FIRST LETTER OF YOUR LAST NAME ☐

CHEMISTRY 1128 **EXAM II** **March 23, 2012**

Name ________________________ **Section** __________________

Signature ________________________ **TA** _______________________

ID # ________________________

PLEASE READ THE FOLLOWING INSTRUCTIONS

Do NOT begin the exam until asked to do so.

There are __10__ 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	____________ / 16	
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Tot al Grade _______________ /150 Checked by _______

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I. (43 points)

A. (10 points) A sealed flask has 0.541 atm of SO_3 at 1000K. The following equilibrium is established.

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$

At equilibrium, the partial pressure of oxygen is measured to be 0.216 atm. Calculate K for the decomposition of SO_3 at 1000 K.

____

B. (6 points) Given the following hypothetical reactions and their equilibrium constants at 75°C,

$3A(g) \rightleftharpoons 3B(g) + 2C(g)$ K_1

$3D(g) + 2B(g) \rightleftharpoons 2C(g)$ K_2

Write the equilibrium constant expression and calculate the equilibrium constant for the reaction below.

$A(g) \rightleftharpoons D(g) + 5/3\ B(g)$ K_p

____

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C. (8 points) Sulfur oxychloride SO_2Cl_2, decomposes to sulfur dioxide and chlorine gases:
$SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$
Equilibrium is established at a certain temperature when the partial pressures of SO_2, Cl_2, and SO_2Cl_2 are 1.88 atm, 0.84 atm, and 0.27 atm respectively.

1. Calculate K at this specific temperature

____

2. If enough chlorine condenses to reduce its partial pressure to 0.68 atm, calculate the reaction quotient Q.

____

3. Which direction will the reaction proceed? (**Circle one**)

LEFT **RIGHT** **STAYS THE SAME**

D. (8 points) Assuming the reaction below is at equilibrium, which direction will the following changes drive the reaction? Write Left, Right, or NC (for *No Change*)

$$C(s) + O_2(g) \rightleftharpoons CO_2(g) \qquad \Delta H^\circ = -393.5 \text{ kJ/mol}$$

1. __________ Increasing the temperature

2. __________ Adding $O_2(g)$

3. __________ Removing some $C(s)$.

4. __________ Expanding the entire system.

____

E. (11 points) Solid ammonium hydrogen sulfide decomposes to ammonia and hydrogen sulfide gases at sufficiently high temperatures:

$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$

The equilibrium constant for the decomposition at 673 K is 0.215. Fifteen grams of ammonium hydrogen sulfide are sealed in a 5.0-L flask and heated to 673 K.

1. What is the total pressure in the flask at equilibrium?

____

2. How many grams of ammonium hydrogen sulfide decomposed?

____

____

II. (47 points)

A. (8 points) An aqueous solution of weak base (B^-) is prepared by dissolving 0.10 mol in water to form one liter of solution. Answer the following questions regarding the solution of weak base as either TRUE or FALSE

1. __________ [HB] = 0.10 M

2. __________ pH = 13.0

3. __________ $[OH^-] \approx [HB]$

4. __________ $[H^+] = \frac{1.0x10^{-14}}{0.10}$

B. (8 points) Calculate the pH of a solution that is prepared by taking 40.0 mL of 0.100 M $NH_3(aq)$ and diluting it with enough water to make 200.0 mL of solution.

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C. (8 points) What is the pH of a solution obtained by mixing 335 mL of 0.00370 M NaOH and 325 mL of $Sr(OH)_2$ with a pH of 12.09? Assume the volumes are additive.

____

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D. **(7 points)** Calculate the percent ionization of a 726 mL benzoic acid ($K_a = 6.6\text{x}10^{-5}$) solution that contains 0.288 mol of benzoic acid.

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E. **(10 points)** A solution of sodium cyanide, NaCN (MM = 49.07 g/mol), has a pH of 12.10. How many grams of NaCN are needed in 425 mL of a solution with the same pH?

____

F. **(6 points)** State whether 1 M solutions of the following salts in water are acidic, basic, or neutral.

1. __________ Na_2HPO_4

2. __________ NaF

3. __________ NH_4NO_3

____

III. (44 points)

A. (8 points) Indicate whether the following statements are true or false.

__________ **1.** A buffer can be made up by a combination of any weak acid and any weak base.

__________ **2.** Consider the titration represented by the following equation:

$$H^+(aq) + NO_2^-(aq) \rightleftharpoons HNO_2(aq)$$

At equivalence point, the resulting solution can act as a buffer.

__________ **3.** Consider a buffer solution prepared by using acetic acid and sodium acetate. When strong base is added to the buffer the concentration of acetate ($C_2H_3O_2^-$) ion decreases.

__________ **4.** A buffer is most effective (most resistant to pH changes) when the concentrations of weak acid and conjugate base are equal.

B. (8 points) Indicate **YES** or **NO** for each of the following as to whether a buffer will form from adding each to 650.0 mL of 0.40 M $Sr(OH)_2$?

__________ **1.** 1.00 mol of HF

__________ **2.** 0.30 mol HCl

__________ **3.** 0.30 mol NaF

__________ **4.** 0.30 mol of HF

C. (4 points) A buffer is prepared in which the ratio $[H_2PO_4^-]/[HPO_4^{2-}]$ is 3.0. What is the $[H^+]$ of this buffer?

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D. (12 points) A buffer is prepared by adding 15.0 g sodium lactate ($NaC_3H_5O_3$) and 12.50 g of lactic acid ($HC_3H_5O_3$) to enough water to make 500.0 mL of solution.

MM of $NaC_3H_5O_3$ = 112.06 g/mol

MM of $HC_3H_5O_3$ = 90.08 g/mol

1. What is the pH of the buffer?

____

2. What is the pH of the buffer after the addition of 0.0500 mol HCl?

____

____

E. **(12 points)** A 0.150 M HCl is used to titrate 25.0 mL of a 0.175 M solution of pyridine (C_5H_5N) which is a weak base ($K_b = 1.7 \times 10^{-9}$).

1. Write a balanced net ionic equation.

____

2. What are the species at the equivalence point?

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

____

4. What is the pH at the equivalence point?

____

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IV. (16 points)

A. (10 points) An aqueous solution contains 4.00 g of uric acid. A 0.730 M KOH is used for titration. After 12.00mL of KOH are added, the resulting solution has pH 4.12. The equivalence point is reached after a total 32.62 mL of KOH are added.

$$HUric(aq) + OH^-(aq) \rightarrow Uric^-(aq) + H_2O$$

1. What is the molar mass of uric acid?

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2. What is the K_a value for uric acid?

____

B. (6 points) Calculate the pH of a formic acid solution that contains 1.45% formic acid (HCOOH) by mass. Assume the density of the solution is 1.01 g/mL. ($K_a = 1.8 \times 10^{-4}$)

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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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