

Final Exam Review

Chapter 11

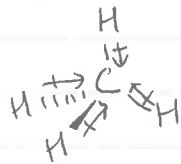
① Polarity (Ch 10)

- bond polarity

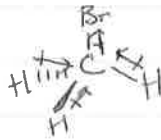
- A bond between 2 atoms is polar if ~~they~~ ^{the atoms} have different electronegativities \rightarrow F \uparrow EN Trend

- molecular polarity

- A molecule is polar if it has ^{unequal} polar bonds + is asymmetrical



polar bonds, all identical
but symmetric bonds + shape
NONPOLAR



\uparrow net

Polar bonds, different.
symmetric shape, but bond polarity
is unequal.

Determine if a molecule is polar:

- ① Draw VSEPR Prediction
- ② Determine ~~each~~ Polarity of each bond
- ③ Determine net Polarity (shape, bonds equal?)

② Intermolecular Forces

1. Hydrogen Bonds - very polar molecules OH, NH, FH
2. Dipole-Dipole - polar
3. LDF - non polar (induced dipole (peer-pressure))

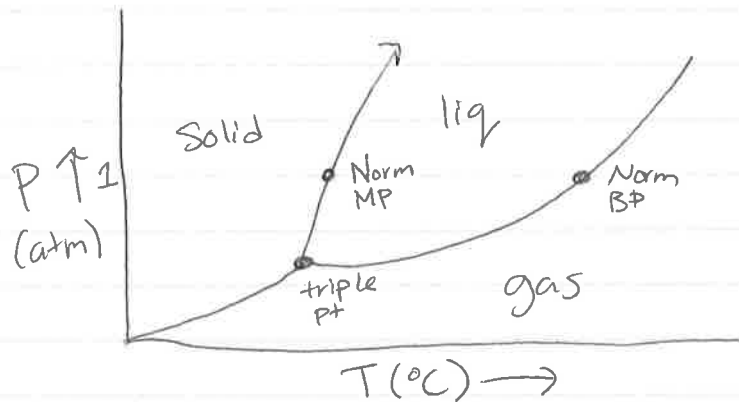
4. Ion-Dipole - solutions (dissolving), strongest

* use IMF to explain BP's ... viscosity, vapor pressure, surface tension

\uparrow \uparrow \uparrow \uparrow

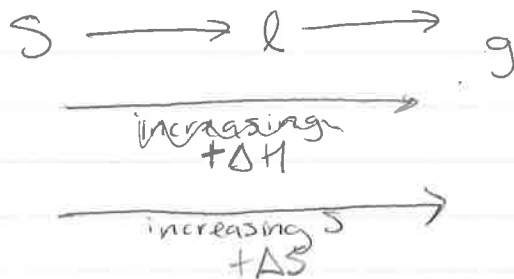
$\text{Clausius-Clapeyron} \rightarrow \ln P_{\text{vap}} = \frac{-\Delta H_{\text{vap}}}{RT} + \ln B$

③ Phase Diagrams



④ Phase changes

- Kinetic E vs. IMF
- Boiling Pt / Evaporation / Vapor P
- Thermodynamics
 - ΔG process is spont. for that p & T
 - $\Delta G = 0$ @ phase boundary



$$\Delta G = 0 = \Delta H - T\Delta S \leftarrow \text{true at phase change}$$

* calc T_b or T_f

- Heating Curves

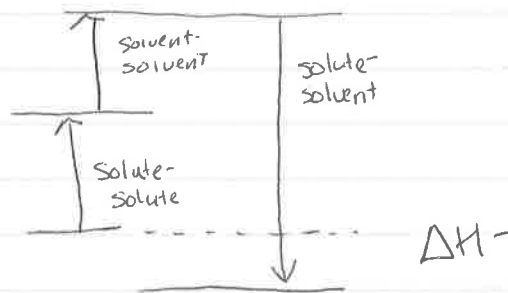
Don't worry about solids

Chapter 12

① Sol'n Thermo

- ΔS usually positive because molec. randomness increases when solute dissolves.
- ΔH

Sign depends on magnitudes of these \rightarrow



"like dissolves like"

$\Delta G \rightarrow$ soluble

* Doesn't tell you how much will dissolve*

② Factors that affect solubility

- Temp s in $l \uparrow T, \uparrow$ solubility (usually)
- g in $l \uparrow T, \downarrow$ solubility

- Pressure only affects g in l
solubility \uparrow as Part. P \uparrow

③ Units!

- Be able to convert!
- M, m, X, Mass%,

④ Colligative Properties \leftarrow Don't worry about NON-Ideal!

- FPD / BPE (van't Hoff) if $Ca(NO_3)_2$, 3 particles
- Vap Pressure raising / lowering

Rault's law $P_{soln} = P_{solu} \times X_{solu}$ \leftarrow if solid added
for $l-l$ mixtures: $P_{Tot} = P_A X_A + P_B X_B$
(mix of 2 volatile substances)

Chapter 13

Kinetics



① Rates

$$\text{Rate}_i = \frac{\Delta[A]}{\Delta t} \text{ concentration change of } i \leftarrow \text{specific to each R or P}$$

$$\text{Overall Rate} = \frac{\text{Rate}_i}{\text{coeff}_i} \quad * \text{ Always } +$$

$$\text{Rate} = \frac{-1}{a} \frac{\Delta[A]}{\Delta t}$$

* Mult by coeff to get specific rate

Average Rate: Must be calculated over the same time interval

Instant. Rate: Tangent to the curve (calculus)

Initial Rate: Inst. Rate @ $t=0$

② Rate Law



$$\text{Rate} = k[A]^x[B]^y$$

↑ ↑
NOT COEFF.

• RXN order

- WRT each species.

- Overall order: add up exponents

• 0th order: Rate is independent of $[A]$

• 1st order: Rate is proportional to $[A]$
 $[A] \times 2, \text{ Rate} \times 2$

• 2nd order: Rate goes as $[A]^2$
 $[A] \times 2, \text{ Rate} \times 4$

• Units

$$\text{Rate: } \frac{M}{s}$$

k: changes w/ order

③ Integrated Rate Laws [] + time relationship
 $A \rightarrow \text{Products}$

* like Lab, if $A + B$, you flood system w/ B, and the eqns only depend on A.

• Zeroth Order

$$[A] = -kT + [A]_0$$

• 1st order

$$\ln[A] = -kT + \ln[A]_0$$

• 2nd order

$$\frac{1}{[A]} = kT + \frac{1}{[A]_0}$$

④ Determine order

① Method of Initial Rates

② Graph IRL

} Very Important!

⑤ Half-life

$$[A]_{t_{1/2}} = \frac{[A]_0}{2}$$

$$\frac{[A]_{t_{1/2}}}{[A]_0} = \frac{1}{2}$$

• Zeroth order

$$t_{1/2} = \frac{[A]_0}{2k}$$

• 1st order

$$t_{1/2} = \ln 2 / k \leftarrow \text{constant interval}$$

• 2nd order

$$t_{1/2} = \frac{1}{k[A]_0}$$

you must calc new $t_{1/2}$ at each half-life for 0th + 2nd order

⑥ T-dependence of Rate

• collision theory

① enough E to get over E_a

$$-E_a/R$$

② correct orientation

$$\downarrow m \left(\frac{1}{T} \right)$$

$$k = A e^{-E_a/RT}$$

steric factor with enough E

$$y = b$$

$$\ln k = \ln A - \frac{E_a}{RT}$$

⑧ Mechanisms

- slow step rate law should be same as overall form
 - I won't ask you to algebraically go from slow step to overall using fast equilibrium trick.
- Mechanism steps add up to overall stoic

⑦ Catalysts

- Lowers E_a / \uparrow Rate of Rxn
- Does NOT Alter equilibrium $[]$, just gets you to eq faster.

Chapter 14

Equilibrium $\xrightleftharpoons[k_{-1}]{k_1}$ @ eq, $\text{Rate}_f = \text{Rate}_r$



① Eq Constant

$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

$$K_p = \frac{P_c^c P_d^d}{P_A^a P_B^b}$$

large K - prod. favored, ΔG^- 10^{-3}

small K - react. favored, ΔG^+ 10^{-3}

- Pure solids + l are left out of K expression.
only (aq) + (g)

$$K_p = K_c (RT)^{\Delta n} \leftarrow \text{moles gas } p-r$$

② RXN Quotient Q

$Q > K$, shift to reactants

$Q = K$, equilibrium

$Q < K$, shift to products

③ LeChat Principle - shift in direction

• Stresses

① Temp

② Pressure / Volume

③ $[]$ of R or P

that reduces stress on system

* Add solid, No shift

* Add inert gas / No shift

④ Calc Eq []'s

- ICE chart
- Approximations
 - check validity
 - $K < 10^{-3}$

* x is much smaller than $[]_i$

5% rule: $\frac{x}{[]_i} \times 100\% \leq 5.0\%$

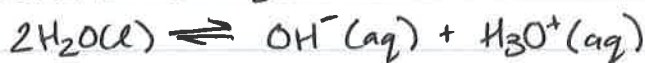
* I won't ask you to calc w/out approx if powers $> x^2$... no cubics or \uparrow

Chapter 15 Acid/Base

① Def'n

- Arrhenius
- Brønsted-Lowry
 - Acid: proton donor
 - Acid: e^- pair acceptor

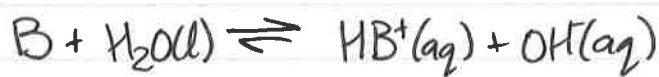
② Dissociation of H_2O



$$K_w = [OH^-][H_3O^+] = 10^{-14}$$

$$pH \text{ of pure } H_2O = 7 \quad [H_3O^+] = [OH^-] = 10^{-7}$$

$$pH = -\log[H_3O^+] \quad pH + pOH = 14$$
$$pOH = -\log[OH^-]$$



$$K_b = \frac{10^{-14}}{K_a}$$

↓ ↑
of K_a of HB^+
B

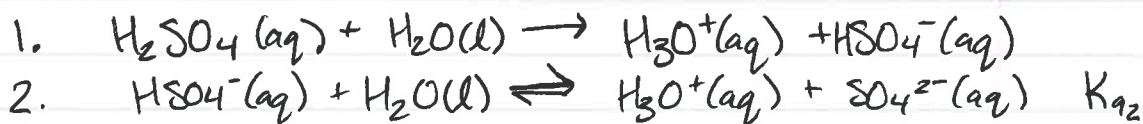
④ pH of Mixtures of Acids

- SA + WA diss SA first, ... carry H_3O^+ into WA dissociation
- WA + WA Stronger Acid 1st, then carry into weaker acid.

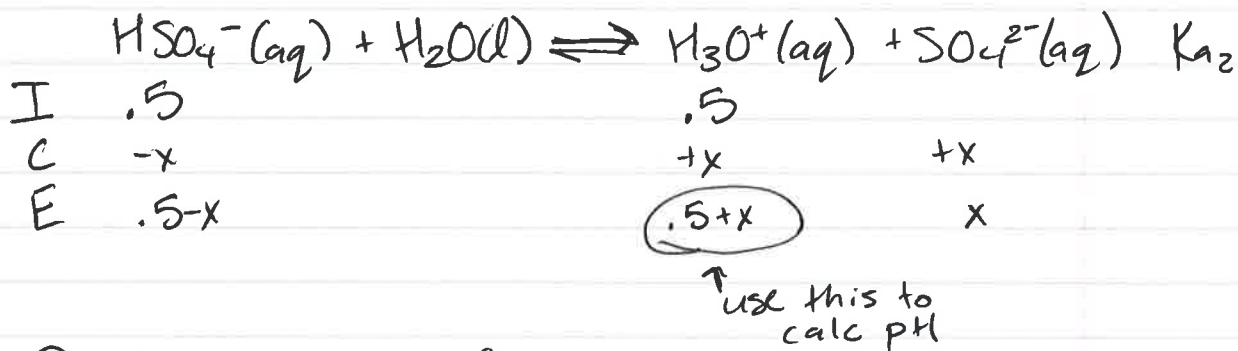
⑤

Polyprotic acids (mixtures of acids)

- WA: use 1st dissociation + K_{a1} to calc $[H_3O^+]$ + pH
- SA: Assume 1st proton comes off completely use K_{a2} to calc pH



if .5M H_2SO_4 , $[H_3O^+]_i = [HSO_4^-]_i = .5M$



⑤ A/B properties of salts

- Salts completely dissociate in H_2O
- Is cation an acid? K_a yes, if from WB
- Is anion a base? K_b yes if CB from WA

~~Chapter 14~~

~~Neutralization~~
~~be able to write steps + final rxn for all~~
~~combs of SA S/W A/B (4)~~

Chapter 16

① Common Ion Effect (Le Chat)

- solubility (K_{sp})
- buffers

② Buffers

- ID what is or isn't a buffer

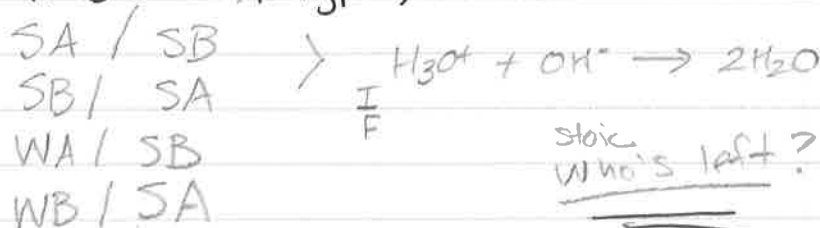
~~NEED~~ NEED WA + CB

one or the other is just a WB/WA problem

$$pH = pK_a + \log \frac{[CB]}{[A]}$$

③ Titrations

- Use neutralization RXNS to help
- Practice this! (4 types)



Chapter 8 / 16

Thermodynamics

① Spontaneous

- Proceeds without external input
- Always proceeds toward equilibrium
- $\Delta G = \Delta H - T\Delta S$
- $\Delta S_{\text{tot}} = \Delta S_{\text{sys}} + \Delta S_{\text{surround}}$ (2nd Law)
 ↑ $-\Delta H/T$

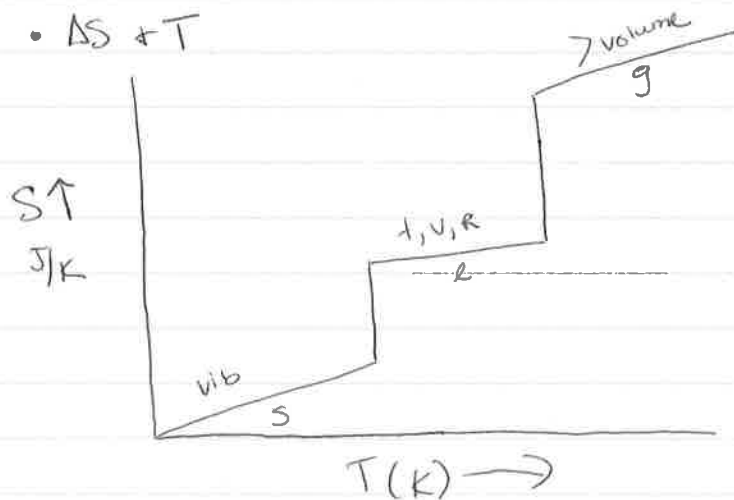
② ΔS_{rxn}

• Positive if:

- ① convert moles $s \rightarrow l, l \rightarrow g$
- ② increases # mol gas
- ③ dissolve an ionic salt w/ $+1/-1$ ions
- ④ dissolve molecular cmpds

• for dissolving

- ① Disrupting crystal $\Delta S \uparrow$
- ② Hydrating ions $\Delta S \downarrow$
- ③ Total is $\Delta S \uparrow$ for ± 1 ions, $\Delta S \downarrow$ for higher ions



③ $S^\circ, \Delta H_f^\circ, \Delta G_f^\circ$

- All 3: P-R

- $\Delta H_f^\circ + \Delta G_f^\circ = 0$ for elements in standard states

④ ΔG

- A rewrite of the 2nd Law

- $\Delta S_{tot} +, \Delta G -$ for spontaneous

- $\Delta G = \Delta H - T\Delta S$

ΔS	ΔH	Spont?
+ -	+	NEVER
+	-	ALWAYS
- -	-	When ΔH outweighs $T\Delta S$, $\downarrow T$
+	+	When $T\Delta S$ outweighs ΔS , $\uparrow T$

- If not at ^{Standard} ~~Eq~~ state:

$$\Delta G = \Delta G^\circ + RT \ln Q$$

$$\uparrow = K @ eq$$

At eq, $K=Q, \Delta G=0$

$$0 = \Delta G^\circ + RT \ln K$$

$$\Delta G^\circ = -RT \ln K$$

ΔG	$\ln K$	K	
-	+	> 1	"Product favored"
+	-	< 1	"reactant favored"
0	0	$= 1$	

Chapter 18

- ① Assign ox numbers
- ② Be able to determine ox/red, oxidizing/reducing agents
- ③ Balance Redox in acid or base
- ④ Voltaic cells
 - draw them
 - calc E_{cell}° , spontaneous?
 - calc E_{cell}° from K or ΔG
 - use E_{cell} + E_{cell}° to calc Q