CHEM 1423 - Exam 3 – March 31, 2016 - Version A

Name_____

(60) **PART I. MULTIPLE CHOICE (Circle the ONE correct answer)**

1. The **pH** of a 0.10 M solution of Hypoiodous acid, HIO, is 5.80. What is the approximate Acid Dissociation Constant of HIO?

   (A) 2.5×10^{-11} (B) 1.6×10^{-5} (C) 4.0×10^{-11}

   (D) None of the above

2. The **pH** of a 0.05 M solution of a weak base, B, is 8.6. Therefore, the base equilibrium constant is approximately:

   (A) 1.3×10^{-16} (B) 7.4×10^{-6} (C) 3.2×10^{-10} (D) $1.6 \times 10^{-!1}$

3. Which of the following aqueous solutions is/are basic (pH > 7)?

   (i) Ammonium Chloride (NH_4Cl)
   (ii) Potassium Nitrate (KNO_3)
   (iii) Pyridinium Bromide (PyrHBr)
   (iv) Sodium Cyanide (NaCN)

   (A) i & iv (B) ii & iv (C) i & iii (D) iv only

4. If added to 2 L of 0.40 M HNO_3, which one of the following would form a buffer?

   (A) 1.20 mol of KOH (B) 1.30 mol of sodium acetate (NaAc)

   (C) 1.30 mol of NH_4Cl (D) 0.60 mol of potassium lactate (KLac)

For #5 - #8: Consider the weak base, Quinoline (Quin). Its base equilibrium constant is 6.0×10^{-10} .

5. What is the approximate pH of a 0.05 M solution of Quinoline?

   (A) 11.0 (B) 5.3 (C) 8.7 (D) 9.4

6. What is the approximate **percent protonation** in a 0.05 M solution of Quinoline?

   (A) 5.5×10^{-6} % (B) 1.1×10^{-2} % (C) 5.5×10^{-4} %

   (D) Cannot be determined without the hydroxide concentration, $[OH^-]$

7. What is the approximate pH of a 0.01 M solution of Quinolinium Chloride, (QuinHCl) ?

   (A) 3.4 (B) 5.6 (C) 8.4 (D) 6.3

8. What is the approximate pH of a solution containing 0.60 M Quinoline (Quin) and 0.20 M Quinolinium Chloride (QuinHCl)?

   (A) 4.3 (B) 5.3 (C) 8.7 (D) 9.7

For #9 - #10: Consider the weak acid, hypochlorous acid, HClO. Its acid dissociation constant is 3.0×10^{-8} .

9. What is the approximate percent dissociation of a 0.005 M solution of HClO?

   (A) 2.4×10^{-3} % (B) 3.5×10^{-1} % (C) 2.4×10^{-1} % (D) 3.5%

10. What is the approximate pH of a 0.10 M potassium hypochlorite, KClO, solution?

    (A) 3.7 (B) 4.3 (C) 9.7 (D) 10.3

For #11 - #15: Tellurous acid, H_2TeO_3, is a diprotic acid with acid dissociation constants, $K_a' = 3.0 \times 10^{-3}$ and $K_a'' = 2.0 \times 10^{-8}$

11. What is the approximate pH of a solution containing 0.05 M Na_2TeO_3?

    (A) 10.2 (B) 9.5 (C) 3.8

    (D) None of the above

12. What is the approximate pH of a solution containing pure $KHTeO_3$?

    (A) 7.7 (B) 5.1 (C) 2.5

    (D) The pH depends upon the concentration of $KHTeO_3$

13. What is the approximate pH of a solution containing 0.50 M $KHTeO_3$ and 0.20 M Na_2TeO_3?

    (A) 7.3 (B) 2.9 (C) 2.1 (D) 8.1

14. What is the approximate pH of a solution prepared by adding 0.40 mol of HNO_3 to 2.0 L of 0.30 M $KHTeO_3$?

    (A) 2.0 (B) 2.8 (C) 2.2 (D) 3.4

15. Approximately what ratio of $[TeO_3^{2-}]/[HTeO_3^-]$ will give a pH of 7.30 ?

    (A) 0.20 (B) 2.5 (C) 1.5 (D) 0.40

Version A

For #16 - #18: Consider the amino acid, Histidine (His). The most positive form of Histidine is His^{2+} and the most negative form is His^{1-}. The three pKa's of Histidine are: $pK_a' = 1.8$, $pK_a'' = 6.0$, and $pK_a''' = 9.2$.

16. What is the isoelectric point (pI) of Histidine?

    (A) 3.9 (B) 6.0 (C) 7.6 (D) 1.8

17. At what pH does one have 50% His^{1+} and 50% His^{0} ?

    (A) 6.0 (B) 3.9 (C) 1.8 (D) 7.6

18. What is the average charge on the Histidine molecule at pH = 9.2 ?

    (A) +1.5 (B) +1.0 (C) +0.5 (D) -0.5

19. If one mixes 99. mL of 0.10 M HCl to 100. mL of 0.10 M NaOH, the pH of the resultant solution is approximately:

    (A) 9.0 (B) 10.7 (C) 5.0 (D) 3.3

20. 180 mL of 0.20 M $H_3PO_4(aq)$ is needed to completely neutralize 200 mL of an aqueous NaOH(aq) solution? What is the approximate Molarity of the NaOH(aq) solution?

    (A) 0.54 M (B) 0.06 M (C) 0.18 M

    (D) None of the above

PART II. THREE (3) PROBLEMS BELOW: REMEMBER TO SHOW WORK FOR CREDIT

(10) 1. Pyridine [C_5H_5N = Pyr] is a weak base with a base equilibrium constant, $K_b = 1.8 \times 10^{-9}$. The pH of an aqueous solution containing Pyridinium Bromide [C_5H_5NHBr = PyrHBr, M = 160.] is pH = 3.1. Calculate the mass percent of PyrHBr in the aqueous solution.

Note: Assume that the density of the aqueous solution is 1.0 g/mL.

Version A

(20) 2. Phosphoric Acid (H_3PO_4) is a triprotic acid with acid dissociation constants, $K_a' = 7.5 \times 10^{-3}$, $K_a'' = 6.2 \times 10^{-8}$ and $K_a''' = 3.6 \times 10^{-13}$

(7) (a) Calculate the pH of a solution prepared by mixing 350 mL of 0.60 M HCl with 800 mL of 0.40 M K_3PO_4.

(7) (b) Calculate the pH of a solution prepared by mixing 900 mL of 0.50 M KOH with 700 mL of 0.40 M H_3PO_4.

(6) (c) Calculate the ratio, $[H_3PO_4]/[H_2PO_4^-]$ required to prepare a buffer solution with pH = 2.62.

(10) 3. When 7.50 grams of a sample of impure Calcium Hydroxide [$Ca(OH)_2$, M = 74.1] is titrated with 0.35 M H_3PO_4, it takes 150. mL of H_3PO_4 to completely titrate the base. Calculate the **mass percent of impurity** in the Calcium Hydroxide sample.

CHEM 1423 - Exam 3 – March 31, 2016 - Version B

Name_____

(60) **PART I. MULTIPLE CHOICE (Circle the ONE correct answer)**

1. Which of the following aqueous solutions is/are basic (pH > 7)?

   (i) Ammonium Chloride (NH_4Cl)
   (ii) Potassium Nitrate (KNO_3)
   (iii) Pyridinium Bromide (PyrHBr)
   (iv) Sodium Cyanide (NaCN)

   (A) iv only (B) ii & iv (C) i & iii (D) i & iv

2. If added to 2 L of 0.40 M HNO_3, which one of the following would form a buffer?

   (A) 1.20 mol of KOH (B) 0.60 mol of potassium lactate (KLac)

   (C) 1.30 mol of NH_4Cl (D) 1.30 mol of sodium acetate (NaAc)

3. The **pH** of a 0.05 M solution of a weak base, B, is 8.6. Therefore, the base equilibrium constant is approximately:

   (A) $1.3x10^{-16}$ (B) $3.2x10^{-10}$ (C) $7.5x10^{-6}$ (D) $1.6x10^{-!1}$

4. The **pH** of a 0.10 M solution of Hypoiodous acid, HIO, is 5.80. What is the approximate Acid Dissociation Constant of HIO?

   (A) $4.0x10^{-11}$ (B) $1.6x10^{-5}$ (C) $2.5x10^{-11}$

   (D) None of the above

For #5 - #8: Consider the weak base, Quinoline (Quin). Its base equilibrium constant is $6.0x10^{-10}$.

5. What is the approximate pH of a 0.01 M solution of Quinolinium Chloride, (QuinHCl) ?

   (A) 5.6 (B) 3.4 (C) 8.4 (D) 6.3

6. What is the approximate pH of a solution containing 0.60 M Quinoline (Quin) and 0.20 M Quinolinium Chloride (QuinHCl)?

   (A) 4.3 (B) 9.7 (C) 8.7 (D) 5.3

7. What is the approximate pH of a 0.05 M solution of Quinoline?

   (A) 8.7 (B) 5.3 (C) 11.0 (D) 9.4

Version B

8. What is the approximate **percent protonation** in a 0.05 M solution of Quinoline?

   (A) 5.5×10^{-6} % (B) 5.5×10^{-4} % (C) 1.1×10^{-2} %

   (D) Cannot be determined without the hydroxide concentration, $[OH^-]$

For #9 - #13: Tellurous acid, H_2TeO_3, is a diprotic acid with acid dissociation constants, $K_a' = 3.0 \times 10^{-3}$ and $K_a'' = 2.0 \times 10^{-8}$

9. What is the approximate pH of a solution containing pure $KHTeO_3$?

   (A) 5.1 (B) 7.7 (C) 2.5

   (D) The pH depends upon the concentration of $KHTeO_3$

10. What is the approximate pH of a solution containing 0.05 M Na_2TeO_3?

    (A) 9.5 (B) 10.2 (C) 3.8

    (D) None of the above

11. What is the approximate pH of a solution containing 0.50 M $KHTeO_3$ and 0.20 M Na_2TeO_3?

    (A) 8.1 (B) 2.9 (C) 2.1 (D) 7.3

12. What is the approximate pH of a solution prepared by adding 0.40 mol of HNO_3 to 2.0 L of 0.30 M $KHTeO_3$?

    (A) 2.0 (B) 2.8 (C) 2.2 (D) 3.4

13. Approximately what ratio of $[TeO_3^{2-}]/[HTeO_3^-]$ will give a pH of 7.30 ?

    (A) 0.20 (B) 2.5 (C) 1.5 (D) 0.40

For #14 - #15: Consider the weak acid, hypochlorous acid, HClO. Its acid dissociation constant is 3.0×10^{-8} .

14. What is the approximate pH of a 0.10 M potassium hypochlorite, KClO, solution?

    (A) 10.3 (B) 4.3 (C) 9.7 (D) 3.7

15. What is the approximate percent dissociation of a 0.005 M solution of HClO?

    (A) 2.4×10^{-3} % (B) 2.4×10^{-1} % (C) 3.5×10^{-1} % (D) 3.5%

Version B

For #16 - #18: Consider the amino acid, Histidine (His). The most positive form of Histidine is His^{2+} and the most negative form is His^{1-}. The three pKa's of Histidine are: $pK_a' = 1.8$, $pK_a'' = 6.0$, and $pK_a''' = 9.2$.

16. At what pH does one have 50% His^{1+} and 50% His^{0} ?

    (A) 1.8 (B) 3.9 (C) 6.0 (D) 7.6

17. What is the average charge on the Histidine molecule at pH = 9.2 ?

    (A) +1.5 (B) +1.0 (C) +0.5 (D) -0.5

18. What is the isoelectric point (pI) of Histidine?

    (A) 7.6 (B) 6.0 (C) 3.9 (D) 1.8

19. 180 mL of 0.20 M $H_3PO_4(aq)$ is needed to completely neutralize 200 mL of an aqueous NaOH(aq) solution? What is the approximate Molarity of the NaOH(aq) solution?

    (A) 0.18 M (B) 0.06 M (C) 0.54 M

    (D) None of the above

20. If one mixes 99. mL of 0.10 M HCl to 100. mL of 0.10 M NaOH, the pH of the resultant solution is approximately:

    (A) 9.0 (B) 10.7 (C) 5.0 (D) 3.3

PART II. THREE (3) PROBLEMS BELOW: REMEMBER TO SHOW WORK FOR CREDIT

(10) 1. Pyridine [C_5H_5N = Pyr] is a weak base with a base equilibrium constant, $K_b = 1.8 \times 10^{-9}$. The pH of an aqueous solution containing Pyridinium Bromide [C_5H_5NHBr = PyrHBr, M = 160.] is pH = 2.8. Calculate the mass percent of PyrHBr in the aqueous solution.

Note: Assume that the density of the aqueous solution is 1.0 g/mL.

Version B

(20) 2. Phosphoric Acid (H_3PO_4) is a triprotic acid with acid dissociation constants, $K_a' = 7.5 \times 10^{-3}$, $K_a'' = 6.2 \times 10^{-8}$ and $K_a''' = 3.6 \times 10^{-13}$

(7) (a) Calculate the pH of a solution prepared by mixing 350 mL of 0.60 M HCl with 850 mL of 0.40 M K_3PO_4.

(7) (b) Calculate the pH of a solution prepared by mixing 900 mL of 0.50 M KOH with 650 mL of 0.40 M H_3PO_4.

(6) (c) Calculate the ratio, $[H_3PO_4]/[H_2PO_4^-]$ required to prepare a buffer solution with pH = 2.66.

(10) 3. When 7.80 grams of a sample of impure Calcium Hydroxide [$Ca(OH)_2$, M = 74.1] is titrated with 0.35 M H_3PO_4, it takes 150. mL of H_3PO_4 to completely titrate the base. Calculate the **mass percent of impurity** in the Calcium Hydroxide sample.