

Titration apparatus

In titration, we use apparatus not often used in other experiments. It's important to know why we use each piece of apparatus and its role in a titration.

Measuring apparatus

- **Volumetric pipettes** are specially calibrated to deliver a **fixed volume** of solution. You fill the pipette with a **pipette filler** to the fill mark, then release the solution into a **conical flask**.
- **Burettes** are **graduated** (they have measurement lines) and deliver a **variable volume** of solution. The scale is the opposite to that of a measuring cylinder – the top mark on the burette is 0.00 cm³. Most burettes have a total volume of 50.00 cm³. You fill the burette using a funnel, then remove the funnel and let the solution down through the tap to fill the **air space**. Read the level of the **meniscus** and note it down.

Accuracy

The 25 cm³ **volumetric pipettes** we use in schools and colleges are grade B standard, which typically have an accuracy of ± 0.6 cm³. This means that, when used correctly, the minimum volume delivered is 24.40 cm³ and the maximum volume delivered is 25.60 cm³.

Each reading you take from a **burette** has an accuracy of ± 0.05 cm³. When you take two readings, this accuracy is doubled. Because the volume delivered by the burette is variable, this accuracy has a bigger impact when you measure smaller volumes. This is clear when the accuracy is expressed as a percentage.

Error in a titre of 10.50 cm ³	Error in a titre of 25.75 cm ³
$\% \text{ error} = \frac{0.10}{10.50} \times 100 = \mathbf{0.95\%}$	$\% \text{ error} = \frac{0.10}{25.75} \times 100 = \mathbf{0.39\%}$

Both volumetric pipettes and burettes are **more accurate** than more commonly used apparatus such as **measuring cylinders**.

Did you know ...?

You don't need to fill your burette to the 0.00 cm³ mark each time. You can easily calculate the volume delivered by subtracting the start reading from the end reading.

Apparatus holding the solutions

- **Conical flasks** hold one of the reagent solutions in a titration. They are a specific shape to make them easy to swirl, so you can mix solutions without any splashing out.
- **Volumetric flasks** are specially shaped flasks that you can use to make up solutions of specific concentrations. There is a fill mark on the neck of the flask which indicates the volume.

Did you know ...?

The earliest titration was reported in 1729! It's an ancient technique but is still carried out in modern laboratories.

Finding the end point

In titration the end point is a complete reaction between the reactant solutions in the burette and the conical flask. You will often use an indicator to give a colour change but some titrations are self-indicating.

- **Indicator bottles** are fitted with a pipette cap to allow you to add one to two drops of indicator to the conical flask.
- A **white tile** provides a clean, bright background under the flask so you can see subtle colour changes.
- You use a **wash bottle** of distilled water to wash down the sides of the conical flask in case any drips of reactant are stuck to the sides. Adding water doesn't change the results of the titration as you're not adding any moles of reactant, the water is just the solvent.

Did you know ...?

Manual titrations can be time consuming, so some simple titrations are automated. However, automatic titrators cost from around £1000 to over £10,000, so it's unlikely you'll find one at a school.