EXPERIMENT #25:

Determination of the K_a of a Weak Acid (and ID of the unknown acid)

Name _____

Instructor _____

Lab Section _____

Date _____

Pre-Lab Questions (Turn in to your Instructor before the laboratory period starts.)

1. Define the following terms
   a. K_a

   b. Endpoint

   c. Equivalence point

2. Why are buffer solutions used to calibrate the pH meter rather than dilute solutions of acids and bases of known concentration?

3. You determine that it takes 26.0 mL of base to neutralize a sample of your unknown acid solution. The pH of the solution when exactly 13 mL of base had been added was 2.75. You notice that the concentration of the unknown acid was 0.1 *M*.
   a. What are the K_a and the pK_a of your unknown acid? (Show work)

   b. What it the probable identity of your unknown acid? (use chart in discussion)

   c. After finishing your calculations, you discover that the actual concentration of the unknown acid was 0.35 *M*. How would this affect your calculation of the pK_a?

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In-Lab Guidelines (This is a guide to the information that you should be observing while in the laboratory. Record this information in the Laboratory Notebook. Turn in the duplicate pages of your observations to your Instructor before you leave the laboratory period.)

Neutralization of Weak Acid with Base

ID of Unknown _____

Volume of Unknown Used _____ mL

Concentration of NaOH soln. _____*M*

Trial 1			
Vol NaOH	pH Reading	Vol NaOH	pH Reading
0.00		13.0	
0.5		13.5	
1.0		14.0	
1.5		14.5	
2.0		15.0	
2.5		15.5	
3.0		16.0	
3.5		16.5	
4.0		17.0	
4.5		17.5	
5.0		18.0	
5.5		18.5	
6.0		19.0	
6.5		19.5	
7.0		20.0	
7.5		20.5	
8.0		21.0	
8.5		21.5	
9.0		22.0	
9.5		22.5	
10.0		23.0	
10.5		23.5	
11.0		24.0	
11.5		24.5	
12.0		25.0	
12.5		25.5	

Trial 2			
Vol NaOH	pH Reading	Vol NaOH	pH Reading
0.00		13.0	
0.5		13.5	
1.0		14.0	
1.5		14.5	
2.0		15.0	
2.5		15.5	
3.0		16.0	
3.5		16.5	
4.0		17.0	
4.5		17.5	
5.0		18.0	
5.5		18.5	
6.0		19.0	
6.5		19.5	
7.0		20.0	
7.5		20.5	
8.0		21.0	
8.5		21.5	
9.0		22.0	
9.5		22.5	
10.0		23.0	
10.5		23.5	
11.0		24.0	
11.5		24.5	
12.0		25.0	
12.5		25.5	

This is a guide. You may need only half these entries for your unknown (monoprotic acid), or you may need an additional column (triprotic acid).

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Observations: (did you spill some of the sample, was the pH meter improperly calibrated, did the pH reading drift, did you forget to rinse the pH electrode between usage, did the magnet alter the pH reading, how hot did the beaker get during the neutralization, etc.)

Determination of K_a by Half Volume Method

ID of Unknown _____

Volume of Unknown Used _____ mL

Concentration of NaOH soln. _____ *M*

Trial Run

Volume of Unknown Used _____ mL

Volume of NaOH Used for
titration of first 10.00 mL of acid _____ mL

pH reading after addition of
10.00 mL acid _____

Observations: (was the titrated solution a very pale pink or was it a dark pink – overshot endpoint, was material spilled, was there a problem with the pH meter, did the solution stay pink when the acid was added, etc.)

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Post-Lab Report (Use the In-lab observations to complete the laboratory report. Turn in to your Instructor when you have completed the report.)

Trial 1.

Plot the pH reading (y-axis) versus volume of NaOH used in titration (x-axis). Determine the equivalence point(s), and the volume of NaOH required to reach the equivalence point(s).

Use this graph to determine the pH reading at the point when the volume of NaOH used is exactly one-half the volume required to reach the equivalence point (there may be more than one equivalence point).

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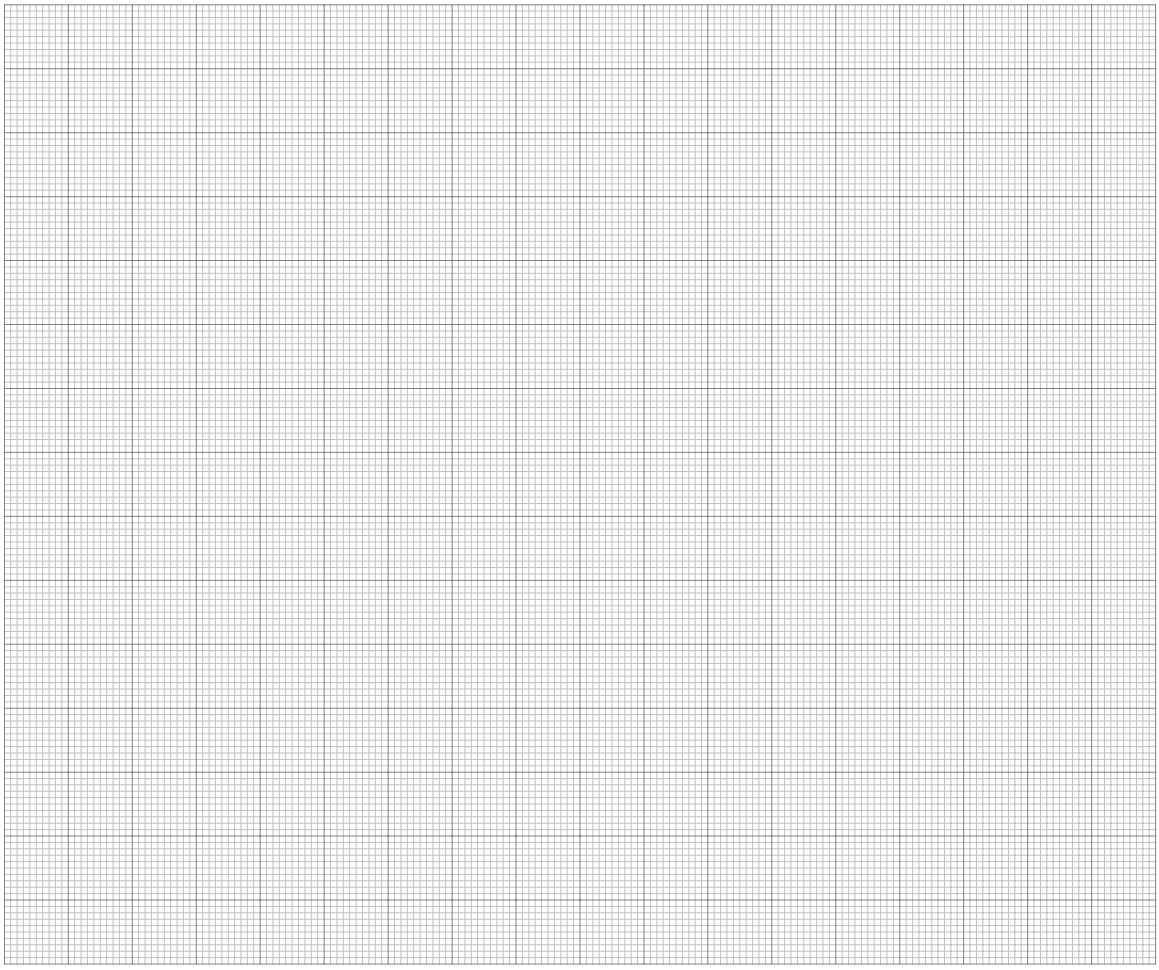
Trial 2.

Plot the pH reading (y-axis) versus volume of NaOH used in titration (x-axis). Determine the equivalence point(s), and the volume of NaOH required to reach the equivalence point(s).



Use this graph to determine the pH reading at the point when the volume of NaOH used is exactly one-half the volume required to reach the equivalence point (there may be more than one equivalence point).

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If you had a monoprotic acid, use the space designated as pK_{a1} to record your data. If you had a polyprotic acid include your data for pK_{a2} and if necessary pK_{a3}.

	Trial 1	Trial 2	Average pK_a	K_a
pK_{a1}				
pK_{a2}				
pK_{a3}				

Based upon your comparison with the table of K_a data of possible acids, what was the identity of youor acid unknown?

Unknown ID _____	Identity _____

Half Volume Method

Use the data you generated in the Half Volume method for the determination of K_a to complete the following table.

Volume of NaOH Used for titration of first 10.00 mL of acid _____ mL

pH reading after addition of 10.00 mL acid _____

pK_a _____

K_a _____

How closely does this pK_a and K_a value agree with the pK_a and K_a value you obtained from the neutralization procedure? Was this agreement/disagreement expected? (explain your reasoning)

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Post-Lab Questions (Turn in to your Instructor with the post laboratory report for this experiment.)

1. Explain how each of the following errors would have altered your results. Clearly explain why your calculations would be high, low, or unchanged. (A single word answer is not acceptable.)
    a. The pH buffers used to calibrate the pH meter were each 0.5 pH units high (4.5 and 7.5 rather than 4.0 and 7.0 respectively).

    b. You decided to take the pH after each addition of 5.0 mL of NaOH rather than after every 0.5 mL during the neutralization of your acid sample.

    c. While using the Half Volume method, your solution was dark pink (you overshot the endpoint) and you added the unreacted acid to this solution.

    d. You refilled your buret between titrations of your unknown acid. Instead of using 0.1 *M* NaOH as you did for the first titration, you used 0.2 *M* NaOH.

2. You are given 10.00 mL of a solution of an unknown acid. The pH of this solution is exactly 2.95. You determine that the concentration of the unknown acid was 0.1224 *M*. You also determined that the acid was monoprotic (HA). What is the K_a and pK_a of your unknown acid?