Chemical Kinetics

Objective 1: Define "rate of reaction"

- The change in the concentration of a reactant or product per change in time
- Rate = $-\Delta$ [Reactants] / ΔT
- Rate = Δ [Product] / ΔT

Objective 2: Describe "collision theory"

- Reactions occur because reactant particles collide
- A collision only causes a reaction if:
    - The particles have appropriate orientation
    - The particles have adequate energy
- Greater energy causes greater velocity leading to:
    - More frequent collisions
    - More bonds break so rearrangement can occur

Objective 3: Describe the Kinetic Theory in terms of particles whose average KE is proportional to the Kelvin temperature.

- In any sample of particles, some have high KE, some have low KE, and everything in between. The higher the temp, the higher the average KE.
    - $KE = \frac{1}{2} mv^2$
    - As temp ↑, Avg ↑ for a given type of particle

Objective 4: Define activation energy (Ea)

- The minimum energy required for a reaction to begin, the height of the energy barrier to the energy to the energy barrier to the formation of products

Objective 5: Explain the qualitative effects of particle size, temperature, concentration, and pressure on reaction rate.

- Particle Size: the > the surface area of a solid, the > its reaction rate. There are more collisions per unit of time so crushed solids react faster than lumps.
- Temp: The higher the temp, the faster the reaction
    - Reasons:
        - (most important) at higher temps, a larger fraction of the molecules have KE > Ea
        - At higher temperatures, particles have higher velocities, so they collide more frequently and with more force (very important: include time)
- Concentration: The higher the # of reactant particles per volume, the higher # of collisions per time so reactions are typically faster at higher concentrations (there may be no affect, but it never slows down reaction rate)
- Pressure: In gaseous systems, higher P's cause higher rates (reason is same as Concentrations)

Objective 6: Explain how a catalyst works

- Catalysts provide an alternate reaction pathway with a lower Ea
- A catalyst increases rate in both directions for reversible systems

Objective 7: Sketch and explain the Maxwell-Boltzmann energy distribution curve for a fixed mass of gas @ different temps

- See paper

Objective 8: Add the effects of a catalyst to the M-Bm Curve

- See paper

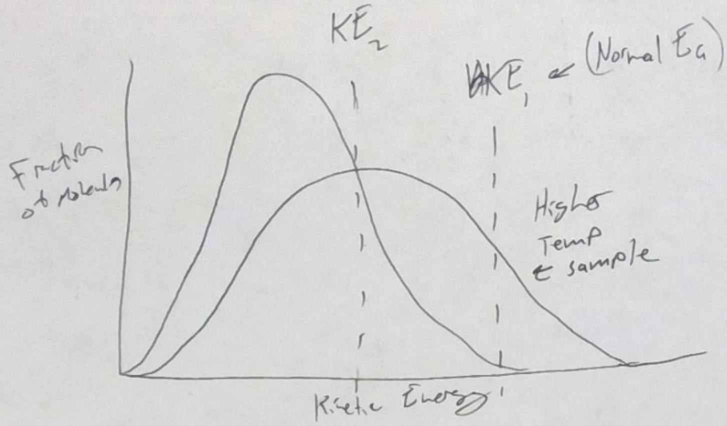
Objective 9: Describe suitable procedures for measuring rates of reaction

1. If the reaction mixture contains mobile ions that change concentration during the reaction (gas or solid) electrical conductivity can be monitored over time (CBMOT)
2. The mass of a product or reactant other than a gas CBMOT
3. The pressure or volume of a gaseous product CBMOT
4. If colored solutions are involved, the absorption or transmission of light by the solution CBMOT
5. If a gas with heavy molar mass is produced, (not H_2) the change in the mass of an open container CBMOT
6. Titrations can be used to monitor concentrations as a reaction proceeds. However the time needed for the titration must be small relative to the time for the reaction to go to completion. Sometimes a reaction can be "quenched" at specific times so the concentration of a reactant can be determined

Objective 10: Draw enthalpy for reactions that are catalyzed and uncatalyzed on same diagram

- See paper

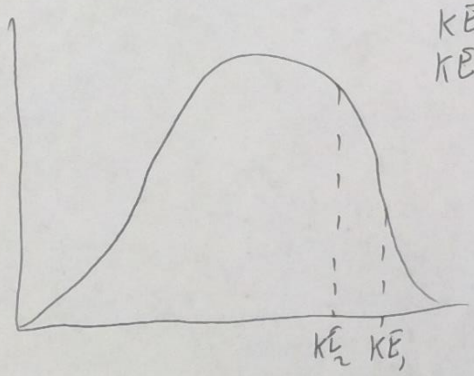
Obj 7:



KE_2 is the catalyst & for it to be minimum, it has to be lower

☆ Area under curves is the same

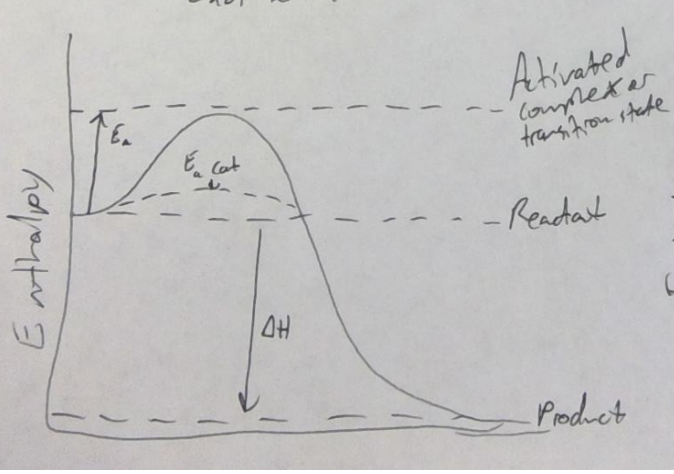
Obj 8:



KE_1 = Normal Activation Energy
KE_2 = catalyzed Activation Energy

Obj 10

Exothermic



Endothermic