Rate Laws: A Summary Name_____Per____

Most chemical reactions are reversible, however, we will confine our study of reaction rates to conditions during which the reverse reaction can be neglected. We can neglect any influence of reverse reactions if we analyze rates soon after the reactants have been mixed, and before the products have had time to build up to significant levels. This will allow us to concern ourselves with the rate of a reaction, which will depend only on the concentrations of the reactants. The concentration vs time graph to the right represents three hypothetical reactions, zero order, first order, second order.

[conc] vs time 0th, 1st, 2nd order

- ◆ zero order
- ■ first order
- ▲ second order

rate = k [A]^n

This expression is called a rate law (more specifically the *differential* rate law). The proportionality constant, k is the rate constant, and n is the order of the reaction which must be determined experimentally. The order of the reaction cannot be determined from the balanced equation. The order of the reaction can be an integer (including zero) or a fraction. Most commonly we will consider zero, first, and second order reactions.

The differential rate law, rate = k [A]^n, demonstrates how the rate of a reaction is dependent on the concentration of the reactants.
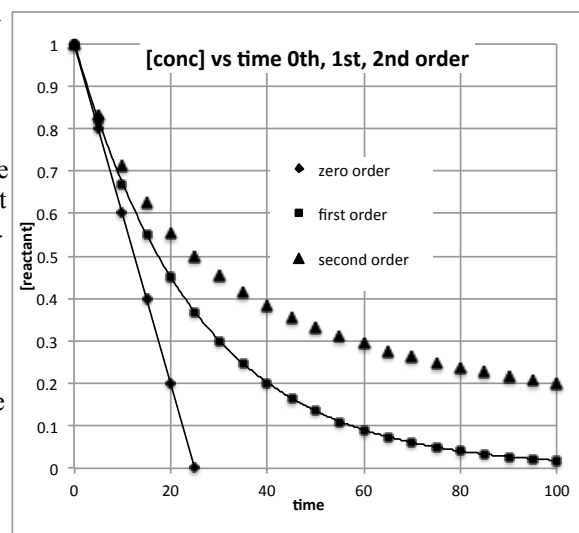
The differential rates laws can be integrated (that's calculus) which will result in equations that will express the concentration as a function of time.

Summary of Kinetics for a reaction A → products

	Zero order	First Order	Second Order
(Differential) rate law – shows the relationship between **concentration** and **rate**	$\text{Rate} = k$	$\text{Rate} = k[A]$	$\text{Rate} = k[A]^2$
units of k	$\dfrac{mol}{L \cdot time}$ or $\dfrac{M}{time}$ or $mol\ L^{-1}time^{-1}$	$\dfrac{1}{time}$ or $time^{-1}$	$\dfrac{L}{mol \cdot time}$ or $\dfrac{1}{M \cdot time}$ or $L\ mol^{-1}time^{-1}$
Integrated rate law – shows the relationship between **time** and **concentration**	$[A]_t = -kt + [A]_0$	$\ln[A]_t = -kt + \ln[A]_0$	$\dfrac{1}{[A]_t} = kt + \dfrac{1}{[A]_o}$
What plot will give a straight line?	$[A]_t$ vs *time*	$\ln[A]_t$ vs *time*	$\dfrac{1}{[A]_t}$ vs *time*
Graphs: slope, rate constant, y-intercept	y-intercept is $[A]_0$ — Slope = −k — $[A]_t$ vs time	y-intercept is $\ln[A]_0$ — Slope = −k — $\ln[A]_t$ vs time	y-intercept is $\dfrac{1}{[A]_0}$ — Slope = k — $\dfrac{1}{[A]_t}$ vs time
Half life	$t_{1/2} = \dfrac{[A]_o}{2k}$	$t_{1/2} = \dfrac{0.693}{k}$	$t_{1/2} = \dfrac{1}{k[A]_o}$