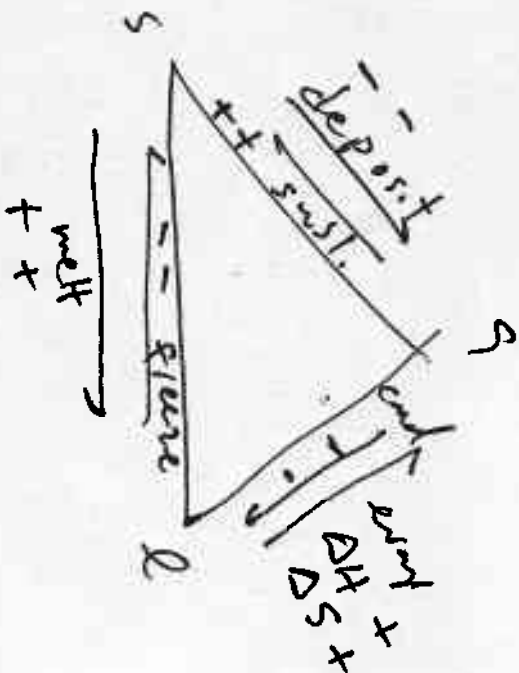


1 temperature dependence of phase changes

$$\Delta G = 0 = \Delta H - T \Delta S$$



2 vapor pressure theory - surface phenomenon

defined Raoult's Law $P = P_0 X$

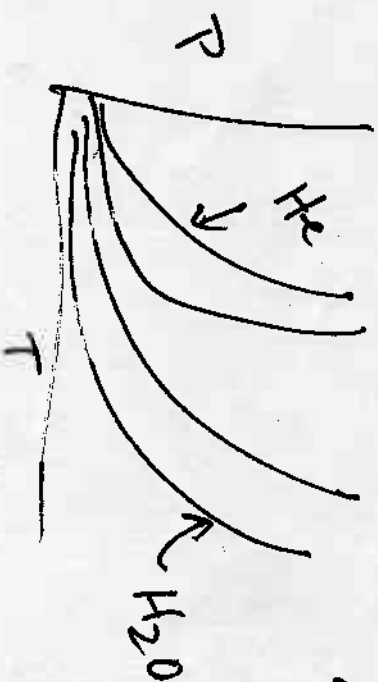
you can create a T dependence Δ vapor pressure

called Cl. Cl. equation $\ln \frac{P_2}{P_1} = \frac{\Delta H}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$

suggests an

exp. of sym. of v.p. vs T

note that ΔH is related to ΔG in very interesting way.



3 salt dissociation in water

Part of lecture on solubility
 # 7 + 8 are from same lecture

Follows the idea that like dissolves like
 H_2O is very polar, large dipole - hydrophilic salts are very polar & have large dipole dipole when salt goes in water

When salt goes in water

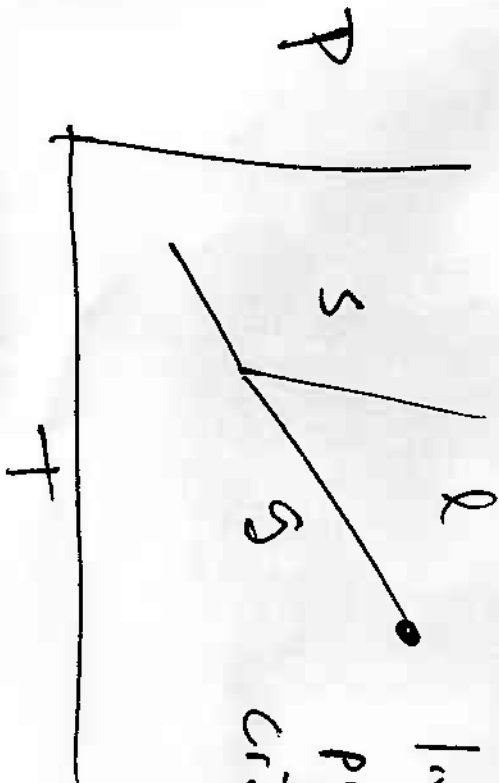
ΔH_{soln} is negative
 hydrophilic crystals together

ΔH_{soln} is positive and
 hydrophobic crystals together

ΔH_{soln} is typically small and positive
 complete and make
 $NaCl$ \uparrow or \downarrow CaO

4 phase diagram interpretation

I want you to know all the phases of a phase diagram



lines $\equiv \Delta G = 0 \equiv$ equilibrium (see #1)

point \equiv triple point \equiv S, L, S exist simultaneously

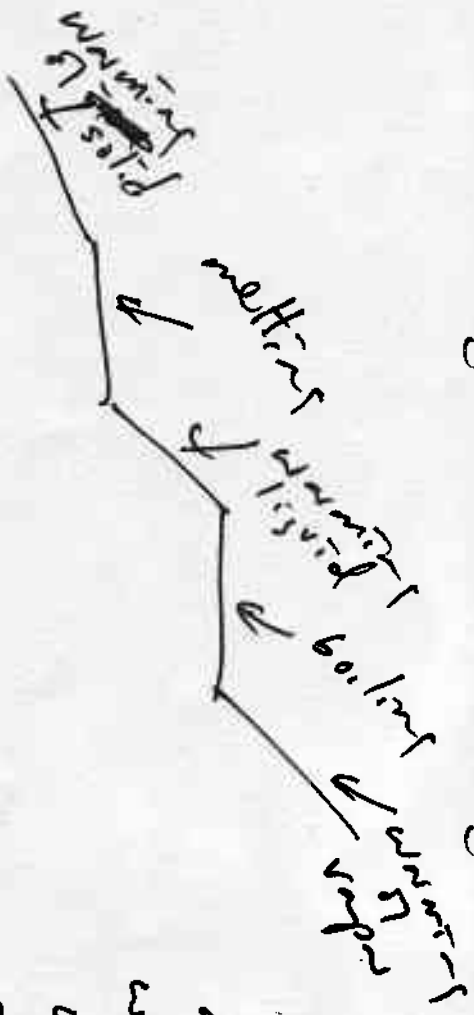
Critical point \equiv value of T, P correspond to the saturation temperature

fluids which have properties between S & L, Be able to identify all the variables of phase diagrams

5 phase diagram navigation

a phase diagram with P_1 and T_1 . I will get you started on send you on a trip. you tell me where you end up and what happens along the way.

6 calculating ΔH from heating across phases transitions



I will start you at one T and end you at another. Along the way you will go through up to 5 changes. you will calculate ΔH at each T

Then.
You have seen this plenty.

7 gas solubility in liquids

gases themselves for several reasons:

1. react like $CO_2 \xrightarrow{H_2O} H_2CO_3$ $HCl \xrightarrow{H_2O} H_3O^+$
2. like themselves like H_2O H_2O
3. Many are dinky + don't bother
 polar liquids like H_2O
 so small amounts N
 He, H_2, O_2 so into H_2O

B_7 TR_2 $w_{0.1}$

gas \rightarrow gas (as)
 so $w_{0.1}$ TR_2 $w_{0.1}$
 exo TR_2 $w_{0.1}$
 Le Chatelier $T \uparrow$,
 so $w_{0.1}$
 some reacts solvent
 gas and fish die

8 ranking miscibility of liquids

like themselves like so alcohol in H_2O
 plus themselves plus like gas into H_2O
 naphtha themselves naphtha like gas into H_2O
 and for the famous in between case



TR_2 $w_{0.1}$ TR_2
 TR_2 $w_{0.1}$ TR_2
 $-OH$ $w_{0.1}$ TR_2
 relative solubility

9 calculating vapor pressure in binary system

Application of Raoult's Law to two components in solution

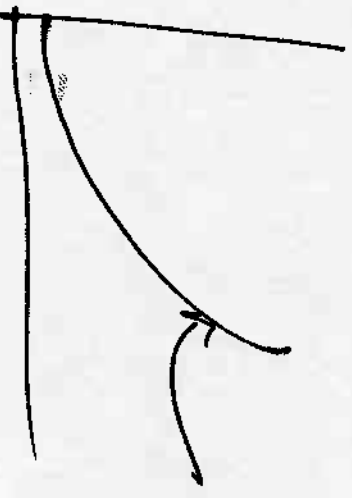
$$P_A = P_A^0 X_A \quad P_B = P_B^0 X_B$$

$$P_{TOT} = P_A + P_B$$

This was our first significant equation.

10 Clausius Clapeyron equation

Application of vapor pressure checks



$$\ln \frac{P_2}{P_1} = \frac{\Delta H}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

make sure
 Clausius part same
 plus +
 minus -
 simple plus +
 minus -
 occurs
 at 760 Torr = 5.P.

11 van't Hoff equation

Answer plus + chngs. you just this for
quit 2. If is
just like. Cl. Cl. eqn.
Do it again.

$$\ln \frac{K_2}{K_1} = \frac{\Delta H}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

12 colligative property application

I have mentioned several colligative property uses

1. cooling radiators - Raoult's Law
2. reducing freezing point - melt ice roads
3. raising boiling point - cook spaghetti faster
4. osmotic pressure change - killing fish, cells lyse

13 colligative property calculation

$$\Delta P = i P^0 X \leftarrow \text{Raoult's Law}$$

$$\Delta T_f = i K_{fm} \quad \left\{ \begin{array}{l} \text{b.p., f.p. change} \\ \text{make } \eta_m \text{ calculate} \end{array} \right.$$

$$\Delta T_b = i K_{bm}$$

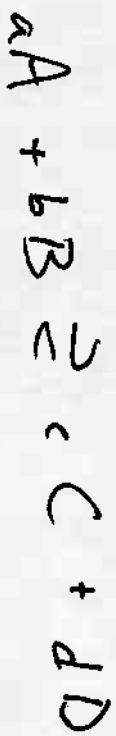
$$\Pi = i M R T \quad \text{osmotic pressure.}$$

1. remember i
2. I will likely

make η_m calculate
 X, M, m

14 setting up K from equilibrium expression

This η_m are going to find the test anyway, so don't bother. If η_m can't do



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

remember that

η + a η you keep
 η + s η_m set to activity $\eta = 1$

15 appreciating the magnitudes of K

K is related through $\Delta G = -RT \ln K$ to

whether a rxn happens.

1. That \ln function blows up K to very large exponents
2. $\Delta G > 0 \rightarrow K < 1$ $\Delta G < 0 \rightarrow K > 1$
3. reactions that happen ^(90% complete) K 's like 10^{20} or 10^{50}
4. reactions that don't happen have K 's like 10^{-14} or 10^{-50}
↑ oh, water doesn't dissociate

16 calculating equilibrium concentrations from K

you have to use the RICE set up for a problem not involving acids or bases. K values are usually -100 to $+100$ and no approx. are possible.

So just crank it out.

1. Write down the K equation
2. Write down the RICE array
3. Stick in the starting amounts
4. Let x equal the thing you want to know at equil.
5. do some stoch. to set every thing to x
6. Find the equil. $[]$ in terms of x
7. stick into equil. equation + solve.

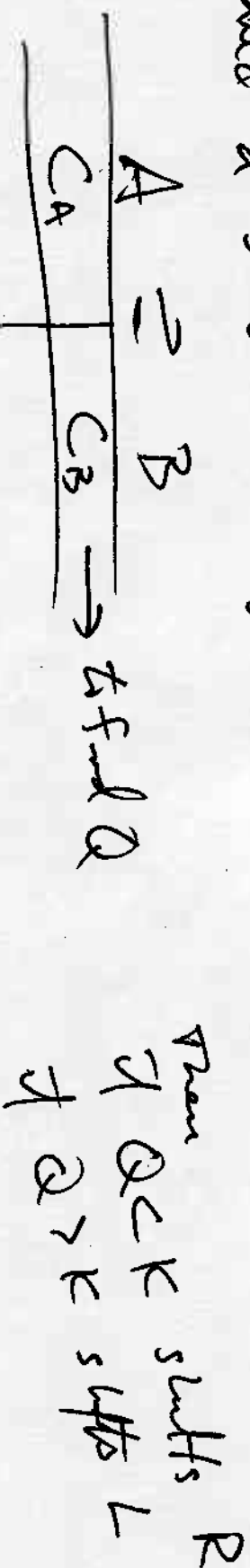
17 calculating equilibrium concentrations from K

Do it again

no $Q > K$ has to be substituted unless
back substitution is possible.

18 determining reaction direction from Q and K

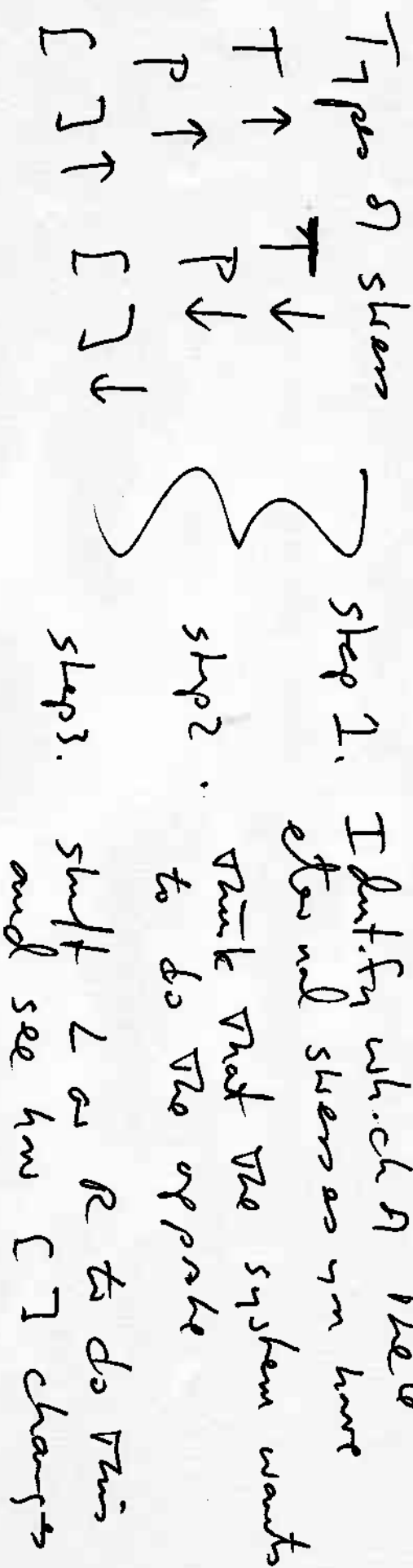
I will give a bunch of concentrations at start
and a bunch at equilibrium



From $Q < K$ shifts R
 $Q > K$ shifts L

19 LeChatelier and reaction direction

Reactions can only go \rightarrow or \leftarrow . So do this to respond to external stress.



20 LeChatelier and reaction direction

do it as you

21 relationship of ΔG to K

$$\Delta G = -RT \ln K. \quad \text{simple plus + ch.f.}$$

To make it harder we mix it.

1. Ask you to find ΔG from $\Delta H - T\Delta S$ or ΔG_f
2. ask you to find a $[C]$ in K

22 theory of auto-protolysis of water

$$\text{at } 25^\circ \quad K_w = 10^{-14} = [H^+][OH^-]$$

and $pH = pOH = 7$ because neutrality means $[H^+] = [OH^-]$
always have same $[H^+]$ as $[OH^-]$

~~Review the above~~

so for small number in react
doesn't react
fall out
itself
50

23. temperature dependence of K_w

at 25°C $K_w = 10^{-14}$

but add some energy ($T \uparrow$) then

$\text{H}_2\text{O} \rightarrow \text{H}^+ + \text{OH}^-$ can happen more.

which means that K_w is larger and $\text{H}^+ + \text{OH}^-$ are larger so $\text{pH} = \text{pOH} < 7$ as $T \uparrow$

and opposite is true at low T

$K_w \downarrow$ so $\text{H}^+ + \text{OH}^- \downarrow$ so $\text{pH} = \text{pOH} > 7$

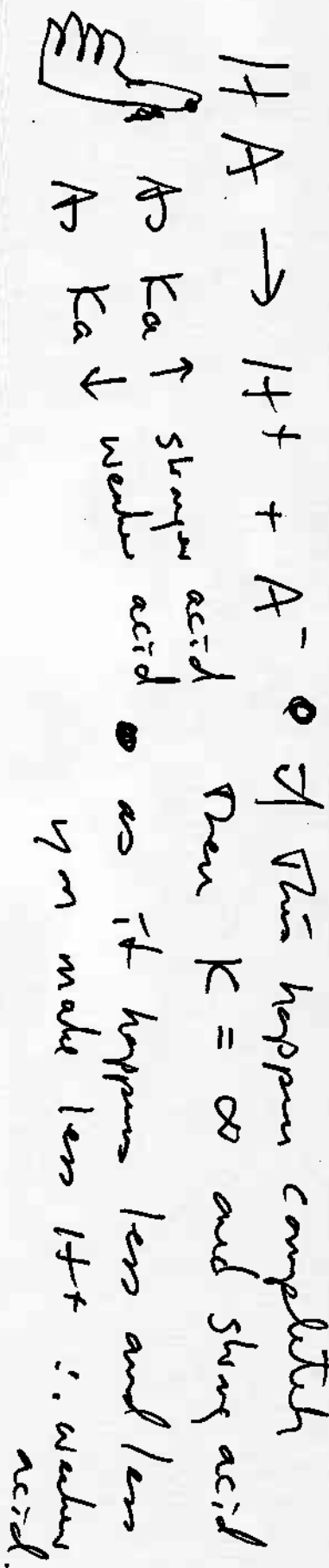
24. converting between pH, pOH, $[\text{H}^+]$ and $[\text{OH}^-]$

at 25°C } Because $K_w = [\text{H}^+][\text{OH}^-] \approx 10^{-14}$ gm $-\log \equiv p$ everything

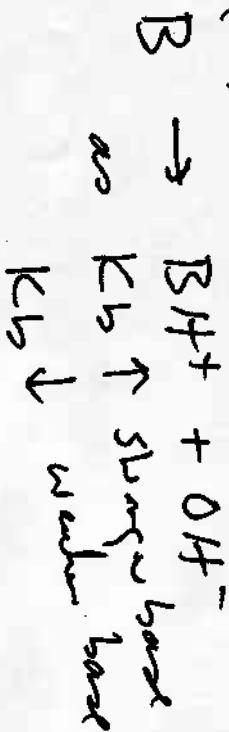
$$\text{p}K_w = 14 = \text{pH} + \text{pOH}$$

so I can give you a pH or pOH or $[\text{H}^+]$ or $[\text{OH}^-]$ and you can solve for any of the others

25. ranking acidity and basicity based on equilibrium constants



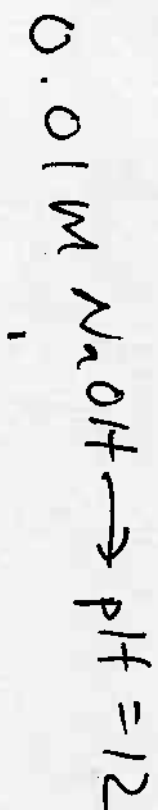
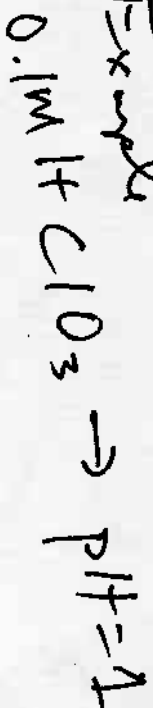
Same for bases



26. strong acid or base calculation

- know your strong acids + bases
- $K \approx \infty$ so what ever goes in as concentration becomes the $[H^+]$ or $[OH^-]$

Example



Example	K_a	strongest
$HA \rightleftharpoons H^+ + A^-$	10^{-2}	\leftarrow
$HB \rightleftharpoons H^+ + B^-$	10^{-6}	
$HC \rightleftharpoons H^+ + C^-$	10^{-9}	weakest

27. weak acid or base calculation

But if K_a or K_b are in range 10^{-4} to 10^{-10}

Now you have a weak acid or base.

$$[H^+] = \left(K_a C_a \right)^{1/2} \quad \left\{ \begin{array}{l} \text{These assume approximation in} \\ \text{RICE} \end{array} \right.$$

$$[OH^-] = \left(K_b C_b \right)^{1/2} \quad \left\{ \begin{array}{l} \text{These assume approximation in} \\ \text{RICE} \end{array} \right.$$

$$K = \frac{x^2}{C-x} \quad \leftarrow \text{is really small so you can ignore } x \text{ and get}$$

28 weak acid or base calculation

do it again. These are weak acids & bases. If you have K_a or K_b in range 10^{-4} to 10^{-10} you can use RICE. Hint: see you have weak acid or base.

Hint. If you have K_a or K_b in range 10^{-4} to 10^{-10} you can use RICE. Hint: see you have weak acid or base.

