

# AP Chemistry Unit 8 Review

## Kinetics

### Honors Lecture Notes: Unit 8

#### Reaction Orders

A reaction order describes how changing the concentration of a reactant affects the rate of reaction. There are three primary types of reaction orders:

- 0: No relationship (doubling conc. does not affect rate)
- 1<sup>st</sup>: Linear relationship (doubling conc. doubles rate)
- 2<sup>nd</sup>: Quadratic relationship (doubling conc. quadruples rate)

Reaction orders are completely unaffected by any kind of outside stimuli (temperature, pressure, etc) and can only be determined through experimental trials. For an overall reaction, there is no relationship between the coefficients on the reactants in the balanced equation and the order of those reactants.

#### Rate Law & Rate Constant

Once the orders are determined for the reactants in a reaction, the orders (often represented by the variables m and n) become exponents in the overall rate law. Any 0-order reactant simply cancels out of a rate law, as anything to the 0 power is simply 1.

$$\text{Rate} = k[A]^m[B]^n$$

The rate constant, k, can be determined using rate and concentration data from any trial of a reaction. The units on k are dependent on the overall order of the reaction. Increasing temperature increases the rate constant.

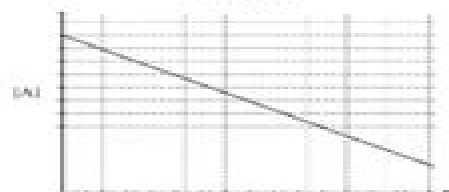
Ex: For a third order reaction, the following unit analysis applies.

$$M/s = k(M)(M)^2 \quad \text{Units on } k = M^{-2}s^{-1}$$

#### Reaction Rate Graphing

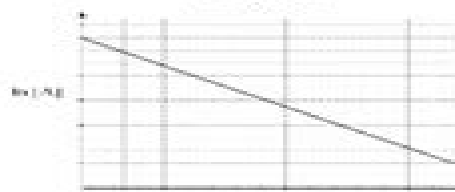
One of the most common ways to gather data for kinetics is through graphing the change in concentration of a reactant over time. Depending on the order of the reaction with respect to a given reactant, it requires a different mathematical function of concentration vs. time to create a straight line, the slope of which is always equal in magnitude to the rate constant.

0 Order



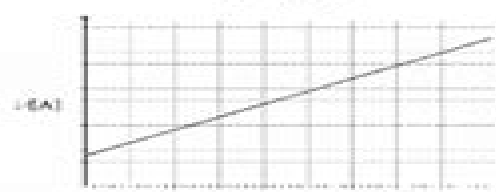
$$[A]_t = -kt + [A]_0$$

1<sup>st</sup> Order



$$\ln [A]_t = -kt + \ln [A]_0$$

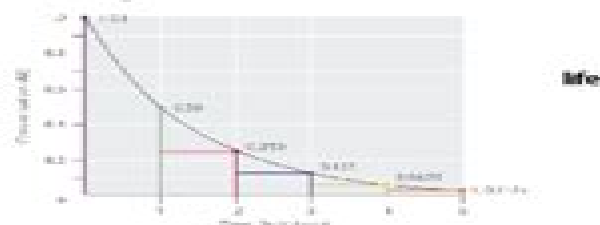
2<sup>nd</sup> Order



$$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$$

Additionally, for first order reactants, the half-life is constant. Half-life describes how long it takes for the concentration of a reactant to decrease to half of its original value. A concentration vs. time graph for a 1<sup>st</sup> order reactant looks like the diagram to the right.

For zero order and second order reactants, the half life is not constant. Half for any reactant can be affected by outside conditions, particularly temperature. The higher the temperature is, the faster a reaction is going to occur, and the shorter the half-life of the reactants will be.



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### **Table of Contents Modeling Chemistry U8 Review V2**

1. Understanding the eBook Modeling Chemistry U8 Review V2
  - The Rise of Digital Reading Modeling Chemistry U8 Review V2
  - Advantages of eBooks Over Traditional Books
2. Identifying Modeling Chemistry U8 Review V2
  - 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 Modeling Chemistry U8 Review V2
  - User-Friendly Interface
4. Exploring eBook Recommendations from Modeling Chemistry U8 Review V2
  - Personalized Recommendations
  - Modeling Chemistry U8 Review V2 User Reviews and Ratings

- Modeling Chemistry U8 Review V2 and Bestseller Lists
- 5. Accessing Modeling Chemistry U8 Review V2 Free and Paid eBooks
  - Modeling Chemistry U8 Review V2 Public Domain eBooks
  - Modeling Chemistry U8 Review V2 eBook Subscription Services
  - Modeling Chemistry U8 Review V2 Budget-Friendly Options
- 6. Navigating Modeling Chemistry U8 Review V2 eBook Formats
  - ePub, PDF, MOBI, and More
  - Modeling Chemistry U8 Review V2 Compatibility with Devices
  - Modeling Chemistry U8 Review V2 Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Modeling Chemistry U8 Review V2
  - Highlighting and Note-Taking Modeling Chemistry U8 Review V2
  - Interactive Elements Modeling Chemistry U8 Review V2
- 8. Staying Engaged with Modeling Chemistry U8 Review V2
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Modeling Chemistry U8 Review V2
- 9. Balancing eBooks and Physical Books Modeling Chemistry U8 Review V2
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Modeling Chemistry U8 Review V2
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Modeling Chemistry U8 Review V2
  - Setting Reading Goals Modeling Chemistry U8 Review V2
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Modeling Chemistry U8 Review V2
  - Fact-Checking eBook Content of Modeling Chemistry U8 Review V2
  - 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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