# Writing a lab report

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An experiment is only finished when you have written up your findings, so in some sense writing your lab report is the most important step.

## 1 Contents

A lab report is a written description of your activities and findings.

- The title of the experiment.
- The date, your name, email address, and other contact information. Include the names of your lab group partners in the introduction with a description of any division of labor that occurred.
- An abstract that summarizes the objectives, methods, and principal conclusions.
- An introduction that outlines the problem you are exploring and the methods used.
- A brief description of the equipment that you used and information relevant to the experiment (time, date, personnel involved). (There is no need to quote extensively from lab handouts).
- A description of how data were acquired.
- A log or summary of observations (e.g., a table). Description of any anomalies or systematic errors that might be present in the data.
- A description of data reduction methods and algorithms. What statistical methods were used to analyze or combine the data into your final result? Describe the methods that you used to estimate the uncertainty in data.
- Comparison of the results achieved with theoretical expectations.
- Summary of conclusions.

A typical lab report should not exceed 10 pages (including tables and figures), single spaced, 12-point font. Do not use font smaller than 12 point. Please print out your reports using the duplex option so that both sides of the paper are used.

## 2 Style

Always start with an outline—you can use the one above. When you have an outline you have a map of where you are going and a way to estimate how much time and effort will be needed to finish the task. The outline will also help you figure out if you have forgotten important tasks.

- In the main body of the report show all relevant equations that you used. Equations should be labeled with equation numbers so that you can refer to them in the text. If you quote an equation without derivation, cite the reference. Equations are part of sentences. Use equations as you present the explanation of what you did. Ideally, when you include an equation, the text preceding and following it will explain in words what the equation means. As equations are part of sentences they need punctuation, for example, if an equation ends a sentence put a period after it. The text preceding and following an equation should always define any new symbolic quantities used in the equation.

- State the principal results, both the intermediate ones and the final ones. Results are not, just in a table of numbers—describe the results in the text. Although a table may contain the actual results, the reader will need help interpreting these results—hence the need for a description. We don't just want the answer: we want to see how you got there! You are writing for a critical (but not antagonistic) reader. You need to convince the reader that at each step that you have done the right thing. Finally, never quote a number with out stating the uncertainty and the units.

- Figures and tables must be clearly labeled with axis labels and each should have a text caption, which is a brief description of what it is about. A figure or table important enough to include in the report should be discussed and referred to by figure number in the body of the report. Figures and tables that are not mentioned in the text will be ignored.

- It is preferable to do all figure labeling in IDL, but not required. It is better to have a graph labeled by hand than not at all. You will find it faster and more accurate if you learn how to do this on the computer. Use the `PLOT` options `TITLE`, `XTITLE` and `YTITLE`, and label plots with `XYOUTS, ANNOTATE`, or `LEGEND`.

- Put tables and graphs in the text close to where they are referenced instead of attaching them at the end. This way it is easier to cross reference the discussion with the data.

- Use the spell checker (there is one integrated into emacs under the TOOLS menu)!

- Clarity, conventional spelling, and good grammar counts. If you can't explain what you have done clearly it probably means that you don't understand it either—and you certainly won't convince anyone else that you know what you are talking about. Read what your write!

- Get your lab partners to read it too. Don't be proud. Remember, you are not just writing for yourself.

- Use bullets sparingly—save them for making important points.

# 3 Writing the report

A blank page can be very intimidating. Here are some ideas to help you get started and follow through to a satisfying conclusion.

- A lab report is a narrative describing your activities. In most writing style is an important consideration. In scientific writing clarity trumps style. The clearer your report, the easier it will be for the reader to understand and follow your logic and writing. Some tips for clear writing include:

- Think before you write! Clear thinking precedes clear writing. The clearer the ideas are in your head, the clearer they will be on the page. Thinking through your report should leave you with a solid understanding of what you want to say.

- Make an outline. Set out your thoughts in a structure to organize and direct the logical flow. While you may or may not follow this outline exactly or even use it as you write, thinking through the structure and logic of your report will help focus your writing and lead to clearer text. The first outline does not have to be complete—you can refine and expand it as you proceed.

- Be explicit. A lab report is not a drama or a mystery where the story is resolved at the end. Never assume that the reader knows what you mean or where you are going. State your objectives and methods early on.

- Keep it simple. Write to express, not to impress! This often means writing in short, simple sentences using simple language. When possible, write short paragraphs that begin with informative topic sentences that tell the reader what you are going to do in the paragraph. Use simple verbs and place them next to their subjects. If possible, eliminate complex clauses or language that may be ambiguous. Use subsections to delineate your direction and purpose.

- Brevity enhances clarity. Try to convey the maximum information in the minimum number of words. Avoid wordiness—eliminate unnecessary determiners and modifiers; change phrases into single words; change unnecessary that, who, and which clauses into phrases; use active rather than passive verbs; replace circumlocutions with direct expressions. Watch out for weasel words and phrases, e.g., “it is known that…”, “experience shows …”. You can find examples at:

  http://owl.english.purdue.edu/handouts/general/gl_concise.html

  These techniques help eliminate wordiness, and give you more room to convey important information.

- Focus on content. Don't worry about format (fonts, font size, justification, etc.). LaTeX helps you to focus on the text not the appearance.

- Seek criticism! Talk about your ideas with others at different stages of writing your report. Get your roommate, lab partner, TA, professor, friend, sibling, or parent, to read your work. Read what you write. Remember, you should be your own severest critic. Finish your lab report a day early (!) and then reread at least eight hours later.

The most enjoyable way to learn about clear writing is to read those who practice it well. Here are some examples: Carl Sagan: “Cosmos”; “Demon Haunted World”; “Pale Blue Dot”. Sagan is one of the best science writers. John McPhee: “Assembling California". McPhee writes on many topics, but his essays and books on geology are superb. “Assembling California” should be required reading for anyone living in the state. Other science writers to watch out for are Timothy Ferris, Richard Dawkins (“The Selfish Gene”; “The Blind Watchmaker”), Peter Galison (“Einstein's Clocks, Poincare’s Maps”), Stephen Jay Gould (“Wonderful Life”).

# 4 Collaboration & cooperation

Collaboration is an essential aspect of lab work. Working together is an effective way of learning. However, when it comes to writing your report and presenting your data, this must be an individual effort. You can and should discuss getting data and understanding it. But the act of presenting it must be your own effort. It's all too easy to cut and paste text and figures from one report to another. Such activities will not be tolerated from either party. If you include a figure or plot generated by another student you must give credit to the source in the figure caption. Presentation of figures from other students should only be used for the purpose of comparison with you own work.