AP CHEMISTRY

Titrations and Acid / Base Equilibrium

(115 Points)

Name, Date and Lab Partner (5 Points)

Procedure (10 Points)

 Complete, step-by-step account

 of actions performed

Data (25 Points)

 Observation Table (10 Points)

 Reagent Volumes (5 Points)

 pH Tables (10 Points)

Analysis/Calculations (30 Points)

Conclusion (30 Points)

Overall Neatness and Organization (5 Points)

Safety (10 Points)

This part is determined by proper lab safety which includes having your goggles and lab coat on properly at all times. Each reminder by the instructor will result in a deduction of 5 or 10 points. This component of the grade can be negative.

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**INTRODUCTION TO ANALYTICAL CHEMISTRY – LAB**

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**EXPERIMENT VI**

TITRATIONS & ACID / BASE EQUILIBRIUM

**INTRODUCTION**

Acids and bases are categorized differently depending upon the Arrhenius, Bronstad-Lowry, or Lewis definition. Typically, most of the acids and bases encountered at this level will be true Arrhenius acids/bases; where H+ and OH- ions are donated directly into solution. The strength of these acids/bases is determined by the amount of H+ and OH- ions they donate into solution. Complete dissociation is a characteristic of strong acids and bases, while partial dissociation is the process of ionization for weak acids and bases. Regardless of the mechanism for dissociation, the relative acidity/alkalinity of all acids and bases can be expressed as a pH/pOH value.

**THEORY**

pH values can be theorized and calculated if information on the relative H+ ion concentration is known.

pH = -log[H+] [H+] = 10-pH

For strong acids who completely dissociate, determination of the [H+] is rather straight forward as long as the [acid] is known. However, in the case of weak acids and bases, the likelihood of these compounds dissociating into their ions in solution must be known to theorize an accurate pH mathematically. The Ka, or acid dissociation constant, is a value that represents the occurrence of dissociation for a specific acid in equilibrium with its ions.

Ka = [H+][A-] / [HA] where HA H+ + A-

The pH calculation for such weak acids therefore must take into account this reduced occurance of dissociation, expressed as pKa.

pH = pKa + log([A-]/[HA]) where pKa = -log(Ka)

For solutions that are prepared in the laboratory, the concentration of the acid and therefore the [H+] should be known. However, when analyzing solutions of unknown concentration, the [H+] and therefore the [HA] can be determined experimentally via titration with a base of known concentration.

During a titration reaction, pH is monitored either directly with a pH probe or indirectly through the use of an indicator. A significant amount of information can be obtained from the graphical analysis of how pH changes overtime as the base is added to the acid of unknown concentration. That will be the focus of this titration experiment; to graph the relationship of pH versus volume of base and see how this relationship differs when titrating a strong acid versus a weak acid. Additionally, the titration curves will be analyzed to determine what information can be obtained about the equivalency point and the Ka of the acids.

**Safety and Disposal**

The acids and bases utilized in this experiment are of sufficient molarity to cause bodily harm through skin contact, eye contact, or ingestion. Use caution when pouring and transporting these solutions and report any spills for immediate neutralization and clean-up.

**Research & Development**

1. Titration calculations rely heavily upon stoichiometric relationships, volume, and concentration values. Identify the affect the following procedures could have on your laboratory results.
	1. The buret is rinsed with diH2O and subsequently filled with base of known concentration. Titration of the unknown acid is initiated.
	2. A 25 mL acid aliquot of unknown concentration is pipetted into a beaker for titration analysis. The meniscus of the acidic solution is slightly below the graduated mark on the volumetric pipette prior to transfer.
2. The two acids analyzed in this experiment are acetic acid and hydrochloric acid. Write the neutralization reactions of each acid with sodium hydroxide below.
3. Determine the equilibrium expression for the dissociation of the weak acid. What value is this expression equal to at equilibrium?
4. Write the equation for the determination of the pH of the strong acid and for the weak acid.

**Investigation**

***Titration of acid A.***

1. Using a 25.00mL volumetric pipet, pipet 25.00mL of acid A solution to a clean and dry 100mL beaker. Label the beaker.

2. In another 100mL beaker, obtain ~75mL of the 0.10M NaOH solution. Label the beaker.

3. Take the appropriate steps to ensure the base, once transferred to the buret, will not be altered in any way.

- Rinse the buret and stopcock with diH2O to clean the instruments.

- With the stopcock closed, rinse the buret with ~5mL of the base solution. Swirl and rotate to coat the walls of the buret. Open the stopcock and allow the solution to discard into the sink. Repeat.

4. Using the buret funnel, carefully add the 0.10M NaOH to the buret. Make sure the stopcock is closed. Go about an inch past the top line on the buret, being careful not to let it overflow.

5. With Beaker B under the buret, slowly bring the meniscus to the 0 mL line. Record the exact starting volume.

6. Turn on the pH meter and place it into the acid beaker. Record the initial pH.

7. Add 2.0 mL of NaOH to the acid beaker. Swirl the solution and record the new pH.

8. Repeat step 7 until a volume of 20.0 ml of NaOH has been delivered to the acid.

9. From 20.0 mL to 30.0 mL of NaOH, measure the pH after 1.0 mL increments of NaOH are added.

10. From 30.0 mL to 50.0 mL, add the NaOH in 2.0 mL increments once again.

11. Stop the experiment at 50.0 mL, record the final volume of NaOH delivered, and wash out the acid beaker.

***Titration of acid B***

1. Using a 25.00mL volumetric pipet, pipet 25.00mL of acid B solution to a clean and dry 100mL beaker. Label the beaker.

2. In another 100mL beaker, obtain ~75mL of the 0.10M NaOH solution. Label the beaker.

3. Take the appropriate steps to ensure the base, once transferred to the buret, will not be altered in any way.

- Rinse the buret and stopcock with diH2O to clean the instruments.

- With the stopcock closed, rinse the buret with ~5mL of the base solution. Swirl and rotate to coat the walls of the buret. Open the stopcock and allow the solution to discard into the sink. Repeat.

4. Using the buret funnel, carefully add the 0.10M NaOH to the buret. Make sure the stopcock is closed. Go about an inch past the top line on the buret, being careful not to let it overflow.

5. With Beaker B under the buret, slowly bring the meniscus to the 0 mL line. Record the exact starting volume.

6. Turn on the pH meter and place it into the acid beaker. Record the initial pH.

7. Add 2.0 mL of NaOH to the acid beaker. Swirl the solution and record the new pH.

8. Repeat step 7 until a volume of 20.0 ml of NaOH has been delivered to the acid.

9. From 20.0 mL to 30.0 mL of NaOH, measure the pH after 1.0 mL increments of NaOH are added.

10. From 30.0 mL to 50.0 mL, add the NaOH in 2.0 mL increments once again.

11. Stop the experiment at 50.0 mL, record the final volume of NaOH delivered, and wash out the acid beaker.

**Titration Analysis**

1. For each of the titrations, plot the graph of pH versus volume of base added. Print out each graph and locate the equivalence point and the half-way point.
2. Identify the volume of base need to the reach the end point and half-way point.
3. Compare the following points on titration graphs: initial pH, equivalency point, final pH. Which graph represents the titration of HCl and which represents HC2H3O2?
4. Calculate the experimental value of the ionization constant for the weak acid using the titration curve.
5. Calculate the concentration of the strong acid.

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

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**Conclusion**

* Discuss the information that can be obtained from a titration curve.
* Discuss the application of titrations and their usefulness.
* Explain your results showing your understanding of equilibrium, dissociation, and pH.