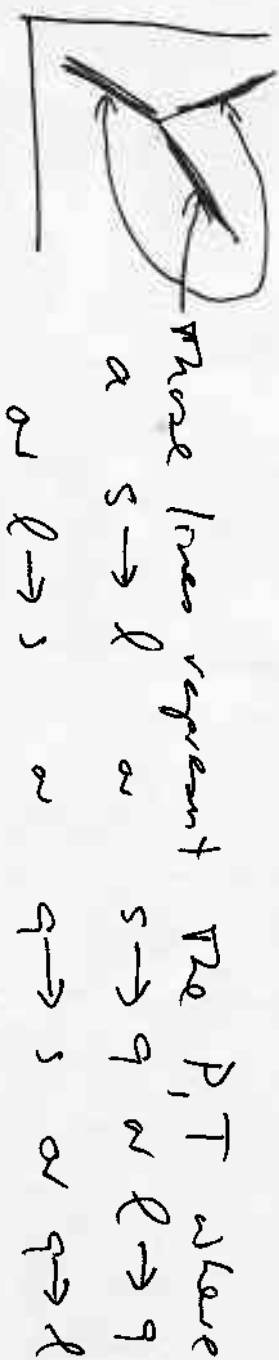


1. Theory: temperature and physical equilibria

Physical equilibria \equiv phase changes $S \leftrightarrow L \leftrightarrow G$
 by definition phase changes are at equilibrium
 which occurs when $\Delta G = 0$



2. Theory: dissolving gases, liquids, solids

● solid Theory: specifically salts in to water
 \hookrightarrow liquid which depends on crystal lattice energy + ΔH_{soln} .

● liquid Theory: "like dissolves like"
 Basically, the larger the charge density, the less the solubility
 and there are two kinds of compounds
 non-polar (organic like CH₃...) ΔE_{non-p}
 polar (-OH type groups) $\Delta E_{polar} > 0$

$\Delta H_{soln} \uparrow$ solubility \downarrow (like O₂)
 $\Delta H_{soln} \downarrow$ solubility \uparrow (like NaCl)
 gas Theory: $\Delta H_{soln} \downarrow$ solubility \uparrow (like NaCl)
 : Henry says as P increases solubility increases
 endothermic ($\Delta H_{soln} \uparrow$) solubility \downarrow (NaCl)

3. Theory: dissolving gases, liquids, solids

I tried to cram all this into 2. go there

4. Ranking: miscibility of liquids

The idea borrows from even 1. This in #2 as well.

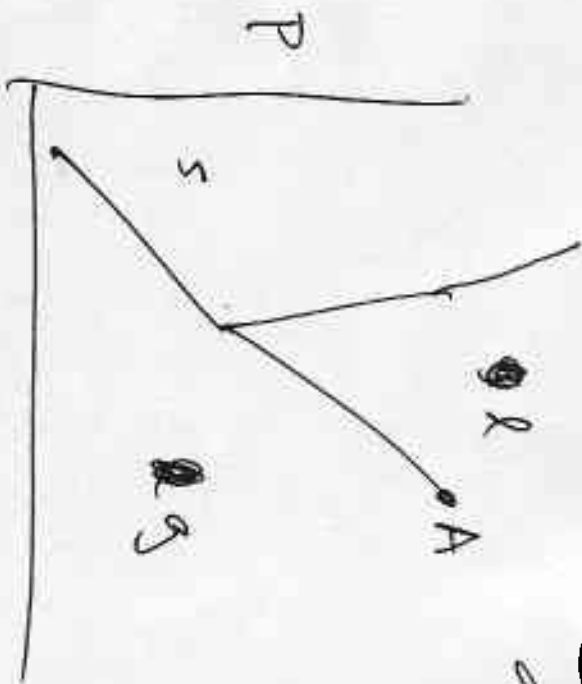
Simply the notion that "like dissolves like"

Example: Which of these dissolves best in C_6H_{14} ?

- a) H_2O
- b) CH_3CH_2OH
- c) $CH_3CH_2CH_2OH$

most "like" C_6H_{14} because most organic

5. Problem: phase diagram navigation



I will write down a phase diagram and ask a question.

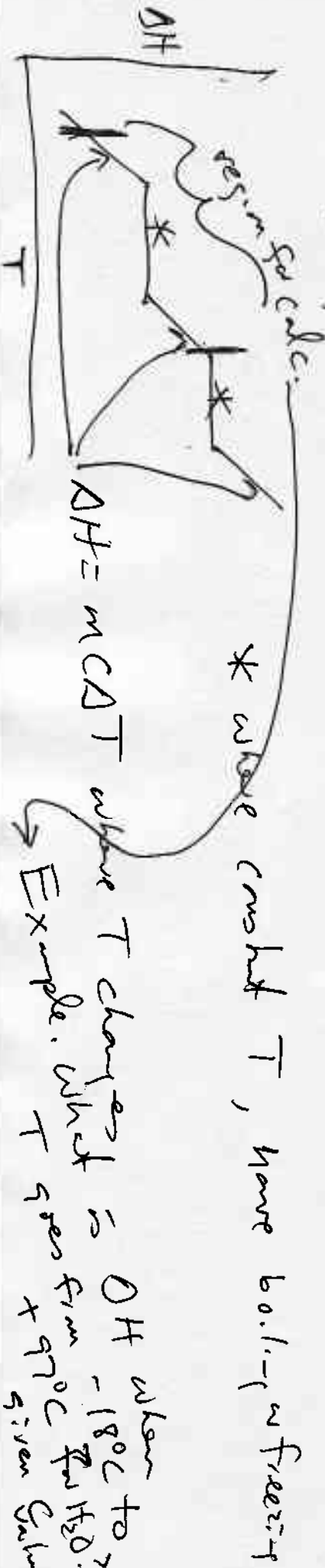
You need to be able to take a starting (P, T) and an ending (P, T) and say what happens along the way.

- name important regions of P-T diagram
- critical point (A) beyond which no distinction of $l \leftrightarrow s$
- triple point \Rightarrow all at same time
- equlib. lines ($\Delta G = 0$)

6. Calculation: ΔH for heating across phases

I will give a starting and stopping T and a bunch of constants. You calculate ΔH for process.

usually $\Delta H = m C \Delta T$ or $\Delta H = m C$



* where constant T, have boiling/freezing

Example. What T gives ΔH when -18°C for H_2O ?
 ΔH when -18°C for H_2O ?
 from 0°C given values

7. Calculation: vapor pressure in binary system

This is a double Raoult's Law calculation.

$P_A = P_A^0 X_A$ and $P_B = P_B^0 X_B \rightarrow P_{TOT} = P_A + P_B$
 give this find this

$P_A^0, P_B^0 \equiv$ pure vapor pressure

$X_A, X_B \equiv$ mole fraction amounts

$X_A = \frac{\text{mols}_A}{\text{mols}_A + \text{mols}_B}$

Hint, I'm not giving grams mols, I'm giving grams so convert first

8. Calculation: Clausius Clapeyron

The first 3 ident. calculated.

$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H^\ddagger}{R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right) \approx \ln\left(\frac{K_2}{K_1}\right) = \frac{\Delta H^\ddagger}{R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right) \approx \ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right)$
 Clausius Clapeyron Van't Hoff Arrhenius

There we plug and chug. Can't you learn to use your TI 83 as at least algebra?

Also, mols, mols, mols!!!! T not K T is Kelvin

9. Ranking: Van't Hoff and solution conc.

I will provide a list of compounds and their concentrations. Turn this into a ranking of # of particles.

Example: 1 mole sugar, 1 mole NaCl, 1 mole Na₂O

1 mole particles
 $\bar{c} = 1$

2 mole particles
 $\bar{c} = 2$

3 mole particles
 $\bar{c} = 3$

These dissociate + more particles

More particles # of particles
More particles more coll. property

So into the following equation

$$\Delta T_b = i K_{fm} \quad \Delta T_f = \bar{c} K_{fm} \quad P = i P^0 \quad \pi = i M R T$$

you will solve for # of particles. Recognize that

m, X or M are related to amounts and so through molar gm can get # particles, grams, etc

These will be exam

11. Setting up K from equilibrium expression

Very simple idea

I give you a chemical reaction, you write products to reactants

$$aA + bB \rightleftharpoons cC \quad K = \frac{[C]^c}{[A]^a [B]^b}$$

* Gigantic Hint *

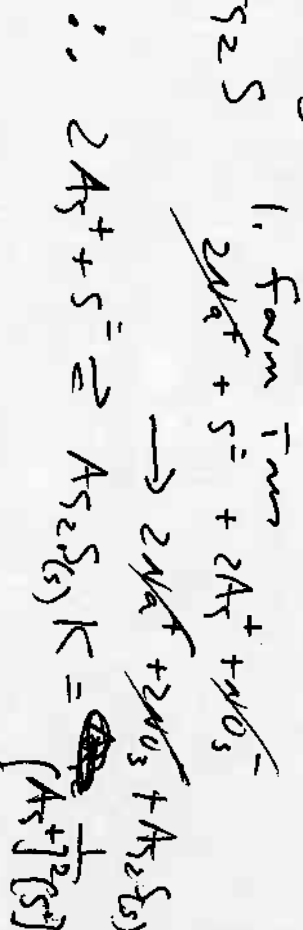
on exam, make sure you don't include solvents like H_2O , pure liquids, pure solids OR compounds appearing on both sides of equation



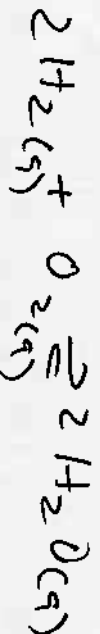
12. Calculation: equilibrium concentrations from K

I will give you an equl. expression,

you give me K_{equl} . I will tell you a bunch of numbers, you tell me missing one.



for the reaction



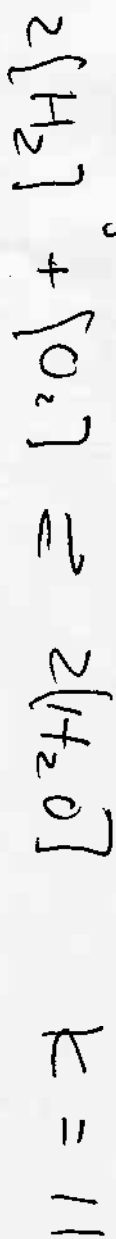
what is $[H_2]$ if $O_2 = 3$, $H_2O = 5$

and $K = 11$?

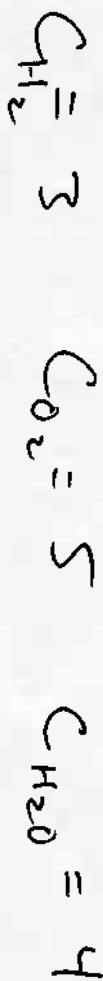
$$K = \frac{(H_2O)^2}{(H_2)^2 (O_2)} = 11 = \frac{(5)^2}{(?)^2 (3)}$$

13. Problem: Reaction direction from Q and K

I give an eq. b. b. r. -



I give you some non-equilibrium values



does rxn shift left or right? if $Q > K$ shift left
if $Q < K$ shift right

$$Q = \frac{(4)^2}{(3)^2(5)} = \frac{16}{45} \quad \therefore Q < K \quad \text{reaction shifts right}$$

14. Problem: LeChatelier and reaction direction

- identify stress (P, T, []) $2\text{H}_2 + \text{O}_2 \rightleftharpoons 2\text{H}_2\text{O}$, $\Delta H < 0$
- do oppo. h
- ask which direction rxn went
- see what increased or decreased

Example P increases, what happens to O_2 ?

• P ↑

• so system P ↓

• shift right 3 moles → 2 moles

• O_2 decreases and H_2O increases

15. Van't Hoff Equation and T vs K

Van is like classic slope + Arrhenius.

see # 8. In Van case it is $2T$ and $2K_{eq}$.

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

Chapter 10,11

16. Temperature dependence of K_w

in pure water

$$K_w = [H^+][OH^-] \text{ and by definition}$$

$$[OH^-] = [H^+]$$

at $25^\circ C$ $K_w = 10^{-14}$ so $pH = pOH = 7$

but that is only at $25^\circ C$

is "neutral"

but at $100^\circ C$ $K_w \sim 10^{-13}$ $\therefore pH = pOH \sim 6$

$0^\circ C$ $K_w \sim 10^{-15}$ $\therefore pH = pOH \sim 8$

17. Ranking A/B strength from K values

I will list a bunch of acids/bases w/ K_a + K_b . Turn them all into K_a or K_b s

rank them and pick the largest, the strongest

Example

	acid	K_a
HA		10^{-4}
HB		10^{-7}

	base	K_b
B		10^{-4}
C		10^{-7}

Which are following

HA, HB, BH⁺, CH⁺

is strongest acid

∴ HA 10^{-4} is largest and strongest, BH⁺ is weakest.

18. Approximations of A/B equations