ACID / BASE TITRATION

PURPOSE

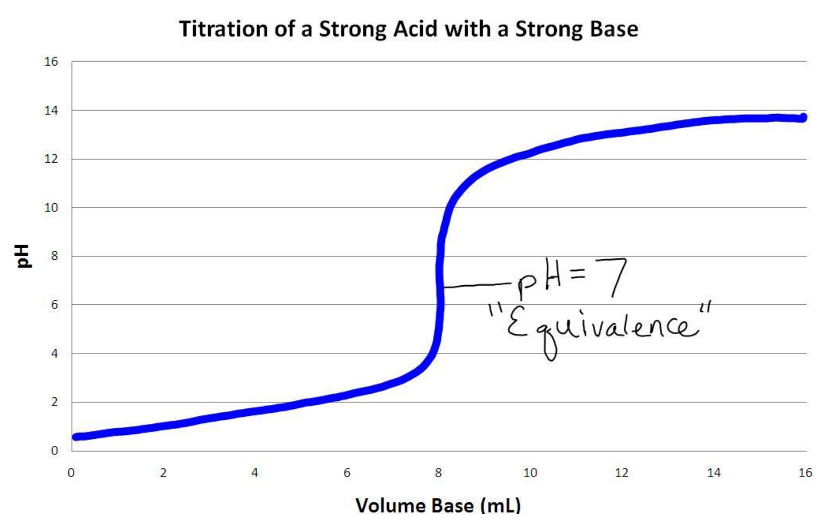
The purpose of this lab is to use the technique of titration to standardize (determine the certain concentration) a solution of potassium hydroxide (KOH) against a known solution of hydrochloric acid (HCl). The KOH solution will then be used to determine the molarity of commercial vinegar via a second set of titrations.

BACKGROUND

Solution stoichiometry has many forms, but the most common uses of this idea are precipitation reactions and acid/base chemistry. Precipitation reactions have been previously addressed, leaving the focus here on acids and bases. More specifically, the focus is to be on Arrhenius acids and bases (those that produce H_3O^+ and OH^-, respectively, when mixed with water). Titration works well to determine the concentrations of these types of solutions.

Acid base titrations simply allow the H_3O^+ formed by the acid to react with the OH^- produced by a base. In order to obtain useful information, such as an unknown concentration, from the results the balanced reaction between the acid and base must also be known. It must also be evident exactly when the acid has reacted with all the base present (the equivalence point). Equivalence points can be determined simply in two ways: by monitoring the pH during the titration, or by use of an indicator. pH titration is more time consuming and data intensive, so the use of indicators is preferred for everyday experiments.

Indicators are themselves weak acid/base compounds that have the useful property of having different colors in these forms. Therefore, certain indicators will change color when in certain pH environments. Determining exactly which indicator to use for your titration can be an involved process, and the details will not be discussed here. It will suffice to say that the color change pH region of the indicator (this can be looked up in various charts) must fall within the equivalence pH range of your titration. As a titration with an indicator proceeds, then, the pH will change depending on what is being titrated (sample) and what is doing the titrating (titrant). At equivalence there is a rapid pH change with little volume of titrant (see Figure 1 below), which is where the indicator should change colors and signal the end of the experiment. It is then a simple matter to use the concentration and volume of the known solution along with the volume of the unknown titrant to determine the concentration of the titrant.



MATERIALS

Chemicals: 0. **0.2483** M HCl, unknown KOH, commercial vinegar, 0.4% aqueous Bromothymol Blue indicator solution, Phenolphthalein indicator solution, DI water.

Glassware and Hardware: 50mL burette, 10mL graduated cylinder, burette clamp, ring stand, 250mL Erlenmeyer flask (or other suitable reaction container), squirt bottle, liquid funnel.

SAFETY

KOH and HCl– Corrosive; eye and skin irritant; harmful if inhaled. In case of eye contact flush with water for a minimum of 15 minutes and then seek the advice of a doctor. In case of skin contact, flush with copious amounts of water immediately. Seek the advice of a doctor (after rinsing) for major exposure.

Wear goggles at all times and take appropriate measures to protect exposed skin.

PROCEDURE

Standardizing KOH

1. Obtain the glassware listed in the materials section.

2. Measure 10.0 mL of ________________ M HCl using the graduated cylinder and place it in the Erlenmeyer flask along with ~20mL of distilled water. Add 2-3 drops of bromothymol blue indicator solution and sit this aside out of the way. The solution should have a faint yellow color.

3. Using the funnel, add approximately 10 mL of the unknown KOH solution to the burette. Move to a sink and allow this solution to run out of the burette for a few seconds. Invert the burette and let the remaining solution pour out the back end.

4. Again using the funnel, fill the burette with the KOH solution to a volume somewhere between 0.00 mL and 10.00 mL. Make sure that the end of the burette is filled with KOH as well by letting a few drops run out through the stopcock into a waste container.

5. Accurately record the starting volume of the KOH for the titration.

6. Place the Erlenmeyer flask containing the HCl under the burette and begin adding KOH slowly to the solution with constant mixing (swirl the container).

7. Continue adding the KOH until the color begins to change from yellow to blue. When this change begins to happen, add KOH very slowly and carefully (drop by drop).

8. When the color changes to blue and stays blue for at least 10 seconds, the titration is over. Record the final volume on the burette for later use.

9. Thoroughly rinse the Erlenmeyer flask or other reaction container and repeat steps 1-8 two additional times (for a total of three trials).

10. Clean and rinse the reaction vessel thoroughly (soap and water) for use in the next experiment.

Determining the concentration of commercial vinegar

1. Measure 2.0 mL of commercial vinegar with the 10.0 mL graduated cylinder and place it in the Erlenmeyer flask (or other reaction container). Add ~20mL of distilled water to the flask with the vinegar. Add 2-3 drops of phenolphthalein indicator solution and set aside. The solution will remain clear, so do not forget to do this!

2. Use the funnel to add KOH to the burette so that the volume is again between 1.00 mL and 10.00 mL. Ensure that the burette tip is charged by letting a drop or two fall into a waste container and discard of the waste appropriately (see "Clean-up and Disposal").

3. Accurately record the starting volume of the KOH for the titration.

4. Place the Erlenmeyer flask containing the vinegar under the burette and begin adding KOH slowly to the solution with constant mixing (swirl the container).

5. Continue adding the KOH until the color begins to change from clear to pink. When this change begins to happen, add KOH very slowly and carefully (drop by drop).

6. When the color changes to the faintest pink and stays pink for at least 10 seconds, the titration is over. Record the final volume on the burette for later use.

7. Thoroughly rinse the Erlenmeyer flask or other reaction container and repeat steps 1-6 two additional times (for a total of three trials).

8. Clean any glassware used except the burette with soap and water.

CLEAN-UP & DISPOSAL

Titrated solutions should be very near to neutral and can be washed directly down the drain. Any waste KOH or HCl is also very dilute, and can be flushed down the drain with copious amounts of water. Commercial vinegar is a very weak acid and can be poured down the sink.

DATA & CALCULATIONS

$HCl\ (aq) + KOH\ (aq) \rightarrow H_2O\ (l) + KCl\ (aq)$

	Titration 1	**Titration 2**	**Titration 3**
Volume HCl used (mL)	**10.0**	**10.0**	**10.0**
Molarity HCl (mol/L)			
KOH Initial Volume (mL)			
KOH Final Volume (mL)			
KOH Volume used (mL)			
Molarity of KOH (mol/L)			

Average Molarity of KOH : _______________ (mol/L)

$HC_2H_3O_2$ (*aq*) + KOH (*aq*) → H_2O (*aq*) + $KC_2H_3O_2$ (*aq*)

	Titration 1	**Titration 2**	**Titration 3**
KOH Initial Volume (mL)			
KOH Final Volume (mL)			
KOH Volume used (mL)			
* Molarity KOH (mol/L)			
$HC_2H_3O_2$ Volume used (mL)	**2.0**	**2.0**	**2.0**
Molarity of $HC_2H_3O_2$ (mol/L)			

* Use your average KOH molarity from the previous titration

Average Molarity of $HC_2H_3O_2$: ________________ (mol/L)

CALCULATIONS