

Name:	Chemistry 106
Signature:	Thursday, Feb. 15, 2007
Please Circle the name of your lecture instructor	
Badger	D'Acchioli Zach
Section Number:	
Student ID Number:	

Exam 1

DO NOT OPEN THE EXAM UNTIL INSTRUCTED



Directions

Please check the exam to make sure there are 11 non-blank pages including the title page.
Read all the questions and directions carefully before entering answers!

Some sections allow you to omit a problem or page. In general we will grade the responses in order for these sections unless you write **OMIT** through the question or page you wish to be omitted. **READ DIRECTIONS CAREFULLY.**

Pencils and pens down when we call time.

Good Luck!

I. Multiple Choice (30 pts): In the space provided please indicate the letter of the response which best answers or completes the statement.

- What color is your exam?
 - yellow
 - blue
 - green
- Which one of the following molecules is most polarizable, and subject to significant instantaneous dipole-induced dipole forces?
 - $\text{H}_3\text{C}-\text{Br}$
 - $\text{H}_3\text{C}-\text{Cl}$
 - $\text{H}_3\text{C}-\text{F}$
 - $\text{H}_3\text{C}-\text{H}$
 - $\text{H}_3\text{C}-\text{I}$
- What one of the following covalent compounds will not exhibit hydrogen bonding in the liquid state?
 - $\text{CH}_3-\text{CH}_2-\text{Br}$
 - $\text{CH}_3-\text{CH}_2-\text{NH}_2$
 - $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{OH}$
 - $\text{CH}_3-\text{NH}-\text{CH}_3$
 - $\text{NH}_2-\text{O}-\text{H}$
- The vapor pressure of a liquid increases with increasing temperature. The temperature at which this vapor pressure is equal to 760 torr or 101,325 Pa is
 - the boiling point
 - the flash point
 - the vaporization point
 - 100 °C
 - the normal boiling point
- Given the pair of reactions shown with the equilibrium constants,
$$\text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{PCl}_5(\text{g}) \quad K_1$$
$$2 \text{NO}(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2 \text{NOCl}(\text{g}) \quad K_2$$
What is the equilibrium constant for the reaction,
$$\text{PCl}_5(\text{g}) + 2 \text{NO}(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + 2 \text{NOCl}(\text{g})$$
 - K_1K_2
 - K_2/K_1
 - K_1/K_2
 - $(K_1K_2)^{-1}$
 - K_2-K_1
- The equilibrium constant for the reaction, $\text{R}_2 \rightleftharpoons \text{D}_2$ is 6.8×10^{-10} . Which one of the following statements is true?
 - The equilibrium concentration of D_2 is always greater than that of R_2 .
 - The equilibrium concentration of R_2 is always greater than that of D_2 .
 - Adding more R_2 will increase the value of the equilibrium constant.
 - Adding a catalyst will increase the equilibrium concentration of D_2 .
 - Adding a catalyst will increase the value of the equilibrium constant.

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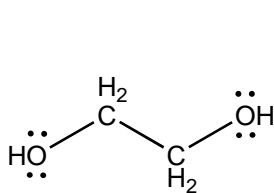
7. The concentration of a pure solid or a pure liquid is left out of the expression for the equilibrium constant because
- solids and liquids drive the reaction in an undetermined fashion
 - solids and liquids do not react
 - their concentrations cannot be determined
 - solids and liquids react too slowly
 - their concentration is constant and independent of the amount of solid or liquid present
8. The expression for the solubility product of $\text{Ba}_3(\text{AsO}_4)_2$ is
- $[\text{Ba}^{2+}]^3[\text{AsO}_4^{3-}]^2$
 - $[3 \times \text{Ba}^{2+}]^3[2 \times \text{AsO}_4^{3-}]^2$
 - $3[\text{Ba}^{2+}] \times 2[\text{AsO}_4^{3-}]$
 - $3[\text{Ba}^{2+}]^3 + 2[\text{AsO}_4^{3-}]^2$
 - $[\text{Ba}^{2+}]_3[\text{AsO}_4^{3-}]_2$
9. The solubility of lead(II) fluoride, PbF_2 , in pure water is 2.1×10^{-3} moles per liter. Calculate the value of K_{sp} for lead(II) fluoride from this data.
- 4.4×10^{-6}
 - 8.8×10^{-6}
 - 1.9×10^{-8}
 - 3.7×10^{-8}
 - 9.3×10^{-9}
10. Which one of the following salts has the highest solubility in water, expressed in moles per liter?
- PbF_2 , $K_{\text{sp}} = 3.6 \times 10^{-8}$
 - Ag_2CrO_4 , $K_{\text{sp}} = 1.2 \times 10^{-12}$
 - CaF_2 , $K_{\text{sp}} = 3.9 \times 10^{-11}$
 - BaF_2 , $K_{\text{sp}} = 1.7 \times 10^{-6}$
 - PbI_2 , $K_{\text{sp}} = 7.9 \times 10^{-9}$
11. The K_{sp} of calcium fluoride is 3.9×10^{-11} . A 0.420 g sample of NaF and a 1.110 g sample of calcium chloride were added to a 1.000 liter volumetric flask, and distilled water was added to the mark. After placing the stopper and shaking the flask to dissolve as much chemicals as would dissolve, what would be the calcium ion concentration remaining in solution afterwards? Be mindful that a precipitate may be formed.
- 0.0036 mole per liter
 - 0.0050 mole per liter
 - 0.0054 mole per liter
 - 0.0058 mole per liter
 - 0.0100 mole per liter

II. Short Answer (20 pts)

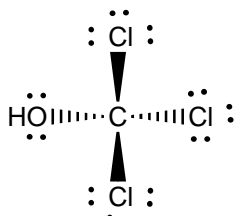
A. (10) Hydrogen bonding questions

(1) What elements must you have for hydrogen bonding to occur?

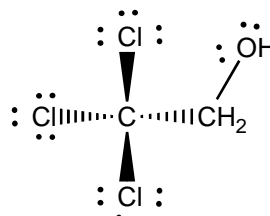
(2) Junior chemist needs to separate the following three compounds from a mixture using paper chromatography. Given a choice between CH_3OH and $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ as potential mobile phases, what should junior chemist use to separate the molecules, and why? Where would the molecules appear on the chromatography paper? Please use the letters **a**, **b**, and **c** to indicate the relative position of spots. Recall that paper contains water molecules, as well as lots of organic molecules with $-\text{OH}$ groups.



a



b

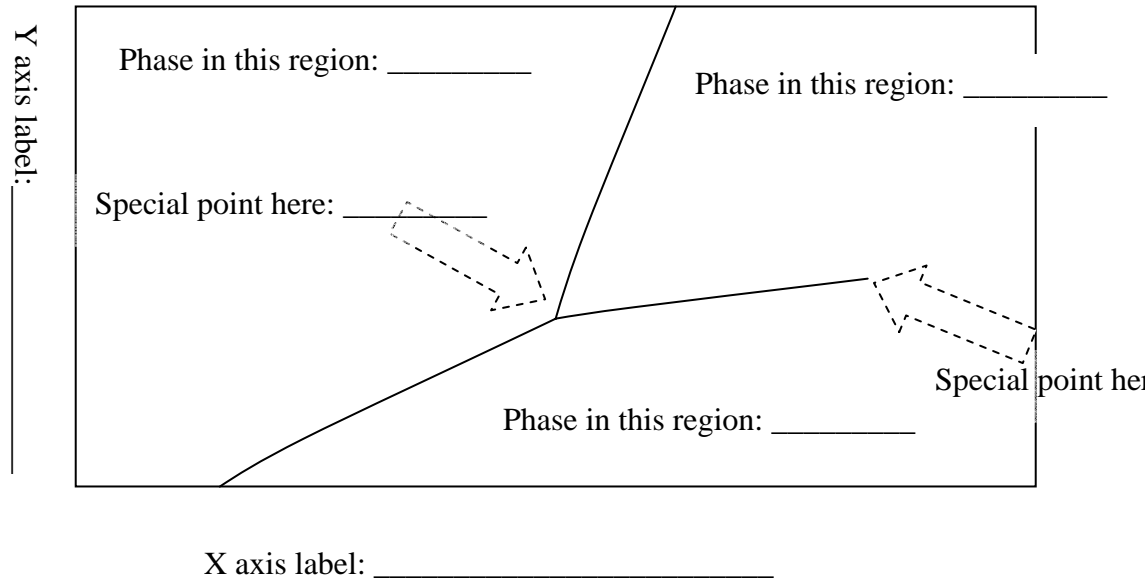


c



B. (10) Phase diagram questions

(a) Label the phase diagram with the phases, special points,



(b) Can this phase diagram be water? _____ Explain:

III. Fill in the Blank (15 pts) Solve any three (3) of the following problems and place your answer in the boxes provided. Note that very little partial credit will be given, so check your answers carefully.

1. Dioxane, $C_4H_8O_2$, has an enthalpy of fusion = 145.8 J g^{-1} and its melting point temperature is $11.0 \text{ }^\circ\text{C}$. How much energy is required to transform 142 g of solid dioxane at $11.0 \text{ }^\circ\text{C}$ into liquid dioxane, also at $11.0 \text{ }^\circ\text{C}$?

2. For the reaction, $2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{SO}_3(\text{g})$, at 450.0 K the equilibrium constant, K_c , has a value of 4.62. A system was charged to give these initial concentrations: $[\text{SO}_3] = 0.500 \text{ M}$, $[\text{O}_2] = 0.00855 \text{ M}$, $[\text{SO}_2] = 0.254 \text{ M}$. Calculate Q and indicate whether the reaction will proceed to the right, left or is at equilibrium.

3. What is molar solubility of calcium hydroxide ($\text{Ca}(\text{OH})_2$)? The K_{sp} of calcium hydroxide is 6.5×10^{-6} .

4. The reaction $\text{CO}(\text{g}) + 2 \text{H}_2(\text{g}) \rightleftharpoons \text{CH}_3\text{OH}(\text{g})$ has $K_p = 6.3 \times 10^{-3}$ at 225°C . What is the value of K_c at this temperature? ($R = 0.0821 \frac{\text{L atm}}{\text{mol K}}$, $K_p = K_c(\text{RT})^{\Delta n}$)

IV. Definitions and Explanations (15): Answer the following questions using legible handwriting and clear, complete sentences.

Why does $\text{CH}_3\text{—CH}_2\text{—O—H}$ have a significantly higher boiling point than $\text{CH}_3\text{—O—CH}_3$ even though they have the same formula, $\text{C}_3\text{H}_6\text{O}$?

Write the expression for the equilibrium constant, K_c , for the reaction,
$$\text{SO}_2\text{Cl}_2(g) + 2 \text{NO}(g) \rightleftharpoons \text{SO}_2(g) + 2 \text{NOCl}(g)$$

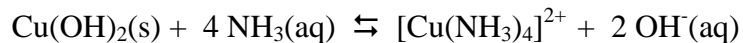
Using Le Châtelier's principle explain how the addition of aqueous ammonia dissolves silver chloride ($K_{sp} = 1.8 \times 10^{-10}$).

V. Thought Questions (20 pts): Solve the problems on any two (2) of the following three pages. Write "OMIT" through the page you wish omitted. Your answers must be clear and complete in order to receive complete credit. SHOW YOUR WORK!

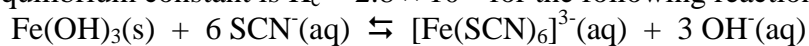
1. A sample of ground water has a calcium ion concentration of 308 mg per liter. What is the maximum quantity (moles) of NaOH that can be added, per liter, without causing any calcium hydroxide to precipitate? The K_{sp} of calcium hydroxide is 6.5×10^{-6} .

2. (5) The following equilibria are known to occur in aqueous media:
- $$\text{Cu(OH)}_2(\text{s}) \rightleftharpoons \text{Cu}^{2+}(\text{aq}) + 2 \text{OH}^{-}(\text{aq}) \quad K_{\text{SP}} = 1.6 \times 10^{-19}$$
- $$\text{Cu}^{2+}(\text{aq}) + 4 \text{NH}_3(\text{aq}) \rightleftharpoons [\text{Cu(NH}_3)_4]^{2+} \quad K_{\text{F}} = 6.8 \times 10^{12}$$

Write the equilibrium constant expression and calculate the numerical equilibrium constant for the following reaction



The equilibrium constant is $K_c = 2.8 \times 10^{38}$ for the following reaction:



Assuming solid iron(III) hydroxide is still present, what would be the $[\text{SCN}^{-}]$ if the equilibrium concentration of $[\text{Fe(SCN)}_6]^{3-} = [\text{OH}^{-}] = 0.11 \text{ M}$?

3. Copper(I) chloride has a $K_{sp} = 1.9 \times 10^{-7}$. Calculate the molar solubility of CuCl in:

a. water

b. 0.150 M CaCl₂ solution

PERIODIC TABLE OF THE ELEMENTS

	1 1A																18 8A	
1	H 1.008	2 2A										13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.003	
2	Li 6.941	Be 9.012										B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	Ne 20.179	
3	Na 22.990	Mg 24.305	3 3B	4 4B	5 5B	6 6B	7 7B	8	9	10	11 1B	12 2B	Al 26.982	Si 28.086	P 30.974	S 32.06	Cl 35.453	Ar 39.948
4	K 39.098	Ca 40.08	Sc 44.956	Ti 47.90	V 50.942	Cr 51.996	Mn 54.938	Fe 55.847	Co 58.933	Ni 58.70	Cu 63.546	Zn 65.38	Ga 69.72	Ge 72.59	As 74.922	Se 78.96	Br 79.904	Kr 83.80
5	Rb 85.468	Sr 87.62	Y 88.906	Zr 91.22	Nb 92.906	Mo 95.94	Tc (98)	Ru 101.07	Rh 102.91	Pd 106.4	Ag 107.87	Cd 112.41	In 114.82	Sn 118.69	Sb 121.75	Te 127.60	I 126.90	Xe 131.30
6	Cs 132.91	Ba 137.33	La 138.91	Hf 178.49	Ta 180.95	W 183.85	Re 186.21	Os 190.2	Ir 192.22	Pt 195.09	Au 196.97	Hg 200.59	Tl 204.38	Pb 207.2	Bi 200.98	Po (209)	At (210)	Rn (222)
7	Fr (223)	Ra 226.03	Ac 227.03	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 (271)	111 (272)	112 (277)		114 (289)		116 (289)		118 (293)

Lanthanide series	#	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide series	†	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)