Syllabus and Guidelines for CH244 Inorganic Chemistry Stonehill College Spring 2019

Dr. Leon J. Tilley Lectures: M, W, F 10:30-11:20 Shields 321 Lab: T, W 1:30-5:30 Shields 321

Office: Shields 314 Office Hours: M by appt. T 6:00-7:30 W 11:30-1:00 Th. 11:30-1:00 F 2:30-4:00

TAs: Meghan Curran, Hannah MacKay, Kyle Paquette LA: Will Gilmore, Pete Giannini, TBA

Phone: 1145/5193(research lab) 508-728-2953 (for texting) email:ltilley@stonehill.edu

Textbook: Rogers, G. E. *Descriptive Inorganic, Coordination, and Solid-State Chemistry*, 3rd ed., Brooks/Cole Cengage: New York, 2011.

Laboratory Text:Girolami, G. S.; Rauchfuss, T. B.; Angelici, R. J. *Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual*, 3rd ed., University Science Books: Sausalito, CA, 1999.

Course Description: This course covers fundamentals of central topics in inorganic chemistry from historical to modern-day perspectives. Topics include: coordination compounds (history, structure, bonding theories, reactivity, applications); solid state chemistry (crystals, lattices, radius ratio rule, defect structures, silicates & other minerals); and descriptive chemistry of the elements.

Goals of the Course:Why do we study inorganic chemistry? The answer might at first seem to be an obvious one, such as "I want to learn more about it," or "I should know more about it," but, as you might surmise, it is much more complex than that. Many of you are at crossroads in your careers, trying to decide, which, if any, areas of chemistry you want to focus on as you progress towards your degree and a job or graduate school. Some of you may fondly remember general chemistry (which has inorganic chemistry in it); others may have preferred organic chemistry. Organic chemistry is often described as the chemistry of carbon or “chemistry relating to life” and inorganic chemistry is the “chemistry of the rest of the periodic table”, but inorganic chemistry is integral to life as well. Many enzymes contain metals; chlorophyll, arguably one of the fundamental compounds of all life contains magnesium, an inorganic element. In reality, all branches of chemistry are so interconnected that we really can't clearly separate them from each other. The primary goal of this course will to be learn enough inorganic chemistry to have an appreciation for its role as an integral part of the chemical (and biological) world. As a result I think that everyone will find at least several aspects of this

course to be stimulating and interesting.

 Week (Dates) Topics Reading

Let's get started! Below is a **tentative** schedule of the course material.

1 (1/14, 16, 18) Coordination compounds: History Chapter 2

 Coordination compounds: A modern view

Coordination compounds: Intro to nomenclature

 1/15, 16 **Lab:** Safety <http://www.youtube.com/watch?v=ALBWxGik64A>

**Lab:** Prussian blue and cyanotypes

**Lab:** Discuss crystal growth Baer, C. D.*JCE* **1990**, 67(5), 410-12

2 (1/23, 25) Structures of coordination compounds Chapter 3

Chelating ligands, lambda and delta isomers

1/22, 24 **Lab: Stoichiometry of Fe(phen) Complex** Handout

1/25  **Prelab due: The Growth of Large Single Crystals**

3 (1/28, 1/30, 2/1) Quiz 1- February 1st – chapters 2 and 3

Tetrahedral, square planar, structural isomers Chapter 3

Bonding theories for Coordination Compounds Chapter 4

Early bonding theories

1/29, 30 **Lab: Optical Resolution of [Co(en)3]3+** Girolami 143-150

4(2/4, 6, 8) Crystal field theory and CFSE Chapter 4

2/5, 6 **Lab: Optical Resolution of Co(En)33+ (finish)**

5(2/11, 13, 15) CFSE (continued) Chapter 4

 Ligand field theory and LFSE

Magnetic Properties, absorption spectroscopy

2/12,13 **Lab: Magnetic Susceptibility** Girolami 117-130, Handout

**Lab: Spectrochemical series** Handout

6(2/18, 20, 22) Rates and Mechanisms of Coordination Compounds Chapter 5

Labile and Inert compounds

Substitution reactions of Coordination compounds

Steady state approximations

2/19, 20 **Lab: Aquation of [Co(NH3)5Cl]2+** Girolami 131-142

Week (Dates) Topics Reading

7(2/25, 27, 3/1) Quiz 2- March 1st – chapters 4 and 5

Electron Transfer reactions (outer & inner sphere) Chapter 5

 Substitution reactions in square planar complexes

 Polymerization reactions using organometallics

Applications of Coordination Compounds Chapter 6

2/26, 27 **Lab: Cobaloximes: Models of Vitamin B-12** Girolami 211-17

**Lab: Synthesis of YBa2Cu3O7** Girolami 17-26

**!**Spring Break! - No Class March 2nd through March 10th

8(3/11, 13, 15) Exam 1 - March 13th - chapters 2-6

Solid-State Structures Chapter 7

Crystal Lattices - Introduction

 A type crystal lattices

3/12, 13 **Lab: Cobaloximes (finish if necessary)**

**Lab: The Growth of Large Single Crystals** Baer, C. D.

(prelab due 1/26) *JCE* **1990**, 67(5), 410-12

9(3/18, 20, 22) ABn type crystal lattices

Structures involving polyatomic molecules and ions Chapter 7

 Defect structures, spinel structures

3/19, 20 **Lab: Iodimetric Titration of YBa2Cu3O7 and**

**Observation of Meissner Effect** Girolami 17-264/5

10(3/25, 27, 29) Silicates (and other minerals) 15.5, Selected Readings

Polymer/inorganic natural systems

Metal-organic frameworks (MOFs)

 Band Theory 15.6, Selected Readings

 Semiconductors and Superconductors

 Nanoparticles, colloids, quantum dots

3/26, 27 **Lab: Periodic Properties of Semiconductors,** Handout

**Investigation of quantum dots and other nanoparticles**

Week (Dates) Topics Reading

11(4/1, 3, 5) Quiz 3 – April 1st – chapters 6 and 7

Solid-State energetics (Theoret. Lattice energy) Chapter 8

 Solubility Rules Chapter 11

 4/2, 3  **Lab: Ksp of Mg(OH)2/solubility** Handout

12(4/8, 10, 12) Periodic law, periodic trends Chapter 9 Discovery of hydrogen, radioactive Chapter 10

processes involving hydrogen

Radioactivity and nuclear chemistry Selected Readings

 4/9, 10 **Lab: Radioactivity**

13 (4/15) The hydrogen economy Chapter 10 and selected readings

 Gas storage solutions

!Easter Break! - No Class April 17th–April 22nd

 4/16 **Lab: Oxidation States of Vanadium**

14(4/23, 24, 26) Quiz 4 – April 23rd – chapters 8 and 9 (Takehome)

Oxygen, Aqueous solutions Chapter 11

Acid/Base character of Oxides

 and Hydroxides, Ozone, Greenhouse effect

Reduction potentials, Electrochemistry Chapter 12

4/24 **Lab: Oxidation States of Vanadium**

15(4/29, 5/1) Exam 2 – May 1st chapters 7-10

Presentations (Groups 2A-8A, lanthanides, Chapters 13-19

 actinides) Selected readings

 4/30, 5/1 **Lab: Presentations**

 **Lab: Crystals Due**

# Grading

## Problem Sets

You will be assigned problem sets for the material in each chapter covered, to be handed in on the specified due dates. The problem sets in total will be scaled to 100 points, or 10 percent of your final grade. You should make sure you are able to do these problems, as material on quizzes and exams may well be taken from them!

## Review Sessions

While there are no required review sessions for this course, each of the TAs will have a weekly time slot when they will be available in the science building to help you with problem sets, with studying for quizzes or exams, or with laboratory reports. In addition, if you do not have time to complete compound characterization (NMR, IR, etc.) within the lab period allotted, the TA will be available to help you with running the instrumentation (for compound analysis only, not for lab work!). You may also get additional help elsewhere (see the Resources for Academic Support section on the last page of this syllabus).

## Exams and Quizzes

Exams and quizzes may contain multiple choice, short answer and essay questions.

You will take four quizzes (approximately half a class in length) on Friday, February 1st, Friday, March 1st, Monday, April 1st, and Tuesday, April 23rd. Each quiz is worth 25 points, or 2.5 percent of your final grade.

There will be two exams. Each exam will be worth a total of 100 points, and will consist of an in-class part (50 points) and a take-home part (50 points). The first in-class exam will be on Wednesday, March 13th, and the second in-class exam will be on Wednesday, May 1st. Take-home exam 1 will be dueonFriday, March 15th and take-home exam 2 will be due Wednesday May 1st.

### Final Exam

The final exam will be worth 200 points, or 20 percent of your final exam. It will include material from all chapters in the book (chapters 1-11 all material covered by me, and chapters 12-19 material covered on your presentations – see next page) as well as material covered in lab.

## Class Presentation - Descriptive Chemistry

When we cover chapters 12-19, each of you will be responsible for giving a PowerPoint presentation teaching the chemistry of one or several elements in a group (either representative elements [1,2,13-18] or lanthanides or actinides) to the rest of the class. You and two of your classmates will choose a group to present. You and your co-presenters should, for the first part of the presentation, give a brief overview of the properties of the elements you are covering in the group. However, each of you should then present an in-depth focus based on one of the elements in the group, relating to an application of that element. You may start with the special topics in the book, but should extend that to specific research you have found in a recent journal article. While you will be using PowerPoint as the principle medium, this is not necessarily expected to be a formal seminar – you should be interacting with the class – you may ask questions, give a quiz, bring in props, demos, etc. You are the teacher!

This presentation will be worth 100 points, or 10% of your grade. We will discuss group assignments in class. **Please note that material from presentations will be covered on the final and you will be responsible for all the material.**

The grading rubric for this presentation is as follows:

Chemistry Content – **20 points** (goes beyond material covered in book, contains relevant reactions and explanations):

Context/Background/Relevance/Interest – **15 points (**background / purpose/ context of presentation is clear; material is relevant and designed to evoke interest)

Visuals - **15 points** (good use of figures, reactions, pictures, models, demos etc.)

Speaking – **15 points** (demeanor, clarity of speaking, not reading from notes)

Organization – **15 points** (flows logically in an understandable fashion, good interaction between presenters, transitions clear, not too short or too long)

References -**10 points** (material is taken from sources other than text, all references cited properly, quality of sources will be taken into account)

Question and Answer – **10 points** (questions answered knowledgeably)

## Labs

This course also has a laboratory component, which I hope you will find to be interesting and exciting. You will be conducting a number of experiments that are designed to investigate a variety of inorganic synthetic and analytical techniques. We will all have fun with the labs. You will be expected to keep a standard lab notebook and write up all reports in standard report format. (We will discuss this if necessary.)

*Safety*

The laboratory safety practices you employed in general chemistry and organic chemistry are those you are expected to adhere to in this course as well. I will briefly cover the various points described on the safety form; be sure you ask any necessary questions to ensure you are clear what is expected of you. **You are expected to wear goggles at all times in the laboratory!** Please also note that if you come in at another time to work in the laboratory that you **notify me** that you will be working and tell me what you will be working on.

*Lab Notebooks*

Maintaining an up-to-date, complete laboratory notebook is essential to your success as an inorganic chemist. At this point, you should be accustomed to keeping a notebook, but do not hesitate to ask if you have questions! While I will not be formally inspecting notebooks, if you are having difficulty doing or writing up an experiment, I will probably need to understand your notebook to help you.

## *Lab Reports*

Your lab report is your chance to express yourself. The format of the lab report should be the same as that of a current, approved chemistry journal such as *Inorganic Chemistry*. The reading and my instructions will provide you with a rough idea of what should be included in the report, but it is up to you to fill in the details. You should go beyond the minimum expectations; try to explore some questions that come to your mind and be sure to look up any additional references you feel to be relevant or helpful. For example, if you have characterized a compound using spectral data, you should compare your results to reference data.

Due dates for lab reports will be announced. The labs will, in total, be worth 300 points, or 30 percent of your grade.

### Summary: A breakdown of the total points for the semester is as follows:

 problem sets 100 points

 4 quizzes (25 points each) 100 points

 two exams 200 points

 final exam 200 points

 descriptive chem. presentation 100 points

labs 300 points

 Total: 1000 points

Course Grades (Found in the HillBook)

The quality of work in a course is indicated by the following grades:

# Course Expectations

## Review of General Chemistry / Assumed Previously Learned Material

As part of this course, you will be expected to have a good working knowledge of the material you learned in your general chemistry (and organic chemistry) courses. Indeed, some of this material, while not explicitly covered in this course will be found on the final exam.

Time Spent Outside the Classroom/Federal Definition of Credit Hour

The federal definition of the credit hour is as follows:

 **Federal Government definition of a Credit Hour:**

“… an amount of work represented in intended learning outcomes and verified evidence of student achievement that is an institutional established equivalence that reasonably approximates not less than-

(1) One hour of classroom or direct faculty instruction and a minimum of two hours of class student work each week for approximately fifteen weeks for one semester or trimester hour of credit, or ten to twelve weeks for one quarter hour ofcredit, or the equivalent amount of work over a different amount of time.

(2) At least an equivalent amount of work as required in paragraph (1) of this

definition for other academic activities as established by the institution including laboratory work, internships, practica, studio work, and other academic work

leading to the award of credit hours.”

In terms of this course, which is three credits, this means that you would be expected at minimum to spend roughly six hours each week outside of class working on material. This can include (but is not limited to) time spent working on problem sets, the symmetry workbook, reading the textbook, and studying for exams and quizzes. In reality, you will probably be spending much longer!

Resources for Academic Support

The Center for Writing and Academic Achievement (CWAA) provides academic support services in a welcoming, professional environment that emphasizes collaborative learning and peer tutoring, supplemented with professional-level support. The CWAA offers a variety of academic support services, including peer tutoring in writing, math, and foreign languages.

The CWAA is located in MacPháidín Library, Room 314. Drop-in hours are offered Sunday – Thursday. Students can visit the [CWAA website](http://www.stonehill.edu/offices-services/cwaa/) to view schedules, make appointments, or request a tutor.

Academic Honor Code/Academic Integrity Policy

My expectation is that you will adhere to **the Stonehill Academic Honor Code and Academic Integrity Policy** found in the 2017-2018 Hillbook under Academic Policies and Procedures.

In this course, presenting another’s work as if it were your own; failing to acknowledge or document a source even if the action is unintended; giving or receiving, or attempting to give or receive, unauthorized assistance or information in an assignment or examination; fabrication of data; submitting the same assignment in this class as was submitted in another class without my prior permission; having another person write a paper or take an exam for you; unauthorized use of electronic devices to complete work; and furnishing false information, including lying or fabricating excuses, for incomplete work are considered violations of the academic integrity policy.

When in doubt, always verify with me if something is being done properly or is allowable in this class rather than simply making an assumption based on the fact that it was or is currently allowable in another class.

A violation of Stonehill’s Academic Integrity Policy may, at my discretion, be as minor as loss of credit on the assignment or exam or as severe as an F in the course.

Students with Disabilities

Stonehill College is committed to providing a welcoming, supportive and inclusive environment for students with disabilities. The Office of Accessibility Resources (OAR) provides a point of coordination, resources and support for students with disabilities and the campus community. If you anticipate or experience physical or academic barriers based on disability, please let me know so that we can discuss options. You are also welcome to contact OAR to begin this conversation or to establish reasonable accommodations for this or other courses. OAR is located within the Academic Services & Advising Suite in Duffy 104. For additional information please call (508) 565-1306 or email accessibility-resources@stonehill.edu.

Inclusive Classroom Statement

Stonehill College embraces the diversity of students, faculty, and staff, honors the inherent dignity of each individual, and welcomes their unique cultural and religious experiences, beliefs, and perspectives. We all benefit from a diverse living and learning environment, and the sharing of differences in ideas, experiences, and beliefs help us shape our own perspectives. Course content and campus discussions will heighten your awareness to these differences.

There are many resources for anyone seeking support or with questions about diversity and inclusion at Stonehill. Resources are infused throughout the Mission Division, Academic Affairs, and Student Affairs. If you’d like more information on how to get connected to resources, the Office of Intercultural Affairs is a good first stop: Location: Duffy 149, Phone: 508-565-1409, Email: diversity@stonehill.edu.

If you are a witness to or experience an act of bias at Stonehill, you may submit a bias incident report online or on the Stonehill App. If you would like to learn more on bias incident prevention and response, or submit a report please visit: <http://www.stonehill.edu/offices-services/intercultural-affairs/bias-response-protocol/>

***A personal note from your professor…*** *If you ever have a concern about my behavior or that of another student in the class, please, please feel free to approach me in person, by email, or with an anonymous note under my door… whatever it takes so that I can continue to work on creating an inclusive classroom environment.  Thank you!*

Cell Phone Policy - Any exceptions must be approved by the professor.

Each cell phone is to be turned to silent mode during class time and remain out of sight throughout the entire duration of the class.

During exam periods each cell phone must be in silent mode and remain visible with the screen side down on the desk. Absolutely no use of the cell phone (i.e., checking

its screen) is permitted from the time an exam is handed out until it has been turned in to be graded.