

Saeta's Rules for Writing Technical Reports

An important goal of this course is to help you learn how to express experimental observations and findings precisely and concisely. You practice this each time you write the summary section of a lab write-up. The technical report represents an extension of this activity and helps familiarize you with the format of a typical paper. The structure and requirements of the report are discussed in Appendix A of your laboratory manual. I strongly encourage you to make an appointment to go over your draft with a member of the Writing Center staff.

Please read Appendix A carefully. Note the following:

1. The final draft should be typed (laser printed), with double-spaced lines except in the abstract. The final length should be 5–8 pages, *no more*. Please see the directions for typography below. I have prepared a template that you may use to help get the layout right. It is saved in MS Word 6 format. See the course page at www.physics.hmc.edu/courses/p28/ to download a copy.
2. Writing a technical report is a **challenging** exercise. Most of us write with difficulty and take many practice attempts to get the final product in acceptable form. Do not be alarmed. This is perfectly normal. It merely means that thinking carefully is hard.
3. Many journals or technical digests limit the length of abstracts. The CLEO (Conference on Lasers and Electro-Optics) digest requires 25 words or fewer. One hundred words is generous, but you must still work hard to state clearly the essential points and no more. **Be as quantitative as possible.**
4. Most people think that scientists don't know how to write. Here's your chance to strut your stuff! **Your mission is to present a clear and convincing case for your results and conclusions.**

Contents and Form

Your purposes are:

1. to entice the reader to continue beyond your title and abstract to read the entire paper;
2. to provide appropriate historical and technical background to motivate the experiment you conducted;
3. to explain clearly the relevant procedural issues and results;
4. to summarize key experimental findings in figures (and occasionally in tables);
5. and to provide as quantitative conclusions of your findings as you can.

Strategy

Perhaps a useful way to write your paper is to prepare first the figure that summarizes your results (graphs and diagrams are both called *figures* in technical papers). Let's say you are writing about the pendulum experiment. You will likely have two figures to think about: amplitude dependence and length dependence. Let's just think about the length dependence figure for the moment. Your figure should show the data with errors and the fitted curve. You may also wish to add residuals $[y_i - f(x_i)]$ with error bars on a second y -axis to your plot, or make a separate residual plot. In this expression, $f(x)$ is the fit function. Plotting residuals zooms in on the agreement (or disagreement) between your data and the theory. Do not put all the fit information on the plot, but copy it down. You'll put it in the figure caption.

Now that you have a nice figure and you have analyzed your data, your goal is to write the introduction, theory, experiment, and results sections that provide the background we need to understand your figure. At the end, you write a conclusion that shows what your result(s) mean in the grand scheme of things. Finally, write a brief, tight, quantitative abstract that summarizes the most important point (or points) of the paper.

Pitfalls

- Avoid imprecise, vague, or unclear language. Carefully define your terms and use them consistently. Avoid jargon and excessive abbreviations.
- Do not fail to tell a story. Organize your information so that the narrative proceeds smoothly and logically.
- Do not repeat every sordid detail from a lab diary; report the logically crucial ones.
- Use SI units unless there is a compelling reason not to. That is, use μm or nm , but not \AA .
- Do not distort unpleasant realities; call it like it is. Don't attempt to cover up flaws in your data; do explain departures from theory when you can.
- Figures are used much more frequently than tables to display data. A well-made graph speaks volumes.

Typography

- A) Algebraic symbols (variables and constants) should be *italicized*. $E = mc^2$, not $E = mc^2$.
- B) Subscripts are *italicized* when they refer to symbols, but roman when they are words

$$B_{\text{bar}} = B_n \tan \tag{1}$$

- C) Vectors are written in **boldface** (usually not italicized), but their magnitude is set in *italics*. Functions such as sine are *not italicized*.

$$\begin{aligned} &= \mathbf{M} \times \mathbf{B} \quad \text{or} \quad = \mathbf{M} \times \mathbf{B} \\ &= MB \sin \end{aligned} \tag{2}$$

- D) Refer to the second figure as “Fig. 2”. Write out “Figure 2” if this starts the sentence.
- E) Figures should have informative captions. Most people “read” a paper by looking at the title, abstract, and figures. By making the figures clear and the captions informative, you increase your chances of getting the reader to read the text.
- F) Number pages.
- G) Do not underline. Book titles should be *italicized*. Volume numbers should appear in **bold**. Example: D. Quayle, *J. Irrepro. Res.* **21**, 1234 (1996). [Note that “1234” is the page number of the article.]
- H) Get your symbols for units right: “Hz” not “hz”, “ Ω ” not “Ohm”, “ $^\circ$ ” not “degree”. Note: units are not pluralized: don't use “secs”, “hrs”, etc. **Never ever** screw up the capitalization of SI prefixes: there's a crucial difference between MHz and mHz.
- I) Abbreviations (e.g., RLC, rms, etc.) must be defined when first used (except in a title, where they should usually be avoided).
- J) A number and the unit that modifies it should be separated by a space (e.g., 50.1 Hz, not 50.1Hz). The space should be a hyphen when the number-unit phrase functions as an adjective before the verb (e.g., A 50-Hz signal was applied across points A and B).
- K) On the Macintosh, you can get a multiplication sign by typing *option-y* in Symbol font. In MS Word for Windows, you can use the Insert Symbol command to get the appropriate sign. I imagine there's a similar command in Word Perfect, but if you use that package you'll have to find it yourself.

- L) If you use superscripts as end note markers, they should appear after the punctuation mark (e.g., ... is given by the Biot-Savart law.¹) If you use numbers in brackets, they go before (... is given by the Biot-Savart Law [1].).
- M) Do not start a sentence with a symbol.
- N) Doan forget two speel cheq. And prufreed. Swapping papers with a friend for proofreading is really helpful.

Style

- O) In *The Elements of Style*, Strunk and White suggest using the active voice as much as possible. This is a worthy goal in scientific writing, but often the role of the investigator is irrelevant to the topic at hand. Let me illustrate. Compare the following descriptions:

By running a current through a coil of wire, we can produce a magnetic field which will deflect the needle of a compass. When we have done this, we can take a bar magnet and position it such that the needle is no longer deflected. Once this has been done, we need only to measure the distance from the needle's center to the magnet. Using this and the properties we have already measured from the magnet and the coils, we can calculate the current through the loop. Because we only took measurements of mass, length, and time we have determined a value for current not based on any other electrical or magnetic quantities.

Hans Christian Oersted discovered in 1820 that a current flowing in a wire generates a magnetic field proportional to the current.¹ By comparing this field to that produced by a calibrated permanent magnet, and by using a geometry in which the constant of proportionality between field and current can be readily calculated, it is possible to measure the current—an *electrical* quantity—by measuring only the *mechanical* quantities mass, length, and time. K. F. Gauss first proposed a technique for making such an absolute determination of current in 1823.² We report here a modification of his technique which yields current measurements having an accuracy of 1%.

In my opinion, the use of the first person in the first paragraph does not add useful information; rather, it detracts from the message that these phenomena exist independent of the observer. The second paragraph uses some active voice and some passive voice, throws in some historical information, and keeps the discussion conceptual, as befits an introduction.

Make no mistake: good writing of any kind, whether technical or not, requires practice and a willingness to rewrite. Simply put, **it's hard!**

- P) Think carefully about how to display your data to fullest advantage. Figures are used *much more frequently* than tables in scientific publications, but sometimes a table is just right.
- Q) An abstract should be as informative and quantitative as possible. It should summarize the important finding(s) of your work. An example:

The speed at which light propagates through air at standard temperature and pressure was studied using a time-of-flight technique. A value of $(2.995 \pm 0.003) \times 10^8$ m/s was obtained, with the dominant error arising from the bandwidth of the oscilloscope used to observe the light pulses. This value is consistent with literature values for c and the refractive index of air.

References

- R) Do not refer to unpublished materials such as Prof. Sparks's lab manual. When citing a book such as HRK, include the appropriate page range. To refer to a different page or section of a previously cited reference, modify the following template:
 - 3 Ref. 1, p. 473. [*ibid.* and *op. cit.* are almost never used in scientific publications]
- S) You should cite any material you reference.
- T) **Do not scan someone else's figure.**

Proofing Marks

- stet. Latin for "let it stand." Leave as it was (I screwed up and marked something and then decided to "unmark" it).
- awk. Awkward—rewrite the sentence or paragraph
- it. *italics*

Figures

A sample figure with caption is shown below. Please adhere to its conventions (framed plot area, mirrored tick marks, etc.) For help in preparing such graphs, please see one of the following web pages:

<http://www.physics.hmc.edu/howto/kaleidagraph.html>
<http://www.physics.hmc.edu/howto/origin35.html>

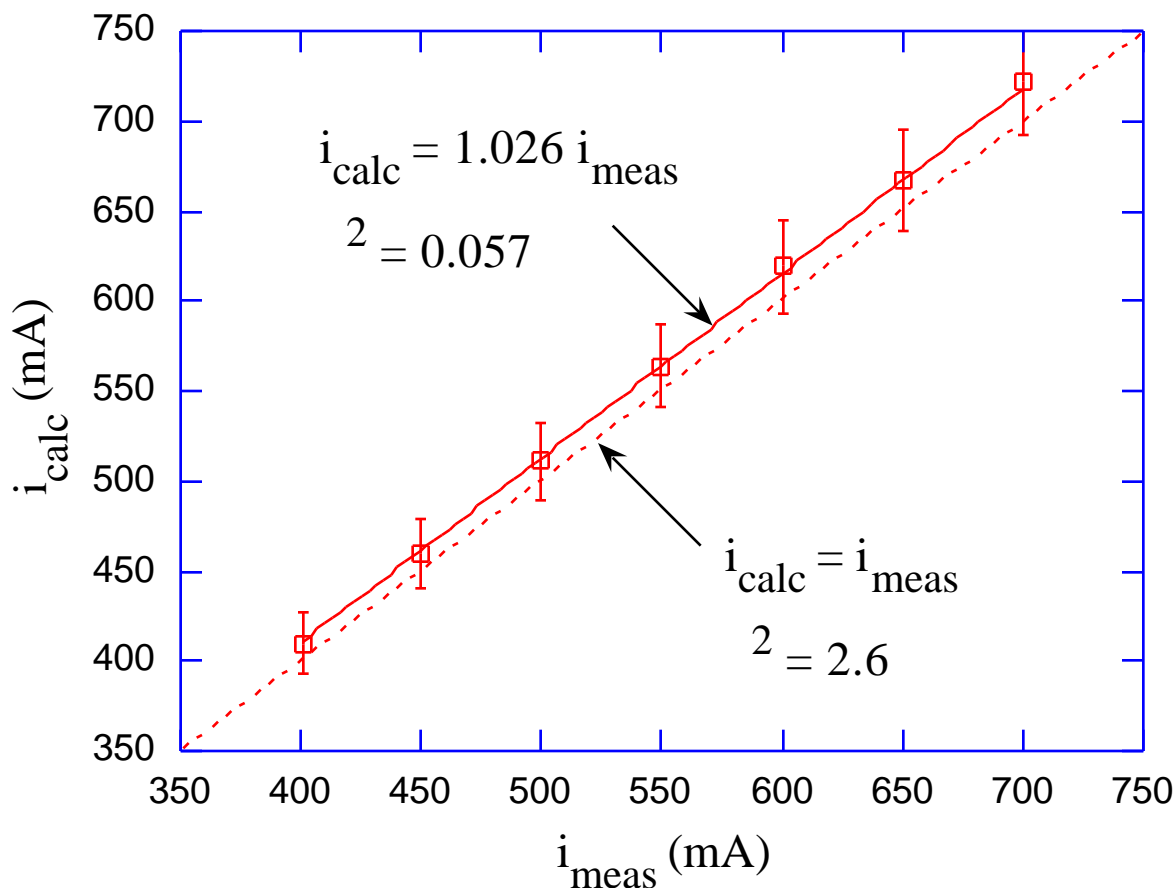


Fig. 1 Comparison of the current calculated from Eq. (2) to the measured current. The solid line shows a least-squares fit to a line passing through the origin. The excellent linearity suggests a systematic error in the measurement of about 2.6%. The small value of χ^2 strongly suggests that the uncertainties in the data have been overestimated. The dashed line shows the expected relation $i_{\text{calc}} = i_{\text{meas}}$, which fits notably less well.

If you use Kaleidagraph to prepare your graphs, enable the Postscript option when you copy the graph to the clipboard for pasting into your document.