Chem 103 First Midterm Exam Guide Summer, 2009

Test #1 will be on July 17,2009 Friday. There may be a review session 1-2 pm Wednesday at PS 607 (to be confirmed)

The test will mainly focus on material in Chapters 15,16 and 17 (up to section 17.3 only). Study your lecture notes and homework assignments. Expect to solve problems. Test yourselves by doing problems similar to the homework and practice problems under time constraints. Midterm problems are usually harder than the practice problems. But if you understand the concepts fully, you should be able to do these problems within 10-15 minutes. If you have not been practicing problem solving, then don't expect to do well unless you study and practice further to improve your speed and test taking skills.

The following topics are mentioned to help focus (but **not** limit) your review:

Chapter 15: Solutes and Solutions:
Understand the process of dissolution and the enthalpies involved. Effect of T on the solubility of solids and gases and why it is so. Solubility of gases and Henry's Law. Know concentration units: molarity, molality, %(w/w), %(w/v), %(v/v), ppm, ppb, X.
Know how to convert from one to the other (look at the examples in the book for your practice). It is not a bad idea to practice the use of conversion factors – which you learned in Chem 101. Can you convert from molarity to molality knowing the density of the solution and the molar weight of the solute? Under what conditions is M and m almost the same? Know the various **colligative properties** and be able discuss and calculate values related to these colligative properties: Raoult's Law, effects on T_b and T_f. Osmotic pressure and the various aspects of osmotic pressure: isotonic, hypotonic, etc solutions. What are colloids (and their components), surfactants (describe them chemically) and micelles. Read up on the water in our planet. How much is there available and why is it such a precious resource? Read up on municipal water purification. What are the methods to disinfect water and what are the advantages or disadvantages of each one?

Chapter 16-17 Acid base equilibria and aqueous solutions (including K_{sp} and K_f)
Know the following: Arrhenius, Bronsted-Lowry and Lewis definitions of acids and bases, strength of acids, Buffers. Acid base titrations. Determination of pH for various types of solutions: a) strong acid, b) strong base, c) weak acid, d) weak base, e) buffers. Calculate pH at various points in a titration – both monoprotic and polyprotic cases. Be able to draw the pH curves by hand. Know about Indicators, solubility and complex formation equilibria. Chelation. Solve equilibria of the following types: K_a, K_b , K_{sp} , K_f .

The following questions are designed to **drill** you in **problem solving** involving pH for your review. Please don't limit yourself to this review. Read the chapter well and know the core concepts well. Look at problems from different angles. (Please don't expect an answer key for this guide). There are other areas which are not included below.

_____ (1) What is the pH of a 0.00010 M HNO_3 solution?

_____ (2) What is the pH of a 0.00010 M NaOH solution?

_____ (3) What is the pH of a solution made up by adding 100. mL of .00010 M HCl to 50.0 mL of 1.0 $x10^{-4}$ M NaOH?

_____ (4) What is the pH of a solution made up by adding 100. mL of 1.0 $x10^{-4}$ M NaOH to 50. mL of .00010 M HCl?

_____ (5) What is $[H^+]$ in a solution made up by mixing 1.0 mL 1.0 M HCl and 99.0 mL water?

_____ (6) What is the $[H^+]$ in a solution of 0.10 M HOAc (acetic acid, $K_a = 1.8 \times 10^{-5}$)?

_____ (7) What is the pH of a solution of 0.10 M NaOAc ($K_a = 1.8 \times 10^{-5}$M for HOAc)?

_____(8) What is the pOH of a solution of 0.10 M NH_3 (ammonia, $K_b = 1.8x\ 10^{-5}$ M?

_____ (9) What is the pH of a solution containing $1.0x10^{-3}$ M NH_3 and .020M NH_4Cl?

_____ (10) what is the $[H^+]$ of a solution containing acetic acid and a pH of 3.56?

_____ (11) What is the $[OH^-]$ of a solution containing a pH of 3.0?

_____(12) A weak acid has a $K_a = 1.0x10^{-4}$. What is its pK_a?

_____(13) A weak acid has a $K_a = 1.0x10^{-4}$. What is the K_b for its conjugate base?

_____(14) A weak acid has a $K_a = 1.0x10^{-4}$. What is the pK_b for its conjugate base?

_____(15) A diprotic acid, H_2A, has pK's 8.4 and 3.5. What is the K_a of H_2A?

_____(16) A diprotic acid, H_2A, has pK's 8.4 and 3.5. What is the pK_{b1}?

_____ (17) A diprotic acid, H_2A, has pK's 8.4 and 3.5. Write the chemical equilibrium equation and value for K_{b1}.

_____ (18) A 22.5 mL HCl solution requires 18.5 mL of 0.15 M KOH to reach equivalence. What is $[HCl]_o$?

_____ (19) A 22.5 mL of H_2SO_4 solution requires 18.5 mL of 0.15 M KOH for complete neutralization. What is $[H_2SO_4]_o$?

_____ (20) Draw the qualitative pH titration curve for problems (18) and (19). (pK_a for HSO_4^- is 2.0).

_____ (21) Titration of 0.394g of sulfamic acid takes 20.mL of 0.10 M HCl to reach equivalence. What is the MW of sulfamic a.?

_____ (22) A diprotic acid, H_2A, has pK's 8.4 and 3.5. 50.0 mL of 0.10M of the diprotic acid, H_2A, is titrated with 0.20 M NaOH. What is the V_e (i.e. the first equivalence point)?

_____ (23) A diprotic acid, H_2A, has pK's 8.4 and 3.5. 50.0 mL of 0.10M of the diprotic acid, H_2A, is titrated with 0.20 M NaOH. What is the pH at the following volumes of NaOH added: 0 , 2.0 mL, 12.5 mL, 25.0 mL, 30.0 mL, 37.5 mL. 50.0 mL. 56.0 mL

_____ (24) A diprotic acid, H_2A, has pK's 8.4 and 3.5. 50.0 mL of 0.10M of the diprotic acid, H_2A, is titrated with 0.20 M NaOH. Draw the pH titration curve. Below it, show the fractions, a, of the acid present.

_____ (25) Suppose that the concentration of bromide ions is $7.3x10^{-7}$M in a solution saturated with AgBr. What is the K_{SP} of AgBr? (skip for now)

_____ (26) What is the solubility of Ag_2CO_3 (pK_{sp} = 11.07) in pure water? (skip for now)

_____ (27) What is the solubility of Ag_2CO_3 (pK_{sp} = 11.07) in 0.10 M K_2CO_3? (skip for now)

_____ (28) What is the solubility of $Ca(OH)_2$ (pK_{sp}=5.30) in pH 13 buffer? (skip for now)

_____ (29) Go over Example 17-16 to practice K_f equilibria. (skip for now)

_____ (30) What is the fraction of acetate, a_{OAC^-}, in a 1.0M HOAc –NaOAc buffer whose pH if 4.4? (pK_a=4.75 for HOAc)

_____ (31) If [HOAc] = 0.500 M in a pH 5.00 acetic acid-sodium acetate buffer, what is [OAc^-]?

_____ (32) Suppose a triprotic zwitterion has the most acid form, H_3A^+ , and pK_a's of 3.0, 6.0 and 10.0. What is the pH of the following solutions: a) 1.0 M H_3ACl (ie. the chloride salt); b) 1.0 M H_2A; c) 1.0 M NaHA (ie the sodium salt); d) 1.0 M Na_2A (i.e. the disodium salt); e) its isoelectric point.

_____ (33) A solution containing a weak monoprotic acid, HX, of unknown K_a is prepared as follows: 50.0 mL of 0.10 M NaOH is added to 20. mL of 0.40M HX resulting in a solution of pH 3.50. What is K_a for HX?

_____ (34) 1.70 g of a weak base, B (pK_b = 11.00) is dissolved in 35.0 mL of 0.20 M HCl, resulting in a pH 2.73 solution. What is the molecular weight of B?

_____ (35) Determine the molar solubility of $PbCl_2$ (pK_{sp}= 4.77) in pure water. (skip for now)

_____ (36) Determine the molar solubility of CuCl (pK_{sp}= 6.76) in 1.00 x 10^{-3}M NaCl. Use quadratic formula if appropriate. (compare your 2 answers : one with short cut and the other using the quadratic equation). (skip for now)

_____ (37) Determine the molar solubility of $La(OH)_3$ (pK_{sp} = 18.6) in pure water. (skip for now)

_____ (38) Determine the molar solubility of $La(OH)_3$ (pK_{sp} = 18.6) in a solution buffered at pH 10.60. (Hint what is [OH^-]=?) (skip for now)

_____ (39) What is the pH of the following solutions:

a) 0.042M HCl (1.38)

b) 3.0 x 10^{-2}M NaOH (12.48)

c) 0.25 M acetic acid. (K_a = 1.8 x 10^{-5}) (2.67)

d) 1.2x10^{-1}M NH_3 (K_b = 1.8x10^{-5}) (11.17)

(40) Indicate whether aqueous solutions containing the solutes below would be expected to be acidic, basic or neutral solutions?

a) NH_4NO_3 b) K_2CO_3 c) KBr d) HCO_2H

(41) If the pH of a potassium formate ($KCHO_2$) is 8.72, what is the concentration of this potassium formate solution? (note: pK_a of $HCHO_2$ = 4.75) (0.049M)

(42) How would you prove that the reaction of HCl with sodium acetate would have virtually 100% completion? ($K_a = 1.8x10^{-5}$). Hint: start with the net ionic equation for this reaction and get K for this reaction.

(43) If the pH of an ammonium chloride (NH_4Cl) is 5.05, what is the concentration of this ammonium chloride solution? (note: pK_b of NH_3 = 4.72) (0.15M)

(45) What is the K_b for the conjugate base of gallic acid if a 0.100 M solution of gallic acid has a pH of 2.704. ($2.51x10^{-10}$)

(46) Write the K_a equilbrium (and the expression for K_a)for the weak acid complex ion, $Fe(H_2O)_6^{2+}$.