PHY117N Main Handout

Spring 2005

1 Schedule

**IMPORTANT:** Come prepared for the first lab, starting the week of January 24. Read through chapter 5 of the manual, at least carefully enough to learn the basic point and purpose of the experiments. Also read this handout, especially sections 2 and 3.

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<th>Week of</th>
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<td>Mar. 7</td>
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<td>Apr. 11</td>
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<td>Apr. 18</td>
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<td>Apr. 25</td>
<td>Practical Exam</td>
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Note that the practical exam is before the usual final-exam period.

It is possible that some of the later labs in the above schedule may be slightly rearranged.
2 Ground Rules

1. The work in this lab will normally be done in groups of two. With your TA’s permission, larger groups will be allowed in exceptional circumstances. Generally you will stay with the same group from week to week, but it is possible to switch at any time if you decide it is necessary. At certain times the groups will be reshuffled and then everyone will switch.

2. You and your lab partner will work together both during the lab and outside, contributing as equally as possible to every aspect of the lab, with your joint efforts culminating in a single report, like co-authors of a research paper, for which you will each receive the same grade. Your equal participation during lab and in the preparation of the report is important in furthering your understanding of the material. It is not acceptable, for example, for you to be entering the data from the last experiment in the computer while your partner is continuing with the next experiment—you should work together on the computer and then work together on the next experiment. (If you are familiar with the computer and the graphics program but your partner isn’t, take the opportunity to teach him or her.) Although discussions about the lab with students other than your lab partner are encouraged, the communal effort on a report should not extend beyond your partner. It does happen on occasion that remarkably similar, if not identical, reports are submitted by different lab groups. This is the point at which cooperation has become cheating.

3. As long as you are both at the same station, there is no problem having a “division of labor.” For example, one person could have the responsibility of writing down data. However, if you do this you should alternate tasks from time to time—don’t let one person only write down data.

4. You should use looseleaf paper for taking data and writing your reports. When you turn your report in, all the pages must be stapled together. If you want you can print up your reports, but there is no problem with them being handwritten if they are neat. In either case, the handwritten raw data you take during the lab itself must be included.

5. Unless otherwise instructed, lab reports are due one week plus one day
after the experiment is performed. Your instructor will tell you where to turn them in. Late reports cannot be accepted!

6. As this is a lab course, attendance is mandatory and missed labs will count as zero, with the following exceptions. If you know ahead of time you are going to have to miss a lab, arrange with your instructor, if at all possible, to attend another lab the same week! However, if you cannot attend another lab, you can, with your instructor's permission, still receive partial credit if you and your usual lab partner each certify that you contributed about equally in the preparation of the report. In order to be completely excused from a lab you did not attend, you must have a verified official excuse.

7. Starting in the second session, there will be closed-book quizzes at the beginning of each period. In order to be prepared both for the quizzes and for the experiments you will perform, it is important that you read the chapter ahead of time. For the quizzes, you will typically be asked to describe the specifics of some particular experimental procedure.

8. It is your responsibility to ensure that you have made (and recorded!) all measurements necessary to be able to perform the required analyses. While every effort has been made to make the lab manual complete and self-contained, it is not intended to be a step–by–step cookbook for performing experiments.

9. There is one further thing: In this lab it will be considered a cardinal sin to move equipment from one lab table to another without the explicit permission of your instructor, and even with such permission the equipment should be returned to its original location when you have finished with it. If a piece of equipment seems not to be working, consult with your instructor. Do your best to leave your lab table at least as neat and orderly as you found it.

10. Your final raw score in this course will consist of the average of your evenly–weighted lab report grades, the uncurved grade on your laboratory final exam weighted as the equivalent of three lab reports, and the results of the lab quizzes, with all lab quizzes together weighted as 1.5 times a single lab report.

11. A curve will then be applied in converting your overall raw score to a semester letter grade.


# Lab Report Format

The original data you write down while doing your experiments will be your “raw data.” It must be in ink, and it must be initialled by your TA before you leave. The raw data will always be turned in as part of your report, included at the very end. Every measurement that the manual asks you to make should be recorded as part of your raw data.

You will have to recopy your raw data to include in the main body of your report. An exception is if the instructions call for a graph; making a graph will substitute for recopying your raw data. But in one form or another every measurement and observation the lab manual asks for will have to be included in the main body of your report.

The overall organization of your lab report should be as follows:

**Abstract**

**Data**

**Calculations**

**Discussion**

For each individual experiment

**Raw Data**

Most of our labs will include a fairly large number of individual experiments; your report should include a section for each one. Each individual section should, in general, have data, then calculations, then discussion. The data will usually be numerical, but sometimes it will consist of qualitative observations. (In the latter case, obviously there will be no calculations.)

The above should be the usual format for the various sections in your report, but specific instructions in the lab manual will occasionally make exceptions.

The raw data will be handwritten in ink, but the rest of your report can be written in ink or pencil, or it can be printed out.

**Abstract**

This is a brief and general description of the goal(s) of the experiments and the results obtained. For this purpose all parts of the lab can usually be
considered as one experiment. The abstract should not be longer than 4–5 sentences. It is intended as an introduction to the reader. As such, three questions should be addressed in general terms: What did you do? Why did you do it? What did you discover? Although the abstract is first, you should probably write it last. It may be helpful to pick out two or three individual experiments as illustrative of the rest.

Data, Calculations and Discussion

This is the main body of your report and should contain your data, your results and your interpretations/analyses of them. Sometimes the lab manual will ask you to put your data in the form of a graph. Otherwise, if there are more than two or three numbers in your data, you should put your data in the form of a table. Sometimes the calculation and discussion will include error analysis, which is described in detail in the appendix of the lab manual. In your discussion, you will answer the questions posed in the manual’s “lab report” sections. You will have to think; this is definitely not a fill-in-the-blank lab. Further, it should be understood that you are expected to write your discussion in complete sentences using proper English grammar!

The most important general guideline for a lab report is that it be accurate, complete, clear and concise. Elaborate and lengthy discussions are time consuming to write (and to read) while often adding little of substance. Thus you should always endeavor to convey the necessary information as concisely as possible, keeping in mind that a large number of words is never an acceptable substitute for clarity or thorough understanding.

Since your lab instructor is not interested in reading pages of arithmetic, include only the minimum number of arithmetic steps needed for clarity. Normally, you should do your calculations on scrap paper and transfer the results to the calculations section.

When you have to perform algebraic calculations, you should generally include enough steps to show that you know what you are doing. If the steps are highly repetitive, it is best to present a sample calculation; you can then say that the rest of your calculations were performed analogously to your sample calculation. It is more important to explain the calculations than present routine, repetitive details.

When interpreting your results, you should keep in mind the relevant errors. The lab manual (and/or your TA) will tell you when detailed error
analysis is required. A further discussion of propagation of errors is given in the appendix of the lab manual. In general all measurements have error ranges, but to save time you do not need to find error ranges unless the manual specifically asks you to do so. Sometimes a full error analysis is also required.

Tables and graphs, when required, are to be neatly and carefully drawn in accordance with the standard guidelines discussed below.

In addition to the above considerations, the general organization and clarity of the report will be reflected in its grade. Poor laboratory technique (e.g., mistreating the equipment) will be assessed a penalty of up to 20%.

4 Tabular Representation of Data

Any appreciable amount of data should be recorded in tabular form, and the tables should be so constructed as to transmit the full informational content of the experiment in a clear form. Toward that end experience has shown the usefulness of certain principles in the construction of tables. These are:

1. Tables should be self-explanatory with title, column and row headings clearly identifying the contents. Although titles in general should be short, shortness is certainly secondary to clarity.

2. Since every measurement is made in some specific unit, the unit of measurement must be given as well as the number obtained in order to have interpretable data. Units are usually listed in column or row headings.

3. Values smaller than 1.0 should not be listed as beginning with a decimal point due to the danger of misinterpretation. A zero should precede the decimal point, as in 0.612 rather than .612.

4. Values of zero are as specific as any other numerical value and should be so listed. They should not simply be indicated as a dash or a dotted line.

5. The absence of data in a table where it might otherwise be expected is generally indicated by a dash or a dotted line.

6. Rulings in tables are to provide clarity and remove ambiguity. They should be used only if they really do serve that purpose.
5 Graphical Representation of Data

Graphs are pictorial representations of data and serve more clearly than a tabular set of numbers to illustrate the changes in a variable, a comparison of variables, or the functional relation between variables. Although the graph contains no information not in the original data, it presents the data in a more revealing and more readily understandable form. There are numerous possibilities for the graphical representation of information.

Certain general procedures are customarily observed in the construction of graphs, and these are listed below:

1. Graphs should be self-explanatory. The title should include all essential information relative to the contents of the graph, in particular the variables being graphed. Although the title should be concise, conciseness is secondary to completeness.

2. Scales selected for the quantitative representation of the variables on the horizontal and vertical axes should be such as to result in a graph of optimum clarity under the given conditions—neither clumsily large nor inadequately small. The scale factor and units of measurement are usually listed alongside of the axes.

3. Too much detail or unrelated information in a single graph can be confusing and so should be avoided. Additional graphs might sometimes be more desirable in such cases.

4. Numerical values of data are not generally included in the body of a graph.

6 Practical Exam

The practical exam will be held during the last week of classes, before the usual final-exam period. It will consist of several individual experiments that are broadly similar to various experiments performed throughout the semester. Students will work individually on the exam, with no cooperation allowed. All work, possibly including some simple calculations, will have to be turned in before leaving the room.

The practical exam grade will be weighted as the equivalent of three lab report grades.