Investigation 30

Hydrolysis of salts

Introduction

A neutralisation reaction involving an acid and a base may be expected to form a salt of pH 7. However, if one of the salt ions reacts with water (hydrolysis) the pH may not be 7.

In this investigation you will choose your own equipment to measure the pH of a variety of salt solutions.

On completion of this investigation, you will be able to:

- identify a range of salts that form acidic, basic and neutral solutions
- identify the species that are responsible for the measured pH of salt solutions
- write chemical equations for the formation of salts during neutralisation, and for the hydrolysis of their respective ions
- explain the acidic, basic or neutral nature of a variety of salts.

Syllabus

Choose equipment and perform a first-hand investigation to identify the pH of a range of salt solutions.

MATERIALS

(per student or group)

- 10 mL 0.1 M solutions of the following salts:
  - sodium chloride (NaCl)
  - potassium nitrate (KNO_3)
  - ammonium chloride (NH_4Cl)
  - ammonium sulfate ($(NH_4)_2SO_4$)
  - sodium hydrogen carbonate ($NaHCO_3$)
  - sodium acetate (CH_3COONa)
  - sodium carbonate (Na_2CO_3)
  - or any other as selected by student
- datalogger with pH probe or pH meter
- small beakers
- test-tubes
- universal indicator solution

INVESTIGATION 30: Hydrolysis of salts

Pre-lab safety information

Material used	Hazard	Control
potassium nitrate	Toxic fumes released on heating, moderately toxic if ingested	Use eye protection Do not heat
ammonium chloride	Toxic fumes of ammonia and hydrogen chloride gas emitted on heating, slightly toxic if ingested	Use eye protection Do not heat
sodium acetate	Skin irritant, slightly toxic if ingested	Use eye and skin protection
sodium carbonate	Skin irritant, slightly toxic if ingested	Use eye and skin protection

Please indicate by signing that you have understood the information in the safety table.

Name (print): _____

I understand the safety information (signature): _____

Disposal of waste
Reuse solutions where possible. Leftover solution in test-tubes can be washed down the sink.

Procedure

1. Select your own equipment that will enable you to measure the pH of selected salt solutions.
2. Repeat the investigation with suitable indicator solutions that will show a colour consistent with the measured pH.
3. Record all your measurements and observations in the results table.

RESULTS

TABLE 1

Test-tube	Contents	Colour	pH
A			
B			
C			
D			
E			
F			
G			

Discussion

1. Based on your measured pH, classify the salts tested as acidic, basic or neutral.
2. Select one acidic salt and write a chemical equation:
   - **a** for its formation from a neutralisation reaction
   - **b** for its hydrolysis with water, explaining its acidic nature.
3. Select one basic salt and write a chemical equation:
   - **a** for its formation from the neutralisation reaction
   - **b** for hydrolysis with water, explaining its basic nature.
4. Fill in the missing words:

   A salt formed from a _____ acid and a _____ base has a pH greater than 7 when hydrolysed in water.

   A salt formed from a _____ acid and a _____ base, has a pH less than 7 when hydrolysed in water.

   Neutral salts are formed when a _____ acid and a _____ base form a salt that does not significantly react with water.

5 Predict whether the pH values of each of the following salts would be above, below or equal to 7. Justify your answer.

a ammonium ethanoate (NH_4CH_3COO)

b ammonium nitrate (NH_4NO_3)

c potassium citrate ($K_3C_6H_5O_7$)

d potassium sulfate (K_2SO_4)

FOLLOW-UP

1 *A buffer solution of pH 4.7 can be made by mixing ethanoic acid (acetic acid, CH_3COOH) and sodium ethanoate (sodium acetate, CH_3COONa). Briefly explain how this buffer solution can maintain this pH despite addition of small quantities of:*

a *water*

b *acid*

c *base.*

2 *The human respiratory system contains a buffer based on the hydrogen carbonate ion (HCO_3^-). Using appropriate chemical equations, explain how a constant pH is maintained.*