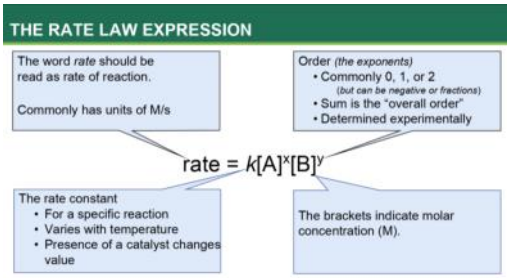
CH 117 - Kinetics Notes

Monday, August 31, 2020 1:22 PM

Kinetics

- Kinetics tells how quickly a reaction occurs, which equals the rate.
- Thermodynamics tells whether a reaction will occur or not.
- The order is determined experimentally; can't use the balanced equation to find the exponents.



Rate Law

- **Methods**

1. Initial Rate
   - Depends on initial concentration of reactants and products
   - Determine rate at beginning of reaction
2. Integrated Rate Law
   - Concentration vs. Time
   - Only study one reactant at a time

- **Order**

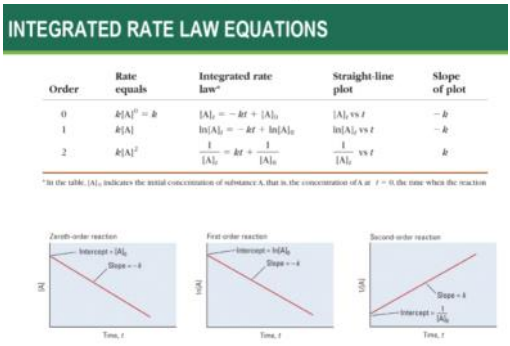
- Use units for rate constant (k)

  Zero order = M/s

  First order = s^{-1}

  Second order = $M^{-1}s^{-1}$

  Third order = $M^{-2}s^{-1}$



- **Steps**

1) Observe Data Table
2) Determine Order
3) Use Order to Get Integrated Rate Law

- **Examples**

4) Using the table below determine the rate law and calculate the rate constant.

Trial	[A]	[B]	Initial Rate
1	0.20M	0.20M	0.4 M/min
2	0.20M	0.40M	1.6 M/min
3	0.40M	0.20M	0.8 M/min

$rate = K[A][B]^2$

$1.6 = K[0.2][0.4]^2$

$1.6 = K(0.2)(1.6)$

$1.6 = K(0.32)$

$K = \frac{0.16}{0.32} = \frac{1}{2}\ M^{-2}s^{-1}$

3rd Order

To find order of each substance

1) Find A or B
2) Find trials that are the same for substance that we are not reviewing
3) Find how substance and initial rate changes (does it double, quadruple, etc?)
4) Set up and equation

2) Find the rate law expression for the following reaction, then solve for the rate constant (use appropriate units).

$$A + 2B \rightarrow AB_2$$

Experiment	[A] (M)	[B] (M)	Initial Rate (M/s)
1	.05	.13	2.2×10^{-4}
2	.06	.19	2.2×10^{-4}
3	.05	.26	8.7×10^{-4}
4	.12	.19	4.4×10^{-4}

1. Write out the rate law equation: rate = k $[A]^X[B]^Y$
2. Solve for the order of [A] by keeping the [B] constant or the same
   a. Pick trials 2 and 4 because the [B] is the same
   b. Since [A] goes up by a factor of $x2^x$ and the initial rate doubles x2
   c. Set the factors equal to each other so: $2^x = 2$ and solve for x which will be one
   d. So now, rate = k $[A]^1[B]^Y$ which is formally written as rate = k $[A][B]^Y$
3. Solve for the order of [B] by keeping the [A] constant or the same
   a. Pick trials 1 and 3 because the [A] is the same
   b. Since [B] goes up by a factor of $x2^Y$ and the initial rate quadruples x4
   c. Set the factors equal to each other so: $2^Y = 4$ and solve for Y which will be two
   d. So now, rate = k $[A]^1[B]^2$ which is formally written as **rate = k $[A][B]^2$**

Now we can plug and chug some numbers, so pick any trial (I will do trial 1)

$$2.2E\text{-}4\ M/s = k[0.05][0.13]^2$$

$$2.2E\text{-}4\ M/s = k\ [0.05]\ [0.0169]$$

$$\frac{2.2E{-}4\ M/s}{[0.05][0.0169]} = k$$

3) Find the units on the rate constant for the following rate law expression.

Rate = $k[A]^2[B]^2$

= 4th Order

2(Order of A) + 2(order of B)

Answer = $M^{-3}s^{-1}$