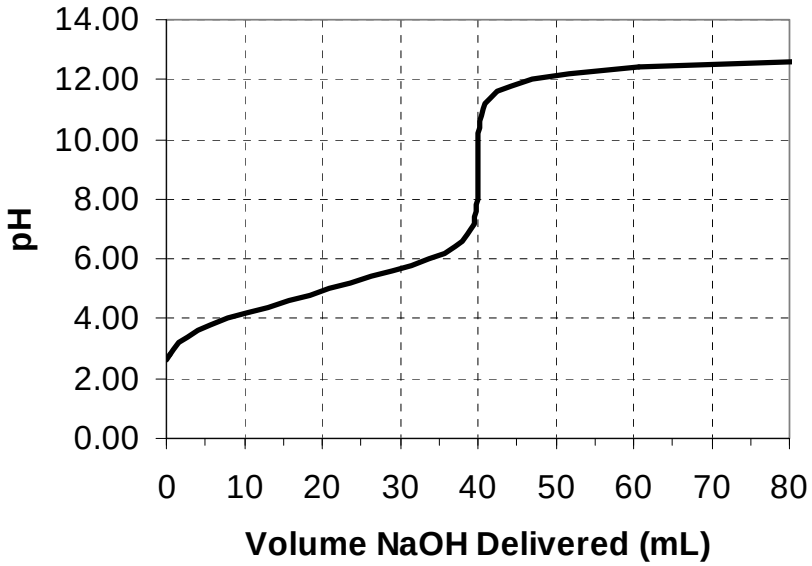
Chemistry 222 **Name**_____
Spring 2014 **80 Points**
Exam 3: Chapters 8-10

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. You do not need to account for activities in your calculations.

1. Find the pH of a solution prepared by dissolving all of the following compounds in one beaker and diluting to a volume of 0.250 L: 0.100 mol benzoic acid ($pK_a = 4.20$), 0.100 mol sodium benzoate, 0.020 mol H_2SO_4, and 0.050 mol NaOH. Assume sulfuric acid dissociates completely (i.e. it is a strong acid).

2. The titration curve below is the result of the titration of 20.00 mL of a 0.100 M solution of one of the acids below with 0.100 M KOH. Identify the acid. Clearly justify your decision by explaining how you ruled out each of the imposters and arrived at your conclusion.



Acid	pK_a's
Acetic	4.75
Phosphoric	2.17, 7.20, 12.15
Succinic	4.21, 5.64
HCl	strong
Maleic	1.91, 6.33
Pyruvic	2.55

3. Complete the following calculations: (8 points each)
   a. Determine the pH of an 8.18×10^{-8} F solution of sodium hydroxide.

   b. A 0.020 F solution of phthalic acid ($pK_{a1} = 2.95$, $pK_{a2} = 5.41$) is buffered at pH 4.00. What fraction of the phthalic acid is present as the amphiprotic form at this pH?

4. You are asked to prepare 500. mL of a 0.300 M acetate buffer at pH 5.10 using only pure acetic acid (MW=60.05 g/mol, pKa=4.76), 3.00 M NaOH, and water. What mass of acetic acid and volume of 3.00 M NaOH is required to make this buffer?

5. A 20.0 mL sample of 0.150 F freakinacidic acid (H_2A, $pK_{a1} = 3.00$, $pK_{a2} = 7.00$) is titrated with 0.100 F NaOH. Calculate the pH at any **three** of the following volumes of NaOH added: 0.0 mL, 20.0 mL, 30.0 mL, 40.0 mL, 60.0 mL, 70.0 mL.

6. Your new employer has asked you to prepare 1.00 L of a pH 12.00 buffer with a total phosphate concentration of 0.0500 M. You have at your disposal 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 12.00 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* 12.00. Why? Explain how you would really prepare this buffer in lab. (4 points)

7. Explain how we are able to use initial concentrations in the Henderson-Hasselbalch equation and still get reasonable estimates of the equilibrium pH of a solution? Under what conditions would this not be the case?

Possibly Useful Information

$V_b \cdot 10^{-pH} = K_a(V_e - V_b)$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
$[H^+] = \sqrt{\frac{K_{a1}K_{a2}F + K_{a1}K_w}{K_{a1} + F}} \approx \sqrt{K_{a1}K_{a2}}$	$pH = \frac{1}{2}(pK_{a1} + pK_{a2})$
$pH = pK_a + \log\frac{[\text{conjugate base}]}{[\text{weak acid}]}$	$\alpha_{H_2A} = \frac{[H^+]^2}{[H^+]^2 + [H^+]K_{a1} + K_{a1}K_{a2}}$
$K_w = 1.0 \times 10^{14} = [H^+][OH^-]$	pH + pOH = 14.00