Prelab: Acid – Base Titrations

Goals:

1) To learn the popular technique of titration.
2) To practice calculations involving concentration and stoichiometry.
3) To determine the concentration of an unknown NaOH solution.

Experiment:

Over the next two weeks, we will be performing two sets of acid-base titrations. Generally, an acid-base titration involves using a buret to slowly add a basic (or acidic) solution with a known concentration to a flask containing an acidic (or basic) solution of unknown concentration. The solution added with the buret is called the titrant and we will call the solution it is added to the analyte. In most cases, the objective of the titration is to determine the unknown concentration of the analyte solution. However, in some cases, the analyte concentration will be known and the goal will be to determine the concentration of the titrant. These objectives are made possible if the stoichiometry of the reaction between the titrant and the analyte is known and if the point at which enough titrant has been added to react with all of the analyte can be determined. If this information is known, stoichiometric calculations will allow the determination of either the titrant or analyte concentration.

The point in a titration at which enough titrant has been added to react with all of the analyte is called the end point. We will use the chemical, phenolphthalein, to indicate when the end point is reached. Phenolphthalein is an indicator that changes from colorless in an acidic solution to pink in a basic solution. In titrations using phenolphthalein, the end point is considered to be the first pale pink color that persists for 30 seconds. Very good results are obtained when the pink endpoint is so pale, that you aren’t quite sure if it is pink. In our experiments, a color comparison chart will used to numerically access the color of the endpoint.

In the first set of titrations, we will use a standardized HCl solution (i.e. one with a known concentration/molarity) to determine the concentration of an NaOH solution. In the second set of titrations we will use this same NaOH solution to determine the concentration of acetic acid in a sample of vinegar.

A buret is used to precisely measure the volume of base reacted with the acid. A buret is essentially an inverted graduated cylinder with a controllable dispensing device on the bottom. Burets are precise to 0.01 mL. By recording the initial volume of base in the buret, and the final volume after reaction with the acid is complete, the volume dispensed can be calculated:

\[
\text{Volume base dispensed} = \text{Final volume} - \text{Initial volume}
\]

The reaction between hydrochloric acid and sodium hydroxide is shown below.

\[
\text{HCl (aq) } + \text{NaOH (aq) } \overset{\text{--------->}}{\text{H}_2\text{O (l) } + \text{NaCl (aq)}}
\]
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These prelab questions must be answered prior to coming to lab:

1) What is the difference between the endpoint and the equivalence point?

For questions 2) through 11), use the following data:

A titration of 25.00 mL of 0.1550 M HCl solution with a solution of NaOH of unknown molarity starts at a buret reading for NaOH of 0.33 mL. The phenolphthalein indicator turns light pink in the acid solution for over 30 seconds at a buret reading of 24.19 mL.

2) What was the volume of HCl you started with?

3) How many moles of HCl were in the original solution?

4) Write the balanced chemical equation for the titration reaction.

5) How many moles of NaOH were delivered with the buret?

6) What was the volume of NaOH dispensed?

7) What is the Molarity of the unknown NaOH solution?