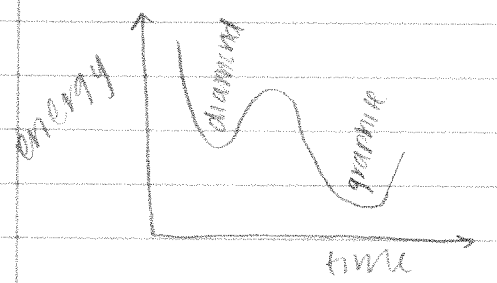
[CLASS NOTES] 2/15

CHEMICAL KINETICS

Diamonds are forever?

- structure of graphite is more stable than diamond, so diamond should decompose
- happens very slowly
- must gain energy to turn to graphite



slow reaction
→ metastable: decomposition is slow

☆ Kinetics = study of rates

- Kinetics can be used to predict whether a rxn occurs on a reasonable time scale
- How long until EQ
- used to understand how a rxn proceeds from reactants to products so that we can better harness useful reactions

$H_2O_2(l) \rightarrow O_2(g) + 2H_2O(l)$ slow reaction

hydrogen peroxide

+ catalyst FAST

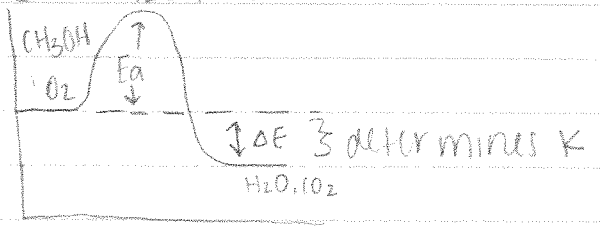
Kinetics vs EQ

- where EQ lies is determined by whether products are downhill/uphill in energy relative to reactants
- all reactions have an uphill barrier to "get ball rolling." small barrier, fast reaction

k = rate constant

- ΔE is the energy difference for products & reactants
  → determines K, the EQ constant

$2CH_3OH + 3O_2 \rightleftharpoons 4H_2O + 2O_2$



- Ea is the energy barrier for reactants to products
  → determines k

$\text{rate} = \frac{\text{distance}}{\text{time}} = \frac{75 \text{ miles}}{1.25 \text{ hrs}} = 60 \text{ mph}$ ← average rate

For a chemical rxn, $\text{rate} = \frac{\text{concentration}}{\text{time}}$

Reaction rate
- change in concentration over a time period
- types of rates
  → average rate
  → instantaneous rate
  → initial rate

☆ rates are always positive

$A \rightarrow B$

initial rates are early in the rxn before B builds up. Ignore $B \rightarrow A$

$A(g) \rightarrow B(g)$ AVERAGE RATES

$\text{rate} = \frac{-\Delta[A]}{\Delta t} = \frac{+\Delta[B]}{\Delta t}$ Δ = final - inital

t = 0s	t = 40s
1 mol A	0.3 mol A
0 mol B	0.7 mol B

$\text{rate} = \frac{0.70 \text{ mol B} - 0 \text{ mol A}}{40 \text{ s}} = 0.18 \text{ mol/s}$

Instantaneous rate
- plot of concentration vs time allows determination of instantaneous rate
- absolute value of the slope of the tangent line @ any point gives instantaneous rate

General case

$aA + bB \rightarrow cC + dD$

$$\text{rate} = \frac{-1}{a}\frac{\Delta[A]}{\Delta t} = \frac{-1}{b}\frac{\Delta[B]}{\Delta t} = \frac{+1}{c}\frac{\Delta[C]}{\Delta t} = \frac{+1}{d}\frac{\Delta[D]}{\Delta t}$$

Ex) $2NO_2(g) \rightarrow 2NO(g) + O_2(g)$

$$\text{rate} = \frac{-1}{2}\frac{\Delta[NO_2]}{\Delta t} \qquad \text{rate} = \frac{+1}{2}\frac{\Delta[NO]}{\Delta t} \qquad \text{rate} = \frac{+\Delta[O_2]}{\Delta t}$$