Chemistry 295 *Inorganic Laboratory* fall 2017

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Meeting time: Scheduled laboratory 1:15–5:15 PM in Discovery W-408. We have good space to have all meetings in the lab. There will be non-chemistry days in which we will not need to wear PPE.

Office hours: Stop by my office as needed or feel free to make an appointment. Plus, I'll be with you every week. I have office hours on Mondays, noon–2:00 pm, if you want a specific time you know you can find me.

Course description: This is an inorganic laboratory. Rather than a traditional laboratory experience, you will target and attempt to address a current problem in inorganic chemistry. It will require more thought and intellectual input that a traditional laboratory course, but the benefits are great. Minimally, you may discover interesting and potentially publishable things.

The course requires that we engage in some planning and experimental design, make what we need, run our experiments, collect data, and analyze our data. If this is to be a useful activity, we need to have at least two iterations.

Learning goals: The overall goal of this course is to leverage prior laboratory experience and classroom knowledge to address research questions in inorganic chemistry. The specific goals of this class map heavily on to the learning goals for a degree in chemistry at UVM

1. Identify (or design) and execute the synthesis of simple metal compounds.
2. Find information in and evaluate the chemical literature.
3. Determine the composition and purity of metal compounds using spectroscopic and analytical techniques.
4. Plan and execute a catalytic reaction.
5. Analyze appropriate data to determine catalyst activity.
6. Communicate results in written and oral form.

In this laboratory, you will map out a plan to address a current problem in inorganic chemistry. The course will provide background (and refresher) information about inorganic chemistry, spectroscopy, and other necessary areas, but it is critical that you read both what is provided and look for more relevant information in the chemical literature.

Making rationally deigned plans, executing these plans, and then evaluating their efficacy is core competency to any job in any field. This is an upper-level lab; more than demonstrating a concept from inorganic chemistry, we are using inorganic chemistry to allow you to design, tinker, think, and explore.

Safety: This is an experimental laboratory—safety in this environment is of paramount importance. Each student will complete a contract that outlines the key safety responsibilities of the course and student.

Course outline: This is not a traditional laboratory course. I am not providing you with a set of pre-designed experiments. At the first class, we will define the problem and scope of our investigation. I have provide several references to frame that discussion. <u>Please read these before our first meeting</u>.

Scientific conduct: Your activity in this course is to generating new data and understanding—you are conducting research. As such, you must conform to UVM's standards for scientific integrity (http://www.uvm.edu/spa/?Page=responsibleconduct.html). There is a zero tolerance policy for the fabrication of data or results in this course.

Plagiarism: We will have a group discussion on the idea of plagiarism in class. While we are looking for you to provide some critical analysis, it is essential that you cite all ideas, content, and images that are used in your work, which are not your own, and that you conform to UVM standards for academic honesty (https://www.uvm.edu/policies/student/acadintegrity.pdf).

Course products: In this course, you will produce new knowledge and (hopefully) understanding. The activities of the course are meant to guide you through that process. Therefore, <u>prompt and thoughtful competition of the assignments is essential to your progress in this course</u>.

<u>Lab notebooks</u>: This is the critical interface between screwing around in lab and doing science. Your notebook captures your work, backs up your data, and catalogs your ideas and thoughts. It should be organized and useable by others. We will discuss, in class, what an appropriate notebook should look like.

<u>Data</u>: You will produce a few kinds of new data. We will discuss and plan on how that is shared and maintained.

<u>Compound plans</u>: This is your basic road map for the experiments you will conduct. The compound plan will have three essential parts.

1. It gives a list of 3–5 compounds. These can be literature compounds or those that you have designed, but all must include preparations—either proposed for compounds of your design or from the literature (and appropriately cited!). At least one of these compounds must be a supported by a ligand that you will prepare in lab.
2. Detailed synthesis and tables of regents. Tell me what you plan to do!
3. What hazards are possible with these syntheses? How do you minimize them?
4. A rationale for the compounds selected will be provided. Why did you choose these? That is, why do you think they will be successful? One way to make that a valid exercise is to think about varying a feature across a set of compounds (e.g., different metals for a common ligand, varying halides, changes in oxidation state or charge, etc.).
5. A basic plan for catalytic reactions and suggestions for charactering those reactions.

Compounds plans are submitted **twice**—one for each round to testing.

<u>Lab reports</u>: This is a summary of your data and analysis in a *manuscript form*. Manuscripts customarily have the following basic format.

1. Abstract. A paragraph summary of your study and key results.
2. Introduction. Your introduction answers three key questions: What are you investigating and why, how does this work relate to prior work in this area, and what is your main hypothesis(es) in the investigation?
3. Results. This section answers what did you do, what happened, and how do you know that?
4. Discussion. In the literature, this is sometimes combined with results but not here. The discussion section will examine what you learned about the reaction, what features of the catalysts matter, and how your work related to the knowledge in the literature. This is the most complex section of your report.
5. Conclusions. A summary of what you learned and where your study can go next, which is critical for the mid-semester report!
6. Experimental detail. The exact procedures and data is presented here.
7. References.

Reports are the product of individual work and writing, but collaboration in the intellectual process is strongly encouraged.

<u>Presentations</u>: The entire CHEM 295 lab class is a single team working on our problem. In that way, it is essential that we share data and discuss results. To facilitate that engagement, each group will present their data and lead a discussion on the implications of their results. The presentations will last approximately 15 minutes and summarize design plan, results, and interpretation (i.e., report content). The team will lead a discussion. A critical part of the presentation is that all team members share the presenting work.

After the formal presentation is complete, the team will field questions and pose discussion questions to the group for approximately five minutes thereafter.

Grading: Your performance in this course will depend on five factors:
1) Lab notebooks & lab performance (10%).
2) Compound plans (2 x 10%)
3) Reports (2 x 15%)
4) Presentations (2 x 15%)
5) Survey completion (2 x 5%)

You'll notice that I mentioned "survey completion" above. I am collaborating with Grinnell investigators to learn about how this experience impacts your learning. Please complete the pre-survey and the final survey as provided. While I will not know your individual results, I know if these are completed (or not) and can compensate appropriately!

Missing any due date will result in a 5% penalty *against your course grade* for any item handed in late. A 5% penalty is a little more than a third of a letter grade (e.g., A to A–). You can *trash* you grade by missing deadlines for the course because there will be six. Does this sound a little hardcore? Well, it is, and for good reason. These materials are steps in your process. Plus, it is benevolent self-interest. I want you to do well—because I will be there with you.

All items are due in class (at 1:15 pm) unless otherwise noted.

The following schedule has a basic flow: There is initial content we need to cover and planning that you (and we) need to do to be successful.

Course Schedule

Date	**Event**	**Location**
8/31	First meeting: course logistics & semester plan, safety, selected topic overview, and talking about our feelings	W-408**
9/7	Second meeting: Compound plans due. Discussion of compounds and plans for catalysis.	W-408**
	NMR tutorial in groups (3:00–5:00 pm)	NMR laboratory
9/14	Laboratory 1-1: Synthesis of ligands and compounds.	W-408
9/21	Laboratory 1-2: Synthesis cont'd and start characterization.	W-408
9/28	Laboratory 1-3: Complete compound characterization.	W-408
10/5	Laboratory 1-4: Catalysis runs.	W-408
10/12	Laboratory 1-5: Catalysis runs, cont'd.	W-408
10/19	Report 1 due. Presentations of data and analysis; analysis of group results.	W-408**
10/26	Compound plans due. Laboratory 2-1: Synthesis of round 2 ligands and compounds.	W-408
11/2	Laboratory 2-2: Synthesis cont'd and start characterization.	W-408
11/9	Laboratory 2-3: Complete compound characterization.	W-408
11/16	Laboratory 2-4: Catalysis runs.	W-408
11/23	No lab—Thanksgiving break	
11/30	Laboratory 2-5: Catalysis runs, cont'd.	W-408
12/7	Presentations of data and analysis; analysis of group results	W-408**
12/14	Final reports due	

**These are non-chemical days in the lab.

I highly recommend that you attend all departmental seminars. As you are now collecting, analyzing, and presenting research data, it is good to see how it is done elsewhere. The department tends to favor Thursdays for seminar, though some may be on Tuesdays (all at 4:25 pm).