

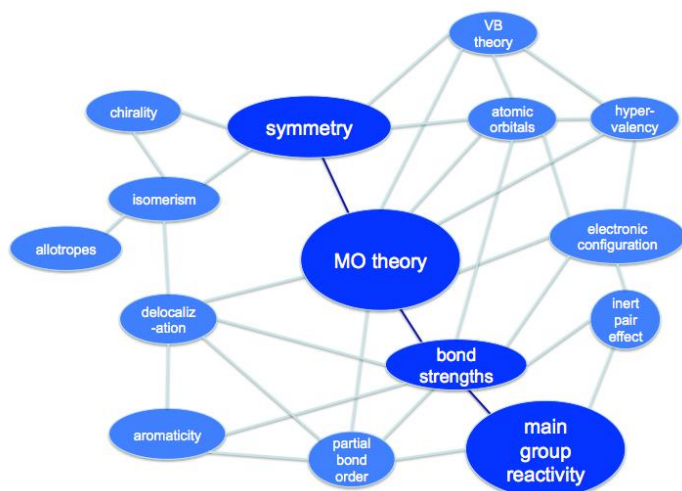
Main Group Chemistry

CHEM 211/ENCH 211

Fall 2023

Welcome to CHEM/ENCH211!

This course focuses on the introduction of the molecular orbital (MO) theory to facilitate our general understanding of the chemical interactions in main group elements. We will build a foundation to understand the MO theory through the discussion of point group symmetry and basic quantum mechanics. We will also extend the MO theory to examine a variety of chemical phenomena and molecular properties. The **Concept map** below highlights the major topics in the course. The four over-riding concepts are shown in darker blue.



General Course Information

Lectures & Tutorials

[REDACTED]

Instructor: Dr. Peng Wang

My main research interest focuses on crystalline materials and crystal growth. Trained as a solid-state chemist in McMaster University, I have a background in synthesizing and studying the physical properties of crystalline materials. I then worked as a postdoctoral scholar in Northwestern University focusing on the exploration, crystal growth and characterization of semiconducting radiation detectors. Subsequently, I served as a scientist in the semiconducting material industry. In 2018, started my position at Queen's University, here I am focusing on the exploration and development of new crystalline compounds for optical and optoelectronic applications.

Contact Information:

Office: CHE303

Email: wang.peng@queensu.ca

Office hours: by email appointment.

Tutorial information is available *via* SOLUS

Laboratories

Lab coordinator: Dr. Jason Vlahakis, Office Room 215 Chernoff Hall.

Email: vlahakis@queensu.ca

Lab manual will be available in CHEM STORES, first floor Chernoff Hall

More information will be announced soon.

onQ site

Students registered in the course can access the course onQ site at <https://onq.queensu.ca/d21/home>. The site includes the assignments, your grades, and other materials.

Equity, Diversity and Inclusivity Statement

Queen's University recognizes that the values of equity and diversity are vital to and in harmony with its educational mission and standards of excellence. It acknowledges that direct, indirect and systemic discrimination exists within our institutional structures, policies and practices and in our community. These take many forms and work to differentially advantage and disadvantage persons across social identities such as race, ethnicity, disability, gender identity, sexual orientation, faith, and socioeconomic status, among other examples.

Land Acknowledgement

We acknowledge that Queen's is situated on traditional Anishinaabe and Haudenosaunee territory. We are grateful to be able to live, learn and play on these lands

Course Outline

1. Introduction & Review (Atomic orbitals, nodes, electronic configuration of elements, Lewis dot structures, formal charges, oxidation state, hypervalency, VSEPR, coordination geometry, inorganic nomenclature)
2. Diffraction and spectroscopy methods (basic theory and instrumentations)
3. Symmetry (operations, elements, point groups, character tables, representations)
4. Valence bond theory (hybridization, electronic configuration)
5. Molecular orbital theory Part I (XY diatomic molecules, polyatomic molecules lacking π bonding)
6. Chirality (definition, chiral centres, isomerism, labels, optical rotation, asymmetric synthesis, polymers)
7. Conformational analysis (conformations, rotational barriers, cyclic compounds, polycyclic compounds)
8. Delocalization and Conjugation (alkenes, isomerization, aromaticity, polyenes, conjugation, colour)
9. Molecular orbital theory Part II (π bonding in polyatomic molecules)
10. Group 13 (boron hydrides, halides, inert pair effect, Lewis acid-base adducts, aluminium)
11. Pnictogens (bond strengths, ammonia, N halides, P, P oxides, P halides, As, Sb, Bi)
12. Oxygen & Chalcogens (sulfur production, elemental S, Se)
13. Halides (elements, interhalogens, C halides, O halides, other element halides, chalcogen halides)
14. Review

Course Materials

- Inorganic Chemistry (4th or 5th edition) by Housecroft & Sharpe
- Organic Chemistry (2nd edition) by Clayden, Greeves & Warren

Intended Student Learning Outcomes

1. Describe basic instrumentations and techniques used in the study of main group chemistry
2. Predict molecular shapes using VSEPR theory, valence bond theory, and molecular orbital theory
3. Describe molecular shapes in terms of point groups, stereochemistry, and types of isomers
4. Prepare molecular orbital diagrams and interpret them to predict bonding order and molecular reactivity

- Explain the causes of differences in structure and reactivity of compounds of different main group elements
- Search for and understand a published research article describing the structure, bonding or reactivity of a main group molecule.
- Perform laboratory experiments using main group molecules given a written procedure.

Approximate Course Timeline

Week	Topic	Readings from Housecroft 4/5 th edition	Readings from Clayden 2 nd edition
1&2	Intro & Review	1	1 & 2
3	Diffraction & Spectroscopy	N/A Follow Lecture notes	
4	Symmetry	3 except 3.8	
5	VB theory	2 and 5	4
6	MO theory part I	2 and 5	4
7	Chirality	3.8 and 19.8	14
8	Conformational analysis		16
9	Delocalization	13.8 and 14.4	7 and pages 723-735
10	Group 13 and Pnictogens	13 and 15	
11	Chalcogens	16	
11	Oxygen	7.4-7.6, 14.9, 17.8-17.9	
12	Halides & review	14.8 and 17	

Suggested Time Commitment

In this course, you should expect to invest on average 8 to 10 hours per week. This will include the time you spend studying course material, practicing course objectives, and participating in course activities and assessments. You are encouraged to adhere to a pre-determined study schedule as you will be more likely to complete the course on time successfully.

Assessment

Assignment 1:	15%	Date TBA
Assignment 2:	15%	Date TBA
1 Final Exam (in person):	45%	Date TBA
<u>Lab</u>	<u>25%</u>	
Total	100% ^a	

NOTES: ^a Students **MUST** pass both the lecture (75% total) and the lab (25%) components to pass the course.

Assessment Learning Outcomes Matrix

Assessment	Outcome #1	Outcome #2	Outcome #3	Outcome #4	Outcome #5	Outcome #6	Outcome #7
Assignment 1	✓	✓	✓			✓	
Assignment 2	✓		✓	✓	✓	✓	
lab							✓
Final Exam (in person)		✓	✓	✓	✓	✓	

Grading Method

All components of this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen's Official Grade Conversion Scale:

Queen's Official Grade Conversion Scale

Grade	Numerical Course Average (Range)
A+	90-100
A	85-89
A-	80-84
B+	77-79
B	73-76
B-	70-72
C+	67-69
C	63-66
C-	60-62
D+	57-59
D	53-56
D-	50-52
F	49 and below

Course Announcements and communications

Throughout the course, we will routinely post course news in the Announcements section of the course homepage. I encourage you to actively check the course onQ main page for course announcements throughout the semester for reminders and additional course information or learning opportunities.

Throughout this course, you may come upon some general questions about the course and any assignments. If you think that your question may benefit other students, you are invited to post your question in the Course Questions discussion forum. Feel free to help answer your peers' questions on this forum. The teaching team will monitor this discussion forum and answer questions. Most questions are answered within 24 hours. Any other questions that you would prefer to share privately, please contact me or your TA at one of the emails listed at the top of this syllabus.

Late Policy

If you require additional time to complete an assignment, please contact me as soon as possible. See below for the Chemistry Department policy on *missed* quizzes, tests, midterms, presentations, and assignments.

Department of Chemistry Policy on Missed Quizzes, Tests, Midterms, Presentations, and Assignments

The Chemistry Department requires that students submit a 'declaration of extenuating circumstances' form before being considered for accommodation. The form, and related information, is available at <http://www.chem.queensu.ca/undergraduate/undergraduate-resources/missed-exam-policy>. Note that this departmental policy does NOT apply to final exams.

Department of Chemistry Policy on Missed Labs

Laboratory work is an integral part of this course. All labs must be completed to pass the course. It is the responsibility of the student to notify the lab coordinator when a lab cannot be completed at the scheduled time. In exceptional circumstances, the following considerations will be given if a scheduled lab cannot be completed at the assigned time: Whenever possible, provisions will be made for a make-up lab preferably shortly before or after the missed experiment; the lab may be completed during the following academic year and a course mark of IN will be assigned until the missing work is completed; In rare circumstances, other accommodations may be made. For further information consult the course instructor and/or the lab coordinator.

Academic Consideration for Students with Extenuating Circumstances

Academic consideration is a process for the university community to provide a compassionate response to assist students experiencing unforeseen, short-term extenuating circumstances that may impact or impede a student's ability to complete their academics. This may include but is not limited to:

- Short-term physical or mental health issues (e.g., stomach flu, pneumonia, COVID diagnosis, vaccination, etc.)
- Responses to traumatic events (e.g., Death of a loved one, divorce, sexual assault, social injustice, etc.)
- Requirements by law or public health authorities (e.g., court date, isolation due to COVID exposure, etc.)

Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances. For more information, please see the Senate Policy on Academic Consideration for Students in Extenuating Circumstances.

Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. Arts and Science undergraduate students can find the Faculty of Arts and Science protocol and the portal where a request can be submitted. Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

For guidance on submitting requests, please see refer to the Resource Guides available on the Academic Consideration website under "Applying for Academic Consideration."

N.B: The COVID-19 pandemic is an evolving situation. If you have symptoms or are deemed a close contact of someone with COVID, please access our COVID-Related Absence Reference Guide on the Academic Consideration website. This guide will provide you with information on applying for consideration, the types of documentation (including non-medical documentation) you can use to support your request, as well as insight into how the Faculty office will assess these requests.

If you need to request academic consideration for this course, you will be required to provide the following name and email address to ensure it reaches our team accordingly:

Instructor name: Peng Wang

Instructor email address: wang.peng@queensu.ca

Lab Coordinator name: Jason Vlahakis

Lab Coordinator email address: jason.vlahakis@chem.queensu.ca

Students are encouraged to submit requests as soon as the need becomes apparent and to contact their Professors/Course Coordinators as soon as possible once Consideration has been verified. Any delay in contact may limit the Consideration options available.

Please follow up with Instructor/Lab coordinator using email within 2 days of receiving verification of your Consideration request.

Accommodations for Disabilities

Queen's University is committed to achieving full accessibility for people with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all their academic activities. The Senate Policy for Accommodations for Students with Disabilities was approved at [Senate in November 2016](#). If you are a student with a disability and think you may need academic accommodations, you are strongly encouraged to contact the **Queen's Student Accessibility Services (QSAS)** and register as early as possible. For more information, including important deadlines, please visit the [QSAS website](#).

Calculator Policy

Calculators acceptable for use during quizzes, tests and examinations are intended to support the basic calculating functions required by most Arts and Science courses. For this purpose, the use of the **Casio 991** series calculator is permitted and is the **only approved calculator for Arts and Science students**. This

calculator sells for around \$25 at the Queen's Campus Bookstore, Staples and other popular suppliers of school and office supplies.

Academic Integrity

Queen's students, faculty, administrators and staff all have responsibilities for upholding the fundamental values of academic integrity; honesty, trust, fairness, respect, responsibility and courage. These values are central to the building, nurturing, and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the Senate Report on Principles and Priorities).

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments and their behaviour conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see Academic Regulation 1), on the Arts and Science website, and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery, use of forged materials, contract cheating, unauthorized use of intellectual property, unauthorized collaboration, failure to abide by academic rules, departure from the core values of academic integrity, and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions appropriate to the severity of the departure that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

Copyright of Course Materials

All materials associated with this course are copyrighted. This includes in-class handouts, emailed information, and all documents and information provided on the course OnQ site. These course materials are for the sole use of students registered in the course. These materials shall not be distributed or disseminated to anyone other than students registered in this course. Failure to abide by these conditions is a breach of copyright, and may also constitute a breach of academic integrity under the University Senate's Academic Integrity policy statement.