The Senior Independent Work & Thesis Guide

The Department of Chemistry
Princeton University

2024 – 2025

Chemistry is often referred to as the Central Science due to its interconnections with the other STEM fields. Chemists play vital roles in biology, medicine, material science, environmental science, and many other disciplines. Careers in chemistry range from traditional laboratory paths of synthetic organic chemistry in pharmaceutical applications and quality control scientists in consumer products and environmental settings to more applied careers in medical forensics, energy technologies, and art conservation. Many of the chemistry faculty at Princeton are also associated faculty in other University departments. The course requirements for the chemistry major reflect this interdisciplinary philosophy. Representative Thesis titles from the Class of 2023 demonstrating the wide spectrum of thesis topics.

Representative Senior Thesis titles from the class of 2023:

- "Evaluation of Phenoxythiazoline-Cobalt Catalysts for $C(sp^2)$–$C(sp^3)$ Suzuki-Miyaura Cross-Coupling Reactions"
- "Optimization of the Light-Driven Contra-Thermodynamic Chain Walking Isomerization of Olefins"
- "Nickel Metallaphotoredox Enabled Phosphonylation of Alkyl Bromides"
- "A Concise and Industrially Viable Synthesis of Squalene"
- "Characterizing the Extein Dependence and Catalytic Mechanism of the Ultra-fast Split Intein NrdJ-1"
- "Analyzing Metabolism with NMR Spectroscopy: A Comparison of Multivariate Statistical Tools in MetaboAnalyst, MATLAB, and R"
- "Exploring Magnetism in Chromium-Based Pyroxenes by Tuning Germanium and Silicon Content"
- "So, It Turns Out Lanthanides Aren't All the Same: Structural Stability of $LnSb_x Te_{2-x-\delta}$ Compounds"
- "Nanoscale Dancing: Photophoretic Swimmers and their Stochastic Movement"
- "Spectroscopic Characteristics of Photosynthetic Cryptophyte Algae: Recombinant Phycobiliproteins and Protein Subunits"

Contents

SENIOR THESIS WORK

During senior year, chemistry majors are expected to continue the laboratory or computational work described in their spring JIW proposal or a new project is outlined in consultation with the PI of the laboratory. Students are expected to continue working in the laboratory with a regular and predictable schedule, and to also begin working on sections that can be included in their final thesis document. For example, materials and methods sections can be written concurrently with laboratory research and results should be summarized as they are obtained.

Seniors are expected to be fully engaged with their research group and attend all research group meetings as required by their PI. Students are regularly called upon to present their current results during group meetings. As a member of the lab, students are expected to be respectful of lab rules and of the space and needs of coworkers. The student and the mentors and/or PI should meet regularly to ensure that the student is investing a reasonable amount of time on the project to move the project forward at a rate that meets the expectations of the advisor.

The Senior Thesis in chemistry is a report on the independent research carried out by the student, either in a laboratory or theoretical setting during their final year at Princeton. It is the culmination of a year's worth of experimental design and execution, and the full analysis of the results. The thesis demonstrates knowledge and the application of fundamental concepts in chemistry. In addition to submission of the written thesis, students will defend their thesis orally.

GOALS FOR SENIOR THESIS WORK

The Goals of the Senior Thesis Work are divided into two components: *Effort and Scholarship*. *Effort* is focused on the execution of the research project during the year and reflects the student's direct contribution to the overall project. *Scholarship* goals are related to the communication of results orally and in writing to peers, mentors, faculty and other members of the department and community at large.

Effort goals are:

- to investigate a scientific question using the scientific method, by designing and conducting experiments. A student will ultimately take both intellectual and practical responsibility for all aspects of the project, constantly evaluating results to determine the next steps to pursue.
- to develop context and approaches for the project by uncovering relevant materials well beyond those provided by the advisor or research mentor.
- to persist diligently in the face of failures and suggest thoughtful alternatives once further persistence seems counterproductive.
- to become an excellent group citizen, contributing to common laboratory duties, and being highly respectful of laboratory rules as well as the space and needs of coworkers.
- to become an active member of a research community and be a good citizen within the department.
- to appreciate diverse approaches to research, and work in a safe, responsible, and ethical manner.

Scholarship goals are:

- to understand the genres of scientific papers and presentations and how these different genres are applicable to the different disciplines in Chemistry.
- to understand the standard structure of a scientific paper and the purpose of each section, and to create both a research proposal (Junior Year) and formal thesis (Senior Year) focused on the Independent Work research project.
- to write a good *Abstract* that have is both concise and thorough and stands alone as a succinct summary.
- to construct a *Background and Significance* section which convincingly establishes the scientific motivation by providing a critical evaluation of the published literature, is thoroughly researched, and masterfully integrates the thesis problem into the context of prior knowledge.
- to write a succinct, specific, and complete set of *Specific Aims* which summarize the research objectives attempted and how they relate to the overall thesis question.
- to write a succinct and complete *Methods* section which provides all the information necessary for anyone to replicate the experiments.
- to present *Results* clearly and effectively, depicted accurately with appropriate figures, and presented in a logical format.
- to write a *Discussion* that thoroughly analyzes the research approach, interprets all results, and makes conclusive statements based on the interpretation of the data.
- to write a final *Conclusion and Future Work* section that summarizes all of the intermediate conclusions into a final narrative which mirrors the *Specific Aims* section and answers the thesis problem asked in the Introduction.
- to include a *Reference* section that attributes prior research and maintains good citations that are uniformly formatted throughout the text.
- to deliver Independent Work results orally in a formal scientific presentation for members of the scientific community.

SENIOR THESIS WORK TIMELINE

<table>
<tr><th>Senior Fall</th><th>Laboratory Research</th><th>Writing Support Workshops</th></tr>
<tr><td>September</td><td rowspan="4">Seniors continue their laboratory research projects, as proposed in their spring Junior Paper, or adapted according to laboratory updates. Regular check-ins with the PI should occur.</td><td rowspan="4">Optional workshops are held during the fall to help students master specific requirements for writing the Senior Thesis.</td></tr>
<tr><td>October</td></tr>
<tr><td>November</td></tr>
<tr><td>December</td></tr>
<tr><td>Wintersession</td><td colspan="2">Seniors are encouraged to participate in Residential College Thesis Bootcamps or work in the laboratory during Wintersession.</td></tr>
<tr><td>January</td><td colspan="2">Students complete a Thesis Outline and initial draft of the Introduction section. The detailed outline should include research done to date and planned experiments. Students and PIs meet to review the outline and discuss progress. A formal progress update is completed and submitted to the DUS.</td></tr>
<tr><th>Senior Spring</th><th>Laboratory Research</th><th>Writing Support Work Sessions</th></tr>
<tr><td>February</td><td rowspan="2">Students continue laboratory research while also working on the Senior Thesis document.</td><td rowspan="2">Optional mentored evening writing sessions are provided as a space for seniors to dedicate to writing their thesis and asking questions about style and format. Seniors can schedule appointments with the ADUS for additional writing questions and help.</td></tr>
<tr><td>March</td></tr>
<tr><td>April</td><td colspan="2">Chemistry Department Senior Thesis is due Mid-April.</td></tr>
<tr><td>May</td><td colspan="2">Chemistry Department Comprehensive Exams (Oral Thesis Examination) is held during the University Comprehensive Exam dates.</td></tr>
</table>

GENERAL THESIS WRITING 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 first-year student 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.

All these 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.

Abstract

The abstract should summarize as briefly as possible (typically less than half a 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 published literature in the area; explain the problems and challenges in the field; and identify gaps in our present understanding that can be addressed by the thesis work. The literature review section should begin broadly and then narrow gradually towards relevant research conducted by your research group, which sets the stage for your project. 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.

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.

Note that most of the Introduction could have been written even before you began your work. Recall that the first-year student 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.

There are no page restrictions on the thesis. The *Introduction* section is typically 6-10 pages. The other sections do not have suggested lengths. The Senior Thesis does not have a minimum or maximum length, but the document should be both complete and concise.

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 and Discussion

The Results and Discussion sections are often combined to add clarity to the thesis narrative. It can sometimes be difficult to draw a sharp line between results and discussion, but you should make clear to your reader what things are results and what statements are interpretations. A rough guideline is that results include things you observed; discussion includes what you think about them. If you wish to present results first in a complete Data and Results section, followed by a Discussion of those results, that is an option. Sometimes it is cumbersome to separate the two, requiring that you reiterate the results when you discuss them. 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.

In your Junior Independent Work proposal, you wrote an Experimental Design section to justify how you were going to carry out your Specific Aims. In your thesis you should weave your Experimental Design into the discussion of your results. Often in research, an experimental approach changes over time depending on the results that were found. During the discussion of your results, you should justify the approaches you chose and identify any changes to procedures. *Briefly* describe the type of 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.

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 labelling of all the features, and a clear and complete legend to explain *everything* that is shown. Although it is obvious 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.

The purpose of the Discussion is to interpret your results and to fit them into the context of previous knowledge. Furthermore, the reading 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.

Conclusions and Future Work

The Conclusion should include your re-analysis of the current state of knowledge with respect to your thesis problem, given the results you have presented. The Conclusion should also reflect on the specific aims and address how they were met, or not. Finally, how would you continue the project if you were staying on beyond graduation? What would be the next steps? This part of the Conclusion section should reflect your re-analysis.

Reference 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. Students should follow the reference style of the Journal of the American Chemical Society, with titles, which includes superscript references in the body of the document. The use of citations managers, like Zotero or EndNote, are strongly encouraged.

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. Your thesis must be signed with the honor code statement and should adhere to all rules governing plagiarism and AI usage, as covered in Rights, Rules, and Responsibilities. The Department of Chemistry *does not* grant any permission to use AI-generated text for independent work.

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 reading 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 published literature in all fields of science, a thesis is one of the very few exceptions.

Figures, Graphics, and Illustrations

The use of appropriate figures, graphics, and illustrations is an important aspect of scientific writing. Many concepts are more easily understood when accompanied by illustrative explanations. Figures, tables, schemes, and other graphics should be located on the page in which they are first mentioned in the text, or as close to that paragraph as possible without breaking across the page. It can be a very time-intensive process to create quality graphics, so work on figures as soon as possible when writing.

The ACS Style Guide, Chapter 15, is an excellent resource for tips and suggestions for creating figures for scientific publications. All figures must be numbered and include a stand-alone figure caption. Each figure must also be referenced within the body of the thesis. Stylistically, you should capitalize the word "Figure" when it is followed by its number when you refer to it in the text, e.g. "In Figure 2 the differences can be seen…" Figures should be numbered sequentially in the order that they appear in the text. Figures include charts, images, graphics, and anything not

counted as a Scheme, Table, or Equation. All figures must be included in the "Figure Table of Contents" in the intro section to the thesis.

It is preferred that you create all figures for your thesis on your own. If, however, you must use a figure that has been published before, you must obtain permission from the publisher, *in writing*, before you may use the figure. All published journal articles have a "Rights and Permissions" link which will lead you to the site where you ask for permission to use a figure. If you use a previously published figure, even if it was published by members of your research group, you must obtain permission, and you must include a statement in the figure caption (usually dictated by the publisher) that says something similar to: "Reprinted from (12). Copyright 2005 American Chemical Society." If you include even a part of an image or change an image slightly you still must receive permission to publish, but instead of saying "reprinted" you should say "adapted." Please note that although figures and images are copyrighted, the data is not, so if you create your own figure from published data, you do not need permission, you only need to cite that the figure was created with "data from reference 12." You must submit all written permissions for reproduced figures along with your thesis as part of an appendix or you may be charged with an honor code violation for copyright infringement.

If you wish to use images in your figures make sure that they are not copyrighted and fall into the category of public domain if they are not your original pictures. Graphics and images included in ChemDraw templates are free to use in scientific publications without further citation.

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.

ORAL THESIS DEFENSE – DEPARTMENTAL COMPREHENSIVE EXAM

The Departmental Comprehensive Exam is styled as an Oral Thesis Defense. A student will give a 15-minute oral presentation summarizing their thesis results to a panel of 3-4 faculty members. A 5-minute question and answer period will follow the presentation. The faculty members present will determine a grade based on the following criteria:

- **Introduction/Background and Aims:** Clearly states purpose and impetus for research, presents logical progression of related studies to motivate primary hypothesis.
- **Results:** Results are logically displayed, clear and well-described.
- **Conclusions:** Findings are clearly stated and follow from results presented; Future directions are mentioned.
- **Presentation:** Appropriate amount of information, clear presentation, confidence, effective use of graphics.
- **Responses to Questions:** Clear and effective response to questions asked.

SENIOR THESIS WORK ASSESSMENT AND GRADING

Senior Thesis Independent Work appears on your transcript as CHM 984, and you earn a letter grade for your Senior Thesis Work which counts as 2 courses in your overall GPA but does not count toward the 31 courses needed for graduation. The Senior Departmental Comprehensive Exam appears on your transcript as CHM 983 and does not count toward the 31 courses for graduation nor toward the overall GPA. Scores for both Senior Thesis and Senior Comprehensive Exam count toward Departmental Honors calculations.

Senior Thesis Grading
The Senior Thesis is evaluated for both ***effort*** and ***scholarship.*** Each thesis is evaluated independently by the thesis advisor and by a thesis reading committee. The thesis advisor evaluates both ***effort*** and ***scholarship*** using separate guidelines contained. The thesis advisor submits the completed evaluations and a brief note justifying the evaluation to the Director of Undergraduate Studies.

The thesis reading committee evaluates ***scholarship only*** using the same guidelines as the thesis advisor. The reading 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 two faculty members in each sub-discipline of the committee evaluate all theses in that sub-discipline. Theses that bridge disciplines are read by additional sub-discipline members, as necessary. Members of the thesis reading committee submit their evaluations and a brief letter justifying the evaluation to the Director of Undergraduate Studies. The DUS and the thesis reading committee together review the evaluations and assign grades. The DUS and the reading committee aim to maintain an overall balance of grades across sub-disciplines, as well as compliance with University's grading expectations.

Guidance about Senior Thesis *Scholarship*
Effort guidance is provided separately.

A-range scholarship is characterized by <u>all</u> of the following:

- the Abstract is both concise and thorough, and stands alone as a succinct summary;
- 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 Methods are succinct and complete;
- all Results are described clearly and effectively, depicted accurately with appropriate figures, presented in a logical format, and are journal-quality;
- in the Discussion section, experimental approach is justified, all results are analyzed thoroughly, interpreted soundly and creatively in context of prior knowledge, and the discussion is journal-quality;
- Citations within the body of the text are appropriate, accurate, and *comprehensive*, are uniformly formatted throughout the text, and are all included in a uniform format in the References list;
- 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 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 Methods are complete;
- most Results are described clearly and effectively, and depicted accurately with appropriate figures and presented in a somewhat logical manner;
- in the Discussion section, much of the experimental approach and many of the results are analyzed thoroughly in the context of prior knowledge;
- Citations within the body of the text are mostly appropriate and accurate, are uniformly formatted throughout the text, and are included in a uniform format in the References list;
- 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 Methods are incomplete;
- some Results are not described clearly, nor depicted accurately with appropriate figures, and logical arguments are not developed fully;
- in the Discussion section, experimental approach is not justified well and some of the results are not analyzed thoroughly or interpreted soundly within the context of prior knowledge;
- some of the Citations used may be inappropriate or inaccurate, some sections may not be cited thoroughly, some of the citations may be missing from the References list, and the formatting may not be consistent throughout the document;
- 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 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 Methods are incomplete;
- many Results are not described clearly, nor depicted accurately with appropriate figures, and logical arguments are difficult to comprehend;

- in the Discussion section, the experimental approach is barely discussed, many of the results are not analyzed thoroughly or interpreted soundly in the context of prior knowledge;
- more than a few of the Citations used may be inappropriate or inaccurate, many sections may not be cited thoroughly, some of the citations may be missing from the References list, and the formatting may not be consistent throughout the document;
- 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 Methods are incomplete;
- most of the Results are not described, figures are missing, and key findings are missing;
- in the Discussion section, the experimental approach is not mentioned and most of the results are not analyzed at all or placed within the broader context of prior knowledge;
- overall, the thesis displays little evidence of scholarship.

Guidance about Senior Thesis *Effort*

Scholarship guidance is provided separately.

An A-range effort is characterized by <u>all</u> 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.
- the student invested an amount of time, both under direction and under his/her own initiative, to move the project forward at a rate that exceeded expectations mutually agreed between student and advisor.

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.
- the student invested an amount of time adequate to move the project forward at a rate that met expectations mutually agreed between student and advisor.

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.
- the student invested an amount of time that moved the project forward at a rate that fell somewhat short of the expectations mutually agreed between student and advisor.

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.
- the student invested an amount of time that moved the project forward at a rate that fell far short of the expectations mutually agreed between student and advisor.

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;
- the student invested too little time to move the project forward.

See the appendix for a copy of the Senior Thesis grading forms.

SENIOR THESIS FORMAT AND BINDING GUIDELINES

Every senior thesis must meet the formatting 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 evaluating the thesis by giving them a clear, clean layout of your work.

Due Date and Number of Copies

You will submit an electronic copy of your thesis by 4:30 PM on Monday, April 14, 2025. Your material must be logged in by the Undergraduate Administrator to assure the department that you met the deadline and in order to avoid late penalties.

You will submit the PDF copy of your thesis to Thesis Central – Seeley G. Mudd Library. Please see http://rbsc.princeton.edu/policies/senior-thesis-submission-information-students for instructions of thesis submission. Your thesis document must be submitted as a PDF file. The file should not exceed 1 GB. When you enter your title and abstract into the submission portal you should use LaTeX commands to ensure that superscripts, subscripts, and italics display correctly.

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 some circumstances, a student may request that the thesis have restricted access for a period of time. To request an embargo, the Restricted Access Form, https://princetonu.sharepoint.com/sites/our/strar/SitePages/Start.aspx, must be completed before 11:55 PM on the day of Commencement.

You may want bound copies for your advisor, yourself, or your family. Local resources for archival-quality binding include Smith-Shattuck Bookbinding (759 State Road, Princeton (609) 497-1445). Bethel Bindery in Tuckerton, NJ, (1500 Route 439, Tuckerton, (609) 296-5043) also produces archival-quality documents.

Formatting[1]

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

Margins: Your margins should be set as follows:

Left	1"
Top	1"
Bottom	1"
Right	1"

Note: If you are planning to print and bind your thesis, you should use a 1.5" Left Margin.

[1] Taken in part, with permission, from the Dissertation/Thesis requirements published by Seely G. Mudd library. https://library.princeton.edu/document/5536

Spacing: The thesis should be typed, double-spaced on standard size paper with the margins listed below. Single-spacing or 1.5-spacing may be used for front or back matter and captions of figures.

Font: Standard fonts such as Times New Roman or Arial are preferred. If using other fonts, be sure to use embeddable Type 1 or TrueType fonts. Script, italic, or ornamental fonts are not acceptable. Italicized font may be used for non- English words and quotations, and for other judicious uses.

Font size should be equivalent in scale to 10-point Arial or 12-point Times New Roman. These rules apply to captions, and bibliographies. Footnotes and endnotes can be one point smaller than the body of the text. Exceptions may be made only for tables and figures produced by different technology or by a graphic artist.

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.

Text Alignment: Text should be aligned-left to avoid large gaps in text which sometimes occur with full justification.

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. Most word processing programs have a default setting to suppress widows and orphans in paragraphs, but also check for headings and subheadings.

References: Citations should be made in the style of the *Journal of the American Chemical Society*. **A copy of the ACS Style Guide is available under E-reserves on the Senior Chemistry Canvas site.** Your bibliography **must** include titles for all references.

Illustrations - Tables, figures, photos, and images: The term ‘illustrations’ covers all non-text elements of a thesis. Each illustration must be numbered consecutively as a figure, table, or scheme. Illustrations should usually occupy the full width of the page, unless they are small enough to be legible in a half-width image. Exceptionally large illustrations may be placed on separate pages with the identifying illustration number and page number. All illustrations must meet the margin requirements.

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, including Appendices. 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.

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

Adviser: [Adviser Name]

May 2025

Page 2 (unnumbered) – Copyright

If you wish to use a copyright statement, please use the following format on Page 2 of your document:

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 of 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

Note: The submitted electronic copy **MUST** contain a copy of your signature. You cannot simply type your name.

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 than one line are singled-spaced.

Page 7+(numbered sequentially, vii, viii) List of Tables, List of Charts, and List of Figures

Numbered sequentially after Table of Contents with lower case roman numerals. Tables of Figures should include the figure number and title of the figure with the appropriate page.

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 section is numbered sequentially starting with Appendix 1. If only one Appendix is included, it is simply "Appendix." Appendix pages are numbered consecutively in Arabic numerals continuing after the bibliography, not as A1, A2… Consult thesis guidelines for content.

RESPECTFUL AND PRODUCTIVE LEARNING ENVIRONMENT

The Department of Chemistry is committed to providing an open and supportive learning environment that is free from all forms of discrimination, harassment, exploitation, or intimidation. Academic rigor and intellectual exchange of scientific ideas is an integral part of your development as an independent scientist. However, exchanges with members of the department must be done in a respectful manner and have an understanding of the diverse background of all members of the Chemistry Department. Dr. L'Esperance, Director of Undergraduate Studies, and Dr. VanderKam, Director of Diversity Programs, are available to meet with any students to discuss any issues relating to interactions with any member of the departmental community.

APPENDIX: EVALUATION FORMS

SENIOR THESIS MID-YEAR PROGRESS REPORT

Student: _____ **Advisor**: _____

To assist us in planning for evaluating this Senior Thesis, this thesis should be read by the following sub-disciplines of the reading committee: (*check all that apply)*

_____ Biological _____ Inorganic _____ Materials _____ Organic _____Physical

Evaluate your student's Senior Thesis progress based on the criteria listed in the "EVALUATION OF SENIOR THESIS EFFORT" document.

Circle the point value corresponding to appropriate statement that describes the student's thesis effort in each category.

Project ownership

5 The student shows both intellectual and practical responsibility for all aspects of his or her project
4 The student shows intellectual and practical responsibility for most aspects of his or her project and/or with some delay
3 The student shows consistent intellectual or practical responsibility but not both, or takes responsibility only late, or for only limited aspects of his or her project
2 The student shows limited and/or inconsistent intellectual or practical responsibility for his or her project
1 The student shows little or no responsibility for his or her project

Source materials

5 The student develops context and approaches for his or her project by uncovering relevant materials well beyond those provided by the advisor or research mentor
4 The student develops context or approaches for his or her project using mainly sources cited in material provided by the advisor or research mentor
3 The student uses the material provided by the advisor or research mentor without going beyond it, or does not develop context or approaches
2 The student makes little use of the material provided by the advisor or mentor
1 The student is poorly acquainted with the material provided by the advisor or research mentor

Persistence

5 The student is diligent in the face of failures, and suggests thoughtful alternatives once persistence appeared fruitless
4 The student is persistent in the face of failures, mostly seeking alternatives from others
3 The student is persistent in the face of failures, but seldom sought alternatives
2 The student is not persistent in the face of failures
1 The student is not persistent, irrespective of success or failure

Group engagement

5 The student is fully engaged intellectually in all the work of the research group, and is an active contributor to all group meetings
4 The student is engaged intellectually in much of the work of the research group and/or is an active contributor in many group meetings
3 The student is engaged in little of the work of the research group, or is an irregular participant in group meetings
2 The student is engaged in little or none of the work of the research group, or is an infrequent participant in group meetings
1 The student shows little or no evidence of being engaged with the research group

Group citizenship

5 The student is an excellent group citizen, does more than his or her share of common duties, and being highly respectful of lab rules and of the space and needs of coworkers
4 The student is a very good group citizen, does his or her share of common duties, being generally respectful of lab rules and considerate of the space and needs of coworkers
3 The student is an acceptable group citizen but does less than his or her share of common duties, or is sometimes inconsiderate of the space or needs of coworkers or neglectful of lab rules
2 The student is a poor group citizen, does 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
1 The student is an unacceptable group citizen

Commitment

5 The student invests an amount of time, both under direction and under his/her own initiative, to move the project forward at a rate that exceeds expectations mutually agreed between student and advisor
4 The student invests an amount of time adequate to move the project forward at a rate that meets expectations mutually agreed between student and advisor
3 The student invests an amount of time that moves the project forward at a rate that falls somewhat short of the expectations mutually agreed between student and advisor
2 The student invests an amount of time that moves the project forward at a rate that falls far short of the expectations mutually agreed between student and advisor
1 The student invests too little time to move the project forward

I have met with my advisor and discussed the contents of this progress report. I understand his/her comments and recommendations, and the expectations required to move this project forward.

Student's Signature_____ **Date** _____

SENIOR THESIS MID-YEAR PROGRESS REPORT: ADVISOR COMMENTS

Student: _____

Each student is expected to submit a detailed outline of their thesis, including a list of completed and planned experiments. Additionally, a draft of the introduction section of their thesis must be submitted (by January 24) to the advisor for review.

Please provide Dr. Robert L'Esperance, DUGS, with comments about this student thesis progress to date.

Advisor's Signature_____ **Date** _____

SENIOR THESIS MID-YEAR PROGRESS REPORT: STUDENT COMMENTS

Advisor: _____

Each student is expected to submit a detailed outline of their thesis, including a list of completed and planned experiments. Additionally, a draft of the introduction section of their thesis must be submitted (by January 24) to the advisor for review.

Please provide Dr. Robert L'Esperance, DUGS, with comments about your experiences with your thesis project and your lab work environment.

Student's Signature_____ **Date** _____

EVALUATION OF SENIOR THESIS SCHOLARSHIP

Student: _____**Advisor**: _____

This evaluation is to be used by ***both*** the research advisor ***and*** the reading 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 criteria presented in the document, "*EVALUATION OF SENIOR THESIS* ***EFFORT***."

Circle the point value corresponding to the appropriate statement that describes the scholarship of the thesis in each category. Evaluation is based on a scale of 5, high, to 1, low.

This thesis should be read by the following sub-disciplines of the reading committee:
(*check all that apply)*

____ Biological _____ Inorganic _____ Materials _____ Organic _____Physical

Each assessment must be justified by a brief note that evaluates merit based on the evaluation criteria rather than on comparison with other students. **Use the back of this form to provide the required justification or attach a separate letter.**

Abstract

___ **5** Stands alone as a succinct summary; concise, thorough, and journal-quality
___ **4** Less than concise or thorough, or would require revision to be journal-quality or to stand alone as a succinct summary
___ **3** Includes the major points but does not communicate them effectively
___ **2** Misses some major points or communicates points poorly
___ **1** Misses many major points and communicates points poorly

Introduction: Background and Significance

___ **5** Convincingly establishes scientific motivation, is thoroughly researched, and masterfully integrates the thesis problem into the context of prior knowledge
___ **4** Discusses scientific context and motivation, provides an accurate overview of the thesis problem, and connects it to prior knowledge
___ **3** Discusses scientific context, prior knowledge, and motivation, and provides an accurate overview of the thesis problem
___ **2** Provides little or no scientific context or motivation or useful overview of the thesis problem
___ **1** Provides no scientific context or motivation or overview of the thesis problem

Introduction: Specific Aims section

___ **5** Succinct, specific, and complete
___ **4** Complete
___ **3** Complete but unspecific or verbose
___ **2** Complete but unspecific and verbose
___ **1** Incomplete

Methods

___ **5** Succinct and complete
___ **4** Complete
___ **3** Partially incomplete
___ **2** Largely incomplete
___ **1** Incomplete

Results

___ **5** All results are described clearly and effectively, depicted accurately with appropriate figures, presented in a logical format, and are journal-quality
___ **4** Most results are described clearly and effectively, and depicted accurately with appropriate figures and presented in a somewhat logical manner
___ **3** Some results are not described clearly, nor depicted accurately with appropriate figures, and logical arguments are not developed fully.
___ **2** Many results are not described clearly, nor depicted accurately with appropriate figures, and logical arguments are difficult to comprehend
___ **1** Many of the results are not described, figures are missing, and key findings are missing

Discussion

___ **5** All results are analyzed thoroughly, interpreted soundly and creatively in context of prior knowledge, and the discussion is journal-quality
___ **4** Many of the results are analyzed thoroughly and interpreted soundly in the context of prior knowledge
___ **3** Some of the results are not analyzed thoroughly or interpreted soundly within the context of prior knowledge
___ **2** Many of the results are not analyzed thoroughly or interpreted soundly in the context of prior knowledge
___ **1** Most of the results are not analyzed at all or placed within the broader context of prior knowledge

Experimental Approach incorporated in Discussion

___ **5** Convincingly justifies the approaches used
___ **4** Provides some justification of the approaches used
___ **3** Provides little justification of the approaches used
___ **2** Provides inadequate justification of the approaches used
___ **1** Provides no justification of the approaches used

Citations

___ **5** The citations within the body of the text are appropriate, accurate, and *comprehensive*, are uniformly formatted throughout the text, and are all included in a uniform format in the References list

___ **4** The citations within the body of the text are mostly appropriate and accurate, are uniformly formatted throughout the text, and are included in a uniform format in the References list

___ **3** Some of the citations used my be inappropriate or inaccurate, some sections may not be cited thoroughly, some of the citations may be missing from the References list, and the formatting may not be consistent throughout the document

___ **2** More than a few used may be inappropriate or inaccurate, many sections may not be cited thoroughly, some of the citations may be missing from the References list, and the formatting may not be consistent throughout the document

___ **1** The citations in the body of the text and recorded in the References list are incomplete and formatted poorly

Overall

___ **5** A masterpiece of impeccable scholarship throughout, written in clear, idiomatic, accurate and precise, sophisticated English

___ **4** Displays very good scholarship and is written in clear, idiomatic, accurate and precise English

___ **3** Displays average scholarship or is written in unclear or cumbersome English

___ **2** Displays poor scholarship or is written in poor English

___ **1** Displays little evidence of scholarship

Recommended *Scholarship* Numerical Grade: _____

Recommended *Scholarship* Letter Grade: _____

A+			A					A-					B+				B			B-			C+	C	C-	D	F
100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	75	70	65	60	50

Evaluation completed by _____

EVALUATION OF SENIOR THESIS EFFORT – SENIOR THESIS ADVISOR

Student: _____ **Advisor**: _____

This evaluation is to be used by the ***research advisor only***. Scholarship is evaluated separately, by the research advisor as well as (independently) by the reading committee, using the criteria presented in the document, "*EVALUATION OF SENIOR THESIS* ***SCHOLARSHIP***."

Circle the point value corresponding to appropriate statement that describes the student's thesis effort in each category. Evaluation is based on a scale of 5, high, to 1, low.

Each assessment must be justified in a brief note that evaluates merit based on the evaluation criteria rather than on comparison with other students. **Use the back of this form to provide the required justification or attach a separate letter.**

Project ownership

___ **5** The student took both intellectual and practical responsibility for all aspects of his or her project from the beginning
___ **4** The student took intellectual and practical responsibility for most aspects of his or her project and/or with some delay
___ **3** The student took consistent intellectual or practical responsibility but not both, or took responsibility only late, or for only limited aspects of his or her project
___ **2** The student took limited and/or inconsistent intellectual or practical responsibility for his or her project
___ **1** The student took little or no responsibility for his or her project

Source materials

___ **5** 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
___ **4** The student developed context or approaches for his or her project using mainly sources cited in material provided by the advisor or research mentor
___ **3** The student used the material provided by the advisor or research mentor without going beyond it, or did not develop context or approaches
___ **2** The student made little or no use of the material provided by the advisor or research mentor
___ **1** The student was poorly acquainted with the material provided by the advisor or research mentor

Persistence

___ **5** The student persisted diligently in the face of failures, and suggested thoughtful alternatives once persistence appeared fruitless
___ **4** The student persisted in the face of failures, mostly seeking alternatives from others
___ **3** The student persisted in the face of failures, but seldom sought alternatives
___ **2** The student did not persist in the face of failures
___ **1** The student did not persist irrespective of success or failure

Group engagement

___ **5** The student was fully engaged intellectually in all the work of the research group, and was an active contributor to all group meetings

___ **4** The student was engaged intellectually in much of the work of the research group and/or was an active contributor in many group meetings

___ **3** The student was engaged in little of the work of the research group, or was an irregular participant in group meetings

___ **2** The student was engaged in little or none of the work of the research group, or was an infrequent participant in group meetings

___ **1** The student showed little or no evidence of being engaged with the research group

Group citizenship

___ **5** 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

___ **4** The student was a very good group citizen, doing his or her share of common duties, being generally respectful of lab rules and considerate of the space and needs of coworkers

___ **3** 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

___ **2** 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

___ **1** The student was an unacceptable group citizen

Commitment

___ **5** The student invested an amount of time, both under direction and under his/her own initiative, to move the project forward at a rate that exceeded expectations mutually agreed between student and advisor

___ **4** The student invested an amount of time adequate to move the project forward at a rate that met expectations mutually agreed between student and advisor

___ **3** The student invested an amount of time that moved the project forward at a rate that fell somewhat short of the expectations mutually agreed between student and advisor

___ **2** The student invested an amount of time that moved the project forward at a rate that fell far short of the expectations mutually agreed between student and advisor

___ **1** The student invested too little time to move the project forward

Recommended *Effort* Numerical Grade: _____

Recommended *Effort* Letter Grade: _____

A+			A					A-					B+				B			B-			C+	C	C-	D	F
100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	75	70	65	60	50

PRINCETON UNIVERSITY
DEPARTMENT OF CHEMISTRY

SENIOR COMPREHENSIVE EXAMS EVALUATION

Student: _____ Advisor:_____

Evaluator: _____

Instructions:

The Senior Comprehensive Exam in Chemistry is an oral presentation that the student will give to a panel of 3 faculty members. The examination will last 25 minutes and typically begins with the student presenting a brief (15-minute) summary of their thesis. This is followed by questions that the faculty members will ask about the thesis, its background, and how it relates to other topics in chemistry. The faculty members present will determine a grade based on the quality of the presentation and the student's ability to answer questions. The grade will appear on the transcript as the "senior departmental exam grade."

Rating Scale: 1 = Marginal 2 = Acceptable 3 = Exceeds Expectations

Scoring Criteria:

Exceeds Expectations (3) – Demonstrates creativity, originality, or understanding beyond basic expectations.

Acceptable (2) – Meets basic expectations for creativity, originality, and understanding.

Marginal (1) – Displays below-average creativity, originality, or understanding of content.

Rating	Category	
	Introduction/Background and Aims: Clearly states purpose and impetus for research, presents logical progression of related studies to motivate primary hypothesis	CONTENT
	Results: Results are logically displayed, clear and well-described	
	Conclusions: Findings are clearly stated and follow from results presented; Future directions are mentioned	
	Presentation: Appropriate amount of information, clear presentation, confidence, effective use of graphics	
	Responses to Questions: Clear and effective response to questions asked	

General Comments:

Overall Rating (Please circle the numeric rating on the grade scale):

A+			A					A-					B+				B			B-			C+	C	C-	D	F
100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	75	70	65	60	50

RESOURCES

People

Director of Undergraduate Studies	Robert L'Esperance	rpl@princeton.edu
Assc. Director of Undergraduate Studies	Susan VanderKam	skillian@princeton.edu
Undergraduate Administrator	Shafon McNeil	smcneil@princeton.edu
Princeton Chemistry Librarian	Emily Wild	ewild@princeton.edu

Technology Support

https://chemistry-it.princeton.edu/

McGraw Center for Teaching and Learning

https://mcgraw.princeton.edu/

Princeton Writing Center

https://writing.princeton.edu/writing-center

Chemistry Style Guide: The ACS Guide to Scholarly Communication Website:

https://pubs.acs.org/doi/book/10.1021/acsguide

Chemical Conventions Section:
https://pubs.acs.org/doi/full/10.1021/acsguide.40401
General Style Conventions (Italics, hyphens, abbreviations, etc.)
https://pubs.acs.org/doi/full/10.1021/acsguide.50301
Numeric Conventions:
https://pubs.acs.org/doi/full/10.1021/acsguide.50401

Other Important University Support Services

Rights, Rules, and Responsibilities
https://rrr.princeton.edu/
Office of Disability Services
https://ods.princeton.edu/
University Counseling and Psychological Services
https://uhs.princeton.edu/counseling-psychological-services
Cultural and Affinity Groups
https://www.princeton.edu/one-community/cultural-affinity-groups
Office of Diversity and Inclusion
https://odi.princeton.edu/
https://inclusive.princeton.edu/
Sexual Misconduct and Options for Reporting Incidents
https://sexualmisconduct.princeton.edu/
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