Reaction Kinetics

Reaction Kinetics deals with the rate of reactions.

What affects the rate of reactions:

1. Temperature
2. Catalyst
3. Particle Size
4. Concentration

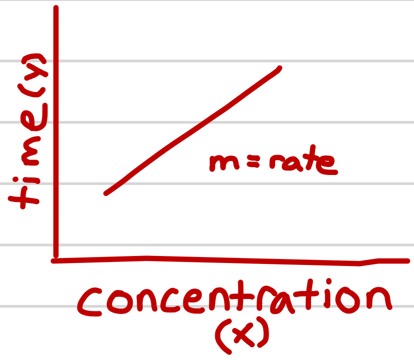
Kinetics

-How slow or fast a reaction occurs

Reaction Rate- the amount of time it takes for a reaction to occur. Although its official definition is an increase in molar concentration of a product of a reaction per unit time or a decrease in the molar concentration of a reactant per unit time.

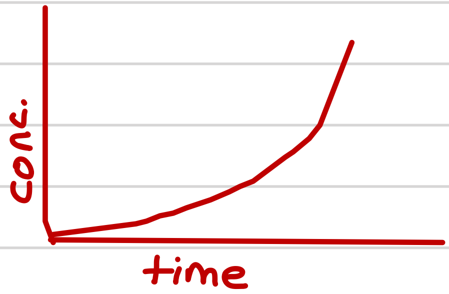
To determine the average rate of formation of something, we would measure that substances change in concentration vs. the change in time.

The slope of a Concentration Vs. Time graph yields the rate of a reaction.

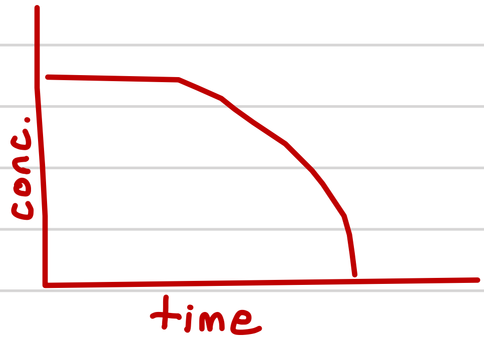


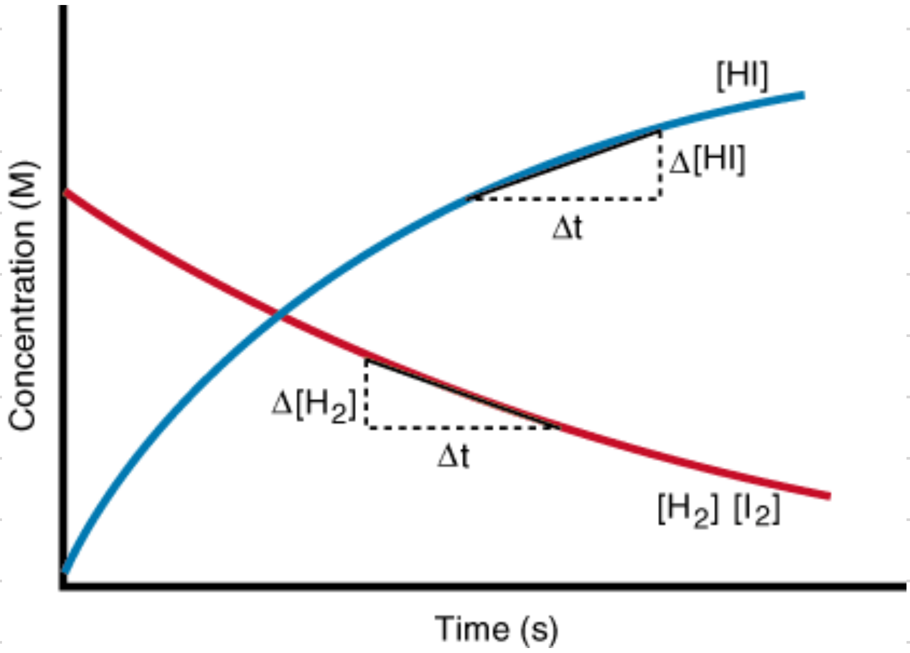
Tracking Reactants and Products

The concentration of a product should INCREASE over time. This is because as the reaction proceeds forward, more product is produced. The graph of a product is pictured below



The concentration of a reactant should DECREASE over time. This is because as the reaction proceeds forward, reactants are used up to form products, so the concentration decreases. The graph of a reactant is pictured below





Rate Laws

A rate law can be written for any equation. It relates the rate of a reaction to the concentration of reactants and a catalyst to various powers.

For example, take the following equation:

aA + bB --C--> dD + eE

Where A, B, D, and E are reactants/products, a, b, d, e are their coefficients, and C is a catalyst.

The rate law would be written as followed:

Rate = k [A]^m * [B]^n [C]^p

In the rate law, k is the rate constant that relates rate and concentration for that reaction. It is constant at fixed temperature but changes with temperature. Its unit is L / mols

m, n, and p are exponents that are experimentally determined and have nothing to do with the coefficients from the balanced chemical equation

When something is placed in brackets ([A], [B], etc.), this is shorthand for the concentration of. So [KI] is read as "the concentration of potassium iodide."

**Note that only the reactants are used when writing the rate law, not the products.

Exponents in a Rate Law

The exponents on the reactants are referred to as the reaction order:

An exponent of 1 is called first order
An exponent of 2 is called second order
An exponent of 3 is called third order

A reactant can have an order of 0, called the zeroth order. This means that it has no effect on the rate (think anything to the zeroth power is 1, and 1 times anything is itself). Zeroth order reactants aren't written in the rate law.

To find the overall order of a reaction, the order of each factor needs to be taken into account. Since reaction order is additive for reactants, simply adding the exponents of a rate law together gives you the overall order of a reaction.

Steps to Writing a Rate Law

1. Write the balanced chemical reaction:
   2 NO2 (g) --> 2 NO (g) + O2 (g)

2. Write a skeleton rate law:
   Rate = k[NO2]^x

3. Find the reaction order
   *to find the reaction order, compare 2 experiments where the concentration of the reactant is changed and compare this to the the change it has on the rate.
   *If more reactants are involved, two experiments must be chosen where ONLY the concentration of the reactant being tested is changed. All other concentrations must remain constant.

	Initial NO_2	Rate of O_2 formation
exp. 1	0.01 mol/L	7.1 E-5 mol/Ls
exp. 2	0.02 mol/L	28 E-5 mol/Ls

$$\frac{\text{Rate exp. 2}}{\text{Rate exp. 1}} = \left[\frac{NO_2 \text{ exp. 2}}{NO_2 \text{ exp. 1}}\right]^x \Rightarrow \frac{28E\text{-}5}{7.1E\text{-}5} = \left[\frac{0.2}{0.1}\right]^x \approx 4 = 2^x$$

$$x = 2$$

4. Now that the reaction order is found, it can be plugged in (rate = k[NO2]^2) and the constant k can be found. To find k, use the [NO2] and rate from any experiment and solve for k.

7.1E-5 = k[0.01]^2 ==> k = 0.71

5. Now, the finished rate law can be written:
   rate = 0.71[NO2]^2