

# Laboratory Report Guidelines

*Ryerson University Department of Physics*

Writing a strong lab report is a skill that often takes significant practice.

Strong reports are:

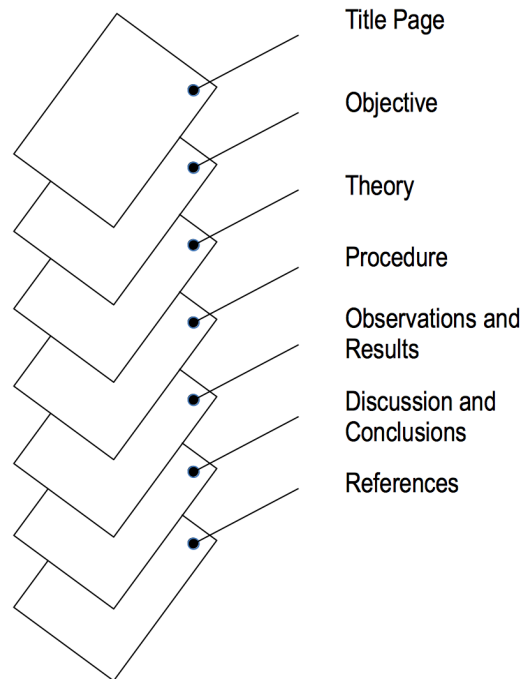
- structured in a clear and organized fashion.
- as concise as possible, and yet sufficiently detailed that it does not omit any of the information required to fully communicate your work and results.

Ideally, a lab report leaves any reader confident in the validity of the results, and with enough information that they could repeat the experiment.

The evaluation of your report will be based on your ability to understand the goal of the experiment, your understanding of the applicable physical principles, your ability to perform the experiment attentively, and your ability to clearly communicate its results in a logical and coherent fashion.

## Report contents:

1. Title Page
2. Objective
3. Theory
4. Procedure
5. Observations and Results
6. Discussion and Conclusions
7. References



## 1. Title Page:

Depending on your program (either Engineering or Science), you will be expected to use a standardized title page template. **See the Physics website's lab section for the appropriate template.**

This page should clearly display:

- The title of the experiment
- Full names of the members of your lab group (only the ones with whom you actually did this experiment). Underline the family name in each case.
- The date the experiment was performed
- The date this report is submitted
- The course number and section
- TA's name

Neglecting any of these details may make it difficult to mark your report in a timely fashion.

## 2. Objective:

This section is written to provide the reader with all the background needed to understand your objective, results and conclusions.

The section should begin with a statement of purpose, i.e. "The purpose of this experiment was to...."

The section should go on to answer the following questions: Why has the experiment been performed? What was sought? What was measured? What was the motivation?

It is often appropriate to provide contextual background, which may include the scientific significance of the experiment, and/or historical details. Don't forget to reference your sources.

### *OBJECTIVE: COMMON PROBLEMS*

Here are typical problems in this section:

- The objective is not clearly stated.
- Background information is missing.

### 3. Theory

The theory section provides a brief explanation of the physical principles applicable to the experiment.

In general, a physics experiment will revolve around an indirect measurement based on fundamental theory or equation. One or more variables contained in the equation are measured experimentally, and based on the original equation, the measurements are then used to calculate a related variable.

In other cases, a physics experiment might take measurements that identify various behavioural trends (e.g. identifying phase transitions during the melting or vapourization of a material).

The theory section should include a written description of the physics involved. The equations pertinent to the experiment should be included, and any algebraic rearrangements required to illustrate a relationship or to isolate a particular variable should be shown and explained in words.

#### *THEORY: COMMON PROBLEMS*

- Written explanation of theory is insufficient.
- Equations are incorrectly written or symbols are not defined.

### 4. Procedure:

This section conveys that you understand the techniques used to conduct the experiment. In your own words, write about the general strategy used to obtain the data. Concisely explain the methods employed in measuring the quantities. The experimental apparatus should be described, as should the data collection techniques.

A diagram of the apparatus is almost always necessary. Schematic diagrams created using computer drawing applications are usually preferable to hand-sketched diagrams.

Describe your procedures in detail so that the reader may reproduce your experiment or analyze potential errors. Usually the steps of the procedure are given in a list. If this is too long it may be broken into stages with steps in each stage. Use past tense, passive voice (e.g., “the length was measured”, rather than any of the following: (i) “we measured the length”, (ii) “we measure the length”, (iii) “we will measure the length”, (iv) “measure the length”, etc...)

The intent of this section is to:

- Indicate the experimental strategy and the procedure followed to obtain the data so that others can assess the validity of the results.
- Use diagrams to describe the apparatus/equipment.

*PROCEDURE: COMMON PROBLEMS*

Typical problems in this section are:

- The apparatus and/or procedure are not clearly described.
- Diagrams are not labeled and/or numbered.
- There are incorrect statements.
- Important information and/or details on data acquisition and analysis are missing.
- Past tense is not used.
- Passive voice is not used.

## **5. Observations and Results**

Tables and/or graphs should be used to display the results of the experiment.

Tables and graphs should be clear and logical and carefully labeled, so that the reader can understand them without referring to the text. Therefore, appropriate graph captions and table titles should be carefully chosen and these should be used for reference in the text (e.g. vague graph titles such as "Y vs X" are not acceptable). Each axis on the graph should be properly scaled and have a label and proper units. When graphs or tables are referenced, their number rather than their title should do this (e.g. "Figure 1 shows that..."). When possible, tables and graphs should be embedded in the text of the report (rather than being appended at the end) to avoid forcing the reader to flip pages.

Example calculations should be provided for ALL values calculated during the course of the experiment.

That is, where measured values from three columns in a table are used to calculate a result shown in a fourth column in the table, provide an example showing each step in the calculation. With your example calculation, **ALSO INCLUDE A CALCULATION SHOWING HOW THE UNCERTAINTY ASSOCIATED WITH EACH OF THE THREE MEASURED VALUES AFFECTS THE UNCERTAINTY IN THE RESULT.** For more detail, see the Error and Uncertainty guide on the Physics website's Labs section.

This section should:

- Present all relevant data in table form, with title and column headings.
- **PROVIDE EXAMPLE CALCULATIONS, INCLUDING UNITS AND SHOWING CALCULATIONS OF THE UNCERTAINTY PROPAGATION.**

- Show all relevant graphs illustrating results.
- Provide a calculated comparison of your result against accepted values.

### *OBSERVATIONS AND RESULTS: TYPICAL MISTAKES*

Here are typical problems in this section:

- The data tables are not properly titled and/or numbered.
- The data are shown without proper units.
- Graphs are not titled and/or numbered.
- Axes of the graphs are not labeled and/or units are incorrect or missing.
- Incorrect type of graph is used or information on the graph is not clearly labeled.
- Calculations are not clearly explained step by step, or even worse, they are missing.
- There is a clear contradiction between the observed data and the results.
- The results are given with an incorrect number of significant digits.
- Uncertainty calculations and/or percentage error calculations are missing.

## **6. Discussion and Conclusion**

This section:

- Summarizes the results of your experiment and comments on the success of the experiment by comparing results to accepted values.
- Identifies problems with the experimental methodology or apparatus.
- Provides suggestions to improve the experiment and/or extrapolates ideas for future experiments that would build upon the present work.

This section is probably the most important one of your report and the main reason you are writing the report. All previous sections are just the foundation, but this section is the true measure of what you have learned from this experiment, as well as the measure of your writing skills.

Present the conclusions you draw from the results. Be sure that your conclusion reflects the purpose of the experiment, as stated in your “Objective” section.

All conclusions should be clearly stated and supported with evidence. Cite specific results and observations from the experiment and tie them to your conclusions.

E.g. “The density of gold was determined to be  $19.2 \pm 0.2 \text{ g/cm}^3$ , which differed from the accepted value of  $19.32 \text{ g/cm}^3$  [1] by 0.5% and fell within the observed experimental uncertainty.”

[1] *CRC Handbook of Chemistry and Physics*, 51st ed.; Weast, R.C., Ed.; The Chemical Rubber Co.: Cleveland, OH, 2008; B-14.

You should indicate whether your measurements and/or calculated values make sense. Do they fall within the expected range? In case the data or results appear to be outside a reasonable range, point out what possible problems might have occurred. When appropriate, recommend ways to correct problems and improve the experiment.

Point out any real trends, analyze why they occur, and explain any significant features or differences from expected results. Summarize reasons for any disagreement between your results and the expected results. When analyzing sources of uncertainty and/or error, be specific and avoid using vague phrases such as "human error."

### *DISCUSSION AND CONCLUSIONS: TYPICAL MISTAKES*

Typical mistakes encountered in this section are:

- This section is only a restatement of the results from the previous section without commenting on the key expected points.
- Incorrect or trivial arguments are used (e.g. sources of error are not sufficiently explained or trivial explanations are offered, such as "old equipment" or "human error" are blamed for the poor accuracy).
- Suggestions for improving the experiment are missing, are insufficient, or inconsequential.
- A conclusion is drawn, but is not supported by experimental evidence.
- No sensible conclusion is drawn (i.e. conclusion is not actually relevant to the stated purpose of the experiment).
- There is no clear evidence of a thorough understanding of the experiment and/or theory behind it.

### **7. References:**

State complete references to any books, articles, websites, etc. from which you obtained information used in your report. Indicate, in the appropriate places in the body of the report, where these references are being used.

### **GENERAL WRITING MISTAKES**

Some typical mistakes are:

- The text portion of the report is not typed (illegible handwriting is not acceptable!).
- The sequence of the sections is incorrect.

- The reference section is missing.
- There are grammatical and/or spelling mistakes.
- Long, confusing sentences are used instead of short and clear ones. Be concise.

### **Important Notes:**

A good report will also reflect your ability to clearly communicate results and important conclusions to the reader. Therefore, it is important that you use proper English grammar and spelling, with clear and short sentences, along with logic and proper style.

- The text portion of the report must be typed starting each section on a new page. Observations, tables, graphs and formulas may be done NEATLY by hand.
- Proofread it carefully.
- Be sure to follow explicitly the content guidelines indicated above.
- Allow at least two spaces between text and tables or figures.
- Avoid being too verbose: be as specific as possible.
- The report must be stapled in the upper left-hand corner, or otherwise bound securely so it can be read and marked without falling apart. A penalty will be applied if this requirement is not met.
- Plagiarism will never be tolerated. Do not copy material (lab manuals, text books, your partner's notes, old lab reports, etc...). When restating work (in your own words) that you are using as reference material, cite the source.

For more information on Ryerson's Academic Integrity Policy, see:

<http://www.ryerson.ca/academicintegrity/>  
<http://www.ryerson.ca/content/dam/senate/policies/pol60.pdf>