PHYSICAL CHEMISTRY LAB, CHEM 3420
Addendum to CHEM 3420 Syllabus

Safety: Safety guidelines for working in a lab must be observed at all times. In order to work in the lab, the Chemistry Department must have a copy of the "Millsaps College Chemistry Department Safety Policy" signed by you. This policy is at the end of this addendum. Please sign it and turn it in.

Goal: To learn some of the experimental and theoretical techniques associated with quantum mechanics and to observe some phenomena that result from quantum mechanics

Grading: See the last page of this addendum as well as the class syllabus.

Lab notebook:

A lab notebook is necessary for keeping accurate records in lab. Proper guidelines include, but are not limited to, the following...

- Write in indelible ink at all times. This means the ink is water- and acetone-proof as well as fade-resistant. (Pilot uni-ball vision pens in black, red, and blue are good. Make sure they say "water-proof/fade-proof.")
- Skip the first few pages of your lab notebook to use for a table of contents.
- Use a notebook that is not spiral bound.
- Never tear out pages from your notebook except in the case of an emergency where you spill a hazardous chemical on your book.
- Include the following (with their headings) in your write-up in the notebook...

  title of the experiment
  purpose of the experiment
  procedure
  observations
  calculations/results
  results & discussion

- Never take your lab notebook out of the lab due to the fact that it might not make it back in the lab. (Exception: Taking the notebook down to the copy room in order to make copies of your experiments)

Peer-reviewed journal articles:

In the scientific community, papers are key to communicating what one has discovered to others. A final paper written by each individual is required on the listed due date. The various skills needed to perform the experiments and theoretical calculations will be taught as well as those for writing a peer-reviewed journal article (including literature searches, examination of journal articles, what question(s) are we researching, etc). Guidelines for the peer-reviewed journal article are on the next pages.

Suggested Guidelines for Peer-Reviewed Journal Articles

With all papers and reports, good writing is the key. Two very important factors MUST be used-- **conciseness and proper grammar**. The majority of scientists do not want to waste their time reading extra words, so do not use them. For example, the following words are extraneous: like, therefore, however, in other words, etc. If one has to say, "in other words," one should have used the other words the first time.

It is an excellent idea to model your report after a scientific paper. There are several different styles for scientific papers. **Journal of Chemical Education**, **Physics Fluids**, and the **Journal of Physical Chemistry**. (While magazines like **Scientific American** and **Nature** are excellent to read, please do not follow their format because their articles are styled in a less formal manner.) While all of these have slightly different styles, the key elements are the same. They all include the following: a title, an abstract, an introduction, experimental method, results, discussion, and conclusions. One or more of these elements may be combined if the style warrants.

I would like for you to develop your own writing style. Thus, I want to give you only guidelines for writing and to give you grading criteria in order for there not to be any ambiguity in grading.

I. Peer-reviewed Journal articles

The author is telling a story: There is a question to be answered. Thus, there are tests to be performed, and their data analyzed to determine the answer. To tell this story, there are certain "must-haves" that should be included in your paper. These elements are listed below and include a brief description of them along with what should be included.

Title: self-explanatory
The title should include a concise description of what you are doing without being too vague. For example: "An Excel Spreadsheet" is too vague of a title. "An Excel Spreadsheet to Learn How to Graph Data in a Linear Plot and Apply Linear Regression" is a bit too precise because you did other things besides graph. "An Excel Spreadsheet to Develop Analytical Skills for Physical Chemistry Lab" is good.

Authors: In most cases, you will not do your experiments by yourself. List your name first, since you are the one writing the report with your lab partners' names after yours. You should also put your collegiate affiliation in the following manner:

Lydia L. Lewis, Timothy J. Ward, and Kristina L. Stensaas
Millsaps College, Jackson, Mississippi 39210

Abstract: a short paragraph that briefly tells the reader what you did, how you did it, what you found, and how what you found is relevant to the scientific community (the big "Why did you do this and how will it impact the scientific world?").

For examples, go to the library and look at articles in the above-mentioned journals.
Abstracts are very helpful because we can read the abstract and determine if that scientist's work is relevant to our own saving time if it's not.

Introduction: Briefly (without nauseating detail) introduces what you are doing and why you are doing it along with any other important facts. Should include previously performed work in the field and why your work is relevant to the scientific community as well as why your work is novel (new, why should they publish it). (You're telling a story. Your work fits into the timeline of the story. Thus, you have to alert your audience to the beginning of the story (previously published work), current events in the story (your work), and where the story may go in the future (how your work is relevant to the scientific community).)

Experimental method: This element is VERY important. The data in a journal article should be reproducible. In order for someone to reproduce the data or to build upon the data, the method needs to be clearly outlined. It is quite correct to refer to previous articles or your lab manual or an instrument manual if they give detailed explanation(s) of one or more parts of the method. If you do so, include AT LEAST a summary of several sentences of it. (Please make sure you paraphrase it and reference it to avoid plagiarism.) But you still must have a short summary. Diagrams and schematics of the apparatus are encouraged and helpful. If you use reagents, it is necessary to tell where they were purchased. For example,

> The initiator, 2,2'-azobisisobutyronitrile (AIBN, 98%, Aldrich), was recrystallized from methanol, and the inhibitor, 2,2',6,6'-tetramethyl-1-piperidinyloxy (TEMPO, 99%, Aldrich), was used as is.

"AIBN" is the chemical's abbreviation, which is used throughout the remainder of the lab report. Aldrich is the chemical company where it was purchased, and 98 % is the percent purity that is listed on the reagent bottle. Typically the experimental method section starts with the reagents that you used and leads into how you did the experiment.

If you mentioned that you do a certain step in the procedure, e.g. "refluxed the solution to reduce the volume of the solvent", then you should explain why you need the volume of the solvent reduced, e.g. because the instrument needed the entire amount of solvate but could only handle a small amount of solvent.

Results and Discussion: the section where your data is shown and discussed. (This section combines both the results and the discussion, which is different from formal lab reports that you have written for Genchem and Organic labs, to allow a better flow for your audience.)

- Present your data in an appealing, easy-to-read format. A table or graph is much preferred over a long list of numbers in a paragraph.
  - ❖ When using tables and/or graphs, include a "**Figure #:** Caption" for graphs or diagrams and "**Table #:** Caption" for tables.
  - ❖ The captions should briefly explain what is presented in the table or graph.
  - ❖ Graphs and tables should be formatted in Word or Excel and embedded within your document at the end of an appropriate paragraph or section so that the flow is smooth to the eye. (The easiest way to "Embed" the table of figure is to copy it from whatever program you're using (e.g. Excel) and "paste special" into your Word document pasting it as a "Picture (Enhanced Metafile)." If you just copy and paste from Excel, the file is permanently connected to Excel so that any changes will update in both documents. The disadvantage to this permanent connection is a LARGE computer file that can slow down your computer.
- **Explain what data was determined and explain what it means.** Contrast your data to theoretical data or other experimental data from other articles to reinforce your points. If you have calculations that you are to perform for your experiment, show an example with this section and then tabulate or graph the data. 1Show **all** data. If you intend to reject some data, explain why you are doing so (the *q*-test, for example).

Conclusions:

- Conclude what you have learned in your study and how it is relevant to the scientific community.
- Reiterate important points from the results section.
- State if you solved the problem you originally set out to do and what you learned from your study. (1Remember, you do an experiment to answer a question.) When you have worked hard enough that you believe your results answer the question, you should try to understand the physical or chemical meaning of your answer. The answer to the question, and the implications of the answer, should be the focus of your conclusion.

  Hint: As you perform an experiment, continue to ask questions:
  "What are we doing?"
  "Why are we performing this experiment?"
  "What information do we hope to obtain from this experiment?"
  "How will this information help my research/skills/learning and how will this information help the scientific community as a whole?"
  These questions will be the focus of your paper.

→Your conclusion should not say you obtained "perfect" data or good data or even acceptable data. The goal of the experiment is to answer a question about how something of God's creation works, not obtain "perfect" data. You do not need perfect data to answer important questions. Getting perfect data does not make you a scientist. You are a scientist when you ask questions about something of God's creation works and design experiments to answer them.

→Many students incorrectly use the conclusion to explain why their data are bad or untrustworthy, so that they will not need to explain the chemical meaning of the data. This will not be allowed. Some error exists in all experimental data - you must find an answer to the initial question despite experimental error. Data that are so "bad" that they do not answer the question will not be accepted. If an experiment is incapable of producing data good enough to answer the question, you must find out why. Therefore, you must repeat an experiment until it answers the question, or until you understand why it cannot. (Journal publishers won't accept articles for publication that don't answer questions.)

References: References should be cited within your report according to ACS guidelines with a "Reference" section included at the end of the report. Any ACS journal (such as the **Journal of Chemical Education** or the **Journal of Physical Chemistry**) follows ACS reference guidelines and are good resources for examples of how to cite and how to format the bibliography. Please use the style of superscript numbers.

1Even if the entire class worked together on an experiment, each student needs to write and turn in an independent paper. Graphs and tables may be shared occasionally, but the prose in each report should be original.

Grammar Reminders:
-Do not use contractions in scientific writing.
-Pay attention to the spellchecker and grammar checker in Microsoft Word. They invented those for a reason. ☺
-There is an on-going debate as to whether scientific writing should use first person. That is up to you. Be consistent with whatever person you use.
-Do not use passive voice excessively.

Note: I urge you to go to the library and look at several copies of the **Journal of Chemical Education** and the **Journal of Physical Chemistry**. If you can't understand about what the scientist is talking, don't write as he does. There is a difference in writing using the jargon of a particular scientific community and unclear writing. One can find the definitions of jargon, but there is little help in understanding poor writing.

Recommended resources:
The ACS Style Guide
Strunk and White's Guide to Grammar
(I have both in my office if you care to peruse them on the premises.)

Grading Criteria:
Everyone always wants to know how things will be graded. I can't say that I blame you. ☺
A report can ALWAYS be improved. Even scientific articles that your professors write can be improved. Thus, there is a high standard to achieve. Grading your reports can be an ambiguous task. To ensure fewer ambiguities and better fairness in grading, the rubric I use is on the following page.

Note: You are allowed one rewrite per lab report. The final grade for that lab report will be an average of the original report and the rewrite.

Student's name:	Excellent	Good	Adequate	Deficient	Seriously Deficient
Abstract Summarizes the objectives, methods, and proposed results in one paragraph without references.					
Introduction Provides sufficient background information to understand the reason for this study.					
Clearly states the hypothesis (or hypotheses) being tested/point of paper.					
Methods Describes methods in sufficient detail to allow others to repeat the experiment.					
Is written in the appropriate style: narrative (paragraphs) rather than an itemized list; past tense; declarative sentences (stating what was done rather than telling the reader what to do).					
Results Narrative clearly states the results of the experiments.					
Tables and/or graphs are included where appropriate to summarize large amounts of data or to show relationships between the independent and dependent variables.					
Discussion Results are interpreted and evaluated regarding their significance and implications.					
<u>Entire Paper</u> **Documentation** Citations (including the author and year of publication) are included in the text where appropriate.					
Complete bibliographic information for every source cited in the text of the paper; references appear at the end of the paper.					
Style Style is clear and concise.					
Mechanics Grammar, syntax, punctuation and spelling are correct.					
<u>Overall</u>					

Millsaps College Chemistry Department
Safety Policy

Note: Work in the Olin Hall laboratory facilities will not be permitted unless a signed copy of this statement is on file in the Chemistry Department Stockroom for the duration of this course. (A copy will be provided in the laboratory for you to sign. This copy should stay in your laboratory book.)

1. Eye protection is required and will be worn at all times in the laboratory and wherever reagents are stored. Your goggles are to be put on as you enter the laboratory and not removed until you leave. Anyone not wearing safety goggles in the lab will be required to leave the lab.
2. No eating, drinking, or smoking is allowed in any chemistry laboratory.
3. The suggested attire is a pair of cotton jeans or slacks and a short or long sleeve shirt. No sandals, clogs, open toed shoes, tank tops, halter tops, bare midriffs, etc. are allowed in the laboratory.
4. Long hair should be confined behind the neck and shoulders in a manner that prevents it from falling forward at any point during the lab.
5. Never work in the laboratory without the supervision of a laboratory instructor or lab assistant.
6. Read the entire laboratory procedure BEFORE the beginning of lab and BEFORE the prelab lecture.
7. No unauthorized or unscheduled experiments are to be performed.
8. Anyone removing reagents or equipment from the lab will be held in violation of the Millsaps Honor Code.
9. Locate and be familiar with the proper use of eyewashes, safety showers, fire extinguishers, and secondary exits.
10. Any special medical condition (for example, pregnancy, diabetes, epilepsy) should be reported to your lab instructor for proper response to possible needs.
11. Reagents should never be tasted.
12. Never smell reagents directly; waft (fan) the fumes toward your nose.
13. Proper handling of equipment and reagents used in an experiment is an individual's own responsibility.
14. Reading labels and using only those specific reagents in proper concentrations for the experiment is an individual's own responsibility.
15. Proper disposal of waste reagents is the user's responsibility. Your lab instructor or lab assistants will give specific directions for disposal of hazardous waste materials.
16. NEVER return excess reagents to the original container or dispose of any SOLIDS in the trough and/or sinks
17. Proper clean up is important to lab safety. Bench tops must be wiped clean, individual equipment should be replaced in drawers so as to avoid breakage. Shared or one day checkout equipment should be returned clean at the end of the laboratory period. Your "mess" is your responsibility, not that of your instructor.
18. Any accident or injury, however minor it may seem, must be reported to your instructor immediately.
19. When pouring liquids from a bottle, place hand over label and pour from the opposite side. This will result in fewer reagent contact incidents. Immediately clean up all spills as soon as they occur.
20. Always add acid to water.
21. Dispose of broken glass in the bins/boxes marked “Broken Glass,” never the trash cans.
22. Never look directly down the end of a container that is being heated. Never direct the open end of a container that is being heated or shaken toward your neighbor.
23. ALWAYS wash your hands before leaving laboratory.
24. Be aware of your actions. Any accident you may have is just as likely to injure your neighbor as it is to injure you.

I have read and understand these standard safety policies of the Millsaps College Chemistry Department and agree to abide by them.

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Student Signature Date Course & Sec. # Desk #