CHEM 36

General Chemistry

EXAM #3

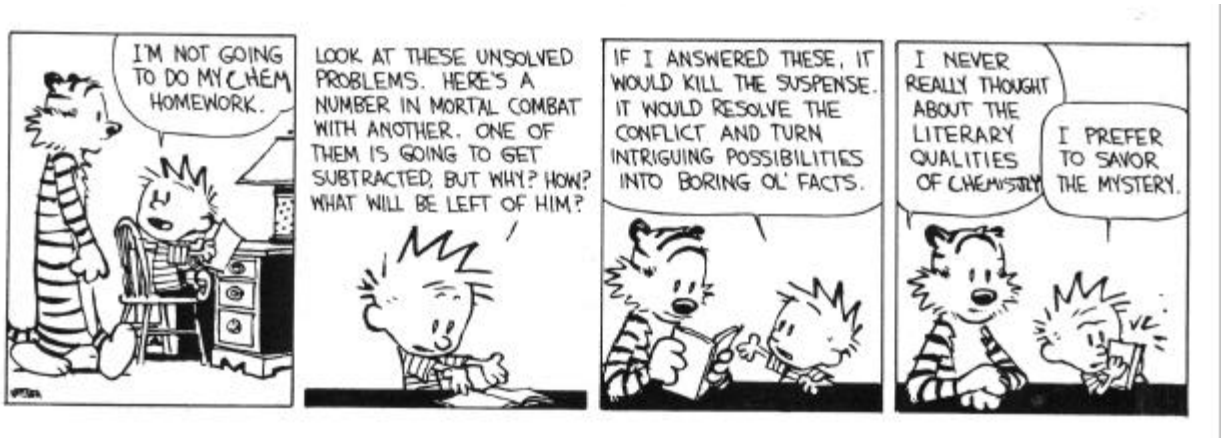
April 17, 2002

Name:_____

INSTRUCTIONS: Read through the entire exam before you begin. Answer all of the questions. For questions involving calculations, show **all** of your work -- **HOW** you arrived at a particular answer is **MORE** important than the answer itself! Circle your final answer to numerical questions.

The entire exam is worth a total of 150 points. Attached are a periodic table and a formula sheet jam-packed with useful stuff. Good Luck!

Page	Possible Points	*Points Earned*
2	25	
3	25	
4	25	
5	25	
6	20	
7	30	
TOTAL:	***150***	



1. a. ***[15 pts]*** How many grams of aluminum hydroxide will saturate 50.0 mL of water at 25 ^{o}C? The solubility-product constant for the dissolution

$$Al(OH)_3\ (s) \leftrightarrows Al^{3+}\ (aq) + 3OH^-\ (aq)$$

is $K_{sp} = 1.9 \times 10^{-33}$.

b. ***[10 pts]*** Would $Al(OH)_3$ be **more soluble** or **less soluble** in an *acidic* solution than in pure water? Explain.

2. The Mohr method is a technique for determining the amount of chloride ion in an unknown sample. It is based on the difference in solubility between silver chloride (AgCl; K_{sp} = 1.6 x 10^{-10}) and silver chromate (Ag_2CrO_4; K_{sp} = 1.9 x 10^{-12}). In this method, one adds a small amount of chromate ion to a solution with unknown chloride concentration. By measuring the volume of $AgNO_3$ added before the appearance of the red silver chromate, one can determine the amount of Cl^- originally present.

    a. ***[10 pts]*** Suppose we have a solution that is 0.100 *M* in Cl^- and 0.00250 *M* in CrO_4^{2-}. If we add 0.100 *M* $AgNO_3$ solution drop by drop, will AgCl or Ag_2CrO_4 precipitate first? Justify your answer with a calculation.

    b. ***[15 pts]*** When Ag_2CrO_4 first appears, what fraction of the Cl^- that was originally present remains?

3. Vitamin C is ascorbic acid ($HC_6H_7O_6$) which has a $K_a = 8.0 \times 10^{-5}$.

   a. ***[10 pts]*** Calculate the pH of a 8.0×10^{-1} M solution of ascorbic acid.

   b. ***[15 pts]*** 40.0 mL of a 0.500 M NaOH solution is added to 25.00 mL of the ascorbic acid solution described above. Calculate the pH of the resultant solution.

4. a. ***[10 pts]*** Calculate the pH in a solution prepared by dissolving 0.050 mol of acetic acid (K_a = 1.76 x 10^{-5}) and 0.020 mol of sodium acetate in water and adjusting the volume to 500. mL.

b. ***[15 pts]*** 0.010 mol of NaOH is added to the buffer from part a of this question. Calculate the pH of the solution that results (assume that the total volume of the solution remains at 500. mL).

5. ***[10 pts each]*** Complete and balance (using the half-reaction method) the following redox reactions (NOTE: you must show ALL of your work in order to receive credit for your answer!):

   a. <u>In acidic solution:</u> $H_2S\ (aq) + NO_3^-\ (aq) \rightarrow S\ (s) + NO\ (g)$

   b. <u>In basic solution:</u> $Fe\ (s) + NiO_2\ (s) \rightarrow Fe(OH)_2\ (s) + Ni(OH)_2\ (s)$

6. ***[5 pts]*** Using the attached Table of Standard Reduction Potentials, circle the stronger oxidizing agent in each of the following pairs:

   a. Ba^{2+} (aq) Ca^{2+}

   b. Cu (s) Fe^{2+}

7. ***[5 pts]*** Using the attached Table of Standard Reduction Potentials, circle the stronger reducing agent in each of the following pairs:

   a. Zn (s) Ca (s)

   b. I^- (aq) F^- (aq)

8. For the following galvanic cell:

$$Fe\ (s)|Fe^{2+}\ (aq)||Ag^+\ (aq)|Ag\ (s)$$

   a. ***[5 pts]*** Write the balanced chemical equation for the half-reaction occurring at the anode.

   b. ***[5 pts]*** Write the balanced chemical equation for the half-reaction occurring at the cathode.

   c. ***[10 pts]*** Using the attached Table of Standard Reduction Potentials, calculate the cell voltage, assuming that all reactants and products are in their standard states.

Extra Credit! -- 10 pts

A universal acid/base indicator is easily made by boiling purple cabbage with the resulting aromatic solution producing dramatic color changes over a wide range of pH's. (Gee, this would make a really neat demo!)

Arrange the following five solutions in order of INCREASING pH and give the color of the cabbage indicator solution for each.

Pure Water
1.0 M NaOH
1.0 M HCl
1.0 M Acetic Acid (HAc)
1.0 M NH_3