

## Chemistry 104: Inorganic Chemistry, Harvey Mudd College, Spring 2026

Instructor: Professor Johnson

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MWF 9-950 a.m., Shan 2407

Course homepage: Canvas Text: [https://chem.libretexts.org/Bookshelves/Inorganic\\_Chemistry/Inorganic\\_Chemistry\\_\(LibreTexts\)](https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Inorganic_Chemistry_(LibreTexts))

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### What is inorganic chemistry?

Inorganic chemistry interfaces and overlaps with the other areas of chemistry. Inorganic chemists synthesize molecules of academic and commercial interest, measure properties such as electronic energy levels, magnetism, and unpaired electron spin with sophisticated instruments, study metal ion uptake in living cells, and prepare new materials like photovoltaics and superconductors. Inorganic chemistry is a diverse field, and we will only be able to touch on some of the chemistry of the 118 elements that currently<sup>¶</sup> reside in the periodic table. The major subdisciplines of inorganic chemistry are coordination chemistry, organometallics, bioinorganic chemistry, and solid-state/materials chemistry. Inorganic chemists study the s-, p-, d- and f-block elements, reaction rates, determine reaction mechanisms, and prepare new compounds. In this course, you will get a broad overview of some areas, and a more detailed study of others.

### By the end of the course you will be able to...<sup>†</sup>

- explain the history and breadth of inorganic chemistry guided by the inorganic Nobel Prizes
- select and use an appropriate theory or model to describe the structure, bonding, reactivity, and physical properties of inorganic elements and compounds
- construct qualitatively correct MO diagrams for centrosymmetric molecules
- describe MOs as  $\sigma/\pi/\delta$ , bonding, non-bonding or antibonding, and be able to draw them
- interpret quantum mechanics calculations on inorganic compounds
- describe the correspondence between qualitative and quantitative MO diagrams
- explain bonding and magnetism in transition metal complexes using MO arguments
- draw mechanisms for common inorganic/organometallic reactions
- ~~explain why and how transition metals are used in biological systems<sup>†</sup>~~
- ~~describe the chemical reaction catalyzed by a metalloenzyme<sup>†</sup>~~
- interpret spectroscopic methods (including UV-Vis, Xray, NMR and IR) for inorganic compounds
- describe how the common crystalline and ionic solids are derived from simple lattices
- describe the composition of more complex solids
- explain the trends in the chemistry of the representative elements
- explain the background, history, and scientific/societal contributions of an inorganic chemist to a general audience

**...if you work on and develop the skills in the course.**

**Teaching philosophy.** I teach through a combination of lecture and small group in-class problem solving activities. I expect you to fully engage in both learning modes. As such, attendance in this class is important. Email me ASAP if you need to be absent due to illness, grad school visits, or athletics. If you are sick, please don't come to class; email me and let me know! Participate in class by asking or responding to questions, and contributing in an active and generous way to the in-class activities. Ask questions *early* and *often* to make sure you understand how to solve the problems in the course. My office hours are under-utilized, but the students who take advantage of them tend to do well in my class. If you miss class, it is your responsibility to check with your classmates in order to find out what happened. The answer to the question "did I miss anything?" is here: <http://canpoetry.library.utoronto.ca/wayman/poem5.htm>

**Homework.** A weekly homework set will be due each Friday in class. There will be occasional problems assigned during class that are due in hardcopy form at the *start of the next class meeting*, though they will not always be collected. Answers to all problems will be posted on Canvas. No late work will be accepted.

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<sup>¶</sup> <https://iupac.org/what-we-do/periodic-table-of-elements/>

<sup>†</sup> not all topics are taught every year; topics still under consideration for this year are greyed out

**Examination schedule.** Instead of using exams as a method of assessment in this course we will have (almost) weekly quizzes and regular mastery quizzes. The goals of more frequent assessment with higher standards and multiple attempts are to give you more opportunities for learning.

1. *Weekly Friday Quizzes:* Each quiz will cover material from the previous week and have 5 questions. You must score at least a 4/5 on the quiz to earn a passing grade with no partial credit awarded. Since the standard for passing is so high, you will be able to earn a quiz re-take through by submitting thorough corrections to the quiz on Canvas. You can then attempt a similar version of each quiz during the retake sessions for each unit.
2. *Mastery Quizzes:* During each quiz re-take session you can also attempt a mastery quiz that synthesizes concepts from the past several weeks. The same high standards of grading will be applied for the mastery quiz, though it may not always be 5 questions.
3. *Oral Final Exam:* Your performance on a 30 minute oral examination scheduled during finals week will also be a part of your grade. More details about this exam will be announced later in the semester.

**Cumulative Project on Diversity in Chemistry:** You will complete a project that will be presented to a general audience. It can take a number of formats: a literature review, a Wikipedia entry, a podcast episode, a board game, an activity for kids, a brochure, or a short paper. Your project will focus on the contributions of a specific individual in inorganic chemistry, with the information content depending on your chemist. More information will be available after the first mastery quiz.

### Course Grade (specifications grading)

Grades are reported to communicate to the outside world a student's learning and understanding of the course material. Grades also provide a student with information concerning the demonstrated level of mastery and may also serve as a motivation to learning. Grades this semester will be determined using specifications (or "specs"). Below are the criteria required to earn each letter grade in this course.

#### Minimum requirements for an A grade

<input type="radio"/> 10 of 10 weekly quizzes passed
<input type="radio"/> 2 of 3 mastery quizzes passed
<input type="radio"/> 36/39 on homework assignments
<input type="radio"/> 9/10 on Diversity assignment
<input type="radio"/> 9/10 on oral final exam

#### Minimum requirements for an A- grade

<input type="radio"/> 10 of 10 weekly quizzes passed
<input type="radio"/> 1 of 3 mastery quizzes passed
<input type="radio"/> 35/39 on homework assignments
<input type="radio"/> 9/10 on Diversity assignment
<input type="radio"/> 8/10 on oral final exam

#### Minimum requirements for a B+ grade

<input type="radio"/> 10 of 10 weekly quizzes passed
<input type="radio"/> 0 of 3 mastery quizzes passed
<input type="radio"/> 34/39 on homework assignments
<input type="radio"/> 8/10 on Diversity assignment
<input type="radio"/> 7/10 on oral final exam

#### Minimum requirements for a B grade

<input type="radio"/> 9 of 10 weekly quizzes passed
<input type="radio"/> 0 of 3 mastery quizzes passed
<input type="radio"/> 33/39 on homework assignments
<input type="radio"/> 8/10 on Diversity assignment
<input type="radio"/> 6/10 on oral final exam

#### Minimum requirements for a B- grade

<input type="radio"/> 8 of 10 weekly quizzes passed
<input type="radio"/> 0 of 3 mastery quizzes passed
<input type="radio"/> 31/39 on homework assignments
<input type="radio"/> 7/10 on Diversity assignment
<input type="radio"/> Oral final exam attempted

#### Minimum requirements for a C+ grade

<input type="radio"/> 8 of 10 weekly quizzes passed
<input type="radio"/> 0 of 3 mastery quizzes passed
<input type="radio"/> 7/10 on Diversity assignment
<input type="radio"/> 30/39 on homework assignments

#### Minimum requirements for a C grade

<input type="radio"/> 7 of 10 weekly quizzes passed
<input type="radio"/> 0 of 3 mastery quizzes passed
<input type="radio"/> 6/10 on Diversity assignment
<input type="radio"/> 29/39 on homework assignments

#### Minimum requirements for a C- grade

<input type="radio"/> 7 of 10 weekly quizzes passed
<input type="radio"/> 0 of 3 mastery quizzes passed
<input type="radio"/> 6/10 on Diversity assignment
<input type="radio"/> 27/39 on homework assignments

### Minimum requirements for a D grade

<input type="radio"/> 6 of 10 weekly quizzes passed
<input type="radio"/> 0 of 3 mastery quizzes passed
<input type="radio"/> 5/10 on Diversity assignment
<input type="radio"/> 26/39 on homework assignments

Falling below these minimum requirements will result in an F grade for the semester.

### Exchanging specifications as “Currency”

I require a high standard for each specification, especially if you are aiming to earn an “A” grade in this course. With that in mind, if you excel in one specification, but have difficulty in another, you can exchange achievement in one specification for another. The exchange rates are found below. Any standard you achieve in the middle column can be exchanged for an improvement in another specification in the right column. For example, a passed mastery quiz could be exchanged for +3 points on homework or +1 point on the oral final exam. I will apply the exchange to give you the highest possible grade in the course. *If a mastery quiz (or equivalent) is exchanged for another specification it no longer counts towards the mastery quiz total used to calculate final grades.*

Specification	Standard of Achievement	Currency Exchange
Mastery Quiz	Mastery quiz passed	Mastery quiz passed
Weekly Quiz	Quiz passed	Quiz passed
Homework	30/30	+3 points
Diversity Presentation	10/10	+1 points
Oral Final Exam	10/10	+1 points

### Honor code policy (including a statement on the use of generative AI recourses)

All students enrolled in this course are bound by the HMC Honor Code. More information on the HMC Honor Code can be found in the HMC Student Handbook. I encourage you to collaborate with other students on homework assignments (e.g., working the problem together and then copying down the group solution). You may not use solution manuals. You may use the assignments and tests of this course from previous semesters, although the direct copying of solutions from previous assignments and tests is forbidden. The AI use policy is *Level 0: No AI Use Allowed*. There is well-documented evidence that AI use inhibits [critical thinking](#). In addition, LLMs were built on [stolen intellectual property](#). The goal of this policy is to encourage students to develop their own understanding of and fluency with course material. The use of any generative AI tools is not allowed in this course and will be considered a violation of the HMC Honor Code. Disallowed uses include, but are not limited to, using generative AI tools to brainstorm ideas, find source materials, summarize ideas, revise your writing, or check your work. Tools that automatically flag spelling and grammatical errors as you write are allowed, but not tools that offer suggested revisions of your sentences. If English is not your first language, you may use translation tools.

**Accommodations policy:** HMC is committed to providing an inclusive learning environment and support for all students. Students with a disability (including mental health, chronic or temporary medical conditions) who may need accommodations in order to fully participate in this class are encouraged to contact the Office of Accessible Education at [access@g.hmc.edu](mailto:access@g.hmc.edu) to request accommodations. Students from the other Claremont Colleges should contact their home college’s Accessible Education officer.

### Course schedule:

Below is the preliminary course schedule. Most reading assignments are from the LibreText, but additional materials will be handed out in class or posted on Canvas. Detailed reading assignments will be provided on the daily schedule.

**Unit I: symmetry and point groups**, Ch 4

**Unit II: Main group chemistry (and bonding)**, Ch 8, 3

**Unit III: Bonding**, Ch. 3, 4, 5

**Unit IV: Solid State chemistry**, Ch 7

**Unit V: Crystal field theory and magnetism**, Ch. 2, 10, 11

**Unit VI: Coordination Chemistry**, Ch. 9, 10, 11, 12

**Unit VII: Organometallic chemistry**, Ch 13, 14, handouts

Nobel [prizes in chemistry](#) that are inorganic or pertain to inorganic chemistry (according to Prof Johnson, anyway)

2025 The Prize was awarded jointly to SUSUMU KITAGAWA, RICHARD ROBSON and OMAR M. YAGHI "or the development of metal-organic frameworks

2023 The prize was awarded jointly to MOUNGI G. BAWENDI, LOUIS E. BRUS and ALEKSEY YEKIMOV for the discovery and synthesis of quantum dots

2019 The prize was awarded jointly to JOHN B. GOODENOUGH, M. STANLEY WHITTINGHAM, and AKIRA YOSHINO for the development of lithium-ion batteries.

2010 The prize was awarded jointly to RICHARD F. HECK, EI-ICHI NEGISHI, and AKIRA SUZUKI for palladium-catalyzed cross couplings in organic synthesis.

2005 The prize was awarded jointly to YVES CHAUVIN, ROBERT H. GRUBBS, and RICHARD R. SCHROCK, for the development of the metathesis method in organic synthesis.

2001 The prize was awarded with one half jointly to: WILLIAM S. KNOWLES, and RYOJI NOYORI, for their work on chirally catalyzed hydrogenation reactions and the other half to: K. BARRY SHARPLESS for his work on chirally catalyzed oxidation reactions.

1996 The prize was awarded jointly to: ROBERT F. CURL, Jr. , SIR HAROLD W. KROTO , and RICHARD E. SMALLEY for their discovery of fullerenes.

1995 The prize was awarded jointly to: PAUL CRUTZEN , MARIO MOLINA , and F. SHERWOOD ROWLAND for their work in atmospheric chemistry, particularly concerning the formation and decomposition of ozone.

1992 RUDOLPH A. MARCUS for his contributions to the theory of electron transfer reactions in chemical systems.

1985 The prize was awarded jointly to: HERBERT A. HAUPTMAN and JEROME KARLE for their outstanding achievements in the development of direct methods for the determination of crystal structures.

1983 HENRY TAUBE for his work on the mechanisms of electron transfer reactions, especially in metal complexes.

1981 The prize was awarded jointly to: KENICHI FUKUI and ROALD HOFFMANN for their theories, developed independently, concerning the course of chemical reactions.

1979 The prize was divided equally between: HERBERT C. BROWN and GEORG WITTIG for their development of the use of boron- and phosphorus-containing compounds, respectively, into important reagents in organic synthesis.

1976 WILLIAM N. LIPSCOMB for his studies on the structure of boranes illuminating problems of chemical bonding.

1973 The prize was divided equally between: ERNST OTTO FISCHER and SIR GEOFFREY WILKINSON for their pioneering work, performed independently, on the chemistry of the organometallic, so called sandwich compounds.

1963 The prize was divided equally between: KARL ZIEGLER and GIULIO NATTA for their discoveries in the field of the chemistry and technology of high polymers.

1944 OTTO HAHN for his discovery of the fission of heavy nuclei.

1935 The prize was awarded jointly to: FRÉDÉRIC JOLIOT and IRÈNE JOLIOT-CURIE in recognition of their synthesis of new radioactive elements.

1931 The prize was awarded jointly to: CARL BOSCH and FRIEDRICH BERGIUS in recognition of their contributions to the invention and development of chemical high pressure methods.

1922 FRANCIS WILLIAM ASTON for his discovery, by means of his mass spectrograph, of isotopes, in a large number of non-radioactive elements, and for his enunciation of the whole-number rule.

1921 FREDERICK SODDY , for his contributions to our knowledge of the chemistry of radioactive substances, and his investigations into the origin and nature of isotopes.

1918 FRITZ HABER for the synthesis of ammonia from its elements.

1913 ALFRED WERNER in recognition of his work on the linkage of atoms in molecules by which he has thrown new light on earlier investigations and opened up new fields of research especially in inorganic chemistry.

1912 The prize was divided equally between: VICTOR GRIGNARD for the discovery of the so-called Grignard reagent and PAUL SABATIER for his method of hydrogenating organic compounds in the presence of finely disintegrated metals

1911 MARIE CURIE, née Marie Sklodowska, in recognition of her services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element.

1906 HENRI MOISSAN in recognition of the great services rendered by him in his investigation and isolation of the element fluorine, and for the adoption in the service of science of the electric furnace called after him.

1904 SIR WILLIAM RAMSAY in recognition of his services in the discovery of the inert gaseous elements in air, and his determination of their place in the periodic system.

1903 SVANTE AUGUST ARRHENIUS in recognition of the extraordinary services he has rendered to the advancement of chemistry by his electrolytic theory of dissociation