CHEM 230L: Essential Inorganic Chemistry Lab

Class Time: (M) Th 8:30 AM – 11:20 AM in DH 306
Professor: Dr. David E. Benson, Ph.D
Office: DH 229
Email: dbenson@calvin.edu
Office Hours: My office hours and M/W/F 10:00 am to 10:30 am. If you would like to meet outside these hours, I am happy to arrange another mutually convenient time.

Course Description

SP. Fundamental analytical and synthetic techniques associated with an inorganic chemistry laboratory will be learned. This includes the ability to safely run aqueous inorganic reactions and characterize products using a wide array of techniques (UV-Visible Absorbance, Magnetometry, Cyclic Voltammetry, and Computational Chemistry). A lab notebook will be maintained, and completed experiments will be summarized in written lab reports.

Prerequisites: Either Chem 240L (old Chem 253L) or Chem 241L (old Chem 261L).

Co-Requisites: Chemistry 230. You will need safety glasses and a composition book. The grade for the lab is separate from your grade for the course.

Course Objectives

Students who complete this course will:

1) Use spectroscopy/magnetometry to identify and characterize the inorganic salt or molecule prepared.
2) Discern the degree of covalent bonding that occurs in a transition metal complex ion or molecule using computational chemistry.
3) Describe oxidant and reductant strength of inorganic salts or molecules using electrochemical techniques.
4) Gain proficiency with the chemical literature and several tools for searching it.
5) Describe connections between God's creation and molecules formed from created matter.

Students may vary in their competency levels on these outcomes and they can expect to achieve these outcomes only if they honor all course policies, attend class regularly, complete all assigned work in good faith and on time, and meet all other course expectations of them as students.

Required Textbook and Resources

- Weller, Overton, Rouke, Armstrong, Inorganic Chemistry, 7th ed., Ch. 8 for techniques
- Lab write-ups and Prelab quizzes on Moodle
- Students should also know how to access and use Microsoft Teams

Course Format

The chemistry of the *d*-block metals and metal ions are primary reagents in chemical synthesis and material preparations. Preparation of *d*-block metal complex ions can involve more advanced techniques than seen in organic chemistry, including air-sensitive preparations. Characterization methods are also

more advanced than melting point, NMR, and IR (although used as well). This lab will focus on preparation and characterization of *d*-block metal complex ions and molecules.

Course Activities and Assessments

Attendance: All labs will be performed with a partner but anaylsis will be done individually. Attendance at all laboratory periods is required. Analysis of data collected on solutions or solids containing metal ions is central to this course and you will be tested individually on your abilty to do these analyses during the lab practicum (below). Therefore preparation before and engagement during the laboratory is essential your success. Given the lab is used for other chemistry labs, alternative lab time cannot be offered.

Safety: Safety goggles (and potentially lab coats) are to be worn in the lab at all times. If you fail to comply with this rule you will be asked to leave. Multiple violations may result in expulsion from the class. In general, lab safety is the result of being careful, alert, and well prepared. Some of these labs and especially special projects may require work with highly reactive compounds or intermediates. So when things can go "boom" in this lab, I am not referring to pop-bottles with dry ice or heating a closed vessel. My point is that you need to think carefully about what you are doing and have a well thought out plan for proceeding. If you are uncertain about how to proceed safely, please consult the instructor. You also must inform the instructor immediately if an accident occurs.

Lab Notebooks: You are required to keep one bound (not loose-leaf) laboratory notebooks. The basic procedures used, equations, primary data, observations, calculations, etc. should be recorded in this notebook for each experiment. It is best to write (not print out) a procedure for the lab ahead of time after reading the procedure on Moodle. Please note the additional labware provided. Also do your calculations beforehand on volumes that need to be added. I expect these calculations to be done Before lab and only minor corrections need to be made when we get to lab so the 3 hours can be used in lab effectively. Entries should be made in ink, not in pencil. The pages should be numbered and dated. Once you have your procedure, take notes on how you performed the experiment, note the actual weights and volumes used. Calculate the actual concentations of solutions, etc. During the analysis of your material (the emphasis of this course) take careful notes on how you performed the analysis and how you can improve your analysis. You will be able to bring your lab notebook to the lab practicum so make sure you write notes on how to perform your analysis. Notebook entries should be well organized, readable and generally neat. However, do not hesitate to cross out errors and mistakes by putting a single line through the mistake. Do not erase or completely black out mistakes! Enter the corrected data or observations where appropriate. You should treat the notebook not as a finished product, but as an accurate chronology of what actually happened in the laboratory.

Lab Reports (informal): Laboratory reports should include an objective (written in your words), any auxiliary data such as spectra, answers to questions, and a conclusion of what you showed/learned during the lab. Also include your laboratory notebook and any products in an appropriate sample bottles. The report should be the work of you and your partner but the analysis should be your own.

The product of the synthesis should be placed in an appropriate sample bottle with a tight cap. The bottle should be labeled. The label should show the formula, your name, the date, the sample weight and the notebook page numbers for the synthesis. The instructor may weigh or otherwise analyze your products as part of the grading procedure.

Lab reports will be due at the end of the lab period the week indicated below. My grader and myself will do our best to return your lab notebooks and reports graded so that you can work on your lab report for the following week. Quality of lab notebook entries will be a criterion in your lab report score.

Informal Lab Report Guidelines: Lab reports should be prepared according to the guideline given outline below. The instructor will grade reports. Don't forget to turn in your final product in a sample vial and your lab notebook. Required components:

1. Primary compound made, name, date of experiment completion/report submission
2. Objective – what did you intend to do or prove? What is is this important in inorganic chemistry?
3. Results – What did you observe? Show all necessary data to argue that you have made the intended compounds, in tabular form if necessary. Be sure to include yield and spectral data. Actual spectra should be included.
4. Questions – Answer all questions in detail
5. Conclusion – Write a conclusion on what you found, discovered, learned from the lab

Lab Practicum: To assess your growth and competency, we will have a lab practicum in-lab on April 7. Details will be provided at least a week before the asssement. I will also ask for a reflection on how analyzing these colored complex metal ions has expanded your appreciation for the complexity of God's creation.

Tentative Assessment Rubric

Informal Lab Reports: 10 reports	10 points each	100 points total
Lab Notebook: (weekly in lab)	5 points each	50 points total
Lab Practicum Written:	25 points	25 points
Lab Practicum Experimental:	25 points	25 points
		200 points

Tentative Grading Scale*

93.0 – 100.0	A	82.0 – 86.9	B	73.0 – 76.9	C	63.0 – 66.9	D
90.0 – 92.9	A-	80.0 – 82.9	B-	70.0 – 72.9	C-	60.0 – 62.9	D-
87.0 – 89.9	B+	77.0 – 79.9	C+	67.0 – 69.9	D+	0.0 – 59.9	F

**Extra credit is not available. I may curve the class at the end of the semester. However, your grade will not be lower than that dictated by the tentative grading scale.*

Course Policies

***Time Management and Late Assignments*:** Deadlines are an unavoidable part of being a professional and this course is no exception. Lab reports are due at the end of the following lab period. My grader andmyself will make every effort to return your lab reports and notebooks as soon as possible. I know that you might need a little grace from time to time and I will offer you one late lab report without deduction if it is turned in before the lab practicum. However, any additional late lab reports will receive a 0 and will not be graded. Please do your best to promptly turn in your lab reports and keep a legible and useful lab notebook.

Masks: As part of creating an environment that is safe and welcoming to everyone, I expect every student to wear an appropriate cloth or medical grade mask that covers both their mouth and nose throughout the entire time they are in the classroom. If I determine that a particular mask is not appropriate, the student will be asked to leave the classroom until they find a suitable replacement. No food or drink may be consumed

while in the classroom. While this is important for health and safety, I recognize that it may also create some barriers to learning. Students are welcome to step out of the room during class time to take a minute for a snack or drink or to take some deep breaths. If you have other concerns or questions about this policy, I would be happy to talk further.

***Communication and Meetings**:* While I check email regularly, email isn't very useful for answering the more technical questions that might come up. If you are having trouble with the course, if you do not understand something important, if you have some special circumstance that is getting in the way of performing well in this course, or if you just want to talk about the course, I'd be happy to set up a time that we can do a video chat. Unfortunately, I will not be able to meet with students in my office this semester.

Practice Netiquette: When you engage your professor or fellow students through email, an online discussion forum, or some other virtual way, have in the front of your mind that a human being – an image-bearer of God – is at the other end of the communication. Remember that the Golden Rule applies on the internet, too. Respect the time of both your professor and fellow students through judicious use of email. Resist the 24/7 temptation of life online and take a regular sabbath. Be aware that, just like in face-to-face interactions, you might have more power or privilege than others online (e.g., even bandwidth raises questions of equity). Before you hit "send," ask yourself if what you've communicated is marked by the fruit of the Spirit (love, joy, peace, patience, kindness, goodness, faithfulness, gentleness, and self-control).

Academic Dishonesty: It is perfectly acceptable to help each other. I encourage you to work together on questions and problems unless I explicitly say otherwise. However, plagiarism and cheating will not be tolerated and may result in an F on the assignment or possible expulsion from the course. Plagiarism includes passing off others' ideas and insights as your own without giving them credit or using unapproved resources to complete an exam. If I have evidence of cheating, at minimum you will receive a 0 on that assignment or exam.

> **Academic Dishonesty:** cheating will not be tolerated. Students are expected to take all tests and exams using only the material that is provided by the instructor (periodic table, sheet of useful conversions, etc). Phones, internet windows (other than the one used to take the test), class notes and textbooks are prohibited.

Respect the intellectual work of your professors: The commitment to building community applies to how you interact with your professor and the content of the course. A key academic virtue is honesty. Calvin's Student Code says, "Calvin University expects … that all course work submitted by students reflects each student's own individual efforts toward learning. These principles about academic honesty also apply to the lectures, Powerpoints, handouts, audio/visual materials, or any other content produced by a faculty instructor. While students may reproduce course content to enhance their own learning, they may not share that content with audiences outside the course without the express permission of their faculty instructor." (Note: Every Calvin student affirms the Student Code during the application process.)

Institutional Policies and Supports: Please refer to the University Course Policies and Resources. Calvin will make reasonable accommodations for persons with documented disabilities. Students should notify Disability Services at disabilityservices@calvin.edu in the Center for Student Success and also communicate with their instructors within the first week of class.

Drop Dates: The last date to drop a full semester course with no refund is March 18.

Final Notes: The above schedule, policies, procedures, and assignments in this course are subject to change in the event of extenuating circumstances, by mutual agreement, and/or to ensure better learning.

Tentative Schedule

Week	Date(s)	Lab	Book Section	Due Date
1	Jan. 13	*Lab 1: $[Ni(en)_x(H_2O)_y]^{2+}$ Speciation Week 1*	*Ch 8.3*	*Jan. 27*
2	Jan. 20	*Lab 2: $[Cu(en)_x(H_2O)_y]^{2+}$ Speciation Week 2*	*Ch 8.3*	*Jan. 27*
3	Jan. 27	*Lab 3: Liquid O_2 and MO calculation of diatomic molecules*	*Moodle*	*Feb. 3*
4	Feb. 3	*Lab 4: Symmetry Elements, Groups, and Infrared Spectra*	*Ch 3.8*	*Feb. 10*
5	Feb. 10	***No Lab, Test #1***		
6	Feb. 17	*Lab 5: Alkali halide structures and volumes*	*Ch 4.10*	*Feb. 24*
7	Feb. 24	*Lab 6: Magnetism of $[Mn(acac)_3]^{x+}$ complex ions*	*p. 278-9, Ch 8.6-7*	*March 17*
Feb. 28-Mar. 4		***Spring Break***		
7	March 10	*Lab 7: $[Cu(en)_2(H_2O)_2]Cl_2$ synthesis and UV-Vis characterization*	*Ch 20.1g*	*March 24*
8	March 17	*Lab 8: Linkage Isomers of $[Co(NH_3)_5(NO_2)]Cl_2$*	Ch 20.2	*March 31*
9	March 24	*Lab 9: Cyclic voltammetry of cobalt complex ions (sign up for time slot with partner)*	*p. 279-81*	*March 31*
10	March 31	*Lab 10: Dye Sensitized Solar Cell*	*Moodle*	*April 7*
11	April 7	***Lab Practicum***		
12	April 14	*Clean-up and Recycling*		