CHEMISTRY 1128 EXAM II March 19, 2010

Name _____ **Section** _____

Signature _____ **TA** _____

ID # _____

PLEASE READ THE FOLLOWING INSTRUCTIONS

Do NOT begin the exam until asked to do so.

There are _8_ numbered pages including 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	_____ /31	
2	_____ /16	
3	_____ /24	
4	_____ /10	
5	_____ /16	
6	_____ /31	
7	_____ /22	
8(Bonus)	_____ /15	

Total Grade _____ **/150 Checked by** _____

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I. (47 points)

A. (15 points) Choose the best answer for the following multiple choice questions. Put the correct answer in the space provided.

_____ **1.** The following are a list of K_a values for weak acids. Which 1.0 M acid will have the lowest $[OH^-]$ concentration?

A. 1.7×10^{-4} **B.** 3.6×10^{-4} **C.** 3.8×10^{-9} **D.** 9.5×10^{-9} **E.** 8.8×10^{-7}

_____ **2.** The following are a list of K_a values for weak acids. Which 1.0 M acid will have the lowest $[H^+]$ concentration?

A. 1.7×10^{-4} **B.** 3.6×10^{-4} **C.** 3.8×10^{-9} **D.** 9.5×10^{-9} **E.** 8.8×10^{-7}

Answer the following questions in the blanks provided:

_____ **3.** If the H^+ concentration is less than 1.0×10^{-7} *M*, the solution is (acidic/basic)

_____ **4.** Is $NH_4I(aq)$ acidic, basic or neutral?

_____ **5.** Water can behave either as an acid or a base, a term describing this behavior of water is

B. (8 points) A 0.115 M solution of weak acid (HA) has a pH of 3.29. Calculate the pK_a for this acid.

_____

C. (8 points) Hydroxylamine is a weak base ($HONH_2$, $K_b = 1.1 \times 10^{-8}$). Calculate the pH of a 0.25 M aqueous solution of hydroxylamine.

_____

_____

D. (10 points) A solution is prepared by adding 75.0 mL of 0.250 M hydrochloric acid to 225.0 mL of 0.0550 M $Ba(OH)_2$ solution. What is the final pH of the solution after mixing? Assume the volumes are additive.

_____

E. (6 points) Consider a 1.0 M HF (**A**) solution and a 0.10 M HF (**B**) solution.

_____ Which has the higher pH, A or B?

_____ Which has the higher % ionization, A or B?

_____

II. (50 points)

A. (6 points) Consider the solutions below, write **YES** if the solution is a buffer and **NO** if it is not a buffer.

_____ **1.** 50.0 mL of 0.15 M HF; 20.0 mL of 0.15 M HCl

_____ **2.** 125.0 mL of 0.15 M NH_3; 150.0 mL of 0.20 M NaOH

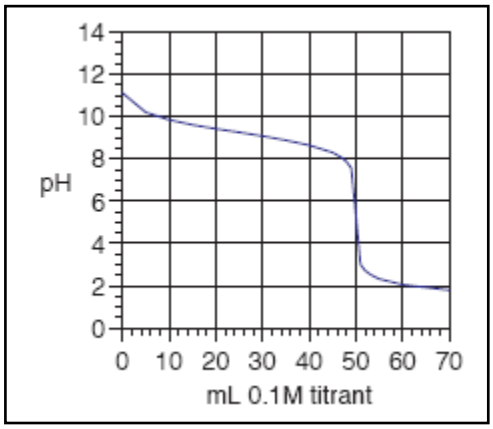
B. (8 points) Consider the titration curve below. The titrating agent (titrant) is the solution in the buret. Both solutions are 0.100 M. There are 50.0 mL of solution to be titrated.

_____ **1.** Is the titrating agent an acid or a base?

_____ **2.** Is the solution to be titrated (solution in the beaker) strong acid/base or weak acid/base?

_____ **3.** What is the pH at the equivalence point?

_____ **4.** What is the K_b of the solution being titrated?



C. (10 points) A buffer is prepared by adding 1.73 g $HCHO_2$ (MM = 46.03 g/mol) to 75.0 mL of 0.200 M of NaOH. What is the pH of the buffer? (Assume the addition of formic acid does not change the volume)

D. (10 points) How many moles of hydrochloric acid would have to be added to 125 mL of a 0.312 M ammonia, NH_3, solution, in order to prepare a buffer with a pH of 8.75?

_____

_____

E. (16 points) A 50.0 mL sample of 0.125 M acetic acid, $HC_2H_3O_2$ is titrated with 0.100 M $Sr(OH)_2$. (Assume that volumes are additive)

1. What is the pH of the solution before any $Sr(OH)_2$ is added?

_____

2. What is the pH of the solution halfway to the equivalence point?

_____

3. What volume of $Sr(OH)_2$ is required to reach the equivalence point?

_____

4. What is the pH of the solution at the equivalence point?

_____

_____

III. (31 points)

A. (8 points) 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.** For the metal M^{2+}, the metal complex ion with CN^- ligands is a high-spin complex, while the complex ion with NH_3 ligands is a low spin complex. The strength of the CN^- crystal field ___ the strength of the NH_3 crystal field.

_____ **2.** The number of isomers for $[Co(NH_3)_4(H_2O)_2]^{2+}$ is ___ 3.

_____ **3.** The number of unpaired electrons in a high spin complex where Fe^{3+} is the central atom is ___ 5.

_____ **4.** The number of **d** electrons in V^{2+} is ___ 1.

B. (12 points) Starting with the complex ion $[Cr(en)_2(CN)_2]^+$, answer the following.

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

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

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

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

_____ **5.** Is the complex paramagnetic (yes/no)?

_____ **6.** If en and CN are replaced for weaker field ligands would (increase/decrease Δ_o for the complex ion?

C. (11 points) What is the concentration of free silver ion, $[Ag^+]$ in an aqueous solution prepared by 0.10 M $AgNO_3$ and 3.0 M NH_3?

$$Ag^+(aq) + 2NH_3(aq) \rightleftharpoons Ag(NH_3)_2^+(aq) \qquad (K_f = 1.6 \times 10^7)$$

_____

_____

IV. (22 points)

A. (10 points) A sample of 0.2140 g of an unknown monoprotic weak acid was dissolved in 25.0 mL of water and titrated with 0.0950 M NaOH. The acid required 27.4 mL of base to reach the equivalence point. After 15.0 mL of base had been added in the titration, the pH was found to be 6.50. What is the acid dissociation constant, K_a, of the weak acid?

_____

B. (12 points) The total hardness of water is determined by the titration of water sample with a standardized solution of EDTA using Eriochrome black T as an indicator. A blank containing a certain amount of Mg^{2+} required 2.60 mL of the EDTA solution to reach the end point. Then, a 100.0 mL sample of hard water is titrated with 0.0210 M EDTA solution and the volume of EDTA required is 23.20 mL.

1. What volume of EDTA is used in titrating the Ca^{2+} in the hard water?

_____

2. How many moles of EDTA are there in that volume?

_____

3. What is the water hardness in ppm (mg/L) $CaCO_3$?

_____

_____

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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!)

Consider a 50.0 mL solution of a weak acid HA (K_a = 1.00 x 10^{-6}), which has a pH of 4.000. What volume of water must be added to make the pH 5.000?

_____

_____

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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}

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