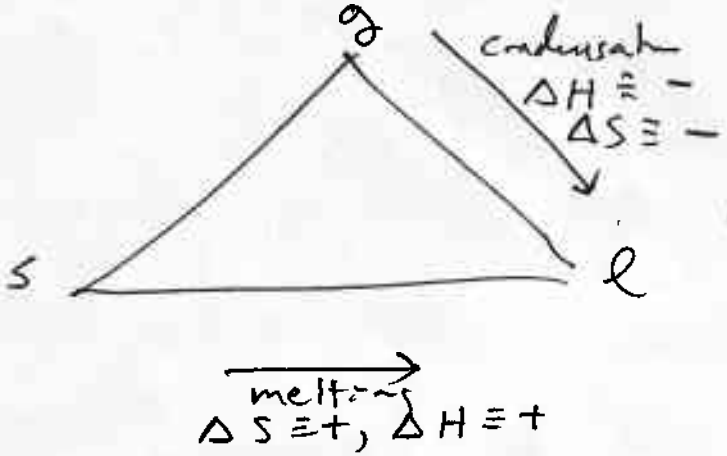
30 question types for the exam

Chapter 8

1 Theory: temperature and physical equilibria (a phase change where you have to predict H and S)

review from CH301 of ~~reaction~~ equation $\Delta G = \Delta H - T\Delta S$

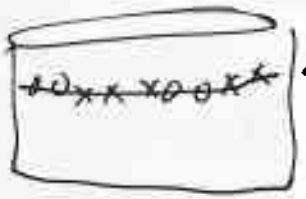


given a transition, you tell me the sign of ΔH, ΔS

(signs are same for all phase change $\Delta H, \Delta S$ $+,+$ or $-,-$

2 Theory: vapor pressure

know what the definition of v.p. is and you will be fine

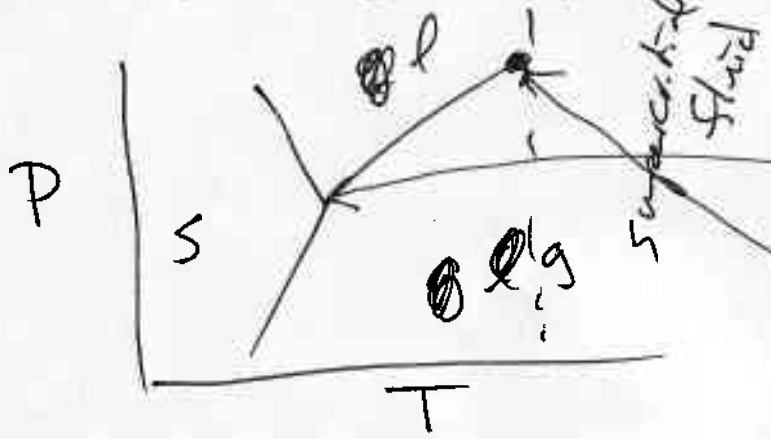


← surface molecules pick up kinetic energy, overcome i.m.f. and vaporize. The smaller the i.m.f the larger the vapor

3 Theory: salt dissociation in water

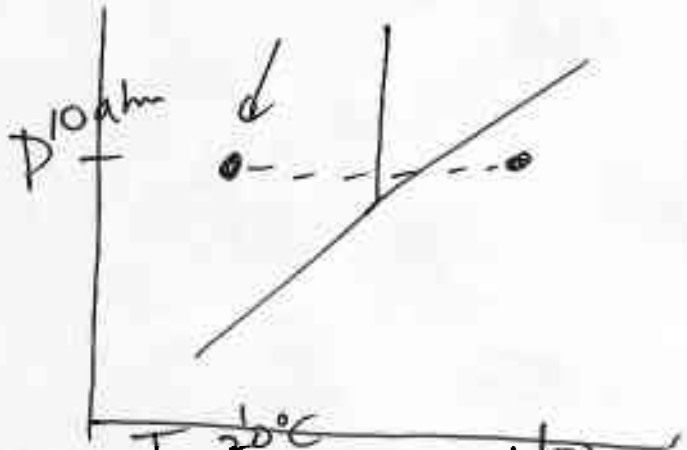
A salt crystal held together by C.L. energy is attacked by water molecules of a ΔH_{soln}. The ΔH_{soln} vs. C.L. energy determines ΔH_{soln} of is + or −. For NaCl it is slightly positive so that according to LeChatelier as the T ↑ more salt dissolves.

4 Problem: phase diagram interpretation



I will give a phase diagram. Know all the famous parts. Lines are equilibria for the phase changes. The triple point is where all phases exist simult. The critical point is the T beyond which no liquid can form as gas pressure increases

5 Problem: phase diagram navigation

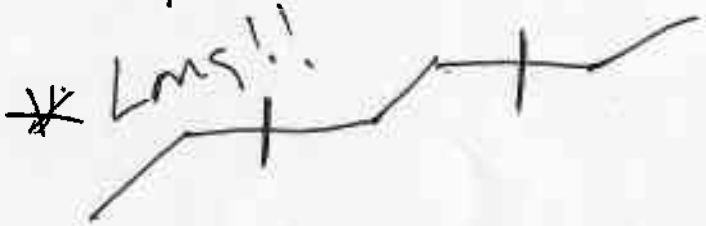


I give you a starting P, T. Then I tell you to walk around the diagram and then say "stop". You tell me where you are.

Example. (10 atm, 20°C) increase to 100°C, what is the phase?
Answer gas (sublimation occurs)

6 Calculation: ΔH for heating across phases

you have 5 possible calculations depending upon where T starts and stops.



3 calc: $\Delta H = mC\Delta T$ (phase)
2 calc: ΔH_{vap} or ΔH_{fus} at b.p. or f.p.

Hint: This problem sucks. (Not water) So be ready for a non-H_2O problem.

7 Theory: gas solubility in liquids

Gases dissolve in liquids because

- reactive like CO_2
- strong IMF like HCl
- wimpy • tiny little things that H_2O doesn't care about He, N_2, O_2

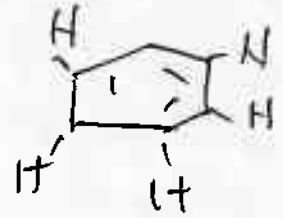
Typically for nonpolar gases they have an exothermic dissolution $He(g) \rightarrow He(aq)$ exo.

$\therefore$ As T ↑ [gas] ↓ and little fishies die

8 Ranking: miscibility of liquids

Employ "like dissolves like" You will be given a compound, either polar or nonpolar. You need to find out which in a list it is most "like". That is most miscible. Least "like" most immiscible.

Example $CHCl_3$ H_2O CCl_4



9 Definition: colligative property

You have learned 4 colligative properties.

- V.p. lowering $P = P^\circ X$ (Raoult's Law) • why we mix antifreeze w H_2O to keep car from overheat
- $\Delta T_b = km$ says that as you add solute to solvent, the T_b goes up.
- $\Delta T_f = km$ says that as you add solute → solvent f.p. ↓ (salt is added to ice)
- $\Pi = MRT$ (osmotic pressure) says that H_2O will cross a semipermeable membrane to equalize [ ]. Why cells explode

10 Calculation: vapor pressure in binary system very similar to gas problem.

Given 2 solvents, each w/ a mole fraction and their P^0 values (pure v.p. values) Perform Raoult's Law on each and give partial V.P. that you add together for P_{TOT}.

$P_A = P_A^0 X_A \quad P_{TOT} = P_A + P_B$

$P_B = P_B^0 X_B$

Hint. calc. do it last.

Hint. I am not handing you $X_A + X_B$, you need to calculate from masses + MW.

11 Calculation: Clausius Clapeyron

Plug + Chug. Given

ΔH_{vap}, R, P_1, T_1, P_2, T_2 One of these is missing. Solve for it.

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

Hint. you don't get to solve for ΔH_{vap} this time.

Hint. Remember that b.p. = at 760 torr

Hint. save +1 end.

12 Ranking: Van't Hoff and solution concentrations

This is the i in the colligative property calculations that corrects for # of particles formed when a cmpd dissolves.

sugar 1 particle $\equiv \bar{i} = 1$

NaCl 2 particles $\equiv \bar{i} = 2$

$CaCl_2$ 3 particles $\equiv \bar{i} = 3$

13 Problem: colligative property application

I have told some practical things about colligative properties. Know these. Explain to a friend.

How to decice icy roads

How to cook pasta faster

How to keep radiator from overheating

How to kill your animals

14 Calculation: colligative property

$P = P^0 X$ Raoults Law

$\Delta T_b = K_b m$

$\Delta T_f = K_f m$

$\Pi = MRT$

} you get a pretty easy plug + chug.

↑ easy.

Chapter 9

15 Problem: Setting up K from equilibrium expression

Given a chemical rxn. Simply write the stuff on right in numerator, stuff on left in denominator.

- put the coeff of rxn in the expnent
- ignore (s) (l), care about (g) (aq)

easy problem.

16 Calculation: calculating K from RICE expression Easy plug & chug.

I give a chem rxn. you create K for it. I tell you the eq.l. amounts. You plug them into K + solve.

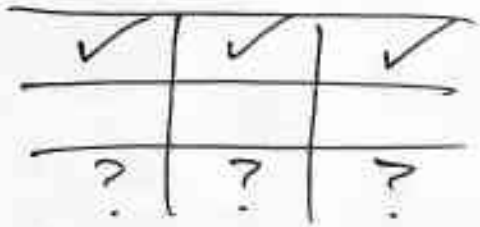
$A \rightleftharpoons B + C$

$K = \frac{\ominus\ominus}{\ominus}$ = answer.

17 Calculation: equilibrium concentrations from K

This is opposite of #16. I give you K and init. amounts. you tell me eq.l. amounts.

$A \rightleftharpoons B + C$



given K.

Hint!! This is the kind of problem where you set the answer equal to x and solve for everything in terms of x

18 Calculation: equilibrium concentrations from K (quadratic)

(a problem to do last)

I give you K + init. amounts. you assign a value for x and find all eq.l. [ ] in terms of x.

The answer will be a quadratic (x^2.)

Solve by back substituting a quad. form a fancy calc.

19 Problem: Reaction direction from Q and K

I will give you a K. and some initial [] values.
you will solve for Q. Compare to K.
Q < K shift right Q > K shift left.

Hint. TRICK TRICK TRICK.
make sure you convert your concentrations into molarity
by dividing by volume. first.

20 Problem: LeChatelier and reaction direction

Three steps.
1. Stress is applied to system ([ ], P, T)
2. system does opposite
3. shift left or right to make step 2 happen.

same.

21 Problem: LeChatelier and reaction direction

22 Calculation: Relationship of ΔG to K

Plug + chug $\Delta G = -RT \ln K$

I will K you find ΔG
or I will give ΔG you find K
But very routine.

H.w. K_p + K_c values
are solved exactly the same way.

Chapter 10

23 Theory of auto-protolysis of water

K is temp dependent. So as T varies for H_2O, K varies. But K is what tells you the H^+, OH^- amounts. So $H^+ = OH^-$ are equal but not always 1×10^{-7}. So real definition neutrality is $pH = pOH$ or $H^+ = OH^-$ not $pH = 7$. ∴ T ↑ K ↑ pH ↓ T ↓ K ↓ pH ↑

24. Temperature dependence of Kw

you will be given the Kw expression

$K_w = [H^+][OH^-]$ with $[H_2O]$ a constant

and will be asked to solve it. (P.S. this is a = bc)

H.w. know your exponent math + calc. or you will fail this test

25. Strong acid or base calculation

Pathetically simple calculation

$H^+ = Ca$

$OH^- = Cb$

You need to know S.A. + S.B. Then the starting amount is the answer. (May have to convert to pH

26. Weak acid or base calculation

If you know your strong acids + bases, then the guys + gals that aren't strong are weak. Then solve.

$H^+ = (Ka\,Ca)^{1/2}$ for weak acids

$OH^- = (Kb\,Cb)^{1/2}$ for weak bases.

You will do this kind of calculation twice

27 Weak acid or base calculation

H.W. When you have a OH^- answer + need to convert it to pH, be ready to do so. Be careful!!

H^+ pH

OH^- pOH

any may be correct

28. Identifying acid and base strength

Distinguish S.A. + S.B.

Strong acids are HCl, HBr, HI, $HClO_4$, $HClO_3$, H_2SO_4, HNO_3
also know their names.

Strong bases are Group 1 hydroxides $NaOH$, $LiOH$, $CsOH$ etc
and Group 2 hydroxides $Ca(OH)_2$ $Ba(OH)_2$ etc.

29. Converting between pH, POH, H+ and OH-

$$H_2O \rightleftharpoons H^+ + OH^-$$

$$1\times10^{-14} = K_w = [H^+][OH^-] \Leftarrow \text{so if given } H^+ \text{ you can give me } OH^-, \text{ etc}$$

$$\text{also } 14 = pK_w = pH + pOH \Leftarrow \text{so if given pH you can give pOH.}$$

30. Ranking acidity and basicity based on equilibrium constants

As K value increases, the rxn shifts more to the r.s.

So for acids $HA \rightleftharpoons H^+ + A^-$ as $K\uparrow$ $H^+\uparrow$ $pH\downarrow$

∴ The larger K_a, the stronger the acid.

Similarly the larger K_b the stronger the base

K_1	$= 1\times10^{-5}$
K_2	$= 1\times10^{-8}$ ← weakest
K_3	1×10^{-2} ← strongest

I will give a list of Ks, find the strongest or weakest from it