Internal assessment

Your final result in IB chemistry is determined by:

- your performance in the three examination papers – **external assessment** contributing 76% of the final mark
- your laboratory work – **internal assessment** contributing 24% of the final mark.

The laboratory component is assessed primarily by your teacher (although the marks are standardized by the IB in a process known as **moderation**, to ensure that the same standards are being applied fairly across all IB schools).

The mark you achieve for internal assessment is based on the application of specific **assessment criteria** to your laboratory work. Each criterion is divided into subheadings known as **aspects** and each of these has a separate descriptor for assessment. You must fulfil the expectations of all the aspects when a particular criterion is being addressed.

Three of the assessment criteria (Design, Data collection and processing, Conclusion and evaluation) are based on some of the written work that you submit as part of your laboratory programme. Each of these is assessed at least twice during your course. The details of the criteria are given below with notes to guide you about how to achieve the best possible result and avoid some of the common pitfalls. It is a good idea to focus only on the descriptor under 'Complete/2' for each aspect so that you are aiming for the top score in each case.

Design

Levels/marks	Aspect 1	Aspect 2	Aspect 3
	Defining the problem and selecting variables	Controlling variables	Developing a method for collection of data
Complete/2	Formulates a focused problem/ research question and identifies the relevant variables	Designs a method for the effective control of the variables	Develops a method that allows for the collection of sufficient relevant data
Partial/1	Formulates a problem/research question that is incomplete **or** identifies only some relevant data	Designs a method that makes some attempt to control the variables	Develops a method that allows for the collection of insufficient relevant data
Not at all/0	Does not identify a problem/ research question **and** does not identify any relevant variables	Designs a method that does not control the variables	Develops a method that does not allow for any relevant data to be collected

Aspect 1: defining the problem and selecting variables

You must give a research question or aim which is a clear statement of what you are going to investigate. It must be much more focused and specific than the general theme provided by your teacher. It will probably say something like 'To find out how … is affected by a change in …'

Here you must identify the variables:
Independent variable (also known as the manipulated variable) refers to the factor that you control and for which you set the values; the **dependent variable** (also known as the responding or measured variable) is the factor that you measure as the experiment proceeds. **Control variables** are factors which must be kept as constant as possible during the experiment so that they do not interfere with the interpretation of the results. (Often an analysis of the control variables may lead to identification of some systematic errors.)

Aspect 2: controlling variables

Here you must clearly state *how* each variable that you identified above will be controlled. If it is not possible to keep a particular variable constant (for example the temperature rise in the laboratory during the course of the experiment), then you should try to monitor the fluctuation during the experiment.

You should record full details of all the apparatus selected. This includes, for example, the size of glassware used, how the reactants are measured, and so on. Similarly, you should include full details of reactant concentrations, mass or volume, the time taken for each step, and so on. For example, instead of saying '25.00 cm^3 of solution X was put in the beaker and heated', it is much better to say '25 cm^3 of solution X was measured with a 25.00 $\pm$ 0.06 cm^3 pipette, transferred to a 200 cm^3 beaker and heated on a hot plate until …' A clear, labelled diagram is often an effective way of describing the experimental set-up.

Remember the guideline that there should be sufficient detail in your written report to enable someone else to reproduce your work exactly.

Selecting the most appropriate piece of glassware for each stage in the experiment is very important.

Aspect 3: developing a method for collection of data

The definition of 'sufficient relevant data' depends on the particular experiment, but you should devise an experiment to collect enough data so that you can answer the aim and evaluate the results. Often this will involve plotting a graph of the effect of changes in the independent variable on the dependent variable, and you will need at least *five* data points to do this. For some experiments, it may be necessary to take repeated measurements to calculate a mean; in others (e.g. titration) it may involve a trial run and then repeats until consistent results are obtained.

Data collection and processing

Levels/marks	Aspect 1	Aspect 2	Aspect 3
	Recording raw data	Processing raw data	Presenting processed data
Complete/2	Records appropriate quantitative and associated qualitative raw data, including units and uncertainties where relevant	Processes the quantitative raw data correctly	Presents processed data appropriately and, where relevant, includes errors and uncertainties
Partial/1	Records appropriate quantitative and qualitative raw data, but with some mistakes or omissions	Processes quantitative raw data, but with some mistakes and/or omissions	Presents processed data appropriately, but with some mistakes and/or omissions
Not at all/0	Does not record any appropriate quantitative raw data **or** raw data are incomprehensible	No processing of raw data is carried out or major mistakes are made in the processing	Presents processed data inappropriately **or** incomprehensibly

Aspect 1: recording raw data

Raw data includes:

- numerical measurements of the variables – quantitative data
- relevant observations – qualitative data.

Remember to include both quantitative and qualitative data in your results

It is acceptable to convert handwritten data into word-processed form after you have finished the experiment, but raw data must be the actual numbers recorded before any processing occurs. So, for example, in an experiment involving titration, it would be the actual readings on the burette, not just the final titre. The best way to record your data is in a table that must have clear headings showing units and uncertainties. The number of significant digits must be consistent in every reading and in the uncertainty stated.

Aspect 2: processing raw data

This should involve some mathematical manipulation of the raw data to determine an experimental value. It may involve taking the average of several readings, doing a calculation of a physical quantity from experimental data, or transforming data into a form suitable for graphical representation such as taking logs or reciprocal values of data.

Note that simply taking tabulated data and presenting it in graphical form does not count as data processing, but if you can calculate the best-fit line through the points and determine the gradient, then you have addressed this aspect of the criterion.

Aspect 3: presenting processed data

Your processed data must be presented in a format that leads to easy interpretation such as a table, graph, spreadsheet, and so on. Graphs must be clearly titled, with appropriate scales, labelled axes with units and accurately plotted data points with a suitable best-fit line or curve. Avoid the common mistake of graphs that are too small. The final result must have clear SI units and the correct number of significant figures.

When the data are processed, the uncertainties collected at the same time must also be considered by propagating the random errors through the calculation. This is explained fully in Chapter 11.

Conclusion and evaluation

Levels/marks	Aspect 1	Aspect 2	Aspect 3
	Concluding	Evaluating procedure(s)	Improving the investigation
Complete/2	States a conclusion with justification based on a reasonable interpretation of the data	Evaluates weaknesses and limitations	Suggests realistic improvements with respect to identified weaknesses and limitations
Partial/1	States a conclusion based on a reasonable interpretation of the data	Identifies some weaknesses and limitations, but the evaluation is weak or missing	Suggests only superficial improvements
Not at all/0	States no conclusion or the conclusion is based on an unreasonable interpretation of the data	Identifies irrelevant weaknesses and limitations	Suggests unrealistic improvements

Aspect 1: concluding

Make a clear statement of conclusion by using your results to answer the original aim. Where possible compare the results with data values and calculate a percentage error between your results and the literature value. You can compare this value with the total estimated random error determined by the propagation of uncertainties. If the experimental error is much greater than the random error, then systematic errors are probably responsible. Consider the direction in which systematic errors might have influenced the results.

Aspect 2: evaluating procedure(s)

Here consider the design of the experiment and method of the investigation, including the precision and accuracy of the measurements. Consider what assumptions you have made in the design.

Aspect 3: improving the investigation

Use the weaknesses identified above to guide you in suggesting improvements. These should aim to address reducing random error, removing systematic error and obtaining greater control of variables. 'More time' and 'use more accurate equipment' are not very helpful.

Manipulative skills

Levels/marks	Aspect 1	Aspect 2	Aspect 3
	Following instructions	Carrying out techniques	Working safely
Complete/2	Follows instructions accurately, adapting to new circumstances (seeking assistance when required)	Competent and methodical in the use of a range of techniques and equipment	Pays attention to safety issues
Partial/1	Follows instructions but requires assistance	Usually competent and methodical in the use of a range of techniques and equipment	Usually pays attention to safety issues
Not at all/0	Rarely follows instructions **or** requires constant supervision	Rarely competent and methodical in the use of a range of techniques and equipment	Rarely pays attention to safety issues

This criterion is assessed over the duration of the course rather than in any specific investigation. You can help yourself to do well here by coming to the classes well prepared, having read any information you were given beforehand and showing an awareness of the investigation. Being alert to health and safety considerations at all times is also essential here.

Personal skills

Levels/marks	Aspect 1	Aspect 2	Aspect 3
	Self-motivation and perseverance	Working within a team	Self-reflection
Complete/2	Approaches the project with self-motivation and follows it through to completion	Collaborates and communicates in a group situation and integrates the views of others	Shows a thorough awareness of their own strengths and weaknesses and gives thoughtful consideration to their learning experience
Partial/1	Completes the project but sometimes lacks self-motivation	Exchanges some views but requires guidance to collaborate with others	Shows limited awareness of their own strengths and weaknesses and gives some consideration to their learning experience
Not at all/0	Lacks perseverance and motivation	Makes little or no attempt to collaborate in a group situation	Shows no awareness of their own strengths and weaknesses and gives no consideration to their learning experience

This criterion is assessed during the group 4 project. Your teacher may suggest that you produce a written form of self-evaluation and you may also take part in peer evaluation within your group. If you are enthusiastic about the project and communicate well with your group, you are likely to be successful here.