Chem 303 Exam 1. March 9, 2006. Take-Home Test
Name_____

You may use your textbook, and notes on this part of the exam. You may not work with other people on this part of the exam. You may use a spreadsheet to determine the activity coefficients, but you must include the spreadsheet (an understandable version) with your exam. Show ALL work for credit. This portion is due by 5:00 PM Monday March 20.

(1) Statistics

Student Group 1 tests an unknown for Ca^{2+} content by EDTA titration with the following results: 121.4 ppm, 124.8 ppm, 120.7 ppm, and 124.9 ppm

Student Group 2 tests the same sample as group 1, but uses Atomic Absorption Spectroscopy with the following result: 125 ppm, 126 ppm, 126 ppm, and 124 ppm.

(a)(15 points) Calculate the means, standard deviations, and the error at 95% CL for the two samples

(b) (10 points) Can you say that the two samples tested (by the two groups) were different samples?

(c)(10 points) Use the F test to determine if there is a significant difference in the precision of the two tests (at the 95% CL).

(d)(5 points) Can a point be discarded by the Q test for either of the two samples above (if yes, show the work)?

(2) Calculate the $[Ba^{2+}]$ in each of the following solutions when saturated with barium hydroxide ($K_{sp} = 3.0 \times 10^{-4}$).
(a)(5 pts) $Ba(OH)_2$ in distilled water (neglect activities)

(b)(15 pts) $Ba(OH)_2$ in distilled water (do NOT neglect activities). Use the Debye-Hückel equation for activities.

(3)(25 points) (Note: You may neglect activity for this problem) A student wants to test water for Fe^{2+} content by precipitation with NaOH.

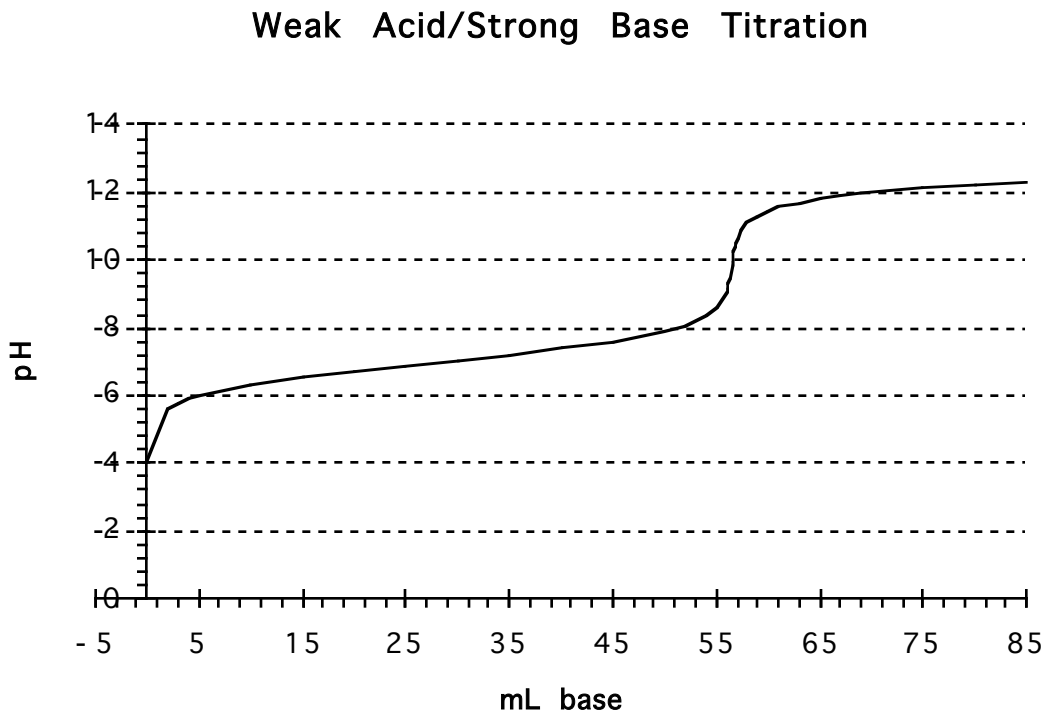
(a) If the lowest concentration of Fe^{2+} expected is 3×10^{-5} M, what is the lowest pH that can be used to precipitate 99.9% of the $Fe^{2+?}$

(b) If Cu^{2+} is present in the water sample with $[Cu^{2+}] = 1 \times 10^{-9}$ M. At what pH will $Cu(OH)_2$ begin to precipitate? How much Fe^{2+} will be present at this point?

(c) Will the presence of the Cu^{2+} cause a problem?

(4) (15 points) How would you prepare a 1.00 L solution of pH = 7.00 buffer from Na_2HPO_4 and NaH_2PO_4 with an ionic strength of 0.300?

(5) A 50.0 mL sample of a 0.100 M weak acid was titrated with NaOH.



pH	Volume
9.14	56.10
9.21	56.15
9.93	56.60
10.22	56.70
10.49	56.87
11.09	58.00

Indicator	pH of Transition
Congo Red	3.0-5.0
Methyl Red	4.8-6.0
Cresol Purple	7.6-9.2
Thymolpthalein	8.3-10.5
Alizarin yellow	10.1-12.0

(a)(10 points) If the K_a for this acid is 3.5×10^{-7}, what is the pH at the equivalence point (which is 56.50 mL of base)?

(b)(5 points) If cresol purple is used as the indicator and the endpoint is noticed at pH = 9.21, what is the difference (in mL of NaOH) between the endpoint and the equivalence point? What %error is this?

(c)(5 points) If thymolphtalein is used as the indicator and the endpoint is noted at pH = 10.49 what is the difference (in mL of NaOH) between the endpoint and the equivalence point? What is the % error caused by the indicator?

(6)(20 points) Construct the titration curve for a weak base with a $K_b = 4.5 \times 10^{-9}$. Use a spreadsheet and plot the curve as in Problem 5 above. Use a 50.0 mL sample of the 0.100 M base to start with and titrate it with 0.0885 M HNO_3. List explicitly the initial pH and the equivalence point and it's pH. Calculate the point for every 0.5 mL (on the mL). Include the worksheet as well as the graph (please explain it so it is easy to understand). Do you think a color indicator would work well with this titration?

(7)(20 points) For phosphoric acid, calculate the fractional composition (alpha values) for all species in solution as a function of pH. See pages 420-421 in your books for some ideas. Do this in a spreadsheet and graph it.