TITRATION CURVES

INTRODUCTION

Read and/or review Sections 4.10 and 16.7 in your textbook.

In an acid - base titration, the plot that is generated when the pH of the titrated solution is plotted versus volume of titrant added is called an acid - base titration curve.

In today's lab you will:

1) Standardize a sodium hydroxide solution
2) Generate a titration curve for the titration of a weak acid with a strong base
3) Determine the equivalence point of the titration
4) Calculate the initial concentration of the weak acid
5) Calculate K_a for the weak acid using titration information

PROCEDURE

Standardization of NaOH

Prior to performing the titration, you need to know the exact concentration of the base that you will be using. Standardizing the base involves performing a titration with a known amount of a stable acid, which in this case is the monoprotic acid potassium hydrogen phthalate (abbreviated KHP). The reaction of KHP and NaOH is

$$NaOH(aq) + KHC_8H_4O_4(aq) \rightarrow H_2O(l) + KNaC_8H_4O_4(aq)$$

Note that one mole of NaOH reacts with one mole of KHP. **Note that the name of KHP is potassium hydrogen phthalate not potassium hydrogen phosphorus!**

Clean your buret and rinse it with deionized water. Next, rinse your buret twice with 10 mL of the NaOH solution that you will be standardizing. Finally, fill the buret with the NaOH solution.

Accurately weigh, to the nearest thousandth of a gram, approximately 0.5 g KHP and transfer it to one of your 250 mL Erlenmeyer flasks. Add approximately 25 mL of deionized water and 2 to 3 drops of the phenolphthalein indicator. Swirl the flask until all the KHP has dissolved. Read the initial volume of NaOH solution in your buret to the nearest hundredth of a milliliter. Slowly add the NaOH solution to the dissolved KHP until a faint pink color is obtained. Placing a white piece of paper under your Erlenmeyer flask helps you better see this color change. Once a lasting pink color has been reached, read your final volume from your buret. Calculate the molarity of the NaOH solution. Repeat this process two more times and calculate the average molarity of the NaOH solution.

1. Double click the “Logger Pro” icon and allow the screen to open.

2. Plug the pH probe into the Go!Link. The Go!Link light should turn green. If not please inform your TA.

3. On the computer screen, choose: Experiment; Calibrate; Go!Link: 1 pH; Calibrate Now.

4. Calibrate the pH probe

    a. Carefully, unscrew the cap and pH probe from the storage container; don’t remove it by force. Gently dab the probe’s glass bulb with a Kimwipe. Set the storage container aside so that you do not spill its contents.

    b. Place the probe in the pH 4 buffer and wait for the reading to stabilize. Select Reading 1; type 4.0; Keep.

    c. Remove the probe, rinse the probe with DI water into a waste beaker, and gently dab with a Kimwipe.

    d. Place the probe in the pH 7 buffer and wait for the reading to stabilize. Select Reading 2; type 7.0; Keep; Done.

5. Generate the Titration Curve

    a. Fill the buret with the standardized NaOH solution. This titration will be easiest to perform if the meniscus starts out at the 0 marking.

    b. Using the preset pump dispenser, pump 100 mL of your assigned unknown monoprotic acid sample into a clean 250 mL **beaker** containing a magnetic stir bar.

    c. Place the pH probe in the center of the beaker so that the glass bulb is completely immersed in the monoprotic acid and clamp it to a stand. Be sure that there is some vertical distance between the glass bulb on the pH probe and the magnetic stir bar (so that there is absolutely no chance that they will come in contact) and begin stirring slowly.

    d. In the toolbar click: Experiment; Data Collection; in the Mode box choose Events with Entry; replace the word Event in the Name box with the appropriate x-axis title, in the Units box type in the appropriate units; Clear “Short Name” ; Done.

    e. Click the start data collection button (triangle) in the toolbar labeled “Collect”.

    f. Wait until the pH reading has stabilized (flickering back and forth between a couple of numbers is OK) and obtain an initial pH reading by clicking the KEEP button located in the toolbar just to the right of the Red Stop Button. Do not click on the STOP button until you are totally done with data collection. You will be prompted for a volume reading. On this step, that will be 0. OK.

    g. Add approximately 0.5 mL of the NaOH solution. The volume added does not need to be exactly 0.5 mL but should be close and recorded accurately. Wait until the pH reading has stabilized, click KEEP, and accurately record the **total** volume of NaOH added.

h. Continue with the titration, adding the NaOH solution in approximately 0.5 mL increments until 50 mL of the base has been added. After each increment, wait until the pH reading has stabilized, click KEEP, accurately record the total volume (not the increment) of base added, and click OK.

i. When the titration is complete, click the stop data collection button (square) located in the toolbar.

j. Click: Analyze ; Autoscale ; Autoscale

6. Print out a copy of the titration curve for each lab partner but keep the titration curve on the computer screen until you are done with the experimental write up. To print click: File ; Print ; and change the "orientation" to landscape under properties. Be sure that the names of all lab partners are entered in the "Name" section and that the date box is checked. OK. Attach a copy of the titration curve to your lab report.

7. Rinse the pH probe with deionized water and gently dab the glass bulb with a Kimwipe. Return the pH probe to its storage container by gently screwing the cap back onto the bottle.

8. When you are done, return your bin to Lab Services.

DATA AND ANALYSIS SHEET: TITRATION CURVES

Name: _____

Date _____ Lab Partner _____

Standardization of NaOH			
	Trial 1	**Trial 2**	**Trial 3**
Mass of KHP			
Final buret reading, NaOH			
Initial buret reading, NaOH			
Total volume, NaOH			
Molarity of NaOH			
Average molarity of NaOH			

Standardization Calculations:

Identification number (or letter) of assigned acid: _____

Initial pH of the acid solution: _____

Using your titration curve, locate the equivalence point of the titration. Circle and label it on the graph.

Volume of NaOH solution required to reach the equivalence point: _____

pH at the equivalence point: _____

Calculate the initial concentration of the acid.

Calculate K_a for the acid using the initial concentration of the acid and the initial pH.

Using your titration curve (hopefully, still on the computer screen), find the pH of the solution when the total volume of NaOH solution that has been added is half of that required to reach the equivalence point (use the cursor to accurately get the point). Circle and label the point on the graph.

½ the volume of base required to reach the equivalence point: _____

pH of the solution at this half-way point: _____

Determine K_a for the acid using this point.

How well do the two K_a values compare? Discuss.