Name______________________________ Lab Section _____________
Partner's Name _____________________ Lab Instructor_______________
Date Turned In__________________ Date Performed_______________

Qualitative and Quantitative Measurement of pH, Part II
Exp 22b Laboratory Report (140 total points)

1. Titration and Ka of a Weak Acid in Vinegar

(20) Graph your data from the titration of vinegar with sodium hydroxide. Attach to this report. Place an X at the *equivalence point* (half-way up steepest part of graph curve), then draw a line to the volume of base added at that point. Draw the vertical line to indicate the *volume* at half the equivalence point and then to the y-axis to mark the corresponding **pH** value.

Show your work for each calculation below. See the instructions in the Manual.

Calculations for Ka of Acetic Acid		**Calculation of Percent Acetic Acid in Vinegar**	
(2) pH at equivalence point, from your graph		(2) Volume of vinegar used initially, from buret in mL	
(2) Volume of base needed to reach equiv. point (V_b) mL		(2) Volume of base needed to reach equiv. point (V_b). Same as at left. mL	
(2) Half the equiv. point volume (½ V_b) mL		(2) Molarity of base used to titrate (M_b)	
(2) pKa (pH at ½ V_b) from graph		(4) Show **calculation** of moles base used. n_b	
(2) Ka of acetic acid from pKa.		(3) Moles of acid initially present, n_a	
		(3) Calculate Molarity of acetic acid in vinegar	
		(3) Molar Mass of acetic acid g/mol	
		(3) Grams of acetic acid present in initial 5.0mL of vinegar.	
		(3) Density of vinegar	
	(10) Verification	(3) Grams sol'n in 5.0mL of vinegar.	
Verification number for above calculations:		(3) Percent acetic acid in vinegar sample	

1. (2) Define equivalence point:

2. (4) Explain how we found the equivalence point of this titration.

3. (4) On the graph for the titration of vinegar with NaOH label the graph with the color of indicator in each pH area.

pH of weak acid equivalence point: pH range at which indicator changes:

4. (4) We used phenolphthalein indicator for the vinegar titration (weak acid-strong base) and bromthymol blue for the strong acid - strong base titration. If we titrate ammonia with hydrochloric acid (wb-sa) approximately what value should the equivalence point be? Consulting the table in the book(p-624), what indicator would you use for this titration? Explain how the expected end point determines the transition point of the indicator we should use.

5. Buffers

b. Acidic Buffer (CH_3COOH/CH_3COO^-)

1. (2) Write the balanced equation for the equilibrium present in the acetic acid/sodium acetate buffer.

2. (5) Should the addition of sodium hydroxide cause this equilibrium to shift? Explain how any shift affects the measured pH.

3. (4) Including values, show how you calculated the theoretical pH of this buffer:

4. (3) If we double the concentration of the CH_3COO^- in this buffer, what will this do to the calculated pH? Show all math with the HH equation.

c. Basic Buffer

1. (2) What was the measured pH of 0.1M aqueous ammonia?

2. (3) Write the K_b expression for the buffer you made from ammonia and ammonium chloride.

3. (6) Write the Henderson-Hasselbalch buffer equation and show how you solved for the **theoretical** pH of your basic buffer.

4. (3) Show all your calculations for the grams of ammonium chloride necessary to make the basic buffer.
   Moles: Grams:

5. (2) What was the measured pH of the buffer you made?

6. (2) Compare the calculated pH of the buffer (from 3.) with the measured pH from the meter (from 5.) How much is the difference?

Summary

1. (9) Solution	initial pH	pH after addition of 2 mL NaOH	change in pH
a. distilled water			
CH_3COOH/CH_3COO^- buffer			
NH_3/NH_4^+ buffer			

1. (3) What general conclusion can you draw from the pH changes upon adding NaOH to the buffers versus adding NaOH to pure water? Why don't we standardize our pH electrodes with distilled water?

Percent Ionization of a Weak Acid

9. (5) Calculate the percent ionization in a 0.053M butanoic acid ($CH_3(CH_2)_2COOH$) solution. $K_a = 1.48x10^{-5}$. See your textbook or Lab manual.