

Practice Problems Chemical Kinetics: Rates and Mechanisms of Chemical Reactions

1. State two quantities that must be measured to establish the rate of a chemical reaction and cite several factors that affect the rate of a chemical reaction.

Answer

The rate of a reaction is defined as the change in concentration as a function of time. Thus, the two quantities that must be measured are the molarity of either a reactant or product and the time.

The factors that affect a reaction rate include the temperature, the concentration of reactants, the surface area (if solids are involved in the reaction), and the presence or absence of a catalyst.

2. Explain why the rate of disappearance of NO and the rate of formation of N_2 are not the same in the reaction, $2CO(g) + 2NO(g) \rightarrow 2CO_2(g) + N_2(g)$.

Answer

Because of the 2:1 stoichiometric ratio between NO and N_2 , the NO must use 2 moles for each mole of N_2 produced. This means the rate of consumption of NO is twice as fast as the rate of production of N_2 .

3. What plot of experimental data can be used to evaluate the activation energy, E_a , of a reaction? How is E_a related to this plot?

Answer

The experimental data required to evaluate the activation energy are rate constants as a function of absolute temperature. If $\ln k$ is plotted against $1/T$, a straight line should result and the slope of the line is equal to $-E_a/R$, where R is the ideal gas constant in energy units.

4. What are the chief requirements that must be met by a plausible reaction mechanism? Why do we say "plausible" mechanism rather than "correct" mechanism?

Answer

A reaction mechanism must meet two criteria. 1) The sum of all of the steps in the mechanism must match the observed reaction, stoichiometry of the reaction must be satisfied. 2) The reaction mechanism must account for the experimentally observed rate law.

Reaction mechanisms are considered "plausible" rather than "correct" because different sequences of elementary reactions may give the same overall reaction.

5. In a reaction mechanism, (a) what is the difference between an activated complex and an intermediate? (b) What is meant by the rate-determining step? Which elementary reaction in a reaction mechanism is often the rate-determining step?

Answer

(a) An activated complex is the structure along the reaction pathway of the highest energy, which determines the activation energy of the reaction. An intermediate can be any structure found in the reaction path.

(b) The rate-determining step is the elementary reaction that controls the mathematical form of the overall rate law. The rate-determining step is usually the slowest elementary reaction.

6. In the reaction $H_2O_2(aq) \rightarrow H_2O(l) + \frac{1}{2} O_2(g)$, the initial concentration of H_2O_2 is 0.2546 M, and the initial rate of reaction is $9.32 \times 10^{-4} M s^{-1}$. What will be $[H_2O_2]$ at $t = 35$ s?

Answer

Use the definition of rate (change in concentration over change in time), recognizing that the initial rate for the loss of hydrogen peroxide is negative and at $t = 0$ s, $[H_2O_2] = 0.2546$ M.

Chemical Kinetics Practice Problems And Answers

Daniela Niemeyer



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Table of Contents Chemical Kinetics Practice Problems And Answers

1. Understanding the eBook Chemical Kinetics Practice Problems And Answers
 - The Rise of Digital Reading Chemical Kinetics Practice Problems And Answers
 - Advantages of eBooks Over Traditional Books
2. Identifying Chemical Kinetics Practice Problems And Answers
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Chemical Kinetics Practice Problems And Answers
 - User-Friendly Interface
4. Exploring eBook Recommendations from Chemical Kinetics Practice Problems And Answers
 - Personalized Recommendations
 - Chemical Kinetics Practice Problems And Answers User Reviews and Ratings

- Chemical Kinetics Practice Problems And Answers and Bestseller Lists
- 5. Accessing Chemical Kinetics Practice Problems And Answers Free and Paid eBooks
 - Chemical Kinetics Practice Problems And Answers Public Domain eBooks
 - Chemical Kinetics Practice Problems And Answers eBook Subscription Services
 - Chemical Kinetics Practice Problems And Answers Budget-Friendly Options
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 - Chemical Kinetics Practice Problems And Answers Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Chemical Kinetics Practice Problems And Answers
 - Highlighting and Note-Taking Chemical Kinetics Practice Problems And Answers
 - Interactive Elements Chemical Kinetics Practice Problems And Answers
- 8. Staying Engaged with Chemical Kinetics Practice Problems And Answers
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Chemical Kinetics Practice Problems And Answers
- 9. Balancing eBooks and Physical Books Chemical Kinetics Practice Problems And Answers
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Chemical Kinetics Practice Problems And Answers
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Chemical Kinetics Practice Problems And Answers
 - Setting Reading Goals Chemical Kinetics Practice Problems And Answers
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Chemical Kinetics Practice Problems And Answers
 - Fact-Checking eBook Content of Chemical Kinetics Practice Problems And Answers
 - Distinguishing Credible Sources

13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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