Core practical 2: Find the concentration of a solution of sodium hydroxide

Objective

- To make a solution of a known concentration of acid and use it to find the concentration of a solution of sodium hydroxide

Safety

- Wear goggles.
- Sulfamic acid can be toxic if it is ingested.
- Ensure burettes are filled when the top of the burette is below eye level.

Specification links

- Practical techniques 1, 4, 5, 6, 11
- CPAC 1a, 2a, 2b, 3a, 3b, 4a, 4b

Procedure

1. Weigh an empty test tube. Scoop approximately 2.5 g of sulfamic acid into the test tube.
2. Reweigh the test tube and its contents accurately.
3. Dissolve the sulfamic acid in approximately 100 cm^3 of water in a beaker.
4. Transfer the solution, including the washings, into a 250 cm^3 volumetric flask and make the solution up to the mark with deionised water.
5. Prepare your apparatus for the titration. The burette will contain the acid and the conical flask will contain the sodium hydroxide solution.
6. Pour a 25.0 cm^3 aliquot of sodium hydroxide solution of unknown concentration into the 250 cm^3 conical flask.
7. Add four drops of methyl orange indicator to the conical flask.
8. Titrate the contents of the flask against the sulfamic acid solution you prepared. Burette readings should be to the nearest 0.05 cm^3. Continue to conduct titrations until you have two concordant titres.
9. Record your results in a table similar to the following:

	Mass of sulfamic acid = g				
	Rough	**Trial 1**	**Trial 2**	**Trial 3**	**Trial 4**
Final burette reading/cm^3					
Initial burette reading/cm^3					
Titre/cm^3					

Notes on procedure

- The students will need instructions on how to prepare glassware for a titration and how to make up a standard solution.

Answers to questions

1. $\frac{0.6}{250} \times 100 = 0.24\%$
2. $\frac{0.05 \times 2}{\text{titre selected}} \times 100$
3. Water left in pipette will dilute the sodium hydroxide solution, changing the number of moles used.
4. The water will not change the number of moles of sodium hydroxide – its volume is measured before it is put into the flask.
5. Phenolphthalein, it changes from pink to colourless

Sample data

	Mass of sulfamic acid = 2.41 g			
	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Final burette reading/cm^3	21.00	41.05	20.85	40.90
Initial burette reading/cm^3	0.25	21.00	0.50	20.85
Titre/cm^3				

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All the maths you need

- Recognise and make use of appropriate units in calculations.
- Recognise and use expressions in decimal and ordinary form.
- Use an appropriate number of significant figures.
- Find arithmetic means.
- Understand and use the symbols: =, <, <<, >>, >, ~ and ≒.
- Change the subject of an equation.
- Substitute numerical values into algebraic equations, using appropriate units for physical quantities.

Equipment

- burette clamp and stand
- solid sulfamic acid
- sodium hydroxide solution of unknown concentration
- methyl orange indicator
- 250 cm^3 conical flask
- 25 cm^3 volumetric pipette plus safety filler
- 100 cm^3 beaker for transfer of solutions
- funnel for filling burette
- 250 cm^3 beaker
- 250 cm^3 volumetric flask
- mass balance (2 d.p.)
- eye protection (goggles)

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7. Add four drops of methyl orange indicator to the conical flask.
8. Titrate the contents of the flask against the sulfamic acid solution you have prepared. Burette readings should be recorded to the nearest 0.05 cm^3. Continue to conduct titrations until you have two concordant titres.
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Initial burette reading/cm^3					
Titre/cm^3					

Analysis of results

1. Calculate the concentration of your sulfamic acid solution. The M_r of sulfamic acid is 97.1.
2. Calculate the mean titre using your concordant results.
3. Calculate the number of moles of sulfamic acid in your mean titre.
4. Sulfamic acid is a monoprotic acid. One mole of sulfamic acid will react exactly with one mole of sodium hydroxide. Calculate the concentration of the sodium hydroxide solution used.

Learning tips

- Indicators are very dilute weak acids. The more you add the less accurate your titration result will be.
- While conducting a titration remember to wash down the inside of the conical flask with distilled water from time to time.
- If you need to scale up to find the number of moles in the full volume of solution in the volumetric flask, use this equation:

$$\text{number of moles in full volume} = \frac{\text{full volume}}{\text{volume in which you know the number of moles}}$$

Questions

1. A 250 cm^3 volumetric flask has an accuracy of +/– 0.6 cm^3. Calculate the percentage uncertainty in the volume of the sulfamic acid solution in the volumetric flask.
2. Each burette reading is accurate to +/– 0.05 cm^3. Calculate the percentage uncertainty in one of your titres.
3. Why should the pipette be rinsed with the sodium hydroxide solution after washing it with water?
4. Why is there no need to dry the conical flask after washing it out between trials?
5. Identify another indicator that could be used in this titration and state the colour change that would be seen at the end point.

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Equipment per student/group	Notes on equipment
burette clamp and stand	
solid sulfamic acid	Approximately 2.5 g per student
sodium hydroxide solution of unknown concentration	200 cm^3 of 0.08 mol dm^{-3} sodium hydroxide solution per student
methyl orange indicator	
250 cm^3 conical flask	
25 cm^3 volumetric pipette plus safety filler	
100 cm^3 beakers for transfer of solutions	
funnel for filling burette	
250 cm^3 beaker	
250 cm^3 volumetric flask	
mass balance (2 d.p.)	

Notes