

The Scientific Paper: A Template with Tips for Managing the Beast that is MS Word

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This paper should serve as an outline for writing scientific papers. It contains all of the important sections that should be included in scientific paper as well as descriptions of what should be included in each of these sections. It also contains some useful tips on how to use MS Word to write scientific papers. The easiest way is to use this document as a template and insert your text and figures as described in the text below. This section is the abstract. It contains a brief description of the project including relevant description of the problem, data collection procedures and a summary of results as well as a brief description of how this information fits into the overall field. The abstract may contain equations like, $\vec{E} = \vec{E}_0 \cos(\vec{k} \cdot \vec{r} - \omega t + \phi)$, but inline equations in Microsoft Word don't look very good. An abstract is usually quite short. Often, the length is limited to between 200 and 400 words.

1. INTRODUCTION

This paper contains a general outline of the information that should be included in a scientific paper. It provides a good template within which you can easily write a paper. When you start out writing papers, you will likely include most of these sections and utilize this fairly standard format. As you gain experience, you may choose a different ordering or different sections as you find appropriate. Remember this is just a template to help you get started. You will have your own style of writing. Your audience and the content of your paper should be the most important guiding influence when writing any paper. The writing process will go much more smoothly if you take some time to answer a few questions before you begin writing. For example, before you begin writing, ask yourself, "Who is my audience?", "What do I want them to get out of this paper?", "What are the most important ideas to convey with this paper?" There are lots of other questions you could ask, but these three will help you generate a document that is pitched at the right level and contains information that is useful to your audience.

However, you should keep in mind that a good scientific paper always introduces the reader to the subject material and provides the appropriate background information that the author thinks the reader will need. A good scientific paper will always make the experimental, computational, or theoretical methods clear enough so that a competent reader should be able to reproduce the work. A clear description of how any data was collected should be included as well as a description of the raw data, generally in graphical format. Any analysis performed on the data should be outlined clearly. Analysis and conclusions drawn from the analysis should generally be described separately from raw data. A paper should end with a set of conclusions based on the analysis. It is the responsibility of the author to carefully lead the reader from the experimental design through the conclusions tying each piece together. For example, it should be clear to the reader explicitly how your analysis leads from your raw data to your conclusions. If you do not make this clear, no matter whether or not you are right, you have not done your job as an author and will find that you have a hard time convincing anyone that what you have done is valid. Finally, every paper should end with a references section. A scientific paper without any references, indicates

that the author believes that every thought conveyed in the paper is original. Any information that you obtain from another source should be cited. The only exception is for material that is considered common knowledge. As a student, your common knowledge will often be somewhat more limited than the average author in a scientific journal. As such, you will often reference information from class notes or textbooks that other authors may not. When in doubt, make a reference. This eliminates any possibility that you will be accused of plagiarism, a very serious transgression indeed.

An introduction generally contains a brief introduction to the material that will be presented. Relevant information includes a clear enunciation of the questions that will be addressed in the paper, background information relevant for understanding the paper, basic theory needed to understand the contents of the paper, etc.

It is important to take into account your audience when writing the introduction. The purpose of an introduction is most often to give your audience enough information so that they will be able to understand the rest of your paper and put it into a larger context. Depending on your audience, this context may vary. For example, if you are preparing a paper with other physics students in mind as the audience, you will write the introduction so they see how their previous physics knowledge will be useful in understanding this paper. If on the other hand, you are writing this paper for a narrow selection of researchers, you will not need to include as much information. Rather, you will present them with enough information so that they can see how this paper fits in with relevant research.

This document will serve as a template for producing professional looking papers in MS Word. Before you begin to modify this document, make sure you have a copy of it saved somewhere so that you can look back at it if you delete or otherwise lose something important in this document.

If you have any questions about the appropriate style for a scientific paper, you should refer the AIP Style Manual at <http://www.aip.org/pubservs/style/4thed/toc.html>.

2. THEORY

Often, if the theory needed to understand a paper is somewhat extensive, a separate section containing a

description of the theory will be presented. This section should contain enough theoretical detail to make it possible for a member of your target audience to be able to reproduce any results you come up with. Obviously, the amount of detail that you include will depend on space constraints and the expected level of expertise of your audience.

In the context of a paper written by an undergraduate for a class, you should include all non-obvious steps and be sure to reference material that is not “common knowledge”. If you just learned the material in a class, you should include references to where the basic derivation comes from. If you start with a non-trivial expression that you had to look up somewhere, either in a book, a paper, or your notes, you should definitely include a reference.

All equations should be incorporated into the text using a program designed to properly format equations. LaTeX, MathType, and Equation editor are common programs. You can insert equations easily into a document using MS Equation Editor. It isn’t the best, or the prettiest, but it works, so I don’t complain. Putting in equation numbers is not natural for Word, so this template contains a simple macro to do this. If you have MathType, it works better, so use it. If not, you’ll notice a couple of buttons up by the list buttons on the toolbar that say [Insert Eq] and [Eq Num]. The [Insert Eq] button inserts and equation and the [Eq Num] button inserts and equation number. To use the equation number button, you must first place the cursor after the equation and press the [Eq Num] button. The resulting inserted number will automatically update.

$$\vec{E} = \vec{E}_0 \cos(\vec{k} \cdot \vec{r} - \omega t + \phi) \quad (1)$$

$$\vec{B} = \vec{B}_0 \cos(\vec{k} \cdot \vec{r} - \omega t + \phi) \quad (2)$$

$$\Delta \vec{p} = \vec{F} \Delta t \quad (3)$$

With these simple tools it is easy to put together a scientific paper.

3. EXPERIMENTAL METHODS

This section is often called experimental design or methods. It contains information about how you went about your experiment. The purpose of this section is to convince your reader that your experimental methods were sound and thorough. That said, if you have made experimental errors that you did not correct, or if you made errors along the way it is your responsibility to report them here. If you do not clearly report your experimental methods, you run the risk of having someone else try your experiment and get other results. This then brings into question the validity of your conclusions and your reputation as a scientist. In addition, if you made errors along the way that you corrected before collecting your final data, it may be worth presenting them here so that others can benefit from your mistakes.

Often you will include a diagram of the experiental setup.

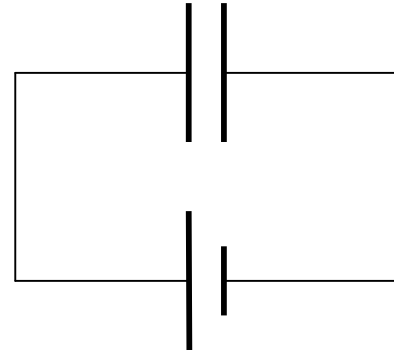


Figure 1 : A capacitor and battery circuit diagram.

Any diagram you include should contain a fairly detailed figure caption. A good rule of thumb is that if someone reads the abstract and looks at all the figures and captions, they should have a reasonable idea what your paper is about. While this isn’t always possible, it is a good thing to shoot for. That said, this document doesn’t even come close to meeting that requirement, but it also isn’t so much a scientific paper as a how to manual on writing one.

As mentioned before, you should include enough information in your experimental design to make it possible for someone else to reproduce your experiment. You should generally outline what you did with enough detail so that it is clear how you setup your experiment and how you collected your data.

It is particularly important to include anything out of the ordinary. Often we make experimental errors in our setup. It isn’t fun, but it happens. If one clearly articulates her setup, it is possible for others to identify these often subtle experimental errors.

4. RESULTS

Your paper should contain a section describing your raw results. Often this will be done by including graphs and/or tables of data. This data should generally not be heavily processed. Rather, one should include results in an understandable format that are a good representation of the data obtained by your experiment or computation. You will have a chance to show processed results in the analysis section, but in this section you need to present the reader with your raw data so she can clearly judge the quality of your analysis and conclusions.

Often you have far too much data to include it all. In this case, you will include a sample of raw data with tables or graphs containing straightforward compilations of this data.

Here is another figure. It is generally best to make all figures only a single column width. When they are inline, it is very easy to locate them with respect to text [3]. You may still have to do some fiddling at the end to get them exactly where you want them, but once you put them somewhere they stay put, with respect to the text.

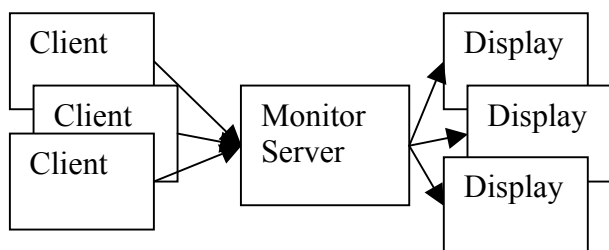


Figure 2 : A high level diagram of the monitor system. Monitor data flows from left to right, and requests for particular monitor data from right to left. The Monitor Server (MS) caches replies from the clients. [4]

You can also insert Tables very easily. Just make a table

Current	Voltage	Power
0.01	0.12	2
0.02	0.13	4
0.03	0.14	6

Table 1 : This is a simple Table to demonstrate how a table should be inserted

In general, you should never include a table in a paper when a figure/graph will do a better job. It is quite rare to see tables in scientific papers. You should never include a long list of data or an excerpt from a spreadsheet unless the particular values in the list are very important. Long lists are hard to read and generally confuse or bore your reader.

Most often tables are used to show a few numbers derived from a larger dataset. This is a good use of tables but should generally occur in the analysis sections because the numbers are derived from the data.

Here is another table. We can reference this table in the same way mentioned in Section 2. Table 3 shows a more common type of info to be contained in a table. This table shows the different sources of uncertainty in a measurement and how much each source contributes to the total uncertainty.

Sources of Error	Size of Error
Statistical Uncertainty	$\pm 0.02eV$
Systematic Uncertainty	$\pm 0.10eV$

Table 2 : This table shows the different sources of uncertainty in a measurement.

5. ANALYSIS

After you have clearly described your results, you will describe how you will analyze these results, that is, how you will process the data you collected to obtain information that will help you answer the questions you brought up in the introduction.

It is critically important that the analysis section of a paper is clear. Your job in the analysis section is to convince the reader that the methods you used to get from your results to your conclusions are sound. If your analysis section is

incomplete or unclear, your reader may not trust the conclusions you draw.

This is another section where you will often have equations, graphs and tables. Remember that whenever you use an equation, graph or table, it should be referred to in the text. Any equation, graph, figure, or table should fit into your explanations. If you include a graph but make not mention of it in the text, the graph either has not reason to be included, or you have omitted important information from the text

6. CONCLUSIONS

Your conclusions section should be brief, but long enough to refocus the reader. The conclusions section describes your assertions based on your data. In essence, it contains the answers you've come up with for the questions you asked in the introduction.

You should also make it a point to place your conclusions within a context. That is, you should discuss the possible implications of your conclusions or how they might be relevant to other researchers. This is often hard to do as a student, but not impossible. Some questions you can keep in mind when writing this section are. Why are these conclusions important? Who might these results affect? What could these results be useful for?

It is important to keep in mind that you should not overstate your conclusions. A common error authors make is to over generalize ones conclusions. For example if I find that a particular type of crystal behaves non-linearly within certain parameters, it is an overgeneralization to conclude that all crystals of that structure will behave the same way. If the author suspects this to be the case, she can state her prediction, but should not assert that it is a fact just because she has a hunch based on her experiment with this one crystal. This leads us to a final sections that you may or may not want to include.

7. SUGGESTIONS FOR FURTHER RESEARCH

This section contains a listing of the directions that the author thinks it will be possible to extend this research. It can be a list of possible future experiments or questions one might ask that are based on the results of the research presented. This section gives the author the opportunity to be somewhat more creative. That said, it should be clear in the paper that the statements made in this sections are suggestions, conjecture and or gut reactions. It is good to include this kind of information, because it helps one to refine her intuition and practice asking interesting scientific questions.

8. REFERENCES

You must include a references section in any scientific paper. To omit the references section is to almost certainly commit plagiarism. As mentioned before, you should include references whenever you have used information from another source. This might be a professors notes or a

textbook. As you advance in your studies, your references will come more and more from journal articles since these articles generally present more recent results.

In MS Word, it is easy to build a references section like the one you see at the end of this document. To do this, add a new reference to the existing list at the end of the document. If you place the cursor at the end of one of the existing references and hit return, a newly numbered reference will come up. To add a cross-reference to this citation, all you need to do is select [Insert][Reference][Cross-Reference], and then select [Numbered Items]. In the [Insert Reference to:] box, select [Paragraph Number]. At the bottom of the [For which numbered item:] list, you will find the numbered references. By choosing one of these and clicking [Insert], you will get a linked cross-reference that will update automatically, like the following reference. [1]

The following few sections are generally not included in a paper, but are placed here to help you work with MS Word. If you read them carefully and use this document as a template you will almost certainly save yourself a lot of pain and suffering associated with formatting documents. Better yet, learn to use LaTeX. It is installed on all the Macintosh machines and generates beautiful output with a minimum of fussing over formatting. Do yourself a favor, learn to use LaTeX and spend your time thinking about the science. I wish I had. That said, you can get by with word. I do just fine. The following are a few tips that will help make your life with Word more bearable.

9. AVOIDING UNEXPECTED BEHAVIORS

Much of the problems people have working with MS Word stem from it's broad functionality. When using word, it is very easy to get confused because it is doing something automatically that you don't understand. Common problems include moving figures around when other text is moved. To avoid this, always put figures and captions inline, rather than as overlays. Never use wrapping with figures. It almost always causes problems.[2]

In addition to problems with figures, you can Tips for avoiding unexpected behaviors in MS Word:

- Always use inline figures, tables and equations
- Learn how to use styles
- This template contains a variety of styles. You will be well served to use the styles contained herein.
- Styles are easy to apply. Just select some text and then choose a style from the style toolbar next to the font.
- Using styles will help you keep the style in your papers more consistent
- For example, always use the "conf_figure_label" style for figure captions
- Also, you should use headings as used here. They will save you lots of time, and keep things nicely organized.
- Notice how the Headings, figure labels and table labels are all setup to update if you add a new heading, figure or table.

- Learn how to use Headers and footers
- Learn how to use autotext to insert things like the date and the page number.

10. FORCING PAGE BREAKS ETC

It's generally a bad idea to force page breaks, etc. but sometimes it is necessary. A simple way to force a page break is to hit the [CTRL][Enter] combination. Maybe [Apple][Enter] on Macs. You should look into how sections work. You'll notice that there is a section break at the end of the references section. At section breaks, you can change the formatting/page layout. For example, this document is setup with two columns in the standard journal style, but you can change this style to single column double spaced very easily. You can define different sections of your document to have different column properties, but you cannot mix column properties within a single section.

10.1. View Formatting Codes

It is easy and often useful to view the formatting codes. These include dots for spaces, funny paragraph symbols at the ends of paragraphs and more importantly, forced page break and section break notes. To show formatting codes, you can click on the funny little paragraph symbol next to the Σ 's above.

11. STYLES STYLES STYLES

Using styles is the key to uniform document format. It makes life easier and it allows you to think about what you are writing rather than formatting. The style menu is easy to use. Just select some text and choose the appropriate style from the style selection box on the toolbar next to the font selection box on the toolbar.

If you want to change the properties of a style, go to the [Format] menu and select [Styles and Formatting]. Explaining how to change styles is beyond the scope of this document, but can be found in the online help and is pretty easy to figure out. One word of caution. Always avoid the [Automatically Update] checkbox. Whenever you see it checked, uncheck it. It is evil and it will cause you serious pain and suffering.[5] It makes your styles change whenever you make a change to any property for any instance of that style. It is pure unadulterated evil, worse than Barney.

References

- [1] I. Newton, "Apples Hurt when they Hit you in the Head", *Journal of Fruit Dynamics* (1521), **21**(3), 321.
- [2] W. Tell, I. Newton, "Arrows Hurt more than Apples", Private Communication.
- [3] R Feynman, M. Fandango, "Quantum Interactions between Apples and Arrows: A Diagrammatic Approach", <http://www.fruitdiagrams.org>.
- [4] C. Ape, "Learning to Climb like a Monkey", *Primate Dynamics* (2001), **4**(10), 57-69.

- [5] K. Kong, "Learning to Club like a Gorilla", *Journal of Newtonian Mechanics and Ape Behavior* (2003), **12**(3), 125-130.