How to Write a Formal Lab Report
AST-1022L

All lab reports should be typed (except for long derivations and graphs, which may be hand-written) and finished by the beginning of class the week following the experiment. Grading will start off fairly easy and get more strict as the semester progresses and your performance improves.

Proving that your methods are sound, your data are relevant, and conclusions you draw from said data are logical is at least as important as the data themselves. The grading criteria for your lab reports is designed to reflect this, as well as hone your critical thinking and understanding of the scientific method. And if you do enter academia in any capacity, these types of reports will be the lifeblood of your career.

The following sections should be included in every report:

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<th>Section</th>
<th>% of your Grade</th>
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<td>Introduction (in no particular order: background; purpose; physical principles and equations)</td>
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<td>Method and Materials</td>
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<td>Data, Analysis, and Discussion</td>
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<td>Conclusion (Summary)</td>
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Introduction:

All of the following 3 elements (in no specific order) must be covered in your own words.

- **Background** – briefly describe the events, observations, and/or real-world applications that make this experiment relevant, i.e. summarize the broader motivations for this research.

- **Purpose** – specify the immediate goals of the experiment: what data did you gather (or try to), how were they used, and what did you hope to learn/prove?

- **Physical Principles and Equations** – describe the basic scientific principles at play, including the equations (properly typeset if possible) involved with the physical meaning of all variables clearly defined.

If you plagiarize the lab manual (or a wiki, or anything else), I will know—I was involved in the latest revision. If you don’t understand the information provided in the manual or in class well enough to put it in your own words, you may consult me or do independent research, but if you do the latter, you must properly cite your sources.
Method and Materials:

Describe how you did the experiment such that a peer with no prior knowledge of the lab could repeat it. Again, do NOT copy the manual; put it in your own words. Include the tools and equipment used (leave basic stuff like pencils/pens, paper, and calculators implicit) and what steps you took. Think about this section like a cooking recipe (similar level of detail and specificity), but written like a short essay instead of a list. Be concise, but when in doubt, err on the side of too much detail.

Data, Analysis, and Discussion:

Present your data and analysis as neatly and comprehensively as possible. Report all quantities in the correct units to the correct number of significant figures. Include ALL of the following unless the instructor specifically tells you to omit something:

- **Typed raw data tables**, and plots if you redid them on the computer
- **Final values** (may be in the tables or incorporated into the text)
- **Error analysis** – you MUST ALWAYS list and explain at least 3 distinct sources of uncertainty inherent in your experiment. This part alone typically accounts for ~10% of your grade or more, so be specific, thorough, and realistic (e.g. don't talk about air resistance when doing photometry). Wherever possible, estimate your margins of error either in the same units as the measurements to which they apply or as percentages of some accepted or theoretical value.

Any question featuring some variation of “how well did you do?” requires either a percent error calculation or logical proof that your answer is within an acceptable range. For instance, if you're using diffraction to calculate the diameter of a pinhole and you can see that it's smaller than a millimeter but not invisible, you should be able to figure out that an acceptable answer must lie somewhere between the naked eye limit (~0.05 mm) and 1 mm. If your answers seemed wrong or counter-intuitive and you've checked your calculations, use this section to explain why you think you got those results. Whatever you do, DO NOT OMIT strange or contradictory data (cherry-picking data can and has ended careers).

Don't speculate about how you might have been careless or what mistakes you might have made. The only relevant uncertainties are those that are intrinsic to the measuring tools (aka “reading errors”) and procedures. Review slides 14 onward in http://www.astro.ufl.edu/~rlpitts/AST1022L-1_impact_craters.pdf for more information about what counts as acceptable sources of error.

- **Answers to ALL assigned questions**, especially “Your Report” questions from the lab manual. Integrate them into the analysis and discussion wherever they logically fit. Write your responses as if your reader doesn't have access to your lab manual.
- **Discussion of the physical meanings and/or implications of your results**, if not already covered in the “your report” questions.
Bear in mind: when using a calculator, you may get answers with many more non-zero digits than your inputs. It is you who must determine how many of those figures are significant and omit the rest. Rounding to the correct number of significant figures does not contribute to the uncertainty in your results because the figures you omit were invalid from the start.

_Simply writing “see worksheets” does not cut it for this section!_ Your worksheets are like class notes. You wouldn't submit your class notes sandwiched between a typed intro and conclusion as a term paper in any other class (I hope), so don't expect me to accept it either. One of the course objectives is to teach you the basics of scientific and technical communication, and part of that is learning to present your findings professionally. That's the purpose of a formal report.

**Conclusion:**
This section is where you **summarize your findings and answer any lingering questions**. Focus especially on your final values and the implications of your results.

**Original Worksheets & Plots:**

Attach all raw data sheets (the ones I initialed, even if you forgot your manual and had to hand-draw your tables), **sample calculations**, and **original plots** at the end. Ensure that your sample calculations are neatly-written and in logical order.

For your plots, make sure that your axes are correctly labeled (with the appropriate units) with the independent variable on the horizontal axis and the dependent variable on the vertical axis. If you hand-draw a plot, use a ruler to keep the axes straight and their increments regularly-spaced. Have the minima and maxima of your data in mind when labeling the scales of your axes—don't squeeze all your data into one small corner of the plot.

**Format Recommendations:**

- Put the title of the lab, your name, your section number, the name[s] of your partner[s] in any (and do something to distinguish your name from theirs), and the date the lab was performed at the top of the first page. Don't bother making a separate title page
- Number your pages, and make sure they are all stapled together securely
- Label each section and/or subsection clearly—continuous walls of text are hard to read and hard to grade.
- Use single-spaced text, 11- or 12-pt font.
- Print in duplex/double-sided mode if you can.
- Please do not add bulk to your reports by attaching the introductory and procedure pages from the lab manual.