Potentiometric Acid-Base Titrations Name_____

INTRODUCTION

In this lab you will be titrating both a strong acid (HCl) and then a weak acid ($HC_2H_3O_2$) with a strong base NaOH while recording the pH. From the collected data a titration curve will be plotted for each acids and differences in the curves noted.

Most substances that are acidic in water are actually weak acids. Because weak acids dissociate only partially in aqueous solution, equilibrium is formed between the acid and its ions. The ionization equilibrium is given by:

$$HA(aq) \Leftrightarrow H^+(aq) + A^-(aq)$$

Where A^- is the conjugate base.
The equilibrium constant is then:

$$Ka = [H^+][A^-] / [HA]$$

The smaller the value for Ka, the weaker the acid. Weaker acids ionize less ([H+] is smaller compared to [HA]) and therefore have a less drastic effect on pH.

Strong acids such as HCl ionizes almost completely in water.

For each of the titrations plot the graph of pH versus volume of base added. In each titration curve locate the equivalence point and the half-way point. The equivalence point assumed to correspond to the mid-point of the vertical portion of the curve, where pH is increasing rapidly. The half-way point is assumed to correspond to the mid-point of the horizontal portion of the curve, where pH is changing very little. From the graph read the volume of base need to the reach the end point and half-way point.

There are a number of differences between the titration curves for a strong acid versus the weak acid.

Weak Acid Titration

The weak-acid solution has a higher initial pH.
The pH rises more rapidly at the start, but less rapidly near the end point.
The pH at the equivalence point does not equal 7.00 (pH > 7.00) for the weak acid titration.

PURPOSE

To construct 2 titration curves. One of a strong acid with a strong bases and the other, a weak acid with a strong base. Also to determine the Ka of the weak acid using the constructed titration curve.

PROCEDURE

1. **Prep the buret with 0.1 M NaOH solution.**

Strong Acid Strong Base Titration-

1. Obtain a clean, dry 250-mL beaker. This is the RXN beaker.
2. Measure 20.00mL of 0.1 M HCl solution to the 250-mL flask.
3. Turn on the pH meter and place it into the flask with HCl. Record the pH.
4. Add 2.0-mL of NaOH to the RXN beaker. Stir (unnecessary if using magnetic stirrer) the solution and record the new pH.
5. Repeat step 4 until 15. ml of NaOH has been added.
6. From 15. mL to 25. mL of NaOH measure the pH in 1.0 mL increments.
7. From 25. mL to 50. mL add the NaOH in 2.0 mL increments.
8. Stop the experiment at 50. mL and wash out the flask. Refill the buret with NaOH for the next titration.

Weak Acid Strong Base Titration

1. Measure 20.00mL of 0.1 M $HC_2H_3O_2$ solution to the clean flask.
2. Refill the buret with the 0.1 M NaOH
3. Repeat the previous experiment with the weak acid.

DATA

1. Record the data of each titration in the appropriate table.
2. Graph a titration curve for each titration. Be sure each curve has an appropriate title and labeled axes.

DATA ANALYSIS AND CALCULATIONS

Strong Acid Titration

1. What is the pH of the equivalence point (also label this on the titration curve)?
2. How many mL of NaOH were used to reach equivalence point?

Weak Acid Titration

3. What is the pH of the equivalence point (also label this on the titration curve)?
4. How many mL of NaOH were used to reach equivalence point?
5. What is the pH of the half-way point (also label this on the titration curve)?
6. How many mL of NaOH were used to reach half-way to equivalence point?
7. Using the pH of the half-way point, calculate the experimental value of the ionization constant (Ka) for the weak acid.

DISCUSSION QUESTIONS

1. What indicator could replace the pH meter in determining the equivalence point of the strong acid?

    Why?

2. What indicator could replace the pH meter in determining the equivalence point of the weak acid?

    Why?

SUMMARY