Internal Assessment

A Guide to Completing Your Chemistry IA Report

In the experimental sciences, your IA will take the form of an independent investigation. The task produced should be complex and commensurate with the level of the course. It should require a ***purposeful research question*** and the ***scientific rationale*** for it. The independent investigation is NOT required to be an experiment (*but an experimental investigation is highly recommended*). Some of the possible tasks include:

- a hands-on laboratory investigation (an experiment)
- extracting data from a database and analyzing it graphically
- producing a hybrid of spreadsheet/database work with a traditional hands-on investigation
- using a simulation (provided it is interactive and open-ended).

Some tasks may consist of relevant and appropriate qualitative work combined with quantitative work, but it is expected that your investigation will be primarily quantitative in nature.

The IA will have the same assessment criteria for SL and HL. The four assessment criteria are (a) research design, (b) data analysis, (c) conclusion, and (d) evaluation. Marked examples of past student IA reports (of each type listed above) have been posted in ManageBac and demonstrate the rigorous and detailed nature of the assessment that takes place.

Your approach to conducting your IA and writing your report should follow this basic format…
(this guide lists both the order you should prepare/conduct the IA, and the order you should report it)

I. Designing your Investigation (Research Design)

Define the Problem

- Report has a title which clearly reflects what is being done in this experiment

Pose a Research Question

- Research question includes independent variable and dependent variable
- A focused problem or a specific research question is identified and described in enough detail for the reader to understand the aim of the experiment.
- Make a single-sentence prediction of the outcome of the experiment.
- Explain the rationale for your prediction.
- Refrain from making personal references. (i.e. No “I think/believe…”)
- Be sure to answer your research question in the “Conclusion” section of your write-up.

Identify the Variables

- The independent variable, dependent variable, and all variables that are controlled in the experiment are mentioned.
- Independent and dependent variables are quantitative (can be measured)
- Variables must be described sufficiently to permit replication (copying) of this experiment.

Manipulating/Controlling the Variables

- The independent variable is discussed, including how it will be manipulated and the level of the precision (sig figs).
- The method(s) used for the effective control of other potential variables is described.
- Described how the controlled variables are maintained at constant values; (if known, identify sig figs).

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II. Planning your Investigation (Research Design)

Materials

- Indicate all the apparatus and materials used, including the volumes of tubes and cylinders, the concentrations of solutions, and the model and manufacturer of any complex apparatus. (Labeled hand-drawn diagrams are encouraged, but photographs are not.)

Diagram of equipment set-up

- Annotate this diagram to show how variables were involved – especially controlled variables. Do not just label the equipment. Additional diagrams are ok only if they provide clarity for a hard-to-understand portion of the procedure.

Procedure

- Procedure should not be simple numbered steps, but should use descriptive paragraphs.
- Make clear what is being measured (include units).
- Procedure should be sufficiently clear so that anyone can repeat the experiment and get the same results.
- Be concise but descriptive.
- Write using passive voice/past tense where applicable.
- If you use a *standard procedure* in your methodology, reference it using MLA, APA, or other citation format

Note – A "standard procedure" is a series of steps that are generally recognized as the method used by everyone to perform a specific laboratory task

III. <u>Getting Ready</u> to Perform the Experiment (Research Design)

Develop a Method for Data Collection

- Independent variable is tested at minimum 5 increments (or intervals or "levels")
- An adequately broad data range is considered. Data across a spectrum of independent variable ranges should be considered when necessary.
- Minimum 5 trials per independent variable increment
- The data gathered enables the aim/ research question/ hypotheses to be adequately addressed.
- Each piece of data collected is relevant to fulfill the aim/research question/hypotheses.
- State how the results will be presented, with reason.
- Describe any calculations that will need to be completed, giving formulas where appropriate.
- Method is described thoroughly and is clearly understandable to the reader.
- Procedure addresses safety concerns: appropriate safety precautions are described.

Notice that 5 represents the MINIMUM amount of data collection required for statistically significant results. Your experimental design should have MORE THAN FIVE trials for each of the MORE THAN FIVE increments of your independent variable

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IV. <u>Actually Performing</u> the Experiment (Data Analysis)

There are many detailed points to include here – but they are VERY important to get full marks!

Recording Raw Data

- Data is collected independently (that means YOU collect your own data).
- Data is primarily quantitative (numerical)
- Data must include qualitative observations. (This may provide inspiration in the conclusion and especially the evaluation later.)
- Data should be properly presented *clearly* in a table/chart.

<u>Table Organization</u>

- ❖ Includes descriptive title (or information can be adequately stated in table headers; table may have double headers) for any table, graph, etc. that is used.
- ❖ Column & row headers identical to graph axes labels (if table is source of graph data)
- ❖ Independent variable on left column
- ❖ uses specific terms *(ie. NaCl instead of salt; volume instead of amount; length instead of size)*
- ❖ tables not split between pages
- ❖ cells contain only one value
- ❖ tables arranged vertically (usually)
- ❖ tables show grid lines

<u>Table Numbers</u>

- ❖ uncertainty in headers after units. Absolute uncertainties expressed to appropriate sig fig.
- ❖ align the decimals in your columns
- ❖ all values in a column must have the same precision (end at the same decimal place)
- ❖ data in table uses correct significant figures
- ❖ averages should have the same precision as the original values
- ❖ percentage or fractional uncertainties should have 2 sig figs

<u>Table Units</u>

- ❖ units in column headings, <u>not</u> in cells
- ❖ units after "/" (for example your heading might be… **Mass / g / ± 0.01**)
- ❖ no parentheses
- ❖ use SI units - according to IB
- ❖ variable that is measured or recorded is clearly stated *(e.g. in the column heading in a table)*.
- ❖ Units for every variable.
- ❖ Uncertainty of measurements –based on significant digits– in the column headings.
- ❖ The same level of precision (number of decimal places) is used for all the entries for a variable.

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V. Analyzing Your Results (Data Analysis)

Processing the Raw Data

- Suitable manner to process the raw data is used (this may involve a mathematical processing, statistical analysis, or transforming the data into a suitable graphical representation).
- All of the raw data has been completely processed.
- Demonstrate errors and uncertainties in your data and propagate errors appropriately.
- Include relevant formulas.
- Units need to be present in final answers only.
- Sample calculation: Neatly present and explain one example only of any type of manipulation that was done to the raw data to help make it more useful for interpretation. *(you don't need to demonstrate sum, mean or standard deviation, but linear regression – if used, for example – should be shown)*.
- The raw data has been processed correctly *(correctly using significant figures and uncertainty values)*.

Presenting the Processed Data

- Suitable format in which to present the processed data is used.
- There are clear <u>headings</u> for all tables
- There are clear <u>titles</u> for all graphs
- Any graphs have appropriate scales, labelled axes with units and accurately plotted data points with a suitable best-fit line or curve if necessary.
- All the processing stages up to the final result can be followed easily (explanations are clear where necessary).
- The final results are shown expressed to the correct number of significant figures.
- The uncertainties and errors of raw data have been taken into account and the work toward this end is shown. *(For addition and subtraction, add absolute uncertainties. For multiplication and division, add relative or percentage uncertainties.)*

<u>Graphing</u>

- ❖ Graph data sourced from single table
- ❖ column & row headings same as graph axes
- ❖ include simple title like "NaCl concentration vs. transmittance"
- ❖ graph is large (the larger the better)
- ❖ simple scale (usually 1,2 or 5 times a multiple/power of 10)
- ❖ [scale does not have to start at zero]

<u>Labelling the Axes of Graphs</u>

- ❖ Independent variable on y-axis (if variable is time, then x-axis is OK)
- ❖ Dependent variable on x-axis
- ❖ Labels &Units
- ❖ Include uncertainty in your label (after units, like: mass / g / ± 0.01)
- ❖ quantitative variables
- ❖ intervals proportional (same scale across entire axis)
- ❖ SI units (according to IB… for instance, use mol dm^{-3} instead of M)

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VI. Explaining your Results (Conclusion)

Concluding Statements

- This is a section in which you get a chance to discuss the results of your experiment.
- Is there a clear pattern in your processed data?
- Explain how your data provides an answer to your research question.
- A conclusion, which is based on a reasonable interpretation of the data, is made. Different graphs are compared or trends in graphs are made explicit.
- Actual processed data MUST be used in conclusion (e.g. quote your data!)
- A justification is given for your conclusion. Reasons for the observed trends in data are written explicitly. Experimental groups are compared with control groups.
- If an already known and accepted value is being measured, values have been compared with that in a textbook or other reference, in order to assess the validity of the result. Percentage error is mentioned in this case.
- When appropriate, compare results with previous research.
- Any literature/references used are fully referenced using MLA, APA or other citation format.

VII. Reflecting on How Things Went (Evaluation)

Evaluating the Procedure

- The design and methods used in the investigation are examined here.
- Include a discussion of the replication of data collection and sample sizes used. The precision of the study is evaluated.
- FIRST, discuss the parts of the methodology that helped you to improve the reliability of your results or reduce the uncertainty in your measurements.
- THEN, identify and evaluate limitations, weaknesses, or errors of methodology.
- Measurement errors are analyzed to evaluate the accuracy of measurements.
- Instrument errors are analyzed (including possibility of calibration errors - when appropriate) to evaluate the accuracy of measurements.
- Random error is evaluated. Random variations in samples that are uncontrollable should be mentioned.
- Each error is explained thoroughly and clearly: How might each have impacted the results?

Improving the Investigation

- Any improvements mentioned MUST address the weaknesses and limitations you identified in your methodology or data collection.
- Modifications to the experimental technique are appropriate to correct the errors you mentioned.
- All proposed modifications are realistic (they are actually variables that can be controlled and whose control would actually improve the investigation).
- All proposed modifications are clearly explained.

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VIII. Authenticity & Academic Integrity

- All sources of information have been cited in-text
- All sources have been included in the correct order in the bibliography
- Citation is consistent and correct throughout (using MLA, APA or Council of Biology Editors format.)
- Student has shown teacher only one draft for feedback and submitted a final report for assessment
- Teacher has provided feedback on the draft and has assessed (awarded marks) the final report
- Teacher has confirmed that student's work is their own

See instructions and examples of MLA format on the web at:
https://owl.purdue.edu/owl/research_and_citation/mla_style/mla_style_introduction.html

See instructions and examples of APA format on the web at:
https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_style_introduction.html

See instructions and examples of CBE/CSE format on the web at:
https://writing.wisc.edu/handbook/documentation/doccse/nameyear/