Australian Islamic College 2021

ATAR Chemistry Units 3 and 4

Task 3

Weighting: 5% (1% Practical Work, 4% Validation Test)

Investigation: Hydrolysis of Salts

Time Available

Practical Work: 1 Period

Validation Test: 35 minutes

Please do not turn this page until instructed to do so.

First Name	Surname

Mark	Percentage

Equipment allowed: Pens, pencils, erasers, whiteout, rulers and non-programmable calculators permitted by the Schools Curriculum and Standards Authority.

Practical Work

Introduction:

When a base neutralises an acid, the result of the reaction is a salt and water. You would expect, therefore that the salt dissolved in the water would be neither acidic nor basic; that is, its pH should be 7 at 25 ^{o}C. However, some ions are known to undergo a reaction with water, in a process known as hydrolysis. When a positive ion reacts with water the process is called *cationic hydrolysis* and results in an acidic solution. When a negative ion reacts with water, the process is called *anionic hydrolysis* and results in a basic solution. In the case of some salts, both the anion and the cation hydrolyse and the resulting pH depends on which ion undergoes hydrolysis the most.

In this experiment, you will determine the pH of a number of salt solutions in water. From the results you will deduce information about which ions have hydrolysed. The type of hydrolysis is related to the relative strengths of the acid and the base from which a given salt is formed. In addition, you will measure the pH of the salt of an amphiprotic anion (an anion which can either gain or lose a proton) and use the result to deduce which occurs to a greater extent.

The pH of each solution will be determined by adding some universal indicator to the solution.

Universal indicator is a mixture of several different indicators which change colour at different pH values, so that a sequence of colour changes is observed over a large pH range. The sequence usually approximates the colours of the spectrum, with red at low pH, green near neutral, and blue or violet at high pH.

Salts formed from a strong acid and a strong base do not undergo hydrolysis. Anionic hydrolysis occurs when a salt is formed from a strong base and a weak acid. For example, consider the weak acid HF reacting with NaOH.

$$HF_{(aq)} + NaOH_{(aq)} \rightarrow NaF_{(aq)} + H_2O_{(l)}$$

The NaF salt that is produced is a basic salt due to anionic hydrolysis.

$$F^-_{(aq)} + H_2O_{(l)} \leftrightarrow HF_{(aq)} + OH^-_{(aq)}$$

When we find the equilibrium constant for this equation, since we are starting with a base F^- we are determining a K_b value. K_b is the equilibrium constant for a base. Note: You can obtain the K_a value for F^- by calculating K_w / $K_{b.}$

Objectives:

1) To measure the pH of a number of salt solutions and identify those which have undergone hydrolysis.
2) To explain why hydrolysis occurs (or does not occur) in terms of relative strengths of the acid and base from which a given salt is made and to write an ionic equation for each hydrolysis.
3) To deduce which is greater for an amphiprotic anion, the K_a (the cationic hydrolysis and further ionisation of the ion) or the K_b (the anionic hydrolysis).

Materials:

Apparatus:

- Reaction plate with wells
- Safety goggles
- Water bottle with distilled water
- Colour chart for universal indicator used
- Lab coat
- Soap and paper towels

Reagents: 0.1 M solutions of each of the following

- Sodium ethanoate
- Sodium chloride
- Ammonium chloride
- Ammonium sulfate
- Calcium nitrate
- Iron(III) sulfate
- Sodium carbonate
- Sodium sulfate
- Potassium bromide
- Ammonium oxalate
- Ammonium ethanoate
- Sodium hydrogen carbonate ($NaHCO_3$)
- Sodium monohydrogen phosphate (Na_2HPO_4)
- Sodium dihydrogen phosphate (NaH_2PO_4)
- Universal indicator solution

Procedure:

1. Put on your safety glasses and lab coat.
2. Make sure you have a reaction plate and a water bottle with distilled water. Wash the reaction plate with tap water and then rinse it with distilled water.
3. Squeeze some of the distilled water into a well in a reaction plate and add two drops of universal indicator as a control.
4. Half fill a well in a reaction plate with one of the solutions. Add 2-3 drops of universal indicator.
5. Record the colour that the solution gives to the indicator. Consult the colour chart provided for your universal indicator and determine the pH of this solution.
6. Repeat this process for all the other solutions you have been provided.
7. Before you leave the laboratory wash your hands thoroughly with soap and water and return all equipment as directed by your teacher. Wipe clean and dry your bench.

Wash all solutions down the sink with lots of water.

Contamination of solutions: Listen to the teacher's instructions about avoiding cross-contamination of solutions.

Safety: At the teacher's discretion up to 20% of your marks for this assessment may be deducted for unsafe behaviour during the practical portion of this assessment.

Pay attention to your teacher's instructions about safety and contamination of solutions. This information may be examined in the validation test.

Data and Observations: (7 marks)

Marking: 1 mark off per mistake. Some flexibility is allowed with colour and pH results.

Solution	Colour of Universal Indicator	pH	Type of hydrolysis reaction (anionic, cationic, both, or neither)
Sodium chloride			
Sodium ethanoate (sodium acetate)			
Ammonium chloride			
Ammonium sulfate			
Calcium nitrate			
Iron(III) sulfate OR iron(II) sufate			
Sodium carbonate			
Sodium sulfate			
Potassium bromide			
Ammonium oxalate			
Ammonium ethanoate (ammonium acetate)			

Table 2:

Solution	Colour of Universal Indicator	pH	Type of hydrolysis reaction (anionic, cationic, both, or neither)
Sodium hydrogen carbonate			
Sodium dihydrogen phosphate (aka mono-sodium phosphate)			
Sodium monohydrogen phosphate (aka sodium hydrogen orthophosphate)			