



Chemistry 232
Analytical Chemistry
Dr. Jeremy Ramsey
Fall 2017



Course Description

The material presented in this course covers the basic principles of analytical chemistry, including calibration methods, measurement statistics, equilibrium, acid-base chemistry, and buffer systems. Additionally, the course will cover an introduction to the major areas of chemical analysis and instrumentation (spectroscopy and separation science).

This course will likely be different from the other courses that you have taken. The material lends itself nicely to a more active method of learning. There will be times that you will be doing things in class instead of watching me present lectures. We will spend a significant amount of time working problems and discussing the material as opposed to the traditional lecture format. In fact, there will be very few class periods where I will lecture for the entire class period.

Philosophy of Instruction

Ultimately, the purpose of this course is for you to learn the fundamentals of analytical chemistry and to be exposed to the foundations of modern instrumental analysis. In my opinion, grades are secondary to your understanding of the subject, and ideally, I would be willing to present each of you with an A. However, my goal is not to help students achieve a certain grade in this course, but rather, is to ensure that students achieve mastery of the subject. By choosing to come to Lycoming, I have dedicated myself to helping each student achieve this goal. The motivation, however, must begin with you. Please take advantage of the opportunities that you have and we will both achieve our goals for the semester.

Learning Objectives

Upon completion of this course, students should be able to

- Perform calculations involving stoichiometry and solution concentration as they relate to laboratory problems
- Use common laboratory tools (such as volumetric flasks, pipets, burets, pH meters, and balances) properly
- Perform calculations involving chemical equilibria (i.e. solubility, acid-base chemistry) and understand how the calculated parameters relate to the chemistry of the system
- Understand the fundamental principles of spectroscopy, separation science, and electrochemistry and how they relate to chemical analysis
- Use the conclusion of statistical analysis to determine sources of experimental error and to direct the path of subsequent chemical experimentation
- Communicate scientific data clearly in an oral presentation
- Use graphical analysis software to analyze data and prepare publishable quality graphs

"In the middle of difficulty lies opportunity"

-- Albert Einstein

"The best way to learn and get better is to screw up and not do it again."

-- Greg Maddux

"Practice isn't the thing you do once you're good. It's the thing you do that makes you good."

-- Malcolm Gladwell from *Outliers: The Story of Success*

The Lycoming Chemistry Department believes that students completing a major in chemistry will be able to:

1. Exhibit proficiency in the major sub-disciplines of chemistry
2. Perform wet laboratory techniques as appropriate to the major sub-disciplines of chemistry
3. Understand and use modern chemical instrumentation
4. Exhibit integrative, problem-solving skills, such as experimental design, data manipulation, and data interpretation
5. Communicate the results of chemical investigations effectively in written and oral form
6. Search the chemical literature, evaluate the results of the search, and access desired research materials
7. Demonstrate responsible conduct in the laboratory, including laboratory safety and ethical research practices

This course will provide instruction in all areas covered by departmental learning goals. The course also provides instruction in support of the Lycoming College mission statement.

Institutional Learning Objectives

This course (lecture and laboratory) supports the following expected student learning outcomes of a Lycoming College education:

- Achieve depth of learning in at least one field of study
- Communicate effectively in written and oral forms
- Think critically
- Demonstrate information literacy skills and technological competence appropriate for their discipline

Prerequisites

- Chemistry 111 or permission of instructor
- Knowledge of chemical reaction stoichiometry and equilibrium (Quiz on Monday 9/4)

Course Materials and Resources

- Analytical Chemistry, Version 2.1, David Harvey
- Bound laboratory notebook
- Safety Glasses
- Calculator capable of performing logarithmic, exponential, and statistical functions. If you have a programmable TI, be sure to bring it along for the ride—it will get a lot of use.
- **Cell phone use and texting in class is not acceptable and will not be tolerated.** They should be placed in your backpack and the ringer should be turned off.
- Remind App/Service. You can text me in case you have a question outside of class as I don't check email when away from campus. Text @6ad4dh to 81010 to receive announcements via text.
- Dropbox or Google Drive account for saving your files and ease of transfer to computers during presentations.

Moodle

This course utilizes a content management system (fancy name for a website) called Moodle. Material will be posted on this site and no announcement will be made so you will be **expected** to check this website frequently. The web address for the site is <http://moodle.lycoming.edu>. The password is pretzel.

Meeting Times

Lecture	MWF	10:15-11:05 am	215 Heim
Laboratory	T, Th	2:00-4:50 pm	207 Heim

Grading

	<u>Points</u>
Examinations (4) and Quizzes	485
<i>First midterm exam score</i>	115
<i>Second midterm exam score</i>	115
<i>Third midterm exam score</i>	115
<i>Final exam (Part ACS)</i>	115
<i>Quizzes</i>	25
Laboratory	150
<i>Presentations</i>	140
<i>Cleanup and Safety</i>	10
Colloquium Attendance	10
Total Points	645

- Percentage grades will be scaled to the number of points indicated above.
- The grading scale will be as follows. Adjustments to this scale are possible, but unlikely.

≥ 90%	A range (A/A- cutoff: 92%)
80-89%	B range (B+/B cutoff: 88%, B/B- cutoff: 82%)
70-79%	C range (C+/C cutoff: 78%, C/C- cutoff: 72%)
60-69%	D range (D+/D cutoff: 68%, D/D- cutoff: 62%)
< 60%	Fail

- **You must achieve at least 60% of the points in each portion of this course (lecture, laboratory, and safety) to earn a passing grade in this course.**
- One exam absence (for instance, an illness or a funeral) can be replaced by the average exam score for the semester only if the reason for the absence is approved by the Provost's office and the instructor is notified in advance. It is highly unusual for extenuating circumstances to lead to exceptions to this policy concerning exams, but they will be considered on a case-by-case basis. **Otherwise, you will be awarded a zero for missed exams.** There is no provision for missed quizzes—they result in a zero.
- Makeup laboratory experiments will be difficult, if not impossible, and will only be permitted for legitimate reasons.
- You will be required to attend a minimum of 5 colloquia (2 points each). If you have a college sanctioned activity that prevents you from attending, please see me to discuss an alternative.
- The cleanup/safety portion of your grade will be awarded based on the cleanliness of the laboratory (and especially the balances) as well as your safe laboratory practices.

Office Hours

If you have questions, stop by my office when you have time—I should be there. I do tend to be busy at times so if you like, you can always make an appointment.

Safety

Safe laboratory practices, including proper attire, will be expected in the lab at all times. Long pants are required as well as closed toe shoes (no sandals). Wearing contact lenses during laboratory session is strongly discouraged, but may be tolerated with prior approval. You will not be permitted to begin any experimental procedures until all safety concerns have been addressed. ***Safety violations may cause you to be removed from the laboratory, a zero to be awarded for the current experiment, and/or a zero to be awarded for the cleanup and safety portion of your grade. Multiple expulsions from the laboratory will cause students to receive zero credit for the laboratory, which will cause failure of the course.***

Attendance

Attendance in class is very important to your success in this course. Although no unexcused absences from either lecture or lab will be tolerated (even on days of exams in other courses), up to three excused absences will be permitted without affecting your grade. The excuse must be legitimate and you may be required to receive approval from the Provost's office or academic dean for the absence. Violations of the attendance policy will result in a 10% reduction in your final grade. In the case of a campus-wide flu outbreak, Lycoming College advises that you do not attend class until any fever has dissipated for 24 hours. I will honor this policy, *so if you find that you have contracted the flu*, you should contact Dr. Ramsey using your Lycoming email prior to missing your first class.

There will be no makeup examinations or quizzes. One exam absence (for instance, an illness or a funeral) can be replaced by the average exam score for the semester only if the reason for the absence is approved by the Provost's office or academic dean and the instructor is notified in advance. Otherwise, you will be awarded a zero for missed exams. It is highly unusual for extenuating circumstances to lead to exceptions to this policy concerning exams, but they will be considered on a case-by-case basis. There is no provision for missed quizzes—they result in a zero.

Homework

In this course, homework assignments will not be collected, but it is strongly suggested that you attempt them. The selected homework problems provide an indication of the topics that I think are important for meeting course goals. This makes solving them of utmost importance to your grade and your performance in the course will likely correlate with the amount of time spent solving problems. Because learning has been shown to be much more efficient through failure, I feel strongly that should be attempted individually before seeking help from others or checking the answer in the solutions manual. Please feel free to stop by my office to discuss any difficulties you may have with any of the suggested problems.

"The most dangerous kind of overconfidence in our abilities comes not when we are already skilled at a task but when we are still unskilled."

-- Christopher Chabris and Daniel Simons from *The Invisible Gorilla and Other Ways Our Intuitions Deceive Us*

Quizzes

Although they will normally be announced, quizzes may be **unannounced** and can be given in either laboratory or lecture class periods. The purpose of these quizzes is to provide you with an opportunity to determine where your deficiencies may be and to provide a “gentle” reminder of how important it is to stay current with the progress of the course. As with the examinations, quizzes should be considered cumulative and may contain information from the laboratory or lecture portion of the course.

Examinations

Examinations will be given during laboratory sessions and will be administered on the following dates. Because the material presented later in the class builds upon concepts presented earlier, all exams should be considered cumulative. Changes to the exam schedule will be made only with unanimous consent of the class and must be made prior to noon on September 1st.

Examination 1	September 21 (Thursday)
Examination 2	October 19 (Thursday)
Examination 3	November 16 (Thursday)
Final Examination**	December 11 (Monday; 1:00 PM)

** The final examination time and date is established by the registrar. It cannot be changed.

Presentations

All students will be required to present multiple times during the semester. The reason for this is that I have found that students tend to perform better in laboratory settings, to take more care during data analysis, and to learn the material much more effectively when the results of the experiments will be presented in front of their peers. There will be four presentations required of each student for this semester—one dealing with a Bootcamp experiment, one dealing with the introduction to their final project, one informing the class about progress made on the final project, and one to report the results of their work on the final project. We will use class time to address what comprises an effective presentation, examine presentations from past students, and critique presented material. The expectation is similar to a writing intensive course, only we will be focusing on oral communication as opposed to writing.

“Success is a function of persistence and doggedness and the willingness to work hard for twenty-two minutes to make sense of something that most people would give up on after thirty seconds.”

-- Malcolm Gladwell from *Outliers: The Story of Success*

"Discipline is just choosing between what you want now and what you want most."

—Unknown Author

"I have not failed. I've just found 10,000 ways that won't work." --Thomas Edison

Laboratory Topic Schedule

The laboratory schedule presented here is tentative and can change during the semester.

Week Beginning (Monday)	Laboratory Topic
August 28	Intro to Spreadsheet Calculation and Computer-Based Graphing
September 4	Measurements and Uncertainty
September 11	Popcorn Statistics
September 18	Buffers and pH Exam 1 (9/21)
September 25	Intro to Titration and Spectroscopy <i>Project Intro Presentations (9/28)</i>
October 2	Intro to Titration and Spectroscopy
October 9	Intro to Titration and Spectroscopy Lab-Project
October 16	Lab-Project Exam 2 (10/19)
October 23	Lab-Project <i>Basic Training Presentation (10/26)</i>
October 30	Lab Project
November 6	Lab Project <i>Project Update Presentations (11/9)</i>
November 13	Lab Project Exam 3 (11/16)
November 20	Lab Project Thanksgiving Break
November 27	Lab Project <i>Final Project Presentations (11/30)</i>
December 4	<i>Final Project Presentations (12/5)</i> Lab Checkout
December 11	Final Exam (12/11)—1:00 pm

"You have to be confused before you can reach a new level of understanding anything."

-- Dudley Herschbach

"There is no limit to what can be accomplished when it doesn't matter who gets the credit."

-- Ralph Waldo Emerson

Bootcamp Laboratory Experiments

1. Introduction to Microsoft Excel/Igor Pro for Data Analysis: How much copper is in a penny?
2. Introduction to Measurements and Uncertainty: Which device is most precise and accurate?
3. Introduction to Statistics: How Much Water is Released When a Popcorn Kernel Pops?
4. Introduction to pH Measurement: Using a pH meter to study buffer performance and capacity
5. Introduction to Titration: Preparation and Standardization of a Sodium Hydroxide Solution
6. Introduction to Spectroscopy: Determination of Red Dye in Kool Aid and Other Drinks

Approved Laboratory Projects for Chemistry 232

Back-Titration for the Analysis of the Carbonate Content of Antacids
Examining the Concentration of Ibuprofen in Liquid Filled Capsules
Examining the Dissolution of Ibuprofen in Pharmaceutical Products
Using Filter Paper as a Means for Detecting Nitrite in Water
Quantitative Characterization of Elephant's Toothpaste
Use of Natural Product Extracts as pH Indicators
Olfactory Scent Detection of Titration Endpoints
Quantification of Protein Concentration using a Smartphone Camera
Determination of Solubility Product Constant Using Potentiometric Titration
Spectroscopic Determination of Caffeine in Coffee
Using Conductivity Measurements to Determine the Identity of Acid Solutions

"Whatever affects one directly, affects all indirectly. For some strange reason I can never be what I ought to be until you are what you ought to be."

-- Martin Luther King, Jr.

"Coming together is a beginning; keeping together is progress; working together is success."

-- Henry Ford

Project Guidelines for Chemistry 232

The culmination of Chemistry 232 is a research project involving the use of the laboratory techniques learned during the semester and the material presented in the lecture portion of the course. You will be given a significant amount of laboratory time to develop your topic and significant progress will be expected when grades are to be assigned. The grade will be assigned primarily on the quality of a presentation that will occur during the last week of the semester.

The purpose of the project in this course is multi-fold. The first is that most chemistry is not performed in a recipe or cookbook fashion. This means that you will have to use your laboratory skills and what you have learned to determine the proper path for a scientific study. This will come in handy when you next perform scientific research or enroll in a research methods course. The second purpose is that the process of performing chemical research requires the use of material learned in multiple chemistry/science courses. This compounding helps to make connections between various sources material, which leads to deeper learning. Lastly, there is almost no better method of observing what students have learned than through a research process. The first page of the syllabus has a detailed list of things you should have learned after completing this course; each of these can be evaluated through the completion of this project.

Although this may seem like a daunting task, you will perform the research project along with a partner (I will assign you a partner). All of the presentations will be performed together and the laboratory work must be shared equally (both partners are not required to do exactly the same things, but the amount of work should be equally distributed).

One mistake that students have historically made during the project is to do the bulk of the laboratory experiments before performing any calculations or data analysis. This has led students to present highly inaccurate/imprecise results and in some cases, the calculations were not performed correctly. A better approach is to perform an experiment, complete the analysis and using the results, decide what needs to be changed in any future experimental procedures. We will use other experiments during the semester as a model for this process.

Lastly, your grade on this project will come primarily from your instructor, but a portion will also be assigned by the students in the class. One of the purposes of this course is for you to learn how to improve your presentation skills and an effective way to do this is through learning to critique other presentations. We will discuss this process throughout the semester.

Laboratory Project Schedule

<u>Date</u>	<u>Assignment</u>
September 8	Project Selection Due with List of Reagents Required
September 28	Project Introduction Presentations
October 26	Bootcamp Presentations
November 9	Project Update Presentations
November 30 & December 5	Final Project Presentations