IB Environmental Systems & Societies
Internal Assessment
Write-Up Guide

This is a guide to assist you in constructing lab write-ups. Use this guide and the IB Rubrics as self-checklists when writing up your labs. Lab write-ups are to be your own work. If you use "outside" information, you must cite your sources in APA format and include a bibliography. Keep in mind that three parties will review your work; you, your teacher and the IB moderators. It is critical to organize your lab write-up PRIOR to submitting it for a grade, and it is necessary for you to submit a complete write-up in order to obtain full credit on both the IB rubric and the course grade.

All write-ups MUST include the following features:

- On Time
- Single Spaced
- Size 12 Times New Roman Font
- Double Sided Preferred (let's save a tree)
- Cover sheet with candidate name, due date, title/lab title and topic number
- Clearly marked sections of the lab, in order and justified left, and in bold type.
    - **Planning**
    - **Data Collection & Processing**
    - **Discussion, Evaluation and Conclusion**
- Clearly marked sub-sections <u>indented</u> and in **bold** and *italic* type.
    - ***Problem Statement, Hypothesis, Hypothesis Explanation, Variables (Independent, Dependant, Control) Apparatus & Materials, Procedure***
    - ***Tables & Results, Sample Calculations, Graphs***
    - ***Discussion, Limitations/Improvements, Conclusion***
- Raw (original, handwritten) data from your lab/experiment
- Unit labels and headings on data, tables and graphs, calculations, diagrams, etc.
- Hand drawn and computer generated tables and graphs.
- Bibliography/Work Cited, in APA format if external sources used.
- Teacher notes or verbal instructions prior to and/or during the lab.
- Staples in the upper left corner.

IB Environmental Systems & Societies
LAB TEMPLATE

Planning [P]

1. Defining the Problem and Selecting Variables
   - Problem Statement/Research Question:
   - Hypothesis:
   - Hypothesis Explanation:
2. Controlling Variables
   - Independent:
   - Dependant:
   - Control:
3. Developing a Method for Collection of Data
   - Apparatus and Materials:
   - Procedure:

Data Collection and Processing [DCP]

1. Recording Data
   - Raw Data and Results:
2. Processing Data
   - Table and Results:
3. Presenting Processed Data
   - Sample Calculations:
   - Graphs:

Discussion, Evaluation and Conclusion [DEC]

1. Discussing and Reviewing
   - Discussion and Reasoning of Results
2. Evaluation Procedure(s) and Suggesting Improvements
   - Limitations of the Experiment, Sources or Error:
   - Suggestions for Improvements:
3. Concluding
   - Conclusion of Results:

Practical Guide to Writing Lab Reports
IB Environmental Systems and Societies SL

Planning

Aspect 1: Defining the Problem and Selecting Variables:

Research Question (RQ):

- The first part of planning an experiment is writing a good **research question** that you will investigate.
- A Good RQ will:
    1. Include both dependent and independent variables
    2. Be Quantitative if appropriate
    3. Include the organism or tissue investigated

Hypothesis

- A hypothesis is a statement that addresses the RQ and makes a **prediction** about what will happen.
- A Good Hypothesis will:
    1. Be written in an "If…, then…" format.
       If the [independent variable] [does something], **then** the [dependent variable] will [do something as a result]. This will then be followed by a detailed **explanation**.
    2. Be explained. This is your background research section! Make sure you completely research and explain your focused question before making your prediction. (**Note:** it is helpful to use **scientific concepts/models**) to explain your prediction.)
    3. Include both dependent and independent variables
    4. Be Quantitative if appropriate
    5. Be Testable (Falsifiable)
    6. Relate to the RQ

Variables

- Variables are the different parts of your experiment that are able to change from one experiment to another. In order to perform a fair test it is important to make sure that we control as many variables as possible in order to gain accurate data.
- A Good Variables list will:
    1. Include the **Independent variable** – the variable you change
    2. Include the **Dependent variable** – the variable that changes as a result if the independent variable
    3. Include other **Controlled variables** (controlled variables are things we need to keep constant in each experiment)

Aspect 2: Controlling Variables:

Control of Variables:

- Part of the methods section of a lab is to include **how you will control the variables** listed above.

- A Good *Control of Variables Section* will:
    1. Specify how the measurements will be collected.
    2. Specify how the other variables will be controlled.
    3. Make sure the each variable in the list is mentioned.

Aspect 3: Developing a Method for Collecting Data:

Apparatus and Materials:

- This section includes the necessary equipment and materials to control and measure the variables list in Aspect 1. Keep this in its own section separate from the Method.

- A Good *Apparatus and Materials List* will:

    1. Indicate the correct materials for each variable
    2. Indicate the precision of measurements:
        - '500 ml beaker', instead of just 'beaker'
        - 'Thermometer (0-100)' instead of just 'Thermometer'
        - '1 meter stick' or '100 cm ruler' not just 'ruler'
    3. Can include an annotate diagram, but not necessary

Methods to Collect Sufficient and Relevant data

- This section (formerly called "procedure") may be written in paragraph form or in a series of steps allowing for the collection of sufficient and relevant data. It is important when planning an experiment to think about the RANGE and SIZE of measurements as well as how many REPETITIONS of the experiment you will do.

- A Good *Methods Section* will:

    1. Include all steps necessary to complete the experiment (even the obvious ones…like you are explaining it to a two year old or your grandparents!)
    2. Include how and when to take measurement or record observations
    3. Address an appropriate RANGE and SIZE of intervals or measurements (appropriate SI units).
    4. Indicate how many times the experiment will be REPEATED. (At least 5 trials)
    5. Make sure the relevant data is able to be collected
    6. Include an appropriate Sample Size

Data Collection & Processing

Aspect 1: Recording Raw Data Data:

Collecting and Recording Raw Data:

Data collection skills are important in accurately recording observed events and are critical to scientific investigation. Data collection involves all **quantitative** or **qualitative** raw data. Quantitative data is defined as things being observed with more or less unaided senses (colour, change of state, etc.) or rather crude estimates (hotter, colder, brighter, etc.) quantitative data involves some measurement. Organize this section into **Figures and Tables**. Figures are Pictures,

Sketches & Drawings or anything that is NOT a table! Tables include Data Collected during Lab.
(Do NOT do any calculations in this section)
(<u>Figures will go FIRST</u>. Start by labeling them with "Figure 1.1, 1.2, 1.3…" BELOW each)

(<u>Tables will go SECOND</u>. Start by labeling them with "Figure 1.1, 1.2, 1.3…" ABOVE each)

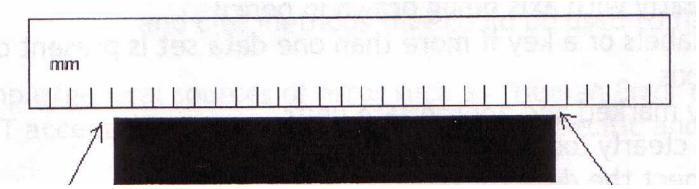
- A Good Data Collector will:
    1. Record all appropriate data
    2. Pay attention to detail
    3. Include **<u>units</u>** for all measurements
    4. Include **<u>uncertainties</u>** of the instruments used (when applicable)

- A Good Figure will:
    1. Neatly display the picture, sketch or drawing
    2. Be labeled appropriately. For example… "Figure 1.1 – Chromatography Strip"
    3. Have an explanation below the picture with as many details as possible on what is occurring/what the picture is showing.

- A Good Data Table will have:
    1. A **<u>descriptive</u>** title ABOVE the Table. For example… "TABLE 1.1 – The Distance Each Pigment traveled in cm After Six trials".
       **Note HOW much information is given in a title!
    2. Headings with units, **no units in body of table!**
    3. Independent variables in the left hand column
    4. Dependant variables across the top

Uncertainties in all measurements

- Whenever we make measurements we do so with some error or uncertainty. We cannot make exact measurements; therefore it is important to indicate what level of uncertainty there may be. **This should be done in the headings after the units are given.**
- Uncertainties are calculated as:
    1. <u>+</u> ½ of the smallest unit measurable by the instrument. For example, a thermometer that is graded to 1^{o}C has an uncertainty of <u>+</u> 0.5 ^{o}C.
    2. <u>+</u> 1 unit of length (1/2 x 2 measurements



Uncertainty at each end of the ruler means
two measurements with a level of uncertainty.

3. PRECISION: You should follow significant figures. Limit your precision to the LEAST precise number. For example: If your data collected was 1.4, 2.34, and 1.5 the round as follows: 1.2, 2.3 and 2.5. You may do (1.40, 2.34, 1.50 if you were that precise to begin with).

Aspect 2: Processing Raw Data:

Data Processing:

Data processing means that you are actually converting the data into another form. Putting numbers into a table is not data processing! This section includes calculations. You will present this data in tables (in which you will have to repeat the raw data) and Graphs. Give a title to explain the nature of the calculation. Below each table, you will show a sample calculation. Graphs will follow the tables. Graphs are figures so the explanation must go below.

- A Good Data Processing section will:
    1. Show the formula you used, even if it is simple
    2. Possibly include processes such as
        - Means
        - Standard deviation
        - % differences
        - Statistical tests
            - t-tests
            - X^2 (Chi-squared) test
    3. Following through with UNCERTAINTIES & SIG FIGS.

Aspect 3: Presenting Processed Data:

Data Presentation:

- Data presentation is not always necessary to every lab. You must evaluate if the data you collected is able to be graphed.

- A Good Data Presentation section will:

    1. Use the appropriate graph type
        - Continuous variable – best line or scatter graphs
        - Discontinuous variable – bar graphs
        - Parts of a whole – pie chart
    2. Have a descriptive title
    3. have appropriate headings with units on both axis
    4. be drawn neatly with axis being drawn in pencil
    5. Have a clear labels or a key if more than one data set is present on one set of axis
    6. have clearly marked and appropriate units
    7. Have points clearly located and marked
    8. Use of Excel is acceptable

Discussion, Evaluation and Conclusion

Aspect 1: Discussion and Reviewing:

Discussion:

- A discussion is the consideration and examination of your original research question and hypothesis in light of the results of your experiment
- A Good Discussion will:
    1. Be clear and well reasoned
    2. Show understanding of context and implications of the results

Reviewing:

- A review simply restates the data recorded in an explanatory manner.
- A Good Review will:
    1. Only state relative concluding data (ex: Processed Data)
    2. Explain the source of data
    3. Include SI units (when appropriate)

Aspect 2: Evaluating the Procedure and Suggesting Improvements:

Evaluation:

- Most difficult part! You are not being judged as a person, so don't take the defensive and try and justify your mistakes! Be honest, and think hard about what you could have done better.

- A Good Evaluation will:
    1. Identify sources of error in method and measurement
    2. Identify limitations in method [whether or not you chose it] and data collection

Improvements:

- After you identify possible sources of error in the investigation and cite methods that could be used to fix them

Simple/general sources of error such as "Human Error or Faulty Equipment" are NOT acceptable unless you are extremely specific and justified.

Aspect 3: Concluding:

Conclusion:

- A conclusion is not simply a restatement of the problem. It requires though and analysis of the relevant data collected and represented.

- A Good Conclusion will:
    1. Refer back to the research question/hypothesis. Remember, you CAN NOT "prove" you hypothesis right. You can <u>support</u> it, or <u>disprove</u> it, but you <u>cannot prove it anything</u>!

2. Be explained with reference to data analysis and literature values
   [translation: don't say something that is not your data!]
    1. Give quantitative relationships between variables where appropriate – linear, exponential, inverse, positive, negative, not "it changed", **Say HOW it changed!**
    2. Compare results with textbook or other literature values

Words NOT to use:

1. Change – don't say the temperature changed, or the graph changed. Use increase or decrease, or another qualitative statement.
2. "It", "They", "Them" – use nouns. It doesn't matter if you say the same thing 100 times! This is not an English paper.
3. "Prove" – You can't prove anything. You can only support your hypothesis.

So… "The temperature changed; therefore it changes too, which proves my hypothesis to be correct." Is a horrible sentence!

References:

- If you use anything that is not yours, you must reference that material no matter how little it is!
- Otherwise you are plagiarizing other's work.
- All referenced should be cited using APA format.