Chemistry 222 **Name**_____
Exam 3: Chapters 8-10 **Fall 2010**
80 Points

Complete five (5) of the following problems. Each problem is worth 16 points. CLEARLY mark the problems you do not want graded. You must show your work to receive credit for problems requiring math. Report your answers with the appropriate number of significant figures.

1. Concisely discuss the validity of the following statements: (8 points each)
   a. A buffer solution is most effective at a pH within ±1 unit of the pK_a for the acid used to make the buffer.

   b. While the pH of a buffer is effectively independent of dilution, the capacity of the buffer diminishes as it becomes more dilute.

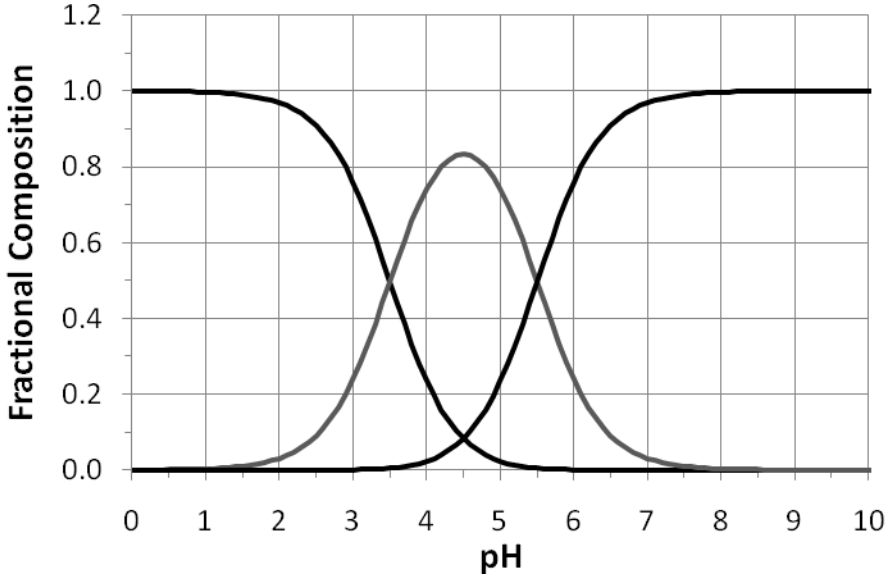
2. Why is every titration where an indicator is used to determine the endpoint subject to titration error? Describe the appropriate choice and use of an indicator help minimize titration error.

3. Calculate the pH of the following solutions: (8 points each)
   a. A 3.6×10^{-8} F solution of HNO_3.

   b. A solution prepared by adding 7.21 mL of 2.14 M NaOH to 1.00 g of hypochlorous acid (HOCl, molar mass 52.46 g/mol, $pK_a = 7.53$), 1.00 g sodium hypochlorite (NaOCl, molar mass 74.44 g/mol) and diluting to 100.0 mL.

4. You need to prepare a pH 4.50 buffer by adjusting the pH of 200.0 mL of a 0.200 M solution of monosodium oxalate ($NaHC_2O_4$). The only acid and base solutions you have available are 100 mL of 0.100 M NaOH, and 100 mL of 0.100 M HCl. Given these solutions, can you make your buffer? Justify your answer with appropriate calculations.
(For oxalic acid, $pK_{a1} = 1.252$, $pK_{a2} = 4.266$.)

5. Consider the fractional composition plot for a weak, diprotic acid (H_2A) below.



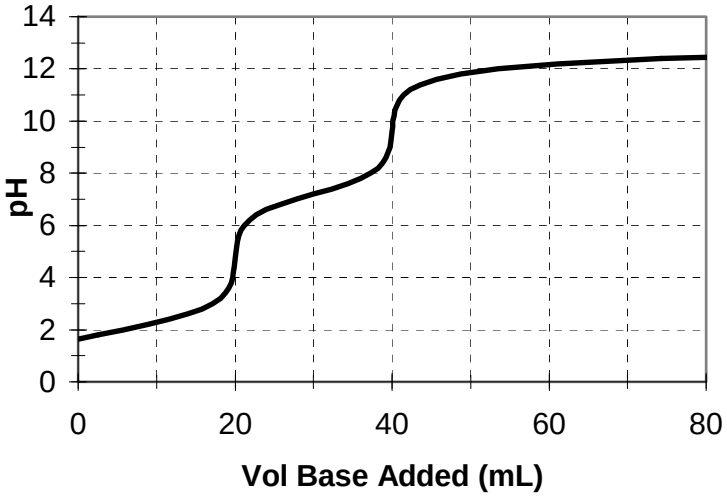
a. On the plot, clearly label the lines that correspond to α_{H2A}, α_{HA^-}, α_{A2^-}

b. Estimate pK_{a1} and pK_{a2} and explain how you arrived at your estimates.

c. For this acid, is it possible to prepare a solution where 99% of the acid is present as HA^-? Justify your answer in terms of the tendencies of the equilibria occurring in solution.

6. I've asked you to go into the lab and help me prepare some unknowns for a new acid/base titration experiment we are considering. Unfortunately, I have neglected to label one solution and am nowhere to be found. To identify the solution, you construct the titration curve below by titrating 20.00 mL of the acid solution with standard 0.100 M NaOH. From the titration curve and the list of possible solution compositions below, identify the composition of the solution. Justify your reasoning by explaining why how you were able to rule out the imposters and choose the appropriate identity.

Solution	pK_a
A: 0.100 M H_2SO_4	strong, 2.00
B: 0.100 M phosphoric acid	2.15, 7.20, 12.35
C: 0.100 M succinic acid	4.21, 5.64
D: 0.030 M HCl and 0.070 M acetic acid	strong, 4.76



Possibly Useful Information

$\left[H^+\right] = \sqrt{\frac{K_{a1}K_{a2}F + K_{a1}K_w}{K_{a1} + F}} \approx \sqrt{K_{a1}K_{a2}}$	$pH = \frac{1}{2}\left(pK_{a1} + pK_{a2}\right)$
$pH = pK_a + \log\frac{\left[\text{conjugate base}\right]}{\left[\text{weak acid}\right]}$	$\alpha_{H_2A} = \frac{\left[H^+\right]^2}{\left[H^+\right]^2 + \left[H^+\right]K_{a1} + K_{a1}K_{a2}}$
$K_w = 1.0 \times 10^{14} = [H^+][OH^-]$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$