tert-BuOK (strong, bulky) Solvent: DMSO (polar aprotic) E2 dominates (strong base, aprotic solvent). Zaitsev's rule: H removed from more substituted -carbon. Product: 3-methylbut-1-ene (major) and 3-methylbut-2-ene (minor)

7. Substrate: secondary alkyl halide (competing mechanisms) Conditions favor E1 (polar protic, weak base) Zaitsev's rule: H from most substituted -carbon Product: but-2-ene (CHCH=CHCH) major, but-1-ene minor

8. E1 is two-step via carbocation (first-order). E2 is one-step, concerted (second-order).

9. The major alkene product has the double bond between the most substituted carbons (most stable alkene).

10. E2 - strong base promotes direct deprotonation, aprotic solvent doesn't stabilize carbocation.