Electronic File Formats

- Please submit a single .pdf file containing all text, endnotes, figures, and tables. You may use any software you like to prepare this file, but to avoid extensive reworking, we strongly suggest that you use LaTeX/REVTeX or Microsoft Word, as described below. The ability to create a .pdf file is built into the Macintosh operating system and is also available in most LaTeX processors and in recent versions of MSWord.

  If you cannot convert your paper into a .pdf file, please state your reason and submit your file in .docx or .doc format in one file. Do not include multiple files.

[Microsoft Word]

If you use MSWord, you should pay especially careful attention to the detailed formatting instructions below. Do not use the "track changes" feature of MSWord. Be sure to use only the built-in MSWord equation editor, and use only standard fonts. For manuscripts that are especially short and simple, MSWord may be more convenient than LaTeX. However, for papers that contain many equations or long reference lists, LaTeX is a better alternative.

To download a Word template: click here.

[LaTeX]

If you use LaTeX, the preferred editable format is LaTeX, using the REVTeX 4.1 style. For typical articles with many equations and/or endnotes, LaTeX/REVTeX is strongly recommended because it handles most of the formatting and numbering automatically. It also handles equations extremely well, making them easy to enter and producing beautiful typeset output. LaTeX is free software, available for all major operating systems. See the LaTeX web site for links and downloading instructions. We recommend that you get a "complete TeX installation," which will include the REVTeX 4.1 style and all needed fonts, packages, and GUI tools. Alternatively, you may wish to try a cloud-based LaTeX processor such as writeLaTeX or ShareLaTeX. For a tutorial on using LaTeX, see our sample manuscript file.

Please download and study a sample manuscript file provided by American Journal of Physics (AJP). It is a tutorial and template for using LaTeX/REVTeX to prepare a manuscript for AJP. The sample file is actually a .zip archive containing a LaTeX source file, two figure files, and a finished .pdf file.

General Style

The *Style Manual* of the American Institute of Physics, 4th ed. (1990) contains a wealth of information on the preparation of manuscripts, including advice on good writing and organization; rules for punctuation, capitalization, English usage, and using mathematical expressions; and lists of standard spellings and abbreviations. Authors are strongly encouraged to download and study the *Style Manual*. Advancing technology has made some parts of this document out of date, while a few of its rules are superseded by AJP's special style conventions. Still, the *Style Manual* is the authoritative reference *unless* there is a conflict with information appearing on the AJP website, in which case the latter takes precedence.

You are encouraged to use SI units, but use of SI units is not mandatory if other units are more appropriate.

Authors are expected to word their manuscripts in a manner consistent with the fact that the physicists, students, and teachers who read AJP include both women and men.

Form

Manuscripts should be using a standard 12-point serif font such as Times New Roman. Margins of at least one inch width should be left on the top, sides, and bottom. All manuscript pages should be numbered.

Length

Authors should make every effort to be concise. Generally speaking, readership and length are inversely related. The term paper shoud consist of 1500 to 2500 words, plus equations, tables, and figures if appropriate. Longer manuscripts are discouraged.

Organization

The main elements of an AJP paper are as follows, in this order:

- Title
- Authors and affiliations
- Abstract
- Introductory section
- Main body, divided into sections and subsections as appropriate
    - Required sections: Methods, Results (data) and Analysis
- Conclusion
- Appendices, if necessary
- Acknowledgments, if necessary
- References

Please include figures and/or tables (with captions), which "float" outside the sequential order of the main text so they can be placed at the top or bottom of a final printed page. You may place each figure or table near where it is first referenced, or place all figures and captions in the end.

Abstract

The abstract should summarize the paper's contents as concisely as possible. It should make the goals of the paper clear, and state the main results or conclusions directly (not merely allude to them vaguely). The abstract should be written so that any physicist, regardless of area of specialization, can read and understand it.

Abstracts must be self-contained. They may not contain references to endnotes.

Introduction

A paper's introductory section must provide the background and context that a typical physicist, regardless of area of specialization, would need in order to understand the paper's purpose and importance. That is, it should *motivate* the paper, in a way that is both informative and inviting. Unlike the abstract, the introduction need not summarize the entire paper or state its main results. Often, however, the introduction ends with a paragraph that outlines how the rest of the paper is organized; this is especially useful for longer papers.

Equations

Mathematical symbols require special typography, such as putting letters in italics and distinguishing minus signs from hyphens. LaTeX math mode takes care of this typography automatically, but MSWord users will have to make a special effort. For all but the simplest expressions, MSWord users should use the built-in MSWord equation editor. Do not use any other equation editor, and be sure to use only standard fonts.

When an equation is important and/or tall and/or complicated, display it on a line by itself, with a number (in parentheses) at the right margin. (In LaTeX, just use the equation environment.) Every equation, whether diplayed or not, must be part of a complete sentence, with correct punctuation before and after. See the sample manuscript file for examples.

When referring to an equation by number, put the number in parentheses and abbreviate "Eq." unless it is at the beginning of a sentence: "Equation (5) follows from substituting Eqs. (2) and (3) into Eq. (4)."

Figures

Number figures in the order in which they are referred to in the text. Provide an appropriate and concise caption for each figure. When referring to a figure, abbreviate "Fig." unless it is at the beginning of a sentence: "Figure 5 shows the results of the new analysis in the same format as Fig. 4."

Tables

Number tables using Roman numerals, in the order in which they are referred to in the text. Provide an appropriate and concise caption for each table. Place each table as close as possible to the text that refers to it or move the tables to the end, after the references.

Conclusion

A concluding section is required in this term paper. A good conclusion provides additional insights—not mere repetition of what you've already said. Note that for some journal/research articles, a conclusion section is customary.

Appendices

Use appendices for material that is less interesting than the rest of the paper but still needed for completeness. Examples might include a technical proof, or a detailed description of research protocols. If there is more than one appendix, label them with capital letters A, B, and so on.

Acknowledgments

Be sure to acknowledge colleagues who contributed in a significant way to your paper.

Citations

Auxiliary author information, such as email addresses, should be listed at the beginning of the endnote section using superscripted lower-case Latin letters followed by right parentheses (e.g., $^{c)}$). Place an identical symbol immediately after the name of the author to whom the information applies. (LaTeX/REVTeX will use different symbols, which are automatically converted to the correct form during production.)

References can also appear as "online citations," for example, ". . . as shown by Eq. (5) in Ref. 3, . . . "

Format of Literature References

References to articles in periodicals should have the following form:

Freeman J. Dyson, "Feynman's proof of the Maxwell equations," Am. J. Phys. **58** (3), 209–211 (1990).

Each article reference should include the article *title* and its *beginning* (as well as ending, if available) page number. Use of the issue number is encouraged but not required unless the periodical is paginated by issue (for example, Physics Today). See the AIP *Style Manual* for a list of standard periodical abbreviations.

A reference to a book should have the following form (include page number or numbers when appropriate):

David J. Griffiths, *Introduction to Electrodynamics*, 2nd edition (Prentice Hall, Englewood Cliffs, NJ, 1989), pp. 331–334.

Example of an article in an edited volume:

M. R. Flannery, "Elastic scattering," in *Atomic, Molecular, and Optical Physics Handbook,* edited by G. W. F. Drake (AIP Press, New York, 1996), p. 520.

In all book and article references, pay special attention to the use and placement of punctuation. Note that article titles are in quotes, while book titles are in italics. List authors' names in the format "Bradley W. Carroll and Dale A. Ostlie" when there are two authors, or "Harvey Gould, Jan Tobochnik, and Wolfgang Christian" when there are three or more. If there are four or more authors you may use the form "William H. Press *et al.*"

References to online material should include a brief description and/or title and the URL enclosed in angle brackets:

For a reference to material that has not been published in print or online, provide as much information as possible and include "(unpublished)" in the citation.

MICHIGAN STATE UNIVERSITY

Effectively communicating your scientific work

- Why you need to communicate effectively
- Types of communication: papers, oral presentations, and posters
  - Distinctions and constraints
- How to communicate your work effectively

Why communication is important

- Through communicating about a problem, you are much more likely to achieve a thorough understanding of a problem yourself.
- Research is a communal endeavor
  - All work builds on the work of others, but that is only possible because others have communicated their work.
  - While science is objective, it is often ambiguous. Clear communication is essential to work through various interpretations and come to a common understanding.
  - Poor communication will undermine the message by making it difficult to decipher or seemingly uninteresting or of little value.
- You will be judged throughout your career (in or out of science) by your ability to effectively communicate information.

Most common types of scientific communication and their basic distinctions

- Papers
  - Most formal form
  - Often goes through peer review
  - Have the greatest opportunity to go into detail
- Oral presentations
  - Most common form of communication by which you will be judged
  - Humans do not learn well by passive listening
    - Cannot go into sophisticated details
    - Must limit equations
    - Must present clear pictures
- Posters
  - Most limited audience
  - Best opportunity for active engagement with your audience

First impressions

- Title/Abstract
  - Convey the basic problem and result clearly and concisely
  - The abstract should state the quantitative results
- Introduction
  - This is the key part. If you do not draw the audience in at the beginning, they will usually be lost.
  - State the problem.
  - Motivation: Context is everything. The audience must see why the problem is important in order to be engaged
    - Motivation can range from fundamental problems to potential applications
    - Context can be historical, empirical, or theoretical
  - Tell the audience what you will tell them
    - State the hypothesis
    - State the basic approach
    - State the results

The heart of the matter I: methods

- There must be sufficient detail for the audience to understand the technical approach.
  - Always include details of manufacturer and model number when the equipment is sufficiently specialized (within the context of the field) that the manufacturer and model number actually matter.
    - Example, if measuring a strong visible light beam with a Si photodiode, the manufacturer and model number aren't needed. However, if counting individual photons in the infrared, the detector make and model are probably important as many people are not even aware that there are detectors capable of such feats.
    - Include further details that might be helpful but are not essential if space/time permit.
- A picture is worth a thousand words
  - A schematic of the experimental layout is often the most efficient way to summarize the experimental system
  - The most effective picture is not necessarily a photograph. A schematic figure with only the essential details and no unnecessary distracting details is often best.
- Do not include details that are not essential for a knowledgeable reader to be able to repeat the study.

The heart of the matter II: results and analysis

- Summarize the data/results with graphs where possible.
  - Clearly annotate graphs with properly labeled axes (including units) and legends
- Describe the method(s) of analysis, especially assumptions used in models and in reducing the number of free parameters in fits.
- Error analysis is crucial.
  - Data has uncertainties
  - Fit parameters have uncertainties
  - State what kind of uncertainties you are reporting (e.g., one standard deviation or five standard deviations).

The heart of the matter III: discussion

- Assess the implications of your results
  - Are the results consistent with the hypothesis?
  - What are the implications for future studies or applications?
- What are the limits of your results?
  - Are there improvements that could be made to increase the confidence in the results?

Conclusions

- Concisely summarize the problem, approach, and results and directions of further study.

References

- Credit must be given where it is due
  - Proper citations minimize your need to explain what is already known and helps readers to find relevant supporting work.
  - Using the work of others without citations is unethical.
- References should be cited in the main text
- Conventions vary by field and journal, but the general format is to place references at the end of a paper and to include
  - Authors, abbreviated journal title, volume, page number, and year of publication:

    [1] J. Doe, and J. Schmoe, *Phys. Rev. Lett.* **84**, 395 (2000).

Written report guidelines

- This is a scientific report, not an experimental manual
  - Do not use excessive detail in discussing the equipment and measurement techniques.
  - Focus on the science; experimental details are to be used as needed to support the science.