Using indigestion tablets to neutralise an acid

This resource accompanies the **Titration experiment** infographic poster in *Education in Chemistry*, which shows learners the steps in the titration procedure in an eye-catching visual. The poster is available to download from: rsc.li/3A6EftG

The investigation is part of the **Nuffield practical collection**, developed by the Nuffield Foundation and the Royal Society of Chemistry. Delve into a wide range of chemical concepts and processes with this collection of over 200 step-by-step practicals: rsc.li/3NI70A1.

Learning objectives

1 Follow a method and carry out a titration to determine which brand of indigestion tablet contains the most active ingredient.

2 Explain the reasons behind particular steps in the titration procedure.

3 Explain how procedural errors can contribute towards inaccurate titres.

This resource is designed for you to use in the early stages of teaching the titration procedure. The method has been written with enough detail for novice learners. When learners next complete a titration they should need less guidance. Observe as they follow the method; in particular, check that they add the correct amount of indicator and remove the funnel during the addition of the acid. Success in carrying out the experiment covers the first learning objective.

Use the follow-up questions to assess understanding of learning objectives two and three.

Introduction

Titration is a long-established quantitative analytical technique. At a basic level it uses a reaction of a volume of a solution of known concentration to find out the concentration of an unknown solution. There are many different types of titration; this practical focuses on an acid-base reaction.

Indigestion tablets contain a mixture of substances which can neutralise stomach acid. These include carbonates of group 2 metals (e.g. calcium carbonate) and group 2 hydroxides (e.g. magnesium hydroxide). In this experiment, learners analyse different brands of indigestion tablet and use the average titres of the titration to determine which tablet contains the most active ingredient.

The focus is on the experiment itself rather than the generation of results which can be used in a classic titration calculation. This makes this experiment ideal to use as learners make the transition from 14–16 chemistry.

The experiment to test a single tablet should take no more than 25 minutes and learners should get quicker as they do repeats. Allocate different groups one

'standardisation' brand of tablet to test and one other brand, so that the class can compare a number of different brands in a one-hour lesson.

Scaffolding

Learners in this age range are on their journey towards independence in carrying out practical procedures. Scaffold the investigation to support learners with limited practical experience using the following suggestions:

- Ask learners to read the method and look at the poster rsc.li/3A6EftG or watch a video rsc.li/4eakxuR on how to use a burette prior to the practical session.
- Demonstrate the correct method for using a burette either in this lesson or a prior lesson.
- Provide samples with the correct colour match for the end point with methyl orange.

For more challenge, extend this practical as a back-titration technique.

Technician notes

Separate technician notes, including information about preparation and disposal and links to relevant CLEAPSS Hazcards and recipe sheets, are available to download from: rsc.li/3NHeVNY

Read our standard health and safety guidance, available from rsc.li/4enTwV3 and carry out a risk assessment before running any live practical.

Equipment

Per person:

- Eye protection: safety glasses to EN166 F or (EN) ISO 16321 C.

Per group:

- Burette, 30 cm^3 or 50 cm^3 capacity
- Conical flask, 100 cm^3
- Beaker, 100 cm^3
- Pestle and mortar
- Stirring rod
- Spatula
- Filter funnel, small (about 35 mm diameter)
- White tile (optional)
- Burette stand and clamp

Chemicals

- Dilute hydrochloric acid, concentration equal to or below 0.4 mol dm^{-3}, 100 cm^3.
- Two or three different indigestion tablets, ideally the 'chalky' type
- Original packets from which the tablets are taken, together with price information for each packet
- Methyl orange indicator solution (or alternative) **DANGER:** Harmful if swallowed. May cause damage to organs. Highly flammable liquid and vapour.
- Deionised or distilled water, about 100 cm^3

Answers

Procedure questions

1.

(a) This analysis is the whole tablet; the addition of more or less water does not change the amount of active reactant.

(b) Indicators are themselves weak acids or bases so too much could affect the final result.

2. The funnel is removed to prevent drops of reagent dropping into the burette during the titration causing a change in the measured volume.

3. Adding water to the conical flask does not change the amount (in moles) of reagent, therefore the result is not affected.

4. The amount of acid that is neutralised by the tablet is calculated by taking the initial reading away from the final reading of the burette. The difference between the readings is not affected by whether the initial reading was 0.00 cm^3 or another value.

Analysis questions

5. The tablet of the same brand is used to standardise the results for the whole class. As differences in technique may occur between the groups, comparison with the same tablet will help to identify anomalies and allow for qualitative comparisons between the different brands of tablets tested by different groups.

6. Answers will vary depending on the brands used. Examples may be of the format:

- [metal] carbonate + hydrochloric acid → [metal] chloride + carbon dioxide + water
- [metal] hydroxide + hydrochloric acid → [metal] chloride + water

7. Equations

(a) $MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$

(b) $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

8. Answers will vary depending on the results. The higher the average titre the larger the amount of active ingredient in the tablet.

9. Learners ought to read the instructions on each packet concerning the recommended dosage. Using this, alongside the price information and the

amount of active ingredient they should be able to draw conclusions about value. Many comparisons are likely to be 'grey' rather than 'black and white'. This could lead to suggestions for further investigations for improving comparisons, but it is unlikely that these will be feasible at school.

10. The experiment is designed to raise 'fair test' principles for discussion, and learners are expected to comment with rational arguments on the validity of the comparisons they make. This could lead to suggestions for further investigations for improving comparisons, but it is unlikely that these will be feasible at school.