Determination of Concentration by Titration

Reminder – Goggles must be worn at all times in the lab!

PRE-LAB DISCUSSION:

In the chemistry laboratory, it is sometimes necessary to experimentally determine the concentration of an acid solution or a base solution. A procedure for making this kind of determination is called an ACID-BASE TITRATION. In this procedure, a solution of known concentration, called a STANDARD solution is used to neutralize a precisely measured volume of the solution of unknown concentration to which one or two drops of an indicator have been added. If the solution of unknown concentration is acidic, a standard base solution is added to the acid solution until it is neutralized. If the solution of unknown concentration is basic, a standard acid solution is added to the base solution until it is neutralized. In this lab, we will be finding the concentration of three unknown acid solutions. Our standard solution will be 0.20 M NaOH.

When carrying out an acid-base titration, you must be able to recognize when to stop adding the standard solution. That is, you must be able to recognize when neutralization has occurred. This is the purpose of the INDICATOR. A sudden color change due to the indicator signals that neutralization has occurred. At this point, the number of HYDROGEN ions from the acid is equal to the number of HYDROXIDE ions from the base. The point at which this occurs is called the END-POINT of the titration. When the endpoint is reached, the volume of the standard solution is carefully determined. Then the measured volumes of the two solutions and the known concentration of the standard solution can be used to calculate the concentration of the other solution.

At the end-point of the experiment, the volume of the acid times the molarity of its hydrogen ions will equal the volume of the base times the molarity of its hydroxide ions. Calculations will be based on the following formula:

(volume of acid)(molarity of H^+) = (volume of base)(molarity of OH^-)

or, more simply…

$$V_a M_{H+} = V_b M_{OH-}$$

Knowing three of these quantities we can calculate the fourth -- in this case the molarity of the acid's hydrogen ions. Since the acids and the base in this experiment have one hydrogen ion and one hydroxide ion, respectively, the molarity of hydrogen ion is the same as the molarity of the acid, and the molarity of hydroxide ion is the same as the molarity of the base.

PURPOSE:

To learn the experimental technique of titration and using this technique, to determine the molarity of three acid solutions of unknown concentration.

PROCEDURE:

1. Open the Virtual Lab Applet
   http://www.sciencegeek.net/VirtualLabs/VLab.html
2. Open the Lab
   File → Load Homework → Allan → Acid-Base Titration

PART I: Titration of HCl "A" solution.

1. Obtain a 250 mL Erlenmeyer flask:
   Tools → Glassware → Erlenmeyers → 250 mL Erlenmeyer Flask
2. Drag the HCl "A" solution from the pane on the left to the "lab table." Drag the HCl "A" ontop of the 250 mL Erlenmeyer flask and then "pour" exactly 1 mL of the acid into the flask.
3. Drag the phenolphthalein from the left pane to the flask, and put 0.50 mL of the substance in the flask.
4. Drag the Distilled Water to the flask, and add 50 mL of distilled water. The exact amount is actually not important, but the extra volume of solution will help you to see the color change at the point of neutralization.
5. Fill a 50 mL buret (Tools → glassware → 50 mL buret) with 45 mL of 0.20 M NaOH stock solution.
6. Now, drag the buret on top of the flask so that you may begin the titration.
   a) Record the initial level of NaOH in the buret, to two decimal places.
   b) Add small amounts of NaOH (no more than 0.10 mL at a time) until the solution in the beaker FIRST turns pink.
   c) Record the final volume of base in the buret, and calculate total volume of base added (subtract final volume from the initial volume).
7. Repeat this procedure two more times for HCl "A".

PART II and Part III: Titration of HCl "B" and HCl "C" solutions.

1. Repeat each step of Part 1 for the two remaining acids, performing a total of three titrations of each.
2. If at any time your "lab table" is too cluttered, glassware and chemicals can be removed by "right clicking" on them and selecting "Remove" or by single clicking on the item, and then clicking the large "X" on the vertical toolbar. Removing items from the lab table does not permanently remove them from the applet, and new chemicals and glassware can always be retrieved from the stockroom and tools menus, respectively.

RESULTS

Data and Observations:

Sample Data Table (You will need three of these)

	Trial #		
	1	2	3
Volume of Acid (mL)	1.00	1.00	1.00
Initial Volume of Base (mL)			
Final Volume of Base (mL)			
Volume of Base added (mL)			
Molarity of Base	0.20	0.20	0.20

Calculations:

1. Calculate the average volume of base required for each of the three titrations for EACH acid solution. Show your work, and record your answer in a table like the one below.
2. Calculate the molarity of each acid solution using the following equation:

$$M_A = \frac{V_B M_B}{V_A}$$

Show your work, and then record your result in a table like the one below.

Solution	**Average Molarity**	**Molarity of HCl**
HCl "A"		
HCl "B"		
HCl "C"		