

Format for Formal Lab Reports

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A formal lab report is a record of your laboratory activities and should include the following sections: Introduction, Experimental Procedure, Data, Analysis and Discussion and Conclusion. Each section is required to have a heading and should be neat, well organized and concise. It is customary in the scientific literature to number the sections of a report, typically with Roman numerals. Reports will usually consist of 2-3 pages of text with accompanying figures and tables.

- I. **Introduction:** The reason for doing laboratory experiments is to further develop your understanding of the concepts and laws of Physics. The objective of a particular experiment is usually stated in the Introduction section of the lab handout. In a few sentences describe the particular concepts and laws of Physics that the lab was meant to demonstrate and state the objective of the lab. If the lab report requires you to carry out any derivations, place them in your Introduction section. Explain how the result of the derivation is relevant to the objective of the experiment.
- II. **Experimental Procedure:** Include a one to two paragraph description of the experimental equipment and procedure, using your own words. Be sure to include a diagram of your experimental set up. A question that always arises is how much detail should be included in the procedure section. A good rule of thumb to apply is write enough detail so that a classmate who missed the lab could carry it out from your description.
- III. **Data:** Include the lab handout behind your written report. Your original (raw) data will usually be recorded in the handout, but it also needs to be included in your report in tabular form. There should be a paragraph describing the data that is contained in the various tables. Your tables should either have a heading or a very clear figure caption. The information should be laid out in such a manner that it is obvious what you are trying to achieve.

IV. **Results and Discussion:** This section contains the analysis of your experimental data. This analysis should include graphs and charts that display the data and the results of any calculations.

Calculations: In this section show any equations that you will be using along with a sample calculation for each.

Show equation → Substitute values → Calculate answer

It is not necessary to show the details of every calculation that you perform, one sample of each formula is sufficient.

Graphing: Graphs should be done on graph paper or printed from an application should as Excel. They should not be done on plain or quadrille paper. Every graph should have a title and the axes should be properly labeled with the correct units.

Curve fitting: The data points should be fitted to the proper curve. Just connecting the dots is not acceptable or appropriate. This is most easily accomplished in Data Pro or Excel and is the preferred method. The idea behind curve fitting is to minimize the error in the individual data points and use the entire data set to describe a relationship that will summarize your results. The “curve” that we will be utilizing is a straight line. Not all the relationships will be linear, but by modifying the equations or the data it will be possible to use a linear trend line for almost every case.

Error Analysis: Thinking about uncertainties and errors is perhaps the most important but difficult part of an experiment. In general, you should spend most of your analysis effort here. Examine the assumptions that went into the derivation of your result. For instance, no friction, massless pulley, etc. Are these assumptions reasonable? If these assumptions don't hold in the case of your experimental setup, how would it affect the result?

You should discuss the quality of your results. Do they seem to agree with your expectations? Be sure to explicitly show your calculations, and always include units. Include the uncertainties (experimental error) in all of your measured variables. The following question must be answered in this section: do your predicted (theoretical or accepted) results and your measured results agree within the limit of these uncertainties? Make a reasonable attempt to account for any discrepancies. For example, if your measured value is too small, try to identify factors that would cause

this.

An acceptable discussion of error analysis is much more than just stating “human and experimental error!” This says nothing and will receive no credit. If there was human error, the corrective action is to go back and carry out the procedure correctly. If there were experimental errors list them and describe how they will affect your experimental results.

V. **Conclusion:**

This is the summary section where you need to demonstrate that you understand the experiment that you just completed. Include a one-paragraph summary explaining very clearly your principal results.

Did your results meet the objectives of the lab? This should be backed up with reference to your data and analysis. Compare your measurements to the expected values. You need to state and discuss whether your results are in agreement with the expected theoretical value. If the value of your percentage error (percentage difference) is much larger than the value of your experimental error, then you must describe the reason for this. State the possible sources of error and describe the expected impact of each of these errors on your experimental results.

Finally, explain what you actually learned from doing the lab.

General Policies:

1. It is preferable that your reports are typed but neat, hand-written reports are acceptable. Hand-written reports should be done in black or blue ink – no pencil or other colored inks. Do not use paper ripped out of a spiral notebook.
2. Your report should be written in paragraph format and not as a list of bulleted items.
3. Your report should utilize the language and concepts of Physics to describe your activities and observations. You should follow the rules of English grammar and make sure all words are spelled correctly.
4. This final reminder should not be necessary at this point in your academic careers but experience indicates otherwise. The pages of your report should be numbered, organized in the proper order and stapled together with your name on the front page.

Important Note:

1. Begin working on your calculations before you finish taking all of your data. If your experimental data are yielding reasonable agreement with the objectives of the lab then finish taking your data. If there isn't agreement then figure out what is wrong, correct the situation and start taking your data over again.
2. A lab report must meet the minimum criteria for effort, organization, neatness and thought. A report that does not meet these criteria will be returned without a grade.
3. The lab is a participatory activity. You must be actively involved in the work being done. No one will be allowed to just sit and watch without contributing.

Calculation of Percentage Error or Percentage Difference.

An important part of the analysis of any experiment is the comparison of your results with a predicted value, an accepted value or similar results measured by another method. In the case of a predicted or accepted value we use one calculation (Percentage Error) and in the case of two experimental results we would use a similar but slightly different calculation (Percentage Difference).

Percentage Error (PE)

$$PE = (\text{meas value} - \text{pred value}) * 100 / \text{pred value}$$

Percentage Difference (PD)

$$PD = (\text{meas value1} - \text{meas value2}) * 200 / (\text{meas value1} + \text{meas value2})$$

The modification of the Percentage Error formula by replacing the “pred value” in the denomination by the average of “meas value1” and “meas value2” prevents a biasing of the calculation. This is done since neither “meas value1” or “meas value2” is considered apriori to be more accurate than the other. A common practice of dividing the difference by the larger of the two measured values would under estimate the value of the Percentage Difference. Hence, the use of the average value in the denominator.