Preparing a Manuscript for Publication

Brad Conrad,[1, a)] Rexford Adelberger,[2] and Will Slaton[3, b)]

[1]*Society of Physics Students, American Institute of Physics (AIP), College Park, MD 20782, USA*
[2]*Department of Physics, Guilford College, Greenboro, NC 27410, USA (formerly)*
[3]*Department of Physics and Astronomy, University of Central Arkanas, Conway, AR 72035, USA*

[a)]*Corresponding author: bconrad@aip.org*
[b)]*wvslaton@uca.edu*

Abstract. Scientific manuscripts are documents that focus on providing a scientific argument to a specific group. In fact, audience selection is potentially the most important decision a science communicator needs to make before preparing a manuscript for publication. This document will outline a process to draft a manuscript for the *Journal of Undergraduate Reports in Physics* (JURP), but can also be used for most publications. In this specific case, junior or senior physics majors and undergraduate professors are your primary audiences. They are knowledgeable about physics, but unlike you, they have not spent much time trying to understand the specific problem being discussed in your report.

OVERVIEW

Scientific manuscripts are documents that focus on providing a scientific argument to a specific group. In fact, audience selection is potentially the most important decision a science communicator needs to make before preparing a manuscript for publication. This document will outline a process to draft a manuscript for the *Journal of Undergraduate Reports in Physics* (JURP), but can also be used for most publications. In this specific case, junior or senior physics majors and undergraduate professors are your primary audiences. They are knowledgeable about physics, but unlike you, they have not spent much time trying to understand the specific problem being discussed in your report.

There is a big difference between the comments you write in the margin of your lab notebook and what you might write in a paper for publication in a scientific journal. Your laboratory data book is a chronological, definitive record of everything that you did. It contains all the data, what you did even if it was ultimately wrong, as well as comments as to what you were thinking at that time. A journal article is a focused summary discussion of the research question, its processes, and conclusions. Authors should avoid discussing experimental dead ends and present a clear scientific argument. The reader does not have to be able to completely reproduce the work from the journal article. Instead, the reader should be able to understand both the physics and techniques of what was done and the rationale behind why it was done.

The goal of a journal article is to announce a new finding, idea, or process. Abstracts should provide the key result as most readers will only look at titles and abstracts. By using key words and clear abstracts, potential readers locate research of interest. If, after reading an article, a reader then wants to find out the finer details of an experiment or derivation, they can contact the author of the paper for a personal in-depth conversation about the subtleties.

The general style of writing used in a physics journal is different from that of literary works. The narrative of the paper is intended to do three things: 1) present the background necessary for the reader to understand the science being reported in the paper; 2) outline the details and the implications of your work; 3) lead the reader through the work in such a way that they can clearly follow the rationale leading to your conclusions. When finished with your paper, the reader should not have to decide for themselves what you are proposing. The narrative should lead readers through your work in an unambiguous manner, telling them what to see and understand in what you did. Assist the reader with interpretation of the data and calculations. Presenting a clear interpretation of your results is the most important part of the paper.

You should take care to make sure that the material is presented in a concise and logical way. Make sure that your sentences do not have too many dependent clauses. Overly complicated or long sentences make the logic of an argument difficult to follow. You should choose a paragraph structure that focuses the attention of the reader on the development of the ideas. Paragraphs should connect to each other, as the manuscript is a focused logical argument.

SECTIONS

Abstract

An abstract is a self-contained paragraph that concisely explains what you did and presents key results. The abstract is often published separately from the body of the paper, so you cannot assume that the reader of the abstract also has a copy of the rest of the paper. You cannot refer to figures or data that are presented in the body of the paper. Since abstracts are used in literature searches, all key words that describe the paper should be included in the abstract. Be quantitative with results and keep it to less than 100 words.

Introduction

This section outlines the background necessary to introduce your results. It is not an abbreviated review of what you are going to discuss in detail later. This section should present the necessary theoretical and experimental context such that a knowledgeable colleague, who is not an expert in the field, will be able to understand the data presentation and discussion. If you are going to use a particular theoretical model to extract some information from your data, this model should be discussed in the introduction.

Where appropriate, factual information should be referenced. When presenting background information, you may guide the reader to a detailed description of a particular item with a statement such as: "A more detailed discussion of laminar flow can be found elsewhere.[1]" If you know where there is a good discussion of some item, you should not repeat it.

How one proceeds from this point depends upon whether the paper is about a theoretical study or an experiment. We will first suggest a format for papers about experimental investigations and then one that describes a theoretical derivation.

Experimental Investigations

The Experiment

This section guides the reader through the techniques and apparatus used to generate the data. Schematic diagrams of equipment and circuits are often easier to understand than prose descriptions. A statement such as "A diagram of the circuit used to measure the stopping potential is shown in Fig. 6" is better than a long set of words. It is not necessary to describe in words what is shown in a diagram unless the average reader would not be able to follow the diagram. If special experimental techniques were developed as part of this work, they should be discussed here. You should separate the discussion of the equipment used to measure something from your results. This section should not include data presentations or discussions of error analysis.

Data Presentation and Interpretation of Results

The data are the truths of your work. This section should lead the reader through the data and how errors were measured or assigned. The numerical data values should be presented in tables and figures, each with its own number and caption, e.g., "The results of the conductivity measurements are shown in Table 3." It is difficult to follow narratives when the numerical results are included as part of the narrative. Raw, unanalyzed data should not be presented in the paper. All figures and tables should be referred to by their number. Any figure or table that is not discussed in the narrative should be eliminated. Items which are not discussed have no place in a paper.

Theoretical Studies

The Model

This part should consist of a theoretical development of the constructs used to model the physical system under investigation. Equations should be on separate lines and numbered consecutively. The letters or symbols used in the equations should be identified in the narrative, e.g., “The potential can be approximated as:

$$W \approx Z - \sigma(\rho) \tag{1}$$

where Z is the number of protons and σ is the screening constant that is dependent on the charge density, ρ , of the inner electrons of the K and L shells.” If you wish to use this equation at a later time in the narrative, refer to it by its number, e.g., "The straight line fit shown in Fig. 3 indicates that Eq. (1) can be used to extract a value of..."

Calculations

This section presents a summary and discussion of the numerical results calculated from the model. The results should be presented in tables or graphs, each with a caption. A table or graph that is not discussed in the narrative should be eliminated. Data that are not interpreted by the writer have no place in a paper. Reference numerical results that are used in the calculations and come from previous work done by others.

Conclusion

In this section, briefly summarize the key result and supporting argument. Be sure to list important quantities and, if appropriate, where this research could lead in the future.

References

All references, numbered in order of appearance, are collected together at the end of the paper. Note that in most cases you do not need to include article titles. Additional formatting guidance for JURP submissions is available on the JURP website and AIP Publishing’s website. See the references for examples.[1-6]

Other Advice

Tables and Figures

Readers often scan papers by looking at the figures and data tables before they read the narrative of the work. Each table or figure should be numbered and have a descriptive caption. Take care to put enough information in the caption that the reader can get some feeling for the meaning of the data presentation. In some journals, tables and figures are placed by the layout editors at the corners of the page to make the format attractive and easy to read, so a figure may not even be on the same page as the discussion of that figure. All lines shown on graphs should be identified, e.g., "The dashed line is drawn to guide the eye" or "The solid line is a fit to the data using the Ising model."

An example of a graph of a set of data is shown in Figure 1. The graph is sized by the range of data points. The bottom left point does not have to be the origin (0, 0). Error bars must be shown with data points. A graph with all the data points clustered in one small corner and lots of white space does not help the reader get a feeling of the dependence of your data. Be careful that the figures you present are not too busy; too much information on a figure makes it difficult to pick out the important parts. Remember that figures often appear much smaller in print so make sure graph fonts are about the same size as in the narrative. Also, color plots could be more expensive to print than black and white and not convey the information any more clearly. Black filled vs empty symbols or solid vs dashed lines offer high contrast on a plot that will be reduced in size for publication. Figures should have high resolution or they may appear blurry.

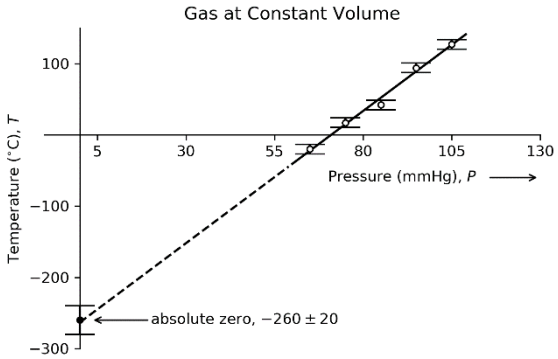

FIGURE 1. A graph of gas temperature versus pressure for an ideal gas at constant volume. The solid line drawn is the least squares fit straight line to the data. The dashed line extrapolates to the intercept, with uncertainty, denoting an estimate of absolute zero. This figure is adapted from John Taylor's *An Introduction to Error Analysis* 2nd Edition. The figure should be centered. To help stay within the space requirement consider having two figures next to each other. If figures have more than one part, each part should be labeled (a), (b), etc.

TABLE 1. Energy states found in the numerical search. The accepted values for these states are also listed.

State	Experimental *eV*	Theoretical *eV*
3S	5.15 ± 0.01	5.13
4S	1.89 ± 0.02	1.93
3P	2.96 ± 0.01	3.02

Numbers and Units

Any experimentally measured data presented in tables, such as that shown in Table 1, should include uncertainties. You should use scientific notation when presenting numbers, $(7.34 \pm 0.03) \times 10^7$ eV. Take care that you have the correct number of significant digits in your results; just because the device shows six digits, does not mean that they are significant. You should use the MKS system of units.

Style

It is often helpful to make an outline of your paper, with figures, before you write it. In this way, you can be sure that the logical development of your presentation does not resemble two octopuses fighting, but that it is linear. Often the order of your journal notebook is not the same order in which you should present the data.

One generally writes the report in the past tense. You also should use the third person. Even though you might have done the work by yourself, use "we," e.g., *"We calculated the transition probability for..."* It is often confusing when you begin sentences with conjunctions. Make sure that each sentence is a clear positive statement rather than an apology.

There are a few words or phrases you should be careful of using. ***Fact*** – This is a legal word and is generally avoided in the physics literature. ***Proof or prove*** – These words are meaningful in mathematics and you cannot prove something in physics, especially experimental physics. ***The purpose of this experiment is*** – Through background information we outline the issue we aim to solve. ***One can easily show that*** – Do not intimidate the reader. Remember that the reader of your paper is a senior in college! ***It is obvious that*** or ***One clearly can see*** – Such statements only intimidate the reader that does not find your work trivial. ***Data*** is the plural form of the noun datum, so use it as such: “The data are” or “The data show that.” ***Human error*** has no specific meaning but instead indicates an unspecified error. Errors must be quantified, not swept under a rug and remain unnamed. ***In order to*** – This phrase can usually be replaced with just the word to. ***Almost exactly*** – We do not know how can something be almost and exact at the same time.

Adhere strictly to the template and format guidelines required by the publisher of the journal. The newest JURP templates and formatting guidelines are available online.

Lastly, the journal may request that you suggest reviewers of your manuscript. Reviewers should be as unbiased as possible and knowledgeable of the area of physics you are doing. Possible reviewers are scientists that have recently published in the same or related areas of physics as your manuscript. Good reviewers will offer helpful criticism of your work to improve the manuscript. The journal editor may also offer suggestions to improve the manuscript and ultimately has the responsibility to accept or reject your manuscript or revisions for publication.

ACKNOWLEDGMENTS

This short section should acknowledge help received from others if it is not referenced in the previous sections. This is where you give credit to a colleague or someone in the machine shop who helped you build a piece of equipment. You may also include your funding source, if appropriate.

REFERENCES

References should be numbered using Arabic numerals followed by a period (.) as shown below and should follow the format in the examples. Ref. 1 is for a book. Ref. 2 is for a journal article.

1. M. P. Brown and K. Austin, *The New Physique* (Publisher Name, Publisher City, 2005), pp. 25–30.
2. M. P. Brown and K. Austin, Appl. Phys. Letters **85**, 2503–2504 (2004).
3. R. T. Wang, “Title of Chapter,” in *Classic Physiques*, edited by R. B. Hamil (Publisher Name, Publisher City, 1999), pp. 212–213.
4. C. D. Smith and E. F. Jones, “Load-cycling in cubic press,” in *Shock Compression of Condensed Matter-2001*, AIP Conference Proceedings 620, edited by M. D. Furnish *et al*. (AIP Publishing, Melville, NY, 2002), pp. 651–654.
5. B. R. Jackson and T. Pitman, U.S. Patent No. 6,345,224 (8 July 2004).
6. D. L. Davids, “Recovery effects in binary aluminum alloys,” Ph.D. thesis, Harvard University, 1998.
7. R. C. Mikkelson (private communication).