Average 70%

FIRST LETTER OF YOU	RST LETTER OF YOUR LAST NAME			
CHEMISTRY 1128	EXAM II	March 28, 2014		
Name <u>FCE</u>		Section KEY		
Signature		···		

PLEASE READ THE FOLLOWING INSTRUCTIONS

Do NOT begin the exam until asked to do so.

There are <u>8</u> 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	/26	
2	/18	
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Chem	1128,	EXAM	II
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(54 points)

A. (10 points) Consider the following six beakers. All have 100 mL of aqueous 0.1 M solutions of the following compounds.

Beaker A has Hi

Beaker B has HNO₂

Beaker C has NaOH

Beaker D has Ba(OH)₂

Beaker E NH₄CI

Beaker F C₂H₅NH₂

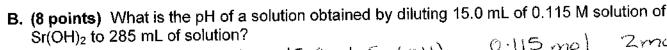
Answer the questions below, using LT (for is less than), GT (for is greater than), EQ (for is equal to), or MI (for more information required).



1. The pH of beaker B _____ the pH in beaker A.

2. The pH in beaker C _____ the pH in beaker D.

3. The pH in beaker C _____ the pH in beaker F.



$$3r(OH)_2$$
 to 285 mL of solution?
of moles of $OH = 15.0$ mL $5r(OH)_2 \times \frac{0.115 \text{ mol}}{1000 \text{ mol}} \times \frac{2mo!OH}{1000 \text{ mol}} \times \frac{2mo!OH}{10$

= 0.0121 => 6 pts 12.08 (2pts)

C. (8 points) A 4.90 x 10⁻³ mol sample of a weak acid HY is dissolved in enough water. To form 0.095 L of solution. If the pH of the solution is 2.65, what is K_a for the weak acid?

$$[HY] = \frac{4.90 \times 10^{-3}}{0.095} = 0.052M \quad pH = 2.65$$

$$(2p+5) \quad [H+J = 2.24 \times 10^{-3}]^{2} \quad (2p+5)$$

$$K_0 = \frac{(2.24 \times 10^{-3})^{2}}{0.052} \quad (2p+5)$$

2 pts for squaring 1 2 pts for set-up

D. (10 points) Ascorbic acid (HC₆H₇O₆, MM = 176.124 g/mol) is also known as vitamin C, and it is a weak acid. A solution of ascorbic acid is prepared by dissolving 2.00 g in enough water to make 100.0 mL solution. If the K_a of ascorbic acid is 7.6 x 10⁻⁵ calculate the following

1. The concentration of $[H^{\dagger}]$ in solution

CH+]= 2.9 x 10-3 M

2pts for set-up

29 x 10-3 2 pts answer

2. The pH of the solution.

The pH of the solution.

$$pH = -\log(2.9 \times 10^{-3})$$
 based on answer
$$= 2.53$$

$$= 2.53$$

All or nothing

2.53

E. (8 points) State whether a 1 M solution of the following salts in water will be acidic, basic, or neutral.

basic 1. K3PO4

basic 2. NH4HCO3 Ka = 5.6 x 10-10

Kb=23x108

neutra 3. NaClO4

acide 4. LiH2PO4

F. (10 points) Thiamine hydrochloride (C₁₂H₁₈ON₄SCl₂) is a water soluble form of thiamine. Its acid dissociation constant is 3.37 X 10⁻⁷. A solution of thiamine hydrochloride has a pH of 3.50. How many grams of thiamine hydrochloride are needed in a 15.00 mL solution to give (MM of HCIZHITON45Clz = 337.27g/mol)

CHT] = 10-3.50 = 3.16 × 10-4 M (2.pts) $3.31 \times 10^7 = \frac{(3.16 \times 10^{-4})^2}{X - 3.16 \times 10^{-4}}$ (2 pts for)

3.37×107× - 1.1 ×10 = 1.0 ×10-7

 3.37×10^{-7}

N=0.297 M (2pts

mass of triamne= 15.00ml x 0.297mol x 337.290 1 mal

=1.504

2 pts for # of moles 2 pts for mass

II. (49 points)

A. (12 points) Answer questions 1 – 4 below, using LT (for is less than), GT (for is greater than), EQ (for is equal to), or MI (for more information required)

Beaker A has a weak acid $(K_a = 1 \times 10^{-5})$

Beaker B has HCI

The volume and molarity of eac acid in the beakers are the same. Both acids are to be titrated with a 0.1 M solutions of NaOH.

1. Before the titration starts, the pH of the solution is Beaker A is _____ the pH of the solution in beaker B.

MI

2. At half neutralization (halfway to the equivalence point), the pH of the solution in Beaker A _____ the pH of the solution in beaker B.

GT

3. When each solution has reached the equivalence point, the pH of the solution in Beaker A the pH of the solution in Beaker B.

도요 4. At the equivalence point, the volume of NaOH used to titrate HCl in Beaker B _____ the volume of NaOH used to titrate the weak acid in beaker A.

Place your answer on the line provided.

- 5. A buffer may be prepared from a weak acid. Which of the acids below is best for the preparation of a buffer with a pH of 4.00?
 - (A) sulfurous acid, H_2SO_3 ; $K_a = 1.7 \times 10^{-2}$
 - **(B)** hydrofluoric acid, HF; $K_a = 6.9 \times 10^{-4}$
 - (C) benzoic acid, $HC_7H_5O_2$; $K_a = 6.6 \times 10^{-5}$
 - **(D)** dihydrogen phosphate ion, H_2PO_4 ; $K_a = 6.2 \times 10^{-8}$
 - (E) ammonium ion, NH_4^+ ; $K_a = 5.6 \times 10^{-10}$



- **6.** All of the following statements are false for the titration of a strong base by a strong acid EXCEPT
 - (A) the equivalence point occurs at pH 7.
 - (B) there will be at least two equivalence points, one for the base and one for the acid.
 - (C) the equivalence point and the end point are identical, regardless of what indicator is used.
 - (D) equal masses of acid and base are required to neutralize the solution.
 - (E) it is impossible to neutralize a strong acid with a strong base.

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B. (8 points) If added to 750.0 mL of 0.243 M HOCI, which of these would form a buffer? On the line provided write YES or NO.

1. $\forall \in S_0.10 \text{ mol NaOCl}$

Haymolay HOCI = 750.0ml x 1000ml =0.182 mol



2. NO 0.10 mol HNO₃

3. YES 0.10 mol KOH

[Ben-] = 0.104 0.425

= 0,245M

02

- **4.** *MO* 0,20 mol KOH
- C. (15 points) A buffer solution is prepared by dissolving 15.00 g of sodium benzoate $(NaC_7H_5O_2, MM = 144.10)$ in 425 mL of 0.249 M $HC_7H_5O_2$. Assume not volume change after NaC₇H₅O₂ is dissolved. K_a of HC₇H₅O₂ = 6.6 x 10⁻⁵.

1. Calculate the pH of this buffer.

#aj mol aj CritgOz = 15.00g NaCrityOz x Irnal | Bent | Imol NaBen

cymol cy HC7H502 = 425mL x 0.249mol = 0.106mol



6Pts 6.6 × 10-5 [H+]0.104

[H+] = 6.7 × 10 5 m PH=-10967x10-5

= 4.17

4.17 (2pts)

2. Calculate the pH of the solution after 0.0255 moles HCl is added to this buffer. Assume no volume change. 6.6x10 = EH+7 0.0785

[H+] 11 x104 PH= 3.96

- **D.** (14 points) A 25.0 mL solution of lactic acid, HC₃H₅O₃, is titrated with 15.00 mL of 0.186 M Ba(OH)₂. K_a of lactic acid is 1.38 x 10⁻⁴.
 - 1. Write a balanced net ionic equation

2pts

HC3H5O3(aq) + OH (aq) -> C3H5O3(aq) +H20

2. What are the species present at the equivalence point?

(2P+S

having H20 is GKV For extra species -1

3. What is the molarity of the initial lactic solution?

(4 pts)

[HLac]= 5.58 x 103 0.0250

0.223 M (2Pts)

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

(6Pb)

$$\frac{1.0 \times 10^{-14}}{1.38 \times 10^{-4}} = 7.25 \times 10^{-11} = \frac{\text{EOH-J}^2}{0.1395}$$

[OH]: 3.18 x10 m

1 mist. 2

PH=8.50

2 mist. 0

III. (47 points)

A. (8 points) Predict whether the forward or reverse reaction or no change will occur when the equilibrium is disturbed by



$$PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^{-}(aq)$$

 $\Delta H = 23.4 \text{ kJ}$

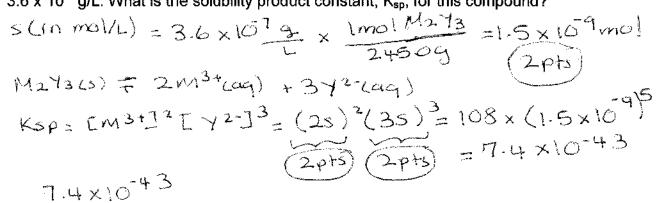
್ಲ್ರ್ಲ್ 1. addition of 1 M Pb(NO₃)₂ solution

forward 2. increase in temperature.

forward 3. addition of Ag+, forming AgCl.

nochange4. Addition of 1 M HCI.

B. (8 points) The solubility of an ionic compound M_2Y_3 , (MM of M_2Y_3 = 245.0 g/mol) is 3.6×10^{-7} g/L. What is the solubility product constant, K_{sp} , for this compound?



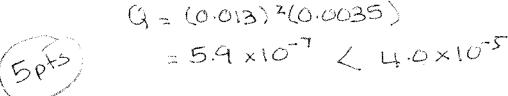


C. (6 points) What is the solubility of solid $Ca_3(PO_4)_2$ ($K_{sp} = 1.3 \times 10^{-32}$) in a 0.20 M Na_3PO_4 solution.



1.3×10⁻³² =
$$[Ca^{2+}]^3 [Pou_3 -]^2$$
 | mist. 3
= $[Ca^{2+}]^3 (o \cdot 2o)^2$ | 2mist. 0
= $[Ca^{2+}] = 6.9 \times 10^{-11} \text{ M} = 3\text{ S}$
 $2.3 \times 10^{-11} \text{ mol/L}$ | $9 = 2.3 \times 10^{-11} \text{ mol/L}$

D. (5 points) A solution containing potassium bromide is mixed with a solution containing lead acetate to form a solution that is 0.013 M in KBr and 0.0035 M in Pb(C₂H₃O₂)₂. Will a precipitate form? K_{sp} for PbBr₂ is 4.0 x 10⁻⁵. (SHOW YOUR CALCULATION)





E. (8 points) Consider the following equation:

$$Cu(OH)_2(s) + 4NH_3 (aq) \rightleftharpoons Cu(NH_3)_4^{2+}(aq) + 2OH^{-}(aq)$$

$$K_{sp}$$
 for $Cu(OH)_2 = 2 \times 10^{-19}$ and K_f for $Cu(NH_3)_4^{2+} = 2 \times 10^{12}$

1. What is the equilibrium constant, K, for the reaction given above?

2.∕What is [NH₃] at equilibrium when 1.68 g of copper(II) hydroxide (97.561 g/mol) are dissolved in 500.0 mL of solution?

#aymol ay
$$Cu(OH)_{22}$$
 1.689 $Cu(OH)_{2} \times \frac{Imol Cu(OH)_{2}}{97.5619}$
 $S = \frac{0.0172}{0.5000} = 0.0344 \xrightarrow{---} 3 \text{ (3 pts)}$
 $4 \times 10^{-7} = \frac{4 \times (0.0344)^{3}}{ENH374} \text{ (3 pts)}$ Allor nothing

4.5 M

F. (12 points) Solid Na_2CrO_4 is slowly added to a solution that is 0.0100 M in Pb^{2+} and 0.0062 M Ag^{+} . K_{sp} of PbCrO₄ = 2.0×10^{-14} K_{sp} of $Ag_2CrO_4 = 1.0 \times 10^{-12}$

1. Which compound will begin to precipitate first? Determine the concentration of CrO₄²⁻ to precipitate each cation?

$$|.0\times10^{-12} = (0.0062)^{2} [\text{CrOy}^{2}] \Rightarrow [\text{CrOy}^{2}] = 2.6\times10^{8}$$

$$2.0\times10^{-14} = (0.0100) [\text{Croy}^{2}] \Rightarrow [\text{CrOy}^{2}] = 2.0\times10^{-12}$$

$$|.0\times10^{-14} = (0.0100) [\text{Croy}^{2}] \Rightarrow [\text{Croy}^{2}] = 2.0\times10^{-12}$$

2. What percentage of first cation precipitated when the second cation starts to precipitate?

$$[Pb^{2+}] = 3.8 \times 10^{-5} M$$
 (2pts)

 $\frac{3.8 \times 10^{-5}}{0.0100} \times 100 = 0.38\%$

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Equilibrium Constants for Weak Acids and Their Conjugate Bases

	Acid	Ka	Base	Кь
Sulfurous acid	H ₂ SO ₃	1.7 x 10 ⁻²	HSO₃ ⁻	5.9 x 10 ⁻¹³
Hydrogen sulfate ion	HSO₄¯	1.0 x 10 ⁻²	SO ₄ ² ·	1.0 x 10 ⁻¹²
Phosphoric acid	H₃PO₄	7.1 x 10 ⁻³	H ₂ PO ₄	1.4 x 10 ⁻¹²
Hexaaquairon(III) ion	Fe(H ₂ O) ₆ ³⁺	6.7 x 10 ⁻³	[Fe(H ₂ O) ₅ OH] ²⁺	1.5 x 10 ⁻¹²
Hydrofluoric acid	HF	6.9 x 10 ⁻⁴	F	1.4 x 10 ⁻¹¹
Nitrous acid	HNO ₂	6.0 x 10 ⁻⁴	NO ₂	1.7 x 10 ⁻¹¹
Formic acid	HCHO₂	1.9 x 10 ⁻⁴	CHO ₂	5.3 x10 ⁻¹¹
Lactic acid	HC ₃ H ₅ O ₃	1.4 x 10 ⁻⁴	C ₃ H ₅ O ₃	7.1 x 10 ⁻¹¹
Benzoic acid	HC ₇ H ₅ O ₂	6.6 x 10 ⁻⁵	C ₇ H ₅ O ₂	1.5 x 10 ⁻¹⁰
Acetic acid	HC ₂ H ₃ O ₂	1.8 × 10 ⁻⁵	C ₂ H ₃ O ₂	5.6 x 10 ⁻¹⁰
Hexaaquaaluminum (III) ion	Al(H ₂ O) ₆ ³⁺	1.2 x 10 ⁻⁵	[Al(H ₂ O) ₅ OH] ²⁺	8. 3 x 10 ⁻¹⁰
Carbonic acid	H ₂ CO ₃	4.4 x 10 ⁻⁷	HCO ₃	2.3 x 10 ⁻⁸
Dihydrogen phosphate ion	H ₂ PO ₄	6.2 x 10 ⁻⁸	HPO ₄ ²⁻	1.6 x 10 ⁻⁷
Hydrogen sulfite ion	HSO₃	6.0 x 10 ⁻⁸	SO ₃ ² ·	1.7 x 10 ⁻⁷
Hypochlorous acid	HClO	2.8 x 10 ⁻⁸	ClO-	3.6 x 10 ⁻⁷
Hydrocyanic acid	HCN	5.8 x 10 ⁻¹⁰	CN ⁻	1.7 x 10 ⁻⁵
Ammonium ion	NH ₄ [†]	5.6 x 10 ⁻¹⁰	NH ₃	1.8 x 10 ⁻⁵
Tetraaquazinc (II) ion	Zn(H ₂ O) ₄ ²⁺	 	[Zn(H₂O)₃OH] ⁺	3.0 x 10 ⁻⁵
Hydrogen carbonate ion	HCO ₃	4.7 x 10 ⁻¹¹	CO ₃ ²⁻	2.1 x 10 ⁻⁴
Hydrogen phosphate ion	HPO ₄ ²⁻	4.5 10 ⁻¹³	PO ₄ ³⁻	2.2 x 10 ⁻²