12.4.B - The Integrated Rate Law Part 2: Second- and Zero-Order

Order	Integrated Rate Law	½ Life
Zero	$[A]_t = kt + [A]_o$	$\frac{[A]_o}{2k} = t_{½}$
First	$\ln([A]_t) = -kt + \ln([A]_o)$	$t_{½} = \frac{0.693}{k}$
Second	$\frac{1}{[A]_t} = kt + \frac{1}{[A]_o}$	$\frac{1}{k[A]_o} = t_{½}$

Second-Order Integrated Rate Law

Starting with our fundamental definition of rate, then employing integration (with calculus), we get the second order rate law:

$$Rate = -\frac{\Delta[A]}{\Delta t} = k[A]^2$$

Integrating yields: $\frac{1}{[A]} = kt + \frac{1}{[A]_0}$

Possibly more concise form:

$$[A]^{-1} = kt + [A]_0^{-1}$$

Second-Order Check

How can we determine if a data set is second-order?

Similarly to the first-order rate law, plotting 1/[A] vs. time produces a linear graph, with a slope of *k*.

The half-life of a second-order reaction is:

$$t_{\frac{1}{2}} = \frac{1}{k[A]_0}$$

The goofy thing here is that half life depends on the initial concentration, as well as *k*. The upshot is that half-lives get *longer* as concentration diminishes.

Zero-Order Integrated Rate Law

Most single reactant reactions show either first or second-order kinetics.

A situation that results in a zero-order reaction is one where a catalytic metal surface or an enzyme with active areas is involved.

In such cases, if the reaction surface is completely occupied by reacting molecules, the presence of more molecules won't increase the production of products.

Zero-Order Math

A plot of concentration vs. time will produce a linear graph for zero-order reactions.

The rate law is: $Rate = k[A]^0 = k(1) = k$

Integrated Form: $[A] = -kt + [A]_0$

Half-life expression: $t_{\frac{1}{2}} = \frac{[A]_0}{2k}$

Homework

Read 12.5 in your Textbook

12.4.B Problems in your Booklet
Due Next Class