Introduction to Chemical Analysis
CHEM 213
Fall 2025

Course Description
Introduction to analytical chemical methods and science. Topics include statistical analysis of data, titrations and equilibrium theory, spectrophotometry and instrumental elemental analysis**.**

Pre-requisites: CHEM 112
Number of credits: 3.0 credits
Learning hours: 144 hours
Modality: On campus
Lectures: [redacted]
Tutorials: [redacted]

Instructor: Diane Beauchemin
Office: Chernoff 308
Phone: 613-533-2619
E-mail: diane.beauchemin@queensu.ca
Questions? Open door policy.

Tutorial TAs: [redacted]

LABS
Lab Coordinator: Kristen Harrington
Office: Chernoff 124
Phone: 533-6000 x. 74665 **E-mail**: kvh4@queensu.ca
Lab Room: Chernoff 210
Lab Timetable: Regular 3-hr lab sessions will be held [redacted] as assigned.

Week 1 (Sept. 2-8): **Introductory Labs (~ 1.5 hrs)** - ***assignment to lab teams*** and **in-lab exercise/quiz** – ***attendance mandatory***.

Weeks 2-11, students rotate between the following five experiments:
1. *Direct Spectrophotometric Analysis of Energy Drinks*
2. *UV-VIS Absorbance Spectrophotometry with Multi-wavelength Detection*
3. *Analytical Techniques based on Fluorescence Spectrophotometry*
4. *Microwave Plasma Atomic Emission Spectrometry for the Analysis of a Sports Drink*
5. *Elemental Analysis using Advanced Techniques of Atomic Spectrophotometry*

Recommended software: Lab data processing will require *Microsoft Excel.*

Lab TAs: [redacted]

Educational Technologies
This course makes use of the following for specific educational use/purposes:

- **onQ:** This electronic tool can only be accessed by students registered in CHEM 213 by going to https://onq.queensu.ca/d2l/home. It contains:
  - the course material (i.e. syllabus, slides and practice problems)
  - a week-by-week calendar of the topics/tests,
  - your grades
  - tips to further help you
  - a discussion board where questions can be asked about the course material.
- **Achieve:** This electronic tool, which comes with the textbook, contains practice problems with an AI tutor to help you practice and deepen your learning.

Required Textbook:
Quantitative Chemical Analysis, 10th Ed., *Daniel C. Harris and Charles A. Lucy*, published by W. H. Freeman & Company is sold in electronic form with Achieve by the Campus Bookstore for $125. This textbook is a good investment, as it is also used for CHEM/ENCH 321 and CHEM/ENCH 411.

The CHEM 213 lab manual published by the Department of Chemistry should also be purchased ($17) from the Science Store (on the ground level of Chernoff Hall). A lab coat, goggles and a Blue Lab Book are also required in the lab and can be purchased at the Science Store for approximately $70 in total.

Lecture topics covered

Analytical Process

1. The Analytical Chemist's Job, General Steps in a Chemical Analysis, SI Units, Chemical Concentrations, Preparing Solutions and Stoichiometry Calculations. (*Chapters 0-1)*

Tools

2. Proper use of the analytical balance, burette, volumetric flask and pipets (*Chapter 2)*

Measurements

3. Types of Error, Gaussian Distribution, Mean, Standard Deviation, Significant Figures, Propagation of Uncertainty. (*Chapters 3-4)*
4. Confidence Intervals, Comparison of Means with Student's t, Grubbs Test for an Outlier. (*Chapter 4)*
5. Calibration curves, Linear Regression and Least Squares, Standard Addition, Internal Standards, Quality Assurance and Method Validation (*Chapters 4-5)*

Atomic spectrometry

6. Atomic spectrometry with flame, graphite furnace and plasma: fundamentals, instrumentation and applications (*Chapter 21)*

Spectrophotometry

7. Spectrophotometry: fundamentals, instrumentation and applications (*Chapters 18-20)*

8. Fluorescence and phosphorescence in chemical analysis (luminescence) (*Section 18-7)*

Chemical Equilibrium

9. Equilibrium constant, solubility product, complex formation, protic acids and bases, pH, systematic treatment of equilibrium (*Chapters 6, 8, 13)*
10. Monoprotic and polyprotic acids, bases and buffers (*Chapters 9-10)*

Titrations

11. Titrations: Calculations, Potentiometric, Spectrophotometric, Precipitation and complexometric Titrations, Titration of a Mixture, End-Point Detection (*Chapters 7, 11-12)*.

Learning objectives

The instructor will:

- Explain the fundamentals of analytical chemistry in a down-to-earth, relevant way.
- Review and deepen some of the knowledge acquired in first year chemistry.
- Teach new material using in-class learning activities involving student participation to deepen student learning.
- Entice students to think critically by deliberately making mistakes for students to find.
- Give feedback to students within a week of each test.
- Inasmuch as possible, answer questions on onQ by the next workday.
- Give lots of examples both in class and on onQ.

Learning expectations and outputs

Students will:

- Come prepared to every lab.
- Submit lab reports on time.
- Attend every lecture and participate in the learning activities.
- Do the (unmarked) assignments and the (marked) weekly in-tutorial and in-class tests.
- Be valued members of their team during weekly group tests.
- Ask questions on onQ so that everybody may benefit from the answers.

Learning outcomes

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

- Demonstrate the proper use of the balance, pipets, burets and volumetric flask.
- Assess the quality of a result and the validity of a method.
- Accurately analyse samples by UV-visible spectrophotometry, fluorescence spectrophotometry and atomic spectrometry techniques.
- Calculate the concentrations of different species of a compound in solution.
- Prepare buffers in various ways.
- Perform titrations successfully and interpret the results.

Important University Dates

Please visit the Faculty of Arts and Sciences Sessional Dates website for all academic deadlines.

SUMMARY OF ASSESSMENT

Lab reports (5):	30%
Individual in-tutorial tests* (10):	27%
Group in-class tests* (10):	13%
Final exam:	30%

Lecture component assessment (all open book) timing and weight

Assessment	Material covered	When (open period when online)	Weight
Individual test* 1 (in tutorial)	Week 1	[redacted]	2.7%
Group test* 1 (in class)	Week 1	[redacted]	1.3%
Individual test 2 (in tutorial)	Week 2	[redacted]	2.7%
Group test 2 (in class)	Week 2	[redacted]	1.3%
Individual test 3 (in tutorial)	Week 3	[redacted]	2.7%
Group test 3 (in class)	Week 3	[redacted]	1.3%
Individual test 4 (in tutorial)	Week 4	[redacted]	2.7%
Group test 4 (in class)	Week 4	[redacted]	1.3%
Individual test 5 (in tutorial)	Week 5	[redacted]	2.7%
Group test 5 (in class)	Week 5	[redacted]	1.3%
Individual test 6 (in tutorial)	Week 6	[redacted]	2.7%
Group test 6 (in class)	Week 6	[redacted]	1.3%
Individual test 7 (in tutorial)	Week 7	[redacted]	2.7%
Group test 7 (in class)	Week 7	[redacted]	1.3%
Individual test 8 (in tutorial)	Week 8	[redacted]	2.7%
Group test 8 (in class)	Week 8	[redacted]	1.3%
Individual test 9 (in tutorial)	Week 9	[redacted]	2.7%
Group test 9 (in class)	Week 9	[redacted]	1.3%
Individual test 10 (in tutorial)	Week 10	[redacted]	2.7%
Group test 10 (in class)	Week 10	[redacted]	1.3%
Final exam	Whole course	Date to be set by the Exams Office	30%

*** There is no make-up test if you miss one.** The best 8 out of 10 tests will be used to calculate the overall test mark for each of the in-tutorial and in-class tests. If you write all the tests and perform better in the final exam than in the tests, the weight of the tests (individual and group) will be shifted to the final.

Students must pass BOTH the lecture and the laboratory components to pass the course. Otherwise, the lowest of 47% or the student's actual mark will be allocated. Students who do not attend all lab sessions may be assigned a grade of incomplete (IN) and be required to attend and pass the missed lab(s) the following year before the IN is cleared from their transcript.

Proctored Exams

Timing of 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.

Copyright of Course Material
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.

Course Feedback
At various points during the course, you may be asked to take part in a variety of feedback activities, such as surveys and questionnaires. This feedback enables the teaching team to improve the course. All surveys are anonymous and are directly related to activities, assessments, and other course material.

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.

Building a Classroom Community
University is a place to share, question, and challenge ideas. Each student brings a different set of lived experiences. You can help to create a safer, more respectful classroom community for learners by following these guidelines:

- Make a personal commitment to learn about, understand, and support your peers.
- Assume the best of others and expect the best of them.
- Recognize and value the experiences, abilities, and knowledge each person brings to the course.

- Acknowledge the impact of oppression on other people's lives and make sure your words and tone are respectful and inclusive.
- Encourage others to develop and share their ideas.
- Pay close attention to what your peers say/write before you respond. Think through and re-read what you have written before you post online or send your comments to others.
- Be open to having your ideas challenged and challenge others with the intent of facilitating growth.
- Look for opportunities to agree with one another, building on and intentionally referencing peers' thoughts and ideas; disagree with ideas without making personal attacks, demeaning, or embarrassing others.

Fostering Accessibility

All of us have a shared responsibility for reducing barriers to learning and fostering accessibility and promoting meaningful inclusion of those with disabilities. The Accessibility Hub at Queen's University's Human Rights & Equity Office offer a host of tutorials that provide us all with practical tips for:

- creating accessible documents, e.g., to submit to your teaching team or share with peers in peer feedback activities/in a presentation,
- emails, e.g., while communicating with group members or your teaching team, and
- meeting practices (e.g., in tutorials/labs/seminars or virtual meetings.

Queen's Email

The university communicates with students via Queen's email. Please check your email regularly to ensure you do not miss important information related to your course.

Policies

Class Attendance

Your presence and participation in class contributes to the knowledge and skills that you will develop throughout this course. I expect that you will attend class regularly, participate in class conversations and learning activities. These types of activities provide active engagement, promote a deeper understanding of the course content, and contribute to your success in this course.

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 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 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.
Please see page 1 for contact information of your instructor, lab coordinator, and TA(s). For more information, please see the Senate Policy on Academic Consideration for Students in Extenuating Circumstances.

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

Queen's Student Academic Success Services (SASS) offers a self-directed, online academic integrity module which help students with:

- Understanding the nature of the academic integrity departure
- Understanding the expectations of and role of sources in scholarly writing
- Integrating sources into your writing (paraphrasing, quoting, summarizing)
- Understanding when and how to cite your sources
- Managing your time effectively to avoid the need for shortcuts
- Taking effective notes to ensure accuracy of source material and correct attribution

Generative Artificial Intelligence (AI) Tools are Not permitted

Except when doing the practice problems in Achieve, 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. Original work, completed wholly by you, is expected to be submitted in this course.

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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