Chemistry 10123, **Exam 2** Name: _____
February 26, 2020 (Please Print)

1. **SHOW ALL WORK.** ***Include balanced chemical equations for any <u>equilibrium</u> reactions and clearly state any assumptions where appropriate.*** The K_{sp} value for cobalt(II) hydroxide, $Co(OH)_2$, is 1.0×10^{-15}. The formation constant (K_f) for the cobalt(II)-ammonia complex ion, $[Co(NH_3)_6]^{2+}$, is 5.0×10^4.

   (a) (10 points) Calculate the pH of a ***saturated solution*** of $Co(OH)_2$ in water.

   (b) (8 points) Calculate the ***molar solubility*** of $Co(OH)_2$ in a 0.50 M NaOH solution.

   (b) (10 points) Calculate the ***molar solubility*** of $Co(OH)_2$ in a 0.50 M NH_3 solution.

2. (8 points) **SHOW ALL WORK.** In a 1.00 M solution of a certain diprotic acid H_2A, the pH was found to be 1.91 and the equilibrium molar concentration of A^{2-} was measured as 5.0×10^{-7} M. Determine both the pK_{a1} and pK_{a2} values for this acid.

3. (8 points) **SHOW ALL WORK.** Silver phosphate, Ag_3PO_4 (molar mass = 418.6), is a sparingly soluble salt. A saturated aqueous solution of this salt contains only 7.50 mg of Ag_3PO_4 per liter of solution. Calculate the solubility product constant (K_{sp}) of Ag_3PO_4.

4. (12 points) Write a ***balanced chemical equation*** for the ***<u>equilibrium</u>*** reaction that corresponds to each of the following equilibrium constants.
(e. g., K_w for H_2O would be: $2\ H_2O \rightleftharpoons H_3O^+ + OH^-$)

   (a) K_{sp} for $Fe_2(CO_3)_3$

   (b) K_a for HN_3

   (c) K_b for $HONH_2$

   (d) K_f for $Cu(CN)_4^{2-}$

5. **SHOW ALL WORK.** Calculate the pH of each of the following solutions. ***Include balanced net-ionic equations for any <u>equilibrium</u> reactions and clearly state any assumptions where appropriate.***

(a) (7 points) Solution **A**: 0.15 M HNO_3

(b) (7 points) Solution **B**: 0.15 M $Ba(OH)_2$

(c) (12 points) Solution **C**: 0.500 M NH_4NO_3 (The pK_b value of NH_3 is 4.74)

6. Suppose you had 100.0 mL of each of the same three solutions in problem 5 above:

Solution **A**: 100.0 mL of 0.15 M HNO_3

Solution **B**: 100.0 mL of 0.15 M $Ba(OH)_2$

Solution **C**: 100.0 mL of 0.500 M NH_4NO_3 (The pK_b value of NH_3 is 4.74)

(a) (8 points) It is possible to prepare a ***buffer solution*** by mixing together the complete volumes of two of these solutions. Which two are they? Circle your answer.

A and **B** **A** and **C** **B** and **C**

Briefly explain your answer (50 words max!). Include the ***balanced net-ionic equation*** for the ***reaction that occurs <u>upon mixing</u>*** the solutions.

(b) (10 points) **SHOW ALL WORK.** Calculate the pH of this buffer solution. ***Include a balanced chemical equation for the main <u>equilibrium</u> reaction in this solution.***

7. **EXTRA CREDIT.** (5 points) **SHOW ALL WORK.** Now suppose that the ***complete volumes of <u>all three</u>*** of the above solutions (i.e., **A**, **B**, and **C**) are mixed together. Calculate the pH of the final solution.