Student Experiment Writing Guide

In this assignment, write everything except the last section in past tense (was), and in the passive voice (no I/we/you etc.).

Note: The first two sections (Research Question and Rationale) can be presented in any order.

Rationale

The purpose of the rationale is to communicate the purpose or reasons behind your experiment.

Include theorems, concepts or background knowledge that is related to your research question.

You are not required to present a hypothesis (prediction of the outcome).

If you include references to external sources in this section, use in-text referencing (Harvard) and place the full citation in a reference list at the end of the assignment.

(Length: 150-300 words)

You are marked in this section on:

- *whether your rationale is "considered" (good mark), "reasonable" (medium mark) or "vague" (poor mark)*

Research Question

State the **research question** that your experiment will attempt to answer. It should be phrased in a way that allows you to look at the connection between two things (rather than the yes/no style question that is used in Research Investigation assignments).

Example, your question may be, "What is the relationship between air speed and the drying rate of a saturated cotton shirt?" Your question needs to be specific (avoiding any vague or general terms when describing the variables) and related to the experiment done in class.

(Length: 50 words)

You are marked in this section on:

- *whether your research question is "specific and relevant" (good mark), "relevant" (medium mark) or "inappropriate" (poor mark)*

Method

The method has three sections, each with its own sub-heading.

Original Method

Summarise the method of the original experiment performed in class in as few words as possible.

Attach the original experiment as an appendix. (Length: under 30 words)

Modifications

Describe the modifications you made to the original experiment with reference to the research question.

This may involve explaining the **limitations of the original experiment** performed in class, and **how you extended, refined or redirected the experiment** to improve upon the original.

An experiment modification can be done by any combination of the following:

- Refine: to make improvement by introducing subtleties or distinctions;
- Extend: to increase the scope, meaning or application of;
- Redirect: to change the course or direction of;

and **justify** why each of the modifications were made.

The justification for each of your modifications should clearly show how the modification improves on the original experiment, and/or how it better tests the research question.

Your modified experiment should not simply be the same experiment done more carefully, or involve doing the same tests more times. There needs to be a distinction between your modified experiment and the experiment done in class.

You may use bullet points, a table or write in paragraph form for this section.

Example, you may use video analysis software to track fast-moving objects rather than a stopwatch (modification) *in order to* reduce the uncertainty in measurements (justification); or test the effect of a different variable (modification) *in order to* closer approximate real-world conditions (justification).

Note that you do not need to write a step-by-step method at any stage.

(Length: 100-175 words)

You are marked in this section on:

- *whether the <u>modifications</u> to your methodology are "justified" (good mark), "feasible" (medium mark) or "inappropriate" (poor mark) and*
- *whether your <u>methodology enables collection of data</u> that is "sufficient and relevant" (good mark), "relevant" (medium mark), or "insufficient and irrelevant" (poor mark)*

Risk Management

Consider any **risks** to person, property or environment that may occur during your experiment, and **how those risks were managed**.

A statement addressing **ethical or environmental considerations** should be included.

The length of this section will depend on the type of experiment being conducted. Do not exaggerate or overstate the risks involved. There is also no need to include the use of stationery such as scissors as part of the risk assessment.

You may use bullet points, or use a table, or write in paragraph form for this section.

You are marked in this section on:

- *whether your <u>management of risks and ethical or environmental issues</u> is "considered" (good mark), "managed" (medium mark), or "inadequately managed" (poor mark).*

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Results

In this section, you present the data that you have collected. You need to have collected a sufficient amount of data to make a reasonable attempt at answering your research question. Have a conversation with your teacher if you are not confident.

For example, if you were looking at the relationship between air speed and the drying rate of wet cotton fabric, you could test multiple air speeds against three pieces of wet cotton each time.

In experiments involving human subjects (e.g., Psychology) sufficient data will come from surveying an appropriate sample size.

First, your table of raw data should be presented in an appendix. Present all of your processed data in a single **table** including percentage errors. Under the table show an example of how you **processed** the data, such as by finding averages, calculating errors or using other formulas. You do not need to show repeated versions of the same calculation for the entire data set.

Second, where possible, use **graphs** to relationships between the variables in your data. Appropriate types of graph should be used to best display your data. e.g. column graph, line graph or scatterplot. In general, if your data is continuous, use a scatterplot; likewise if your data is discrete use a column graph. If specific measurement uncertainties are known or can be calculated, especially in Physics and Chemistry, include **error bars** in the graph of your results.

A short description of the relationships demonstrated by the graph needs to be included.

You are marked in this section on:

- *whether your <u>collection of data</u> is "sufficient and relevant" (good mark), "relevant" (medium mark) or "insufficient and irrelevant" (poor mark) and*
- *whether your <u>processing of data</u> is "correct and relevant" (good mark), "basic" (medium mark) or "incorrect or irrelevant" (poor mark)*

Analysis of Results

You need to analyse your results by identifying **trends, patterns or relationships** in the data. To do this, <u>describe</u> the pattern (using words like increased, decreased, linear, exponential, sharply, significantly, little effect, no effect), then be more specific by putting <u>numbers</u> to it. For example:

- Results indicated that as air speed increased, the drying rate of the fabric increased linearly [description of pattern], losing approximately an additional 0.5 g of water per minute for each 3 m/s increase in air speed [numbers]. OR
- The results showed that an increased air speed had little effect on the drying rate of the fabric [description of pattern], with air speeds between 0.8 and 2.6 m/s resulting in a similar loss of approximately 2.1 g ± 0.3 g of water per minute [numbers].

The first sentence of your analysis should contain the biggest finding that is most useful to answering your research question. The next several sentences can be used to pull apart your data in more detail, identifying all other trends and patterns using the same description-numbers technique.

(Length: 150-300 words)

You are marked in this section on:

- *whether your <u>identification of trends, patterns or relationships</u> is "thorough" (good mark), "obvious" (medium mark) or "incorrect or irrelevant" (poor mark) and*

Evaluation of Evidence

Limitations of the evidence

Limitations refer to the size and scope of what you were able to test in your experiment.

Sources of error affecting reliability

Reliability refers to the accuracy and precision of your measurements. These could include uncertainties caused by the instruments or the method used to collect your data; a limited range of tests for the independent variable; a small sample size; variables that were out of your control that may have affected the results; and so on. Avoid vague statements like "human error", which are not specific enough and "better time management was needed", which is not a limitation of the experiment itself.

Sources of error affecting validity

Does your experimental design and data allow you to answer your research question with a degree of accuracy?

Suggested improvements and extensions

Improvements should suggest changes to your method that minimises error or improve data collection.

Extensions are changes to your method that would allow you to collect data outside the scope of your original modification.

(Length: 100-300 words)

You are marked in this section on:

- *whether your <u>identification of the uncertainty and limitations</u> of your evidence is "thorough and appropriate" (good mark), "basic" (medium mark) or "incorrect or insufficient" (poor mark)*
- *whether your <u>suggested improvements and extensions</u> to the experiment are "logically derived" (good mark), "related" (medium mark) or "ineffective or irrelevant" (poor mark)*

Conclusion

You should now **answer your research question**. The opening sentence of your conclusion should be a concise, direct answer to your research question. For example, "This experiment indicated that higher air speed produces a faster drying rate for cotton shirts." Do not use the word "prove", as you will not be able to prove any relationship in an experiment of this scale.

Justify your conclusion by summarising key evidence from your analysis. Also consider the uncertainty and limitations of your research. For example, "A positive linear relationship was observed in wind speeds between 0.8 and 4.5 m/s [evidence from analysis]. However, a different relationship may apply at wind speeds outside this range [limitation]."

Note that you may place your conclusion here, immediately after the Results section, or after the Evaluation section that follows. Use whichever makes more sense for your experiment.

(Length: 50-100 words)

You are marked here on:

- *whether your <u>conclusions</u> are "justified" (good mark) ,"reasonable" (medium mark) or "inappropriate or irrelevant" (poor mark)*

References

Include an alphabetical list of any references that you used. All of these are likely to be from the Rationale.

You are marked here on:

- *whether your <u>acknowledgment of sources</u> are referenced "appropriately throughout the rationale" (good mark) or listed in a bibliography (poor mark)*

File Naming

SURNAMEFIRST-STUDENT#-U3-PHYSICS-IA2