

Phys3113: Discovering Modern Physics

Tips on Writing a Short Paper

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INTRODUCTION

Now that you've researched and sharply defined the topic of your paper, you're ready to write the preliminary version. Don't panic! The **preliminary version** is just a trial run—a chance to try out your ideas about how to present what you've learned about your topic. *This is not, however, a “rough draft.” The preliminary version should be as good an approximation to your final paper as you can construct.* So it should include figures, tables, references, and any other elements you plan for your final version. (Of course, anything you do in the preliminary version can be changed before you write your final version.)

Why write a preliminary version? First, you can best sort out your ideas if you write them down. Second, you will get invaluable feedback from your readers, who will offer constructive criticism on your version. Finally, returning to a preliminary version after you've gotten a little distance from it will immeasurably improve the final version you make when you revise the preliminary version. This version, therefore, gives you a chance to find out what works and what doesn't work. Using the feedback and your reflections on the preliminary version, you'll be able to develop a final version that is effectively embodies your ideas.

How do I get prepare a “preliminary version” of my paper? Every paper is (or should be) an organic thing, evolving as the author shapes, drafts, and revises it until it satisfies his or her goals. Since a preliminary version is a trial run of the final paper, it should contain all the pieces that will make up the final paper. Below you'll find a list of the specific elements that must appear in your preliminary version (and your final paper). In addition, construct whatever figures or tables you want to include (with captions). Add references to external resources you used. Type it up. Run it through a spell checker. Proofread it carefully. And you're done.

When you write your preliminary version, be free with your thoughts. Remember, you can always revise what you write! A great way to self-critique a preliminary version is to do something else for a day or so, then come back to it and, as objectively as possible, ask yourself the following questions: If I knew nothing about this subject, what in this paper would confuse me? How can I restructure, add or subtract material, or rewrite certain paragraphs to make my paper more interesting and/or comprehensible?

What elements must be in a preliminary version? The *structure* of your preliminary version should be the same as the structure of your final version. At the most basic level, here is the structure *all* papers (about anything) should have:¹

1. **Introduction**
2. **Body of the paper**
3. **Conclusion**
4. **Figures, Tables, etc.** (if appropriate)
5. **References**

The following paragraphs look at each of these sections (and other elements) in a little more detail. (Remember, though, that within this overall structure and the rough guidelines below, the subject matter of your paper will help you shape your particular paper.)

¹You should have a section called **Introduction** and a section called **Conclusion** but *don't* call the central section of the paper **Body!** Instead, devise with a *short*, succinct title for this section that describes what it is about (e.g., “The Theory of the Photon” or “The Physics of Bose-Einstein Condensation” or “The Compton Experiment”). Similarly, if you label subsections of your paper, devise *short*, appropriate meaningful titles for them. The purpose of all this is to help your reader see *at a glance* what each section or sub-section is about.

Introduction.

The introduction consists of a paragraph or two that **sets the stage for your paper**. *The goals of your introduction are to situate your reader so he or she knows what you're going to be talking about and to make your topic so interesting that your reader wants to read on.* Somewhere in your introduction you must state clearly and in a single sentence what the paper is about; this statement must be specific and focused, not vague and all-encompassing. That is, your reader must get from it a clear idea of *precisely* what aspect of your topic you'll be discussing.²

Body of the Paper.

In the body of the paper you **develop a logical sequence of ideas that leads your reader through the topic to an understanding of whatever point you're trying to make**.³ Depending on the focus of your paper, this part might contain historical/biographical background, information about experiments you're discussing, physics that is relevant to understanding your topic, necessary mathematics, figures and tables (with captions), and other relevant material. The particular sections and subsections that will appear in the body of your paper will depend on the approach you're taking to your topic.

Conclusion.

The conclusion is one of the most important parts of your paper. It's the part your reader will most likely remember. In the conclusion, you **step back from the detailed discussions in the body and bring the paper to closure**. *The goal of the conclusion is to take your reader out of the paper, leaving us satisfied that we've learned something interesting.* The conclusion must reiterate the focus of your paper and briefly summarize the high points of the development you've constructed.

Appendices (optional).

You may include appendices containing information about your topic that isn't required or doesn't belong in the main text. For instance, appendices are good places for *mathematical derivations* or *supplemental data*.

References.

You must include an entry in the reference list for all citations in your paper; similarly, every citation must include a reference in this list.

Your paper is not supposed to be a report of original research; rather, it's supposed to be **an original synthesis of what you've learned about your topic**: a construction *largely in your words* of your findings about the subject. You must clearly and unambiguously reference very insight, paraphrase, result, derivation, idea, or direct quotation you take from another source; every figure and/or table you include, unless your own work, must include a citation. Failure to properly cite the literature you used constitutes **plagiarism**, one of the most heinous crimes in science.

Tables and table captions (optional).

You may include tables in the body of your paper, near where you first refer to them, or on separate sheets of paper at the end. In general, tables are far less useful than figures, which are easier for readers to assimilate and authors to discuss. *Every table must have a caption.* All tables must be cited sequentially in your paper. **Never include a table without explicitly discussing it in your**

²Never write in any paper like "My topic is . . ." or "This paper is about . . ." Rather, make sure the topic and focus are clearly stated in your introduction.

³As a rule of thumb, give each sub-idea *at least* one paragraph. Remember that a paragraph is a kind of miniature paper. Each paragraph should make and discuss one (and only one) point. One sentence in each paragraph should clearly indicate (directly or indirectly) what the paragraph is about. If you can't find such a sentence, then you need to revise the paragraph or combine it with a prior or subsequent one.

paper, telling your reader what you want him or her to notice about the table and why it's important.

Figures and figure captions (optional).

You may include figures in the body of your paper or separately at the end. Figures must be numbered sequentially as cited in the text. *Each figure must have a caption, in your own words, that clearly identifies each element of the figure. Figure captions must explain the figure in sufficient detail that a reader with a background in your subject can understand the figure without having to read the text. Never include a figure without explicitly discussing it in your paper.*

How do I get started? Everybody is different. There are no rules. Here are a few suggestions, drawn from lots of experience of lots of writers.

1. **Do one thing at a time.** This is the most powerful tip for writing papers (and preparing talks) that I know. It means: *don't* try to organize your ideas, figure out how to explain them, decide which equations and figures to use, decide about how you're going to say what you're going to say, try to write effective transitions between items you're discussing, check the spelling, fix the grammar, polish your prose—don't try to do all these things *at the same time*. Do first things first. Get your ideas in logical sequence; this will help you organize the paper quickly. Then write out your ideas in general terms, not worrying about technicalities. See if they follow logically; if not, try other arrangements. Then decide what figures, tables, equations, witty audio-visual clips, MP3 files, or whatever will help to explain the ideas more effectively. Then figure out where to put each one and what to say about it. Only late in the process, in writing your final version, should you give close attention to small details (fine tuning) like thorough spell checking, polishing figures etc., including all references in the correct format, etc.
2. **Develop your paper from the inside out.** At the simplest level, this means write the body first. It's impossible to write the Conclusion before you know what you've written in the Body. And it's *much* easier to write the Introduction once you know fairly clearly what you're introducing. So leave these until the latter stages of putting together your preliminary version.⁴
3. **Don't try to write a "polished" preliminary version.** Of course, even a preliminary version should be readable and as free of grammatical errors as possible. But don't try to make it perfect. The key point here is to get your ideas on paper in some sort of sensible sequence. You'll have lots of opportunity to polish later.⁵
4. **Include something about each figure or table you will likely want to include.** Again, don't spend lots of time making these items "pretty." But your preliminary version will be much more valuable to you (and comprehensible to your readers) if it includes *something* about each figures, table, etc. you (now) intend to include. If you don't have time to prepare a figure or table, include information that describes it roughly. Even that's better than nothing.
5. **Include something about every sub-section of your paper.** If you intend to include a sub-section in your paper but haven't had time to fully research it, write a rough summary of what will be in it *and label this paragraph as a summary*. Again, the key thing is to get *something* that looks as much as possible as your final version as you conceive it now.

⁴The same principle is often very helpful in organizing and writing elements of the paper. For instance, I often write down the equations for a short sub-section or discussion *first*. Then I can decide exactly which equations to leave in (and which to toss), what notation to use, and what I want the reader to know about the equation *before* worrying about the prose to stitch the equations together or how I'm going to get into and out of the derivation. You can do the same thing with Figures and Tables and lots of other elements of the paper.

⁵Another reason to not spend a lot of time polishing a preliminary version is that you *may* decide, after you get some feedback, to drop stuff, rewrite a few paragraphs, or restructure the body of your paper. Time you spent polishing parts of your first draft you later toss is wasted time—something you can't afford.

How can I make my paper more effective? The first trick to writing an effective paper is **revision**. The more versions you do (within your reason, time constraints, and other responsibilities), the better your paper will be. The second trick is to solicit and pay attention to **constructive feedback** on your preliminary version.⁶ Here are a few “tricks of the trade” for writing effective short papers.

- **Write in your own voice.** Don’t adopt the stilted “passive voice” construction often found in (bad) physics papers. It’s OK to use “I” when discussing *your* ideas and conclusions. On the other hand, don’t use colloquialism expressions or slang. Strike a balance between conversational informality and arch formality. Remember: your prose should be invisible. Its sole job is to communicate your synthesis of what you’ve learned clearly and interestingly to your reader.
- **Keep your audience in mind.** Remember that you are writing for readers whose background is comparable to yours. *Don’t write your paper at an artificially high a level.*
- **Define all symbols, specialized terms, and abbreviations.** One of the most common (and serious) flaws in short papers is the use of symbols or jargon or acronyms without definition. Remember, *your reader doesn’t know as much about your topic as you do.* For each abbreviation you use, spell out the full name the first time you use it; thereafter, you can use the abbreviation by itself.
- **Don’t pad your paper.** Include what you need to make your point clearly. Cut everything else.
- **Discuss each table, figure, or equation you present.** A common mistake in short papers is including these items without explanation. *Everything you include should be in your paper because it relates clearly to the discussion you’re developing.* For each such item, you must explicitly tell us what you want us to notice and what insights or conclusions you draw from the item. In other words, *you* must explain why you’re including the figure, equation, or table. *Remember, your reader can read only your prose, not your mind.*
- **Don’t loose focus: be selective.** Avoid tangents, sidelines, and detours that lead your reader away from the main idea, the focus of your paper. Don’t include every fascinating tidbit or note you dug up during your library/internet search. Part of what is “original” about this paper is your selectivity: choose from the material you’ve gathered information only that which contributes to a clear understanding of the *single aspect of your topic that is the focus of your paper.*
- **Be specific.** Don’t generalize. Be sure to support every major step in the development of your thesis statement with examples or references. As you revise your paper, scrutinize every paragraph and eliminate all generalizations or vague statements.
- **Tell a story.** The very best papers—even physics papers—have an internal logic to their organization that makes readers want to read the paper. (Writers who want to sound sophisticated call this the “narrative arc” of the paper.) Even if you later write research papers or technical reports, you can (almost always) organize your material so the papers has a well-defined beginning, middle, and end—must like a story. (The structure suggested above ensures this.) If you then construct the body of the paper so every new step or point follows *logically* from the one before it, then your paper will tell a story and will be much more compelling, interesting, and memorable. *Never*, unless there is a compelling reason to do so, allow mere chronology to define the logic of the paper.⁷

What format should my paper have?

- **It must be typed, double-spaced, on one side of the paper only.** Leave margins of one inch (no more) on each side of the page and on the top and bottom. *If you use a dot-matrix or laser-jet printer, be sure the ink/toner is dark!*

⁶“Pay attention” does not mean that you implement every suggestion your readers make! It means that you consider seriously each such suggestion, solicit clarification from your reader if the suggestion isn’t clear, and decide for yourself whether implementing the suggestion will improve the paper and is feasible.

⁷The single exception I can think of is an historical paper—such as, say, a history of the discovery of the electron. Here you at least would want to establish a chronology in your Introduction, but even here the chronological sequence should serve more as a frame for the main discussion in the paper than as the only organizing principle.

- **It must be free of typographical, mathematical, and grammatical errors.** Run it through a spell check, get a friend or two to proof it for you . . . do whatever is necessary, but *don't hand in a sloppy, error-ridden paper*. You've worked hard to develop your ideas; they deserve the best presentation you can give them.⁸
- **It must have a title page.** The title page contains the title of your paper, your name, the date, and details of this course.
- **The references must follow standard American Physical Society (APS) style, including journal abbreviations.** (You need not follow APS format for anything else in the paper, although you certainly can if you want to.) You can download handouts on both topics from our web page.

What mistakes should I avoid like the plague? Here's a short list of things that turn almost all readers off when they read a paper. The absence of these from your paper will guarantee that it does the job you want it to as well as possible (and guarantee a higher grade).

- typographical errors;
- unexplained symbols;
- the words “obviously,” “clearly,” “easily,” etc.
- uncredited ideas, paraphrases, etc.
- figures, tables, or equations presented without explanation;
- no introduction;
- no conclusion.

⁸Why is eliminating all typographical, spelling and grammatical errors so important? Well, have you ever watched a really good movie or TV show on a television whose reception was so poor that there was a lot of “snow” or noise on the screen and lots of static on top of the audio? Pretty irritating, isn't it? That's what reading a good paper which is full of typos is like! These errors distract your reader from what you want him or her to focus on—your ideas—to mentally correcting your errors and (with increasing frustration) trying to figure out what you're trying to say. Every error undermines all the hard work you put into researching and writing the paper. Get them all out!