Lab Write-Up Format

General Methods:

- Write your inquiry in the third person rather than the first person.
  - e.g. "The contents of the test tube were mixed incorrectly." is preferred to "Neville was a klutz and mixed the wrong chemicals."
- Use sub-headings to organize your inquiry:
  - Introduction
  - Research Question
  - Hypothesis
  - Variables
  - Materials
  - Method
  - Data/Observations
  - Analysis
  - Evaluation
  - Conclusion
  - Works Cited
- Use labelled diagrams to aid descriptions if needed
- Use clear language and specific terminology – "volume" and "mass" are infinitely better than "amount".
- Refer to the IB Syllabus, pages 25-29, for further clarification.

Design

Title
Most often, your research question, re-worded in statement format.

Introduction:
Background information sets the tone for the experiment. Usually supported by references to established research, it also can be used to explain specialized terminology, and may include diagrams to illustrate concepts. References are cited in-text (De Jong 2008), not with footnotes.

Research Question:
Best written in the form, "what is the effect of X on Y?" where "X" is your independent variable, and "Y" is your dependent variable.

Hypothesis:
"If _____(IV) _____(change), then _____(DV) will _____ (effect)." Make your prediction in this form, and then explain in detail why you think that will happen in your lab.

For example:
If temperature is decreased, then the volume of O_2 gas produced by catalase per minute will also decrease.

Variables:
Must be explicitly identified and be reasonably expected to effect the outcome of the experiment. Can be organized in table format, as follows:

Dependent Variable (DV)		What you are measuring. Be specific!
Controlled Variables	Independent Variable (IV)	What you are manipulating – "controlled over a range of values". Aim for about 5 values for your independent variable.
	Fixed Variables (Constants)	What you are keeping constant – "controlled at a fixed value". Include factors that could have been chosen as an independent, but you are not examining in this investigation.
Uncontrolled Variables		Factors, which may have an effect, but are out of your control.

Materials
A concise list of all chemicals, tools, glassware, organisms, etc., which you used during the lab. Give sizes and amounts in SI units, and organisms' scientific (Latin) names.

Method
During the planning stage, list steps that show a method that controls the variables and collects sufficient relevant data. In a post-lab write-up, attach this as an appendix, and summarize your methods in paragraph format. Your method must include explicit reference to how control of variables is being achieved.

Points to remember:

- Design is complete, and clearly outlined. It allows for collection of sufficient, relevant data, and/or excludes collection of irrelevant data. Three trials is a minimum (five is better!). Collection of three points of data (e.g. from manipulating the independent variable) is a minimum, but more is better for that line-of-best-fit.
- The use of all materials, supplies, etc. is clearly outlined.
- The design minimizes potential variables (i.e. keep track of your identified "fixed" variables).
- Labeled diagrams may be used to clarify complex procedures or apparatus set-up.
- Includes details of data collection and analysis
  - replication
  - pre-treatment of materials
  - controls
  - sample sizes
  - methods of measurement
  - calculations made
  - statistical tests used
  - etc.

Data Collection & Processing

Qualitative data are those observations that would enhance interpretation of your results. Quantitative data are numerical measurements of variables, and should be organized for easy interpretation.

Tables
Shows raw data, and may also show processed data. Write a detailed title, include all column headings, units and uncertainties. Be consistent in your use of significant figures.

More information on tables can be found at
http://www.saburchill.com/IBbiology/sci_invest/006.html

Drawings
Some data may be in diagram form. Drawings should be as accurate as possible, neat with title and labels, and include an indication of magnification (i.e. scale bar).

Analysis of Data
Explain any data processing formulas used (mean, standard deviation, etc.). Show sample calculations.

- Error analysis, correlations between data and uncertainties are performed when appropriate. These are statistical tests used to confirm the validity of data and which help us accept or reject the hypothesis.

For more about statistics, visit http://www.saburchill.com/IBbiology/stats/stats_hp.html or check out Merlin, an add-in for MS Excel (http://www.heckgrammar.kirklees.sch.uk/index.php?p=10310).

Graphs

Choose the best graph form to display your data. Include a descriptive title, labels & units on both axes, and a key or legend if necessary. Include a brief summary below the graph.

- Use graph paper & a ruler, or a computer graphing program such as MS Excel.
- Each graph, table or figure is important to the reader's final understanding of your investigation.
- Each graph, table or figure has an informative caption.
- Each graph, table or figure is self-sufficient and includes explanations of numbers used, replicates, units of measurement, etc..
- Graphs, tables and figures are numbered sequentially through the text as they appear.
- Major results arising from each graph, table or figure is briefly described in words, but the significance of the results to the study is **not** discussed at this point.
- Presentation of data allows for easy interpretation.

For more on graphs, visit http://www.saburchill.com/IBbiology/graphs/001.html

Conclusion & Evaluation

- List specific results. E.g. "A temperature of 50°C resulted in a reaction rate of 4 m^3s^{-1}. A temperature of 60°C resulted in a reaction rate of 5 cm^3s^{-1}, etc." These numbers should represent processed data or averages.
- Compare your results to your hypothesis. How are they similar? How are they different?
- Explain results.
- List potential problems with your experiment. (Take notes of problems during your experiment. Look at your list of fixed variables – this is a great source of potential problems!) Consider sources of human error, and the accuracy of equipment used.
- Identify the weaknesses of your experiment, and the significance of those weaknesses to your findings.
- List possible solutions to the potential problems identified above. How could you make it more likely that these variables are kept constant?
- You could also identify ways to extend the investigation at this point.

For more about error analysis, go to http://www.saburchill.com/IBbiology/sci_invest/007.html

Finally, if you're still not certain how to format your report, including references (and in-text citations), go to http://www.union.edu/PUBLIC/BIODEPT/Jumpamine.html for a good example.

Works Cited:

Follows the CSE (Council of Science Editors) format – formerly CBE (Council of Biology Editors). http://library.osu.edu/sites/guides/csegd.php.