Investigating Acid Base Reactions

Background

When an acid reacts with a base a neutralisation reaction occurs. There are many acids and bases available in the laboratory and this investigation will enable you to explore the neutralisation process between different types of acid and base.
During the neutralisation process the pH, conductivity and temperature of the system changes. These changes can be monitored and used to detect the end point of the reaction. The end point of the reaction can also be determined by the use of indicators, which change colour as the pH changes.

Practical Techniques

You will need to find out about volumetric analysis (titrations) and how to make up accurate solutions.

Where to start

Plan an experiment to find out how the pH changes when a strong acid is neutralised by a strong base.
You can use 25 cm^3 of a 1 mol dm^{-3} sodium hydroxide solution and titrate it with a 1 mol dm^{-3} hydrochloric acid solution. You should continue to add the acid until there is no significant change in pH. You can follow the change in pH of the solution with a pH meter.
You should plot a graph of your results. You may be able to record the results directly onto a computer.

You should then repeat the experiment using different acids and bases. You could try sulphuric acid, ethanoic acid or phosphoric acid instead of hydrochloric acid. You could try ammonia solution or sodium carbonate instead of sodium hydroxide.

Are there any differences in the shapes of the graphs you obtain? Can you explain these? Can you use the definition of pH for strong and weak acids and bases and the theory of buffering to help explain the shapes?

Possible Investigations

- How does changing the relative concentrations of the acid to the base affect the shape of the pH graph?

- Investigate the change in conductivity of the solution as you react the acid with the base.

- Investigate enthalpy changes of the solution as you react the acid with the base.

- Investigate the pH range in which indicators change colour as you react the acid with the base. Do all indicators change colour at the same pH?

- Compare the effectiveness and accuracy of using of using conductivity, enthalpy and indicators to determine the end point of a neutralisation reaction. What is the lowest concentration that each technique is effective at?

- Investigate the use of olfactory indicators to determine the end point of a titration.

Sources of Information

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Teachers' Notes

General

This investigation is based around standard experiments and is suitable for students of all ability ranges. The suggested initial experiment is based around pH curves and teachers may wish to direct students straight to some of the other suggested investigations and ignore this starting point.
This investigation provides many opportunities for the use of data logging equipment.

Chemical Principles

Acids and Bases, Buffers, Indicators, Equilibrium

Essential Equipment

Burettes, pipettes, pH meter.

Essential Chemicals

Sodium Hydroxide, Hydrochloric Acid

Safety

No risk assessment has been given. It is essential that students prepare a detailed risk assessment before they start. Teachers must be satisfied that this is suitable for the proposed investigation.