CHMB31H3 - Introduction to Inorganic Chemistry

SYLLABUS

Fall 2017

Marco Zimmer-De Iuliis email: m.zimmer.deiuliis@utoronto.ca office: EV546 phone: 416.287.7662

Office hours: Tuesday from 11:00 am to 12:30 pm, Friday from 11:00 am to 12:30 pm

Welcome to the amazing, complex and colorful world of inorganic chemistry, a chemistry discipline that deals with all chemical elements (natural and artificial), their properties and reactivities. There are 92 naturally occurring elements (the rest were made in the laboratories) and as you can imagine, the material can be rather overwhelming. *Essential* for successful mastering of the inorganic chemistry material is solid understanding and knowledge of material from introductory chemistry courses (CHMA10H3 and CHMA11H3). Using this knowledge as a basis, inorganic chemistry can be turned into a piece of cake (a somewhat big piece, but still a piece...). Keep in mind that these 92 naturally occurring elements, these 92 LEGO blocks, are what all the stuff is made of: from the most distant stars and galaxies to the tiniest grain of dust in my office. This means that inorganic chemistry is everywhere.

Our course material is divided in two parts. The first part will cover introductory topics. You have already encountered most of this material in CHMA10H3 and CHMA11H3 courses and it would be a good idea to refresh your memory (the detailed topic list is given below). During this part we shall not only review these basic concepts but also further expand and apply them to the problems that are more related to the inorganic chemistry material. The second part of the course will cover the descriptive chemistry—the chemistry of the elements—for hydrogen and elements of Groups 1, 2 and 13-18 (or the main group chemistry). Our detailed list of our topics (the chapter numbers are from our textbook Shriver & Atkins' Inorganic Chemistry 6th edition) can be found later in the syllabus.

Office hours and contact info

My office is located in the new environmental sciences and chemistry building (behind the Instructional Center), 5th floor, room EV546. The office hours can be found on the Blackboard portal (under 'Contact') and are also located at the top of this document. If you would like to see me outside the office hours (for any reason), please e-mail me and we'll schedule the time. You can pay me a visit before the semester starts and before

announcement of the regular office hours if you like. If you are contacting me via e-mail: m.zimmer.deiuliis@utoronto.ca. Please allow two working days for me to respond.

Achieving Success in Inorganic Chemistry

As mentioned previously, **stay on the top of your material**: read, practice and take notes on regular basis. Much of the material requires knowledge from CHMA10 and CHMA11–**do not be shy** to go back and refresh your memory. **Take advantage of office hours**–note the questions that come up as you study, come to the office hours and discuss them. **Ask questions during the lectures**– while the question is fresh in your mind and the material is still new. Attend Facilitated Study Groups–they help a lot!

Marking Scheme

Laboratory component	= 25%
2 term tests, 20% each	= 40%
Final exam	= 35%

Both term tests will be composed of short answer questions and for each you'll have 90 min to write. Some details will be communicated on the Blackboard portal and/or in class prior to each test. The first term test is going to be in October (written in class). It will cover all material from the lecture 1 up to the week of the test. The second term test (written during class time in November) is going to cover the material covered between first term test and second term test.

The final exam is cumulative with about 1/3 of questions covering material from the first half of the course (material from the first term test) and 2/3 of questions covering the second part of the course (material covered after the first term test). The final will have both multiple choice and short answer questions and will take 3 hours.

Examples of old term tests and final exams will be posted on the blackboard. The format of your exams will be the same. Use these as extra practice problems. Please note that you will find old homework assignments (problem sets) among these old tests/exams. You will not have homework assignments in this course, besides the lab datasheets.

Missed term test policies

If you **miss a term test**, you must contact me ***within 24-48 hours*** of the missed test and provide the appropriate documentation ***within one week of the term test.*** If the reason is medical, you should download the official UTSC medical form available at http://www.utsc.utoronto.ca/~registrar/resources/pdf_general/UTSCmedicalcertificate.pdf and have your doctor complete the form. If no acceptable documentation for your absence is provided within one week of the test you will be assigned zero grade for that test. With the documentation you have two choices for make-up:

a) add the value of the missed test to your final exam (for example, if you miss a term test for a valid reason and chose this option, your final exam will be worth 35% + 20% = 55% of your final mark), *or* b) write a make-up test (the time/place would be determined in advance).

The readings and problems from your textbook will be given to you at the end of each lecture in your lecture notes. The lecture notes will be posted on the Blackboard regularly in *pdf* format. These notes provide you with the overview of important concepts, ideas etc. and are the basis for class discussions and lectures. They will be your primary source - master them first and after move to the textbook to expand your knowledge and then (only if you want to) check other sources.

Knowledge of material from BOTH lecture notes and relevant textbook readings is expected.

You might know by now that there is a Lecture Cast for this course as well. Regardless of this fact, **I strongly encourage you to attend the lectures regularly**. There is a lot of material to be covered. If you do not attend the lectures and wait for the Web cast, you will easily end up having to watch hours and hours of material – *really not a good idea to master this subject*. If you come to the lectures and use Lecture Cast only in a case of sickness or class conflicts, or to fill in your notes, you'll remain on the top of the material covered and be more successful in the course (in comparison to only relying on Lecture Cast). This course (unfortunately) does not have tutorials in the program. However, just like during previous years, we shall have some practice time during the class. There will also be facilitated study groups

Facilitated study groups (FSG) for CHMB31H3

Facilitated Study Groups for CHMB31H3 will be available for this year. These weekly study sessions are open to everyone in the class. Attendance is voluntary, but students who attend regularly often earn higher grades. Please be sure to fill out the survey in the first week of class to help ensure the study groups are scheduled at

optimal times. If you have any questions, please ask your facilitator, or visit the FSG website at http://ctl.utsc.utoronto.ca/home/fsg.

Ancillary Fees

Students taking CHMB31 will be assessed a $25.00 ancillary fee which will cover the cost of chemicals, filter paper, Pasteur pipettes and other items consumed over the course of the lab. For more information regarding ancillary fees students are encouraged to visit the following website: http://www.planningandbudget.utoronto.ca/tuition.htm

COURSE TOPICS (in the order they will occur) with LEARNING OBJECTIVES (LOs)

Part 1: Fundamental concepts

1. Inorganic chemistry – a general introduction to the discipline and our course
2. The Elements – what are they? (Chapter 1 and on-line materials)
    a. Atoms and their structure
    b. Electronic structure
    c. Structure of nucleus, radioactivity, fission and fusion
    d. Nucleosynthesis: the birth of elements in stars and laboratory (basics of stellar and interstellar inorganic chemistry and artificial nuclear reactions)
    e. The periodic table of the elements: Overview

NOTE: Topics 2a, 2b, and 2e are related to the first year chemistry material and it would be a good idea to refresh your old knowledge early!

L01: Students will be able to relate the stability of elements to the binding energy of the nucleons composing the element and develop an understanding of why unstable nuclei undergo radioactive decay.

L02: Students will gain an appreciation for the differences between nuclear fission and fusion and their applications and role in nucleosynthesis.

L03: Students will combine their prior knowledge of atomic structure with a quantum mechanical approach to atomic structure including orbitals as wave functions, quantum numbers for electrons, Slater's Rules, and the Pauli Exclusion Principle.

L04: Students will be able to interpret and explain trends in the periodic table based on their newly developed understanding of atomic structure.

3. Molecules, compounds and bonding (Chapter 2)
    a. Lewis bonding model and VSEPR theory
    b. Valence bond (VB) theory
    c. Basics of molecular orbital (MO) theory

NOTE: Topics 3a, and 3b have been covered in detail in the first year. In this case, solid prior knowledge **is expected**! We shall devote significant portion of our time to MO theory (3c.)

4. Review of Important concepts:
    a. Chemical equilibrium
    b. Thermodynamics
    c. Types of inorganic reactions
    d. Redox reactions and electrochemistry (Chapter 5)
    e. Acids, bases and their reactions (Chapter 4)

NOTE: Topics 4a, 4b, and 4c are not covered in the textbook but we really need them. You can use your CHMA10H3 and CHMA11H3 textbook and/or notes as sources (that should be adequate) to review this important material; solid prior knowledge **is expected**! Topics 4d and 4e are covered in the textbook but as you'll see most of it is again an important revision of CHMA10H3/CHM11H3 material with some new concepts added.

L05: Students will be able to predict and explain the structure of atoms based on different bonding models including VSEPR, Valence Bond Theory and fundamental Molecular Orbital Theory.

L06: Students will gain a more in-depth knowledge and understanding of important fundamental chemical concepts such as equilibria, thermodynamics, inorganic reaction types and redox chemistry.

5. Structure of simple solids (Chapter 3)

a. Describing the structure of solids
b. Metals and alloys; metallic bonding
c. Ionic solids; ionic bonding
d. Thermochemistry and energetics of solid formation

L07: Students will be able to describe the structures of various solids using unit cells. As well, students will be able to predict the type of lattice formed by a solid based on the lattice enthalpy and The Born-Mayer Equation.

Part II: Main group chemistry

6. Periodic table revisited (Chapter 9)

a. Periodic trends
b. Basic classes of inorganic compounds and their periodic characteristics

7. Hydrogen (Chapter 10)

8. The Group 1 elements (Chapter 11)

9. The Group 2 elements (Chapter 12)

10. The Group 13 elements (Chapter 13)

11. The Group 14 elements (Chapter 14)

12. The Group 15 elements (Chapter 15)

13. The Group 16 elements (Chapter 16)

14. The Group 17 elements (Chapter 17)

15. The Group 18 elements (Chapter 18)

L08: Students will be able to describe properties of the various groups in the periodic table. Students will examine and compare the reactivity of each group and be able to compare and contrast reactivity and properties across the periodic table.

Some special topics that will be covered only if the time permits:

1. Special topic I - Inorganic chemistry in nature I: Introduction to inorganic chemistry in living systems and medicinal inorganic chemistry
2. Special topic II - Inorganic chemistry in nature II: Introduction to mineralogy: silicate and carbonate minerals (we shall cover silicates and carbonates within Group 14; this 'Special topic' is intended as an extension.)
3. Special topic III – Inorganic Chemistry in nature III: Inorganic chemistry of atmosphere and gaseous giant planets

Laboratory Component of CHMB31H3

The laboratory component starts during the week of September 11th and runs every other week. There are in total 5 experiments to be performed, each designed to demonstrate basic points from the lectures:

- Experiment 1: Acid-base and redox chemistry
- Experiment 2: The chemistry of groups 1 and 2
- Experiment 3: The chemistry of groups 13 and 14
- Experiment 4: The chemistry of groups 15 and 16
- Experiment 5: The chemistry of group 17 and inorganic analysis

Although every effort has been made to ensure that the experiments closely follow the lecture content, due to scheduling and other issues related to the organization of this course and classes in general, this is not always the case.

Keep in mind that the laboratory component of this course is mandatory. The labs for this course are compulsory. Make-up labs will be organized only for the students that missed the lab due to a serious illness or injury and have a medical note as a proof. Having a test on the day of the lab is not an excuse to miss the lab. Other details regarding the laboratory (i.e. requirements, best practices etc.) can be found in the introduction part of the lab manual. The complete lab manual will be posted on the Blackboard portal as a .pdf file and is *free of charge*.

Experiment/lab schedule

Week of:	**Practical groups**	**Experiment**
Sept. 11th	PRA001, PRA003 & PRA005	Experiment 1
Sept. 18th	PRA002, PRA004 & PRA006	

Sept. 25th	PRA001, PRA003 & PRA005	Experiment 2
Oct. 2nd	PRA002, PRA004 & PRA006	
Oct. 9th	**Reading week – no classes, no labs**	
Oct. 16th	PRA001, PRA003 & PRA005	Experiment 3
Oct. 23rd	PRA002, PRA004 & PRA006	
Oct. 30th	PRA001, PRA003 & PRA005	Experiment 4
Nov. 6th	PRA002, PRA004 & PRA006	
Nov. 13th	PRA001, PRA003 & PRA005	Experiment 5
Nov. 20st	PRA002, PRA004 & PRA006	

Lab Learning Outcomes

Students will explore the reactivity of the inorganic elements by observing changes in pH, solubility, and redox properties as well as the effect of temperature on rates of reaction. By performing these experiments, students will apply the concepts learned from lecture to observe and predict the outcome of a reaction.

Students will practice communicating as a professional for all work done in the lab of this course including, but not limited to: completing data sheets based on observations during the lab, preparing a neat, well-organized, detailed, and well-written notebook including doing any required pre-lab research or preparation or calculations, and writing emails to TAs and instructors in a courteous and polite manner.

AccessAbility

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the Access*Ability* Services as soon as possible.

Access*Ability* Services staff (located in Rm SW302, Science Wing) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations 416-287-7560 or email ability@utsc.utoronto.ca. The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course

Academic Integrity

Academic integrity is one of the cornerstones of the University of Toronto. It is critically important both to maintain our community which honors the values of honesty, trust, respect, fairness and responsibility. It also protects you, the student within our community as well as the value of the degree towards which you are all working so diligently. Detailed information about how to act with academic integrity, the Code of Behavior on

Academic Matters, and the processes by which allegations of academic misconduct are resolved can be found online: http://www.artsci.utoronto.ca/osai/students and http://www.utsc.utoronto.ca/~vpdean/academic_integrity.html

Section B of the University of Toronto's Code of Behaviour on Academic Matters (http://www.governingcouncil.utoronto.ca/policies/behaveac.htm) lists actions that are considered academic offences. Some of the most common offences are:

- To use someone else's ideas or words in their own work without acknowledging that those ideas/words are not their own with a citation and quotation marks, i.e. to commit **plagiarism**.
- To include **false**, **misleading** or **concocted** citations in their work.
- To obtain **unauthorized** assistance on any assignment.
- To provide **unauthorized** assistance to another student. *This includes showing another student completed work*.
- To submit their own work for credit in **more than one course** without the permission of the instructor.
- To **falsify** or **alter** any documentation required by the University. This includes, but is not limited to, doctor's notes.
- To use or possess an unauthorized aid in any test or exam.

There are other offences covered under the Code, but these are by far the most common. Please respect these rules and the values which they protect. Offences against academic integrity will be dealt with according to the procedures outlined in the Code of Behavior on Academic Matters.

CHMB31H3 Resources

Your required textbook:

Shriver, Weller, Overtone, Rouke, and Armstrong. **Inorganic chemistry**. 6th edition. New York: W.H. Freeman and Company, 2014.

Also recommended:

Hadzovic. **Solutions manual for Inorganic Chemistry**. 6th edition. New York: W.H. Freeman and Company, 2014.

Other suggested books

Greenwood N.N., Earnshaw A. **Chemistry of the Elements**. 2nd edition. Oxford: ButterworthHeinemann, 1997. (Call No. QD466 .G74 1997 SCAR; available also on-line at http://simplelink.library.utoronto.ca/url.cfm/2717)

This is an excellent inorganic chemistry textbook. Importantly for us, it has a very good coverage of nucleosynthesis and formation of elements in the stars. The rest of it is an advanced reading. If you would like to explore and learn more about the elements, their properties and compounds, this book is a great starting point. It covers in particular detail the elements, their properties and compounds.

Miessler G.L., Tarr D.A. **Inorganic Chemistry.** 3rd edition. Upper Saddle River: Pearson Education; 2004. (Call No. QD151.3 .M54 2004)

Some popular books (non-textbooks) on chemical elements:

Atkins P.W. **The Periodic Kingdom: A journey into the land of the chemical elements**. New York: Basic Books; 1995. (Call No. QD466 .A845 1995 SCAR)

Emsley, J. **Nature's building blocks: An A-Z guide to the elements**. Oxford: Oxford University Press; 2001. (Call No. QD466 .E486 2001 SCAR)

Ball, P. **The ingredients: A guided tour of the elements**. Oxford: Oxford University Press; 2002.

There are many other popular science books dealing with the elements, their birth and occurrence, their compounds and history. Some of them can be fount in UTSC library!

On the web

VISUAL ELEMENTS PERIODIC TABLE

www.rsc.org/chemsoc/visualelements/pages/periodic_table.html

A beautiful and artistic representation of periodic table and the elements

WEBELEMENTS www.webelements.com

Provides a lot of data for each element (but I find it a bit messy)

WEBMINERAL www.webmineral.com

Minerals are only one place where we can find inorganic chemistry in nature.

THE GUIDED TOURS OF METALLOPROTEINS

http://www.chem.utoronto.ca/coursenotes/GTM/main.htm

The other place where we find inorganic chemistry is in us and all other living creatures!

CHEMLIBRE ON-LINE TEXT BOOK

https://chem.libretexts.org/Core/Inorganic_Chemistry

This is a good supplemental text for you to consult as extra reading or further clarification.

GOOD LUCK AND SEE YOU SOON!!

MZD