Syllabus

Introductory chemistry laboratory II

Introductory Chemistry Laboratory is a two-semester sequence of courses in modern experimental chemistry. Students in these courses use standard laboratory techniques for running reactions, preparing samples, and measuring their properties. They analyze data and evaluate the reliability of methods. They document their procedures and observations so others can understand and replicate their findings. Finally, they interpret their results in terms of chemical theory and draw conclusions about materials. Students who master these laboratory skills will be prepared to carry out research in chemistry, biology materials, and neuroscience.

Course information

Instructor

Simon Garcia, garcias@kenyon.edu

Availability

Drop-in office hours: As listed in the online College directory.

Appointments: Look up the gmail calendar for garcias@kenyon.edu and check for times available between 8:30a–5:30p.

Class meetings

Once per week, 1:10–4:00p, in Tomsich 103 and Tomsich 105.

For more details…

Log in to Moodle and look for: *Chem 126: Spectroscopic analysis, Spring 2016*.

Learning objectives

Knowledge

By the end of the this course, you should understand concepts involving: internal standardization, nuclear magnetic resonance, vibrational modes, polymer structure, acid-base equilibrium, buffers, and intermolecular forces.

Skills and habits

Through course activities, you should strive develop the following skills and habits:

- prepare samples for NMR, IR, and microtitre visible spectroscopy
- operate an FTIR spectrometer, microtitre plate reader, and pH electrode
- assign signals of an NMR spectrum to protons in a molecular structure
- build organic molecules for electronic structure calculations
- prepare buffers of desired pH
- calculate and apply response factors from experimental data
- identify chemically equivalent atoms in a molecular structure
- assess the reliability of an experimental method

Professional

By the end of this course, you should be able to apply for a job, internship, or scholarship involving laboratory or policy research. In applications and interviews, you should have at least three stories to tell about:

- researching background information on an experimental method or concept
- reading and adapting established procedures for a new experiment
- practicing a new technique until you mastered it
- proposing an experiment to investigate a specific research question
- using three modern spectroscopic techniques
- coordinating procedures and data collection with 3 or 4 teammates at a time
- organizing and analyzing data, and drawing conclusions from them

Course activities

To meet course objectives, we have designed this course to be project oriented and experiential. Class activities incorporate best research practices and modes of investigation. Projects provide a context for applying laboratory techniques, and for understanding how experimental methods are developed and implemented. Lab work is planned through discussion and coordination with teammates.

Activities in this course are organized into four, 3-week-long projects to investigate research questions in experimental chemistry. Each project is defined by a method of analysis and some questions about a chemical phenomenon that the method can address. Your ultimate aim is to design experiments to answer these questions. To accomplish this goal, you will need to: research background information on the method, practice using new techniques, write experimental protocols and implement them, organize data collection of the entire class, share results, and present your conclusions. Your fourth project will be an application of one of the three methods.

Activities for each project follow a three-week cycle of proposing, implementing, and assessing an experiment. Each stage requires action before and during lab.

Session I: Propose an experiment and prepare for it

Before lab

Read the project description and note any unfamiliar terms or concepts. Follow up by researching background information and published data on compounds relevant to the project. Study the reference protocol for the project and compare it with the sample notebook entry. Finally, copy or paraphrase the sample entry into your own notebook, leaving blanks where appropriate.

In lab

Submit your notebook for review. Check your understanding of the project and the method by working on a short quiz with your team. Discuss, propose, and outline a new experiment based on the reference protocol. After your proposal is approved, write the protocol as a public document, and assign experimental parameters to each team member. Practice basic lab techniques needed for the experiment.

Session II: Implement experiment

Before lab

Write the materials and procedure section of your lab notebook, based on the protocol you wrote in Session I and which experimental parameters were assigned to you. Check your understanding by self administering the written quiz (odd-numbered questions) and then marking it.

In lab

Submit notebook and marked quiz responses for review. Conduct your experiment, while recording observations and measurements. Share your data in a public spreadsheet. Discuss and outline your analysis; after it is approved, add the details to your protocol.

Session III: Assess experimental results

Before lab

Write the analysis section of your lab notebook, based on the protocol you wrote in Session II and your data. Check your understanding by self administering the written quiz (even-numbered questions) and then marking it.

In lab

Submit notebook and marked quiz responses for review. Compare your results with teammates, discuss their implications, and propose follow-up experiments. Outline your conclusions; after it is approved, write up your argument in a document.

Examinations

You will have two special opportunities to demonstrate mastery of your knowledge and skills: a 2-hour written examination in Week 10, and a 10-minute practical examination during Finals Week.

Expectations

Preparing for class

Before each project you will research background information on the method and problem. As you read assigned articles and look for new ones, refer to the study questions frequently and try to answer them. Come to the first session ready to discuss the method with your teammates.

You will also prepare your laboratory notebook for an established method protocol. This process helps you understand how procedures are specified in order to minimize confusion and ensure consistency. You will model it on a completed sample notebook. As you write your entry, compare with the method protocol and explain to yourself why each section includes the information that it does. You will submit your completed notebook at the start of first lab session.

In subsequent weeks you will reinforce your understanding by answering questions in a self-administered quiz, and then marking your responses. In addition, you will prepare notebook entries based on the protocol for your team's project. You will submit both your marked quiz and notebook at the beginning of each lab session.

Collaborating with classmates

You should be ready to collaborate with fellow students in class, since experimental work is organized around team projects. When you start a project, you will propose an experimental procedure in discussion with your teammates, write a protocol for the experiment, and then assign tasks to teammates for the following week. You will contribute to these discussions earnestly.

In subsequent weeks, you will implement the experiment. The laboratory is a social environment, and progress on experiments requires interpersonal feedback. Each member in a team needs to communicate their intentions, coordinate tasks, provide and ask for updates on status of tasks, and have some patience for mistakes.

Practicing laboratory techniques

You will have many opportunities in each project to practice techniques. Get as much practice as you can — before, during, and after the project.

Citizenship

A laboratory is a professional workplace, one in which you keep equipment and benches clean, use time efficiently, dispose of materials responsibly, treat classmates with respect and care, anticipate potential hazards, and follow directions from instructional staff.

Attendance

You will attend all classes energetic, sober, and dressed for laboratory work. Arriving to class while impaired from sleep deprivation, drug abuse, or other activities will result in dismissal for the day. Severe or repeated incidents will result in permanent dismissal from the course.

Safety

The experiential nature of this course requires special vigilance and standards of behavior in class. To put it bluntly, failure to observe standard practices and precautions can leave you or someone else dead, disfigured, maimed, or sterile. Rough play, unauthorized experimentation, belligerence, or other activities deemed unsafe by the instructor will result in dismissal for the day.

Written examination

The written examination will be 1–2 hours long. Because of limited time, it will not include every concept or skill encountered in class, but rather a *sample* of topics. The exam will include questions about basic concepts and calculations, and ask you to prepare notebook entries in response to hypothetical situations and data. Posted quizzes are fairly representative of exam questions.

You should bring a calculator and a 3″ × 5″ card of personal notes for reference, and write or print on both sides of it. You will receive a list of laboratory protocols and a sheet of correlation tables.

Practical examination

The Registrar will set the date and time of the final exam. It is your responsibility to check the Registrar's schedule before you make travel plans. *The College explicitly requires professors to give the exam at the time scheduled by the Registrar.*

Grading

Your grade for this course certifies (c) participation in discussion and collaborative work, (b) knowledge of experimental principles, and (c) proficiency with basic laboratory techniques. The total grade is thus based on participation (50%), the written exam (25%), and the practical exam (25%).

Participation represents experience in a collaborative, project-oriented environment. Missing class, refusing to contribute to activities, or failing to respect team members deprives your fellow students of experience in the course, and will reduce your participation grade.

Resources

Calculator

Your calculator should be capable of exp, ln, 10^x, log, x^y, sin, and $\sin^{-1}$ functions (devices with internet, voice, or text-messaging functions are prohibited on exams). A calculator is expected for assignments and exams.

Laboratory notebook

Use the type provided by the Laboratory Coordinator, which is *numbered, duplicating, and top-perforated* (*i.e.*, makes copies onto a yellow back page as you write, and the white, top page is perforated for removal). The Hayden-McNeil *Student Lab Notebook* with spiral binding meets these criteria at a reasonable price. You may use the same notebook in other laboratory courses, including Organic Chemistry Lab and Biochemistry Lab.

Computing device

You will document your in-class work using Google Docs and Google Sheets, so use a computing device capable of creating, accessing, and editing such documents. You will likely need a keyboard to work effectively.

Policies

Attendance. Attendance at all class meetings is expected. Excessive, unexplained absences will result in dismissal from the course. Only the Dean of Students (not the instructor) can excuse an absence. If you must miss a class meeting, or will be late, please notify the instructor by email, or ask a friend to tell the instructor.

Etiquette. Upon arriving in class, please greet the instructor and the students sitting near you. Silence any devices you have. Maintain a respectful presence in class, and avoid distracting fellow classmates from their work. When working on a computer or tablet, please direct your attention to the instructor when interrupted. If you require frequent trips to the restroom or need to monitor your phone for an important message, inform your classmates and instructor so they understand your situation. Keep in mind at all times how your actions affect the people around you.

Classroom Space. We will move around during class, so please keep unnecessary items off the tables. You only need your notebook, pencil/pen, and calculator at the desk. Place bags and food on window sills at the back of the classroom.

Excused absence. There are no excused absences.

Unexcused absence. There are no unexcused absences.

Discretionary absence. All absences are discretionary: you are responsible for judging the necessity to miss class. You may miss one session without disadvantage to your participation grade.

There are various reasons you might need to miss class, such as illness, athletic competitions, religious obligations, or simply oversleeping. When this happens, please notify the class and instructor of your situation so we won't worry about you.

Extenuating circumstances. In special cases, such as an extended or serious illness that confines you to your bed (the "Dorm List"), long-term emotional distress due to bereavement, MagiKarp evolution, or other emergency situation, please inform the Dean of Students, who will notify me of your absence (while keeping the reason confidential). Afterward, consult with me and the Dean of Academic Advising to make special arrangements for completing your course work.

Exam dates. The final exam for each laboratory period is posted on the Registrar's web site. Check your calendar to ensure that this date is free.

Changes to syllabus. The policies articulated in this Syllabus are subject to change in response to unusual situations. You will be notified of any changes at least 48 hours before they go into effect.

Academic honesty. Please note the College's principles and policies regarding academic honesty:

> Kenyon College is, at the core, an intellectual community of scholars — students and faculty — engaged in the free and open exchange of ideas. Critical to this lively exchange and deep engagement with ideas is the academic integrity of our work, both inside and outside the classroom.
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> At Kenyon we expect all students, at all times, to submit work that represents these standards of academic integrity. It is the responsibility of each student to learn and practice the proper ways of documenting and acknowledging those whose ideas and words you have drawn upon (see *Academic Honesty and Questions of Plagiarism in the Course Catalog*). Ignorance and carelessness are not excuses for academic dishonesty. If you are uncertain about the expectations for academic honesty in a class, please ask your instructor for clarification.

Accommodations. Please note the College's principles and policies regarding academic accommodations:

> Students who anticipate they may need accommodations in this course because of the impact of a learning, physical, or psychological disability are encouraged to meet with their instructor privately — early in the semester — to discuss their concerns. In addition, students must contact Erin Salva, Director of Student Accessibility and Support Services (740-427-5453 or salvae@kenyon.edu), as soon as possible, to verify their eligibility for reasonable academic accommodations. Early contact will help to avoid unnecessary inconvenience and delays.

Only the Director of Student Accessibility and Support Services is authorized to review your documentation and to recommend an accommodation. Discussions with the Director are not shared with the instructor. The Director will work with you to design an accommodation tailored to your exact situation. If your accommodation requires special conditions or services provided by the instructor, then you must inform the instructor *at least two weeks before the service is needed*.

Compliance with Title IX of the Education Amendments Act. Please note the College's principles and policies regarding sexual misconduct:

> Kenyon College seeks to provide an environment that is free of gender bias, discrimination, and harassment. If you have been the victim of sexual harassment/misconduct/assault, interpersonal violence, or stalking we encourage you to report this. Faculty members are required by federal law to notify the College's Title IX Coordinator of any relevant information you provide. For further information, please refer to Kenyon College's Title IX and VAWA Policy:
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> http://www.kenyon.edu/directories/offices-services/title-ix/policy/

Schedule

Week	Project
1	Introduction
2	Quantifying mixtures with NMR spectroscopy
3	Quantifying mixtures with NMR spectroscopy
4	Quantifying mixtures with NMR spectroscopy
5	Predicting vibrational modes of a polymer
6	Predicting vibrational modes of a polymer
7	Predicting vibrational modes of a polymer
8	Measuring dissociation constant of a dye
9	Measuring dissociation constant of a dye
10	Measuring dissociation constant of a dye
11	*Written examination*
12	Independent project
13	Independent project
14	Independent project
Finals	*Practical examination*