Writing Lab Reports for 1101/1125/1225 Labs

The lab reports for 1101, 1125, and 1225 courses consist of following sections: Headings, Purpose, Apparatus, Data, Calculations, Uncertainty Analysis, Conclusions, and Discussions.

Lab report should be written on loose paper and then stapled like an article. If possible, you may use computer printouts. When written by hand, follow the guideline “write with pen, draw with pencil”. To respect the integrity of scientific writing, white-out and erasable pen are strictly forbidden in lab reports. We reserve the right to run an eraser through the whole report before marking.

Below is a description of the sections in a typical lab report.

Prelab

Some labs have a prelab assignment that is available online. Print it out or copy it to blank pages, finish it and bring it to the lab. When handing in the report, attach the prelab to the end of your report.

Headings

Your lab report starts with the experiment title, your name and your partner’s name, your course and section number, desk number, and the date.

Purpose

State the purpose of the lab in one or two sentences. You should keep in mind the purpose throughout the lab, and answer the purpose in the “Conclusions” section.

Apparatus

List all the apparatus used along with the identifying numbers. Draw a schematic diagram of the apparatus if it can help people to understand the setup. The main idea of this section is to provide information for other people to reproduce your experiment.

Data

Treat data as the most valuable part of your entire report. Make sure that:

- The meaning of each piece of data is clear.
- Data must have units. The unit should be the one used by the measuring device.
- Data must have uncertainties, with same decimal places as the readings themselves. It is good practice to briefly explain how you decided on the uncertainty.

Group data logically, and use tables to help you organize the data.

Calculations

Here you calculate the results from the raw data. The steps are:

- Do any necessary unit conversions.
- Write down the equation in symbols that calculates the result from the raw data. Usually this equation is given. If not, you may have to derive it.
- Substitute in the numerical values with the units, and calculate the numerical result.

At this stage, since you do not know the uncertainty of the result yet, you do not know how many digits you should keep for the result. Keep at least 5 non-zero digits when you truncate a number from your calculator.

Uncertainty Analysis

In this section, you calculate the absolute and percentage uncertainties of the result. Usually you do this by "Uncertainty propagation" (see links for rules and examples below). Occasionally your final result is an average of multiple results. In this case, you can use the scatter—the maximum value minus the minimum value divided by two—as the uncertainty of the result.

For uncertainty propagation rules and examples, see

- http://www.langaraphysics.com/propagationrules.pdf
- http://www.langaraphysics.com/propagationexamples.pdf.

Conclusion

Your conclusion must answer the purpose of the lab. Write in a sentence and avoid the use of any symbols. Report the final result with significant digits and proper units. Use scientific notation for very large or very small numbers. For example:

"The density of metal cylinder #13 was found to be $(2.80 \pm 0.06)\times10^3$ kg/m^3 (±2%)."

Pay attention to the format of the result in conclusion. Both the absolute and percentage uncertainty should be included. The absolute uncertainty is kept to 1 or 2 significant digits, and the value itself must end in the decimal place as the uncertainty. The percentage uncertainty is shown to the nearest integer percent or to 1 sig fig if it is less than 1%.

Discussion

A lab report is incomplete without the "Discussions" section to properly interpret the results.

First, you discuss if your result agrees with the reference value within the uncertainties. If you have measured same quantity in two different ways, compare these two results. Remember that two values agree within uncertainty if the ranges that they cover overlap.
(see http://www.langaraphysics.com/measurementsadvanced.pdf for details)

An ideal experiment will have agreement with the reference value, small uncertainty, and a few negligible systematic effects (physical factors that have been ignored in the experiment, but may affect the accuracy of your result). However, don't be discouraged if that is not the case for you. Many discoveries in physics were made from “unsuccessful experiments” that yielded surprising and unpredicted results. Nonetheless, thoughtful reflection is required in either case.

If your result does not agree with the reference value, the first thing to do is to verify that all your calculations have been done correctly. If you are confident of your calculations, it is possible that there are significant systematic effects due to the difference between the way you conducted the experiment and the way the system have been modelled by the physics formula used. Most real-life systems have to be simplified with certain assumptions in order to work with our physical model. Think about what assumptions have been made in your experiment and question if any of them have been violated. Discuss what effects these differences may have on your results. Be specific, for example:

- instead of just saying “air resistance”, say “as the ball flew through the air, the air resistance, which we ignored in our calculation, would reduce the speed of the ball over time, making it smaller than our expected speed, so the ball may land closer than where we had predicted.”
- note that a particular piece of data having a large uncertainty is not a valid reason for disagreement, as the uncertainty is accounted for in your uncertainty propagation.

If your result agrees with the reference value, there is still room for improvement in reducing the uncertainty of the result. First, think about which factor contributes most to the final uncertainty by considering the percentage uncertainty of each data point and how these uncertainties propagated through. Then, target your suggested improvement to the major source of this uncertainty. For example:

- if your ball bounce height position data has a large uncertainty because you have to measure while the ball is moving very fast, switching to a ruler with more precise markings is not going to help, whereas using a slow motion camera to record and review the bounce may help.

General Formatting

Above, we introduced how to write each section of the lab report. Some labs contain a combination of more than one problem. If that is the case, you may want to finish all sections of Problem 1 before starting Problem 2. However, depending on how closely the two problems are related, you may combine the purpose, the conclusions and discussions.

A final hint of writing good lab report: when writing a report, make it “reader-friendly”! For example, simple explanations like “see graph for calculations” will greatly help the readers.