WRITING A FORMAL LAB REPORT

Introduction
No successful experiment is complete until a report of it is published. No matter how carefully and cleverly an experiment is conducted all the effort is in vain if no one ever learns of it. The ability to communicate the results of your investigations is a key skill that every scientist must learn. To help you develop this important skill you will be asked to write formal lab reports for some of your experiments. This type of report uses a format similar to that used in professional scientific journal articles. This handout will discuss how to write a formal lab report.

1. Characteristics of a Lab Report

1-1: Writing
The lab report is designed to be a record of your work as well as a discussion of your interpretation of the experiment and the conclusions you draw from it. You will need to write so the reader can understand not only what you did in the laboratory but also how it connects to the physics concepts. Like any other report or paper you produce you need to pay attention to how you write as well as what you write. While your reports won't be graded specifically on grammar, spelling and composition, the language of the report needs to be clear and correct.

1-2: Practical Details
All formal lab reports must be word-processed. Handwritten documents will not be accepted for the formal lab reports.

You may have graphs generated by computer during data taking in the lab. You can simply attach these to the report in the appropriate place. Data tables should be retyped in your report from your lab notes or worksheet.

1-3: Citations
If you use material from other sources you will need to cite the sources. Failure to do so is a violation of academic integrity. The most common format for citations is the APA documentation style. We will use the APA style in this class.

You can find a detailed discussion of the APA style at a number of websites:

http://owl.english.purdue.edu/owl/resource/560/01/
http://www.wooster.edu/psychology/apa-crib.html

A few examples of the APA style are given on the next page.
Citations in Text
Place the author's name and the date of publication in parenthesis separated by a comma.

- Quotations:
  The detector will be “approximately 50 times more efficient at the detection of neutron events” (Luther et. al. 2003 p. 35).

- Summary:
  J. J. Thompson measured the ratio e/m_e in 1897 (Serway & Beichner, 2000).

If you use a graph or other material prepared by one of your lab partners you need to cite this in the text (though not in your reference list). This is called a personal communication and the format is as follows:

  …as shown in the graph (J. Cobber, personal communication, January 10, 2007).

Reference List
At the end of your report you should have a list titled “References” which list all the works you have cited in the body of your report. Examples of the format for entries in the reference list are given below.

- Book:

- Report or Document:

- Webpage:

2. The Content of the Lab Report

2-1: Structure
The lab report is broken down into a series of sections each of which deal with a specific aspect of the experiment or analysis. The report should begin with a title, date and a list of lab partners. The lab report should then contain the following sections: Purpose, Theory, Apparatus, Procedure, Data and Analysis, Conclusions, and Questions.
2-2: Purpose of the Lab
The first section in your lab should discuss the purpose of the exercise. You should clearly explain the goals of the experiment. What are you trying to measure? What physics concepts or principles do you seek to test? A good purpose section is detailed and specific. If written well it can help you decide what conclusions you can draw from the experiment when it is completed.

2-3: Theory
No experiment is independent of theory. In this section you should present all the theoretical considerations you will need to analyze and interpret the data from your experiment. Discuss the physical concepts that you are using or testing in the investigation. Derive or cite all the equations you will need in the analysis. It is particularly important that you clearly state any assumptions or approximations that go into the interpretation of the experimental data.

While your textbook and other written sources are important for this section, you should listen carefully to your lab instructor when he or she presents the preparatory lecture at the beginning of the lab. If you are unclear about any of the concepts that are involved in the lab exercise you should ask before you begin acquiring data.

2-4: Apparatus
The purpose of this section is to describe the physical instruments and other devices you used in your experiment. The section should be sufficiently detailed so that another scientist could reconstruct your laboratory setup from the information you have provided.

You should sketch the apparatus, clearly labeling important features. If you are using multiple instruments be sure to indicate how they are connected. The sketches should be designed to show the key elements of the apparatus. If the positions of the various parts of the experimental setup are important make sure these can be seen from your sketch.

In addition to the sketch you should briefly describe the operation or function of each piece of equipment. Record any instrument settings and identify by brand and model number all major pieces of equipment.

Photographs of the apparatus can be used but make sure they clearly show both the particular instruments used and their connections. In most cases a clear well-labeled schematic is preferred to a photograph.

2-5: Procedure
In this section you should outline the procedure you used to conduct the experiment. It is not necessary to duplicate all the details in the lab manual but an overview of the material in the manual is required. Be sure to explain any parts of the procedure that are not detailed in the manual. You should use sufficient detail so that you could repeat the experiment a year from now using only your lab report. Pay particular attention to those parts of the procedure that you found difficult or confusing. Give advice on how to overcome difficulties or make the procedure more efficient and reliable.
2-6: Data and Analysis

The heart of your lab report is the presentation and analysis of data. It is important that the data is in an easily understood format. Numerical data should be presented in tables with clear headings for each row and column. Be sure to include appropriate units. Whenever possible measurements should be recorded with their uncertainties.

Any calculations should be presented with all the equations that are used. If you need to make a number of identical calculations on a series of numbers a single sample calculation is sufficient. Be sure to include the units in your calculations.

You will often need to graph your data. Occasionally these graphs will be generated using the software on the lab computer during the lab. Make sure you have a well-designed graph before you leave the lab. In most other cases you will need to graph your data outside of lab. You will be expected to use computer software such as MS Excel™ or Mathematica© to create the graphs. Unless otherwise stated hand-drawn graphs will not be accepted.

Graphs should have a title stating what is being plotted along with clearly labeled axes. Choose the scales so that the important features of the graph can be easily seen. Make sure the graph and the data points are large enough so that they are clear. If the computer is used to generate a “fit” line be sure that it does not obscure the actual data. Any “fit’ equations displayed on the graph should be recopied into the lab report. Computer-generated graphs can be attached to the lab report.

The data you have taken in the lab must be analyzed and interpreted. This will include extracting values from the data using theoretical equations, calculating uncertainties, and indicating trends in or properties of the data.

Error analysis is particularly important. No result is meaningful without a clear indication of its uncertainty. This uncertainty should be quantitative. “The error in the value for the acceleration due to gravity was small” is unacceptable as a measure of uncertainty. “The acceleration due to gravity was found to be 9.75 m/s² ± 4.0%” is an appropriate statement of uncertainty. Make sure you understand the distinction between mistakes, error and discrepancy. As well as the quantitative result for error you should discuss the sources of error in the experiment. Review appendix A for more details on error analysis.

Finally, this section should include a clear statement your results. This may be a single number or the confirmation (or disconfirmation) of a hypothesis. Be as detailed and specific as possible.

2-7: Conclusions

The conclusions section of your report is a brief summary of your experiment and a discussion of what you learned.

The summary should be in the form: “Our experiment measured/tested X using method Y and our results were Z.” Obviously your summary will probably take more than a single sentence but it should be no more than a paragraph or two.

The discussion should include your comments on the difficulties and successes of the experiment. Suggestions on how the experiment might be altered to give better results or explore new features of the phenomenon should be included.
2-8: Questions

If there are specific questions asked in the lab handout that you have not already addressed you should include your answers here. Please clearly indicate what questions you are answering either by writing out the questions or including the question in your answer.