What is a Reaction Mechanism?

Worksheet

A reaction mechanism is a series of elementary steps that combine to give the overall chemical reaction. Each step involves a specific collision between molecules, and intermediates are species formed in one step and consumed in another.

Questions

1. Which species is an intermediate in the following steps? Step 1: A + B C. Step 2: C + D E.

A) A
B) C
C) B
D) E

2. In a reaction mechanism, what does the rate-determining step determine?

A) The activation energy of the reaction
B) The overall reaction rate
C) The number of intermediates
D) Whether the reaction is exothermic

3. For the mechanism: (1) NO + O NO + O (fast) and (2) NO + O NO + O (slow), what is the rate-determining step?

A) Step 1
B) Step 2
C) Both equally
D) Cannot be determined

4. Why are reaction mechanisms important?

A) They balance chemical equations
B) They explain how reactions actually occur at the molecular level
C) They increase reaction yield
D) They lower activation energy

5. The decomposition of NO has two elementary steps. Step 1: NO NO + O (slow). Step 2: NO NO + O (fast). What is the intermediate?

6. For a two-step mechanism: (1) Cl + H HCl + H (slow) and (2) H + Cl HCl + Cl (fast), identify the rate-determining step.

7. If the overall reaction is 2NO + O 2NO and the mechanism is (1) 2NO NO (fast equilibrium) and (2) NO + O 2NO (slow), write the rate law.

8. Define: What is a reaction mechanism?

9. Define: What is an intermediate in a reaction?

10. Define: What is the rate-determining step?

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Answer Key

1. B) C - C is formed in Step 1 and consumed in Step 2, making it an intermediate.

2. B) The overall reaction rate - The slowest step controls how fast the overall reaction proceeds.

3. B) Step 2 - Step 2 is marked as 'slow,' so it is the rate-determining step.

4. B) They explain how reactions actually occur at the molecular level - Mechanisms reveal the step-by-step molecular pathways and explain rate laws and intermediates.

5. An intermediate is formed in one step and consumed in another. NO is formed in Step 1 and consumed in Step 2. Intermediate = NO Overall: NO NO + 2O (NO cancels)

6. The rate-determining step (RDS) is the slowest step in the mechanism. It controls the overall reaction rate. RDS = Step 1 (Cl + H HCl + H) The predicted rate law: rate = k[Cl][H]

7. Step 1 is fast equilibrium: K = [NO]/[NO] Step 2 is rate-determining: rate = k[NO][O] Substitute [NO] = K[NO]: rate = kK[NO][O] = kb[NO][O]

8. A sequence of elementary steps that shows how reactants combine to form products, including intermediates.

9. A species formed in one elementary step and consumed in a later step; not present in the overall chemical equation.

10. The slowest elementary step in a mechanism; it controls the overall rate of the reaction.

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