A Guide to Experiments

1   Uncertainties of instruments

All instruments have a built-in uncertainty; that is, a range in which the true reading lies, even when the instrument is read without parallax error and is calibrated according to regulations by appropriate standards laboratories.

Some typical uncertainties are shown in the table below:

Instrument	Uncertainty
Electronic balance	±2 in the last decimal place Examples: (4.275 ± 0.002) g, (38.77 ± 0.02) g
Pipette	±0.01 mL
Burette	±0.02 mL per reading* *This means that a titre would be recorded as, for example, (22.08 ± 0.04) mL
250 mL standard flask	±0.25 mL
10 mL measuring cylinder	±0.1 mL
100 mL measuring cylinder	±0.5 mL
1000 mL measuring cylinder	±5 mL

2 A classification of experimental errors Systematic errors

These occur as a result of a permanent fault in the instruments used or its incorrect calibration. This will not be eliminated, by repeating the measurement, and will cause the experimental value for the concentration or other quantity to be always above or always below the true value. Sources of error that can be considered to be systematic for school laboratory experiments include:

- the loss of some of the substance during transfer into a standard flask or the meniscus of the solution not sitting exactly at the etched mark in the standard flask when a standard solution is prepared for a volumetric analysis, since this solution will be used in each titration;

- the use of a water supply to prepare all solutions which is not at pH of 7 or which contains other contaminants such as salts that will interfere with the results;

- conducting the experiments at different temperature conditions to those used for calibrating the instruments;

- the use of an indicator for a set of titrations which changes colour just before or just after the precise moment when the equivalence point is reached.

Random errors

These cause measurements to be distributed randomly on either side of the true value. Their effect can be reduced by repeating the measurements and taking a mean.

Sources of error that can be considered to be random for school laboratory experiments include:

- parallax errors when reading the instruments;

- fluctuations in temperature or pressure at which the experiment is conducted, or in the amount of current delivered by a power source;

- subjective judgement determining when an indicator has changed colour.

Mistakes

These are normally caused by carelessness, inexperience or a temporary fault in the apparatus, such as leakage. They are not considered to be scientific errors.