Preparing a Manuscript for Publication

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Abstract. Scientific manuscripts 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 Research in Physics and Astronomy* (JURPA) but can also be used for most publications. In this specific case, junior and senior physics majors are your primary audience. They are knowledgeable about physics, but unlike you, they have not spent much time trying to understand the specific problem discussed in your report.

INTRODUCTION

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 a scientific journal. Your laboratory data book is a chronological, definitive record of everything you did. It contains all the data and what you did, even if it was ultimately wrong, as well as comments reflecting your thoughts at that time. A journal article is a focused summary and discussion of the research question, your processes, and your conclusions. Authors should avoid discussing experimental dead ends and, instead, present a clear scientific argument. The reader does not have to be able to reproduce the work from the journal article. Instead, the reader should be able to understand the physics, techniques, and rationale behind why you did what you did.

Make sure that you present the material in a concise and logical way. Overly complicated or long sentences make the logic of an argument difficult to follow. 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 OF THE PAPER

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 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 keywords 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 colleague who is not an expert in the field can 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. If you know where there is a good discussion of some item, you do not need to repeat it. 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].”

How one proceeds from this point depends upon whether the paper is about a theoretical study or an experiment. We first suggest a format for experimental papers 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 description. It is not necessary to describe 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 and 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 and discussed in the narrative.

Theoretical Studies

The Model

This part of your paper 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 W 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. 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.

Acknowledgments

This short section should acknowledge help received from others. This is where you give credit to research advisors, colleagues, and the person in the machine shop who helped you build a piece of equipment. You may also include your funding source, if appropriate.

References

In JURPA manuscripts, reference materials should be cited in text using brackets [1]. The references, numbered in order of appearance, are collected together at the end of the paper. JURPA references should follow a modified version of the Vancouver system. References should be numbered using Arabic numerals followed by a period, as shown below, and should follow the format in the examples.

Note that you do not need to include article titles in citations for JURPA papers, and journal titles should be given in their ISO 4 standard abbreviations. Refer to authors by their first initial and last name as shown. Include all authors unless there are more than ten. In that case, list the first ten followed by "et al."

1. L. C. McDermott, Am. J. Phys. **58**, 734–742 (1990).
2. P. M. Sadler and R. H. Tai, Sci. Educ. **85**, 111–136 (2001).
3. C. D. Hoyle, D. J. Kapner, B. R. Heckel, E. G. Adelberger, J. H. Gundlach, U. Schmidt, and H. E. Swanson, Phys. Rev. D **70(4)**, 042004 (2004).
4. M. P. Brown and K. Austin, Appl. Phys. Lett. **85**, 2503–2504 (2004).

Book titles should be in italics, and both authors and editors should be acknowledged as shown. Do not forget to include the location where the book was published.

5. P. Brown and K. Austin, *The New Physique* (Publisher Name, City, State, 2005), pp. 25–30.
6. J. B. Marion, *Classical Dynamics of Particles and Systems*, 2nd ed. (Academic Press, New York, 1970).
7. J. M. Martín-Martínez, in *Adhesion Science and Engineering,* Vol. 2, edited by D. A. Dillard and A. V. Pocius (Elsevier, New York, 2002), p. 573.
8. J. Bishop, in *The Gale Encyclopedia of Science Vol. 2*, 6th ed., edited by K. H. Nemeh and J. L. Longe (Gale, Farmington Hills, MI, 2021), pp. 1182–1184.
9. R. T. Wang, in *Classic Physiques*, edited by R. B. Hamil (Publisher Name, City, State, 1999), pp. 212–213.

Additional examples are shown for reports (10–12), websites (13–15), and other sources (16–18).

10. E. R. Banilower, "2018 NSSME+: Status of High School Physics," (Horizon Research, Inc., Chapel Hill, NC, 2019).
11. M. Plisch, R. M. Goertzen, and R. Scherr, "Sustaining Programs in Physics Teacher Education: A Study of PhysTEC Supported Sites," in *Noyce Conference* (Washington, DC, 2014).
12. Texas A&M University Education Research Center, "Evaluation of 2017 Mitchell Institute Physics Enhancement Program (MIPEP) Summer Institute" (2017).
13. SpecialChem SA, *Glass transition temperature* (Omnexus, 2022). Available at https://omnexus.specialchem.com/polymer-properties/properties/glass-transition-temperature.
14. Cosmic Watch, *Catch Yourself a Muon* (2023). Available at www.cosmicwatch.lns.mit.edu/about.
15. A video demonstration of the prototype is available at https://youtu.be/GcB1Kzv6Cxo.
16. C. D. Smith and E. F. Jones, "Load-cycling in cubic press," in *Shock Compression of Condensed Matter*, AIP Conference Proceedings 620, edited by M. D. Furnish et al. (AIP Publishing, Melville, NY, 2002), pp. 651–654.
17. D. L. Davids, "Recovery effects in binary aluminum alloys," PhD thesis, Harvard University, 1998.
18. A. Cox, developer, Tracking the Coriolis Force [computer software] (Open Source Physics 2012). Available at www.compadre.org/Repository/document/ServeFile.cfm?ID=12042&DocID=2935.

FORMATTING AND STYLE

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 for the reader to get a feel 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 graph is shown in Fig. 1. The graph is sized by the range of data points. A graph with all the data points clustered in one small corner does not help the reader get a feel for the dependence of your data. Error bars must be shown with data points.

Figures 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. Be careful that the figures you present are not too busy; too much information 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. Consider how best to convey the information clearly. Filled vs empty symbols, or solid vs dashed lines, offer high contrast on a plot that may be reduced in size for publication. Figures should have high resolution or they may appear blurry.

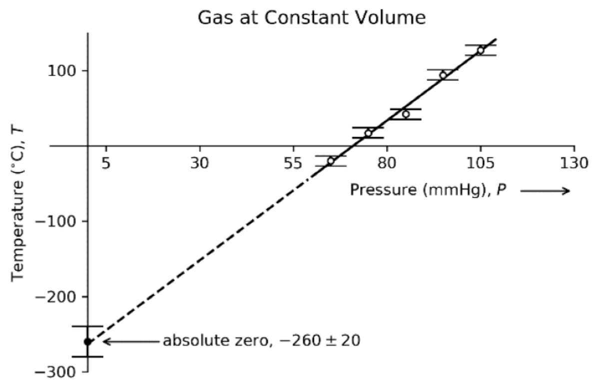

FIGURE 1. A graph of gas temperature versus pressure for an ideal gas at constant volume. The solid line drawn is the least-squares fit straight line to the data. The dashed line extrapolates to the intercept, with uncertainty, denoting an estimate of absolute zero. This figure is adapted from John Taylor's *An Introduction to Error Analysis*, 2nd edition.

Numbers and Units

Include uncertainties in any experimentally measured data presented in tables, such as in Table 1. 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. Use the MKS system of units.

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

Style

It is often helpful to outline your paper, with figures, before you write it. In this way, you can be sure that the logical development is linear and does not resemble two octopuses fighting. One generally writes the report in the past tense and uses the third person. Even though you might have done the work by yourself, use "we," e.g., "We calculated the transition probability."

There are words or phrases you should be careful of using: *Fact*—This is a legal word generally avoided in the physics literature. *Proof or prove*—These words are meaningful in mathematics, but 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*, *It is obvious that*, or *One clearly can see*—Such statements only intimidate the reader who does not find your work trivial. *The data was* or *the data shows*—Data is the plural form of the noun datum: "The data are" or "The data show that." *Human error*—This indicates an unspecified error. Errors must be quantified, not swept under a rug to remain unnamed. *In order to*—Just say "to" instead. *Almost exactly—S*omething cannot be almost and exact at the same time.

We look forward to your submission!