Teacher Resource Bank

GCE Chemistry

PSA15: A2 Physical Chemistry

- Investigate how pH changes

A2 Physical Chemistry

PSA15 Investigate how pH changes

Technical Sheet

To investigate how pH changes when a weak acid reacts with a strong base.

Whenever possible, students should work individually.
If it is essential to work in a pair or in a small group, because of the availability of apparatus, supervisors must be satisfied that they are able to assess the contribution from each student to the practical activity.

Requirements

- Two burettes
- Two funnels
- 100 cm^3 beaker
- Deionised (or distilled) water in a wash bottle
- Stand and clamp
- pH meter with probe
- 0.100 mol dm^{-3} sodium hydroxide solution
- 0.100 mol dm^{-3} ethanoic acid solution
- Standard pH buffer solutions at pH 4.00, 7.00 and 9.20
- Glass stirring rod
- Graph paper

Centres may choose to use other weak acid/strong base combinations or strong acid/weak base combinations.

Centres are expected to carry out and be responsible for their own safety risk assessments.

A2 Physical Chemistry

PSA15 Investigate how pH changes

Student Sheet

The aim of this experiment is to investigate how pH changes when a weak acid reacts with a strong base.

Introduction

This experiment investigates how the pH of a solution of ethanoic acid changes as sodium hydroxide solution is added.

The results are plotted in a graph which shows the general pattern of how the pH changes when a weak acid reacts with a strong base.

It is necessary initially to calibrate a pH meter so as to give accurate pH values for each pH reading.

It is the responsibility of the student to carry out and be responsible for their own safety risk assessment before carrying out this experiment. Wear safety glasses at all times. Assume that all of the reagents and liquids are toxic, corrosive and flammable.

Experiment

Part 1 Calibrate the pH meter

a) Rinse the pH probe thoroughly with deionised water, and shake it gently to remove excess water. Place the probe in the standard pH 4.00 buffer solution provided, ensuring that the bulb is fully immersed. Record the pH reading in a suitable table.
b) Repeat this process using the standard pH 7.00 and 9.20 buffer solutions. Rinse the pH probe thoroughly with deionised water before taking each reading. Record the pH readings in your table.

The ability to process the data is NOT part of the PSA but this is a useful task to complete.
Your teacher can help you with this part of the work.

c) Plot a graph of your **recorded pH** reading (*x* axis) against the **pH of the buffer solution**. Your graph may be a straight line or a curve.
This calibration graph will be used in the next part of the experiment to convert pH readings into more accurate pH values.

A2 Physical Chemistry

PSA15 Investigate how pH changes

Part 2 The measurement of the pH of the mixture of acid and alkali

a) Rinse a burette with the 0.100 mol dm^{-3} solution of ethanoic acid provided and then fill the burette with this solution, ensuring that it is filled below the tap. Label this burette so that you do not confuse it with second burette.
b) Use the burette to transfer exactly 20.0 cm^3 of ethanoic acid to a clean 100 cm^3 beaker.
c) Rinse a second burette with the 0.100 mol dm^{-3} sodium hydroxide solution provided and then fill this second burette with this solution, ensuring that it is filled below the tap.
d) Rinse the pH probe with distilled or deionised water and clamp it so that its bulb is fully immersed in the ethanoic acid solution in the beaker. Use a glass rod to stir the solution gently and record the pH reading in a suitable table.
e) Using the second burette, add exactly 2.0 cm^3 of the sodium hydroxide solution to the beaker containing the ethanoic acid. Stir the mixture gently with the glass rod and measure the pH of the mixture. Record the pH reading.
f) Add the sodium hydroxide solution in 2.0 cm^3 portions from the second burette to the ethanoic acid in the beaker until 40 cm^3 of the sodium hydroxide solution have been added. Take a pH reading after each addition of sodium hydroxide solution, and in each case record the pH reading in your table.
g) Rinse the pH probe with distilled or deionised water when you have taken all of your readings.

Analysing the data

The ability to process the data is NOT part of the PSA but this is a useful task to complete.

Your teacher can help you with this part of the work.

- Use your calibration graph from Part 1 to adjust, as appropriate, the pH readings obtained in your experiment in Part 2. These corrected pH values should be entered into a new column in the Table of results.
- Plot a graph of the corrected pH values from Part 2 (*y* axis) against volume of sodium hydroxide solution added. Join the points in the most appropriate way.
- Comment on the shape of the curve.

Teacher Notes and Marking Guidance

The specific marking guidance in the specification is as follows

2 marks: All areas of the task are carried out competently.
The apparatus is used correctly.
The pH values are recorded correctly.
The pH changes are in the expected range.

1 mark: One of the areas of the task is performed poorly.
The apparatus is used incorrectly **OR**
The pH values are recorded incorrectly **OR**
The pH changes are not in the expected range.

0 marks: At least two of the areas of the task are performed poorly.
The apparatus is used incorrectly.
The pH values are recorded incorrectly.
The pH changes are not in the expected range.

Guidance for Teachers

Teachers are expected to exercise professional judgement in assessing the competence of their candidates in following the instructions.

Candidates should have been given guidance in the correct use of equipment and this guidance **can continue during the practical session** for which this PSA forms a part.

If, however, the guidance required is fundamental or frequent, then the student should **not** be awarded 2 marks.

Most judgements of 2 marks, 1 mark or 0 marks will depend on

- whether the candidate can measure out the relevant quantities of reagent with care and precision.
- whether the candidate is able to use the pH probe and pH meter with care and is also able to measure pH values with appropriate precision.
- whether the shape of the pH curve is as expected.

Teachers may reasonably judge whether the results lead to an acceptable pH curve for the pair of reagents chosen and therefore the follow-up activity of plotting the graph is a worthwhile task for students to undertake. It is important to remember when marking these practical exercises that PSA is about student competence and that for a student to score full marks on this exercise **perfection is neither expected nor required**.