Phys 471 – Modern Experimental Physics II

Lab Notebook Format

Obtain a Computation Notebook (bound volume with cross-hatched paper for `easy plotting') to keep your notes in. Your labs will be graded based partly on the content of this notebook, so it is important that you communicate your work effectively to the marker.

Good notebook skills will be essential to you as a practicing physicist, so it is important that you get in the habit of keeping good records early. The following requirements are designed to help you practice good scientific record-keeping skills, and to enhance your grade by communicating to the marker what you have done and how you obtained your results.

Lab Notebooks - what you write and when

You must maintain a bound laboratory notebook in which you record all observations and data, and in which preliminary calculations are performed. Do not record data on loose pieces of paper. We expect your notebook to resemble one produced by a professional scientist.

What the notebook is for:

The notebook should be structured to record the progress of the experiment. Thus, acquired, and the calculations made during the experiment are systematized by being written in the notebook, and are kept there for later use. A typical scenario might be a data-run with a machine operated by a group of 5 researchers working around the clock for two weeks. During that time, machine and experimental problems arise and are solved (or not solved), experimental details are changed, sometimes according to the experimenter's original plan but sometimes also to answer new questions posed by the data obtained. At a later time (sometimes years later), the data from this run are combined with data from other runs, final calculations are made, and a paper is submitted for publication. Months later, the paper gets returned by the journal's referee with comments requesting revisions. The revised paper the gets published. In court proceedings, the original lab notes are used as evidence.

When entries are made in the notebook

Whenever you do any work on an experiment, you should be making entries in the notebook. Often, the recollection of the exact sequence of happenings in the lab is helped by being able to tie the entry to a given day and time. Logbook entries should be jottings on your description of what the experiment is all about. The next entries should be jottings on your preliminary background reading and investigation. The book should then progress through records of your experimental set-up, should include data (which is both numbers and narrative) and calculations, and in the end evaluations and conclusions. All of these entries must be made simultaneously with the actions they describe. Thus, indications of apparatus idiosyncrasies must be written at the time the idiosyncrasies are observed, not two weeks later.

General Logbook Format

All entries must be in ink. Cross out any mistakes with a single line.

Page 1: Title, your name and contact info, and your schedule for the semester.

Page 2: Table of contents, filled in over the course of the semester as you work.

Pages 3-end: Records of the work you have done for the class. Each lab should have its own section, formatted as described below.

All pages should be sequentially numbered. Never tear any pages from your logbook.

Each page should begin with the date, and the lab number you are working on. List your lab partner's name if you worked with someone else. For example:

"Friday, Sept. 14, 2012. Steve Wozniak, Lab 1 (Lab Partner: Steve Jobs)"

Leave a small space at the end of **each page** for the lab instructor to initial and date that page.

A page from a lab notebook, dated, clearly written in ink, and initialled and dated by a colleague not directly involved in the research is recognized by patent law as proof of discovery or invention. This kind of format, including initialization and dating by a colleague, is routinely followed by national and corporate research labs.

Sections

Your report for each lab should be divided up into the following sections.

1. PRE-LAB EXERCISES AND LECTURE NOTES:

Record your answers to any pre-lab preparations and lecture notes in this section.

2. PURPOSE

Be specific and brief. A hypothetical example: "In this lab we plan to measure the rates of both charged-current and neutral-current reactions between solar neutrinos and deuterium. If we observe a difference between these two rates, that would be evidence for neutrino oscillations and, hence, a nonzero neutrino mass."

3. APPARATUS AND SETTINGS:

Sketch the apparatus, and describe the signal path where appropriate. Record every connection and setting in a clear and concise manner. This and the next section are the most important ones in your notebook. The information you record here must be complete enough and clear enough for one of your peers (i.e.

one of your classmates who has not yet done the lab you are doing) to reproduce your results just from reading your notebook.

Your lab instructor will sometimes check your work by reproducing your results based on what you write in this section, and you will only get credit for this section if he is able to reproduce your results from your notes.

4. PROCEDURES AND RAW DATA:

This is your diary. Record your actions and results as they happen.

Your data should include numbers, comments and descriptions, systematically entered (in tabular form where possible). Print out screenshots from the oscilloscopes and tape them into your notebook here as needed. Be quantitative wherever possible, and don't forget units and error bars where appropriate.

Preliminary calculations and graphs should always be made while the data are being accumulated. If you obtain unexpected results, try and find out why. Record any debugging you do. Remember that error estimates are an important part of your data!

Leave wrong results or mistakes in your lab book, crossed out with a single line.

Again, your instructor will occasionally try and reproduce your results by following your procedures as you record them in this section. Again, you will only get credit for this section if your instructor is able to reproduce the results you report from the procedures you list.

If your result is wrong, but reproducible, you will still get partial credit. Irreproducible results, even if they are right, will earn little or no credit at all.

5. ANALYSIS AND CONCLUSIONS:

If your raw data needs to be analyzed, do that here. Write one paragraph, at least, in conclusion, whether you needed to do any analysis or not.

Final calculations and graphs based on your data, preferably in tabular form where appropriate. You do not have to include detailed arithmetic, although algebraic equations, explaining how each calculated column in the table was found, are useful. Include any computer code that you use.

Did you see evidence for the effect you set out to observe? What was the value, with units and uncertainties, of the quantity you set out to measure? If your results did not agree with your expectations, as is sometimes the case, speculate on possible reasons.

Summary of how Experimental Work in Physics is Performed

1. Experiments are performed to provide critical tests of physical models, to determine the physical, properties of a system, or to constrain our knowledge of fundamental physical constants. An understanding of the underlying physical principles is needed before you can begin. Your logbook should contain sufficient background information to make clear the physics being addressed in the experiment.
2. The design of the experiment is based on the problem that is being addressed and it includes estimates of the anticipated sources of error. Your logbook should contain sufficient information to show how the planned experiment will work to answer the objectives.
3. The equipment and apparatus are selected and tested to ensure that they are appropriate for the task and that they are working properly. The logbook should contain detailed information to show how the planned experiment will work to answer the objectives.
4. The data are recorded directly into the logbook, or, if an automated acquisition system is being used, references to the data files are kept along with examples of typical data to make sure the experiment is working according to the design.
5. When you are satisfied that sufficient, good quality data have been acquired, the detailed analysis can be done, including a rigorous analysis of the errors.
6. Finally, you publish the results. In Phys 471, this means that your write a report in the form of a Physical Review Letter.

In General:

The logbook should contain a complete record of the experiment. Each entry must be long enough to allow you to fully reconstruct the experiment from the written record. Organization is essential; it is important for you to plan the work before you start in order to optimize the time spent working on it in the lab.

Taken in part from the CalTech Senior Physics lab course website.