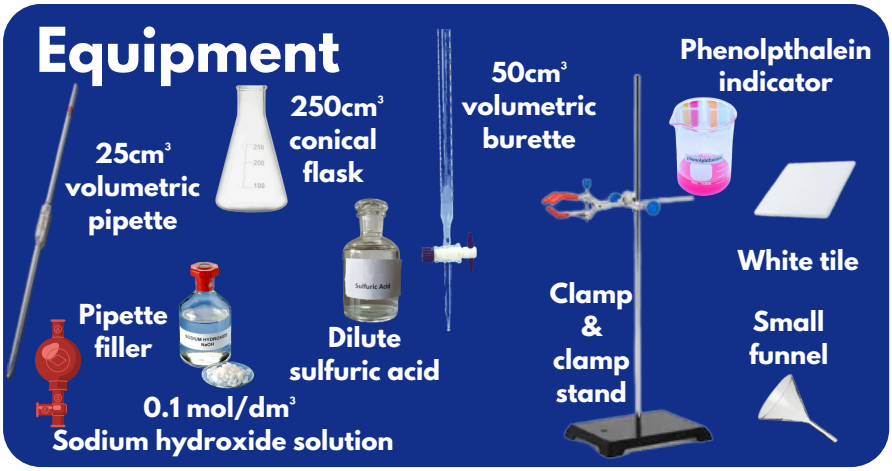
Equipment



Learning Objectives -

- Determine the reacting volumes of solutions of a strong acid (sulfuric acid) and a strong alkali (sodium hydroxide solution) by titrations.
- Determine the concentration of one of the solutions in mol/dm³ and g/dm³ from reacting volumes and known concentrations of others.

When an acid reacts with a base, a neutralisation occurs

acid + base ⟶ salt + water

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

The first trial in a titration is referred to as a "rough" trial because it is primarily used to give a quick, approximate measurement of the endpoint, rather than an accurate one, it helps:

- **Determining the endpoint range**
- **Improves precision as you can slow down and add the titrant drop by drop towards the endpoint.**
- **Reduces waste as you less likely you overshoot the endpoint, saving time and resources.**

Method:

1) Use the pipette and pipette filler to put exactly 25 cm³ sodium hydroxide solution into the conical flask.

2) Put the flask on the white tile.

3) Clamp the burette vertically in the clamp stand, leaving just enough room underneath for the conical flask and tile.

4) Close the burette tap.

5) Use the small funnel to carefully fill the burette with dilute sulfuric acid. Before it completely fills put a small beaker underneath the tap, gently open it to allow acid to fill the tap, before closing again and filling the burette to the 0.00 cm³ line. Remove the funnel.

6) Put 5–10 drops of phenolpthalein indicator into the conical flask. Swirl the flask to mix and put under the burette on top of the tile. The contents of the flask will go pink.

7) Carefully open the burette tap so that 10 cm3 sulfuric acid slowly flows into the flask. Constantly swirl the flask when adding the acid. Then add the acid drop by drop until you see a permanent colour change from pink to colourless in the flask. You need to be able to shut the tap immediately after a single drop of acid causes the colour to become permanently colourless.

8) Read the burette scale carefully and record the volume of acid you added to 2dp.

9) Repeat steps 1–8 until you have concordont results. Present results in a table.

As we start with a fixed volume of sulphuric acid. this is the limiting reactant – it is essential this is accurate to obtain a valid result.

The tile helps you see the colour change

Rinse glassware between repeats

Concordont – results need to be within 0.10cm³ of each other.

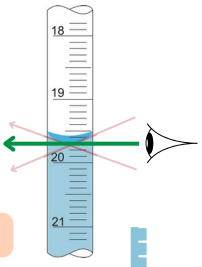
Volume of dilute sulfuric acid needed to neutralise 25cm³ sodium hydroxide solution (cm³)			
Trial 1 (rough)	Trial 2	Trial 3	Mean
15.65	**15.60**	**15.70**	**15.65**

Mean value = $\frac{15.65 + 15.6 + 15.7}{3}$ = 15.65

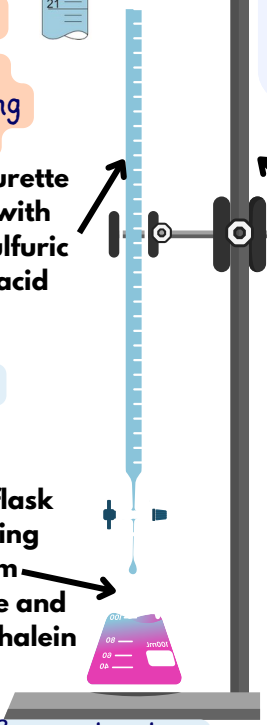
Reacting volumes:
Sodium hydroxide - 25 cm³
Sulfuric acid - 15.65cm³

REQUIRED PRACTICAL 2 NEUTRALISATION

ALWAYS take readings from the bottom of the meniscus



REMEMBER to remove the funnel otherwise more liquid will drip into the burette causing the initial reading to change



The colour change indicates when all of the sodium hydroxide has been neutralised

Mean concentration of acid in mol/dm

1) Moles NaOH = Molarity x volume / 1000
= 0.1 x 0.025 = 0.00025 moles NaOH

2) Equation shows that NaOH : H_2SO_4 moles is 2:1
= 0.00025 / 2 = 0.000125 moles H_2SO_4

3) Concentration of H_2SO_4 in mol/dm³
= moles x 1000 / volume
= 0.000125 x 1000 / 0.01565
= 0.0798 = 0.80 mol/dm³

4) Concentration in g/dm³ = step 3 x Mr
= 98 x 0.80 = 78.40 g/dm³

The indicator phenopthalein gives a sharp colour change, so we know exactly when neutralisation occurs.

Pink ⟶ Colourless

Hazards

Exam Style Questions - Neutralisation

1. A student carries out a titration.
a) What is the purpose of the rough titration? (1 mark)
b) Why are concordant results important? (1 mark)

2. Why is it important to take burette readings from the bottom of the meniscus? (1 mark)

3. A student uses 25.0 cm^3 of sodium hydroxide and finds that 15.65 cm^3 of sulfuric acid is needed to neutralise it. Calculate the concentration of the sulfuric acid in mol/dm^3. (4 marks)

- **Sodium hydroxide concentration = 0.10 mol/dm^3**
- **Equation: $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$**

4. The student wants to calculate the concentration of the sulfuric acid in g/dm^3. The relative formula mass (Mr) of H_2SO_4 is 98. Use your answer from Question 3 to calculate the concentration in g/dm^3. (1 mark)

5. Why is phenolphthalein a suitable indicator for this titration, but not universal indicator? (2 marks)

5. Why should the funnel be removed from the burette before titration begins? (1 mark)

6. A student repeats the titration and gets the following results:
Trial 1 = 15.70 cm^3
Trial 2 = 15.65 cm^3
Trial 3 = 15.60 cm^3
Which results should the student use to calculate a mean and why? (2 marks)

10. Why should you rinse the conical flask between titration repeats? (1 mark)

Exam Style Questions - Neutralisation

1. A student carries out a titration.
a) What is the purpose of the rough titration? (1 mark)
b) Why are concordant results important? (1 mark)

Mark One - To get a quick estimate of where the end point is
Mark Two - Concordant results show the titration is reliable and repeatable (within 0.10 cm^3)

2. Why is it important to take burette readings from the bottom of the meniscus? (1 mark)

Mark One - To make the volume reading accurate

3. A student uses 25.0 cm^3 of sodium hydroxide and finds that 15.65 cm^3 of sulfuric acid is needed to neutralise it. Calculate the concentration of the sulfuric acid in mol/dm^3. (4 marks)

- **Sodium hydroxide concentration = 0.10 mol/dm^3**
- **Equation: $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$**

Mark One - Moles of NaOH = 0.10 × 0.025 = 0.0025 mol
Mark Two - Moles of H_2SO_4 = 0.0025 ÷ 2 = 0.00125 mol
Mark Three - Concentration = 0.00125 ÷ 0.01565 = 0.0799 mol/dm^3
Mark Four - Final answer with correct units = 0.080 mol/dm^3

4. The student wants to calculate the concentration of the sulfuric acid in g/dm^3. The relative formula mass (Mr) of H_2SO_4 is 98. Use your answer from Question 3 to calculate the concentration in g/dm^3. (1 mark)

Mark One - 0.080 × 98 = 7.84 g/dm^3

5. Why is phenolphthalein a suitable indicator for this titration, but not universal indicator? (2 marks)

Mark One - Phenolphthalein gives a sharp colour change from pink to colourless
Mark Two - Universal indicator changes gradually through a range of colours

5. Why should the funnel be removed from the burette before titration begins? (1 mark)

Mark One - Extra acid could drip in and change the starting volume

6. A student repeats the titration and gets the following results:
Trial 1 = 15.70 cm^3
Trial 2 = 15.65 cm^3
Trial 3 = 15.60 cm^3
Which results should the student use to calculate a mean and why? (2 marks)

Mark One - Use 15.65 cm^3 and 15.60 cm^3
Mark Two - They are concordant – within 0.10 cm^3 of each other

10. Why should you rinse the conical flask between titration repeats? (1 mark)

Mark One - To remove any remaining acid or alkali that could affect the next result