CHEMISTRY EXTENDED ESSAY

"INVESTIGATION OF THE EFFECT OF THE STRENGTH OF ACIDS AND BASES IN HYDROLYSIS PROCESS AND DETERMINATION OF THE EFFECT OF MOLARITY ON THE OCCURRENCE OF HYDROLYSIS"

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ABSTRACT

Acids and bases are the daily life topics because they are in everything we use in daily life. The tooth paste, the soap, fruits, vinegar and else is the examples of acids and bases which we use so much. Though, they are topics from daily life most of their properties are unknown like *hydrolysis.* As acids and bases can be strong or weak, their strength can affect their tendency to react with other chemicals, to neutralize another acid or base. This is called hydrolysis.

In this experiment I tried to examine the production of hydrolysis based on the strength. According to my hypothesis; hydrolysis is the neutralization reaction which is affected by the strength of the acid or the base. When one of them, the acid or the base, is weak and the other is strong the neutralization reaction cannot be fully finished. The ions coming from the weak one reacts with water and forms its original acid or base.

$NaOH$(sodium hydroxide) is a strong base which can neutralize acids and NH_3(ammonia) is a weak base which cannot fully neutralize an acid because the ammonium ion coming from NH3 reacts with water and form NH_3 again. HCl(hydrochloric acid) is a strong acid that can neutralize bases and CH_3COOH(acetic acid or vinegar acid) is a weak acid and it cannot fully neutralize a base.

The experiments that I have done prove my hypothesis with one extra information. As the hydrolysis process is based on the strength of the acid or the base it can also be affected by the molarity of the chemical. Molarity and the strength of acids and bases are the things that affect the occurrence of hydrolysis process as happened during my experiments. The results of my experiments have been affected by the molarity of the solution that I have used.

Word Count: 304

INTRODUCTION

In secondary school we learned a little information about acids and bases. It was the most interesting topic of chemistry-actually we didn't have a chemistry lesson but we know that acids and bases is a topic of chemistry. It is a topic from whole life, every day we come across to lots of acids and bases. I remember from my childhood that, I used to like the taste of toothpaste. In secondary school I learned that it is a base also I learned that soap is another base which I used to play while I was washing my hand. Because of this little entertainment, I never forget that bases are slippery. Since that time I have an interest about acids and bases because they are interesting and useful in every period of your life.

After having our chemistry lessons separated from other science lessons at high school, I learned lots of different topics about chemistry, however acids and bases is still the most interesting topic in chemistry for me. Thus, I decided to choose this topic for my extended essay. After searching lots of information about acids and bases, I decided to do my extended essay on hydrolysis. Even though it was a short topic, I wanted to do my experiments about this topic because of its being interesting.

Since the day humanity started, people have been questioning the entire world and themselves. It is a necessity to know what is going around. As the people were always being afraid of nature, they wanted to examine it.

One of the examined area was the chemicals in the entire world, and to make this examination easier people used some classifications. One of these classifications is the categorization of substances or chemicals as "acid" or "base".
Acid, which has a sour taste, got its name from the Latin word *acidus* which also means sour. They react with active metals and bases. Acids turn the colour of *litmus paper*[1] into red.

Base, on the other hand, has a bitter taste and reacts with acids and some metals which are called *amphoteric metals*[2]. Different from acids, bases turn the colour of litmus paper into blue.

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[1] Litmus paper is paper that has been treated with a specific indicator - a mixture of 10-15 natural dyes obtained from lichens (mainly *Roccella tinctoria*) that turns red in response to acidic conditions (pH < 7) and blue under alkaline conditions (pH > 7). When the pH is neutral (pH = 7) then the dye is purple. (http://chemistry.about.com/b/2009/01/09/what-is-litmus-paper.htm)
[2] Metals which can both react with acids and bases.

The usual products of acid and base reactions, neutralization, are salt and water. When both the acid and the base are strong the result of neutralization is salt and water. However, when one of them, the acid or the base, is weak the result may change according to the weak one.

The weak acid anion and the weak base cation have a tendency to react with water and form its original weak acid or base.

When both of them are weak, the result of neutralization depends on the relative strengths of both acid and base. The one with the least relative strength decides the acidic or basic property of the result solution.

HYPOTHESIS

The general form of neutralization is in the following;
Acid + Base ⟶ Salt + Water
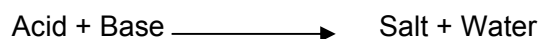
And the reverse of this reaction, which is
Salt + Water ⟶ Acid + Base is called **hydrolysis.**

Most of the hydrolysis reactions occur because of the tendency of weak acid or base to react with water and form its original acid or base. Furthermore, when there is excess acid anion or base cation in the solution, hydrolysis can also occur.

The result of this case is that; **the strength of acids and bases affect the formation of hydrolysis.**

Acid and base neutralization can be done in four different cases; both the acid and the base is strong, the acid is strong but the base is weak, the acid is weak but the base is strong and both are weak. Because of these four different possibilities, the final solution can be neutral, acidic or basic.

   Strong acid + Strong base:[3]

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[3] <http://chemistry.about.com/od/acidsbases/a/aa110204a.html >

HCl + NaOH --> NaCl + H_2O
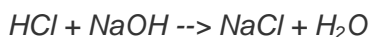
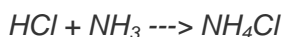*When strong acids and strong bases react, the products are salt and water. The acid and base neutralize each other, so the solution will be neutral (pH=7) and the ions that are formed will not reaction with the water (if there is any).*
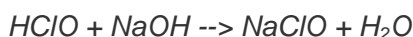
Strong acid + weak base:

HCl + NH_3 ---> NH_4Cl

The reaction between a strong acid and a weak base also produces a salt, but water is not usually formed because weak bases tend not to be hydroxides. In this case, the water solvent will react with the cation of the salt to reform the weak base. For the reaction above:
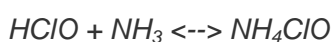
HCl (aq) + NH_3 (aq) <--> NH_4^+ (aq) + Cl^- while
NH_4^- (aq) + H_2O <--> NH_3 (aq) + H_3O^+ (aq)

Weak acid + Strong base:

HClO + NaOH --> NaClO + H_2O

When a weak acid reacts with a strong base the resulting solution will be basic. The salt will be hydrolyzed to form the acid, together with the formation of the hydroxide ion from the hydrolyzed water molecules.

Weak acid + Weak base:

HClO + NH_3 <--> NH_4ClO

The pH of the solution formed from the reaction of a weak acid with a weak base depends on the relative strengths of the reactants. For example, if the acid HClO has a K_a of 3.4 x 10^{-8} and the base NH_3 has a K_b = 1.6 x 10^{-5}, then the aqueous solution of HClO and NH_3 will be basic because the K_a of HClO is less than the K_a of NH_3.[4]

The strength of acids and bases affect the formation of hydrolysis. If one of them is weak and the other is strong hydrolysis occurs, however if both of them is weak or both of them is strong no hydrolysis occurs.

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[4] Taken from the website; <http://chemistry.about.com/od/acidsbases/a/aa110204a.htm >.

With all these information, I have decided to search the affect of the strength of acid or base over hydrolysis.

Research Question: *To what extend does the strength of acids and bases affect the formation of hydrolysis?*

In this experiment I will use titration method. *An acid-base titration is the determination of the concentration of an acid or base by exactly neutralizing the acid/base with an acid or base of known concentration. This allows for quantitative analysis of the concentration of an unknown acid or base solution. It makes use of the neutralization reaction that occurs between acids and bases and the knowledge of how acids and bases will react if their formulas are known[5].* To give an example for this method, I want to use a strong acid HCl and a strong base NaOH which I will also use in my experiment.

In titration method we put the unknown acid or base solution into the beaker and put the known solution into the burette. There should be an indicator in the solution-phenolphthalein- which is in beaker to determine the end point. Then the stopcock of the burette is opened and let the base be added to the acid solution. When the colour of the acid solution become pink(dark pink) the stopcock is closed and the titration is finished.

With the known volume of neutralized solution, we can calculate the molarity of the unknown acid or base solution by the help of the equation in the following.

Mbase added x Vbase = Macid x Vacid solution

METHOD DEVELOPMENT AND PLANNING

When I first looked at the information that I've used in my introduction, I understand that I have to do four different experiments. First, I have to do an experiment with strong acid and strong base, to see that no hydrolysis will occurs in that reaction. Then, I have to do another experiment

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[5] Taken from the website <http://en.wikipedia.org/wiki/Acid-base_titration >.

with a weak acid and weak base to again confirm my prediction which says that hydrolysis occurs only when one of them is weak. After doing these two experiments, I have to do the last two experiments which will confirm my hypothesis.

Materials and Apparatus

Beaker and Burette for titration
0.01M, 0.5 M HCl solutions
0.01M, 0.5 M NaOH solutions
1M, 6M NH3 solutions
1M, 6M CH3COOH solutions
Pure water
Phenolphthalein

Part I

Preparation of 0.01M HCl and 0.01M NaOH solution
Close the stopcock of burette and put 50mL of 0.01M NaOH inside. Put some amount of 0.01M HCl solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Preparation of 1M NH3 and 1M CH3COOH solution
Close the stopcock of burette and put 50mL of 1M NH3 solution inside. Put some amount of 1M CH3COOH solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Preparation of 1M CH3COOH and 0.01M NaOH solution
Close the stopcock of burette and put 50mL of 0.01M NaOH inside. Put some amount of 1M CH3COOH solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Preparation of 1M NH3 and 0.01M HCl solution

Close the stopcock of burette and put 50mL of 0.01M HCl solution inside. Put some amount of 1M NH3 solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Part II

Change the concentrations of weak acid and base and do the same procedure again.

Preparation of 0.01M HCl and 0.01M NaOH solution

Close the stopcock of burette and put 50mL of 0.01M NaOH inside. Put some amount of 0.01M HCl solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Preparation of 6M NH3 and 6M CH3COOH solution

Close the stopcock of burette and put 50mL of 6M NH3 solution inside. Put some amount of 6M CH3COOH solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Preparation of 6M CH3COOH and 0.01M NaOH solution

Close the stopcock of burette and put 50mL of 0.01M NaOH inside. Put some amount of 6M CH3COOH solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Preparation of 6M NH3 and 0.01M HCl solution

Close the stopcock of burette and put 50mL of 0.01M HCl solution inside. Put some amount of 6M NH3 solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Part III

This time change the concentrations of strong acid and strong base. Use the concentrations of part one for weak acid and weak base.

Preparation of 0.5M HCl and 0.5M NaOH solution

Close the stopcock of burette and put 50mL of 0.5M NaOH inside. Put some amount of 0.5M HCl solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Preparation of 1M NH3 and 1M CH3COOH solution

Close the stopcock of burette and put 50mL of 1M NH3 solution inside. Put some amount of 1M CH3COOH solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Preparation of 1M CH3COOH and 0.5M NaOH solution

Close the stopcock of burette and put 50mL of 0.5M NaOH inside. Put some amount of 1M CH3COOH solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

Preparation of 1M NH3 and 0.5M HCl solution

Close the stopcock of burette and put 50mL of 0.5M HCl solution inside. Put some amount of 1M NH3 solution into beaker and put pure water in it until it becomes 50mL. Lastly, put 5 drops of phenolphthalein into beaker.

DATA COLLECTION

See tables at appendix 1.

Part I

Preparation of 0.01M HCl and 0.01M NaOH solution
Preparation of 1M NH3 and 1M CH3COOH solution
Preparation of 1M CH3COOH and 0.01M NaOH solution
Preparation of 1M NH3 and 0.01M HCl solution

Part II

Preparation of 0.01M HCl and 0.01M NaOH solution
Preparation of 6M NH3 and 6M CH3COOH solution
Preparation of 6M CH3COOH and 0.01M NaOH solution
Preparation of 6M NH3 and 0.01M HCl solution

Part III

Preparation of 0.5M HCl and 0.5M NaOH solution

Preparation of 1M NH3 and 1M CH3COOH solution

Preparation of 1M CH3COOH and 0.5M NaOH solution

Preparation of 1M NH3 and 0.5M HCl solution

DATA ANALYSIS

The Calculation of the Average Volumes of Acids and Bases in Burette:

Part I

Preparation of 0.01M HCl and 0.01M NaOH solution

Finding Average Volume of NaOH;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(24.00±0.05) + (22. 00±0.05) + (22.00±0.05) + (22. 00±0.05) + (27. 00±0.05)] / 5

Vaverage= (24.00±0.21%)+(22. 00±0.23%)+(22.00±0.23%) + (22. 00±0.23%) + (27. 00±0.19%)] / 5

Vaverage= (23.40± 1.09%)

Vaverage= 23.40±0.25mL

Preparation of 1M NH3 and 1M CH3COOH solution

Finding Average Volume of NH3;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(12.00±0.05) + (12. 00±0.05) + (14.00±0.05) + (11. 00±0.05) + (11. 00±0.05)] / 5

Vaverage= (12.00±0.41%)+(12. 00±0.41%)+(14.00±0.35%) + (11. 00±0.45%) + (11. 00±0.45%)] / 5

Vaverage= (12.00± 2.07%)

Vaverage= 12.00±0.25mL

Preparation of 1M CH3COOH and 0.01M NaOH solution

Finding Average Volume of NaOH;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(50.00±0.05) + (50. 00±0.05) + (50.00±0.05) + (50. 00±0.05) + (50. 00±0.05)] / 5

Vaverage= (50.00±0.10%)+(50. 00±0.10%)+(50.00±0.10%) + (50. 00±0.10%) + (50. 00±0.10%)] / 5

Vaverage= (50$\pm$ 0.50%)

Vaverage= 50.00$\pm$0.25mL

Preparation of 1M NH3 and 0.01M HCl solution

Finding Average Volume of HCl;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50. 00$\pm$0.05)] / 5

Vaverage= (50.00$\pm$0.10%)+(50. 00$\pm$0.10%)+(50.00$\pm$0.10%) + (50. 00$\pm$0.10%) + (50. 00$\pm$0.10%)] / 5

Vaverage= (50$\pm$ 0.50%)

Vaverage= 50.00$\pm$0.25mL

Part II

Preparation of 0.01M HCl and 0.01M NaOH solution

Finding Average Volume of NaOH;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(24.00$\pm$0.05) + (22. 00$\pm$0.05) + (22.00$\pm$0.05) + (22. 00$\pm$0.05) + (27. 00$\pm$0.05)] / 5

Vaverage= (24.00$\pm$0.21%)+(22. 00$\pm$0.23%)+(22.00$\pm$0.23%) + (22. 00$\pm$0.23%) + (27. 00$\pm$0.19%)] / 5

Vaverage= (23.40$\pm$ 1.09%)

Vaverage= 23.40$\pm$0.25mL

Preparation of 6M NH3 and 6M CH3COOH solution

Finding Average Volume of NH3;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50. 00$\pm$0.05)] / 5

Vaverage= (50.00$\pm$0.10%)+(50. 00$\pm$0.10%)+(50.00$\pm$0.10%) + (50. 00$\pm$0.10%) + (50. 00$\pm$0.10%)] / 5

Vaverage= (50$\pm$ 0.50%)

Vaverage= 50.00$\pm$0.25mL

Preparation of 6M CH3COOH and 0.01M NaOH solution

Finding Average Volume of NaOH;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50. 00$\pm$0.05)] / 5

Vaverage= (50.00$\pm$0.10%)+(50. 00$\pm$0.10%)+(50.00$\pm$0.10%) + (50. 00$\pm$0.10%) + (50. 00$\pm$0.10%)] / 5

Vaverage= (50$\pm$ 0.50%)

Vaverage= 50.00$\pm$0.25mL

Preparation of 6M NH3 and 0.01M HCl solution

Finding Average Volume of HCl;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50. 00$\pm$0.05)] / 5

Vaverage= (50.00$\pm$0.10%)+(50. 00$\pm$0.10%)+(50.00$\pm$0.10%) + (50. 00$\pm$0.10%) + (50. 00$\pm$0.10%)] / 5

Vaverage= (50$\pm$ 0.50%)

Vaverage= 50.00$\pm$0.25mL

Part III

Preparation of 0.5M HCl and 0.5M NaOH solution

Finding Average Volume of NaOH;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(4.00$\pm$0.05) + (2. 00$\pm$0.05) + (3.00$\pm$0.05) + (2. 00$\pm$0.05) + (3. 00$\pm$0.05)] / 5

Vaverage= (4.00$\pm$1.25%)+(2. 00$\pm$2.5%)+(3.00$\pm$1.67%) + (2. 00$\pm$2.5%) + (3. 00$\pm$1.67%)] / 5

Vaverage= (2.80$\pm$ 9.59%)

Vaverage= 2.80$\pm$0.27mL

Preparation of 1M NH3 and 1M CH3COOH solution

Finding Average Volume of NH3;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50. 00$\pm$0.05)] / 5

Vaverage= (50.00$\pm$0.10%)+(50. 00$\pm$0.10%)+(50.00$\pm$0.10%) + (50. 00$\pm$0.10%) + (50. 00$\pm$0.10%)] / 5

Vaverage= (50$\pm$ 0.50%)

Vaverage= 50.00$\pm$0.25mL

Preparation of 1M CH3COOH and 0.5M NaOH solution

Finding Average Volume of NaOH;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50.00$\pm$0.05) + (50. 00$\pm$0.05) + (50. 00$\pm$0.05)] / 5

Vaverage= (50.00$\pm$0.10%)+(50. 00$\pm$0.10%)+(50.00$\pm$0.10%) + (50. 00$\pm$0.10%) + (50. 00$\pm$0.10%)] / 5

Vaverage= (50$\pm$ 0.50%)

Vaverage= 50.00+0.25mL

Preparation of 1M NH3 and 0.5M HCl solution

Finding Average Volume of HCl;

Vaverage= (V1+V2+V3+V4+V5) / 5

Vaverage= [(50.00+0.05) + (50. 00+0.05) + (50.00+0.05) + (50. 00+0.05) + (50. 00+0.05)] / 5

Vaverage= (50.00+0.10%)+(50. 00+0.10%)+(50.00+0.10%) + (50. 00+0.10%) + (50. 00+0.10%)] / 5

Vaverage= (50+ 0.50%)

Vaverage= 50.00+0.25mL

Calculation of unknown molarities of acids and bases in beaker:

Part I

Preparation of 0.01M HCl and 0.01M NaOH solution

Finding the initial molarity of HCl with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00+0.05) = (0.01) x (23.40+0.25)

M1 = (0.01) x (23.40+0.25) / (50.00+0.05)

M1 = 0.047 molar

Preparation of 1M NH3 and 1M CH3COOH solution

Finding the initial molarity of CH3COOH with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00+0.05) = (1) x (12.00+0.25mL)

M1 = (1) x (12.00+0.25mL) / (50.00+0.05)

M1 = 0.24 molar

Preparation of 1M CH3COOH and 0.01M NaOH solution

Finding the initial molarity of CH3COOH with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00+0.05) = (0.01) x (50.00+0.05)

M1 = (0.01) x (50.00+0.05) / (50.00+0.05)

M1 = 0.01 molar

Preparation of 1M NH3 and 0.01M HCl solution

Finding the initial molarity of NH3 with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00+0.05) = (0.01) x (50.00+0.05)

M1 = (0.01) x (50.00±0.05) / (50.00±0.05)

M1 = 0.01 molar

Part II

Preparation of 0.01M HCl and 0.01M NaOH solution

Finding the initial molarity of HCl with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00±0.05) = (0.01) x (23.40±0.25)

M1 = (0.01) x (23.40±0.25) / (50.00±0.05)

M1 = 0.047 molar

Preparation of 6M NH3 and 6M CH3COOH solution

Finding the initial molarity of CH3COOH with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00±0.05) = (6) x (50.00±0.05)

M1 = (6) x (50.00±0.05) / (50.00±0.05)

M1 = 6 molar

Preparation of 6M CH3COOH and 0.01M NaOH solution

Finding the initial molarity of CH3COOH with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00±0.05) = (0.01) x (50.00±0.05)

M1 = (0.01) x (50.00±0.05) / (50.00±0.05)

M1 = 0.01 molar

Preparation of 6M NH3 and 0.01M HCl solution

Finding the initial molarity of NH3 with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00±0.05) = (0.01) x (50.00±0.05)

M1 = (0.01) x (50.00±0.05) / (50.00±0.05)

M1 = 0.01 molar

Part III

Preparation of 0.5M HCl and 0.5M NaOH solution

Finding the initial molarity of HCl with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00±0.05) = (0.5) x (2.80±0.27)

M1 = (0.5) x (2.80±0.27mL) / (50.00±0.05)

M1 = 0.056 molar

Preparation of 1M NH3 and 1M CH3COOH solution

Finding the initial molarity of CH3COOH with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00±0.05) = (1) x (50.00±0.05)

M1 = (0.5) x (50.00±0.05) / (50.00±0.05)

M1 = 1 molar

Preparation of 1M CH3COOH and 0.5M NaOH solution

Finding the initial molarity of CH3COOH with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00±0.05) = (0.5) x (50.00±0.05)

M1 = (0.01) x (50.00±0.05) / (50.00±0.05)

M1 = 0.5 molar

Preparation of 1M NH3 and 0.5M HCl solution

Finding the initial molarity of NH3 with the help of the equation;

M1 x V1 = M2 x V2

M1 x (50.00±0.05) = (0.5) x (50.00±0.05)

M1 = (0.5) x (50.00±0.05) / (50.00±0.05)

M1 = 0.5 molar

CONCLUSION AND EVALUATION

The aim of this experiment was to find the effect of the strength of acids and bases in hydrolysis process. According to the researches that have been done before a controlled experiment was designed shows that when one of the acid or the base is weak hydrolysis occurs but the other should be strong. To see this, four different chemicals have been used. As a strong acid HCl(hydrochloric acid) and as a weak acid CH_3COOH(acetic acid) was used; as a strong base NaOH(sodium hydroxide) and as a weak base NH_3(ammonia) was used. These four different chemicals was paired as; strong acid strong base, strong acid weak base, weak acid strong base and weak acid weak base to see all the cases apart from the ones in which hydrolysis occurs.

According to the hypothesis when one of the acid or the base is weak hydrolysis occurs but the other should be strong. The experiments and the data that have been collected shows that there is an effect of strength in hydrolysis and this effect is the effect that have been written in hypothesis with some exceptions and errors. As it has been researched before the experiment, when one of the acid or the base in neutralization process is weak and the other is strong hydrolysis occur. This is the result of not fully decomposed weak acid or base which firstly decomposes in water and then reacts with water to form its original acid or base. That's the reason why the colour-as indicator is used it shows that the reaction is finished as a colour change- doesn't change when hydrolysis occurs.

After collecting my data, I have processed them firstly to find the average volumes of bases in burette (and HCl during the neutralization of HCl and NH3). The results have been shown in the first part of data analysis. After having the average volume values of the trials, I have used them to find the initial molarities of acids (and NH3 during the neutralization of HCl and NH3). The results of the ones in which full neutralization occurred is normal and the ones that are expected however, the ones in which hydrolysis occurred have not expected values. For instance, the one in which 6M NH3 and 0.01M HCl is used the initial molarity of NH3 has found as 0.01 molar though it not that much possible when 6 molar of NH3 is used and has 50mL of water. Thus, the results of the ones in which hydrolysis occurred is not the normal or expected values.

The data that I have collected shows that hydrolysis occurred when one of them is weak and the other is strong but there are some other conditions that hydrolysis occurred. For instance, the

neutralization of weak base NH3 and weak acid CH3COOH should occur but the experiment result shows that while they were at higher concentrations, which are 6 molar, no neutralization occurred as it is shown in part II. Also in part III there is an error about these two chemicals, NH3 and CH3COOH. No proper neutralization occurred in their titration. This is because of the high concentrations they have. Thus, this result shows that apart from the strength also concentration effects the formation of hydrolysis. After having this result I have researched about the effect of concentration over hydrolysis process and found that molarity also gives the acid or base strength.

There are some limitations that prevented having a proper result. First of all, as it is explained in the previous paragraph, concentration also affects hydrolysis process. Thus, having a proper result about the strength was limited because in some cases hydrolysis occurred because of the high molarity that the acids and bases have. For this reason, to have a more valid result the experiment should have been done with less molarities like 0,5 or 0,1 instead of 6.

During the experiment to see whether it is because of hydrolysis or the not enough base added, I have added 150mL more to acid but still there was no change. However, maybe if I have used more bases like 200 or 250 mL there can be some colour changes occurred. I should try higher volumes.

To improve this experiment and to have a proper result to prove the hypothesis more trials can be done with different concentration which are not so higher, like 6. Seeing the effect of more molarities can also help to find the effect of molarity in hydrolysis process.

APPENDICES

Appendix 1: The data collection tables.

Part I

Preparation of 0.01M HCl and 0.01M NaOH solution

Trial	Volume of NaOH solution(mL) (± 0.05)	Volume of NaOH added to HCl solution(mL) (± 0.05)
1	50.00	24.00
2	50.00	22.00
3	50.00	22.00
4	50.00	22.00
5	50.00	27.00

Table1: The table shows the total volume of NaOH used for titration and the volume of NaOH added over HCl solution to neutralize it.

Preparation of 1M NH3 and 1M CH₃COOH solution

Trial	Volume of NH3 solution(mL) (± 0.05)	Volume of NH3 added to CH3COOH solution(mL) (± 0.05)
1	50.00	12.00
2	50.00	12.00
3	50.00	14.00
4	50.00	11.00
5	50.00	11.00

Table2: The table shows the total volume of NH3 used for titration and the volume of NH3 added over CH3COOH solution to neutralize it.

Preparation of 1M CH₃COOH and 0.01M NaOH solution

Trial	Volume of NaOH solution(mL) (± 0.05)	Volume of NaOH added to CH3COOH solution(mL) (± 0.05)
1	50.00	50.00
2	50.00	50.00
3	50.00	50.00
4	50.00	50.00
5	50.00	50.00

Table3: The table shows the total volume of NaOH used for titration and the volume of NaOH added over CH3COOH solution to neutralize it though it couldn't.

Preparation of 1M NH₃ and 0.01M HCl solution

Trial	Volume of HCl solution(mL) (± 0.05)	Volume of HCl added to NH3 solution(mL) (± 0.05)
1	50.00	50.00
2	50.00	50.00
3	50.00	50.00
4	50.00	50.00
5	50.00	50.00

Table 4: The table shows the total volume of HCl used for titration and the volume of HCl added over NH3 solution to neutralize it though it couldn't.

Part II

Preparation of 0.01M HCl and 0.01M NaOH solution

Trial	Volume of NaOH solution(mL) (± 0.05)	Volume of NaOH added to HCl solution(mL) (± 0.05)
1	50.00	24.00
2	50.00	22.00
3	50.00	22.00
4	50.00	22.00
5	50.00	27.00

Table5: The table shows the total volume of NaOH used for titration and the volume of NaOH added over HCl solution to neutralize it.

Preparation of 6M NH_3 and 6M CH_3COOH solution

Trial	Volume of NH3 solution(mL) (± 0.05)	Volume of NH3 added to CH3COOH solution(mL) (± 0.05)
1	50.00	50.00
2	50.00	50.00
3	50.00	50.00
4	50.00	50.00
5	50.00	50.00

Table6: The table shows the total volume of NH3 used for titration and the volume of NH3 added over CH3COOH solution to neutralize it but it couldn't.

Preparation of 6M CH₃COOH and 0.01M NaOH solution

Trial	Volume of NaOH solution(mL) (± 0.05)	Volume of NaOH added to CH3COOH solution(mL) (± 0.05)
1	50.00	50.00
2	50.00	50.00
3	50.00	50.00
4	50.00	50.00
5	50.00	50.00

Table7: The table shows the total volume of NaOH used for titration and the volume of NaOH added over CH3COOH solution to neutralize it though it couldn't.

Preparation of 6M NH₃ and 0.01M HCl solution

Trial	Volume of HCl solution(mL) (± 0.05)	Volume of HCl added to NH3 solution(mL) (± 0.05)
1	50.00	50.00
2	50.00	50.00
3	50.00	50.00
4	50.00	50.00
5	50.00	50.00

Table 8: The table shows the total volume of HCl used for titration and the volume of HCl added over NH3 solution to neutralize it though it couldn't.

Part III

Preparation of 0.5M HCl and 0.5M NaOH solution

Trial	Volume of NaOH solution(mL) (± 0.05)	Volume of NaOH added to HCl solution(mL) (± 0.05)
1	50.00	4.00
2	50.00	2.00
3	50.00	3.00
4	50.00	2.00
5	50.00	3.00

Table9: The table shows the total volume of NaOH used for titration and the volume of NaOH added over HCl solution to neutralize it.

Preparation of 1M NH_3 and 1M CH_3COOH solution

Trial	Volume of NH3 solution(mL) (± 0.05)	Volume of NH3 added to CH3COOH solution(mL) (± 0.05)
1	50.00	50.00
2	50.00	50.00
3	50.00	50.00
4	50.00	50.00
5	50.00	50.00

Table10: The table shows the total volume of NH3 used for titration and the volume of NH3 added over CH3COOH solution to neutralize it but it couldn't.

Preparation of 1M CH₃COOH and 0.5M NaOH solution

| Trial	Volume of NaOH solution(mL) (± 0.05)	Volume of NaOH added to CH3COOH solution(mL) (± 0.05)
1	50.00	50.00
2	50.00	50.00
3	50.00	50.00
4	50.00	50.00
5	50.00	50.00

Table11: The table shows the total volume of NaOH used for titration and the volume of NaOH added over CH3COOH solution to neutralize it though it couldn't.

Preparation of 1M NH₃ and 0.5M HCl solution

Trial	Volume of HCl solution(mL) (± 0.05)	Volume of HCl added to NH3 solution(mL) (± 0.05)
1	50.00	50.00
2	50.00	50.00
3	50.00	50.00
4	50.00	50.00
5	50.00	50.00

Table 12: The table shows the total volume of HCl used for titration and the volume of HCl added over NH3 solution to neutralize it though it couldn't.
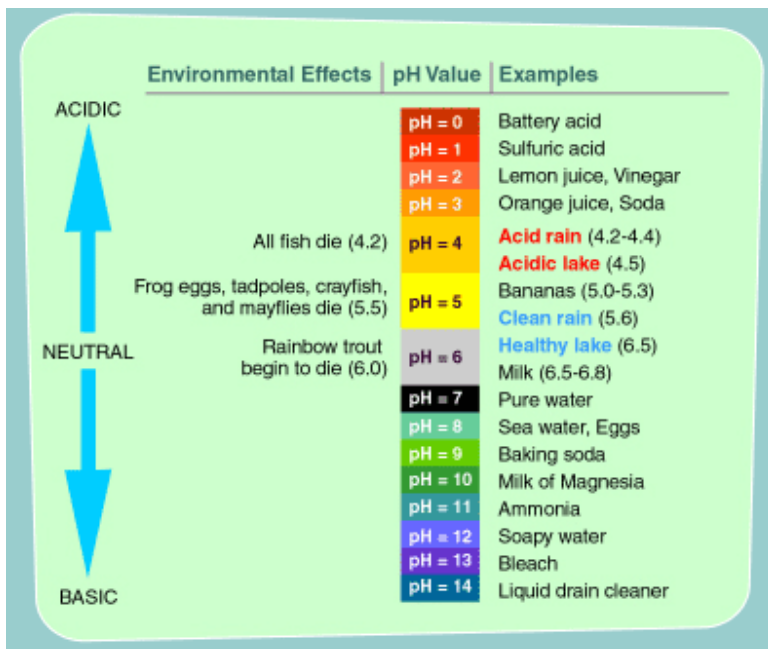
Appendix 2: The pH scale in which the strength of acids and bases are shown.

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6 http://www.epa.gov/acidrain/education/site_students/images/phscale.gif

Appendix 3: Photos that have been taken during the experiment.

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