

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)
- 1st: Linear relationship (doubling conc. doubles rate)
- 2nd: 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.

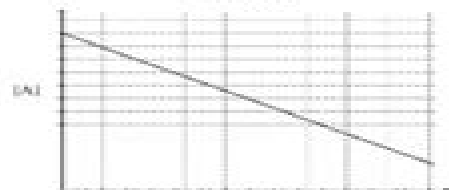
Ex: For a third order reaction, the following unit analysis applies.

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

Reaction Rate Graphing

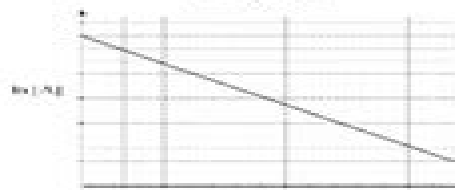
One of the most common ways to gather data for kinetics is through graphing the change in concentration of a reactant over time. Depending on the order of the reaction with respect to a given reactant, it requires a different mathematical function of concentration vs. time to create a straight line,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

0 Order



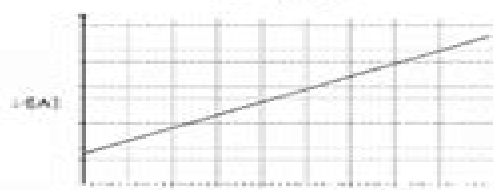
$$[A]_t = -kt + [A]_0$$

1st Order



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

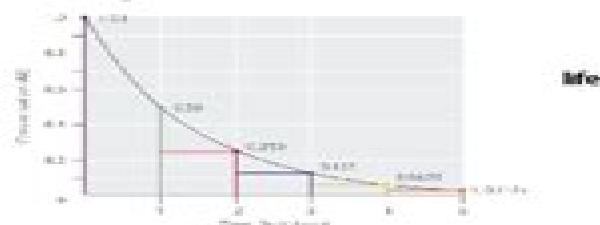
2nd Order



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

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 1st 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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