**Experiment**

**Instructions**

The following experiments cover the concepts of acids and bases, pH and their uses.

You are required to work through each experiment in this booklet.

Some of the set questions can be answered in the space provided in the booklet while the rest of the questions and your observations and data must be recorded in a reflective learning journal which not only documents your practical work but also includes notes and your research displaying your learning during these investigations.

**Introduction:**

Acids and bases are common solutions that exist everywhere. Almost every liquid that we encounter in our daily lives consists of acidic and basic properties, with the exception of water. By definition, an acid is a substance that can donate a proton (H+ ion) and a base is a substance that can accept a proton from an acid. pH is a measure of how acidic or basic a solution is. The range goes from 0 - 14, with 7 being neutral. pH’s of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base.

**Experiment 1:** Properties of Acids and Bases

Due to their differences in being able to donate or accept a proton, acids and bases have a unique set of properties which define them and allow them to be identified. This practical task looks at those properties and uses them to aid in the classification of unknown solutions.

**Aim:**

To investigate the properties of acids and bases and to use these properties to identify unknown solutions.

**Materials:**

Dimple plate Universal indicator and colour chart

1.0 M HCl 1.0 M NaOH

Red litmus paper Blue litmus paper

Conductivity probe 1.0 M sodium carbonate solution

Magnesium metal pieces 3 ‘unknown’ solutions (at least 1 base or acid)

**Procedure:**

Part 1: Testing the properties of Acids and Bases

* Place a few drops of 1.0 M HCl in 6 different wells on a dimple plate
* Using universal indicator, place a drop in one well and approximately measure the pH using the colour chart provided.
* Place a small piece of red litmus paper in the next well and record your observations.
* Place a small piece of blue litmus paper in the next well and record your observations.
* Measure the conductivity of the solution using a conductivity probe
* Test the reaction to carbonate by adding 3-4 drops of the carbonate solution to the next acid well.
* Test the reaction to metal by adding a piece of magnesium metal to the acid well and observe any reaction.
* Rinse out the dimple plate and repeat the above tests using 1.0 M NaOH and record your observations.

Part 2: Testing unknowns

* Using the unknowns provided, complete the same tests as above. Record your observations and classify each unknown as either acid or base.

Appropriate recording of results and observations 3 marks

**Questions:**

1. Construct a table showing the various properties of acids and bases that have been shown by this experiment.

2 marks

1. Add any more properties of acids and bases that were not shown by this experiment by conducting further research.

2 marks

1. a) Write the chemical equation for the reaction of sodium carbonate and hydrochloric acid (including states).

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1 mark

b) How could you prove that the gas evolved in this reaction is the one you put in the above equation?

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1 mark

1. a) Write the chemical equation for the reaction of magnesium and hydrochloric acid (including states).

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1 mark

b) How could you prove that the gas evolved in this reaction is the one you put in the above equation?

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1 mark

c) Write the chemical equation for this test?

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1 mark

**Experiment 2:** What is pH and how is it measured?

A liquid may be an acid, base, or neutral. The degree of acidity or basicity can be measured by using the pH scale. The scale runs from around 0 through to 14 and is divided into three areas: Acid (readings below 7), neutral (reading of 7), and basic (readings above 7). Each progression either increases or decreases the pH of a substance 10 times. For example, the pH of 5 is ten times more acidic than a pH of 6. It is for this reason that the pH scale is logarithmic as the difference between a solution of pH 1 and a solution of pH 14 is quite large.

**Aim:**

To prepare a series of dilute solutions that equate to a particular pH.

**Materials:**

0.1 M HCl 1 M NaOH

pH probe Universal indicator and colour chart

Test tubes 1 ml pipette

10 mL pipette Distilled water

Dimple plate Dropping pipette

**Procedure:**

* Place eight clean test tubes in a rack and number test tubes 1 – 7
* Pipette 10 mL of 0.1 M HCl into test tube 1
* Pipette 9 mL of distilled water into tubes 2 – 7.
* Transfer 1 mL of solution from test tube 1 into test tube 2 and mix well.
* Transfer 1 mL of solution from test tube 2 into test tube 3 and mix well.
* Continue this process through to test tube 7
* Place another clean test tube in the rack and fill with 9 mL of distilled water and 1 mL of the solution from test tube 7. Mark this tube with an X.
* Take another 7 clean test tubes and label 8 - 14.
* Pipette 10 mL of 1.0 M NaOH into test tube 14
* Pipette 9 mL of distilled water into tubes 8 – 13.
* Transfer 1 ml of solution from test tube 14 into test tube 13 and mix well.
* Continue this process down to test tube 8.
* Place a few drops of each tube into wells on a dimple plate and add 1 drop of universal indicator to each solution. Record the approximate pH using the colour chart supplied.
* Using a pH probe, measure the pH of each solution. Record the accurate pH.

Appropriate recording of results and observations 2 marks

**Questions:**

1. Write the ionisation equation (including states) for hydrochloric acid in water.

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1 mark

1. Set up the following table and fill in the required details (the first tube has been provided for you as an example):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test Tube # | [H3O+] (M) | [OH-] (M) | Theoretical pH | Actual pH |
| 1 | 10-1 | 10-13 | 1 | 1 |

4 marks

1. a) Calculate the concentration of hydrochloric acid in test tube 2.

2 marks

b) Moving from tube to tube, what is the dilution factor for each step?

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1 mark

c) How many times greater is the concentration of hydronium ions in test tube 2 than test tube 5?

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1 mark

1. Calculate the volume of water required to change a 10 mL solution at pH 3 to pH 5.

2 marks

1. Is the following statement correct? “The test tube marked X should have a pH of 8.” Explain.

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3 marks

**Experiment 3:** Strong and weak acids and bases

Different acids and bases have different strengths. This means that at a given concentration, different acids and bases produce different hydronium (hydrogen) or hydroxyl ion concentrations when dissolved in water. Strong acids and bases produce the highest concentrations because they completely dissociate. Weak acids and weak bases produce a hydronium or hydroxyl ion concentration that is less than their total concentration. The electrical conductivities of aqueous solutions give an indication of the concentration of ions in the solutions.

**Aim:**

To investigate the effect of acid and base strength on electrical conductivity and solution concentration.

**Materials:**

Conductivity probe

1.0 M, 0.1 M, 0.01 M, 0.001 M solutions of HCl, CH3COOH and HNO3

1.0 M, 0.1 M, 0.01 M, 0.001 M solutions of NaOH and NH3

**Procedure:**

Using the conductivity probe test the conductivity of each of the solutions provided. Make sure to rinse the probe with distilled water in between readings.

Appropriate recording of results and observations 2 marks

**Questions:**

1. Based on your results for conductivity, name each of the acids and bases used as either strong or weak.

2 marks

1. Why do strong acids conduct electricity better than weak acids?

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1 mark

1. a) Write the ionisation equation of nitric acid in water.

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1 mark

b) Write the equation for the reaction of ammonia in water.

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1 mark

1. a) Calculate the amount (in mole) of hydrochloric acid in a 50 mL 0.1 M solution.

1 mark

b) Calculate the amount (in mole) of acetic acid in a 50 mL 0.1 M solution.

1 mark

c) What amount (mole) of sodium hydroxide would be required to neutralise:

i. 50 mL 0.1 M HCl \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ii. 50 mL 0.1 M CH3COOH \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1 + 1 = 2 marks

1. Based on your results to this experiment and some of the answers to the above questions, does the amount (in mole) of the acid or base necessarily reflect the pH of the solution? Explain.

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2 marks

**Experiment 4:** Indicators

An indicator is a substance that changes colour at a certain pH. There are many indicators that can be used to test the pH of an aqueous solution. Indicators themselves are weak acids that undergo an ionisation reaction with water to form a conjugate base. The indicator and its conjugate base have different colours in either acidic or basic solutions.

**Aim:**

To determine the pH range and the colours associated with several indicators.

**Materials:**

Dropping pipettes Dimple plates

Thymol blue Methyl orange

Bromophenol blue Methyl red

Bromothymol blue Phenol red

Phenolphthalein Pre-made solutions from pH 1 to pH 14

**Procedure:**

* Place a few drops of each pH solution in the wells of a dimple plate
* Add a few drops of a particular indicator
* Record the colour of the indicator in each particular pH solution in an appropriate table
* Rinse plate well and repeat the above with the other indicators

Appropriate recording of results and observations 2 marks

**Questions:**

1. a) I have a solution with a pH 8.0. If a student was given this solution without knowing the pH, which two of the above indicators could provide an approximate range for the pH of this solution?

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2 marks

b) What is the pH range provided by these indicators? (Hint: Use VCAA Data Booklet)

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1 mark

1. Using the formula HTb for the Thymol Blue indicator, write the ionisation equation for this indicator with water and clearly indicate the colours of the acid and its conjugate base.

2 marks

**Research Task:** Uses of acids/bases

Acids and bases can be found everywhere in the world around us. They are found in our bodies, in the food we eat and are also used widely in industry.

In this research activity you will are required to prepare a 1 page summary of research into any application of acids and bases.

Some examples of research topics:

* Describe the role of acids and bases in the digestive system.
* The use of acids in the production of fertilisers.
* Discuss the importance of pH in blood and describe how the body regulates changes in pH.
* Which natural substances can act as indicators and how do they work?

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| --- | --- | --- | --- | --- |
| **Research Task Assessment Rubric** | | | | |
|  | **0** | **1** | **2** | **3** |
| **Use of information from other sources** | Notes are not student's own work. | Some notes are student's own work. | Most of the notes are student's own work. | All the notes are student's own work. |
| **Coverage of research topic** | Not covered well. | Some points have been covered. | Most points have been covered. | All, or more than all, points have been covered. |
| **Presentation** | Not presented well | Presentation at a basic level | Some thought in to presentation | Presented in a thoughtful and imaginative way. |
| **Number and variety of sources** | Information is from one resource only. | Information is from a few resources or from resources of the same kind. | A small variety and number of resources have been used. | A large number of resources of different kinds have been used. |

12 marks

**END OF TASK BOOK**