

PHY 451 Term Paper

Term Paper: The content of the paper should preferably be based on the third Innovative Experiment. The paper will be journal-style, 13 ± 2 pages, double spaced, with one-inch margins. It should include a literature survey with proper citations, in-depth analysis, and conclusions, in addition to reporting the main techniques and experimental results obtained.

Experiment 3

Section	Laboratory Dates	Rough Draft of Term Paper Due	Notebook & Final Term Paper Due
1	Nov. 4, 11, 18, 25	Nov. 28 Email to Prof. Ruan	Dec. 5 Prof. Ruan's Office
2	Oct. 30, Nov 6, 13, 20	Dec. 2 Email to Prof. York	Dec. 5 Prof. York's Office

Make your research matter

Quick notes on how to write
meaningful technical reports and
journal papers?

Research is a community work

- Objective science is empirical, and is subjective to human interpretation. Most concrete sciences are created through constant interpretation and reinterpretation of the empirical results. All interpretation (models) are based on hypotheses.
- Interpretation has a subjective out-layer to it. Quantitative results alone do not convey science. Perception matters!!!
- Scientific writing is an important part of research.



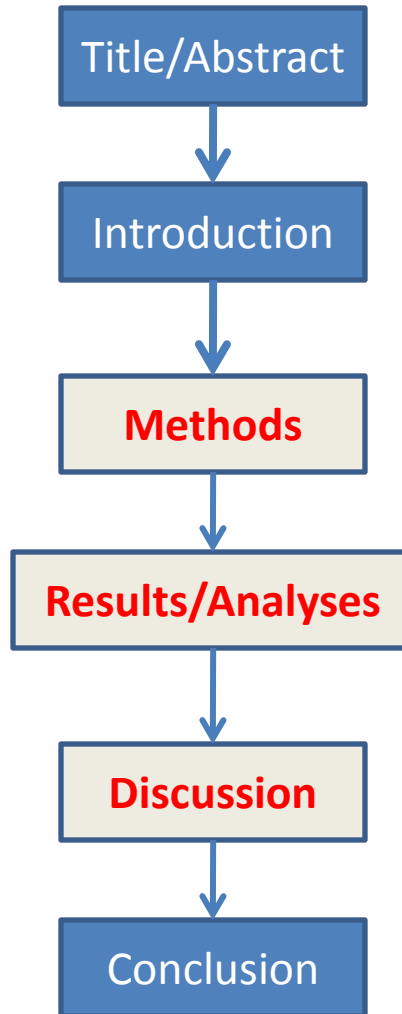
Exploratory and hypothesis driven researches

For **hypothesis driven research**, techniques only go so far as to test the hypothesis. A more powerful technique allows better resolutions to resolve the problem. The methodology alone does not create new sciences?

For **exploratory research**, new techniques expose new science opportunities. Yet, to define the sciences, you still need to come up with hypotheses.



Writing a journal paper



Cover page/ Abstract

Title page should include a title, followed by an authors list, the address (by default, it is Department of Physics and Astronomy, Michigan State University), and an abstract.

The title should be succinct, yet informative, reflecting the most significant aspect or purpose of the paper.

The **abstract** should be a short summary of the paper, including **goals**, key **methods** used, and main **findings**, to be described within 8 sentences and 250 words. **Avoid technical terms that are yet to be defined!!**



Introduction

- The introduction paragraph should **start with sentences that motivate the readers the importance of your work**. Depending on the project, this could be, but not limited to, based on the need of improving the measurement techniques, extending the scope of the investigation, specific inquiry targeting issues relevant to the on-going efforts, or verifying hypothesis inspired by prior results in related fields.
- Following the motivating sentences, the **problems of interest should be clarified**, which can be from historical, empirical, or theoretical perspectives.
- The introduction could end with **propositions of how you will investigate, resolve, or improve the understandings of the problems you introduce earlier**.
- Try to avoid nontechnical background information

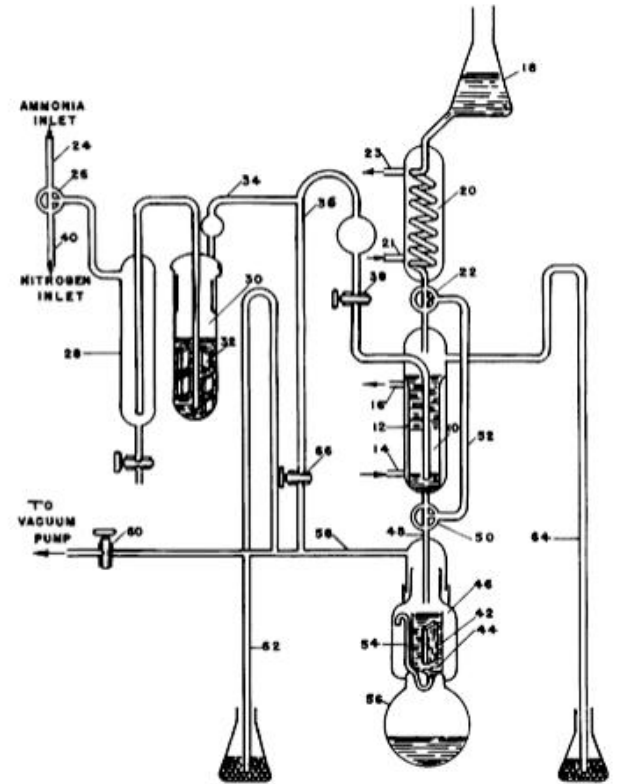
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"I'm looking for a motivation consultant who advocates screaming, blackmail, and violence."

Methods

- The method paragraph should provide sufficient details for the reader to understand the techniques you use to investigate the problems. For your work that relies on a specialized setup, **it is almost always required to show the schematic diagram of your set up.** The key components of your setup should be labeled and explained in the figure caption.
- Procedures for implementing the special measurements, and/or samples preparation should be included.
- Try to **incorporate the schematic diagram in describing the procedures** in the main text.



Analyses/Results

- Here you **present your main experimental results**, which must be in the forms of summarizing graphs, and/or tables with proper labels and units. Assign reference labels and cite these results in the main text using reference labels, such as “see Fig. X or Table X”.
- **The method you use to analyze the data should also be described.** (Almost all models depend on some hypotheses to reduce the parameter space.)
- **Pay attention to the error analysis**, which should include the uncertainties associated with the raw data and the fitting parameters, when available. If, due to the nature of the experiments, it is difficult to directly implement the uncertainties in a computerized analysis, provide the uncertainties based on your subjective estimates of uncertainty for each observable and the rules of error propagation.
- **Any kind of estimate of the uncertainties and errors associated with your results is better than nothing.**



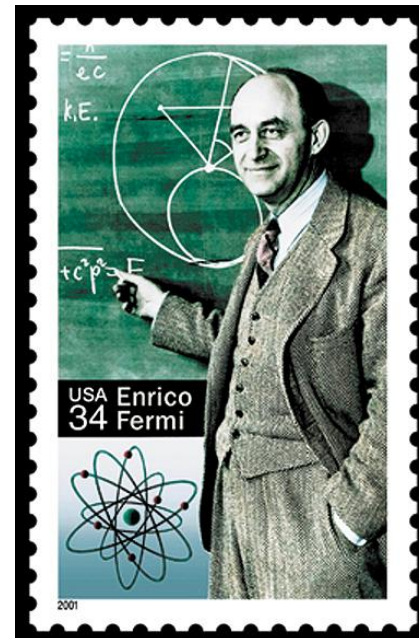
Discussion

- This section should **provide an assessment of the impact of your experimental results**. Systematic effects that might affect the interpretation of your results should be considered.
- Based on your analyses, **the propositions made at the introduction should be examined**. Sometimes, it is easier to make the argument by comparing your findings with those obtained from other methods, or accepted values in the literature.
- If you are **exploring different methods** of experimentation, try to **compare the pros and cons** of each method. If you are **limited by your instrument resolution** to reach a definitive conclusion, **set an upper or lower bound** based on your error analysis, and discuss ways to further improve your measurements.



Note on writing captions

- Figure and table **captions should be self-explanatory**. Readers should be able to get the rough ideas of your experiments by just looking at the figures/tables and the captions that come with them without getting into the main text.



Conclusion

- A succinct summary of your achievements and/or problems worthy of further pursue directly resulted from your efforts should be stated here. Like the abstract, this paragraph should be short, preferably no more than 8 sentences and 250 words.



References

- Give credit to where the information comes from.
- Examples:

[1] F. Bloch, *Phys. Rev.* **70**, 460 (1946).

[2] N. Bloembergen, E.M. Purcell, R.V. Pound, *Phys. Rev.* **73**, 679 (1948).

[3] E.L. Hahn, *Phys. Rev.* **80**, 580 (1950).

[4] H.Y. Carr, E. M. Purcell, *Phys. Rev.* **94**, 630 (1954).

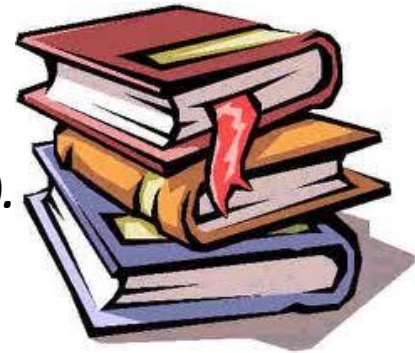
[5] Agilent oscilloscopes user's guide,

<http://cp.literature.agilent.com/litweb/pdf/54622-97036.pdf>.

- Cite references in the main text:

The technique of nuclear magnetic resonance (NMR) was developed by F. Bloch [1] in 1946 as a way of measuring the magnetic moment of matter.

The technical specification of the oscilloscope [5] placed an upper bound of .06 mV on the resolution of our signal.



Contributions/Acknowledgments

- *Specify the contributions made by each co-author. An example is given below from an article in the Journal of Nature Physics:
“The experimental work was carried out by S.R.G. and I.T., using a sample prepared by D.P. The analysis was carried out by S.T.B. and S.R.G. The theory was devised by S.T.B. and P.C.W.H. The manuscript was written by S.T.B., S.R.G. and P.C.W.H. with input and discussion from all authors.”*
- *Acknowledge people or support which makes this work possible. Avoid giving acknowledgment within the text.*



Resources

[American Journal of Physics](#)

(<http://scitation.aip.org/content/aapt/journal/ajp>)

[The Journal of Undergraduate Research in Physics: JURP](#)

(<http://www.jurp.org/>)