Appendix A

Writing a Lab Report

A formal report will be required of each student for most experiments. However, in some experiments, you will only be required to do a piece of the report so that you can develop a sense of what the sections should include. Reports should be written as if they will be read by a fellow student with similar class experience but who did not experience this particular experiment.

The report is due by the end of the working day on Monday. (You should plan to turn it in before 4:30pm.) If you report is late, then you lose five additional points on every Thursday and Monday after the due date. Reports must be typed and can be submitted on paper or electronically. If you submit the report by email, then I will reply with a "Thank you." If you do not receive the thank-you, then you should assume that I did not receive your report.

Lab reports will be graded on clarity (which includes your overall organization, your use of paragraphs, grammar, and spelling, as well as using the technical terms correctly) as well as on scientific content. The report should contain the following sections (unless otherwise indicated for the specific lab exercise):

— Names of author *and co-experimenters*, name of experiment, date experiment was performed.

Abstract An abstract is a brief summary of your report; it will be easiest to write this after you have written everything else, but it should be placed at the beginning of the report. Although it accompanies your report, it is not considered *part of* your report and should not be referred to by any other section of the report. The abstract should only be about three sentences long (a brief summary) and is usually organized as follows: a simple statement of the objectives of the experiment, followed by a simple statement what you measured in order to achieve that objective, and ending with an indication of how successful your experiment was by citing the most important numerical results (with uncertainty). The important results are those that give evidence for your conclusion. You may also include a relevant percent difference.

The point of the abstract is to tell someone who is *already familiar* with the concept of your experiment how your specific experiment went.

Apparatus A list of the equipment used in the experiment including a description of any new or unfamiliar pieces or of unusual uses of some familiar piece. Diagrams should be given whenever it clarifies either what the equipment looks like or how it fits together to do the experiment.

Theory Although the abstract captures the essence of the concept explored by this exercise, this section should explain the underlying concepts. It should be written to an audience with the background knowledge of one of your fellow students who has been in class with you, but was unable to attend this particular lab exercise. You can treat ideas from class as familiar when you reference them, but some of these may still need an explanation to connect them to this experiment. You should begin by stating the objectives of the experiment, the principle which you are trying to verify. This might not be as simply stated as in the abstract since the goal here is to explain, rather than merely state, how it is that the principle can be proven. Once you have stated the objectives, you will *briefly* give the experiment a conceptual context by discussing the physical laws and concepts involved in reaching your objectives, by defining new terms, and by characterizing physical laws and relevant models. Equations used should be derived in order to relate the form of the equation that expresses the principle (as presented in class) to

the form of the equation that will be useful for your calculation. All variables should be identified and it is important to relate the equations used to the physical situations that they represent, while showing how measured variables can be related to the final calculated result.

The point of the theory section is to connect what we knew before the lab to what we have discovered through the lab, to introduce the reader to the important ideas that can be applied to the physical relationships, to connect how the relationships (possibly expressed via equations) might be verified by considering a particular graph, and to compare what we should see if the theory is correct to what we might see if the theory were actually different than we are proposing.

Procedure A brief outline of the experimental procedure. ***This must be in the student's own words***, not copied or even transposed from the instruction sheets or from other laboratory manuals. Apply the general ideas of the theory to justify or explain the specific steps. Note that scientific reports are generally written in the past tense, passive voice: "measurements of the half-life were made using the technique..." rather than the active voice: "we measure the half-life by..."

The points of this section are: to enable the reader to visualize which measurements were made and how they relate to the theory, to allow you to repeat the experiment at a later date, and to provide enough information that another student (who has not done the lab) to reconstruct your experiment.

Data Provide a table of measured and calculated data including uncertainties and units. Show how your calculations were performed. Whenever possible, a graphical record of the data should be given. Even if you did not measure the data in order smallest-to-largest, you should report it this way so that patterns in the data are obvious by glancing down the column.

Analysis Analyze your data based on the predictions of the Theory Section. Describe important features of the data and how they express various features of the theory, such as: Is the graph linear or quadratic? What are the slope and intercept? Is your result reasonable and consistent in the context of the theoretical expectations? Cite uncertainty or %-uncertainty as applicable. Cite %-error or %-difference as applicable. Give a *quantitative* statement of the sources of uncertainty and their effect on the results of the experiment. Explain the steps taken to minimize the uncertainties.

The point of this section is to provide the connection between the data and the theory in order to draw a conclusion in the next section.

Conclusions A brief discussion of what you can conclude *about* the initial assumptions and objectives *based on* the analysis. Reference the theory section as appropriate. Cite the relevant results from your analysis which support your conclusion. Why do these numbers support your conclusion?