WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

Syllabus

CHEMISTRY 311

Spring 2020

CHEMISTRY ACROSS THE PERIODIC TABLE

Course Information	4 credit hours (Traditional Carnegie Definition: 2.5 hr whole-class meetings; 4 hr discussion/lab per week)
Whole-Class Meetings	1:20 to 2:10 p.m. MWF (1315 Chemistry)
Pre-Laboratory Discussion Meetings	7:45 to 8:35 a.m. or 1:20 to 2:10 p.m., T or R (2373 or 2381 Chemistry)
Laboratory Meetings	8:50 to 11:50 a.m. or 2:25 to 5:25 p.m., T or R (1329 Chemistry)
Instructor Information	Professor Sam Pazicni 9349 Chemistry (608.263.5801) *sam.pazicni@chem.wisc.edu*
Instructor Office Hours	T and W 9:00 to 10:00 a.m. (otherwise ***feel free*** to make an appointment!)
Teaching Assistants	Michael Roy (601, 603) *mroy@wisc.edu* office hour: R 12:00 to 1:00 p.m. Katherine Ziebarth (602, 604) *kziebarth@wisc.edu* office hour: M 2:15 to 3:15 p.m. TA Office Hours are located in Room 1201 at Desk 43
Canvas Course URL	https://canvas.wisc.edu/courses/190013
Instructional Mode	face-to-face
Course Guide Description	Explores the properties, reactions and uses of elements and compounds, with emphasis on coordination chemistry of transition- metal ions, bioinorganic chemistry, solid-state structure and main- group elements. The weekly three-hour laboratory introduces students to the synthesis and characterization of inorganic compounds. • **Breadth**: Physical Science; counts toward the Natural Science requirement • **Level**: intermediate • **L&S Credit**: counts as Liberal Arts and Science credit in L&S

Ninety-eight chemical elements form the building blocks of every substance on Earth—they are elegantly organized into what we now call the Periodic Table. In **Chemistry 311**, *Chemistry Across the Periodic Table*, you will learn about patterns of reactivity among chemical families, unique properties of selected elements, and how these reactivity patterns and properties are manifest in real-world applications. The course will emphasize the quantum mechanical underpinnings of atomic structure and chemical periodicity; the descriptive chemistry of the main group elements; the coordination chemistry of the transition metals, lanthanoids, and actinoids; and solid-state chemistry. **Students in CHEM 311 are expected to have successfully completed CHEM 104, CHEM 109, CHEM 115 or an equivalent with a grade of C or above**.

Commitment to Equity and Inclusion

I expect this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability—and other visible and nonvisible differences. **All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class**. Should you like more information, https://diversity.wisc.edu/ is an excellent resource.

It is my intent that students from all diverse backgrounds and perspectives be well-served by this course, that the learning needs of my students be addressed both in and out of class, and that the diversity that you bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally, or for other students or student groups. To help accomplish this:

- I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.
- If any of our class meetings conflict with religious events you wish to observe, please let me know so that we can plan appropriately.
- If you feel like your course performance is being impacted by your experiences outside of class, please don't hesitate to come and talk with me. I will try to be a resource for you.
- I am open to you submitting feedback that remains anonymous to the rest of the class. This will lead to me making a general announcement to the class, if necessary, to address your concerns.

Overall Course Objectives

By the end of this course, you should be able to:

- articulate the quantum mechanical nature of the atom, using graphical and pictorial representations of electron *quantization* and wavefunctions, as well as electron configurations;
- use the *effective nuclear charge* model to explain electron configurations and periodic trends;
- construct Lewis models of main-group compounds and coordination complexes, use them to draw conclusions about the molecular shape, physical properties, and reactivity of the compounds;
- determine the symmetry elements possessed by a molecule, the molecular point group to which that molecule is classified, and predict the molecule's potential chirality, polarity, and NMR behavior using symmetry;
- describe the *electronic structure* of molecules using molecular orbital theory;
- apply an appropriate model of acid/base reactivity to a particular chemical situation;
- describe the aqueous redox chemistry of the elements using correct language and diagrammatic representations;
- explain structure and reactivity trends of representative element compounds using acid/base, redox, chemical periodicity, and/or chemical bonding principles;
- use *hard/soft acid/base* and *crystal field* models, where appropriate, to explain the properties of coordination compounds;
- describe the stoichiometry and energetics of solid-state compounds in terms of select archetypal structures and general periodic trends;
- apply *band theory* to explain the behavior of various materials;
- use appropriate laboratory techniques, apparatus, and instrumentation to synthesize and characterize inorganic compounds;
- compose and produce professional scientific reports that include well-crafted standard sections (abstract, introduction, procedure, results, discussion, and references); and
- develop a concise disciplinary writing style that is suitable for publication by practice and with guidance from peer and instructor review.

Course Structure and Expectations

This course will challenge you to reason observations of the natural world with chemical logic. We will learn a finite set of principles and models that can be applied to unlock the patterns of *chemistry* observed *across the periodic table*. I will do my best to guide you in mastering the material, but no course or instructor can learn for

you. **Learning is something only you can do.** To help you, the course will be structured around sets of *learning objectives*, which will inform all conventional class meetings, coursework, and assessments. These learning objectives are meant to organize not only the material that will be covered in the course, but also your learning activities and strategies outside of class.

You will need to devote a considerable amount of effort (and, consequently, time) to mastering the chemical principles discussed in this course. A good rule of thumb is that you should spend approximately three hours outside of class for each hour you are in class. Throughout this course, emphasis will be placed on applying chemical models and reasoning to effectively explain phenomena and solve scientific problems. **Applying chemical models to successfully solve problems requires a basic knowledge of principles, facts and terms—*a vocabulary of chemistry*.** Some of this background and vocabulary should have been obtained from your General Chemistry course. **From time to time you may need to review material you studied in previous courses to understand the new material presented in this course**.

We will have three whole-class meetings per week in this course, occurring on Mondays, Wednesdays, and Fridays. These whole-class meetings will include discussions, problem solving, lectures, and various other learning activities. For these class meetings you should: 1) review the assigned material in the text and take your own notes; 2) complete an online "Warm-Up" that will the review fundamental ideas necessary for engaging in whole-class meetings; and 3) attend class, take your own notes, and actively participate in class activities.

Course Materials

Textbook. *Foundations of Inorganic Chemistry* by Gary Wulfsberg, published in 2018 by University Science Books (ISBN: 9781891389955). Either a physical copy or an *e*-text (available from the publisher's website, http://www.uscibooks.com/wulfsberg3.htm) is required. Additional purchase options can be found at the University Book Store website: https://text.uwbookstore.com/home.

We will also consult a variety of readings, web sites, and videos. Pertinent resources (as noted on the course schedule) will be available on our Canvas site. Additionally, it is useful to be able to refer to a general chemistry textbook with which you are familiar. An online general chemistry textbook is available in Canvas.

Calculator. An inexpensive calculator is required. It should have capabilities for square roots, logarithms and exponentiation (antilogarithms), and exponential (scientific) notation operations. You may use programmable calculators in this course.

For the Laboratory. These materials may be purchased from Alpha Chi Sigma (AXΣ) in room 1375 of the chemistry building, tentatively from Tuesday, 21 January, to Friday, 31 January, 7:45 a.m. to 4:45 p.m. Purchases through AXΣ can be made with Wiscard or cash, as indicated below**.**

Lab Manual. *Chemistry 311, Laboratory Manual*, Spring 2020 edition. (Wiscard only, $20.00)

Lab Notebook. Carbonless laboratory notebook with duplicate pages. You will need a new notebook for CHEM 311 because you will use all the pages. (cash only, $15.00)

Lab Coat. A lab coat is required at all times when you are in the lab. (Wiscard only, $12)

Safety Goggles. Industrial quality eye protection is required at all times when you are in the lab. They must be indirectly vented and completely seal around the eyes and fit over regular glasses if you wear glasses. (cash only, $5.00)

Local bookstores sell appropriate lab notebooks and safety goggles, for a higher price.

Model Kits. A molecular model kit is extremely useful. Model kits like those used in Organic Chemistry are just fine, as long as it has atoms with six bond sites at 90° angles. The MolyMod (http://www.molymod.com/) products and sets that would work well for this course include MMS-009 (Inorganic/Organic Student Set) or MMS-002 (Advanced Level Chemistry Set). **You may use a model kit when appropriate on course midterms**; if you don't have your own, you can certainly borrow communal kits that will be on hand.

Communication of Course Information

Much of the material for this course is only available via *Canvas*, accessible via https://canvas.wisc.edu/. **The course is named CHEM 311: Chemistry Across the Periodic Table 001 (SP20).** You will use this site to access course information; remain aware of your course progress; download whole-class materials, readings, and other learning materials; access useful websites/tutorials; complete Warm-Up activities and other assignments; and read announcements that I post. You should log on to this CHEM 311 Canvas site as soon as possible to explore the contents and learn where important files are located. Our Canvas site is organized as a weekly course schedule—you will find resources (learning objectives, websites, videos, readings, exam preparation materials, laboratory information, etc.) embedded in this course schedule. If you experience issues with Canvas, send an email to instructional technology specialist Dr. Rachel Bain, rbain@chem.wisc.edu.

Much information about this course will be transmitted via email, using automated email lists created via *WiscList*. **An email was sent to everyone on the main course list on Monday, 20 Jan 2020.** If you did not receive such an email, *please contact me immediately*.

Feedback on course assessments used in CHEM 311 will be done using *GradeScope*. You also may be using this site to submit certain assignments. You have been automatically added to the course *GradeScope* page and can access the site at the following URL: https://gradescope.com/courses/84002.

Learning Activities in Chemistry 311

Various learning activities are offered to meet the needs of different types of students; however, if you find that your learning needs are not being met or that you are not satisfied with some aspect of the course please bring your concern to me immediately.

Whole-Class meetings. During class meetings on Mondays, Wednesdays, and Fridays, I will lecture, provide examples, and facilitate class discussions and problem-solving in order to aid your understanding of the material. Attending class sessions is not required; however, students who consistently attend outperform those who do not.

What to do *before* coming to class meetings. Review the relevant text(s) prior to each class meeting and complete the Warm-Up activity. Reading assignments are provided within the *Canvas* course schedule, as are the learning objectives; use the learning objectives as a guide for your reading. Take the time to carefully review the illustrations, equations, and graphs in these readings, as visualization is an important tool that chemists use to understand the world. **Try to make your reading an active process**; keep track of those learning objectives that are confusing so you will be able to pay especially close attention as those concepts are covered in class. Please remember, **the Web is generally not an appropriate substitute for the selected texts, unless otherwise noted**; there is a great deal of incorrect and/or misleading information on the internet.

What to do *during* class meetings. In class, I will outline goals, present illustrations, and facilitate class discussions/activities that will allow you to reflect on what you have read prior to coming to class. **A class meeting is in no way intended to describe or explain *everything* you should be learning**; rather, it will provide additional insight into select topics and attempt to illustrate the important conceptual connections between topics. Class meetings will also give you an opportunity to think about these topics and test whether you understand them. **You should take notes during class meetings**. Note taking should be an active, thoughtful process; your notes should reflect your understanding of what *you* heard and saw, and not merely repeat what the instructor or a peer has stated. I will also provide opportunities for you to test your understanding of particular concepts through in-class questions and discussion. If there are concepts or ideas that are not clear to you feel free to ask me after class, by email, or in office hours. **Please do not expect to learn everything you need to know from the class meetings; you will learn far more by reading, working practice exercises, and asking questions on your own or with a group of other students outside of class.**

What to do *after* class meetings. After class meetings, you should review which learning objectives have been covered during that class meeting**. You should inventory your comfort with the objectives covered by reviewing texts/readings and attempting to work sample exercises without looking at the answers.** If you get a few practice exercises correct, great!; you can move on to the next objective. If you struggle with these activities even after you feel you are comfortable with a certain learning objective, something is wrong, and you should seek assistance from a peer or from me. You can also challenge yourself to explain learning objectives or how to solve associated problems to your peers. **Remember, *memorizing* is not *learning*. Only when you feel you can teach material to others have you sufficiently learned the material yourself.**

Assessment Strategies

Warm-Up Exercises

Whole-class meetings are designed based on the assumption that you have engaged properly with the material prior to coming to class. "Warming up" by answering a set of fundamental questions will allow everyone in the class to begin whole-class meetings on the same foot, so to speak. **All Warm-Up exercises will be administered using Canvas. Only correct responses to Warm-Up exercises will contribute positively to your overall course grade; incorrect responses will lower your overall course point total.** The first Warm-Up of the semester will prompt you to submit a picture of baby Yoda as evidence that you have read through this syllabus. You will have two opportunities to complete each Warm-Up exercise; if you choose to use both attempts, the average score of the two attempts will be recorded. Thus, it is to your advantage to thoughtfully engage in the Warm-Up exercises before Friday problem-solving sessions.

Warm-up exercises will be available at least 48 hours prior to each whole-class meeting and will close at 12:00 p.m. of that day. Once the warm up is closed, it cannot be completed. **Warm-up exercises will contribute 20% to your overall course grade.**

Laboratory Activities

The CHEM 311 laboratory is designed to be an integral part of your learning experience. In the lab, you will focus on two primary objectives: the synthesis of compounds and the analysis of their structure. These goals are essential to modern inorganic chemistry research. Laboratory activities will give you the opportunity to explore the reactivity of a wide variety of elements with your own hands, and you will experience the beauty and variety of inorganic compounds. Many people who become inorganic chemists were inspired by their lab experience! **Altogether, laboratory activities will contribute 40% to your overall course grade**.

Additional information about CHEM 311 laboratory activities, reporting, and assessment can be found in the *Laboratory Syllabus* document.

Exams

There will be four midterm exams administered during normal whole-class meetings. Each midterm exam will cover the material up to that point in the course and since the previous exam. Please realize however, that chemistry, *by nature*, is cumulative. So, even though topics may "belong" to previous exams, they may show up when we are studying subsequent material. There will also be a two-hour comprehensive final exam. Because students develop new skills at different rates and because the course is truly cumulative along the way, **improvement counts in Chemistry 311. The point value of exams throughout the term increases, even though the lengths of the exams do not**. It is worth more to do better later; so, you do not need to be "perfect" at the outset of the course. **Altogether, exams will contribute 40% to your overall course grade**.

Please note the exam dates below on your calendar. If you have an unavoidable conflict, contact me well in advance. **If circumstances arise unexpectedly that preclude your taking an exam, please contact me before the scheduled exam time.**

Midterm Exams:	Friday, 07 February	1:20 to 2:10 p.m.	1315 Chemistry
	Friday, 06 March	1:20 to 2:10 p.m.	1315 Chemistry
	Friday, 03 April	1:20 to 2:10 p.m.	1315 Chemistry
	Monday, 20 April	1:20 to 2:10 p.m.	1315 Chemistry
Final Exam:	Friday, 08 May	7:45 to 9:45 a.m.	Location TBA

Modules, Learning Objectives, and Practice Exams. The sections of the Canvas course outline corresponds to the content of the course's five exams: 1) atoms, elements, and periodicity; 2) structure and properties of coordination compounds; 3) symmetry, bonding, and molecular shapes; 4) the solid state; 5) structure and reactivity of representative elements. Each module contains sets of learning objectives organized by week and a content page named "Midterm Resources", where practice exams and other midterm information can be found. The practice exams are good models of what to expect when you sit for actual exams. If you do not understand how to solve these practice exam exercises, feel free to ask me. **Answer keys to certain practice exams will be released 48 hours prior to the exam**.

How To Prepare For Exams. A recommended strategy is: 1) review the learning objectives for the module referring to your notes or the text if necessary; 2) work practice exercises and seek an intervention (from the book, the tutorials, your notes, a friend, or me) if you have not mastered the objective; 3) simulate the test taking situation by working the practice exams in a quiet place; 4) "grade" your own test using the text, your colleagues, and/or the key as a guide; 5) review those areas that you identify strong (you don't want to forget what you do well!) and as weak. **Remember, this is only a recommended strategy and does not guarantee an acceptable exam performance**. Rather, use this as a guide to constructing a successful, *individual* strategy.

If You Are Unexpectedly Sick, Or Otherwise Unable To Attend An Exam

If you are unable to attend an exam because of an unavoidable conflict (*e.g.*, a religious observance), contact me and your TA as soon as possible. **If circumstances arise unexpectedly that preclude your taking an exam, please contact us before the scheduled exam time.** We recognize that in an emergency situation, you may not be able to contact us in a timely way.

Resources

Electronic Mail

You are encouraged to contact me by email if you have questions about anything to do with the course. E-mail is available at all times of day and night, so you can send messages whenever something comes to mind. However, don't always expect an immediate response! **I will try to respond to emails within 24 hours. Chemistry is often difficult to explain via e-mail**, given the variety of representations chemists use to explain what they observe. Therefore, please do follow up if I respond to your email with "I'll be happy to discuss your questions during office hours".

Study Groups

You may collaborate with other students on anything you wish in this course, except examinations. That said, you may work with your peers on midterm self-assessments or warm-ups, should you choose. Study groups reflect the teamwork inherent in the way modern science is done.

Chemistry Department Facilities

Computers are available for use in room 1375 Chemistry. Room 1371 is a study room for chemistry students. The staff in the Undergraduate Chemistry Office, room 1328, can assist you with enrollment, advising, and many other things.

Academic Performance, Progress, and Accomplishment

Your course grade will be based on a maximum of **1000 points**, partitioned as follows:

first midterm exam	60 points
second midterm exam	70 points
third midterm exam	80 points
fourth midterm exam	90 points
fifth and *final* examination	100 points
laboratory work	400 points
warm-up exercises	200 points
TOTAL	**1000 points**

Extra Credit. I am philosophically opposed to giving certain individuals opportunities while not granting the same to everyone. True, I *could* give everyone extra credit opportunities. However, I am also opposed to giving assignments "just for points". For you to earn "retroactive credit", I would have to present you with (and subsequently evaluate) something that would assess whether you have mastered something you previously had not. This is difficult to do, as this course progresses and revisits topics over and over again in a cumulative fashion (*i.e.*,

hopefully everyone has made gains in one way or another). For these reasons, **no extra credit opportunities will be offered in Chemistry 311**.

Letter Grades. Although grades are not the ultimate measure of your knowledge, abilities, or potential, they are useful guides to you and to others. Your level of accomplishment will be recognized at the end of the semester by the letter grade you receive for the course. **Individual accomplishment is measured against course standards and not against the performance of other students**. The course standards are presented below. Final grades will be based upon this absolute point scale. If you score the number of points indicated, then you will receive the letter grade indicated, regardless of how many other students achieve the same grade. **There is no curve**. Therefore, it is to your benefit that you help other students learn and they help you learn.

Please note that grades are in no way meant to measure "effort", but only "performance". Grades are meant to measure your understanding and if you are able to demonstrate that understanding by performing unfamiliar, yet related, tasks. For some, effort and performance are linked, i.e. the harder one works and studies, the better one's performance on exams will be. **For others, unfortunately, effort and performance are not linked**. If you find the latter to be the case, please consult me immediately, as you may not be employing useful study habits when preparing for exams.

Final course letter grades will be determined by the following point total ranges:

A	900 points or more	≥ 90%
AB	860 to 899 points	~86-90%
B	810 to 859 points	~81-86%
BC	770-809 points	~77-81%
C	680-769 points	~68-77%
D	600-679 points	60-68%
F	below 600 points	<60 %

Whatever the case, if you achieve a score in a particular point range, you are guaranteed a letter grade no lower than what is assigned to that point range.

Please note these important policies and procedures

Academic Integrity

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, please refer to https://conduct.students.wisc.edu/misconduct/academic-integrity/.

If you are in any way unclear regarding what constitutes plagiarism, please complete UW-Madison Libraries' Plagiarism Tutorial, available at: https://lo.library.wisc.edu/plagiarism/.

Accommodations for Students with Disabilities

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide

reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. For more information, please visit UW-Madison's McBurney Center website, available at: https://mcburney.wisc.edu/.

Emotional or Mental Health Distress

Your academic success in this course is very important to me. If, during the semester, you find emotional or mental health issues are affecting that success, please contact University Health Services. More information about mental health can be found here: https://www.uhs.wisc.edu/mental-health/.

Classroom Behavior

To ensure a climate of learning for all, disruptive or inappropriate behavior may result in exclusion (removal) from this class. If you bring a cell phone to class or the laboratory, please silence it for the duration of the class or laboratory period. If there is a situation that absolutely requires you to answer your cell phone during a class, please set the phone to silent/vibrate and sit in a location where you do not disturb other students when leaving the classroom to accept a call.

Confidentiality and Mandatory Reporting

UW-Madison and its faculty are committed to assuring a safe and productive educational environment for all students and for the university as a whole. To this end, the university requires faculty members to report any incidents of sexual assault shared by students. If you wish to speak to a confidential support service provider who does not have this reporting responsibility because their discussions with clients are subject to legal privilege, please contact UW-Madison Survivor Services (https://www.uhs.wisc.edu/support-services/). Survivor Services provides confidential support to UW-Madison student victims/survivors of sexual assault, sexual harassment, dating violence, domestic violence, and/or stalking.

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Laboratory Syllabus
CHEMISTRY 311
Spring 2020

The CHEM 311 laboratory is designed to be an integral part of your learning experience. In the lab, you will focus on two primary objectives: the synthesis of compounds and the analysis of their structure. These are essential goals of modern inorganic chemistry research. Your lab exercises will give you the opportunity to explore the reactivity of a wide variety of elements with your own hands, and you will experience the beauty and variety of inorganic compounds. Many people who become inorganic chemists were inspired by their lab experience.

Week	Lab Experiment	submission	evaluation
20-24 Jan	**no lab**		
27-31 Jan	*Malachite Bead*	report	10 pts.
03-07 Feb	*Polysiloxanes*	CPR	10 pts.
10-14 Feb	*Prussian Blue*	report	10 pts.
	Rhodium Rainbow	worksheets (delayed)	20 pts.
	IR tutorial	worksheet	10 pts.
	UV-Vis Tutorial	worksheet	10 pts.
17-21 Feb	*Lewis Acid/Base* (Phenanthroline)	CPR	20 pts.
24-28 Feb	*DMSO Complexes*	report	20 pts.
02-06 Mar	*Magnetic Susceptibility*	CPR	20 pts.
09-13 Mar	*Nickel Series,* week 1	report	40 pts.
23-27 Mar	*Nickel Series,* week 2		
30 Mar – 03 Apr	*Co(salen),* week 1	CPR	40 pts.
06-10 Apr	*Co(salen),* week 1		
13-17 Apr	*Nickel Nano*	report	20 pts.
20-24 Apr	*OLED*	worksheet	10 pts.
27 Apr – 01 May	**no lab**		

Calibrated Peer Review

Four of your lab reports will be evaluated using Calibrated Peer Review (CPR) a system designed to help you learn how to write a scientific report. Using CPR you will also learn how to recognize a well written scientific report, how to evaluate your own writing, and how to review and evaluate other students' work.

CPR requires that you demonstrate your ability to recognize good scientific writing by a process called *calibration*. During calibration, you will be asked to read three versions of the same laboratory report and to recognize the good and bad aspects of each report. CPR will then ask you questions about each report so that you can demonstrate that you can distinguish a poor report from an average and a good report. The calibration process is to ensure that when

you evaluate the reports of other students you can do so in a consistent and fair way. It is also designed to teach you how to recognize when a report you have written is good enough to submit for evaluation by others.

CPR involves a process called *peer review* that is used to evaluate scientific papers to decide whether they should be published. When a scientist completes a research study, writes a report, and submits the report to a scientific journal for publication, the editor of the journal must decide whether to publish the report, to ask the author to revise it, or to decline to publish because the report is not good enough. Other scientists who do research similar to that reported in the paper—peer reviewers—are asked to review the paper and provide to the editor their opinions regarding its quality. Peer reviewers provide constructive, courteous criticism of the paper, which the editor returns to the author so that the author can improve the paper. In CHEM 311 you will serve as a peer reviewer of your own laboratory report and of the reports of three other students.

For each experiment with a CPR report you will write an individual laboratory report and prepare it for upload to CPR. Then you will review three laboratory reports that your instructors have written. The three reports illustrate high quality, medium quality, and low quality. You will use these reports to calibrate your ability to recognize a well written report; part of your grade will depend on how well you calibrate. Next, you will read and review three laboratory reports by other students in CHEM 311. As is often true in peer review of scientific papers, the reports will be anonymous—you won't know who wrote each report you review. As is almost always true in peer review of scientific papers, the reviewers will also be anonymous—after the reviews are completed, you won't know who the three reviewers of your report were. At the end of the process you will be able to see the reviews of your work and use them to improve your subsequent lab reports. CHEM 311 TAs have observed that after using CPR the quality of students' lab reports increases significantly, which is good because whatever your future career the ability to report scientific results is going to be an important skill that potential employers will value.

Laboratory Report Criteria

Any scientific report should provide information in a format that is easily assimilated and interpreted by a reader. As you write each lab report consider these questions and make certain that you have addressed each of them in your report. Your TA will use these criteria to evaluate your report but note that some will be weighted more strongly than others; it is not sufficient just to check off each box but rather the overall presentation is what counts.

1. Does the title describe the report content concisely, adequately and appropriately?
2. Does the abstract convey a sense of the full report concisely and effectively? Is there a clear statement of the overall findings?
3. Does the introduction provide sufficient information for the reader to understand the concepts tested, the purpose, and the scientific context of this laboratory exercise?
4. Is the procedure clearly and completely described with an appropriate level of detail that would allow someone to reproduce the experiment?
5. Are the results described clearly and with sufficient support? Are the findings, observations, and characterization data presented logically and appropriately?
6. Are figures and tables used effectively in this report, providing clear and accurate information?
7. Does this report successfully integrate figures and tables with the text? Do the figures and tables help to create a concise and effective presentation?
8. Does the discussion include a summary of the findings and back up this summary with specific reference to the results? Is there sufficient explanation of the results and is it presented logically? Are the results effectively placed in a broader scientific context?
9. Are the conclusions clearly stated and well supported?
10. Are there three or more references to appropriate sources of information and are they cited using ACS format?

You will also be evaluated on the attention to safety and effectiveness of your laboratory work and on the quality of your laboratory notebook, which should contain a legible and complete record of the experiment.