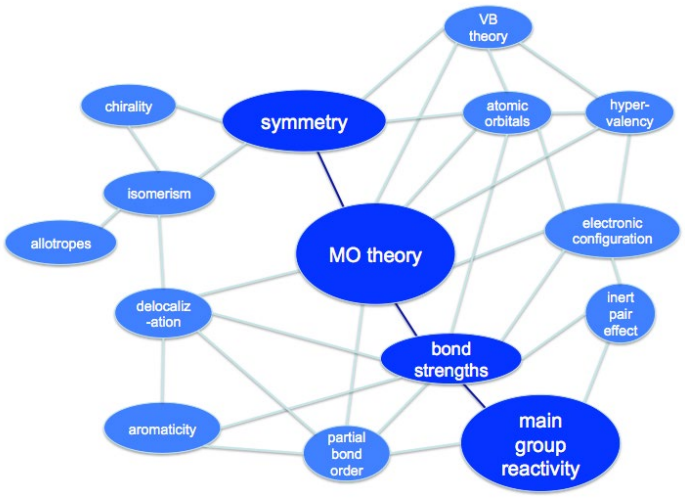
Main Group Chemistry
CHEM 211/ENCH 211
Fall 2025

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

Course: CHEM 211/ENCH 211
Course title: Main Group Chemistry
Pre-requisites: CHEM112
Semester and year: Fall 2025
From 2025-09-02 to 2025-12-02
[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 Instructor: 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/d2l/home. The site includes the assignments, your grades, and other materials.

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 (4^{th} or 5^{th} 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
5. Explain the causes of differences in structure and reactivity of compounds of different main group elements
6. Search for and understand a published research article describing the structure, bonding or reactivity of a main group molecule.
7. 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
Lab	25%	
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.

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. In this class I will work to promote an anti-discriminatory, anti-racist and accountable environment where everyone feels welcome. Every member of this class is asked to show respect for every other member.

Land Acknowledgement

The territory that Queen's University occupies is included in the Dish with One Spoon Wampum Belt Covenant, an agreement between the Iroquois Confederacy and the Confederacy of the Ojibwe and Allied Nations to peaceably share and care for the resources around the Great Lakes. The Kingston Indigenous community continues to reflect the area's Anishinaabek and Haudenosaunee roots. There is also a significant Métis community as well as First Peoples from other Nations across Turtle Island present here today.

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 any extenuating circumstance (illness, bereavement, traumatic event, injury, family emergency, etc.) which is short-lived, begins within the term, and will not last longer than 12 weeks - see Academic Consideration webpage for details (https://www.queensu.ca/artsci/undergraduate/student-services/academic-consideration)

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. For more information, undergraduate students in the Faculty of Arts and Sciences should consult the Faculty's webpage on Academic Consideration in Extenuating Circumstances and submit a request via the Academic Consideration Request Portal. Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

Students are encouraged to submit requests as soon as the need becomes apparent and to contact their instructor and/or course coordinator as soon as possible once academic consideration has been granted. Any delay in contact may limit the options available for academic consideration. While we encourage instructors to accommodate, each instructor has discretion in deciding whether or how to apply the Academic Consideration. For more information on the Academic Consideration process, what is and is not an extenuating circumstance, and to submit an Academic Consideration request, please see the Faculty of Arts and Science's Academic Consideration website. ASO courses include links to information on **Academic Consideration** on your **Course Homepage** in onQ.

Please see the Teaching Team page for contact information for your instructor and TA(s), where relevant.

For more information, please see the Senate Policy on Academic Consideration for Students in Extenuating Circumstances.

Accommodations for Disabilities

Queen's University is committed to working with students with disabilities to remove barriers to their academic goals. Queen's Student Accessibility Services (QSAS), students with disabilities, instructors, and faculty staff work together to provide and implement academic accommodations designed to allow students with disabilities equitable access to all course material (including in-class as well as exams). If you are a student currently experiencing barriers to your academics due to disability related reasons, and you would like to understand whether academic accommodations could support the removal of those barriers, please visit the QSAS website to learn more about academic accommodations or start the registration process with QSAS by clicking Access Ventus button at Ventus | Accessibility Services | Queen's (queensu.ca)

VENTUS is an online portal that connects students, instructors, Queen's Student Accessibility Services, the Exam's Office and other support services in the process to request, assess, and implement academic accommodations.

To learn more go to: https://www.queensu.ca/ventus-support/students/visual-guide-ventus-students

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 Queen's University is dedicated to creating a scholarly community free to explore a range of ideas, to build and advance knowledge and to share the ideas and knowledge that emerge from a range of intellectual pursuits. Each core value of academic integrity, as defined in the Senate Academic Integrity Policy, gives rise to and supports the next.

Honesty appears in presenting one's own academic work, whether in the context of an examination, written assignment, laboratory or seminar presentation. It is in researching one's own work for course assignments, acknowledging dependence on the ideas or words of another and in distinguishing one's own ideas and thoughts from other sources. It is also present in faithfully reporting laboratory results even when they do not conform to an original hypothesis. Further, honesty is present in truthfully communicating in written and/or oral exchanges with instructors, peers and other individuals (e.g. teaching assistants, proctors, university staff and/or university administrators).

Trust exists in an environment in which one's own ideas can be expressed without fear of ridicule or fear that someone else will take credit for them.

Fairness appears in the proper and full acknowledgement of the contributions of collaborators in group projects and in the full participation of partners in collaborative projects.

Respect, in a general sense, is part of an intellectual community that recognizes the participatory nature of the learning process and honours and respects a wide range of opinions and ideas. However, "respect" appears in a very particular sense when students attend class, pay attention, contribute to discussion and submit papers on time; instructors "show respect by taking students' ideas seriously, by recognizing them as individuals, helping them develop their ideas, providing full and honest feedback on their work, and valuing their perspectives and their goals" ("The Fundamental Values of Academic Integrity", 3rd Edition, p. 8).

Ultimately, responsibility is both personal and collective and engages students, administrators, faculty and staff in creating and maintaining a learning environment supported by and supporting academic integrity.

Courage differs from the preceding values by being more a quality or capacity of character – "the capacity to act in accordance with one's values despite fear" ("The Fundamental Values of Academic Integrity", 3rd edition, p. 10). Courage is displayed by students who make choices and integrous decisions that are followed by action, even in the face of peer pressure to cheat, copy another's material, provide their own work to others to facilitate cheating, or otherwise represent themselves dishonestly. Students also display courage by acknowledging prior wrongdoing and taking proactive measures to rectify any associated negative impact.

All of these values are not merely abstract but are expressed in and reinforced by the University's policies and practices.

Copyright of Course Materials

Course materials created by the course instructor, including all slides, presentations, handouts, tests, exams, and other similar course materials, are the intellectual property of the instructor. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution, posting, sale or other means of dissemination, without the instructor's express consent. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights.

Syllabus statements for Generative Artificial Intelligence (AI) Tools

Permitted with citation: Students must submit their own work and cite the work that is not theirs. Generative AI writing tools such as ChatGPT are welcome in this class, provided you cite the material that they generate. Any other use constitutes a departure from academic integrity.

Turnitin Statement-Mandatory

This course makes use of Turnitin, a third-party application that helps maintain standards of excellence in academic integrity. Normally, students will be required to submit their course assignments through onQ to Turnitin. In doing so, students' work will be included as source documents in the Turnitin reference database, where they will be used solely for the purpose of detecting plagiarized text in this course. Data from submissions is also collected and analyzed by Turnitin for detecting Artificial Intelligence (AI)-generated text. These results are not reported to your instructor at this time but could be in the future.

Turnitin is a suite of tools that provide instructors with information about the authenticity of submitted work and facilitates the process of grading. The similarity report generated after an assignment file is submitted

produces a similarity score for each assignment. A similarity score is the percentage of writing that is similar to content found on the internet or the Turnitin extensive database of content. Turnitin does not determine if an instance of plagiarism has occurred. Instead, it gives instructors the information they need to determine the authenticity of work as a part of a larger process.

Please read Turnitin's Privacy Policy, Acceptable Use Policy and End-User License Agreement, which govern users' relationship with Turnitin. Also, please note that Turnitin uses cookies and other tracking technologies; however, in its service contract with Queen's Turnitin has agreed that neither Turnitin nor its third-party partners will use data collected through cookies or other tracking technologies for marketing or advertising purposes. For further information about how you can exercise control over cookies, see Turnitin's Privacy Policy.

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