Experiment 32: Independent Project – Method Development

Purpose

The purpose of this experiment is to develop an acid base titration experiment for the analysis of an unknown acid. This will include testing three different indicators and selecting the best volume to use for the acid solution being analyzed.

Background

An acid base titration relies on an acid base neutralization reaction. The equivalence point is when the moles of H^+ equals the moles of OH^-. Since the equivalence point cannot be seen visually, an indicator must be used. The color of the indicator depends on the pH of its surrounding. The change in color of the indicator, referred to as the endpoint, will be used to indicate the equivalence point.

The selection of the indicator is critical. The endpoint must be at the same point of the titration as the equivalence point. Three different indicators will be tested, to determine which one is best for the combination of acid and base used for this titration method. To make sure the indicator color change matches with the equivalence point, an S-shaped titration curve will be made. The large pH increase during the titration will show the equivalence point. The volume of titrant added, and the pH and color of the solution in the receiving beaker will all be recorded.

The volume of acid to use for each trial is important. Typically, three trials of the titration are done during an acid base titration experiment. The buret should only have to be filled once to perform all three trials. Therefore, a trial should not use more than 15 mL of titrant (the base solution). To get good significant figures, a trial should use at least 10 mL of titrant. Determine the best volume of acid to pipet into the Erlenmeyer flask so each trial will use 10 mL – 15 mL of titrant.

Chemicals

Acid: unknown, assume monoprotic, a solution of approximately 0.050 M – 0.075 M

Base: 0.10 M NaOH solution

Indicators (in solution form): methyl orange, bromothymol blue, phenolphthalein

Equipment

Buret, 50 mL

Beaker, 100 mL – 150 mL, as the receiving vessel during the titration

Graduated cylinder, 10 mL

Funnel, narrow stem, for use with the buret

Beakers, medium size, for obtaining the acid and the base solutions

pH meter for measuring the pH during the titration

Experimental Procedure

Part A: Determining the best indicator to use for the titration

For each of the three indicators, do a titration with the NaOH solution as the titrant in the buret. Use 20 mL of acid, measured with a graduated cylinder, in the receiving beaker. Add three drops of indicator to the acid solution in the beaker. Perform a titration as you did in Experiment 30, to make an S-shaped titration curve. Record the volume of NaOH used and the color and pH of the solution in the receiving beaker at each increment. Plan the increments of NaOH to get enough data points for the curve, but allow enough time to complete this project during the lab session. *It's more important to finish this project than to get a perfect S-shaped curve.*

Part B: Determining the best volume of acid to use

For a titration of this acid with the 0.10 M NaOH, the volume of NaOH used for each trial should be between 10 mL and 15 mL. You are using a graduated cylinder for this method development, but for an actual experiment, a student would be pipetting the acid solution into an Erlenmeyer flask. Consider the volume of base used to reach the equivalence point (the large increase in pH) for the titration in Part A that worked well, and an easy volume of acid to pipet. How much acid should be used for each trial? This section of the project, Part B, involves calculations. No additional experimentation is needed.

Part C: Performing one trial of your titration method

Use the best indicator chosen in Part A with the volume of acid determined in Part B. Perform one trial of the titration. Determine the molarity of the unknown acid.
You do not have to measure the pH of the solution in Part C. You are just doing one trial of the titration and using the data to calculate the molarity of the unknown acid solution.

Notebook:

As your Raw Data section, record the data obtained for Part A and Part C.
As part of your Experimental Procedure section, write the experimental procedure that a student would have to follow to complete three trials of the titration based on your method (just a titration without a pH meter).
As part of your Data Tables section, make a table of expected students results (your results from Part C).
As part of your Calculation/Results section, plot the three S-shaped curves for Part A (use Excel or Google Sheets). Show on each curve where the equivalence point is and where the visual endpoint. Show the calculation of the acid molarity in Part C.

As part of your Conclusion section, state the best indicator to use and the best volume of acid to use. Explain your logic for choosing the indicator. Explain your logic for choosing the volume of acid to use. State the determined molarity of the acid solution.