Chemistry 222 **Name**_____
Spring 2016 **80 Points**
Exam 3: Chapters 8-10

Complete problem 1 and four of problems 2-6. CLEARLY mark the problem 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. You may ignore activity coefficients in all problems.

You MUST complete problem 1. (16 pts.)

1. Find the pH of a solution prepared by dissolving all of the following compounds in water in one beaker and diluting to a volume of 0.500 L: 0.100 mol acetic acid ($pK_a = 4.76$), 0.100 mol sodium acetate, 0.030 mol HNO_3, and 0.040 mol NaOH.

Do <u>four</u> of problems 2-6. Clearly mark the problem you do not want graded. (16 pts. ea.)

2. Your new employer has asked you to prepare 1.00 L of a pH 7.00 buffer with a total phosphate concentration of 0.0500 M. You have at your disposal only the following compounds

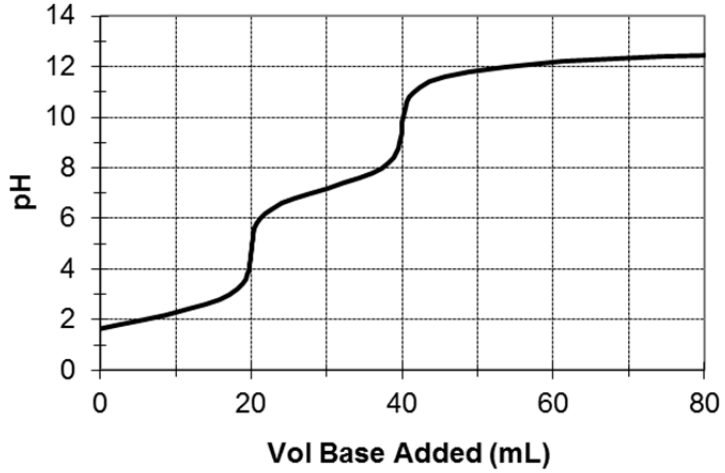
Compound	K_a	Molar Mass (g/mol)
H_3PO_4	7.11×10^{-3}	97.9950
NaH_2PO_4	6.34×10^{-8}	119.9769
Na_2HPO_4	4.22×10^{-13}	141.9588
Na_3PO_4	--	163.9407

   a. Which two compounds would you use to prepare a buffer of pH 7.00 and how many grams of each of the two selected compounds would you need? (12 points)

   b. If you did exactly what you calculated in part (a), you would not get a pH of *exactly* 7.00. Why? Explain how you would really prepare this buffer in lab. (4 points)

3. 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 how you were able to rule out each of the imposters and choose the appropriate identity*.

Solution	pK_a
A: 0.100 M maleic acid	1.83, 6.07
B: 0.100 M succinic acid	4.21, 5.64
C: 0.100 M phosphoric acid	2.15, 7.20, 12.35
D: 0.030 M HCl and 0.070 M acetic acid	strong, 4.76



4. Calculate the pH of 1.6×10^{-7} M calcium hydroxide (a strong base). What fraction of the total OH^- in this solution is from the calcium hydroxide?

5. You are asked to prepare 200.0 mL of a 0.150 F benzoate buffer at pH 4.50 using only pure benzoic acid (MW= 122.125 g/mol, pK_a=4.20), 3.00 M NaOH, and water. What mass of benzoic acid (in grams) and what volume of 3.00 M NaOH (in mL) will you need to prepare this buffer?

6. A weak diprotic acid, H_2A, has acid dissociation constants of $K_{a1} = 3.06 \times 10^{-4}$ and $K_{a2} = 3.37 \times 10^{-11}$. Calculate the pH and molar concentrations of H_2A, HA^-, and A^{2-} at equilibrium for a 0.140F solution of NaHA.

Possibly Useful Information

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