



Chemistry 332  
Analytical Chemistry  
Dr. Jeremy Ramsey  
Fall 2011



### 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, separation science, and electrochemistry).

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. By active, I mean that you will be doing instead of watching. 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 written and oral presentations
- 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*

### Prerequisites

- Chemistry 111 or permission of instructor
- Knowledge of chemical reaction stoichiometry and equilibrium (Quiz on Friday 10/3).

### Meeting Times

Lecture	MWF	10:15-11:05 am	215 Heim
Laboratory	T	1:00-3:50 pm	207 Heim
	Th	2:00-4:50 pm	207 Heim

### Required Course Materials

- Quantitative Chemical Analysis, 8<sup>th</sup> edition, Daniel Harris
- 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 phones 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.

### 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/moodle/course/view.php?id=1420>

### Office Hours

I like a more open format for office hours. If you have questions, stop by when you have time. I do tend to be busy (especially as I teach General Chemistry during the same semester as this course); so if you like, you can always make an appointment. I really like to spend time with my students (and it can get lonely sitting in my office), so feel free to drop by anytime to chat. My door is (almost) always open.

### Safety

Safe laboratory practices, including proper attire, will be expected 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. **Repeated or severe 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.**

Grading

	<u>Points</u>
<b>Examinations (4) and Quizzes</b>	<b>500</b>
<i>Highest midterm exam score</i>	120
<i>Middle midterm exam score</i>	110
<i>Lowest midterm exam score</i>	100
<i>Final exam (ACS Standardized)</i>	120
Quizzes	50
<b>Laboratory</b>	<b>265</b>
<i>Laboratory Examination</i>	80
<i>Presentations</i>	175
<i>Cleanup and Safety</i>	10
<b>Colloquium Attendance</b>	<b>15</b>
<b>Total Points</b>	<b>780</b>

- 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.***
- 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 and the instructor is notified in advance. ***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 (3 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.

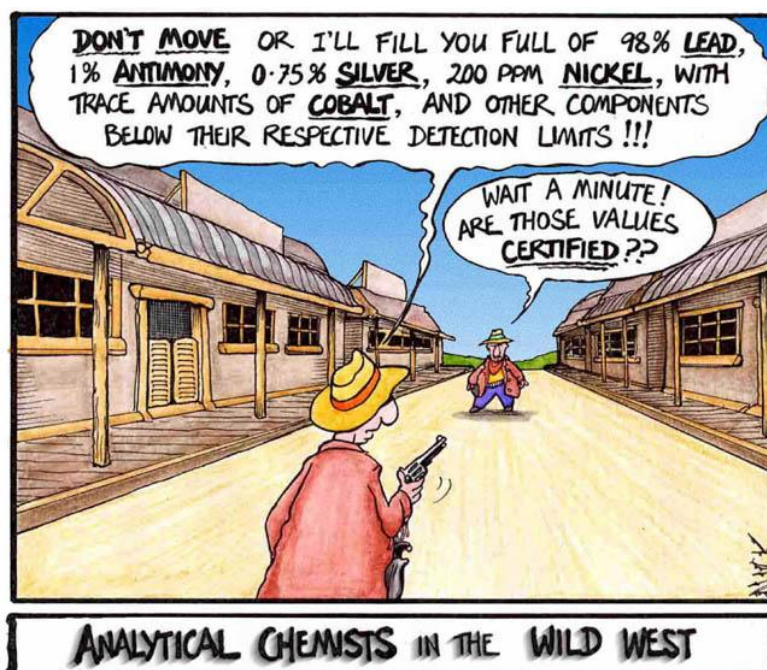
## Attendance

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 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 or your lab instructor 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 and the instructor is notified in advance. Otherwise, you will be awarded a zero for missed exams. 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. 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 without 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.



### 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 September 6<sup>th</sup>.

Examination 1	October 6 (Thursday)
Laboratory Exam	October 18 (Tuesday)
Examination 2	November 3 (Thursday)
Examination 3	December 1 (Thursday)
Final Examination **	December 15 (Thursday; 1:00 to 4:00 PM)

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

### Lab Reports

Lab reports and data sheets are due on the date announced in class following completion of the experiment. Grades on late lab reports will be reduced by 25% plus 5% per calendar day beyond the due date. The format of the reports will be covered prior to the first due date. Reports will be collected via Moodle. *No handwritten reports will be accepted.*

### 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 purpose is similar to what is expected in a writing intensive course, only we will be focusing on oral communication as opposed to written.

“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*

“In order to succeed, your desire for success should be greater than your fear of failure.”

-- Bill Cosby

“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.

<b>Week Beginning (Monday)</b>	<b>Laboratory Topic</b>
August 29	Intro to Excel and Igor Pro
September 5	Measurements and Uncertainty
September 12	Popcorn Statistics
September 19	Instrument Calibration <i>Project Intro Presentations (9/22)</i>
September 26	Intro to Titration and Spectroscopy
October 3	Intro to Titration and Spectroscopy <b>Exam 1 (10/6)</b>
October 10	Open Lab Time <i>Bootcamp Presentations (10/13)</i>
October 17	<b>Lab Exam (10/18)</b> Lab Project
October 24	Lab Project
October 31	Lab Project <b>Exam 2 (11/3)</b>
November 7	Lab Project
November 14	Lab Project <i>Project Update Presentations (11/17)</i>
November 21	Lab Project
November 28	Lab Project <b>Exam 3 (12/1)</b>
December 5	<i>Final Project Presentations (12/6 and 12/8)</i>
December 12	Final Exam (12/15)

**Bootcamp Laboratory Experiments for Fall 2011**

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 in a kernel of popcorn?
4. Introduction to Calibration: Measurements using a pH electrode and meter
5. Introduction to Titration: Standardization of a Sodium Hydroxide Solution
6. Introduction to Spectroscopy: How Much Cranberry Juice Is in a Cran-Apple Juice Mixture?

**Approved Laboratory Projects for Chemistry 332-- Fall 2011**

Analysis of the Percarbonate Content of OxiClean  
Back-Titration for the Analysis of Antacids  
Olfactory Scent Detection of Titration Endpoints  
Spectroscopic Detection of Titration Endpoints  
Determination of Salicylate in Topical Creams and Acne Medicine  
Measurement of Acidity Constants of Bromothymol Blue and Other Indicators  
Determination of the Effectiveness of Water Filters for Removing Calcium and Magnesium Ions  
Determination of the Sodium and Chloride Content in Sports Drinks  
Quantitative Determination of Nickel in Metal Alloys  
Determination of Sulfate in Seawater  
Use of Natural Product Extracts as pH Indicators  
Determination of the Critical Micelle Concentration of Laundry Detergents  
*Advanced: Using Salicylate to Detect the Amount of Iron in a Vitamin Tablet*  
*Advanced: Using a Digital Camera as a Detector for Thin Layer Chromatography*  
*Advanced: Using a Desktop Scanner to Measure the Absorption of Light*  
*Advanced: Determination of the Reducing Sugar Content of Honey*

**Project Guideline for Chemistry 332 During the Fall 2011 Semester**

The culmination of Chemistry 332 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. This will not be tolerated when grades are assigned and will lead to low grades on the final project (C- and below). 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**

<b><u>Date</u></b>	<b><u>Assignment</u></b>
September 9	Project Selection Due
September 22	Project Introduction Presentations
October 13	Bootcamp Presentations
November 17	Project Update Presentations
December 6 & 8	Final Project Presentations