Name: ________________________________ Section: ____________________

Pre-Lab Questions: Buffers and Determination of Equivalent Mass and K_a of an Unknown Acid

1. What is the equivalent mass of each of the following acids?
    1. $HC_2H_3O_2$
    2. $KHCO_3$
    3. H_2SO_3
    4. H_3PO_4

2. It is found that 24.6 mL of 0.116 M NaOH is needed to titrate 0.293 g of an unknown acid to the phenolphthalein end point. Calculate the equivalent mass of the acid.

Name: ___________________________________ Section: ______________________

Data and Questions

Part 1A: pH of Unknown and Buffer Solutions

Enter in the appropriate space the name of the indicator used, the observed color of unknown after addition of the indicator, and the estimated pH value from the pH paper for the unknown.

Liquid Unknown #: __________

pH paper estimate: _________________ (3-pH unit range)

Indicator Used	Color of Unknown	Color of Buffer pH = ________	Color of Buffer pH = ________	Color of Buffer pH = ________

Estimate pH based on matching of colors = ____________ (within 0.5 pH unit)

Part 1B: pH of Acetic Acid Solutions

(Note: HAc = $HC_2H_3O_2$, acetic acid).

	1.0 M $HC_2H_3O_2$	0.10 M $HC_2H_3O_2$	0.010 M $HC_2H_3O_2$
pH			
K_a			
% dissociation			

SHOW YOUR CALCULATIONS ON THE NEXT PAGE.

Name: ______________________________ Section: ___________________

1.0 M $HC_2H_3O_2$ (aq):

0.10 M $HC_2H_3O_2$ (aq):

0.010 M $HC_2H_3O_2$ (aq):

Name: ___________________________________ Section: ______________________

Part 2: pH of Salt Solutions

1. PREDICT whether each of the salt solutions below is expected to be acidic, neutral, or basic:

   $NaCl$ __________ $NaC_2H_3O_2$ __________ Na_2CO_3 ____________

   NH_4Cl _________ KNO_3 _____________ $ZnCl_2$ ______________

2. Using the pH meter immersed in each salt solution, determine the actual pH:

   $NaCl$ __________ $NaC_2H_3O_2$ __________ Na_2CO_3 ____________

   NH_4Cl _________ KNO_3 _____________ $ZnCl_2$ ______________

3. Write balanced MOLECULAR, IONIC, and NET-IONIC equations for the hydrolysis reactions of each salt solution. From the net-ionic equation, verify that the reaction is acidic, neutral or basic.

   A. $NaCl(aq)$:

   Molecular:

   acidic neutral or basic?

   Ionic:

   _____ Net-Ionic:

   B. $NaC_2H_3O_2(aq)$

   Molecular:

   Ionic:

   _____ Net-Ionic:

Name: ______________________________ Section: ____________________

C. $Na_2CO_3(aq)$

Molecular:

Ionic:

_____ Net-Ionic:

D. $NH_4Cl(aq)$

Molecular:

Ionic:

_____ Net-Ionic:

E. $KNO_3(aq)$

Molecular:

Ionic:

_____ Net-Ionic:

F. $ZnCl_2(aq)$

Molecular:

Ionic:

_____ Net-Ionic:

Name: ________________________________ Section: ____________________

Part 3: Determination of K_a and Properties of a Buffer

Solid Unknown Number: ____________

1. Original pH of the half neutralized solution: ___________

2. Calculate K_a of the Weak acid:

3. Fill in table:

	tap water (original pH)	tap water (pH after)	Buffer (original pH)	Buffer (pH after)
addition of 0.1 M HCl				
addition of 0.1 M NaOH				

4. How does the table above show that the half-neutralized solution is indeed a buffer?

5. Using the data on your table above, comment on the buffering ability of your half-neutralized solution in comparison to the tap water.

6. Comment on the comparison between adding a strong acid vs a strong base to your buffer solution (i.e. is this solution more resistant to an increase or a decrease in pH?).

Name: ___________________________________ Section: ______________________

Part 4: Determination of the Equivalent Mass of an Unknown Acid

Given: ____________ M NaOH

Fill in the table below

Sample	Mass unknown acid (g)	Volume NaOH used (mL)	Volume NaOH used (L)	Mol NaOH equal to Mol H^+	Gram Equivalent Mass of Acid (g/mol H^+)
Trial 1					
Trial 2					
					Average GEM: _________ g/mol H^+

Show sample calculations below

Part 5: Determination of the K_a and Equivalent Mass of an Unknown Acid using LabQuest Mini

Use the same unknown sample as part 4. Solid Unknown Number: _______

1. Determine the approximate mass desired to reach the equivalence point in approximately 15 ml of NaOH added.
   Approximate mass to use = (mass of acid/volume of base)$_{part\ 4}$ x 15ml desired

2. Mass accurately weighed into a clean, dry 150 ml beaker. _____________

3. Using the graph, determine the volume and pH of titrant at equivalence point.

   Volume _______________ pH ____________

4. Using the graph, determine the volume and pH at the half-equivalence point.

   Volume _______________ pH ____________

Name: ________________________________ Section: ____________________

5. Solve for the pK_a, K_a, and gram equivalent mass of your unknown acid using the data collected in part 5.

   Unknown #: _______

6. Calculate the average of all three GEM that you determined (two from part 4 and one from part 5).

7. Why is the equivalence point NOT at pH 7?

8. Identify the following areas on the weak acid/strong base titration curve.
   A) Weak acid
   B) Buffer zone
   C) Equivalence point, salt
   D) Strong base zone
   E) Half equivalence point

Name: ______________________________ Section: ____________________

Post-Lab Questions: Buffers and Determination of Equivalent Mass and K_a of an Unknown Acid

1. A buffer was prepared by mixing 50.0 mL of 0.10 M HX and 25.0 mL of 0.10 M NaOH. The K_a of HX is 1.5×10^{-6}. Calculate the pH of this buffer.

2. The following values were experimentally determined for the titration of 0.145 g of a weak acid with 0.100 M NaOH:

Volume of NaOH, mL	pH
0.0	2.88
5.0	4.15
10.0	4.58
12.5	4.76
15.0	4.93
20.0	5.36
24.0	6.14
24.9	7.15
25.0	8.73
26.0	11.29
30.0	11.96

   A. Construct a titration curve (pH vs Volume of NaOH).

   B. Examine the graph for the required volume to reach the equivalence point?

   C. Examine the graph and state the pH at the half-equivalence point?

   D. Determine the K_a of the acid.

   E. Calculate the gram equivalent mass of the acid.

Name: ______________________________ Section: ____________________

3. The following acid-base indicators are available to indicate the end point of this weak acid/strong base titration. Which of them would be most appropriate? Explain.

Indicator	**Color Change**		**pH Transition**
	Acid Form	**Base Form**	
Bromphenol blue	yellow	blue	3.0-5.0
Bromthymol	blue	blue	6.0-7.6
Thymol blue	yellow	blue	8.0-9.6