**PhD Requirements for the Inorganic Path**

Department of Chemistry

University of Wisconsin-Madison

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Available on the web at <http://www.chem.wisc.edu/content/inorganic-requirements>

**1) *Coursework (Years 1 and 2)***

All inorganic Ph.D. students take the following **two core courses** during their **first** fall semester.

* **Chem 608:** *Symmetry, Bonding, and Molecular Shapes* (3 credits)
* **Chem 713:** *Chemistry of the Elements* (3 credits)

You must take 9 credits of additional coursework including at least two of the following courses:

* **Chem 606:** *Physical Methods for Structure Determination* (3 credits)
* **Chem 613:** *Chemical Crystallography* (3 credits)
* **Chem** **630:** *Selected Topics*: Chemistry of Inorganic Materials (2-3 credits)
* **Chem 714:** *Organometallic Chemistry of the Transition Elements* (3 credits)
* **Chem 801:** *Selected Topics in Inorganic Chemistry (any topic)* (2-3 credits)

You must also take the following course every semester:

* **Chem 900**: *Seminar -- Inorganic Chemistry* (1 credit)

During the first two years there is a graded assignment:

The inorganic faculty will designate one or two seminars per semester as “CHEM 900 Seminars”. The faculty host and speaker for each of these seminars will prepare a set of papers related to the topic of the seminar that are to be distributed to the CHEM 900 students no later than 9 days before the seminar (i.e., by the Monday of the week before the seminar). The students are to read these papers in preparation for the visit of the seminar speaker. The CHEM 900 students will submit a list of three to five questions to the host due the day before the seminar (these will be graded and constitute ¼ of the grade for that seminar), and write a critical seminar/literature report (constituting ¾ of the grade for that seminar) due one week after the seminar. All post-seminar question periods will begin with questions from students. Additionally, the CHEM 900 students will be given a time slot to meet with the seminar speaker for discussion. The host will evaluate all written materials, assigning a grade (pass, marginal, fail). In their first three semesters, students receive an automatic Satisfactory grade. After the fourth semester a final grade of Satisfactory or Not Satisfactory is assigned that is cumulative over all four semesters.

Format for the report:

~ 5-7 pages double-spaced, not including figures or references.

Every Ph.D. student at UW-Madison must complete a **safety course** during the 1st year. This course is **only offered in January**, the week before the beginning of the regular semester.

* **Chem 607:** *Laboratory Safety* (1 credit) Offered only during Winter Break

Every Ph.D. student at UW-Madison must attend a seminar course aimed at the new graduate students during the 1st semester. This course offers insight into the Ph.D. program and consists of presentations by faculty and students.

* **Chem 901:** *Teaching of Chemistry* (1 credit)

**Each Fall/Spring Semester, doctoral students must register for 8-15 credits**. A minimum of 8 credits is required. Your credit load is filled out beyond your courses by registering for inorganic research. **Graduate students must also enroll every summer.** In the 8-week summer session, non-dissertators should register for 2 credits of research. Dissertators must register for 3 credits of research every semester and during summer.

* **Chem 994:** *Research – Inorganic (with advisor)* (1-15 credits)

**2) *Thesis background exam* (2nd year research report and oral defense)**

In your 2nd year, you will prepare a written research report including a critical evaluation of the literature in your field, your progress to date in your own research, and your vision and plan for the future directions for your research. The written report is due on Jan. 31st, at the beginning of your fourth semester of study.

Your report should be submitted electronically to Kristi Heming. Your Ph.D. advisor may wish to approve your report before you submit it; please be sure to obtain such approval before you turn in it. At the beginning of your report, make sure to append an evaluation sheet that will be used by your faculty mentoring committee. The evaluation form can be found here: https://www.chem.wisc.edu/deptfiles/2nd%20yr%20report%20eval%20form.pdf. Your committee will read the report and fill out the evaluation sheet prior to your research progress presentation at your mentoring committee meeting.

After submitting your written report, you will schedule a meeting with your faculty mentoring committee. At this meeting, you will make a formal presentation of your research progress to this committee: a 15-minute overview of your accomplishments, with graphics (e.g. PowerPoint) is appropriate. Be prepared to answer questions about your research progress and thesis proposal. At this stage of your graduate study, your results should convince your committee that you have identified a project or set of projects worthy of in-depth study. This meeting should occur before the end of the Spring semester.

Your faculty mentoring committee will typically evaluate your progress in four key areas (using the evaluation form found here: https://www.chem.wisc.edu/content/inorganic-chemistry):

1. Knowledge of the scientific literature in your research area
2. Knowledge of the key techniques used to address your research problems
3. Demonstrated progress to date in Ph.D. research
4. Demonstrated understanding of the scientific method through a coherent explanation of the objectives, goals, and approach for your Ph.D. research.

The combined written report / oral presentation format gives you an opportunity to practice your scientific exposition skills. In addition, the thesis background presentation process encourages you to evaluate your progress after the first year of research, and to formulate future research plans. Preparing the report and oral presentation should provide an excellent opportunity for you to assess your own advancement toward the Ph.D. Honest and accurate self-assessment is essential for professional success. This is a time for you to ensure: 1) that you have mastered the intellectual background for your research, 2) that you understand the significance of your efforts and goals, and 3) that you are committed to pursuing a research-based Ph.D. degree.

Your research report should be written in the style of a paper for the *Journal of the American Chemical Society*, with the general format shown. The document should be approximately 15-20 pages long, using 11 pt Arial font, double-spaced; it is expected that you write concisely and present your data effectively. Figures and Tables should be included as appropriate to explain your work and to show your data (routine data, or work that you do not intend to pursue further should be included in an Appendix). Specific information on the style of *JACS* may be found on the journal web site under “Instructions for Authors” or in the *ACS Style Guide* in the library. You should consult with your Ph.D. advisor as to the appropriate focus for your report and research plan.

#  Abstract (<1 page)

# Introduction/Background & Significance (~3-4 pages)

# Summary of Research Progress (~8-12 pages)

## Experimental Methods

## Results and Discussion

# Future Plans/Thesis Proposal (~3 pages)

# References Cited (complete citations with titles)

# *Optional* Appendix

You may have pursued more than one project by the end of your second year. Research on some of these projects may already have been terminated, for example, because the project was completed or because an underlying assumption was shown to be incorrect. It is unnecessary to provide "future plans" for such projects. This type of effort may be discussed in Part III, or the description may be placed in the Appendix. If you are currently working on two (or more) reasonably distinct projects, you may choose to provide separate write-ups that include Parts I-IV for each project. In this case, the total length for all projects must still fall within the recommended page limits. Alternatively, you may choose to focus the entire report on your most promising project, and place information on other projects in the Appendix. You should consult with your Ph.D. advisor about how best to document your efforts.

**3) *Original Research Proposal (3rd Year)***

During your third year, you will write and orally defend anoriginalresearch proposal (RP). The recognition and development of original and meaningful research problems is an important part of a Ph.D. degree, and the purpose of the RP is to develop and test aptitudes in this area. You should begin to seek out original, independent research ideas that may be used for the RP as early as the beginning of your second year. Current literature, seminars, and course work are all possible sources of ideas for your RP. The RP should be in the general area of inorganic chemistry. *The topic* *must be one on which you have not worked previously, and must be unrelated to research being done in the UW chemistry department*. Proposals far removed from your Ph.D. research are preferred; those in similar, though unrelated areas are acceptable. The proposal will be your own intellectual property and it should represent the best independent research idea that you have had to date. Your RP requirement should be completed in your third year. The latest date on which a written proposal will be accepted is January 31st, with an oral defense completed before the end of the Spring semester.

Turn in an electronic copy of your RP to Kristi Heming; she will distribute it to the appropriate faculty members for review for approval. If your RP contains serious problems, you will be asked to revise it or possibly reconceive it before you are allowed to defend. If you have not been informed whether you are cleared to defend your proposal after two Wednesdays have passed, please notify Kristi.

**Planning the Proposal:**

A good research proposal should seek to answer an important scientific question, the approach should be practical and well described, and the experiments designed to give clear-cut answers. *The scope of your proposal should be a project to be completed by an advanced graduate student or postdoc in one-two years*. You should NOT develop an entire research program. Kristi has examples of RPs written by recent Ph.D. students available for you to review to give you a sense of the proper scope for your proposal

To help you select a topic and develop a good proposal, you should answer the following questions. Write down answers to these questions well before you begin to prepare the formal document. Your answers will help you to develop a well-constructed proposal.

1. Why is the proposed research important? What is the perceived need? Why should you do it? What timely scientific question will this work answer?
2. Where is the WOW in the science?
3. What does your approach enable that no one else can do with existing methods?
4. In what way is the work original?
5. What is the long-range goal?
6. What are the specific objectives? What are the hypotheses to be tested and questions to be answered?
7. Do the specific objectives lead toward accomplishment of the long-range goal?
8. What are the experiments that you propose to do? Is the methodology "state of the art"? What are the expected results? What will you do if your first attempts fail (i.e., what is your back-up plan)?
9. What does the first paper look like?

**Written Proposal Guidelines:**

Your written proposal should follow the style described in the following outline. Your completed proposal should be not more than 10 pages double-spaced including figures and references. Please use Arial 11 point font.

*i) Specific Aims*

* Describe in a few sentences the overall goal of the research and provide an enumerated list of Specific Aims that the proposed studies will address. Clearly distinguish between:
	+ broad, long-term goal; e.g., “explore the mechanisms of organometallic copper oxidase reactions” (hard to quantify progress in achieving this objective).
	+ specific aims; e.g., “use kinetics and spectroscopic tools to investigate the mechanism of copper catalyst oxidation by molecular oxygen” (easy to quantify progress in achieving this objective). The Specific Aims comprise a list of items needed to pursue the broad, long-term goal.

*ii) Background and Significance*

* Briefly summarize background information that is relevant for your proposal.
* Critically evaluate the current knowledge in the field.
* Demonstrate your understanding of the subject by identifying the knowledge gaps that your proposed research is intended to fill.
* State concisely the importance of the research by relating the Specific Aims to the broad, long-term goals.

*iii) Experimental Design and Methods*

In this section, you should outline the experimental designand proceduresthat you will use to accomplish the Specific Aims of this project as formulated in section i. The experimental approach should be outlined clearly and in sufficient detail that the plan may be evaluated by the reviewers (your faculty mentoring committee.)

* Number the subsections in the Experimental Design and Methods section according to the numbers used for the Specific Aims in section i. Use sub-numbering within this section when describing several methods applicable to the same specific aim.
* If applicable, show reaction sequence diagrams for the syntheses of unknown compounds and describe how the success of your synthetic endeavors will be tested using physical characterization methods.
* Explain how experimental and/or computational data are to be collected*,* analyzed*,* and interpreted.
* Discuss potential **difficulties**and **limitations**of the proposed procedures and outline alternative approachesto achieve the aims.

**Note**: The Experimental Design and Methods section is the most important part of your RP. Your primary goal in this section is to convince the reviewers that the research tools and approaches you propose to utilize are well chosen for addressing the Specific Aims formulated in section i. Your description should indicate that you really understand and know how to carry out the research you propose, and that you are familiar with the techniques and their limitations.

*iv) Literature Cited*

* Use JACS format, but also include the titleof each article and book chapter; e.g.:

[1] Andruniow, T.; Kozlowski, P. M.; Zgierski, M. Z. "Theoretical Analysis of Electronic Absorption Spectra of Vitamin B12 Models", *J. Chem. Phys.* **2001**, *115*, 7522-7533.

[2] Johnson, M. K.; Robinson, A. E.; Thomson, A. J. “Low Temperature Magnetic Circular Dichroism Studies of Iron-Sulfur Proteins”, In *Iron-Sulfur Proteins*; Spiro, T. G., Ed.; Wiley-Interscience: New York, 1982; pp 367-406.

* Choose wisely the references that you include. Your choice of citations tells the reviewer about your ability to evaluate the work of others and to distinguish the important from the mundane.

**Proposal Evaluation:**

All members of your faculty mentoring committee will receive a copy of your proposal for evaluation in the four categories listed below. A copy of the RP evaluation form can be found here: https://www.chem.wisc.edu/deptfiles/RP%20Evaluation%20sheet.doc\_.pdf.

1. Scientific Merit: Is the proposed research worth doing; does it answer important questions; does it lead to new and nontrivial results?
2. Practicality: Does the proposed research address a suitably chosen scientific problem; would an advanced graduate student or postdoctoral fellow be expected to make substantial progress in a reasonable amount of time?
3. Technical Competence: Will it work? Are theoretical arguments sound; will the experiments lead to conclusive results; has the student overlooked reasonable alternatives; will synthetic steps work (i.e., are the references to well-documented analogous reactions appropriate)?
4. Presentation: Is the proposal understandable; does it clearly describe the significance of the problem and the proposed solution; does it include pertinent references to the literature?

After review by your faculty research committee, your proposal will be accepted (with minimal or minor revisions), returned for revision, or rejected. If your proposal is acceptable, it will be approved for oral defense. If it is returned for revision, your major professor will provide a summary of critical comments to help you prepare a satisfactory version. If it is rejected, you must develop a new proposal. If you are asked to make major revisions, your revised proposal will be re-evaluated. The revised document should be accompanied by a cover letter detailing the changes you have made to the text and how you addressed the specific comments you received from the faculty. When your research proposal accepted, with minimal or minor revisions, you will schedule a defense to be completed before the end of the Spring semester, but preferably **within the next 30 days**.

**Proposal Defense:**

The research proposal presentation is both an oral *examination* and a *defense* of the proposal. The proposal itself will loosely define and limit the boundaries of the examination; however, you are expected to be fully knowledgeable about the subject including background information, descriptive chemistry, theory, techniques, methodology, and alternatives. You are also expected to be fully aware of the connections between your proposal and your courses, recent seminar presentations in the department, or recent papers in key journals.

You will present and defend your proposal to your faculty mentoring committee. You should prepare a presentation on the proposed research of no longer than 20 minutes. Your presentation should focus on the proposed work; introduce background material only as needed and when it is required to understand your proposed experiments. It is customary for questions to be asked both during and after the presentation; hence, you should expect to be interrupted as you make your presentation. You should strive to answer the questions as clearly and concisely as possible, with expert use of relevant chemical concepts and vocabulary. Immediately following the exam, the committee will evaluate your performance on a pass / conditional pass / fail basis, and will inform you of its decision. If you receive a conditional pass, you may be asked to undertake modest additional work to complete your requirement. If you are judged to have failed, you will be asked either to reschedule another defense or to prepare a new proposal.

**4) *Research Seminar* (4th year)**

You will present a seminar in the regularly scheduled Inorganic Seminar series. The seminar will include a brief review of the field of your dissertation research and a presentation of your results to date. This requirement is an opportunity for you to make a formal research presentation to a knowledgeable audience. Your goals are: (i) to effectively present your work in the appropriate context, (ii) to prepare a compelling visual presentation, and (iii) to practice good oral communication skills.

You will give your seminar in your 4th year, preferably in the first semester of that year. You will prepare a short abstract (in the style of an ACS meeting abstract: 300-500 words) and a print out of your slides (6 slides/page, *numbered please*) to hand out to the audience before your talk (50 copies, double sided). Please turn in one hard copy or a PDF file of each of these items to Kristi Heming in the Inorganic office.

**Planning the Seminar:**

Your presentation should be prepared using PowerPoint or a comparable multimedia program. *Before preparing the complete set of slides for your presentation, you should compose one slide, go to the seminar hall, and project the slide*. Go to the very back of the room and check that the font is large enough and that the slide is not too crowded. With PowerPoint slides, less text and larger font is easier to read. Once you have determined an appropriate font size, continue with that for the rest of the slides. The computer projection system should be utilized to present the talk; you should practice in room 1315 to be certain that you are comfortable with the technology. Plan to talk for approximately 45-50 minutes with 10-15 minutes for audience questions/comments.

There are many resources to help you to learn to prepare an effective presentation. Given the importance of oral and visual communication for job interview seminars, you are advised to seek out as many opportunities to practice these skills as possible. Such opportunities include group meetings, “super-group” presentations, and posters or talks at scientific meetings. The following web sites give useful information for graduate students to learn about oral presentation skills.

<http://www.chem.umn.edu/groups/haynes/philosophy.html>; <http://www.kumc.edu/SAH/OTEd/jradel/effective.html>; <http://pages.cs.wisc.edu/~markhill/conference-talk.html>;

Characteristics of a good talk:

1. A good talk is a well-organized talk. Attention to organization will benefit your entire audience, and will help everyone to learn from your presentation.
2. A good talk has a point to make, and makes that point effectively through wise and judicious selection of the material covered. Present enough material to keep the listeners' attention, but not so much that an informed listener cannot be thinking critically as you speak. Do not try to cover every detail in the field.
3. A good talk balances breadth and depth, offering a critical assessment of an area of current research. Identify several key issues and discuss them in depth. Be critical in your reading and presentation. Think about the diversity of your audience when approaching your topic and tailor your presentation so that a broad inorganic audience will walk away with an understanding of the field.
4. A good talk points out the holes in arguments, and the limitations of the current state of knowledge. When you present studies and their conclusions, do not simply repeat what you have read. Instead, tell your audience why the explanation is accepted and how other alternatives have been invalidated experimentally. In the best talks, the speaker goes even further, pointing out alternative acceptable hypotheses and/or critical experiments that have yet to be performed.
5. A good talk includes a clear context within which to appreciate the material that you are presenting. As the frontiers of chemistry expand, more and more students pursue research displaced from classical inorganic fields. We encourage this trend; however, new methods and concepts must be clearly and thoroughly explained. Show your audience how inorganic chemistry is relevant and important to understanding new fields, by emphasizing the inorganic aspects in your presentation.

Helpful speaking hints:

* Virtually everyone gets nervous before a presentation. The most effective way to counter the effects of nervousness is to know your material as thoroughly as possible. Practice your talk several times in front of other people, in front of a mirror, and in the lecture hall. Memorize the sequence of your slides, as this will imbue your presentation with confidence. It may be helpful to memorize the first few minutes of your talk, but memorize the entire talk only if it is absolutely necessary because a memorized speech is never as compelling as a presentation with a spontaneous edge. Concentrate on speaking loudly, clearly, and slowly. You will naturally speak too rapidly when nervous.
* When using a laser pointer, avoid excessive movement of the dot on the screen. If you are very nervous, try using both hands to hold the pointer, or only turn the pointer on when you need it. If you use the pointer in your right hand, it is easier to point to the screen while looking at the audience if you stand to the right of the screen (audience's right); vice versa for left handed use.

**Seminar Introduction:**

It is the custom that the student speaker who gave the last student seminar prior to yours will introduce you to the audience. Please prepare a very short biography of yourself, <1 paragraph, to aid your colleague in making the introduction. A typical biography should include where and when you received your bachelor’s degree, the name(s) of your undergraduate research mentor(s), and the topic(s) of your undergraduate research. Additional details may be included. If you are unsure who will be doing the introduction, please check with Kristi Heming. She will help you to identify the peer who will introduce you.

**Seminar Evaluation:**

All attendees at your seminar will be asked to fill out an evaluation form. Copies of this form are available here in Kristi Heming’s office. The peer who introduced you to the audience is also responsible for collecting the evaluations and turning them in to Kristi Heming in the Inorganic office. Approximately 1 week after your seminar, you will receive a computerized printout summarizing the evaluation data, as well as the original copies of the evaluation comments.

Immediately after your seminar, your faculty mentoring committee will meet with you briefly to share their impressions of the seminar. The faculty will provide constructive criticism to help you to improve your presentation skills (both written and oral) as well as a critical evaluation of the seminar content.