Measuring chemical amounts by titration

Accurate chemical analysis by titration often involves preparing a solution of an unknown sample. Then it may be necessary to dilute a solution quantitatively. Next, the analysis may require some form of titration to measure the volume of the sample solution that reacts with a certain volume of a reference solution with an accurately known concentration (see Sections 5.5–5.9 in Student Book 1).

Volumetric measuring instruments

You need to appreciate the accuracy and limitations of the equipment you use.

You must develop your titration technique through practice and take pride in your ability to get consistent results. You should aim to achieve two titres that agree to within 0.10 cm3.

When using a pipette:

* use a safety filler
* check the cleanliness of the pipette and safety filter
* rinse the pipette with the solution to be measured in it
* line up the bottom of the meniscus with the graduation at eye level
* allow the pipette to drain under gravity
* touch the tip of the pipette with the surface of the solution in the flask.

When using a burette:

* check cleanliness and rinse the burette with the solution to be measured from it
* check that the tip is full of solution
* remove the funnel after filling
* read the position of the bottom of the meniscus against the scale at eye level with a white card held behind at an angle to reflect light onto the meniscus
* add the solution from the burette drop by drop at the end-point while swirling the contents of the flask
* take the reading to the nearest half-scale division (0.05 cm3).

It is very important to present your results in a neat table showing both burette readings for all the titrations you carry out, including the rough titration. Always show that you have read the burette to the nearest half-scale division; that is to the nearest 0.05 cm3. Above the table of the results state clearly what was in the burette, what was in the flask and how the end-point was detected.

Analysing and drawing conclusions

In order to analyse the results of a titration successfully, you must have a clear understanding of the purpose of the experiment. From the titration itself you can either work out the concentration, in moles per dm3, of one of the solutions, or you can work out the ratio of the amounts of the two main reactants.

You can combine this information with anything else you know about the solutions and the reactants, as illustrated by the examples in Chapter 5 in Student Book 1.

You must select from your titration results the values for the titre which are sufficiently precise to allow you to calculate an accurate mean value.

In working out the concentration of one of the reactants, you must relate your calculations to the balanced equation for the titration reaction.

You must follow the guidance about measurement uncertainty to estimate the overall percentage uncertainty in the calculated result and quote the final answer to the number of significant figures consistent with the precision of the experiment (see Section 5.9 and Practical skills sheet 5).

Evaluation

Where possible, compare your final answer with published values, formulae or equations if these are known.

Discuss possible reasons for any differences between your results and published (accepted) values.

Suggest possible improvements to the design of the procedure, or the apparatus used, which might improve the results.

Sometimes you may be asked to evaluate an account of a titration carried out by someone else. If so, check through all aspects of the procedure and analysis to identify any points where the reported analysis did not correspond to best practice.