Kinetics

So many equations…so many units…

Summary of Kinetics Equations			
Order	Zero	First	Second
Rate Law	Rate = k	Rate = k[A]	Rate = $k[A]^2$
Integrated Rate Law *y = mx + b*	$[A] = -kt + [A]_0$	$\ln[A] = -kt + \ln[A]_0$	$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$
Plot needed to give a straight line *"Graph C, N, R"*	$[A]$ versus t	$\ln[A]$ versus t	$\frac{1}{[A]}$ versus t
Relationship of rate constant (k) to the slope of the straight line	Slope = -*k*	Slope = -*k*	Slope = *k*
Units on rate constant (k)	$\frac{M}{s} = Ms^{-1} = \frac{mol}{L \bullet s}$	$\frac{1}{s} = s^{-1}$	$\frac{1}{M \bullet s} = M^{-1}s^{-1} = \frac{L}{mol \bullet s}$
Half Life Equation *Use integrated law when solving other half life related problems*	$t_{1/2} = \frac{[A]_0}{2k}$	$t_{1/2} = \frac{0.693}{k}$	$t_{1/2} = \frac{1}{k\,[A]_0}$

Arrhenius Equation

$$k = Ae^{-Ea/RT}$$

k = rate constant
Ea = Activation Energy
T = Temperature
A = Frequency Factor
R = 8.31 J/mol•K

When Graphing…

Graph ln(k) versus $\frac{1}{T}$

$$\boldsymbol{ln(k) = \left(-\frac{E_a}{R}\right)\left(\frac{1}{T}\right) + ln\,(A)}$$

y = m x + b

Finding Units for k

Remember:

$$rate = k[A]^x[B]^y \; etc\ldots$$

Rearrange:

$$k = \frac{rate}{[A]^x[B]^y \; etc\ldots}$$

Remember:

$$rate\ units = \frac{M}{s}$$

$$Concentration\ unts = M$$

$$Overall\ Order = (x + y + etc\ldots)$$

Substitute in your units and rewrite:

$k = \frac{M/s}{M^{(x+y+etc\ldots)}}$ → $k = \frac{M}{M^{(x+y+etc\ldots)} \bullet s}$ → **then cancel out units**

Units for k based on overall order of reaction $k = \frac{M}{M^{(x+y+etc\ldots)} \bullet s}$		
Overall Order	**Example of Units Plugged In**	**Final Units for k**
0	$k = \frac{M}{M^{(0)} \bullet s} = \frac{M}{1 \bullet s}$	$\frac{M}{s} = Ms^{-1}$
1	$k = \frac{M}{M^{(1)} \bullet s} = \frac{\cancel{M}}{\cancel{M} \bullet s}$	$\frac{1}{s} = s^{-1}$
2	$k = \frac{M}{M^{(2)} \bullet s} = \frac{\cancel{M}}{\cancel{M} \bullet M \bullet s}$	$\frac{1}{M \bullet s} = M^{-1}s^{-1}$
3	$k = \frac{M}{M^{(3)} \bullet s} = \frac{\cancel{M}}{\cancel{M} \bullet M \bullet M \bullet s}$	$\frac{1}{M^2 \bullet s} = M^{-2}s^{-1}$
4	$k = \frac{M}{M^{(4)} \bullet s} = \frac{\cancel{M}}{\cancel{M} \bullet M \bullet M \bullet M \bullet s}$	$\frac{1}{M^3 \bullet s} = M^{-3}s^{-1}$
Etc…etc…etc…		

Remember: $M = \frac{mol}{L}$ $\quad \frac{1}{M} = M^{-1} = \frac{L}{mol}$

↑

You may see this substituted into k units.

For example: $M^{-1}s^{-1} = \frac{L}{mol \bullet s}$