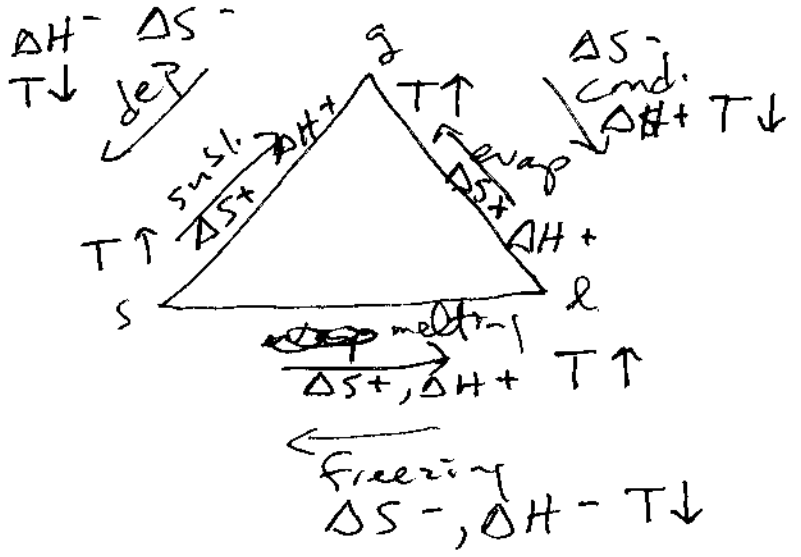
Final Exam: Questions 1 - 19

① T dependence of physical equilibria (phase changes)



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

← apply this set of ideas to a phase change

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② dissolving solids

this will be specifically salt into water

There are two ΔH values in competition

$\Delta H_{soln} = CL\ energy + \Delta H_{Hyd}$

- ΔH_{soln} = endo or exo is a result of two competing ΔH values
- CL energy = energy in a salt crystal / Ionic bonds
- ΔH_{Hyd} = energy that water needs to overcome C.L.

For example $\Delta H_{CaO} >> \Delta H_{Hyd}$ NaCl ←

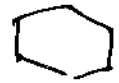
- ΔH_{soln} is small usually because C.L. ≈ ΔH_{Hyd}
- ΔS_{diss} is always +
- charge density determines size of C.L + ΔH_{Hyd}

(3) miscibility: like dissolves like

so compare

polar	vs	nonpolar
$\Sigma \Delta EN \neq 0$		$\Sigma \Delta EN = 0$
like H_2O or $CHCl_3$		symmetrical like CH_4 or CCl_4

in general, polar stuff has OH like bonds
nonpolar stuff has organic alkyl CH_3-CH_2

organic dissolves organic : $CH_3CH_2CH_3$ dissolves in 
water soluble dissolves water soluble : $CH_3\overset{O}{\overset{\|}{C}}OH$ dissolves in H_2O

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(4) miscibility ranking.
I will give you a collection of molecules. you rank them from

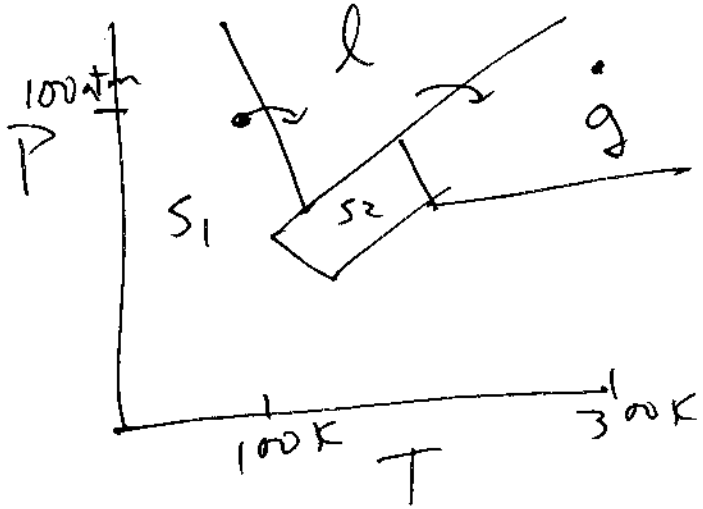
least polar ⟶ most polar

using the concepts in (3) above

Example C_6H_{14}, C_3H_6O, $C_6H_{12}O_6$, H_2O
least OH-like < < < most OH-like

5. Phase diagram navigation. I will give you a phase diagram. You will start at some P, T data point and will be told to go somewhere else. At that part, you tell me what is happening.

Example



Starting at 100 atm, 100 K, if you increase the T by 200 K, how many phase changes do you go through?

Answer is 2.

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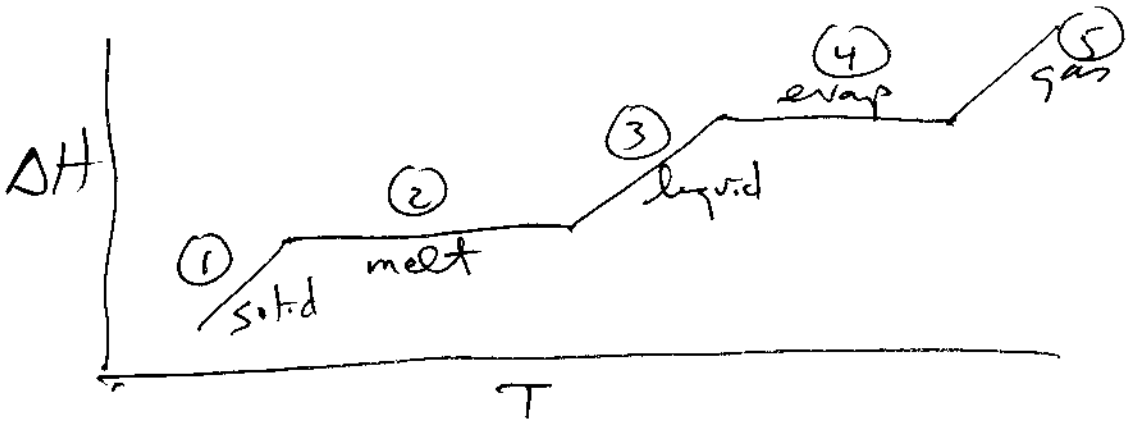
6. ΔH across phase changes



I will give a starting T and an ending T, you tell me how much ΔH is involved.

(1), (3), (5) are $mC\Delta T$

(4) ΔH_{fus} x amt

(5) ΔH_{evap} x amt

(7) Vapor pressure in binary system.
This is Raoult's Law for a mixture.

Raoult Law says that the total vapor pressures in a system is the sum of v.p. of ind. species

$$VP_{TOT} = VP_1 + VP_2$$

$$P_{TOT} = P_1 + P_2$$

$P_1 = P_1^\circ X_1 \qquad P_2 = P_2^\circ X_2$

$P_1^\circ + P_2^\circ$ are pure v.p.
$X_1 + X_2$ are mole fractions ⟹

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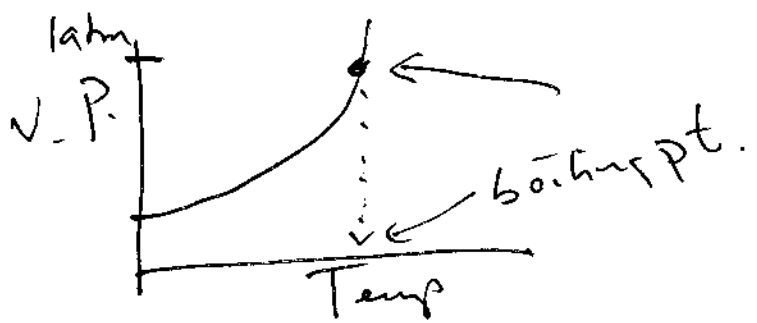
(8) Clausius Clapeyron. Plug + Chug

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

This says that if you have one T + v.p you can predict a second T or v.p.



note this is a clever way to ask for a boiling point because if given ΔH + @ P_1, T_1, $P_2 = 1$ atm so $T_2 =$ b.p.

9. Van't Hoff

When doing colligative property calculations, the property is a # of particles.

but 1 mole NaCl ≠ 1 mole sugar ≠ 1 mole of $CaCl_2$

so $\bar{i}$ is the van't Hoff factor that corrects for this

1 M NaCl = $\bar{i} = 2$ 1 M sugar $\bar{i} = 1$ 1 M $CaCl_2$ is $\bar{i} = 3$

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10. Colligative Property Calc. This is a place to change for either

$\Delta T_b = K_b m$ $\Delta T_f = K_f m$ $\Pi = MRT$ $P = P^0 X$

f.p. or b.p changes ↓ osmotic pressure.

Be able to determine m and remember ΔT is a temp. change not a single T value.

11. K from equil. expression. Easy.

I give you an equil. expression (chem. rxn).
you tell me K.

$NaCl_{(s)} \rightleftharpoons Na^+_{(aq)} + Cl^-_{(aq)} \Rightarrow K = [Na^+][Cl^-]$

↑ note pure solids + liquids have activity = 1.

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12. This will be a quadratic involving gases.

Example $2HF_{(g)} \rightleftharpoons H_{2(g)} + F_{2(g)}$

I give you a starting amount of stuff and you stick into the RICE expression to solve for unknown equil. value. This will not be approx. So you should back substitute the answers.

What is $[H_2]$ if start with $C_{HF} = 1$

$2HF \rightleftharpoons$	H_2	+ F_2
1	0	0
$-2x$	x	x
$1-2x$	x	x

$K = \frac{x^2}{1-2x}$

I give you K, and since $x \equiv [H_2]$ you can solve

13. Rxn direction from Q + K

Remember $Q < K$ shift right $Q > K$ shift left

So I will give you K and shifting amounts you predict system changes.

Example if $K = 4$ and $2NH_3 \rightleftharpoons 3H_2 + N_2$

Then if $NH_3 = 1$, $H_2 = 1$, $N_2 = 1$ Then does NH_3 increase at eq'l.?

$2NH_3 \rightleftharpoons N_2 + 3H_2$

1	1	1
−	+	+

$$Q = \frac{(1)(1)^3}{(1)^2} = 1$$

so $Q < 4 = K$

so rxn shifts right

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14. Le Chatelier + rxn direction.

When a stress is applied to a system, rxn shifts to avoid the stress.

So Examples

$2NH_3 \rightleftharpoons N_2 + 3H_2$

if P ↑ Then rxn shifts left to make less P

$2NH_3 \rightleftharpoons N_2 + 3H_2$

if NH_3 ↑ Then rxn shifts right to make less P

$2NH_3 \rightleftharpoons N_2 + 3H_2$

if exo, and T is increased Then rxn shifts left to reduce T