About Those Lab Reports: A Guide to Formatting

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Abstract

This is where you should write a quick summary of your experiment and most interesting results. In the real world, the **Abstract** (and probably **Conclusions** too) will often be the only section people read so it's important to make it concise and pack a powerful scientific punch. Think of it as a trailer full of spoilers for a movie so incredibly awesome that you still want to pay money to see the whole thing. If you have numerical results it's a good idea to include them.

As an example, here is the abstract from Idle (2005):

> *The typical spices used in winter include nutmeg, cinnamon, clove and anise. These spices contain two groups of chemicals, the allylbenzenes and their isomers, the propenylbenzenes. It was suggested 40 years ago by Alexander Shulgin that these substances act as metabolic precursors of amphetamines. The biotransformation of these precursors to nitrogen-containing metabolites is reviewed. These reactions have not been reported in humans. Whether or not the pharmacology and toxicology of spices such as nutmeg can be explained on the basis of their allylbenzene or propenylbenzene content is speculative. Humans may be exposed to amphetamines derived from these precursors in forno, the formation during baking and cooking, for example in the preparation of Lebkuchen, or Christmas gingerbread. It is possible that this may be responsible, in part, for uplifting our mood in winter. However, the role of these aromatic substances, acting simply as odours, evoking old memories of winters past, cannot be ignored. Whether spices have a true pharmacological effect or they act as aromatherapy remains to be elucidated through clinical and laboratory studies.*

1 Theory/Introduction

In this section you want to summarize the history of the field that motivated your particular experiment and explain the basic theory you use to design the procedure and interpret the results. Include references where appropriate.

As an example, here is the introduction from Goldstein et al. (2012):

> *One of the most familiar features of a bundle of hair such as a ponytail is its 'body' or 'volume.' Close examination reveals that this property arises in a subtle way from the stiffness and shapes of the individual fibers, whose meandering paths through the bundle produce many collisions with other hairs. These meanderings are in part a consequence of the contacts themselves, but hairs also have an intrinsic waviness or curliness. Such curvatures may be generated during growth, and vary with ethnicity. They are clearly also modied by chemical, thermal, and mechanical forces, as in the 'water wave' treatment, or a 'perm'. From Leonardo to the Brothers Grimm our fascination with hair has endured in art and science. Yet, we still do not have an answer to perhaps the simplest question that captures the competing eects of lament elasticity, gravity, and mutual interactions: What is the shape of a ponytail? Note that the average human has 10^5 head hairs, so if even a modest fraction is gathered into a ponytail, the number involved is enormous: this is a problem in statistical physics.*

At this point, you might want to include equations to clearly explain the theory behind your procedure. Later in their paper, Goldstein et al. (2012) describe the equation of state (EOS)[1] of the ponytail using their proposed definition of the energy of an axisymmetric bundle of hair fibers:

$$\varepsilon\left[\rho, \mathbf{t}\right] = d^3\mathbf{r}\rho\left(\frac{1}{2}A\kappa^2 + \varphi(\mathbf{r}) + \langle u\rangle\right), \tag{1}$$

where $\kappa = |(\mathbf{t}\cdot\nabla)\,\mathbf{t}|$ is the curvature field. The terms in Eqn. 1 are the elastic energy of mean curvature, the bending modulus A, the external (e.g. gravitational) potential φ, and a fiber connement energy per unit length $\langle u\rangle$ that aggregates all terms involving disorder, such as contacts and natural curvatures.

[1] It's fine if you use abbreviations or initialisms in your document as long as you define them the first time they're used.

Item	Known Occurences
Hat	1
Everyday sock	3
Pair of soccer socks	1
Wrapped granola bar	1
Dirty Kleenex	600
Stick	300
Bowl of dog food	3284
Danaerys Targaryen keychain	1
Platter of smoked salmon	1

Table 1: Stuff my dog (see Figure 1) ate.

Notice that the equation is centered, numbered and because it's part of the sentence, includes punctuation where appropriate. Most word processors are capable of automatically dealing with equation formatting. If you want to continue in upper year science courses and beyond, you'll want to start using $\LaTeX$ to format your documents sometime soon.

2 Apparatus & Procedure

This is where you talk about what physical stuff and/or software you used in your experiment and how you used it. This section should **not** include your results. Your goal here is to explain everything thoroughly enough for a reader to know how to precisely reproduce your procedure. To accomplish this, you'll want to include every tiny detail that might be relevant while taking care to state things plainly and be as concise as possible.

Feel free to add figures or tables that enhance and clarify the explanations you provide in writing. Note that all figures and tables require a caption. These are easy to add in $\LaTeX$ and most word processors. Make sure that all figures you include get mentioned in the text.

2.1 A Subsection

You can add subsections to organize the content of your report.

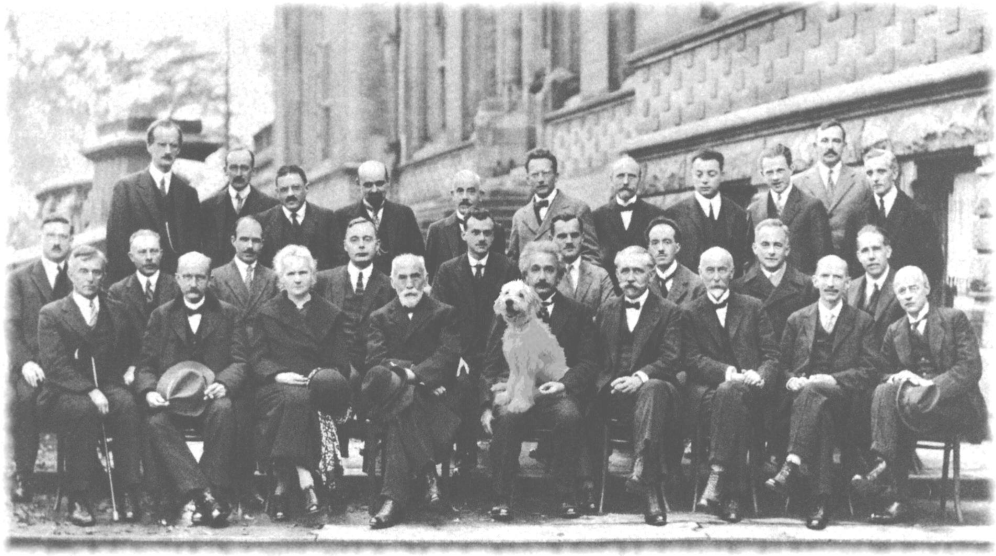

Figure 1: This is a picture of my dog, Rasalhague, attending the 1927 Solvay International Conference on Electrons and Photons. You'll probably want to include figures that show more circuit diagrams and fewer dogs, but dogs are always welcome.

3 Data & Analysis

Now that you've described the finicky details of your procedure, it's time to talk about the data it yielded and what you did with them. Describe any statistical methods you used to understand your data and state all of your numerical results. Show off all the plots you made with figures, as described in Section 2. You can always refer to things you've labelled in the document, like Fig. 1, Equation 1, and Table 1.

The PHYS 2400 lab manual includes specific Analysis Questions throughout. They should serve as prompts for things that you'll definitely want to touch on as you explain your analysis and results (some of these points might belong in the Results and Discussion section, you can go ahead and put them there if it feels right.) These points should come up organically as you write, but I'm sure Sam will appreciate if you point out places where you're answering a question posed in the manual using footnotes[2].

[2] This is a footnote. It's easy to format using LaTeX or your WYSIWYG word processor of choice.

4 Results & Discussion

Here, you need to summarize the results of your analysis and interpret them. Is there anything weird going on? Talk about how accurate your results are and what you could do to improve accuracy and minimize uncertainty. Discuss the implications of what you've found on the field and what should be considered next, science-wise, to advance the state of human knowledge, explore the phenomenon more deeply etc.

5 Conclusions

Like I said in the Abstract, there's a good chance that this is one of the only things people might read (fortunately for you, we'll pore over every word of your lab reports in order to grade you fairly) so you need to make it count! Summarize your important results (again), figure out what final conclusions you can draw from them and how these conclusions fit into the related science that's been done by other people (and maybe you!)

Science Achieved.

References

Goldstein, R. E., Warren, P. B., & Ball, R. C. 2012, Physical Review Letters, 108, 078101

Idle, J. R. 2005, Prague Med Rep, 106, 27

Appendices

A Sample Calculations

Here, we'll want to see examples of all the non-trivial calculations you made during the lab and derivations used to propagate uncertainties.