Physics 475: Lab Requirements and Guidelines

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Winter Term 2010-11

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Lab Requirements

Here are a few guidelines for your lab book:

1. Records and description of what you have done in the lab are to be kept in a hard cover lab book, preferrably one with included graph paper.

2. The *Prelab* questions are not required unless specified. They are meant to be a refresher for some of the questions you will be dealing with.

3. Have a *Purpose*! Yes, you should write down the "Purpose" as a part of the lab but you literally should have a purpose or goal. And I don't just mean "My purpose is to do the lab." You should know prior to taking data just what it is you want to accomplish. In principle you could follow blindly follow a recipe without a title and get the correct final product but I wouldn't recommend it. Likewise without a goal in mind, that you stick to, your lab will not be coherent and unified; it won't have any purpose. You will go back to the clichéd "Our result came/did not come within experimental error" for a Conclusion.

4. Your lab book should look like a working journal. Since it is a journal it is bound to be a little messy. That is a good thing! When is it too messy? If the data should have been in a table and instead it is scrawled all over the place you should clean it up. If it is so messy that one week later you would have no idea what you did it is too messy. Slow down, leave more space, be a bit more organized. Of course the two most common problems aren't messiness. They are *I'll get the data from my partner later.* and *I'll just write it on scrap paper for now.* This year I am going to be stricter on these counts. **I will check your books before you leave the lab to make sure you have complete raw data tables written in ink. If they are not there I will consider the lab incomplete.**

5. The parts of a lab write-up I would usually expect to be included are title, partner's name, date, purpose/hypothesis, answers to prelab questions if necessary, important elements of apparatus (with a sketch/drawing as appropriate), theory, important elements of the procedure (could someone reproduce what you have done based on the lab handout and your lab book? could someone make sense of the data recorded based on what you have written down?), data tables (see above), refined/transformed data if appropriate, graphs (with labelled axes, slope values on graph, generate either by hand or with a computer but not Excel!), data/error analysis, discussion/conclusions. Conclusions should touch on your purpose, limitations, and possibly extensions/improvements of the experiment. Again if it is messy, that's fine. A few rough notes and comments add character. I sometimes use your old lab books to reproduce experiments and use data in illustrations.

6. The figures/graphs need to be of **high quality** and they can be of high quality based on my experience with these experiments. In most cases they say how the successful the experiment was or wasn't.

7. The computers in the lab are set up with "SigmaPlot" which I find easy to use. It does not calculate "max/min" slopes but you really should work on your technique for this error estimation in any case. One thing it does that is extremely handy is "Quick Transform" which allows you to make easy modifications of the raw data all at once (so you aren't doing the same step with your calculator over and over). There is also a laser printer in the lab. Please trim the graphs and paste/tape them into your book.

8. The conclusions/discussions should be there and they should be **thoughtful**. You should definitely compare your result and its uncertainty to the commonly accepted value but this by itself isn't sufficient. This section is usually where I try to determine what you learned from the lab. This is a big challenge for students but it is worth the reward.

   Here are a few additional things that you might think about:

   (a) What is the biggest limitation of the experiment? Are there easy ways to improve the experiment? Again be *thoughtful*. I don't consider another 20 hours of measurements with a reduction in error from 10% to 9% to be that fruitful but a couple of extra trials to reduce error by half is a great idea.

   (b) Don't immediately assume that the "junky" part of the experiment is the biggest source of error. For many experiments the analog meters or metre sticks do a fine job compared to the other elements.

   (c) Don't just say "reading error"! What does that mean? I think of the classic "reading error" as you try to make a measurement of the length of an object and you need to read "between the lines". If you have a rod with that is less than 100 cm in length and you use a metre stick that is marked in cm to try and make measurements to the nearest mm, then yes, there is a reading error. I would estimate 2-3 mm. But suppose the metre stick is marked in mm and you try to estimate tenths of mm. Most students blindly say the error is 0.2 mm (and this is a reading error) *but* is this the total error? Suppose the ends of the rod aren't flat? Is the metre stick really calibrated this accurately? Are you measuring exactly parallel to the rod? All of these things contribute to the error and I can think of situations where they would be bigger than 0.2 mm and reading error would be unimportant. (Using a stop watch and quoting 0.01 s is another example where the reading error is dominated by other uncertainties.)

   (d) Are there systematic errors? Usually this manifests itself as approximations you made in the theory. In a well designed experiment these effects are small compared to the other errors but they can creep in. Data that doesn't fit straight lines when it should is a sure indication of a prominent systematic error. That is one of the reasons we make plots rather than just plug a few numbers into a formula.

   (e) Just plain old mistakes. Yup, they happen. You hope to catch them before you leave the lab but if you don't try and figure out what happened and how this affects your conclusions.

9. Another thing I want you to develop is your experimental technique. These experiments usually involve several components working in concert. What do you expect from each of these sub-units? Can you test their function? Jim and I are happy to help but it doesn't

hurt for you and your partner to take a couple of minutes to think things over. It is almost always easiest to do this one piece at a time rather than just say “it doesn’t work”. There are handheld voltmeters available for testing.

Lab Handouts

This being a 4th year course they won’t be the lab handouts that you are used to. I will often describe the purpose and the goal and the various bits of equipment you need (sometimes just verbally) but I expect you to do lot more with the theory, the planning, the assembly, the analysis, and the testing. I will at least try to put some sample data and current state of the experiments on the website www.stfx.ca/people/cadams/physics475 and follow the links. There are also several labs that require work. So you may be assigned various tasks and essentially doing two or three labs concurrently. All of this is much closer to the way you would really do experiments and is entirely consistent with 4th year lab courses at other institutions (when they have them! Some places such as Dal got rid of their 4th year lab course.)

Lab Scheduling/Partners

I will put something together for this. Once we get going I will have a concrete plan but it may need to modified as various experiments work or don’t work. And I’ll pick your experimental team.

Marking

Lab book collection days and marking schemes are in the course description. I will do weighting of the labs to give the longer ones more weight. I will be a bit more forgiving with late lab books compared to assignments but YOU MUST ASK ME. I won’t consider not handing the book in reason to grant an extension. Late work will be penalized as an assignment.