Titration Notes

Titration is a volumetric technique used to determine the concentration of a solution. One solution is used to analyze another.

Method

A known amount (# moles) of one substance is placed in an **Erlenmeyer flask**. We can calculate the amount either by knowing the mass of a solid reactant, or by knowing the concentration and volume of a reactant in solution.
A few drops of an appropriate **indicator** are added to the **Erlenmeyer flask**.

The solution of unknown concentration is placed in a **buret**. A **buret** is a device that can deliver precise volumes of solution. The initial volume reading on the **buret** is taken. Burets can be read to ± 0.02 mL.

The unknown solution is added to the **Erlenmeyer flask** until the two reactants have been combined in the stoichiometric ratio, which is the ratio given by the chemical equation. This point is called the **equivalence point**. If a good **indicator** has been chosen it should change colour at this point. The point at which the indicator changes colour is call the **end point**.

The final volume reading on the **buret** is taken. The two volume readings (initial and final are used to calculate the total volume of the unknown solution that had been added.)

Calculations

- Calculate the number of moles of the known substance. ($n = m/M$ or $n = cv$)
- Calculate the number of moles of the unknown substance, using the ratio given in the chemical equation.
- Calculate the concentration of the unknown solution. ($c = n/V$)

pH curves

If we were to plot the pH of a solution against volume of base added, we would get the following curves.

Note the position of the equivalence point for each curve. The equivalence point only occurs at pH = 7 when a strong acid is being titrated with a strong base. When a weak acid is titrated with a strong base, the pH is greater than 7 at the equivalence point, and when a strong acid is being titrated with a weak base, the pH is less than 7 at the equivalence point.

TITRATION LAB - STANDARDIZING A SODIUM HYDROXIDE SOLUTION

INTRODUCTION

Before beginning this lab, be sure to read pp: in the text.
Define the terms titration, acid-base indicator and endpoint.

It is difficult to make up solutions of sodium hydroxide for which the concentration (in mol/L) is known accurately. This is because:

a) Solid sodium hydroxide is **hygroscopic.** This means it soaks up water vapour from the air, which in turn affects its mass.
b) Carbon dioxide in the air and dissolved in the water used to make an NaOH solution will react with the NaOH thereby reducing its concentration.

PURPOSE

The purpose of the laboratory exercise is to determine accurately the concentration of a solution of sodium hydroxide by titrating and acidic primary standard, potassium hydrogen phthalate ($KHC_8H_4O_4$) , with the sodium hydroxide solution. This process is called **"standardizing the sodium hydroxide solution"**.

APPARATUS AND MATERIALS

electronic balance
weighing paper
scoopula
solid potassium hydrogen phthalate
Erlenmeyer flask
100 mL beaker
sodium hydroxide solution
wash bottle
buret
buret clamp
retort stand
phenolphthalein solution

METHOD

1. Mass between 1.0 g and 1.1 g (to the nearest 0.01 g) of $KHC_8H_4O_4$ on a weighing paper. This will allow the number of moles of acid to be calculated.

2. Dissolve the solid acid in approximately 25 mL of water in the Erlenmeyer flask. (The volume of water used is not critical, since you already know the number of moles of acid present.)

3. Add 3 drops of **phenolphthalein** solution to the Erlenmeyer flask. Be sure you understand the function of the phenolphthalein.

4. Use the 100 mL beaker to add NaOH solution to your buret

PLEASE TAKE ONLY WHAT YOU NEED TO FILL YOUR BURET

5. Titrate the acidic primary standard in the Erlenmeyer flask with the NaOH solution of unknown concentration in your buret.

6. Rinse out the titration flask and repeat the titration until you have at least two titrations that you feel confident were accurately done. Regardless of whether you consider a particular titration "good" or "bad" record ALL data on the data sheet provided.

7. For each titration you feel was accurately done, calculate the concentration of the NaOH solution used. If the results do not agree within the limits given by your teacher, repeat the titration

8. **Be sure to follow all cleanup procedures at the end of the lab period. Failure to do so will damage the burets.**

CALCULATIONS

Once all of the data are collected, the task is to determine the mol/L concentration of the NaOH solution used in the titration To aid in accomplishing this, refer to "PART 2: STANDARDIZING A SOLUTION" on the handout entitled "Methods for Solving Titration Problems". Further practice with this type of calculation can be found on the handout entitled " Practice Problems: Titration".

A quiz on the theory and methods used in this laboratory and on the calculations involved will be held next class.

TITRATION DATA

a) Show data for all trials, even for those in which you know there was an error. Under "Comments" make a note if you are aware of an error.

b) Put a * beside the trials you decide to use in your calculations. Calculate the concentration of the unkown NaOH solution for at least two trials. Report the average value obtained for the concentration of NaOH

Trial number	Mass of $KHC_8H_4O_4$ used (g)	Buret Initial reading (mL)	Buret Final reading (mL)	Volume of NaOH used (mL)	Comments