Chemistry 355
Intermediate Inorganic Chemistry

Instructor Information
Dr. Jason S. D'Acchioli
Professor and Department Chair
Office: CBB 303A
e-mail: jdacchio@uwsp.edu
https://chemdac.uwsp.edu
715-346-2297

I. Course Description and Learning Outcomes. This course is intended to be a survey of aspects of modern inorganic chemistry. As you progress through the course, you will find that Inorganic Chemistry combines elements (no pun intended) from ***all*** areas of chemistry, including general chemistry, organic chemistry, physical chemistry, analytical chemistry, and biochemistry. Becoming comfortable with ***chemistry*** is one of the most important goals of this course. A key aspect of the course will be the use of current literature. Chemical literature is one of the best places to learn about techniques and methodologies, and to get fresh ideas for research. The onus will, of course, be on you to read all of the assigned material. I will not necessarily cover every reading assignment in class; it will be up to you to ask questions on the readings.

I strive for inclusive excellence in Chem 355—regardless of race, ethnicity, gender, sexual orientation, beliefs, socio-economic status, or cognitive ability, you should feel comfortable in this class. If you ever feel uncomfortable, please come and see me.

After completing Chem 355, you should be able to satisfy the following learning outcomes.

1. Apply foundational principles of Inorganic Chemistry to identify and explain the chemical and physical properties of matter.

2. Evaluate and communicate solutions to chemistry-related issues and problems, particularly Inorganic Chemistry related issues and problems, according to accepted scientific standards as, for example, a report, poster, or oral presentation. Please note I will focus on the oral communication aspect of the Chemistry major.

3. Search and discuss the modern chemical literature and databases.

II. Course Information

Schedule for Spring 2019

<table>
<tr><th></th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td>8AM</td><td>R, P, G</td><td rowspan="2">Off Campus</td><td rowspan="2">Off Campus</td><td>R, P, G</td><td>R, P, G</td></tr>
<tr><td>9AM</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td></tr>
<tr><td>10AM</td><td>R, P, G</td><td>Chem 355</td><td>R, P, G</td><td>Chem 355</td><td>Chem 355</td></tr>
<tr><td>11AM</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td></tr>
<tr><td>12PM</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td></tr>
<tr><td>1PM</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td></tr>
<tr><td>2PM</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td><td>R, P, G</td><td rowspan="3">Meetings</td></tr>
<tr><td>3PM</td><td rowspan="2">Off Campus</td><td rowspan="2">Off Campus</td><td rowspan="2">Meetings</td><td rowspan="2">Meetings</td></tr>
<tr><td>4PM</td></tr>
</table>

R, P, G stands for Research, Projects, Grading

A. Course Materials

1. Rayner-Canham, G., and Overton, T. *Descriptive Inorganic Chemistry*, 6th ed. (Required; available from text rental)
2. http://pubs.acs.org: American Chemical Society Journals
3. http://www.rsc.org/Publishing/index.asp: Royal Society of Chemistry Journals
4. https://chemdac.uwsp.edu: My URL for the course
5. https://www.uwsp.edu/canvas/Pages/default.aspx: Use Canvas to follow your progress!

B. Course Assessments

1. **Problem sets:** There will be a total of 6 problem sets, each worth 60 points, and each set will contain several questions, some of which will require you to use the SciFinder database. I will, however, grade only three problems from each set. Don't try to guess which problems I'm going to grade! There will be a 10-point penalty for incomplete problem sets (didn't finish a problem, when you could have come and spoken with me? Yup, that's incomplete). Late problem sets will be assessed a 10%-per-day penalty. I will drop the lowest problem set score.
2. **Examinations and Literature Discussions:** Examinations will take place on Wednesday evenings from 6 to 9 PM. Exams will be divided into two parts: a written part based on

lecture material, and an oral part based on a class literature discussion. The literature discussions will be held 2-weeks prior to each exam. I will provide you with a paper from the inorganic chemistry literature, along with questions to guide your reading. We will then meet in class on those discussion days to discuss the answers to those questions, often with you presenting your answers. The oral portion of your exam will based on the answer to one of your questions.

3. **Quizzes:** Every so often I'll give you a quiz as a "check" on your understanding. You never know…

4. **Final exam.** The final exam will be cumulative. However, it will focus more heavily on material covered between Exam 3 and the Final.

Exams will occur on the following dates.

Exam	**Date**	**Time**
Exam 1	February 27	6-9PM
Exam 2	March 27	6-9PM
Exam 3	April 24	6-9PM
Final Exam	May 14	10:15AM - 12:15PM

C. Grading

Assignment	**Point Value**
3 exams, 150 points each	450
6 quizzes, 10 points each	60
6 problem sets, 60 points each, lowest dropped	300
Final Exam	200
Total	1010

Total points accumulated will be converted to a percentage of the total points possible. I reserve the right to adjust these cut-off points, but in no case will the cut-off for a particular grade be higher than those listed.

Grades will be assigned according to the following scheme: 90.0-100%, A; 88.0-89.9%, A-; 85.0-87.9%, B+; 83.0-84.9%, B; 79.0-82.9%, B-; 74.0-78.9%, C+; 68.0-73.9%, C; 65.0-67.9%, D+; 60.0-64.9%, D; 59.9% and lower, F.

January 31	Last day to add or drop a 16-week course without a grade
April 5	Last day to drop a 16-week course

D. Learning Objectives and Course Material

The course schedule appears in an addendum to the syllabus. Please note I do ***not*** list what topics I will cover on a particular day; rather, I indicate which chapter from Rayner-Canham and Overton will be covered. I adjust my pace, as necessary, to accommodate the difficulty–or ease!–of material. That being said, the following are the learning objectives you will be able to meet after finishing a particular chapter.

Chapter 1. The Electronic Structure of the Atom.

As we finish Chapter 1, you will be able to . . .

1. . . . describe the components of an atom.
2. . . . qualitatively describe electrons in terms of the wavefunction, $\psi(x)$, including its angular and radial parts.
3. . . . describe, and show, how an electron's location can change based on effective nuclear charge, Z_{eff}.
4. . . . write electron configurations for atoms, ions, and excited states.

Chapter 2. The Structure of the Periodic Table.

As we finish Chapter 2, you will be able to. . .

1. . . . define and identify basic periodic trends.
2. . . . define and identify basic group trends (includes ideas from Chapter 9).
3. . . . define and utilize concepts from the following to place elements and ions in energetic order:
   (a) Ionization energy, IE
   (b) Electron affinity, EA
   (c) Electronegativity (Pauling), χ
4. . . . utilize Slater's rules to quantitate Z_{eff}
5. . . . identify and utilize other periodic trends such as the "diagonal relationship" and the "Knight's move"

Chapter 3. Covalent Bonding and Molecular Spectroscopy.

As we finish Chapter 3, you will be able to. . .

1. . . . define and identify the basic symmetry elements and operations: E (identity), σ (mirror plane and reflection), C_n (rotational axis), S_n (improper rotational axis), and i (inversion)
2. . . . draw Lewis structures, including assigning formal charges to atoms.
3. . . . use Lewis structures in conjunction with VSEPR to draw 3-dimensional representations of molecules.

4. . . . apply symmetry elements and operations to VSEPR structures.
5. . . . assign point groups to molecules.
6. . . . use valence-bond theory to describe bonding.
7. . . . use hybrid orbital theory to describe bonding.
8. . . . use molecular orbital (MO) theory to describe bonding.
9. . . . construct qualitative frontier MO diagrams for diatomic molecules.
10. . . . identify Lewis acids and Lewis bases (includes ideas from Chapter 7).
11. . . . use Lewis acid/base theory from a frontier orbital perspective, to describe bond formation in inorganic complexes (includes ideas from Chapter 7).
12. . . . define hard-soft acid-base theory (HSAB) (includes ideas from Chapter 7).
13. . . . use HSAB to rationalize bond formation (includes ideas from Chapter 7).

Chapter 19. Transition Metal Complexes.

As we finish Chapter 19, you will be able to . . .

1. . . . describe and identify the characteristics of a transition metal complex (coordination number, ligands).
2. . . . identify and/or determine the number of stereoisomers of transition metal complexes.
3. . . . name transition metal complexes.
4. . . . explain the bonding in transition metal complexes using crystal field theory (CFT).
5. . . . calculate crystal field stabilization energy (CFSE) in octahedral and tetrahedral transition metal complexes.
6. . . . differentiate between high-spin and low-spin transition metal complexes.
7. . . . use CFSE to explain trends in the properties of transition metal complexes.
8. . . . apply concepts from CFT to explain the electronic absorption spectra of transition metal complexes, including the energy of electronic transitions, and the nature of the transitions.
9. . . . qualitatively explain the differences between CFT, ligand-field theory, and MO theory of transition metal complexes.
10. . . . explain the difference between kinetic and thermodynamic factors in transition metal complex formation. Describe general mechanisms of transition metal complex formation (substitution reactions, *cis* versus *trans* effects).
11. . . . rationalize the syntheses of transition metal complexes using a variety of principles, including thermodynamics, HSAB, CFSE, etc.

Chapter 23. Organometallic Chemistry.

As we finish Chapter 23 , you will be able to...

1. ...extend principles of transition metal complexes to organometallic complexes.
2. ...identify organometallic complexes.
3. ...identify ligand types in organometallic complexes (σ-donor and π-acceptor), and how their electronic structures affect the metal.
4. ...describe the synthesis and reactivity of some main-group organometallic complexes.
5. ...use the so-called 18-electron rule (effective atomic number rule, EAN) to rationalize the stability and reactivity of transition metal organometallic complexes.
6. ...describe bonding in organometallic complexes, especially in terms of σ-donor and π-acceptor ligands.
7. ...identify some common "spectroscopic handles" for transition organometallic complexes.
8. ...explain the steps of a common transition metal organometallic catalytic cycle in terms of the 18-electron rule, and terminology such as *reductive elimination* and *oxidative addition*.

Chapters 4 and 5. Solid State Chemistry.

As we finish Chapter 4, you will be able to...

1. ...describe bonding in extended structures (solids).
2. ...identify and compare various unit-cell packing arrangements.
3. ...define a unit cell, and use that definition to determine properties such as unit cell volume and side length.
4. ...describe differences between ionic and covalent solids.
5. ...use periodic trends such as anion and cation size to describe the properties of ionic compounds.
6. ...describe various types of ion packing.
7. ...use the radius ratio rule to determine optimal packing arrangements.
8. ...describe common classes of solid-state clusters, e.g. perovskites and spinels.

E. Etiquette and Inclusive Excellence. It is absolutely essential that you show respect to your peers and your instructor. As such, the following will not be tolerated:

1. *Cell phones/iPhones/other electronic devices*. Turn them off during class!

2. *Informal e-mails*. Sending an e-mail is not like texting or tweeting. A properly formatted e-mail should look like a letter, with a subject, salutation, body, and signature. Well-written e-mails are effective at communicating ideas. Poorly written e-mails only serve to confuse and annoy the reader, and portray you in a less than flattering light.

F. Academic Misconduct. Full information on academic misconduct can be found at `https://www.uwsp.edu/dos/Pages/Student-Conduct.aspx`. Academic misconduct is a serious matter, with a wide-range of penalties. Please familiarize yourself with faculty, staff, and student rights and responsibilities regarding academic misconduct. Please let me know if you have questions pertaining to academic misconduct.

G. Disability Services. There are a number of resources available for students with documented disabilities. A full listing of them can be found at `https://www.uwsp.edu/datc/Pages/default.aspx`. Please be aware that, in order to take advantage of some of the services, you must provide me with an Accommodation Request Form which I will sign. You must return the form to Disability Services.

January 2019

MON	TUE	WED	THU	FRI	SAT	SUN
31	1	2	3 Winter Break	4	5	6
7	8	9	10 Winter Break	11	12	13
14	15	16	17 Winter Break	18	19	20
21	22 Classes Begin Chapter 1	23	24 Chapter 1	25 Chapter 1/2	26	27
28	29 Chapter 2	30	31 Chapter 2	1	2	3

Addendum 1

February 2019

MON	TUE	WED	THU	FRI	SAT	SUN
28	29	30	31	1 Chapter 2	2	3
4	5 Chapter 2	6	7 Chapter 2/9 PS 1 Due	8 Chapter 3	9	10
11	12 Chapter 3	13	14 Chapter 3	15 Chapter 3 Literature Discussion 1	16	17
18	19 Chapter 3	20	21 Chapter 3	22 Chapter 3 PS 2 Due	23	24
25	26 Chapter 3	27 Exam 1 6-9PM	28 Chapter 19	1	2	3

Addendum 2

March 2019

MON	TUE	WED	THU	FRI	SAT	SUN
25	26	27	28	1 Chapter 19	2	3
4	5 Chapter 19	6	7 Chapter 19	8 Chapter 19 PS 3 Due	9	10
11	12 Chapter 19	13	14 Chapter 19	15 Chapter 19 Literature Discussion 2	16	17
18	19	20	21 Spring Break	22	23	24
25	26 Chapter 19	27 Exam 2 6-9PM	28 Chapter 19	29 Chapter 19	30	31

Addendum 3

April 2019

MON	TUE	WED	THU	FRI	SAT	SUN
1	2 Chapter 19	3	4 Chapter 19	5 Chapter 19 PS 4 Due	6	7
8	9 Chapter 19	10	11 Chapter 19/23	12 Chapter 23 Literature Discussion 3	13	14
15	16 Chapter 23	17	18 Chapter 23	19 Chapter 23 PS 5 Due	20	21
22	23 Chapter 23	24 Exam 3 6-9PM	25 Chapter 4/5	26 Chapter 4/5	27	28
29	30	1	2	3	4	5

Addendum 4

May 2019

MON	TUE	WED	THU	FRI	SAT	SUN
29	30 Chapter 4/5	1	2 Chapter 4/5	3 Chapter 4/5 PS 6 Due	4	5
6	7 Chapter 4/5	8	9 Chapter 4/5	10 Chapter 4/5	11	12
13	14 Final Exam 10:15-12:15	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2

Addendum 5