

Chemistry 140

The following handout is the way Kalyn Owens (another chemistry instructor) writes her lab handouts. Your mission is to translate the appropriate parts of her write-up into the expected parts of the standard Furutanian write-up – that is, Part 1 should be the purpose, Part 2 should be the materials, Part 3 should be the procedure, and so forth. Some notes:

- Condense her “learning objectives” into two main points for the purpose in Part 1.
- Her pre-lab questions should be incorporated within Part 2 of your write-up.
- Ignore the “drawing molecules” parts of her procedure.
- Pay attention to making observations of the reaction (record this in Part 4).
- We will report each group’s acid concentration so you can do the calculations in Part 6.
- Only one Part 7 question: her post-lab question 2

Please have Parts 1 through 4 ready **before** class on Wednesday, October 25. For this particular writeup, please write an **abstract** and **paper-clip** it to the front of your individual writeup. The abstract and the carbon-copy pages of the write-up is due in class on **Wednesday, November 1**.



Chemistry 140

Experiment 4: How do we Determine Solution Concentrations? *Part 1*

Learning Objectives

- Learn how to perform a laboratory-based titration
- Build knowledge of solution chemistry topics, stoichiometry, and acid-base chemistry
- Use drawing to visualize solution chemistry reactions

- Use titrations to quantify ions in solution and acid concentrations
- Build Notebook skills through careful documentation of experimental data
- Apply chemical terminology and concepts regarding quantifying matter and representing chemical equations

Introduction

Titration is a volumetric technique used to determine the concentrations of solutions (see pgs 95 and 96 of your text for further elaboration). A titration involves the addition of a titrant (a solution of known concentration) to an analyte (a solution of unknown concentration), or vice versa, with the use of a buret. The titration is carried out until it reaches an equivalence point (the exact point at which the reaction between the two solutions is complete). A chemical indicator is often used to aid in the identification of the equivalence point. An indicator changes color upon reaching the equivalence point or endpoint. Since we will be carrying out an acid-base titration, the indicator must change color upon reaching the endpoint at a specific pH. An example of such an indicator is phenolphthalein. It should be noted that the indicator selected is dependent upon a given titration so that the observed color change is close to the ideal equivalence point. Once the titration is completed, we can use the volumes obtained for each solution, as well as the concentration of the titrant, to determine the concentration of the analyte.

Pre-lab Assignment

Read Section 3.7-3.10 in your text.

1. Prepare your notebook (as in the lab notebook handout). Prepare tables for your data.
2. Answer the following pre-lab questions on a separate sheet of paper.
 - a) Write the balanced neutralization reaction for HCl plus NaOH
 - b) Write a single mathematical expression for calculating the molarity of an acid by titrating it with base.

Notes

- HCl is a strong acid and NaOH is a strong base. You will be working with dilute solutions, but should still be cautious. If you get some on your skin, rinse with lots of water (use soap for HCl, but not for NaOH)
- Put your used solutions into the waste container in the hood
- Remember to read the volume at the bottom of the meniscus, and to record all measurements with the correct significant figures

Procedure

Part 1

1. Perform one “quick and dirty” titration with HCl and NaOH to get a feel for the technique (see titration instructions below). After this trial, spend some time thinking about what is happening on the molecular level and complete the following tasks:
 - a. Draw *in-lab* molecular level pictures of what’s in your flask at the following points in the titration:

- i. Before you begin the titration
 - ii. Half-way to the end-point
 - iii. At the end-point
 - b. Complete in-lab calculations
 - iv. Calculate the concentration of H^+ and OH^- in the flask **before** the titration
 - v. Calculate the concentration of H^+ and OH^- in the flask **half-way to the end-point** and indicate which of these ions is the limiting reactant.
 - vi. Calculate the concentration of H^+ and OH^- in the flask at the **end-point** and indicate which is the limiting reactant.
2. Perform a second and third trial (very carefully this time) and use the data (your calculated average) from these two trials to verify the Molarity of the Acid. Be sure to create data tables to present your data and to show all your calculations in your notebook. Share your data with the class by writing your Acid Concentration on the white board.

Titration instructions

Obtain 10.00 mL of the acid using a volumetric pipet and record the Molarity. Transfer the unknown acid into an Erlenmeyer flask. Add three drops of phenolphthalein. Obtain about 50 mL of NaOH and record the Molarity. Rinse the buret a few times with small portions of the titrant (NaOH solution). Fill the buret with the titrant. Make sure that the buret tip is filled with the titrant and that there are no air bubbles present. Record the initial volume. Slowly add the base into the flask that contains the unknown acid (analyte), swirling the flask to mix the two solutions. Eventually, you will observe a localized flash of color. At this point, add the base dropwise, swirling the flask in between each drop. Continue this process until you observe a faint but permanent pink color in the flask and should observe a change on the computer screen. Record the volume on the buret.

Post-Lab Assignment

Be sure that all data, calculations, and drawings are in your notebook!

1. Prepare a separate report including:
 - a. Data and Result tables (neatly present all your raw data and calculated results from trials 2 and 3).
 - b. Copy the calculations from one of your trails (found in your notebook) as a means to show me a set of "sample" calculations.
 - c. Redraw your Molecular level drawings for trail 1.
2. Write a two or three sentence technical description of the "end-point".