Dougherty Valley HS Chemistry - AP
Acid Base – Titrations

Worksheet #15

Name: **Period:** **Seat#:**

Required Sections: (Refer to R-15 for guidelines and requirements. Make note of any specific changes given by your teacher in class.)

Prelab: Purpose, Materials, Reagent Table, Procedures, and set up Data Tables before you get to class.
During Lab: Data section – Fill out your data table that is already set up from the prelab.
Post-lab: Calculation section, Post-Lab Questions, Post-Lab Two Pager done on separate Worksheet.

Background

A titration is a process used to determine the volume of a solution that is needed to react with a given amount of another substance. In this experiment, your goal is to determine the molar concentration of two acid solutions by conducting titrations with a base of known concentration. You will be testing a strong acid, HCl, solution and a weak acid, $HC_2H_3O_2$, solution. You will use the sodium hydroxide, NaOH, solution that you standardized in Lab 6 as your base of known concentration. The reaction equations are shown below in net ionic form.

$$H^+ (aq) + OH^- (aq) \rightarrow H_2O(l)$$

$$HC_2H_3O_2(aq) + OH^- (aq) \rightarrow H_2O(l) + C_2H_3O_2^- (aq)$$

The stoichiometry of the two reactions is identical; thus, your calculations will be straightforward. However, you will observe a significant difference in how the two acid solutions react with NaOH.

In this experiment, you will monitor pH as you titrate. The region of most rapid pH change will then be used to determine the equivalence point. The volume of NaOH titrant used at the equivalence point will be used to determine the molarity of the HCl solution.

You will deliver volumes of NaOH titrant from a buret. You will enter the buret readings manually to store and graph each pH-volume data pair.

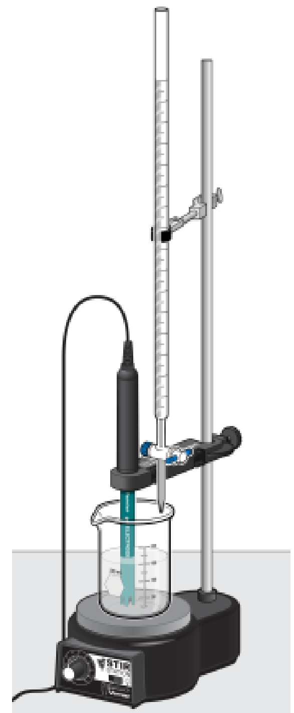

Figure 1

Objectives

In this experiment, you will
- Accurately conduct acid-base titrations.
- Determine the equivalence point of a strong acid-strong base titration.
- Determine the equivalence point of a weak acid-strong base titration.
- Calculate the molar concentrations of two acid solutions.

Materials

Chemicals
- 0.100 M sodium hydroxide, NaOH
- Unknown molarity of hydrochloric acid, HCl
- Unknown molarity of acetic acid, $HC_2H_3O_2$

Equipment
- Computer with USB port, or a USB adaptor
- LabQuest Mini
- Logger Pro
- Vernier pH sensor
- Stir station and magnetic stirring bar.
- Electrode support
- 250mL beaker
- 50-100mL beaker x 2
- 50mL grad. cylinder
- 25mL grad. cylinder
- 50mL burette
- 50mL burette clamp
- Disposable pipettes
- Distilled H_2O

Procedure

1) Obtain and wear goggles.

2) Obtain about 25 mL of a hydrochloric acid solution of unknown concentration in a small beaker. Add 50 mL of distilled water to a 250 mL beaker. Use a pipette and 25mL graduated cylinder to transfer 10 mL of the HCl solution into the 250mL beaker.

3) Place the beaker on a Stir Station and add a stirring bar.

4) Connect a pH Sensor to Channel 1 of a Vernier computer interface. Connect the interface to the computer using the proper cable.

5) Set up a Stir Station, burette clamp, and 50.0 mL burette to conduct the titration (see Figure 1). Rinse and fill the burette with 0.100 M NaOH solution. Use the other small beaker to help with this step. **Note**: Record the concentration of the NaOH solution in your data table.

6) Use an Electrode Support to suspend the pH Sensor on the Stir Station, as shown in Figure 1. Position the pH Sensor so that its tip is immersed in the HCl solution but is not struck by the stirring bar. Gently stir the beaker of acid solution.

7) Start the Logger *Pro* program on your computer. Open the file “07a Acid-Base” from the *Advanced Chemistry with Vernier* folder.

8) You are now ready to begin the titration.

a. Before adding NaOH titrant, click Collect. Once the displayed pH reading has stabilized, click Keep. In the edit box, type **0** (for 0 mL added). Click OK to continue.

b. Add the next increment of NaOH (enough to raise the pH about 0.15 units). When the pH stabilizes, again click Keep. In the edit box, type the current buret reading as accurately as possible. Click OK to continue.

c. Continue adding NaOH solution in increments that raise the pH by about 0.15 units and enter the buret reading after each increment. When a pH value of approximately 5.0 is reached, change to a one-drop increment.

d. After a pH value of approximately 10 is reached, add larger increments that raise the pH by about 0.15 pH units, and enter the buret level after each increment.

e. Continue adding NaOH solution until the pH value remains constant.

9) When you have finished collecting data, click Stop. Dispose of the reaction mixture as directed. Rinse the pH Sensor with distilled water in preparation for the second titration.

10) Follow the steps below to find the *equivalence point*, which is the largest increase in pH upon the addition of a very small amount of NaOH solution. A good method of determining the precise equivalence point of the titration is to take the second derivative of the pH-volume data, a plot of $\Delta^2 pH/\Delta vol^2$.

a. View a plot of the second derivative on Page 3 by clicking Next Page, .

b. Analyze the second derivative plot and record the volume of NaOH at the equivalence point.

11) Go back to the original titration graph. Conduct a second trial if directed by your instructor. If you wish to save the results of the titration, choose Store Latest Run from the Experiment menu.

12) Rinse your glassware, use a new disposable pipette, and repeat the necessary steps to test the acetic acid solution. Conduct a second trail of the acetic acid solution if directed by your instructor. Analyze, print, and save the titration data for your acetic acid solution trial(s).

Data Table

1. Make your own data table! Remember, you need to make sure your data table has all required elements!

HCl trial	Volume HCl (mL)	[NaOH] (M)	Equivalence point (mL)	$HC_2H_3O_2$ trial	Volume $HC_2H_3O_2$ (mL)	[NaOH] (M)	Equivalence point (mL)
1				1			
2				2			

2. Glue in a copy of your Logger Pro graph below your data table.

Calculations - Record any, and all, manipulation of numbers in your calculation section.

1. Calculate the molar amounts of NaOH used in the reaction with the HCl solution and with the $HC_2H_3O_2$ solution.
2. Calculate the molar concentration (molarity) of the HCl solution and the $HC_2H_3O_2$ solution.

Post-Lab Discussion Questions

1. Compare the actual molarity of your two acid solutions with your calculated molarities. Were the calculated molarities within a reasonable range (about 5%) of the actual values? If not, suggest reasons for the inaccuracy.
2. The equivalence points of the two titration curves were not in the same pH range. Explain.