

GUIDELINES FOR PREPARING THE CHEM 4900 RESEARCH REPORT

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty mentor. Undergraduate research generally requires the use of advanced concepts, a variety of experimental techniques, and “hands on” experience using state-of-the-art chemical instrumentation and/or computational methods. Ideally, undergraduate research should focus on a well-defined project that stands a reasonable chance of completion in the time available. A literature survey alone is not a satisfactory research project. Neither is repetition of established procedures.

Research is genuine exploration of the unknown that leads to new knowledge that often warrants publication in a scientific journal. But whether or not the results of a research project are publishable, the project should be communicated in the form of research report written by the student. Preparation of a comprehensive written research report is an essential part of a valid research experience, and the student should be aware of this requirement at the outset of the project. Interim reports may also be required, usually at the termination of the quarter or semester. Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critiqued by the faculty mentor and corrected by the student at each stage.

Guidelines on how to prepare professional-style research reports are not routinely available. For this reason, the following information on report writing and format is provided to be helpful to undergraduate researchers and to faculty mentors.

Organization of the Research report

Most scientific research reports, irrespective of the field, parallel the method of scientific reasoning. That is: the problem is clearly defined, a hypothesis is created, experiments are devised to test the hypothesis, experiments are performed, and conclusions are drawn. This framework is consistent with the following organization of a research report”

Title

Abstract

Introduction

Experimental Methodology or Theoretical Analysis

Results

Discussion

Conclusions and Summary

References

Title and Title Page

The title should accurately reflect the content and emphasis of the project described in the report. It should be as short as possible and include the essential key words.

The author's name (e.g. John C. Smith) should follow the title on a separate line, followed by the author's affiliation (e.g., Department of Chemistry, University of North Texas, Denton, TX, 76203), the date, and possibly the origin of the report (e.g., In partial fulfillment of a Individual CHEM 4900 Research Project under the supervision of Professor Michael Richmond, December, 2007).

All of the above information could appear on a single cover page. Acknowledgements and a table of contents can be added as preface pages if desired.

Abstract

The abstract should, in the briefest terms possible, describe the topic, the scope, the principal observations and the conclusions. It should be written last to reflect accurately the content of the report. The length of abstracts varies but seldom exceeds 200 words.

A primary objective of an abstract is to communicate to the reader the essence of the paper. The reader will then be able to judge whether or not to read the full report. Were the report to appear in the primary literature, the abstract would further serve as a key source of indexing terms and key words to be used in information retrieval. Author abstracts are often published verbatim in *Chemical Abstracts*.

Introduction

“A good introduction is a clear statement of the problem or project and why you are studying it.” (The ACS Style Guide, American Chemical Society, Washington, DC 1986.)

The nature of the problem and why it is of interest should be conveyed in the opening paragraphs. This section should describe clearly, but briefly, the background information on the problem, what has been previously done (with proper literature citations), and the objectives of the current research project. A clear relationship between the current project and the scope and limitations of earlier work should be made so that the reader will understand why the project was undertaken.

Experimental Details, Computational Methodology or Theoretical Analysis

This section should describe what was actually done. It is a succinct exposition of the laboratory notebook, describing procedures, techniques, instrumentation, safety and special precautions, and so on. It should be sufficiently detailed that other experimental researchers would be able to repeat the work and obtain comparable results.

For theoretical reports, the section would include sufficient theoretical or mathematical analysis to enable derivations and numerical results to be checked. Computer programs from the public domain should be cited. New computer programs that are developed during the course of the research project should be described in outline form.

If the experimental section is lengthy and detailed, as in synthetic work, it can be placed at the end of the report or as appendix so that it does not interrupt the conceptual flow of the report. The placement of lengthy synthetic procedures will depend on the nature of the research project and the discretion of the writer.

Results

In this section, relevant data, observations, and findings are summarized. Tabulation of data, equations, charts and figures can be used effectively to present clearly and concisely. (Many scientific journals now allow authors publish lengthy tables and data pertaining to the characterization of new compounds as supplemental data or supporting information. Such information is available to journal readers as an electronic appendix to the published paper.) Schemes to depict reaction sequences may be used here or elsewhere in the report.

Discussion

The crux of the reports is the analysis and interpretation of the results. What do the results mean? How do they relate to the objectives of the project? To what extent have they resolved the problem? The “Results” and “Discussion” sections are interrelated, and they can often be combined into a single section.

Conclusions and Summary

A separate section outlining the main conclusions of the project is appropriate if conclusions have not already been stated in the “Discussion” section. Directions for future work are also suitably expressed here.

A lengthy report, or one in which the findings are complex, usually benefits from a paragraph summarizing the main features of the report – the objectives, the findings, and the conclusions.

In manuscripts prepared for publication there is customarily a section devoted to acknowledgements. However, there is no rule about this, and research reports prepared for CHEM 4900 frequently place acknowledgements following the title page.

References or Literature Cited

Literature references should be collated at the end of the report and cited in one of the formats described in **The ACS Style Guide** or standard journals. Do not mix formats. All references should be checked against the original literature.

Preparing the Manuscript

The personal computer and word processing software have made manuscript preparation and revision a great deal easier. Students should have the opportunity to use a word processor or have access to graphics software that allows numerical data to be graphed, chemical structures to be drawn, and mathematical equations to be represented. These are essential tools of the technical writer. All manuscripts should be carefully proofread for typographical and grammatical errors before being submitted. The faculty advisor should edit preliminary drafts before the report is presented in final form.

Useful Reference Texts

Writing the Laboratory Notebook, by Howard M. Kanare; American Chemical Society, Washington DC 1985.

This book describes among other things the reasons for careful and accurate note keeping, organizing and writing the laboratory notebook with examples, and provides photocopies from laboratory notebooks of famous scientists.

The ACS Style Guide, edited by J. S. Dodd; American Chemical Society, Washington DC 1997.

This volume is an invaluable writer's handbook in the field of chemistry. It contains a wealth of information on preparing any type of scientific report and is useful for both students and professional chemists. Every research laboratory should have a copy, and it should be accessible as the **Handbook of Chemistry and Physics**. It gives pointers on the organization of a scientific paper, correct grammar and style, and accepted formats in citing chemical names, chemical symbols, units and references. There are useful suggestions on constructing tables, preparing illustrations, using different typefaces and type size, and giving oral presentations. In

addition, there is a brief overview of the chemical literature, the way in which it is organized and how information is disseminated and retrieved. A list of other excellent guides to technical writing is also provided. Students are also encouraged to read **The Basics of Technical Communicating**, by B. E. Cain, American Chemical Society, Washington, DC 1988.