Chemistry 222 **Name**_____
Spring 2021 **80 Points**
Exam 3: Chapters 8-10

Do <u>five</u> of problems 1-6. Clearly mark the problems you do not want graded. (16 pts. ea.) 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 activities in all problems.

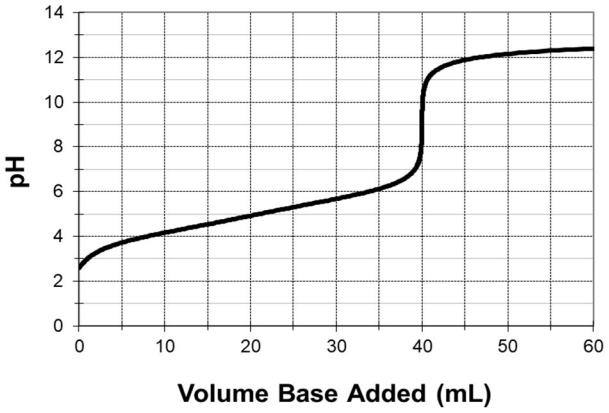
1. Find the pH of a solution prepared by dissolving all of the following compounds in water in one beaker and diluting to a volume of 0.500 L: 0.100 mol acetic acid ($pK_a = 4.76$), 0.100 mol sodium acetate, 0.040 mol HCl, and 0.060 mol NaOH.

2. You are asked to prepare 0.500 L of 0.200 M acetate buffer at pH 4.90 using only pure acetic acid (MW=60.05 g/mol, pKa=4.76), 3.00 M NaOH, and water.
   a. How many grams of acetic acid will be needed to prepare the 0.500 L buffer? Note that the given concentration of acetate refers to the concentration of all acetate species in solution. (6 points)

   b. What volume of 3.00 M NaOH, must be added to the acetic acid to achieve a buffer with a pH of 4.90 at a final volume of 0.500 L? Ignore activity coefficients. (10 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 acetic acid	4.76
B: 0.100 M maleic acid	1.83, 6.07
C: 0.100 M nicotinic acid	2.03, 4.08
D: 0.100 M succinic acid	4.21, 5.64



4. Calculate the pH of 6.6×10^{-7} M nitric acid. What fraction of the total H^+ in this solution is from the nitric acid?

5. What is the predominant species present in a solution of maleic acid that is buffered at pH 4.00? If the formal concentration of this solution is 0.125 M, what is the concentration of the predominant species at this pH? Maleic acid is **H**OOC(CH)$_2$COO**H**, but you can call this H_2A. $K_{a1} = 1.20 \times 10^{-2}$ and $K_{a2} = 5.37 \times 10^{-7}$

6. A weak diprotic acid, H_2A, has acid dissociation constants of $K_{a1} = 1.20 \times 10^{-2}$ and $K_{a2} = 5.37 \times 10^{-7}$. Calculate the pH and molar concentrations of H_2A, HA^-, and A^{2-} at equilibrium for a 0.125F solution of NaHA.

Possibly Useful Information

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