Lab Report Expectations

Stony Brook Physics Labs

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1 General Information

Lab reports will consist of four parts: a Proposal section (worth 20 points), a Data Table (10 points), Analysis (60 points), and an Executive Summary (10 points). In total, each lab is worth 100 points.

Lab reports will be generally turned in either physically or on Blackboard (this is up to your TA). The "Proposal" section will be due on the day of the lab, and the rest will be due one week later (with a few exceptions - see below).

If your TA asks for the reports physically, you should have them printed out and stapled before lab. You will hand your TA two things each week: the proposal for the lab that week, and the lab report from the previous week (except the proposal, which you had already turned in).

If your TA asks for the reports digitally, then you should upload them to Blackboard each week, before lab begins. All documents should be uploaded as either a Word (.doc/.docx) or PDF (.pdf) document, so that your TA can comment on your work directly, *except* the data table, which should be uploaded as an Excel document.

Handwritten information (where necessary) can be scanned and submitted as a PDF, so even that should be submitted digitally. There is a scanner in the main library and another scanner in the physics library on C floor of the physics building. Please do *not* just take a picture of your document and submit that; it may not be accepted, at your TAs discretion!

Regardless of whether your TA asks you for physical or digital submissions, **do *not* just e-mail your TA your lab report.** Individual exceptions may occur, but as a general rule, e-mail submissions will not be accepted.

There are some exceptions to the one-week-later rule for lab submissions.

The second lab will be due 48 hours after the third lab class ends (to the mailbox for your section in A131, if submissions are physical). This enables you to make any final edits before you submit using your feedback from lab 1 (since you will only receive that feedback as of the third lab class).

Labs that would be due on the week of a midterm are due one week later; that is to say, you have two weeks to do such labs. (There are no lab classes on the week of midterms and there are no labs due, either.)

Your final lab will also be due one week after class ends, and (if physical submission) will be turned in to the mailbox for your section in A131.

2 Proposal (20 pts)

On the day of the lab, you will turn in a short proposal. You will have to read (and understand) the lab manual before class in order to write this, and one goal of this piece of writing is to demonstrate that you have adequately prepared for the lab.

Treat this as though you are asking somebody for permission to do this experiment. Perhaps you are asking a funding agency for money to buy equipment, or a boss for time allocation for a project.

You don't need to emphasize the "request" part of it, nor imagine any specific scenario, though. Those are just to give you an idea of the kind of document this is supposed to be.

Your proposal should be *short* - at most one page, unless the lab is very long (and/or your TA says otherwise). The people reading these proposals in real life don't want to have to listen to you ramble, so cut it down to the essential details!

Do not copy text from the lab manual. If you feel an image is helpful to your explanation, however, you can feel free to use it.

This part can be broken into two subsections (either explicitly or implicitly).

2.1 Goals

In this subsection of your proposal, you want to focus on the essential final results of your experiment.

What physical constant(s) are you trying to determine, at the conclusion of the lab? What laws of physics are you validating?

In short: why would I (as someone interested in funding/guiding/etc. "interesting science") want to do experiment you will be doing in this lab?

Note: this should focus on the *science* goals of the experiment, not the "teaching goals." Sure, in a particular experiment, you might be growing your understanding of Newton's second law, but your audience doesn't really care about what you're learning, just what you are doing to advance science!

Obviously, in an introductory lab, the actual experiments you will be doing won't be advancing the state of human knowledge or anything dramatic like that (and there's no need to overblow your aims in the proposal in that sense). However, verifying known results is still a part of science, as is measuring unknown quantities (like the properties of some object you have), so you may find it helpful to your writing to focus on your results in that sense.

Typically, you will have somewhere in the ballpark of 3-4 goals per experiment. Rarely (if ever) is there only one quantity we are measuring or one law we are exploring. So be sure to read the manual carefully, and identify all of them!

If you're lost, two good places to start:

First, look at the data table, and look at the cells highlighted in purple - these will tell you important final quantities you are calculating. This may not be exhaustive, but will usually give you a pretty good idea of what the lab is aiming towards, at a glance.

Second, identify any plots you are supposed to make for this lab. A plot will, in general, show a relationship between two variables (in particular, a linear plot will tell you whether the quantities are linearly related). So whenever you have a plot where you can see whether or not the relationship is linear, you are learning about how the quantities plotted on the x and y axes of the plot are related.

2.2 Methods

In this subsection of your proposal, you should summarize *how* you are going to measure the quantities or validate the laws you proposed to measure or validate in the first part.

There are two parts to understanding this, and you should thoroughly explain both.

Firstly, what is the experiment itself? What are the quantities you are directly measuring in-lab, and how are you measuring them? (This isn't nearly as extensive as a procedure, but should at least mention all the measurements taken, and highlight the most important ones.)

Secondly, how do you propose to get from the measurements you take to the quantities you *actually* want to measure? How will you determine whether the laws you want to test actually are observed to hold or not?

Keep in mind that this should be short, especially compared to what you may be used to. Again: this is a proposal, not an explanation of how to do the experiment. The "funding agency" (or similar audience) wants to make sure you have a *plan* to determine the quantity or validate the law. They don't care about (nor expect you to have worked out, necessarily) all the itty-bitty nitty-gritty details!

When explaining the second part, while equations can be a *part* of your explanation, they should not be your whole explanation. You have to highlight what to use where, at the very least. You also do not necessarily need the equations themselves - a concise summary of the steps involved (what laws to use, what plots to make and what to do with those plots) will suffice.

3 Data Table (10 pts)

You should submit a fully filled-out[1] data table (unless your TA says explicitly to neglect something). All units should be correct; incorrect units (or incorrect unit conversions) on your data table will lose you points. This should be in the standard form presented in the provided Google Doc worksheets.

[1]Note that cells filled with red are not required, so "fully filled-out" does not include those cells.

If your TA offers a place to digitally upload your data table, you should do so. If they ask for by-hand submissions, they may *also* require that you print out a data table to hand in, in which case you should do that as well.

Please do not change the format of the data table from the form given on Google Sheets (unless your TA tells you to)! If you have need of additional cells, you can feel free to use space outside of where data is already allocated, but leave the cells that are already there where they are.

4 Analysis (60 pts)

Analysis is a large number of individual parts, and the point allocation between these parts will vary from lab to lab based on what the individual labs require.

Generally, the analysis is almost all of the real physics content of the lab, thus why it is allocated a large number of points.

4.1 Calculations

For any calculation you do, you should write a sample calculation. Show how you calculated that quantity and how you propagated any relevant uncertainty.

If your TA accepts digital data table submissions, you can do your calculations in Google Sheets(/Excel/etc.) in place of sample calculations. Note that this is more involved than just writing your numbers; you actually have to use the formulas there! See the Google Sheets Basics document for more information.

The second method is recommended where available. This is *far* faster and easier if you know how to use these programs,[2] and is usually easier on your TA to grade, too.

4.2 Plots

In many labs, you will have to make a plot. This should generally be done in the PHY121/122 Plotting Tool, available from the main webpage of your course and from any manual that requires a graph.

Your graph should be able to be understood *without* reference to the main text of your report - it should explain, by itself, what it is plotting! This is primarily a matter of having an adequately descriptive title, and good axis labels.

[2] Actually, even if you don't know already, it'll still probably save you time over the course of the semester - that's how useful it is.

This is because, in practice, people who look at your work may only glance over the text and skip to the plots to see what they show, to get a quick understanding. For this reason, you need to make sure these plots tell a story almost by themselves!

To this end, your plot should always have the following features:

- **Title:** Your title should describe exactly what is plotted on both axes and the conditions under which the variables were taken. Some examples of titles of varying qualities (all for the same plot):
  - "v vs. t": Terrible. What is v? What is t?
  - "Velocity vs. time graph": still bad. Velocity of what? What does this physically represent?
  - "Velocity of a ball rolling down a hill vs. time": Generally, good. I know understand what is represented on both axes of the graph *and* can imagine the scenario under which these variables were taken. Still room for improvement.
  - "Velocity of a ball rolling down a 15° incline vs. time": Excellent. You've told me not only the quantities plotted and the scenario, but the relevant physical parameters of the scenario. This is what you should ideally be aiming for.
  - "Velocity of a 0.5cm-radius iron ball rolling down a 15° wooden incline placed in a lab on floor A of the physics building at Stony Brook after being released from rest by...": Going overboard. There is information here that is not immediately relevant to your measurement, which it prevents me from easily extracting the information I want. Some of these things might be relevant for error analysis, but they wouldn't be central features of the experiment.
- **Axis labels:** Should be descriptive of the variable you are plotting (e.g., "Velocity" rather than "v"), and should include the units of the quantity plotted. Does not require all the parameters mentioned in the title, though - these can be short. E.g.: "Velocity [m/s]"
- **Error bars:** If your data has uncertainties, you should add error bars (in x and/or y as relevant) to your plot. Make sure to select that you want to use them from the drop-downs when making your plot!

Moreover, there are some things which will usually work automatically, but you should check:

- **Data:** Check that it follows a general trend. If you have one data point that looks out-of-line, look at it, identify why, and fix it - it's probably a data entry error.

- **Error bars:** Your error bars should *at least* be smaller than the range of your data, unless there is reason to think otherwise. If your error bars are larger than this, you have probably either mispropagated or severely overestimated your uncertainties.
- **Trendline:** Look at the trendline the plotting tool makes. Does it go through (or at least, generally along with) the error bars of the points on the plot? If it does not, you should identify why.
- **Plot boundaries:** You should ensure that all your data points (with their error bars) fit *comfortably* on the plot (so: not on the very edge of the plot, etc.). This should usually work automatically, but it may require manual tweaking of the boundaries of the plot from time to time.

There is more to do if you decide to make your plot in Excel (or another spreadsheet program) instead of with the plotting tool. See the Plotting reference documents for more information about what additional modifications you need to make sure you make.

4.3 Questions

Every manual will have some number of questions at the bottom of it. Your TA will request that you answer some subset of these questions.

They may cover analysis of your data. They may be theoretical questions about the physics involved in the experiment. They may be mathematical derivations of physics used in the experiments. They may be discussions of systemic errors involved in the experiment. They may be comparisons of your numbers to other quantities of interest. They may be discussion of physics tangentially related to the experiment.

Some questions may require multiple paragraphs, and some may be answerable in a single sentence. Answers to questions should be long enough to be complete, but should not ramble.

You can feel free to simply number the answer to your questions individually, rather than attempting to integrate questions into some sort of discussion.

4.4 Other

Some labs (especially in PHY122) have other components of the analysis that are specific to that lab. These would be things like sketches of observations and the like. Individual instructions on such components will be provided with the relevant lab manual.

5 Executive Summary (10pts)

Once you have completed all of the analysis for your report, you should summarize your key results in a short write-up.

This should not include all the intermediary calculations and discussion, and should focus on your final results. Suppose that the person who is reading this doesn't care about how you did your experiment or any of the details - they only want to know what physical laws you validated and what quantities you measured.

Perhaps they are interested in using the quantity you measured for some other calculation they are doing, for instance - they want a number for "how strong is gravity" that they can cite from your report and move on.

In your proposal, you proposed a question to answer. What is the value of such-and-such constant? Does this law of physics actually hold? In your executive summary, your goal is to quickly answer all of those questions.

Thus, whenever you measure some "final" physical quantity, you should report the value you measured (*with uncertainty and units*), and mention whether it is compatible with what is expected (be it a "theoretical value" or something similar). Whenever you attempt to validate some law of physics, you should mention whether your results ultimately support the law of physics or not.

This should be a standalone document - that is to say, I should be able to read it without having read any of the rest of your report and still understand what is going on. To that end, you should begin it with a few sentences describing the experiment itself. Similarly, if there is a significant systemic error affecting your results, you may find it worth mentioning here. To reiterate, though: your focus should ultimately be on your results.

Like the proposal, this should be *at most* one page. It will often be shorter - a half a page, or even just a paragraph, depending on the length of the experiment. Again: this is not for discussing everything you did during the experiment; this is for concisely summarizing your results.