

**Advanced Analytical Chemistry
CHEM/ENCH 411 3.0 units**

Fall 2026

Wednesday September 9th – Tuesday December 8th

Instructors:

Weeks 1-6

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Weeks 7-12

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LECTURES:

Questions?

1. Use the onQ discussion forum so that the whole class may benefit from the answers to your questions.
2. Drop by our offices (open-door policy).
3. Make an appointment (in person or virtual).

onQ: This electronic tool can only be accessed by students registered in CHEM/ENCH 411 by going to <https://onq.queensu.ca/d2l/home>. It contains:

- the course material (i.e. syllabus, slides, practice problems, answers to some past final exams, quizzes, etc.),
- your grades,
- a discussion forum to get to know each other (each post rewarded by a related joke), and
- a discussion forum where questions can be asked about the course material.

Equity, Diversity and Inclusivity Statement

Equity in an educational institution is achieved when all members of our society have fair and equal opportunity to participate in and enjoy the benefits of an education, including the opportunity to experience success and human dignity while developing the skills, knowledge and attitudes necessary to contribute as leaders and citizens in society.

Recommended Text: Quantitative Chemical Analysis, 11th Ed., *Daniel C. Harris and Charles A. Lucy*, published by W. H. Freeman & Company is sold as loose-leaf version by the Campus Bookstore for \$129.99. Alternatively, it is available for 180 days as an eBook for \$94.99 (<https://campusebookstore.com/link/?id=eb8d7dac-9753-4a34-b970-cc7bb245b72f>). **Previous editions are also acceptable.**

Although asynchronous delivery is most accessible, the course is offered in person to maximize interactions, and thus engagement, through numerous in-class activities (review at the beginning of class, live demonstrations, bingo games, etc.), which cannot be held online. Past performance in this course when taught by Beauchemin or Beauchemin and Oleschuk is summarized below.

Year	# of students	Average	Lowest mark	Highest mark	% $\geq 80\%$
2024 (in person) (2 instructors)	27	71	51	89	30
2022 (first half in person; asynchronous)	30	77	53	97	65
2021 (asynchronous)	51	81	34	98	29
2020 (asynchronous)	27	80	56	99	78
2019 (in person)	19	82	53	97	74
2018 (in person)	20	83	65	100	70
2017 (in person)	20	85	72	98	80
2016 (in person)	20	84	70	98	70

Learning objectives

The instructors will:

- ◆ Explain advanced topics in analytical chemistry in a down-to-earth, useful way.
- ◆ Review and deepen some of the knowledge acquired in second or third year analytical chemistry.
- ◆ Teach new material using interactive activities to deepen student learning.
- ◆ Ensure students' understanding through regular open-book test.
- ◆ Give feedback to students to group tests within a week of each test.
- ◆ Inasmuch as possible, answer questions on onQ by the next workday.
- ◆ Give many examples.

Learning expectations and outputs

Students will:

- ◆ Attend every lecture.
- ◆ Participate in learning activities.
- ◆ Be valued members of their team during group tests.
- ◆ Ask questions on onQ so that everybody can benefit from the answers.

Course Learning Outcomes (CLOs)

At the end of this course, students will be able to:

1. Select the best way to take a representative sample.
2. Calculate the uncertainty associated with the primary and secondary sampling steps, as well as the overall uncertainty of the method.
3. Develop analytical methods including sampling, storage and preservation, sample preparation, sample introduction into the analyzer, and calibration strategy.
4. Describe the main components of a mass spectrometer and their purpose.
5. Use isotopic abundance information to deduce the elemental composition of an unknown.
6. Become familiar with GC-MS, LC-MS as well as other MS techniques and their advance applications.

7. Interpret mass spectra obtained using different ionization techniques (EI, MALDI, ESI, etc.).
8. Make a clear oral presentation.

Summary of Assessment:

Individual tests (11)	34.5% (best 9 out of 11, in class)
Group tests (11)	17.5% (best 9 out of 11, in class)
Oral presentation	15%
Final exam	35% (3-hour exam, with a 10% bonus question)

Assessment (all open book), course learning outcomes (CLOs) assessed, timing and weight

Assessment	CLOs assessed	When	Weight
Test* 1 (in class)	#2		5.5%
Test 2 (in class)	#1		5.4%
Test 3 (in class)	#2 #3		5.4%
Test 4 (in class)	#3		5.4%
Test 5 (in class)	#3		5.4%
Test 6 (in class)	#4		5.4%
Test 7 (in class)	#5		3.5%
Test 8 (in class)	#6		3.5%
Test 9 (in class)	#6		3.5%
Test 10 (in class)	#7		3.5%
Test 11 (in class)	#7		3.5%
Oral presentation	#8		15%
Final exam	All CLOs	Date to be set by the Exams Office	35%

* Both 3.6% (3.7% during week 1 or 2.4% during weeks 7-11) individual test and 1.8% (or 1.1% during weeks 7-11) group test. **There is no make-up test if you miss one.** The best 9 out of 11 tests will be used to calculate the overall test mark for each of the individual and group tests. If you write all the tests and perform better in the final exam than in the tests, the weight of the latter will be shifted to the final.

Location and Timing of Final Examinations

As noted in Academic Regulation 8.2.1, "the final examination in any class offered in a term or session (including Summer Term) must be written on the campus on which it was taken, at the end of the appropriate term or session at the time scheduled by the Examinations Office." The exam period is listed in the key dates prior to the start of the academic year in the Faculty of Arts and Science Academic Calendar and on the Office of the University Registrar's webpage. A detailed exam schedule for the Fall Term is posted before the Thanksgiving holiday. **Students should delay finalizing any travel plans until after the examination schedule has been posted. Exams will not be moved or deferred to accommodate employment, travel/holiday plans or flight reservations.**

Course Outline

- a) **Introduction and review of fundamental concepts** (Week 1)
- b) **Sampling strategies for liquid, solid and gaseous samples** (Week 2)
- c) **Storage and preservation considerations** (Week 3)
- d) **Advanced sample preparation methods** (Week 4)
 - a) Microwave-assisted strategies
 - b) Sorbent extraction
 - c) Solid-phase microextraction
 - d) Chemical vaporization
- e) **Flow injection analysis** (Week 5)
 - a) Limited dispersion
 - b) Medium dispersion
 - c) Large dispersion
 - d) Reduced dispersion
- f) **Inductively coupled plasma (ICP) spectrometry** (Week 6)
 - a) Conventional sample introduction
 - b) Plasma processes
 - c) Calibration strategies
 - d) Hyphenation to liquid chromatography
- g) **Mass spectrometry instrumentation** (Weeks 7-10)
 - a) Analyzer Types (Magnetic Sector, Quadrupole, Time of Flight, Orbitrap, FTICR)
 - b) Ionization methods and Sample introduction systems (Gas Chromatography (electron ionization, Chemical Ionization), High Pressure Liquid Chromatography (Atmospheric Pressure Chemical Ionization, APCI), Electrospray Ionization (ESI), Matrix Assisted Laser Desorption Ionization (MALDI)).
Ambient Ionization (Liquid Micro Junction, Desorption Ionization (DESI), Direct Analysis in Real Time, and WALDI
- h) **Mass spectrometry imaging** (Week 11)
- i) **Oral presentations** (Week 12)

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 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 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.

We all share in maintaining a culture of integrity, if you become aware of anyone trying to share, or solicit, answers to tests or exams, please remind them that this is against the rules and inform me immediately.

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 instructor's intellectual property. 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 (including note sharing sites), 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.

Queen's Policy Statement on Academic Integrity

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. Queen's students, faculty, administrators and staff therefore all have responsibilities for supporting and upholding the fundamental values of academic integrity. Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility and by the quality of courage. These values and qualities 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.

The following statements from "The Fundamental Values of Academic Integrity" (2nd edition), developed by the International Center for Academic Integrity (ICAI), contextualize these values and qualities:

1. **Honesty** Academic communities of integrity advance the quest for truth and knowledge through intellectual and personal honesty in learning, teaching, research, and service.
2. **Trust** Academic communities of integrity both foster and rely upon climates of mutual trust. Climates of trust encourage and support the free exchange of ideas which in turn allows scholarly inquiry to reach its fullest potential.
3. **Fairness** Academic communities of integrity establish clear and transparent expectations, standards, and practices to support fairness in the interactions of students, faculty, and administrators.

4. **Respect** Academic communities of integrity value the interactive, cooperative, participatory nature of learning. They honor, value, and consider diverse opinions and ideas.
5. **Responsibility** Academic communities of integrity rest upon foundations of personal accountability coupled with the willingness of individuals and groups to lead by example, uphold mutually agreed-upon standards, and take action when they encounter wrongdoing.
6. **Courage** To develop and sustain communities of integrity, it takes more than simply believing in the fundamental values. Translating the values from talking points into action -- standing up for them in the face of pressure and adversity — requires determination, commitment, and courage.

Students are responsible for familiarizing themselves with and adhering to the Senate [regulations](#) concerning academic integrity, along with [Faculty or School](#) specific information. Departures from academic integrity include, but are not limited to, plagiarism, use of unauthorized materials, facilitation, forgery and falsification. Actions which contravene the regulation on academic integrity carry sanctions that can range from a warning, to loss of grades on an assignment, to failure of a course, to requirement to withdraw from the university.

Using generative AI writing tools such as ChatGPT in your submitted work is not permitted in this class. This type of use constitutes a Departure from Academic Integrity.

Copyright of Course Materials

Course materials created by the course instructor, including all slides, presentations, handouts, tests, exams, postings on the CHEM/ENCH 213 onQ website, 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.

Timing of Proctored Final Examinations

Once the exam schedule has been finalized, the exam date will be posted on your SOLUS account. The exam dates for each term are listed on the Faculty of Arts and Science webpage under "[Important Dates](#)." Student exam schedules for the Fall Term are posted on SOLUS immediately prior to Thanksgiving and on the Friday before Reading Week for the Winter Term. **Students should delay finalizing any travel plans until after the examination schedule has been posted.** Exams will not be moved or deferred to accommodate employment, travel/holiday plans or flight reservations. For information regarding what is considered extenuating circumstances and qualifications for Academic Consideration, please visit the [Faculty of Arts and Science's Academic Consideration webpage](#).

If you are unable to attend an exam and receive approval for a deferred proctored exam, a further deferral of that exam will not be accommodated.

Academic Support

All undergraduate students face new learning and writing challenges as they progress through university: essays and reports become more complex; effectively incorporating research into writing becomes more important; the types of assignments become more diverse; managing your time and developing the skills you need to read and think critically gets more challenging. I encourage students to contact Student Academic Success Services (SASS). SASS offers many different ways to receive support:

- Free online or in-person [appointments](#) to get personalized support on writing and academic skills from expert staff and trained peers.
- [Workshops](#) and [drop-in programs](#). SASS' [Events Calendar lists events coming soon](#).
- [Online resources](#) that provide strategies for academic skills and writing development at university.

If English is not your first language, SASS has specific resources for [English as Additional Language students](#), including weekly programs and EAL academic skills appointments. You can meet on an ongoing basis with an EAL consultant to work on your academic writing, speaking, listening, and reading skills.

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>

Academic Consideration for Students in 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 Illness or Injury (stomach flu, anxiety/depression, mononucleosis, concussion, broken bones, surgery, medical treatments, etc.)

- Traumatic Event/Confidential (Bereavement, serious injury, illness or required treatment for a significant other/family member or a traumatic event such as divorce, sexual assault, social injustice, etc.)
- Requirements by Law or Public Health Authorities (court dates, jury duty, requirements to isolate, etc.)
- Significant Event (varsity athletic event, distinguished event, serving in the Reserve Forces, 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. 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.

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](#).

Turnitin Statement

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.

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