Carry out a practical investigation into a substance present in a consumer product using quantitative analysis. [4 Credits, Internal Assessment]

Dilutions

Final titre results should ideally fall between 10 and 25 mL.

- Less than 10 mL means a larger percentage error.
- More than 25 mL is time consuming and wasteful, meaning a lot of time is spent refilling burettes and a lot of solution is used.

Therefore, it is often necessary to dilute the consumer product before carrying out a titration in order to obtain more convenient concentrations.

In this assessment, you will need to dilute a consumer product before analysing it.

This is because if you used it undiluted you would:

- Use a lot of the consumer product in the analysis (expensive)
- Need to analyse it using more concentrated chemicals like 2.00 mol L^{-1} acids or bases (not really very safe)
  OR
  Use really large volumes (titres) of more dilute acids and bases (both highly inaccurate and very time consuming as you have to keep refilling a burette).

How to estimate the dilution factor.

You will be given a sample of the consumer product e.g. vinegar, and the 'other standard solution' that will be used in the titration, e.g. 0.100 mol L^{-1} NaOH

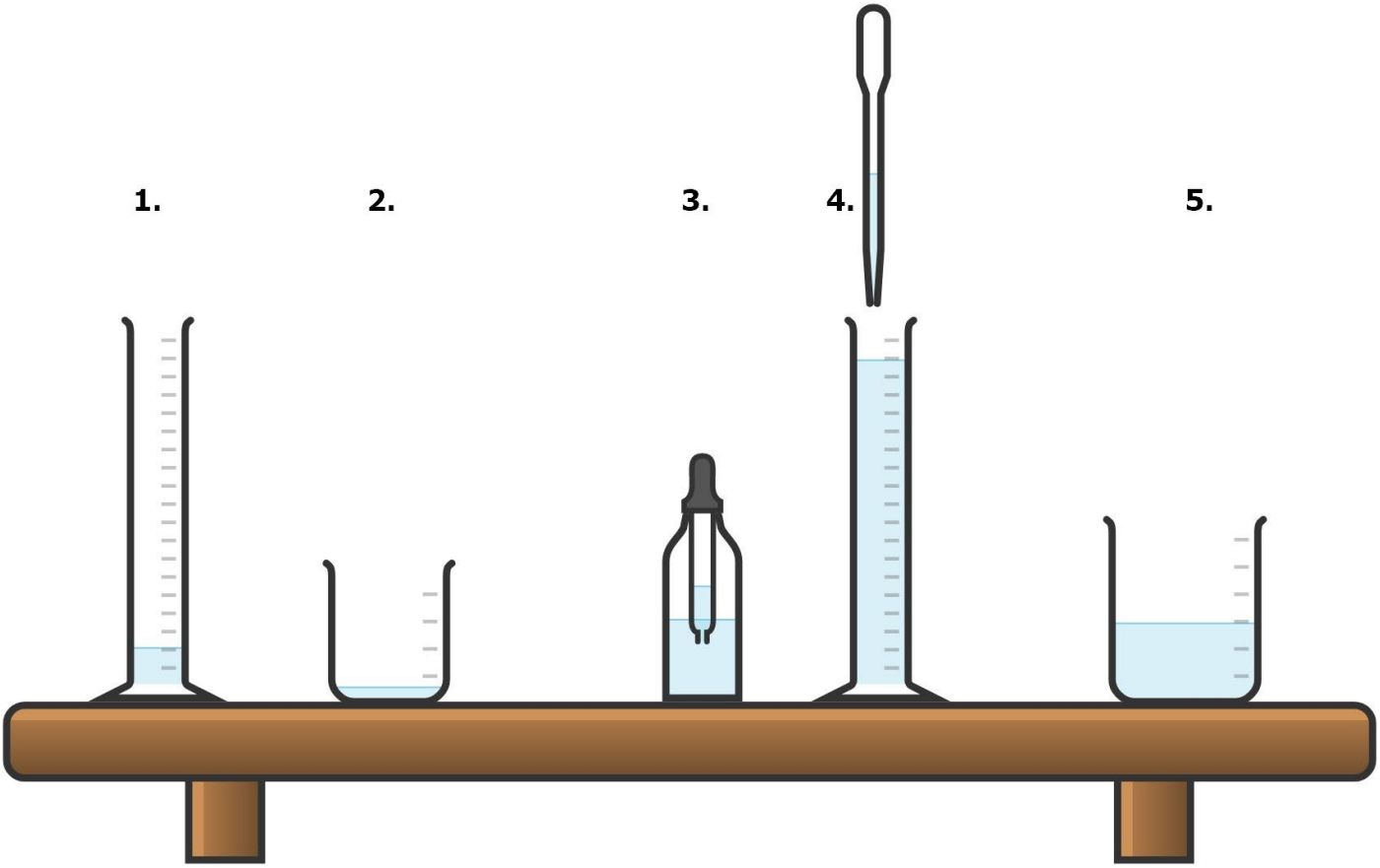
Examples of some acid-base titrations.

consumer product = vinegar (ethanoic acid); other solution = dilute NaOH

consumer product = cloudy ammonia (NH_3); other solution = dilute HCl or dilute H_2SO_4

consumer product = drain unblock (NaOH); other solution = dilute HCl or dilute H_2SO_4

The easiest way to do this is to first find out how much of the standard solution is required to get a colour change with 1 mL of the commercial product. The volume needed will be roughly the dilution factor necessary.



Put 1 mL of consumer product e.g. vinegar, in a 10 mL measuring cylinder (1.)

Pour into a small beaker (2.)

Add a drop of indicator (3.)

Fill the 10 mL measuring cylinder (4.) with the other solution e.g. 0.100 mol L^{-1} sodium hydroxide, NaOH (5.)

Add the NaOH 1 mL at a time to 2. swirling or mixing with a glass rod, until the indicator changes colour. Record the volume added.

Example: About 1 mL of vinegar solution (acid) required about 8 mL of a standardised NaOH solution (base) to reach the end point.

So….. if 1 mL of an acid required about 8 mL of a standardised base solution to reach the end point, these results suggest that a 10 mL sample would require about 80 mL of the base or a 20 mL sample would require about 160 mL of the base.

Both of these would be far too high.

IMPORTANT THING TO REMEMBER!

The volume needed will be *roughly* the dilution factor necessary.

But it is easiest to dilute 1/2, 1/5, 1/10 etc rather than do the maths to work out 1/8.

Standard equipment that would be available for carrying out the dilutions could be 10.00, 20.00 and 25.00 mL pipettes, 100.0 and 250.0 mL and 500.00 mL volumetric flasks and 50.00 mL burettes. *Availability may differ from school to school.*

A volume of 8 mL is not that far off 10 mL.

So, try diluting the solution 10x. 10x means 1 in 10. 1 in 10 means 1 mL + 9 mL, the total volume being 10 mL.

This would mean either:

- Dilute 10.00 mL of acid to a total volume of 100.00 mL using distilled water in a 100.00 mL volumetric flask
- Dilute 25.00 mL of acid to a total volume of 250.00 mL using distilled water in a 250.00 mL volumetric flask
- Dilute 50.00 mL of acid to a total volume of 500.00 mL using distilled water in a 500 mL volumetric flask

Which one you would choose to do will depend on the pipettes available, the volumetric flasks available and the volume of solution you will need. If you want to use 50.00 mL and the largest pipette is a 25.00 mL pipette you run the risk of decreasing the accuracy by having to pipette twice.

Whichever dilution 'recipe' you select, this would mean a 10 mL sample of diluted acid would require only about 8 mL of the base. Small titres are not as accurate, especially any that are less than 10.00 mL. (You should never use a titre less than 5.00 mL).

The volume of the titre and therefore the accuracy can be increased by pipetting a 20 mL sample which would give an expected titre of about 8 x 20/10 = 8 x 2 = 16 mL of the base.

So, the final method would be to dilute the acid 10x by pipetting 25 mL into a 250 mL volumetric flask) and then titrating 20 mL samples of the diluted acid with the base.

No 20.00 mL pipettes? Pipetting a 25 mL sample which would give an expected titre of about 8 x 25/10 = 8 x 2.5 = 20 mL of the base. This will also be fine to use.