Titration of a strong acid against a strong base using an indicator

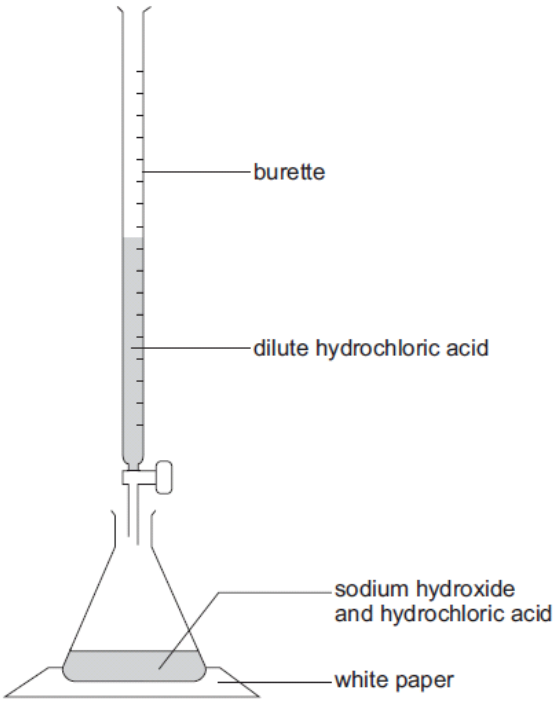
Introduction

In this experiment sodium hydroxide is neutralised with hydrochloric acid to produce the soluble salt, sodium chloride in solution. An indicator is used to show when neutralisation has occurred. The solution could then be concentrated and crystallised to produce sodium chloride crystals.

Apparatus

burette
measuring cylinder
100 cm^3 conical flask
small filter funnel
white paper
dilute sodium hydroxide
dilute hydrochloric acid
indicator
clamp stand, boss and clamp or burette stand

Diagram of Apparatus



Method

1. Use the small funnel to fill the burette with acid. Run a little acid out into a waste beaker to fill the part of the burette that is below the tap. Record the starting volume of acid in the burette.
2. Accurately measure 25 cm^3 of sodium hydroxide solution into a conical flask.
3. Add 2 drops of indicator.
4. Add 0.1 cm^3 of acid at a time, swirl the flask after each acid addition. Keep adding acid until the indicator changes colour. Record the final volume of acid in the burette.
5. Repeat steps 1-4 twice more.

Analysis

1. Calculate the volume of acid that was needed to neutralise the alkali in each repeat.
2. Calculate the mean volume of dilute hydrochloric acid needed to neutralise 25 cm^3 sodium hydroxide solution.
3. What do your results tell you about the concentration of the alkali?

Risk Assessment

Hazard	Risk	Control measure
Hydrochloric acid and sodium hydroxide are corrosive	Hydrochloric acid or sodium hydroxide spilling onto hands when filling burette or measuring volume of liquids	Wear gloves Wash hands immediately after contact with solutions
	Hydrochloric acid or sodium hydroxide splashing into eyes when filling burette	Wear goggles
Burette and pipette made from glass which is brittle and is sharp if broken	Burette breaking when clamping giving danger of cuts.	Take care when clamping burette not to overtighten
	Pipette breaking when being handled giving danger of cuts.	Take care when using pipette

Teacher / Technician notes

Reagents:

- Hydrochloric acid – Refer to CLEAPSS hazcard 47A
- Sodium hydroxide – Refer to CLEAPSS hazcard 31

Sodium hydroxide and hydrochloric acid solutions do not need to be made up to a high degree of accuracy, but should be reasonably close to the same concentration and less than 0.5 mol/dm^3.

Burette stands and clamps are designed to prevent crushing of the burette by over-tightening, which may happen if standard jaw clamps are used.

A white tile can be used to go under the titration flask, instead of white paper.

Students need training in using burettes correctly, including how to clamp them securely and fill them safely. You should consider demonstrating burette technique, and give students the opportunity to practise this. Students do not need the acid volume to start on 0 in the burette, but must ensure that the reading is not above zero.

In this experiment a pipette is not essential and measuring cylinder is acceptable. However, a pipette and filler could be used to increase accuracy if desired.
There is an opportunity here with more able students to do quantitative measurements leading to calculations but the primary aim is to introduce students to the titration technique to produce a neutral solution.

Indicators you can use include screened methyl orange (green in alkali, violet in acid) and phenolphthalein (pink in alkali, colourless in acid).

At the end of the experiment the solution can be left to crystallise slowly in a warm room to produce large crystals or heated to half the volume of solution with a Bunsen burner and allowed to cool.

Students should design their own table, but a suggested table format is shown below.

	Trial			
	1	2	3	Mean
Final volume of acid in burette (cm^3)				
Initial volume of acid in burette (cm^3)				
Titre (volume added) (cm^3)				

Working scientifically skills covered

2. **Experimental skills and strategies**
   Apply a knowledge of a range of techniques, instruments, apparatus and materials to select those appropriate to the experiment.

   Carry out experiments appropriately having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.

   Make and record observations and measurements using a range of apparatus and methods.

3. **Analysis and Evaluation**
   Translate data from one form to another.

   Carry out and representing mathematical analysis.

4. **Scientific vocabulary, quantities, units, symbols and nomenclature**
   Use an appropriate number of significant figures in calculation.