

CHEM 4654: Inorganic Chemistry & Lab
(Including some information for CHEM 4654L: Inorganic Chemistry Lab)

Instructor: Dr. Eric S. Eitrheim

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Office Phone: (405) 974-5519

Lecture Meeting Location: Old North 208

Lab Meeting Location: Recitation: HOH 312

Lab: HOH 359

Lecture Meeting Time: 10:30 – 11:45 AM

Tues/Thurs (Lecture, Old North 208)

Lab Meeting Time: 1:00 – 4:50 PM

Thurs 1:00 – 1:50 PM (Recitation, HOH 312)

Thurs 2:00 – 4:50 PM (Lab, HOH 359)

Office Hours:

M, W 9:00 AM – 11:00 AM

T 1:00 – 3:00 PM

There is a tentative schedule laid out in this syllabus. Special announcements and schedule changes will be announced at the beginning of the lectures or on D2L.

General Course Information

CHEM 4654 (CRN: 10411) and the accompanying lab (CHEM 4654L) is worth 4 credit hours. CHEM 4654 covers atomic theory and spectroscopy, periodic properties, descriptive chemistry, inorganic structure and bonding, coordination chemistry, organometallic chemistry, symmetry and group theory. Students must be concurrently enrolled in CHEM 4654L (CRN: 10412).

Required Text and Class Materials (Lecture: CHEM 4654)

- Text: "Inorganic Chemistry", Miessler and Tarr, 5th Edition, Prentice-Hall, 2014.
- Non-programmable scientific calculator. (No cell-phones, tablets, laptops or other handheld devices can be used in place of a non-programmable scientific calculator for tests or quizzes. For example, the **TI-30XS series** can be used which are about \$12-\$20.

Required Text and Class Materials (Lab: CHEM 4654L)

- Text: "Microscale Inorganic Chemistry", Szafran, Pike, Singh. Wiley, 1991.
- Approved laboratory safety goggles
- Bound laboratory notebook with carbonless duplicate pages
- Appropriate clothing (long pants, closed-toed shoes, covered shoulders, etc)

Academic Deadlines:

The last day to drop this course is Nov. 2nd, 2018

Contact Information and Office Hours

Please see my contact information listed above. Email is preferred, as I check it frequently during weekdays. This course is fast-paced so it is important that you do not fall behind. If you

are having difficulty, please see me as soon as possible. There are resources available to aid you, including myself. I am available during my office hours, but additionally, any time my office door is open, feel free to come in with questions or concerns. If my office hours do not fit your schedule, please email me to set up a time.

Learning Objectives and Course Goals

Upon successful completion of this course you should be able to:

1. Understand the atomic structure and aspects of the atomic spectroscopy of the elements.
2. Understand bonding descriptions of simple molecules, and the prediction of structures.
3. Understand the structures of transition metal coordination compounds, their magnetic properties, and the origins of their electronic spectra.
4. Understand the basic aspects of structure and bonding in transition metal organometallic compounds.
5. Be able to classify the symmetry of a molecule, understand its role in bonding and spectroscopy, and understand basic aspects of group theory.

Electronic Devices

All electronic devices must be off or on silent for the entire class session. Electronic devices (laptops, tablets, etc.) will be allowed in class (non-exam days) for the purpose of note taking. These should be used in a manner that is non-distracting to students around you and you should be on task. Headphones are not allowed in class during lecture or exams. Electronic recording (video, voice, photographic etc.) of any type is expressly forbidden. I reserve the right to revoke your electronic privileges at any time. *Likewise, during testing/quizzes, if I see an electronic device (i.e. cell phone) out during the exam/quiz, it will be considered cheating. Cell phones may not be used as a calculator.*

Course Format: FLIPPED CLASSROOM

This course will be taught using a flipped course approach. This means that much of the content will be introduced prior to coming to class. Class time will be used to **briefly** review the content, answer questions, and work on various types of problems and questions related to the content. In order to be successful in this course, you should plan on spending at minimum 60 minutes per day, six days per week working on this course outside of class time.

Pre-Class Content Delivery

At the start of each chapter, you should scan through the chapter, and focus on section headings, as well as mathematical equations. This will help you focus on important content when you learn about it in the powerpoints and class. Before coming to class, you

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should read the assigned pages of the textbook as well as the assigned powerpoint slides. The PowerPoint slides are in the content area of D2L.

In Class

At the start of each class, I will ask what you thought were the important ideas in the text and PowerPoint, as well as what topics or ideas trouble you. I will briefly discuss these, and then I will have you work on selected problems in small, assigned groups. After groups complete the problem set we will discuss the most common errors and then begin discussing the next topic for the day.

After Class

After class, you should align your reading notes and class notes, and compile them in your notebook. You should also begin working the additional problems related to the material just covered. If you are unsure of a topic, get help as soon as possible.

Laboratory Reports (5 @ 50 pts = 250 Points Total)

Lab Reports will be due at the start of lab (1pm) on the days shown on the calendar. A physical copy, including the carbon copies of your lab notebook will be due in person at that time, but the same lab report should also be submitted on D2L to the appropriate dropbox folder. There will be a 20% (10 points) per day that the lab is late. Over 5 days late will not be accepted for credit. **Copying material from the lab manual, course textbook, or from the internet, and placing it your lab report as your own work is plagiarism. You will receive a failing grade on that lab report if you plagiarize. A turnitin score of 30% or more will be considered plagiarized.**

Lab Notebook (25 Points)

You will turn in your lab notebook at the end of the semester for a grade. This means partners should *both* be keeping a separate lab notebook with appropriate detail and organization.

Final Presentations (75 Points)

Final Presentations will be done in groups yet graded separately based on your individual contribution.

Exams (3 @ 150 pts = 350 Points Total) & Final Exam (200 Points)

You will have three lecture exams in addition to the final exam. These exams are scheduled as shown on the attached schedule. Your exams will likely be a mixture of multiple choice, matching, and short answer. For each exam you will need to bring a pencil and a non-programmable scientific calculator. You will need to show all of your work on the exam to receive full credit. If you miss an exam due to illness or other unforeseen circumstance, you need to notify me by email as soon as possible, preferably before the exam and no later than the next class period. If you provide a documented legitimate reason for your absence (ex: doctor's note),

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I will reschedule your exam for a time no later than 48 hours after the original exam time. Exams must be made up within 48 hours of the original exam date. If you miss an exam without notifying me and providing a legitimate reason for the absence, you will receive zero points for that exam. These exams are all mandatory for the completion of this class. A make-up exam will not necessarily be the same exam that was missed and may differ in numerous ways, including, but not limited to, the questions, format, and length of the exams.

The Final Exam is a standardized ACS (American Chemical Society) Inorganic Chemistry Exam. These are exclusively multiple choice problems and will take the entire final exam slot for the course. Not every question found on these exams will have been covered in class and everyone's grades will be adjusted to correct for this. Please still attempt all questions as guessing can only help you, even if you have not seen the material previously.

Attendance Requirements

Your attendance at every class is crucial for your success in this course and will be recorded each day. You are expected to come to class prepared to actively participate in the lectures. This means having read the assigned chapter before class, attempting the sample problems in the text, and reviewing the assigned PowerPoint slides. Valuable information will be covered during the in-class activities & interactions that you will miss if you are not present. If you miss an exam due to illness or other unforeseen circumstance, you need to notify me by email as soon as possible, preferably before the exam and no later than the next class period. If you know you are going to miss class for a legitimate reason (illness or death in the family, school sponsored event, etc.), I can work with you in advance to make alternative arrangements for your exam. The key is communication. I cannot help you if I am not aware of the situation. Student Athletes: Please email me your schedule of conflicting practices/games by the end of your first week of classes. The responsibility for rescheduling and promptly notifying me regarding future foreseen conflicts lies with the student.

Grade Distribution

Your total score for the class will be calculated from the following Assessments:

| Assessment | Points | Percentage |
|---|-------------|-------------|
| Laboratory Reports (5 @ 50 pts) | 250 | 25% |
| Lab Notebook | 25 | 2.5% |
| Final Presentations | 75 | 7.5% |
| Exams (3 @ 150 pts) | 450 | 45% |
| Comprehensive ACS Final Exam (multiple choice questions only) | 200 | 20% |
| Total | 1000 | 100% |

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Course grades will be assigned according to the following scale:

| Letter Grade | Percentage | Point Range |
|--------------|-------------|---------------|
| A | >85.0% | 850+ pts |
| B | 75.0-84.9% | 750 - 849 pts |
| C | 65.0-74.9% | 650 - 749 pts |
| D | 55.0-64.9% | 550 - 649 pts |
| F | Below 55.0% | below 550 pts |

Academic Dishonesty

Students are expected to be the sole source for any work submitted in their name. The utilization or submission of work of others is a violation of the University of Central Oklahoma scholastic dishonesty policies and disciplinary steps will be taken. As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. *Likewise, during testing/quizzes, if I see an electronic device (i.e. cellphone) out during the exam/quiz, it will be considered cheating. Cell phones may not be used as a calculator.*

Copying material from the lab manual, course textbook, or from the internet, and placing it your lab report as your own work is plagiarism. You will receive a failing grade on that lab report if you plagiarize.

The minimum penalty for academic dishonesty in this course is a grade of "0" for the quiz, exam, or assignment; without an opportunity to replace or drop the grade.

The Central Six

At the University of Central Oklahoma, we are guided by the mission of helping students learn by providing transformative experiences so that they may become productive, creative, ethical and engaged citizens and leaders contributing to the intellectual, cultural, economic and social advancement of the communities they serve. Transformative Learning is a holistic process that places students at the center of their own active and reflective learning experiences. Transformative Learning develops beyond-disciplinary skills and expands students' perspectives of their relationships with self, others, community and environment.

We seek to engage students in transformative learning in six core areas: **discipline knowledge**; leadership; research, creative and scholarly activities; service learning and civic engagement; global and cultural competencies; and health and wellness. (<http://www.uco.edu/central/tl/central6/index.asp>)

Syllabus Attachment

The syllabus attachment (link below) contains important university information.

<http://www.uco.edu/academic-affairs/files/aa-forms/StudentInfoSheet.pdf>

Disability Services

The University of Central Oklahoma complies with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990. Students with disabilities who need special accommodations must make their requests by contacting Disability Support Services, at (405) 974-2516. The DSS Office is located in the Nigh University Center, Room 305. Students should also notify the instructor of special accommodation needs as soon as possible. Per Title IX of the Education Amendments of 1972 ("Title IX"), pregnant and parenting students may request adjustments by contacting the Title IX Coordinator, at (405) 974-3377 or TitleIX@uco.edu. The Title IX Office is located in the Lillard Administration Building, Room 114D.

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Lecture Topics:

Reading assignments are given for the assigned text: Miessler and Tarr, *Inorganic Chemistry*, 5th Edition. However you should be aware that many of these topics build directly on material that was introduced in your General Chemistry course. You should use a General Chemistry text as a companion to the Miessler and Tarr text. While we will review some of this basic material in class, we will not spend very much time re-developing these very basic concepts.

Tentative Calendar: Subject to Change

| <u>Topic #</u> | <u>Topic</u> | <u>Chapter/Sections</u> |
|-----------------------|--|-------------------------------------|
| 1 | Atomic Structure & Periodic Properties | 2.1-2.3 & 8.1 |
| 2 | Solid State Structures & Energetics | 7.1, 7.2 & 7.5 |
| Exam #1 | Tuesday, September 18 | |
| 3 | Localized Bonding Theory | 3.1, 3.2 |
| 4 | Symmetry & Group Theory | 4.1-4.3, 4.4 |
| Exam #2 | Tuesday, October 23 | |
| 5 | Molecular Orbitals | 5.1-5.3 & 5.4.3 |
| 6 | Coordination Chemistry I (Structures & Isomers) | 9.1-9.4 |
| 7 | Coordination Chemistry II (Bonding) | 10.1-10.3 |
| Exam #3 | Tuesday, November 27 | |
| 8 | Organometallic Chemistry | 13.1-13.3 (14.3 as time permits) |
| Final Exam | Thursday, December 13 | 11:00 am – 12:50 pm |

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| Month | Week | Tuesday Lecture 10:30 – 11:45 AM | Thursday Lecture 10:30 – 11:45 AM | Thursday Lab 1:00 – 4:50 PM |
|-------|------|--|---|---|
| Aug | 1 | 21 Intro/Syllabus Nucleosynthesis | 23 Atomic Theory Dev./Structure 1-1: Ch2 slides 1-37; pg. 9-13 (2.1) | 23 Check-in Lecture: Coordination Chemistry & Isomerism |
| | 2 | 28 Schrödinger Equation 1-2: Ch2 slides 38-75; pg. 16-36 (2.2) | 30 Periodic Properties/Trends 1-3: Ch2 slides 76-124; pg. 36-40 (2.3) & 249-257 (8.1) | 30 Exp #20A Metal Complexes of DMSO: Cu(DMSO) ₂ Cl ₂ |
| Sep | 3 | 4 Solids: Simple lattices type A 2-1: Ch7 slides 1-33; pg. 215-224 (7.1.1-7.1.3) | 6 Solids: Types AB & ABn 2-2: Ch7 slides 34-61; pg. 224-225 (7.1.4) | 6 Exp #20A IR Analysis of "Linkage" Isomerism |
| | 4 | 11 Solids: (Thermo) Lattice Energy 2-3: Ch7 slides 62-86; pg. 226-227 (7.2.1) | 13 Thermochemical Cycles 2-4: Ch7 slides 87-107; pg. 227-228 (7.2.2) & 239 (7.5) (website) | 13 REPORT 1 DUE (#20A) Group review for Exam 1 |
| | 5 | 18 EXAM 1 (Topics 1 & 2; Ch. 2 & 7) | 20 Simple Bonding Theory (Lewis Dot) 3-1: Ch3 slides 1-29; pg. 45-50 (3.1) | 20 Exp #22A & Handout Synthesis of Metal Acetylacetonates: Cr(acac) ₃ |
| | 6 | 25 VSEPR 3-2: Ch3 slides 30-63; pg. 51-63 (3.2.1-3.2.3) | 27 LCP, Bond dist., Polarity, H-bonding 3-3: Ch3 slides 64-89; pg. 63-69 (3.2.4-3.4) | 27 Exp #22A & Handout Magnetism lecture; Determination of Magnetic Susceptibility of Cr(acac) ₃ |
| Oct | 7 | 2 Symmetry Elements & Operations 4-1: Ch4 slides 1-30; pg. 75-80 (4.1) | 4 Point Groups (Flowchart & Otterbein) 4-2: Ch4 slides 31-56; pg. 80-89 (4.2) http://symmetry.otterbein.edu/index.html | 4 REPORT 2 DUE (#22A) Exp #34C Reaction of Wilkinson's Catalyst with Aldehydes; IR Analysis of RhCl(PPh ₃) ₃ & RhCOCl(PPh ₃) ₂ |
| | 8 | 9 Properties of Groups 4-3: Ch4 slides 57-75; pg. 90-94 (4.3.1-4.3.2) | 11 Character Tables 4-4: Ch4 slides 76-100; pg. 95-100 (4.3.3) | 11 REPORT 3 DUE (#34C) Start Group Presentations (on Dec 6) |
| | 9 | 16 Application of Group Theory 4-5: pg. 100-110 (4.4) Exam 2 Rev. | 18 Fall Break No Class | 18 Fall Break No Lab |
| | 10 | 23 EXAM 2 (Topics 3 & 4; Ch. 3 & 4) | 25 Molecular Orbitals (MO's) 5-1: Ch5 slides 1-27; pg. 117-122 (5.1) | 25 Exp #29 Synthesis of [Cr(en) ₃]Cl ₃ |
| | 11 | 30 Homo/Hetero Diatomic MO's 5-2: Ch5 slides 28-55; pg. 122-138 (5.2 -5.3.1) | 1 MO's for larger molecules 5-3: Ch5 slides 56-87; pg. 143-158 (5.4.2 - 5.4.5) | 1 Exp #29 Determination of "Spectrochemical Series" for Selected Cr ³⁺ Complexes |
| Nov | 12 | 6 Coordination Chem. Basics 6-1: Ch9 slides 1-35; pg. 313-317 (9.1) | 8 Nomenclature (Coord. Chem.) 6-2: Ch9 slides 36-48; pg. 317-321 (9.2) | 8 REPORT 4 DUE (#29) Work on Group Presentations (on Dec 6) |
| | 13 | 13 Isomerism 6-3: Ch9 slides 49-67; pg.322-336 (9.3) | 15 Bonding; Crystal Field Theory (CFT) 7-1: Ch10 slides 1-29; pg. 357-364 (10.1 - 10.2) | 15 Jeff Lux (Field Trip) Exp Handout Ni²⁺ Preparation of Macrocylic Tetraaza Ni ²⁺ Complex |
| | 14 | 20 Ligand Field Theory (LFT) 7-2: Ch10 slides 30-58; pg. 365-382 (10.3) | 22 Thanksgiving Break No Class | 22 Thanksgiving Break No Lab |
| | 15 | 27 EXAM 3 (Topics 5 & 6; Ch. 5 & 9) | 29 Ch13 Organometallic: 18 e- rule 8-1: pg.475-486 (13.1-13.3) | 29 (Tori Forbes Seminar 3-5pm) Exp Handout Ni²⁺ NMR and IR Analysis of a Macrocylic Complex |
| Dec | 16 | 4 Ch14 Catalysis (& Review) 8-2: section 14.3 (as time permits) | 6 Group Presentations | 6 REPORT 5 DUE (Handout Ni²⁺) Presentations/Review/Lab checkout |
| | 17 | 11 No Class – Finals Week | 13 Final Exam 11:00 AM-12:50 PM | 13 No Lab – Finals Week |

Tentative Schedule: Subject to Change