Chem CP5 Titrations and calculations

Objectives

C5.9C Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator.

C5.10C **H** Carry out simple calculations using the results of titrations to calculate an unknown concentration of a solution or an unknown volume of solution required.

Maths requirements

1a Recognise and use expressions in decimal form.

1c Use ratios, fractions and percentages.

2a Use an appropriate number of significant figures.

2b Find arithmetic means.

3a Understand and use the symbols: =, <, <<, >>, >, ∝, ~.

3b Change the subject of an equation.

3c Substitute numerical values into algebraic equations using appropriate units for physical quantities.

Learning outcomes

5th **SC5.9C** Describe the steps in carrying out an acid-alkali titration.

7th **SC5.10C** **H** Calculate the number of moles of solute in a given volume of solution.

9th **SC5.10C** **H** Deduce the mole ratio of acid to alkali from a balanced equation.

9th **SC5.10C** **H** Calculate the concentration of a solution using the results of an acid-alkali titration.

9th **SC5.10C** **H** Calculate the volume of solution required in an acid-alkali titration, given the concentrations of both the acid and the alkali.

Exploring

1. Core practical – Acid–alkali titration

This practical forms part of the core practical requirement of the specification. It is supported by the information on *Students' sheet CP5(Titration)* and in the Student Book.

A set of instructions for this practical is given on Students' sheet CP5(Titration). The practical could also be used to see whether students can follow instructions and make accurate measurements.

The worksheet has the details for using methyl orange, but you can use phenolphthalein if you prefer. Students need to know the colour changes of both indicators, and either is suitable for this titration. Students are not expected to know that a particular indicator is not suitable for certain titrations; for example, phenolphthalein is not suitable for a titration between a weak acid and a strong alkali. However, they should know why universal indicator is not suitable in a titration. (It has too many different colours and so there is no clear change in colour.)

This method has more detail than the method used previously in Worksheet SC8e.1, and these additional techniques, such as rinsing the burette and pipette, may be needed for the examination. You may need to demonstrate the whole titration experiment first – see Explaining 2. Students usually obtain a high volume for the first (rough) titration, because they add the acid too quickly. Students should repeat the titration until they obtain two concordant results within 0.2 cm^3. They should take the mean of these concordant results. A common error in examinations is that students take the mean of all the titration results.

Students could either use the results of the titration experiment to prepare pure, dry crystals of sodium chloride (as revision of *SC8e Alkalis and neutralisation*) or use them to calculate the concentration of hydrochloric acid. If needed, the instructions for preparing sodium chloride crystals are at the bottom of page 1 of the worksheet.

The results table on page 2 of SC14d.1 has space for five sets of results, but students do not need to do five titrations. Explain that students need to repeat the titration until they have two concordant results (i.e. results that are within 0.2 cm^3 of each other).

Support: Students who are not preparing for the Higher Tier papers can follow the method on page 1 of Worksheet SC14d.1 and then record their results in the table on page 2. They can work out the mean titre and then carry out the additional steps to help them prepare pure, dry crystals of sodium chloride.

Stretch: Students can follow the practical instructions on the first page of Worksheet SC14d.1 and then write up the experiment in their own words. This should include designing their own results table and calculating the concentration of the hydrochloric acid (with help from Skills Sheets as needed).

⚠ Safety

Eye protection must be worn.

Show how to use a pipette filler.

If students heat the solution to obtain sodium chloride crystals, they should: take care when heating the sodium chloride solution, because hot salt may spit out of the basin when almost all the water has evaporated; stop heating once crystals start to form; not touch the tripod and gauze when they are hot.

Equipment (per group)

eye protection, burette, burette stand or retort stand with burette clamp, plastic funnel to fit top of burette, 25.0 cm^3 pipette, pipette filler, conical flask, white tile, methyl orange (few drops, or phenolphthalein can be used), hydrochloric acid (about 100 cm^3, 0.1 mol dm^{-3} – the concentration should not be written on the label), sodium hydroxide solution (about 100 cm^3, 0.10 mol dm^{-3}), distilled/deionised water in a wash bottle

Optional (for sodium chloride crystal preparation): Bunsen burner, heat-resistant mat, tripod, gauze, tongs, evaporating basin

Course resources

Chem Students' sheet CP5