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GUIDELINES FOR SENIOR THESIS WORK

GENERAL BACKGROUND

The promotion of independent thinking is one of the loftiest goals of higher education, and the senior thesis work represents Princeton’s common mechanism for approaching this goal. To understand this role you may find it useful to look through the lens of the humanities, where the thesis is expected to demonstrate students’ mastery of the art of scholarship, although in the sciences you may seldom hear the task put in these terms. You may also find it helpful to examine the general meaning of the term scholarship, as well as the underlying principles of knowledge that are used in mastering it: know, use, understand, analyze, synthesize, evaluate. These terms reflect a hierarchy of learning, and you are expected to apply all the steps in completing the work of the thesis.

The essence of scholarly research is the creation of new knowledge through careful, systematic study. Thus your thesis work is expected to make a recognizable and novel contribution to the body of knowledge in your field. Note that this definition transcends all fields, and defines the common element in Princeton theses on topics as diverse as religion and chemistry. The common bond is analysis; you may want to consult a dictionary to get a clear understanding of this crucial term. Analysis is the single most important thing you will do in your thesis work as well as in the writing of the thesis, regardless of whether your novel contribution results from experimental or computational research in chemistry, or, as is more common in the humanities, analysis of existing works.

In chemistry the thesis is not only the hallmark of your Princeton education and the culmination of untold hours of your effort. It is also a record that is written to document your accomplishments for a scientific audience. It is not expected to be understood by family and friends. Your efforts to make it so will not be appreciated by the grading committee, who must read all the theses in the department: it takes a lot of time to do a thorough and fair job even when theses are succinct. You should assume the members assigned to read your thesis have an appropriate background to understand your work without your explaining basic principles. Thus, more is definitely not better; extraneous information is neither warranted nor welcome. Although it is a laudable goal to make scientific work understood by a general audience, the thesis is not the place to hone this skill.

All theses must be organized into sections Introduction, Methods, Results, Discussion, and References. If you are unsure what the contents of each section should be, consult your thesis advisor, the senior class advisor, or published papers that you find clarifying. The placement and contents of the Methods section may vary by field; consult your advisor and/or prior theses from your group or in your field for guidance. Before you use a published paper or a thesis as a model for any purpose, consult one or more faculty members to be sure it is a good model!
ABSTRACT

The abstract should summarize as briefly as possible (never more than one page) the motivation, principal results, and conclusions of the thesis. Abstracts are typically easier to write after completion of the main text.

INTRODUCTION

The introduction to your thesis should be written to enable a professional chemist to understand why and how you carried out the thesis work. As you are writing for chemical professionals, the introduction need not and should not start from first principles. The following sub-sections may help you to frame the introduction appropriately.

BACKGROUND AND SIGNIFICANCE

This section should answer the question: Why is your work important? Briefly sketch the background to your thesis work; critically evaluate relevant existing knowledge; explain the problems and challenges in the field; and identify gaps in our present understanding that can be addressed by the thesis work. Conclude with a statement of what the thesis is about and why you believe it represents an advancement of the field. This exposition is intended to place your work into a broader scientific context, and to provide clear and logical motivation for both the general approach and the specific aims (below) of the thesis. This section may need to occupy as much as 5-6 pages, but not significantly more.

SPECIFIC AIMS

This section serves as a convenient abbreviation to help readers keep everything in order. It is intended to answer, in very specific terms, the question: What did you do/attempt to do? No background or other narrative material belongs in this section; it is not meant to stand alone, nor to provide details about the experiments or experimental system, but rather to provide a succinct and specific summary of the attempted and completed research. This section should occupy no more than one page. It could, for example, consist of little more than a well-organized, minimalistic outline describing questions to be answered, hypotheses tested, and experiments conducted. It may be easiest to write this section after writing the rest of the thesis.

EXPERIMENTAL APPROACH

This section of the Introduction should parallel Specific Aims to explain how you approached the thesis question, and why. Justify the approaches you chose. Briefly describe the experiments or calculations you conducted, and how you analyzed the data and interpreted the results. Indicate how each of your results addresses the gaps in present knowledge outlined in Background and Significance. For any gaps that are not addressed, discuss why. With some variation among fields, this section may be quite short or may need to occupy as much as 3-4 pages, but not more.
Note that most of the Introduction could have been written even before you began your work. Recall that the freshman writing seminars implement the idea of writing as an aid to thinking. Getting an early start on writing your Introduction is one of the best ways to leverage this idea for the work you will carry out.

Beyond the above sections, there are no page restrictions on the thesis. It must be complete, and no one grades theses on thickness.

METHODS

Methods for experiments, computations, and analysis must all be described here. The relevant rule for this section is that it should provide sufficient detail to enable a trained, competent chemist to replicate your work. The key phrase here is trained, competent chemist. Thus, you can simply name methods that are standard in your field, e.g., electrophoresis, and you should not describe them, but you must describe in full any novel features and any deviations from the standard. No details about the background of the methods belong here unless you have developed a new method (in which case it becomes a result itself, and must be also described in the Results section, with all the details required to replicate it in Methods). Thus, you need not explain how a method works unless you invented it. Like the Introduction, much of the Methods might be written very early in your work.

RESULTS

It can sometimes be difficult to draw a sharp line between results and discussion. A rough guideline is that results include things you observed; discussion includes what you think about them. Sometimes it is cumbersome to separate the two, requiring that you reiterate the results when you discuss them. For this reason some published papers combine the two sections, and you may do so. You may find it useful to read several papers of each type to see how each approach works in order to make the best choice for your case.

Each result must be explained in words even if it is shown in a figure. Although common knowledge says that a picture is worth a thousand words, scientific figures do not speak for themselves. You must describe what is shown on each figure almost as if the reader cannot see it, e.g., “Figure X shows that the free energy change for the reaction depends linearly on temperature over the range 298 to 325 K, with a slope of ~ -2 kcal/mol K.” Again, find examples in the published literature that do this task well – not all do! Finally, nothing that is visible on a figure should be left unexplained in the text.

On the other hand, ironically, most experienced readers of scientific papers study the figures first, and sometimes do not even read the text. As a rule, each figure must be designed to be as self-explanatory and self-contained as possible. This requires clear labeling of all the features, and a clear and complete legend to explain everything that is shown. Although it goes without saying that all symbols, labels, etc. must be
distinguishable, legible, etc., you will need to make a final check to ensure that photoreduction or formatting requirements have not compromised clarity.

Control experiments are an essential part of scientific work that is as important as any others. As chemical professionals, graders will think of the controls they would have done, and will judge the quality of your conclusions in this context. Whenever control results are critical to your interpretation of an experiment, they must receive the same careful presentation, description, and interpretation as the rest.

Results that are not new need not be described in the same detail as novel ones. For example it may be adequate to simply say in words that certain results replicate those of published work, rather than showing a figure. You needn’t characterize compounds that are not new; you can simply report that characteristics X, Y, or Z conform to those already reported. On the other hand, anything you did that is new must be documented completely.

Remember that your thesis is evaluated by graders who are professionals in your field. They will value a professional approach to your work. The thesis is no place to whine about why your experiments didn’t succeed or why you did not complete the work.

**DISCUSSION**

The purpose of the Discussion is to interpret your results and to fit them into the context of previous knowledge. Furthermore, the grading committee will judge the quality of your thesis in part on the soundness of your conclusions and the logic of the arguments you marshal to reach them. Thus you must interpret your data, because results, like figures, do not speak for themselves. What do your data suggest? What are the ambiguities in your data? Are there alternative interpretations? These should be considered explicitly, and argued for or against using logically developed arguments. In other words, if you propose that the data support a given conclusion, you must lead readers through your logic so they can judge for themselves if your reasoning is sound.

The Discussion should also include your re-analysis of the current state of knowledge with respect to your thesis problem, given the results you have presented.

Finally, how would you continue the project if you were staying on beyond graduation? What would be the next steps? This part of the Discussion should reflect your re-analysis.

**REFERENCES AND ATTRIBUTIONS**

Complete citations, *including complete titles*, of all research articles, book chapters, etc. must be included in the list of references, and each one must be cited in the text at the appropriate place. Use a consistent formatting style for citations in the text; consistency is more important than the choice of style, and the same goes for the reference list.
It can sometimes be difficult for students to understand how to correctly reference statements in the thesis. It is not easy to give all-encompassing guidelines either, but the following may be useful. A statement that is common knowledge within your discipline, or that is self-evident from context, need not be referenced, but a specific fact generally requires a reference. For example, the fact that glucose oxidase oxidizes glucose need not be referenced, but its $K_m$ and $V_{max}$ values should be referenced, citing the original work in which the given values were determined. A useful dividing line might be whether the information is presented in the standard textbooks of the field. In other words, if a thesis grader would probably find the information on his or her bookshelf, it probably does not require a citation. However, graders will not appreciate having to do a search to confirm a fact that you don’t reference. This is the one case where more is not necessarily worse; if in doubt it may be better to reference a statement unnecessarily than to omit a needed reference.

Referencing serves several purposes: to indicate information that is already established; to credit those who have established it; to demonstrate scholarship and thereby establish the authority of the cited facts. These points require that the cited source(s) be both authoritative and primary. Scientists have been called professional skeptics; your thesis readers will not accept claims at face value if the citations are substandard. When in doubt you should err toward using the most authoritative source available, generally published works rather than internet sources. Most published works have been vetted by the process of peer review, and experienced readers can often interpret the citation itself to infer the likelihood and quality of such review, and thus the authority of the claim. On the other hand, the provenance of internet sources is generally unknown and sometimes unknowable; exceptions are generally limited to sites maintained by scientific organizations, such as the Protein Data Bank. You should cite the original work that established the facts you cite, rather than a later review, summary, or textbook. High-quality scholarship demands that you have evaluated the quality of the evidence yourself directly in the published sources: you are responsible for knowing what is in the references you cite. Your grade will reflect the quality of your scholarship and not only the quality of your work.

Direct quotations of the words of others are essentially never used in scientific writing, regardless of whether or how they are attributed, placed in quotes, cited, etc. Just don’t do it! And of course using the words of others without attribution is plagiarism. Graders easily recognize any deviation from your own characteristic writing voice, and routinely check such passages using efficient string searches. Students sometimes justify borrowing because someone else has said something much better than they could, or they may feel that there is only one way to say it. Neither is necessarily true. By recasting the information in your own words you demonstrate your mastery of it - besides the fact that plagiarism is an actionable offense.

Supporting evidence that comes from unpublished work other than your own must be clearly identified as such, and attributed to a specific person. For example, “The melting point of compound X is 165 °C (unpublished; personal communication from Dr. John Smith, postdoc in the research group of Prof. Jane Doe).”

*It must be entirely clear what you did and what others did; anything and everything that was done by anyone other than yourself must be attributed specifically, with name and
details. For example, “The clone of protein X was provided by Dr. John Smith, a postdoc in the research group of Prof. Jane Doe.” Ambiguities on this issue will not be regarded favorably by the grading committee. Related to this issue, do not use the first person plural (we) anywhere. This is your thesis; there is no we. Although the use of the first person singular is very restricted in the published literature in all fields of science, a thesis is one of the very few exceptions.

APPENDICES

All data and methods essential to replicate your work must be present in the thesis. Some large or unconventional items, or uninteresting but necessary details such as extensive data tables, standard characterization measures, etc. may be included as a supplement to the main text in the form of one or more appendices. Your advisor can suggest which items are appropriate for the appendix vs. the main text.

GENERAL GUIDELINES

It is essential that readers be able to follow the logic of your ideas or arguments. To this end, here are some general principles for scientific writing that you may find useful. These apply throughout the thesis (and for that matter in most everything you write!).

A paragraph should contain only one main idea (or claim or argument). The purpose of each paragraph is to present a stepwise development of its central idea. In general, six to eight sentences are the ideal length of a paragraph, the usual number required to develop one main idea and keep the reader’s attention. A way to tell if you’re on the right track is to write one word or phrase in the margin of each paragraph identifying its central idea. The transition between paragraphs must also be logical, leading the reader through your thought process.

Each of you has taken a freshman writing seminar. The thesis is the ultimate application of what you learned there, and in many ways the writing seminars aim to anticipate the thesis. Thus, you should certainly refer back to the critiques from the professional staff of the writing center for specific guidance about your own expository style. The writing program aims to provide guidance not only about writing but also about scholarship as well. Their course materials may therefore be useful at an early stage in the design of your thesis work, not just for the writing.

One of the hallmarks of high-quality scholarship is accurate and precise - even elegant - use of the language. However, unless you can use the language with absolute correctness, attempts at elegance will appear foolish. There is nothing wrong with a simple but correct style. Educate yourself about the many pitfalls in American usage (lead vs. led; imply vs. infer; the list is long but there are several websites devoted to clarifying common misusages). A well-written and well-argued thesis can command a higher grade than a poorly written one, and can redeem inconclusive results or unsuccessful experiments.
Finally, your thesis advisor has valuable experience with publishing papers, and should also be your most important source for critical input on scientific aspects of your work. Some of your Ph.D. student or postdoc mentors will also have experience with writing published papers, plus detailed knowledge of your work. You should encourage all readers of your drafts to make scientific as well as expository critiques. *Note that this implies you should seek scientific input while you still have time to act on it.* It is advisable to seek such advice outside your own research group as well, to provide perspective that is independent of the pre-existing narrative about your project.
FORMAT AND BINDING GUIDELINES

Every senior thesis must meet the formatting and binding requirements indicated below. These guidelines a) permit the Seeley G. Mudd Manuscript Library to archive your document, b) help you produce a professionally formatted thesis, and c) assist our faculty in grading the thesis by giving them a clear, clean layout of your work.

COPIES:

You submit the following copies of your thesis to the Undergraduate Administrator, Room A22 Frick, by 4:30 p.m. on the due date: Monday, April 23, 2012. Your material must be logged in by the Undergraduate Administrator to assure the department you met the deadline and in order to avoid late penalties.

These four copies will include:

   a) Two hardbound copies - **No** softbound copies will be accepted. These copies must be exact replica of your thesis.

   b) One unbound copy - This unbound copy **must be an identical copy** of your bound thesis, including pages reproduced in color. This unbound copy **must** be printed on standard printing paper, one-sided only.

   c) One electronic copy - A PDF version of your thesis must also be submitted directly to the Undergraduate Administrator. If you have any difficulties converting your thesis to a PDF document, please consult the New Media Center for assistance in order to maintain your formatting, figures, graphs, etc.

You may also want to order extra copies for yourself, your parents, etc.

These copies will be distributed as follows:

1. One bound copy will be given to your advisor. The second bound copy will be cataloged in the Chemistry Library after grading is completed by the thesis committee.

2. The unbound copy will be stored in the Princeton University Archives in the Seeley G. Mudd Library and made available to researchers in accordance with U.S. Copyright Law. It is the policy of the University that all researchers have access to senior theses on deposit in Mudd Library. In addition, “fair use,” as defined by the federal copyright law, allows for limited copying of senior theses on deposit in Mudd. Under extraordinary circumstances, a student may petition the Dean of the College in writing to restrict access to a thesis for a specified period of time.
EXTRA COPIES OF SELECTED PAGES:

In addition, you are required to submit two copies of your title page and abstract for our files.

BINDING - Timing:

Keep in mind that a stitched binding, which is the most durable type of binding, will take approximately three days to complete. Be sure to add enough time to your thesis production plan to account for this process. In general, allow at least forty-eight hours for binding services. It is not uncommon for companies to experience a backup of work.

All required copies of your thesis must be turned in by the due date. Difficulties in scheduling the binding process will NOT justify an extension of the thesis deadline.

Local resources for binding include, but are not limited to, Triangle Repro (150 Nassau Street, Princeton - (609) 924-4630) and Smith-Shattuck Bookbinding (759 State Road, Princeton (609) 497-1445).

FORMATTING:

Cover: Covers must be constructed of a hard, firm material for durability. (Soft covered documents will not be accepted.)

Cover - Lettering:
1. The following information should be printed on the cover of your thesis:
   - Thesis title
   - Your full name
   - Your thesis advisor’s name
2. The following should be printed on the spine:
   - Your last name
   - Your class year

Software: The use of Microsoft Office Word is not required. Please work with your faculty advisor to determine the most appropriate software for the development of your thesis document.

Spacing: The thesis should be typed, double-spaced on standard size paper with the margins listed below.

Margins: In order to accommodate the binding process, set your margins as follows:
Left 1 ½”
Top 1”
Bottom 1”
Right 1”

**Printing:** Your thesis **must** be printed on only **one side** of the paper.

**Paper:** It is recommended that your thesis be printed on acid-free, archival quality bond paper (20 to 24 pound substance), 8 ½ × 11 inches in size, for permanence and durability.

**Special note:** The unbound copy for the Seeley G. Mudd Manuscript Library **must** be printed on standard printing paper, one-sided only.

**Font:** Fonts must be clear and easy to read, and of 10 point or greater size or 10-12 characters per inch. To determine the characters per inch, put a rule under a line of text and count the average number of characters in an inch. The number may vary if you use right justification or a printer that produces proportional spacing. Serif fonts, such as Times New Roman or Garamond, are preferred, but Sans Serif fonts such as Arial are also acceptable.

The document should use only one style of font. Exceptions are made only for graphs, charts, pictures, or photographs that are imported from programs that do not allow captions and other attached material to be altered.

**Widows and Orphans:** Avoid “widow” lines (short lines ending a paragraph at the top of a page) and also “orphan” lines which are headings, subheadings or a single line of a paragraph at the bottom of a page as much as possible.

**Pagination:** The title page and copyright page should be unpaginated. All pages before the beginning of the body text of the thesis (abstract, table of contents, lists of tables, acknowledgements, etc.) should be paginated with lower case roman numerals, beginning with iii. All pages of the text, including drawings, illustrations, figures, bibliography, appendices, etc. should be numbered in Arabic numbers, beginning with 1 and running consecutively to the end of the manuscript. Numbers should be located in the bottom center or bottom right margin or top right margin, and should be no closer than ½ inch from an edge. Do not use letter suffixes (10a, 10b). **ALL PAGES OF TEXT MUST BE NUMBERED.**

**References:** Follow the ACS Style Guidelines for listing references and formatting the bibliography. A **copy of the ACS Style Guide is available in the Lewis Library. Chapter 14 covers the rules for references**, and is available under E-reserves on the Senior Chemistry Blackboard site. A concise resource you might wish to consult is [http://library.williams.edu/citing/styles/acs.php](http://library.williams.edu/citing/styles/acs.php).

**Illustrations - Tables, figures, photos, and images:** The term ‘illustrations’ covers all non-text elements of a thesis, such as line drawings, graphs, maps, photographs, facsimiles of manuscript pages, so forth. Each illustration must be numbered consecutively. Large illustrations are normally placed on separate pages with the identifying illustration number and page number. All illustrations must meet the margin requirements.
All material in the thesis must be photo reproducible. Photographs may be included, but must be clear and high contrast. Color graphics may be included, but they must be clear when reproduced in gray scale.

**Drawings, Equations and Formulas:** Line drawings that are to be used directly in the bound copy of the thesis without photographic, offset, or electrostatic (i.e. Xerox) reproduction must be prepared directly on the same high-quality, long-lived and durable paper described previously and drafted and lettered in black India ink or other non-water-soluble ink. If copies of figures are to be used, they must be prepared and printed in such a way as to meet the same paper and reproduction standards required for the text of the thesis.

All subscripts and superscripts must be large enough to be read. To test for readability, photocopy such a page using a 25% reduction. If the sub- or superscripts are still readable, then the text is probably large enough. No letter or symbol should be less than 2 mm in size. Labels on figures can be lettered using a guide or template. Transfer letters are fragile, and figures or pages of text prepared with transfer lettering cannot themselves be part of the thesis, but must be presented in electrostatically reproduced (photocopied) form.

**Printed Sources:** Excerpts from other publications or sources, such as manuscript pages, maps, autographs, passages of script, formulas or mathematical symbols - whether text or illustration, letter-size or over-sized, high contrast or continuous tone - can be reproduced in black and white by the various methods developed for other illustrative materials. Items to be included in the thesis should be photographically reproduced or offset or electrostatically printed. Such copies should have high contrast. Copies should be made on the same long-lived and durable paper as required for the text of the thesis.

**PREFATORY PAGES:**

**Page 1 (unnumbered) - Title Page:**

TITLE

Your name

Submitted in Partial Fulfillment of the Requirements of the Degree of Bachelor of Arts

To the Department of Chemistry of Princeton University

(date)
Page 2 (unnumbered) - Copyright: If you wish to use a copyright statement, please use the following format on Page 2 of your document:

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Copyright law protects the rights of the creator. By simply writing your thesis, you own it. Current laws allow the University’s Mudd Manuscript Library to make single copies in response to research inquiries. If, in the future, you wish to publish portions or your full thesis, you may do so as the owner without procuring any written permissions.

Page 3 (numbered iii) – Honor Statement:

I hereby declare that I am the sole author of this thesis, and that this thesis represents my own work in accordance with University regulations.

______________
Signature

Page 4 (numbered iv) - Acknowledgments: This optional page is for giving credit to those who helped you with your thesis and/or gave you support to do so. The length and people acknowledged are left to your discretion.

Page 5 (numbered v) – Abstract: No more than one page. Consult the thesis guidelines for content.

Page 6 (numbered beginning with vi) – Table of Contents: Doubled spaced between entries. Entries longer then one line are singled spaced.

Page 7 (numbered sequentially after Table of Contents with lower case roman numerals) - List of Tables, List of Charts, and List of Figures: Numbered sequentially after Table of Contents with lower case roman numerals

BODY OF THESIS: Numbered sequentially in Arabic numerals starting with 1

Bibliography: Numbered sequentially in Arabic numerals continuing from after the thesis body

Appendices: Each Appendix is numbered sequentially starting with 1. Appendix pages are numbered consecutively in Arabic numerals continuing after the bibliography. Consult thesis guidelines for content.
EVALUATION AND GRADING GUIDELINES

The thesis advisor and the thesis grading committee grade the Senior Thesis. The thesis grading committee consists of two faculty members from each of the four sub-disciplines, Biological Chemistry, Inorganic and Materials Chemistry, Organic Chemistry, and Physical Chemistry.

The thesis advisor grades both effort and scholarship. Using the grading guidelines listed below, the thesis advisor will submit the completed Senior Thesis Grading form to the Director of Undergraduate Studies.

The two faculty members for each subdiscipline will evaluate all theses in their field for scholarship. The reading committee will follow the same guidelines for scholarship as the thesis advisor. Theses that bridge two disciplines will be read by both subdisciplines for scholarship. Members of the thesis grading committee will submit their evaluation forms to the Director of Undergraduate Studies.

The Director of Undergraduate Studies and the thesis grading committee will review the Senior Thesis grading forms and assign grades. The grading committee will maintain an overall balance by discipline and compliance with the University grading expectations.
GUIDANCE FOR GRADING OF SENIOR THESIS EFFORT

This guidance is to be used by the research advisor only. Scholarship is graded separately, by the research advisor as well as (independently) by the grading committee, using the document, Guidance for grading of senior thesis scholarship.

An A-range effort is characterized by all of the following:
- the student took both intellectual and practical responsibility for all aspects of his or her project from the beginning;
- the student developed context and approaches for his or her project by uncovering relevant materials well beyond those provided by the advisor or research mentor;
- the student persisted diligently in the face of failures, and suggested thoughtful alternatives once persistence appeared fruitless;
- the student was fully engaged in all the work of the research group, and was an active contributor to all group meetings;
- the student was an excellent group citizen, doing more than his or her share of common duties, and being highly respectful of lab rules and of the space and needs of coworkers.

A B-range effort may in part resemble an A-range effort, but may exhibit one or more of these minor deficiencies:
- the student took intellectual and practical responsibility after some delay, or for only some aspects of his or her project;
- the student developed some context or approaches for his or her project, but used mostly sources cited in material provided by the advisor or research mentor;
- the student persisted in the face of failures, but usually sought alternatives from others;
- the student was fully engaged in some of the work of the research group, or was an active contributor in some but not all group meetings;
- the student was a very good group citizen, doing his or her share of common duties, being respectful of lab rules, and being considerate of the space and needs of coworkers.

A C-range effort may in part resemble a B-range effort, but may exhibit one or more of these significant deficiencies:
- the student took intellectual or practical responsibility but not both, or took responsibility only late, or for only limited aspects of his or her project;
- the student used only the material provided by the advisor or research mentor and did not go beyond it, or did not develop context or approaches;
- the student persisted in the face of failures, but did not seek alternatives;
- the student was engaged in little of the work of the research group, or was an irregular participant in group meetings;
- the student was an acceptable group citizen but did less than his or her share of common duties, or was sometimes inconsiderate of the space or needs of coworkers or neglectful of lab rules.
A D-range effort may in part resemble a C-range effort, but may exhibit one or more of these major deficiencies:
• the student took little or no intellectual or practical responsibility for his or her project;
• the student made little or no use of the material provided by the advisor or research mentor;
• the student did not persist in the face of failures;
• the student was engaged in little or none of the work of the research group, or was an infrequent participant in group meetings;
• the student was a poor group citizen, doing far less than his or her share of common duties or being often inconsiderate of lab rules or of the space or needs of coworkers.

An F-range effort exhibits one or more of these fundamental deficiencies:
• the student took little or inconsistent interest in his or her project;
• the student was poorly acquainted with the material provided by the advisor or research mentor;
• the student completed little or no work;
• the student showed little or no evidence of being engaged with the research group;
• the student was an unacceptable group citizen.
GUIDANCE FOR GRADING OF SENIOR THESIS SCHOLARSHIP

This guidance is to be used by both the research advisor and the grading committee. It evaluates only the thesis itself, i.e., the contents between the covers. Effort is graded separately, by the research advisor only, using the document, Guidance for grading of senior thesis effort.

A-range scholarship is characterized by all of the following:

- the Abstract is both concise and thorough, and stands alone as a succinct summary;
- the Introduction is coherent, logical, well-organized, and scholarly;
- the Background and Significance section of the Introduction convincingly establishes scientific motivation, is thoroughly researched, and masterfully integrates the thesis problem into the context of prior knowledge;
- the Specific Aims section of the Introduction is succinct, specific, and complete;
- the Experimental Approach section of the Introduction convincingly justifies the approaches used;
- the Methods are succinct and complete;
- all Results are described clearly, depicted accurately, analysed thoroughly, and interpreted soundly and creatively in the context of prior knowledge;
- citations and attributions in the text are comprehensive, appropriate, and scholarly;
- all citations in the References list are complete, accurate, uniformly formatted, and are cited in the text;
- overall, the thesis is a masterpiece of impeccable scholarship throughout, and is written in clear, idiomatic, accurate and precise, sophisticated English.

A B-range thesis may in part resemble an A-range thesis, but may exhibit one or more of these minor deficiencies:

- the Abstract is less than concise or thorough, or would require revision to stand alone as a succinct summary;
- the Introduction is mostly logical and organized;
- the Background and Significance section of the Introduction discusses scientific context and motivation, provides an accurate overview of the thesis problem, and integrates it into the context of prior knowledge;
- the Specific Aims section of the Introduction is complete;
- the Experimental Approach section of the Introduction provides some justification of the approaches used;
- the Methods are complete; most Results are described clearly, depicted accurately, analysed thoroughly, and interpreted soundly in the context of prior knowledge;
- citations and attributions in the text are appropriate and accurate; most citations in the References list are complete, accurate, uniformly formatted, and cited in the text;
- overall, the thesis displays very good scholarship, and is written in clear, idiomatic, accurate and precise English.
A C-range thesis may in part resemble a B-range thesis, but may exhibit one or more of these significant deficiencies:

- the Abstract includes the major points but does not communicate them effectively;
- the Introduction is sometimes confusing or disorganized;
- the Background and Significance section of the Introduction discusses scientific context and motivation, and provides an accurate overview of the thesis problem; the Specific Aims section of the Introduction is complete but unspecific or verbose;
- the Experimental Approach section of the Introduction provides little justification of the approaches used;
- the Methods are incomplete; some Results are not described clearly, depicted accurately, analysed thoroughly, or interpreted soundly in the context of prior knowledge;
- citations and attributions in the text are inappropriate or inaccurate;
- the References list is incomplete or inconsistently formatted, or contains entries that are inaccurate or are not cited in the text;
- overall, the thesis displays average scholarship, or is written in unclear or cumbersome English.

A D-range thesis may in part resemble a C-range thesis, but may exhibit one or more of these major deficiencies:

- the Abstract misses some major points or communicates the main points poorly;
- the Introduction is confusing or disorganized;
- the Background and Significance section of the Introduction provides little or no scientific context or motivation nor a useful overview of the thesis problem;
- the Specific Aims section of the Introduction is incomplete, unspecific, or verbose;
- the Experimental Approach section of the Introduction provides inadequate justification of the approaches used;
- the Methods are incomplete; many Results are not described, depicted accurately, analysed, or interpreted in the context of prior knowledge;
- citations and attributions in the text are missing or inappropriate;
- the References list is incomplete or inconsistently formatted, or contains entries that are inaccurate or are not cited in the text; overall,
- the thesis displays poor scholarship, or is written in unclear or cumbersome English.

An F-range thesis exhibits one or more of these fundamental deficiencies:

- the Abstract misses most major points and communicates the points poorly;
- the Introduction is confusing and disorganized;
- the Background and Significance section of the Introduction provides no scientific context or motivation and no overview of the thesis problem;
- the Specific Aims section of the Introduction is missing or incomplete;
- the Experimental Approach section of the Introduction provides no justification of the approaches used;
- the Methods are incomplete; most Results are not described, analysed, or interpreted; citations and attributions in the text are missing or inappropriate;
- the References list is incomplete; overall, the thesis displays little evidence of scholarship.
**SENIOR THESIS GRADING FORM**

Student: ____________________________       Advisor: ____________________________

1. **Faculty Advisor.** Referring to the attached Guidance documents, enter three numerical grades in the spaces provided: (a) one for scholarship, (b) one for effort, and (c) one overall grade. Do not enter any letter grades. All grades in the range 93-100 must be accompanied by a letter from the faculty mentor that justifies the grade in detail, clearly distinguishing scholarship and effort, and evaluating merit based on the grading guidance rather than on comparison with other students.

(a) **Scholarship.** Based on the Guidance for grading thesis **scholarship**, this thesis should be graded:

   _____ (93-100: a masterpiece of impeccable scholarship throughout)
   _____ (78-92: sound scholarship throughout)
   _____ (63-77: acceptable scholarship throughout)
   _____ (55-62: poor scholarship)
   _____ («55: inadequate scholarship)

(b) **Effort.** Based on the Guidance for grading thesis **effort**, this thesis should be graded:

   _____ (93-100: exemplary effort in all respects)
   _____ (78-92: solid effort in all respects)
   _____ (63-77: acceptable effort in all respects)
   _____ (55-62: weak effort)
   _____ («55: inadequate effort)

(c) **Advisor overall thesis grade _____** (points only)

(d) This thesis should be read by the following subdisciplines of Thesis Grading Committee:
    (check all the apply)

   _____ Biological   _____ Inorganic/Materials   _____ Organic   _____ Physical
2. Grading committee. Referring to the attached Guidance document, each reader enters one numerical grade for scholarship in the appropriate space provided. Do not enter any letter grades. All grades in the range 93-100 must be justified by a brief note from the reader that evaluates merit based on the grading guidance rather than on comparison with other students.

Based on the Guidance for grading thesis scholarship, this thesis should be graded:

- ___ ___ ___ ___ ___ (93-100: a masterpiece of impeccable scholarship throughout)
- ___ ___ ___ ___ ___ (78-92: sound scholarship throughout)
- ___ ___ ___ ___ ___ (63-77: acceptable scholarship throughout)
- ___ ___ ___ ___ ___ (55-62: poor scholarship)
- ___ ___ ___ ___ ___ («55: inadequate scholarship)

Committee average scholarship points ___

Final thesis points = (Faculty scholarship points × 30%) + (Faculty effort points × 30%) + (Average committee scholarship points × 40%) = ___

Final thesis letter grade ___

| A+ | A | A− | B+ | B | B− | C+ | C | C− | D | F |
|----|---|----|----|---|---|----|---|---|---|---|---|
| ≥98| ≥93| ≥88| ≥84| ≥81| ≥78| ≥73| ≥68| ≥63| ≥55| <55|