CHEMISTRY 1128 EXAM II March 20, 2009

Name _____ **Section** _____

Signature _____ **TA** _____

ID # _____

PLEASE READ THE FOLLOWING INSTRUCTIONS

Do NOT begin the exam until asked to do so.

There are 9 numbered pages including a table of equilibrium constants for weak acids and their conjugate bases, a periodic table and equations page in this exam. Check to see that they are all here before you begin the exam. Return all these papers when you are finished. Write your name on every page. Use a pen with blue or black ink for the entire exam.

Exams done in pencil, erasable ink, or where white-out, liquid paper, etc. have been used are *ineligible for regrades*.

Be sure to follow all directions. In working any numerical problem, you MUST SHOW ALL YOUR WORK. No credit will be given unless all work is clearly shown and the method of solution is logically correct. Pay attention to units and significant figures throughout.

Do not write below this line

Page	Total	Grader
1	_____ /28	
2	_____ /22	
3	_____ /20	
4	_____ /12	
5	_____ /17	
6	_____ /26	
7	_____ /10	
8	_____ /15	
9(Bonus)	_____ /15	

Total Grade _____ /150 Checked by _____

Chem 1128, EXAM II **Name _____**
March 20, 2009

I. (50 points)

A. (10 points) You have four test tubes labeled A-D. Each contains 100.0 mL of solution as follows:

A. 0.10 M $HClO_4$ **B.** 0.10 M $HC_2H_3O_2$ **C.** 0.10 M $NaCHO_2$ **D.** 0.10 M NaOH

Answer the questions below, using **LT** (for *is less than*), **GT** (for *is greater than*), **EQ** (for *is equal to*), or **MI** (for *more information required*) in the blanks provided.

_____ **1.** The pH of C __ the pH of D.
_____ **2.** The pH of A __ 13
_____ **3.** The percent ionization of A __ the percent ionization of D.
_____ **4.** The pH of C __ 7
_____ **5.** When solution B is added to solution D, the pH is __ 7.

B. (10 points) What is the pH of a solution obtained by adding 13.0 g of NaOH (MM = 40.0 g/mol) to 795 mL of a 0.200 M solution of $Sr(OH)_2$? Assume no volume change on addition of the NaOH.

_____

C. (8 points) A 0.148 M solution of a monoprotic acid has a percent ionization of 1.55%. What is the acid dissociation constant (K_a) for the acid?

_____

_____

D. (7 points) Trimethylamine, $(CH_3)_3N$, is a weak base. An aqueous solution that is 0.25 M trimethylamine has a pH of 11.63. What is K_b for trimethylamine?

_____

E. (7 points) $C_6H_4NH_2COOH$, para-aminobenzoic acid, is used in some sun screen agents is a weak acid and its K_a is 2.2×10^{-5}. What is the pH of the solution prepared by adding 0.0825 mol para-aminobenzoic acid to enough water to make 1.50 L solution?

_____

F. (8 points) State whether 1 M solution of the following salts in water are acidic, basic, or neutral.

_____ $Zn(NO_3)_2$

_____ CH_3NH_3Cl

_____ NaF

_____ NH_4NO_2

_____

II. (49 points)

A. (10 points) Classify the following with the terms AB (acid buffer), BB (basic buffer), XA (non-buffer, acidic), XB (non-buffer, base), or XN (non-buffer, neutral).

_____ **1.** 0.100 mol HNO_3 + 0.100 mol $Ba(OH)_2$

_____ **2.** 0.100 mol HNO_3 + 0.150 mol NH_3

_____ **3.** 0.100 mol OCl^- + 0.100 mol HOCl

_____ **4.** 0.200 mol NaOH + 0.100 mol HOCl

_____ **5.** 0.100 mol HOCl + 0.100 mol NaOH

B. (10 points) A 0.5224 g sample of an unknown monoprotic acid was dissolved in water to a total volume of 20.0 mL and titrated with 0.0998 M NaOH. The equivalence point of titration occurs at 23.82 mL. The pH of the solution after the addition of 11.91 mL of base was 4.72.

1. What is the molar mass of the weak acid?

_____

2. What is the acid dissociation constant, K_a, for the weak acid?

_____

_____

C. (12 points) A buffer is prepared by adding 5.0 g of ammonia (NH_3, MM = 17.03 g/mol) and 20.0 g of ammonium chloride (NH_4Cl, MM = 53.49 g/mol) to enough water to make 2.50 L solution.

1. What is the pH of the buffer solution?

_____

2. What is the pH of the buffer after the addition of 0.100 mol of KOH? (with no volume change)

_____

_____

D. (17 points) A 25.0 mL sample of 0.250 M pyridine, C_5H_5N, (K_b = 1.7 x 10^{-9}) is titrated with 0.150 M HCl. **(one mole of pyridine reacts with one mole of strong acid)**

1. What is the initial pH before the titration?

_____

2. What is the volume of acid required to reach equivalence point?

_____

3. What is the pH at the equivalence point?

_____

III. (26 points)

_____

A. (8 points) Answer the following questions in the blanks provided.

_____ **1.** How many of the following can act as ligands: NH_4^+, NO^+, SO_4^{2-}, NH_3, $H_2NCH_2CH_2NH_2$?

_____ **2.** A complex, $Pt(NH_3)_2Cl_2$ exists with two isomers. The geometry is ___.

_____ **3.** In a complex ion, the ligand is a _____ base.

_____ **4.** Write the formula for the aluminum salt of the complex ion, $[PtCl_2(NO_2)_2]^{2-}$.

B. (10 points) Starting with the complex ion $[Co(en)_2(SCN)Cl]^+$, answer the following.

_____ **1.** What is the coordination number of the Co?

_____ **2.** The charge on the Co is _____.

_____ **3.** What is the abbreviated electronic configuration of the Co **<u>in the complex</u>**?

_____ **4.** What is the geometry of the complex?

_____ **5.** The number of geometric isomers possible for the complex.

C. (8 points) Consider an octahedral complex with chromium(II), Cr^{2+}, as the central metal and four ligands: two oxalates (ox), and two water molecules. The electron configuration of Cr^{2+} is $[Ar]3d^4$.

1. Draw the structure of the complex. Circle your answer.

2. Draw the geometric isomer of the complex. Circle your answer.

IV. (25 points)

A. (10 points) Consider 50.0 mL of 0.100 M HX which is a monoprotic weak acid. The solution is divided into 2 equal parts:

- Beaker 1 contains 25.0 mL of 0.100 M HX only.
- Beaker 2 contains 25.0 mL of 0.100 M HX which is neutralized with 0.221 M NaOH.

Answer the following three parts based on this information.

1. When the contents of Beaker 1 are combined with the contents of beaker 2, the pH of the resulting solution is 5.77. What is K_a for HX?

_____

2. What is the pH of the solution in Beaker 1?

_____

3. How many mL of NaOH are required to neutralize HX in beaker 2?

_____

_____

B. (15 points) A solution is made up of

5.0 mL of 2.00 X 10^{-3} M $Fe(NO_3)_3$

5.0 mL of 2.00 x 10^{-3} M KSCN

It is determined that the following reaction occurs

Fe^{+3} (aq) + SCN^- (aq) $\rightleftharpoons$ $Fe(SCN)^{2+}$ (aq)

1. What is the number of moles of Fe^{3+} initially present?

_____

2. At equilibrium, $[Fe(SCN)^{2+}]$ is 1.40 x 10^{-4} M. How many moles of $Fe(SCN)^{2+}$ are in the mixture at equilibrium?

_____

3. How many moles of Fe^{3+} remain in the solution at equilibrium?

_____

4. What is the concentration of Fe^{3+} at equilibrium?

_____

5. What is K, equilibrium constant, for the reaction at the temperature in which the experiment is performed?

_____

_____

BONUS (15 points) All or nothing – no partial credit

The bonus should be done only after you have completed the main part of this exam and the checked your work for errors. The time allotted for this exam does not include time for the bonus. *Trial* and *error solutions will not be accepted.* (SHOW ALL WORK!)

The solubility of $Ca(OH)_2$ at 25ºC is 0.153/100g H_2O. Assuming that the density of a saturated solution is 1.00 g/mL, calculate the maximum pH one can obtain when $Ca(OH)_2$ is dissolved in water?

Equilibrium Constants for Weak Acids and Their Conjugate Bases

	Acid	**K_a**	**Base**	**K_b**
Sulfurous acid	H_2SO_3	1.7×10^{-2}	HSO_3^-	5.9×10^{-13}
Hydrogen sulfate ion	HSO_4^-	1.0×10^{-2}	SO_4^{2-}	1.0×10^{-12}
Phosphoric acid	H_3PO_4	7.1×10^{-3}	$H_2PO_4^-$	1.4×10^{-12}
Hexaaquairon(III) ion	$Fe(H_2O)_6^{3+}$	6.7×10^{-3}	$[Fe(H_2O)_5OH]^{2+}$	1.5×10^{-12}
Hydrofluoric acid	HF	6.9×10^{-4}	F^-	1.4×10^{-11}
Nitrous acid	HNO_2	6.0×10^{-4}	NO_2^-	1.7×10^{-11}
Formic acid	$HCHO_2$	1.9×10^{-4}	CHO_2^-	5.3×10^{-11}
Lactic acid	$HC_3H_5O_3$	1.4×10^{-4}	$C_3H_5O_3^-$	7.1×10^{-11}
Benzoic acid	$HC_7H_5O_2$	6.6×10^{-5}	$C_7H_5O_2^-$	1.5×10^{-10}
Acetic acid	$HC_2H_3O_2$	1.8×10^{-5}	$C_2H_3O_2^-$	5.6×10^{-10}
Hexaaquaaluminum (III) ion	$A\ell(H_2O)_6^{3+}$	1.2×10^{-5}	$[Al(H_2O)_5OH]^{2+}$	8.3×10^{-10}
Carbonic acid	H_2CO_3	4.4×10^{-7}	HCO_3^-	2.3×10^{-8}
Dihydrogen phosphate ion	$H_2PO_4^-$	6.2×10^{-8}	HPO_4^{2-}	1.6×10^{-7}
Hydrogen sulfite ion	HSO_3^-	6.0×10^{-8}	SO_3^{2-}	1.7×10^{-7}
Hypochlorous acid	$HC\ell O$	2.8×10^{-8}	$C\ell O^-$	3.6×10^{-7}
Hydrocyanic acid	HCN	5.8×10^{-10}	CN^-	1.7×10^{-5}
Ammonium ion	NH_4^+	5.6×10^{-10}	NH_3	1.8×10^{-5}
Tetraaquazinc (II) ion	$Zn(H_2O)_4^{2+}$	3.3×10^{-10}	$[Zn(H_2O)_3OH]^+$	3.0×10^{-5}
Hydrogen carbonate ion	HCO_3^-	4.7×10^{-11}	CO_3^{2-}	2.1×10^{-4}
Hydrogen phosphate ion	HPO_4^{2-}	$4.5\ 10^{-13}$	PO_4^{3-}	2.2×10^{-2}

_____