**Chemistry 240**

**Introduction to Inorganic Chemistry**

**Syllabus – Spring 2020**

**Class Periods**

*Lecture:* 12:15 PM – 1:30 PM on Tuesday & Thursday in Wall 320

*Laboratory:* Wednesday (Section A) 1:30 PM – 4:20 PM Wall 235

Thursday (Section B) 1:40 PM – 4:20 PM Wall 235

**Instructor MILE Student Partner**

Prof. Mitch Anstey Claire Tobin

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Phone: x2310

**Office Hours**

Office hours is the term for when I will have my door wide open and invite you in to talk about the course, a future major, careers, life, and just about anything that you think is important. I love to have people visit! Maybe you plan on asking for a letter of recommendation in the future? Getting to know each other in office hours is a great first step in that process.

**Monday** 12:30-2:30 PM

**Tuesday** 1:30-2:30 PM

**Wednesday** 4:30-5:30 PM

**Thursday** 4:30-5:30 PM

**Friday** 11:30-12:30 PM

**Course Description**

Inorganic chemistry is a branch of synthetic chemistry typified by its focus on compounds composed of elements other than carbon and hydrogen. But don’t let that fool you! Even graphite (all-carbon allotrope) and Bucky balls (C60) are considered to be in the purview of inorganic chemistry. Inorganic chemistry is best described when contrasted with organic chemistry, and the two together form synthetic chemistry. This course will serve as a survey of structure, bonding, symmetry and reactivity of compounds composed of elements all across the periodic table!

**Content Resources**

There are no required texts for this class. I have several texts available for you to borrow (one week limit each time) if you find that you need them. If you prefer to purchase or rent your own textbook, that is perfectly fine with me, but know that it is not necessary.

In general, we will be compiling our own textbook of sorts, so I would encourage you to use a 3-ring binder to organize the materials that are given to you. I have some if you would like one. I think you’ll find that the combination of your own notes and the content I give to you will be more than enough for studying and to use as a reference.

Supplemental & Optional Texts

* *Inorganic Chemistry* by Miessler, Fischer, and Tarr
* A general chemistry text such as *Chemistry*, 9th edition by Zumdahl and Zumdahl or *Chemistry: An Atoms-Focused Approach* (2nd edition by Gilbert *et. al.*
* Chemistry 240 Laboratory Manual (*provided by Chemistry Department*)

**Learning Outcomes**

Introduction to Inorganic Chemistry explores the myriad ways in which the elements can combine to form new and interesting materials. The class will provide tools to evaluate the structure of materials and compounds, explore the symmetry of the resulting structures, and determine the consequences of those previous two in the context of chemical reactivity. At a minimum, your success in the course will require attendance at the specified class times, participation in your working group, and an additional 5-10 hours of weekly work outside of class. This work is a combination of problem sets, independent or group study, and office hours visits. At the end of this course, my hope is you will have an appreciation for the diversity of the Periodic Table and how all of the elements combine to make our world what it is.

* Correlate nuclear decay processes with a reactants-to-products description
* Identify characteristics of nuclear stability and calculate thermodynamic values
* Predict and explain the observed electronic structure of atoms, ions, and molecules
* Identify symmetry operations and point groups of a given molecule in a specific structural orientation
* Identify acid-base interactions in the form of chemical bonds between elements in a molecule
* Identify the building blocks and symmetry of crystalline solid-state materials and their relationship to one another
* Build a Band Theory Model from concepts in Molecular Orbital Theory
* Predict and explain chemical structures of homoleptic main group, transition metal, and lanthanide compounds based on several bonding models including Ligand Field Theory and Crystal Field Theory
* Correlate aforementioned bonding models to electronic structure of chemical compounds
* Rationalize the oxidation-reduction behavior of a compound or element based on molecular or periodic trends

**Topics Covered**

* Nuclear Composition and Reactions

*Nuclear Binding Energy*

*Radioactive Decay*

*Applications*

* Electronic Structure of Transition Metals, Lanthanides, Actinides

*Neutral Atoms*

*Charged Ions and Common Oxidation States*

* Symmetry and Group Theory

*Operations and Point Groups*

*Chirality*

*Applications of Symmetry*

* Molecular Orbital Theory

*Bonding Types (*σ*,* π*, and* δ *bonds)*

*Homonuclear and Heteronuclear Diatomics*

*Group Orbitals for Larger Molecules*

* Donor-Acceptor Chemistry

*Lewis Acid-Base Reactions*

*Hard-Soft Acid-Base Interactions*

* Types and Structures of Crystalline Solids

*Simple Structures*

*Lattice Energy*

* Main Group Chemistry

*General Trends*

*Elements in Groups (I, II, XIII, XIV…)*

*Orbital Interactions and Non-Bonding Orbitals*

*Geometries*

* Coordination Chemistry

*Nomenclature*

*Isomerism*

*Coordination Number and Geometries*

*Bonding Models (Crystal Field Theory, Ligand Field Theory, Jahn-Teller Effect)*

*Magnetic Behavior*

* Elementary Reactions in Inorganic Chemistry

*π-Bonding*

*Associative/Dissociative Substitution*

**Classroom Experience**

*MILE: More Inclusive Learning Environments*

I read an article about professors at colleges. It described professors as plumbers who were hired for their ability to be great bakers. The idea they were discussing was related to how most large research-focused schools choose their next faculty members. They are chosen for their ability to do great research, and their ability to teach is a distant second. In fact, most of the graduate work necessary for obtaining a doctorate is focused solely on their own learning and research. Not on the craft of teaching!

MILE is a student-proposed program that is being piloted this year at Davidson. It is supported through Fostering Inclusivity and Respect in Science Together (FIRST) and the Center for Teaching and Learning (CTL). **This program has paired a student (Claire Tobin) with the faculty member (me!) to give me feedback on the things that happen in our classroom that can lead to barriers in the learning process.** How do I engage with students? Did I create an activity that was confusing or ill-suited for the content? These are some of the many questions I want to have answered.

Claire Tobin will sit in this course and observe how we all interact with each other. Claire and I will meet regularly to discuss what I’m doing in the classroom and how I can improve. They are not a tutor, and they are not expected to field questions or interact during class time. Claire is a resource for you to give feedback to me, anonymous or otherwise, so that I can continue to be a better instructor. You can invite Claire to join your group to observe, meet separately, or email. For more information, please go to [www.dropbox.com/s/3q7z8ceba97o843/MILE%20Pilot%20Spring%202020%20copy.pdf](http://www.dropbox.com/s/3q7z8ceba97o843/MILE%20Pilot%20Spring%202020%20copy.pdf).

*POGIL: Processed-Oriented Guided Inquiry Learning*

The main and, some might say, notorious feature of this course is its use of the POGIL pedagogical method of active learning. From the POGIL webpage: “…In a typical POGIL classroom or laboratory, students work in small teams with the instructor acting as a facilitator. The student teams use specially designed activities that generally follow a learning cycle paradigm.” In my own words: **POGIL attempts to create that moment of discovery that is key in lodging a concept, fact, or thought into your memory**.

On most days, you will be given some introductory or explanatory content from me to help introduce and put into context the content of the course, but you will largely develop content mastery through the guided group activities.

But why?! So glad you asked! POGIL seeks “to develop content mastery through student construction of their own understanding, and to develop and improve important learning skills such as information processing, communication, critical thinking, problem solving and metacognition, and assessment.” In short, it’s about the journey. The skills you will take from this class will be just as important as the content within. **All of these skills are transferable to future learning, working, and communicating outside of the STEM world**, which is also important for scientists to do anyway!

Does it work?! You ask good questions! In 2014, Freeman et al. published a meta-analysis of the effectiveness of a “transmission-intensive, teacher-centric approach and a constructivist, student-centric approach” as measured by exam performance and pass rates. (PNAS, 111 (30), E3025) **They found that a student in the 50% percentile of a lecture course would rise to the 68% percentile of that same course had they engaged in active learning instead**. In 2017, Walker and Warfa published data showing that focusing on these process skills with POGIL decreased the failure rate by 38%, thereby increasing student retention in STEM (PLoS ONE, 12 (10), e0186203). These are just a sampling of the data that shows POGIL and other active learning techniques provide real benefit to students.

*Inclusivity and the Group Work Experience*

This course uses small groups as a way to maintain engagement throughout the learning process. By keeping groups to a limit of four members, each student has a greater opportunity to contribute to the activity and exercise their own understanding. **But this all hinges on the group being inclusive of each member**. Each person *does* have a role to play, and each person should be valued for those contributions.

There is a difference between “belonging” and a “sense of belonging.” Belonging can be viewed as the valued presence of a person in a group, which is created through net positive contributions to the group such as support or leadership. A sense of belonging, as experienced by the individual, is the perspective of those contributions, which may not reflect the reality or entirety of those positive contributions. Simply stated, your sense of belonging to a group might underestimate how much the group values and appreciates your presence. This is commonly called impostor syndrome.

To that end, I ask you to consider two points: **it is easy to be accidentally exclusive, and inclusion is an intentional process**. To ensure that your group provides an experience where all the members are valued and encouraged to contribute, you as an individual must make an intentional effort to be inclusive. Some ways in which you can work towards this goal are to:

* Provide time for each person to weigh in on questions, should they want to
* Allow each person to read sections of the activity; avoid talking over one another
* Be self-reflective about your possible implicit biases
* Avoid making assumptions about the knowledge or progress of group members

How will I help to create a more inclusive environment?

* Periodically change the roles in the group; mix up the groups
* Avoid calling on specific students
* Trained to facilitate group activities
* Highlighting exemplars of chemists beyond the Eurocentric viewpoint

**Reviews and Final Exam**

A series of three reviews will be given throughout the semester. An entire class period will be devoted to each review except for the final review, which will be held during exam week (May 8th-13th) and will be self-scheduled. Each review will focus on material since the previous review (or start of the semester in the case of the first review). However, the topics build upon one another in this course, so don’t let your guard down!

*Review Schedule:*

February 25th

March 31st (*tentative*)

Self-Scheduled during Exam Week (May 8th-13th)

**Problem Sets**

Problems sets are a key tool for practicing the new techniques, models, and information you will see in this course. These will come in the form of handouts with a series of long-form questions similar in style to those you will see on reviews and the final. You may work in groups to complete them, but the copy that is turned in must be in your own words and represent your understanding of the material.

After each review, the next problem set *may* come in the form of the previous review. Each student will be tasked with correcting any wrong answers to their previous review. At this time, students may also request a regrade of their entire exam. (*If you received a 100% on your review, then you don’t have any corrections and get a 100% for that problem set! Likewise, if you received a 50% on your review, you will have a lower limit of 50% and will need to answer the remaining questions correctly to receive a 100%. As noted below but copied here for clarity, if you don’t turn in the assignment, it will be a zero regardless of your “lower limit.”*)

Additionally, this class will use a POGIL-style lesson plan that includes questions to be done in a group during class and after. The completion of these problems will count toward a participation grade.

**Laboratory**

Do not schedule any conflicts with your assigned lab period. If a mandatory school-sponsored activity or religious holiday or observance creates a conflict, contact me to plan in advance of the date (at least 3 weeks). If you miss a lab without prior notification, you will receive a zero for that experiment.

Lab period will begin with a pre-lab introduction addressing new experimental techniques and safety information for that day. Arrive on time as this information can be critical to completing your work quickly and safely! If you arrive after the start of the pre-lab introduction, you will not be able to participate in any pre-lab quizzes or assignments that are given beforehand (zero points).

Record all data and calculations in your personal notebook. It may be necessary to submit your notebook to examine primary data or calculations, so keep all of this work until the end of the course. Lab reports will be due at the start of the following week’s lab section.

**Honor Code**

Sample reviews will be made available from previous years; this is for your own use this semester. Use of CHE 240 reviews from other semesters is not permitted. Reviews and exams must be pledged. When you add your signature, you are making the following pledge:

“*On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others*.”

You are encouraged to discuss homework problems with classmates, tutors, study groups, or with me. But the final answer and assignment should be your own work.

Laboratory reports must be prepared on your own. You may not refer to lab reports prepared by previous or current CHE 240 students. When you are working with a lab partner or partners, you may share data, work together on calculations, and compare answers, but you may not copy any part of your partner’s report. All written answers must be in your own words.

**Grading**

In an effort to remove my biases from the equation, you will be asked to use your student ID # in place of your name on any graded work that you will turn in. I see a movement across Davidson to use this tactic to help faculty make the course more equitable, and I see many more benefits than drawbacks to this small change. Thank you for working with me on this!

Your grade in this course will be determined as follows:

**Three Reviews** 45%

**Problem Sets** 30%

**Laboratory** 20%

**Participation**  5%

**Attendance**

Consistent with college policy, **a student who misses more than 7 lectures (25%) will not receive a passing grade**. 25% is quite a lot… so if you are missing lectures, please contact me to discuss your circumstances.

**Late Assignment Policy**

I am usually pretty receptive to a story about all sorts of conflicting assignments for your classes. Say you had a 10-page paper due the same day on your lab report. UGH! These things can be ironed out, but we have to communicate. If you think your assignment in my class will be late for whatever reason, you should let me know before it’s late! Without notice, a loss of 10% on the assignment per day is the standard penalty.

You didn’t turn in the assignment at all? That’s a zero!

**Accommodations**

The college welcomes requests for accommodations and will grant those that are determined to be reasonable and maintain the integrity of a program or curriculum. To make such a request or to begin a conversation about a possible request, please contact the Office of Academic Access and Disability Resources, which is located in the Center for Teaching and Learning in the E.H. Little Library: Beth Bleil, Director,[bebleil@davidson.edu](mailto:bebleil@davidson.edu), 704-894-2129; or Alysen Beaty, Assistant Director, [albeaty@davidson.edu](mailto:albeaty@davidson.edu), 704-894-2939. It is best to submit accommodation requests within the drop/add period; however, requests can be made at any time in the semester. Please keep in mind that accommodations are not retroactive.

**Dr. Beeston’s RESOURCES FOR SUCCESS™**

Dr. Ruth Beeston retired last year, and she knew a ton about Davidson! Here, for your benefit and mine, are her RESOURCES FOR SUCCESS.

The **Math & Science Center** (MSC) offers free assistance to students in all areas of math and science, with a focus on the introductory courses. Trained and highly qualified peers hold **one-on-one and small-group tutoring sessions** on a drop-in basis or by appointment, as well as timely recap sessions ahead of scheduled reviews. Emphasis is placed on thinking critically, understanding concepts, making connections, and communicating effectively, not just getting correct answers. In addition, students can **start or join a study group** and use the MSC as a group or individual study space. Located in the Center for Teaching & Learning (CTL) on the first floor of the College Library, **drop-in hours are Sunday through Thursday, 8-11 PM, beginning Tuesday January 21st**. **Appointments may be scheduled for Sunday through Thursday, 4:30-6:30 PM, using the online scheduling system linked from the MSC website**; appointments are also available at other times upon request. For more information, visit <http://www.davidson.edu/offices-and-services/center-teaching-and-learning/student-resources/math-science-and-economics-center>, or contact Dr. Mark Barsoum (mabarsoum or x2796).

Some recommendations for success in the course:

* Set aside time every day to review chemistry notes, read the book, and work on problem sets. Do not attempt to tackle whole assignments in a single sitting.
* Vary your study/work location. Studies have shown that the brain makes associations between concepts and background sensations (lighting, scenery…) and that making multiple associations with the same material can improve learning. It is worth a try!
* Avoid distractions (emails, texts, facebook\*…) during your study. Set goals, and reward yourself when you have completed your work!
* Get more sleep. You may have to give up or scale back on some extra-curricular commitments, but it will pay off academically.
* Get help during office hours (or make an appointment). Let’s talk about what success for you might look like and plot a path there together!
* Form study groups and help each other. There is no better way to master something than to explain it to others.
* Ask for help if you need it, when life gets in the way. Some good contact info:

Campus Police 704-894-2178 or 911 Chaplain’s Office 704-894-2423

Dean of Students Office 704-894-2225 Georgia Ringle, health educator 704-894-2902

Student Health and Counseling 704-894-2300

\*Editor’s Note: Facebook is a social network used by an older generation. Please insert Instagram, Snapchat, or Tik Tok where applicable.

**CHE 240 Schedule for Laboratory Experiments**

January 15–16 Introduction, Safety Talk™ by Lee Maiorano, Discussion of Lab

Reports

January 22–23 Use of Mercury Software for 3D model viewing

January 29–30 Atomic Orbitals

February 5–6 Lewis Dot Structures Review

February 12–13 Metal Organic Frameworks as Elements of Symmetry (Week 1)

February 19–20 Metal Organic Frameworks as Elements of Symmetry (Week 2)

February 26–27 **NO LAB**

March 4–5 SPRINGBREAKWAAAHAHAHHHHHHHHH **NO LAB**

March 11–12 **NO LAB**

March 18–19 Exploring MO Theory with Spartan

March 25–26 Hard-Soft Acid-Base Chemistry

April 1–2 Preparation of Brass

April 8–9 Metallurgical Preparation of Antimony

April 15–16 Synthesis of an Interhalogen Compound, K[ICl4]

April 22–23 Analyzing the *d*-Orbital Electron Configuration of Metal

Acetylacetonate Complexes

April 29–30 Continuation of last experiment; lab clean up