Report Guidelines:

The final report should have a length appropriate for its purpose. I expect papers of approximately **15** to **20** pages, but the actual length is greatly affected by the inclusion of drawings, etc. and ancillary materials. The *quality* of the report is *more important* than its length. **Writing a clear and organized report does not happen without significant work!** We will work on this together if needed.

Before beginning your report please carefully review the report guidelines below. Writing a good report requires knowing what you are writing about. It makes sense to draft introduction and background early in the project (it helps you define what you don't yet know) you can't write a good report without first analyzing your results and drawing meaning from them.

Note that equations are part of the prose and should be numbered and have the appropriate punctuation. Make sure ***ALL*** Figures have Figure Captions and pages are numbered. Be sure to include a discussion of ABET realistic constraints (even BA and BS Physics majors).

EPS majors make sure it is clear that you are doing engineering and make sure it is clear that you are doing engineering design: "devising a system, component, or process to meet desired needs". Make sure the "desired need" is clear.

Your report should follow the format. In general use 12-point font for text and include the following:

Title Page

a. Title of project (in 22 size font or similar) with your name.

b. Submitted for PHY 481 or 482 for partial fulfilment towards a degree of …. (BA-Physics, BS-Physics, BS-Engineering Physics (concentration in ---).

c. Date

d. List adviser(s) and, if outside physics, their departments.

Table of contents (This is super easy in both Latex and word).

Informative Abstract

a. This abstract is much longer than the typical abstracts that you write. It can be up to a maximum of **3 pages** and should be at least **1 page**. Think of it as an Executive Summary of your project. (I will send out an example of this)

b. While the abstract is the first thing read after the title, it is prepared last, after you know what you are writing about.

c. More info at the end of this document.

The **body** of your paper should be broken up into sections to show your work logically. Deviations are permitted if they serve the purpose of making your paper clear, but it is important that your writeup has a narrative flow. Think of it as a scientific story, where you explain why your project is important (with appropriate background information so that it is a self-contained document).

Introduction
The AIP Style Manual describes this section as where the reader and writer go into the huddle and discuss the limits and purpose of the paper.

a. The introduction provides necessary background information for the reader. Remember that the reader is **not just the expert mentor**. Discuss the problem and your approach in general terms and explain why it is interesting. Use the Introduction to introduce the problem you are working to solve and put it into context. Who (citations) did what important work before that needs to be discussed to put your work in context. Procedure typically follows where you give details of what you did. Remember the goal is for other scientist to reproduce your work and even to spot errors in your approach.

b. Include information on what alternative paths you might have taken and why you chose the path you took. Some of this information is appropriate for the introduction…some might work better in the body, again please think about story and flow. Include, as appropriate, a discussion of wrong paths that you took. Don't focus on mistakes but on legitimate ideas that did not workout. Do not include that you spent a week taking data with the instrument unplugged.

Theory & Calculations
Provide relevant calculations and math background. Depending on your project you can have this as a separate section or weave the information throughout the paper, as you feel appropriate.

Results & Discussion
Sometimes these sections are separate. You decide and should be dictated by your overall narrative. You may wish to interpret your results as you present them in which case you may have multiple sections, each dealing with a different phase of your project. In some cases, a separate section is devoted fully to the DATA before any analysis/interpretation is done.

Be sure to include well-labeled graphs and tables of significant data. Include error estimates where appropriate and discuss your error analysis method.

a. After all your hard work please do **not** just throw data/results at the reader. Your job is to digest and disseminate the results in a way that is understandable.

Typically, plots are better than tables of numbers, however, tables have their strengths when constructed thoughtfully (please don't give me a three-page table of all of your results, but a small table comparing a few things can be nice). Every plot, table, and/or figure needs its own title and caption.

b. Make sure any number used has the correct number of significant figures and an uncertainty. The uncertainty should be justified in the text and not just made up because it "feels right". If you need to review how to propagate uncertainty, please ask me or your project advisor. In tables, typically put measured quantities first and things you calculate next. If possible, give the equation in the table heading. Plots should (usually) have error bars.

Discussion/conclusion

a. Your results don't really speak for themselves, that remains your job. If you are trying to figure out how to write a certain paragraph and an image or figure will help you get your point across…make one!

b. Discuss what your results actually mean. Discuss the limitations of your data and your project, discuss how your result answers (or doesn't) the question(s) you introduced in the introduction. Discuss what should be done next to get better answers.

c. Before you wrap it all up with a conclusion give a discussion (about 1 to 2 pages) of realistic engineering/physics constraints that apply to your project. All Students **MUST** discuss constraints impacted by your project (e.g. economic, environmental, sustainability, manufacturability, ethical, health and safety, social, political impact, etc).

d. Where some concerns may not be obvious, discuss how they would impact if you were to move beyond prototyping (or if you had more time). Discuss these constraints with your advisor.

e. Some of these constraints may require a separate section to properly identify and fully discuss. Make the discussion significant.

f. Conclusion

References

a. You must have cited work, using proper citation format (APS and AIP format) …for example:

Let's say I want to reference this sentence, I would add a superscripted number at the end here.[1]

Then in the references section I would have:

[1] First Name Initial. Last Name/Surname, "*Article title*," Journal Title, Volume, Starting page or article number (Year).

b. I would highly recommend using Bibtex (if using Latex) or Zotero/Mendeley (if using word) and their corresponding browser/word plugins.

Appendix

You may have important information that, while it should be included, interrupts the "flow" of your narrative. You can put this information in an appendix. Could be computer code (unless the project was just about writing code) or details of a chemical procedure. I may ask for a hardcopy, but I plan to just use an electronic copy (Word or PDF).

More Regarding Informative Abstracts

The informative abstract, as its name implies, provides information from the body of the report— specifically, the key facts and conclusions. To put it another way, this type of abstract summarizes the key information from every major section in the body of the report. It is as if someone had taken a yellow marker and highlighted all the key points in the body of the report then vacuumed them up into a one- or two-page document. (Of course, then some editing and rewriting would be necessary to make the abstract readable.)

Specifically, the requirements for the informative abstract are as follows:

- Summarizes the key facts, conclusions, and other important information in the body of the report.

- Usually about 10 percent of the length of the full report: for example, an informative abstract for a 10-page report would be 1 page. This is not set in stone and can be a bit longer or shorter depending on your project and writeup.

- Summarizes the key information from each of the main sections of the report, and proportionately so (a 3-page section of a 10-page report ought to take up about 30 percent of the informative abstract).

- Phrases information in a very dense, compact way. Sentences are longer than normal and are crammed with information. The abstract tries to compact information down to that 10-percent level. It's expected that the writing in an informative abstract will be dense and heavily worded. (However, do not omit normal words such as *the*, *a*, *an*…).

- Omits introductory explanation, unless that is the focus of the main body of the report. Definitions and other background information are omitted if they are not the major focus of the report. The informative abstract is not an introduction to the subject matter of the report—and it is not an introduction!

- Omits citations for source borrowings. If you summarize information that you borrowed from other writers, you do not have to repeat the citation in the informative abstract (in other words, no brackets with source numbers and page numbers).

- Includes key statistical detail. Don't sacrifice key numerical facts to make the informative abstract brief. One expects to see numerical data in an informative abstract.

- Omits descriptive-abstract phrasing. You should not see phrasing like this: "This report presents conclusions and recommendations from a survey done on grammar-checking software." Instead, the informative abstract presents the details of those conclusions and recommendations.

- This last point is particularly important. People often confuse the kinds of writing expected in descriptive and informative abstracts. Study the difference between the informative and descriptive phrasing. More information can be found at:

    - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3732725/
    - https://www.easterbrook.ca/steve/2010/01/how-to-write-a-scientific-abstract-in-six-easy-steps/