



## Chemistry 327: Fundamentals of Analytical Sciences

**Credits:** 4 credit hours

**Course URL:** <https://learnuw.wisc.edu/>

**Course Designations and Attributes:** Breadth - Physical Science; counts toward the Natural Science requirement; Level – Intermediate; L&S Credit - Counts as Liberal Arts and Science credit in L&S

### Meeting Times and Locations:

Lecture: TuTh 8:50-9:40 am in B371 Chemistry

Disc	Time	Room	Lab		Laboratory Room
301	W 7:45-8:35 am	CHEM 2307	601	TuTh 1:20-4:20 pm	MED SC CTR 5385
302	W 7:45-8:35 am	CHEM 2377	602	TuTh 1:20-4:20 pm	MED SC CTR 5385
303	W 7:45-8:35 am	VAN HISE 140	603	TuTh 1:20-4:20 pm	MED SC CTR 5385
304	W 7:45-8:35 am	VAN HISE 123	604	TuTh 1:20-4:20 pm	MED SC CTR 5385
305	W 7:45-8:35 am	STERLING 2333	605	TuTh 1:20-4:20 pm	MED SC CTR 5360

**Instructional Mode:** All face-to-face

**How Credit Hours Are Met:** CHEM 327 is a 4-credit class that meets each week for two 50-minute lectures, one 50-minute discussion, and two 3-hour laboratories. Over the course of the semester, students are expected to engage in at least 180 hours of learning activities, which includes class attendance, reading, studying, preparation, problem sets, laboratory reports, and other learning activities.

### INSTRUCTORS AND TEACHING ASSISTANTS

**Lecturer:** Dr. Linda Zelewski

**Office Hours:** Tuesday and Friday 10:00 am-12:00 pm and by appointment in Chem 2126

**Email/Preferred Contact:** [zelewski@wisc.edu](mailto:zelewski@wisc.edu)

**Laboratory Director:** Dr. Pamela Doolittle

**Email/Preferred Contact:** [pam.doolittle@wisc.edu](mailto:pam.doolittle@wisc.edu)

**Office:** 535 Service Memorial Institute (SMI)

### Teaching Assistants:

Section	TA	Preferred Email
301/601	Lisa George	<a href="mailto:lgeorge4@wisc.edu">lgeorge4@wisc.edu</a>
302/602	Jiabao Guo	<a href="mailto:jguo245@wisc.edu">jguo245@wisc.edu</a>
303/603	Elizabeth Bayne	<a href="mailto:ebayne@wisc.edu">ebayne@wisc.edu</a>
304/604	Eli Larson	<a href="mailto:ejlarson2@wisc.edu">ejlarson2@wisc.edu</a>
305/605	John Pavek	<a href="mailto:jpavek@wisc.edu">jpavek@wisc.edu</a>

**TA Office Hours:** See Learn@UW

## **COURSE DESCRIPTION**

Fundamentals of chemical measurement in chemistry, biology, engineering, geology, and the medical sciences. Topics include equilibria of complex systems, spectroscopy, electrochemistry, separations, and quantitative laboratory technique. Lecture, lab, and discussion.

**Requisites:** Chem 104 or 109

## **Course Learning Outcomes**

Students will be able to

- Apply statistical methods for the evaluation of laboratory data
- Use calibration and sampling methods important to quantitative analysis
- Model chemical systems and experimental data using relevant quantitative, mathematical, and computational methods.
- Learn analytical methods based on titrations, separations, electrochemical measurements, and spectroscopy and interpret the results for chemical analysis
- Identify, formulate, and solve integrative problems using appropriate information and approaches.
- Develop skills in working collaboratively with others, both chemists and those from other disciplines, to solve problems and create new knowledge.

## **GRADING**

Below are the point values of items that will be graded. Adjustments to graded items and point values may be made during the semester if needed.

3 Midterm Exams	450 points
9 Homework Assignments	~225 points
Instructional Prelab Quiz	6 points
14 Prelab Quizzes and Laboratory Reports	210 points
Laboratory Project	60 points
Class Participation	15 points

Grading will be based on the following scale: A 90.0%, AB 88.0%, B 80.0%, BC 78.0%, C 70.0%, D 60.0%. This scale may be adjusted downward at the end of the semester, depending on the overall class average. It will never be adjusted upward.

## **DISCUSSION SESSIONS**

Attendance is required. Your TA will provide important pre-lab information as well as answer any questions you may have about labs, homework, or lecture material. To get the most from discussion section, you need to be prepared. It is your responsibility to communicate to your TA the concepts you do not understand and the skills you need to practice. You should ask your TA specific questions and make sure you understand the questions and the answers given by your TA and by fellow students. Bring your lab notebook and manual with you to discussion.

## LABORATORY SESSIONS

The laboratory sessions are a significant and inseparable part of this course.

**You must complete all of the labs and earn a minimum score of 60% on all laboratory assignments (combined prelab, lab report and project grades) in order to receive a passing grade in the course.**

**Standard Labs:** 14 standard laboratory sessions related to the course content are designed to help you practice and gain proficiency in mastering course concepts, as well as develop specific laboratory techniques important to the field of analytical chemistry. Each of the standard labs is worth 15 points and has three graded components. You must take the online Pre-lab Quiz on Learn@UW prior to coming to lab (6 points). You will be graded on the accuracy of your lab results (5 points), and your lab notebook will be graded for completeness and clarity (4 points). ***Please note that for some weeks each lab section has a different lab schedule.*** Be sure to check the schedule at the end of this syllabus so that you prepare for the appropriate lab and take the appropriate online Prelab Quiz.

**Pre-lab Quiz:** Prior to taking the pre-lab quiz, read about the experiment in the lab manual and prepare your notebook pages. You should be familiar with the overall concepts of the experiment and the methods used in the experiment. You should also understand the procedure and how to do the calculations you will need to do with the raw data.

You may attempt the quiz twice and your highest score will appear in the grade book. Note that there is a time limit (usually 30 minutes) for each attempt. The clock begins timing once you start the quiz and you cannot stop and come back later in the day to finish, so be prepared to complete the entire quiz once you begin. Most quizzes have questions that involve calculations, so you should have a calculator, scratch paper, pencil, and your lab manual available when you attempt a quiz.

Check your lab schedule to make sure you are attempting the correct quiz. Quiz ending dates and times have been set-up by section and are set to end at 1:20 pm the day you are scheduled to do a lab. ***Quizzes must be completed before this time or you will receive zero points for the prelab.***

When taking a quiz, ***do not include units when entering numbers for computational questions.*** The auto-grade feature will not recognize the units and it will mark your answer wrong. In all other parts of the course (lab notebook, homework, exams, etc.) you should always include units. Also be sure to enter the correct number of significant figures for a calculated answer. ***An error in the number of significant figures will result in an incorrect answer and zero points for your answer.***

**Laboratory Project:** For your laboratory project, you will work on determination of ibuprofen as the active pharmaceutical compound of an over the counter drug called Advil. More information regarding the project will be provided later during the semester.

**Laboratory Notebook:** See “Laboratory Overview” in your lab manual for guidelines on keeping a laboratory notebook.

**Laboratory Reports:** Your laboratory report will consist of the carbonless copies of the relevant pages from your laboratory notebook and the completed (yellow) summary sheet from your lab manual. Laboratory reports are due to your TA at the beginning of the following laboratory period after you have completed the experiment. A penalty of one point per day will be deducted if you submit your report late. Late lab reports placed in your TA’s mailbox must be

accompanied by an email message sent prior to submitting the report. Failure to email your TA may result in additional points lost if your TA does not know to look for your report in his/her mailbox.

**Laboratory Conduct:** Safety goggles and proper attire must be worn at all times in the laboratory. Your lab begins at 1:20 pm, and it is essential that you arrive on time so that you do not miss important information. Points will be deducted from your lab score for unsafe or inadequate conduct including, arriving late, not wearing goggles, not cleaning up spills promptly, and not cleaning your lab area before leaving the lab.

**Special Laboratory Accommodations:** Students requiring special accommodations in lab should contact the laboratory director, Dr. Pam Doolittle ([pam.doolittle@wisc.edu](mailto:pam.doolittle@wisc.edu)) before the first lab meets.

## REQUIRED TEXTBOOK, SOFTWARE & OTHER COURSE MATERIALS

- **Textbook:** Quantitative Chemical Analysis, Ninth Edition, by Daniel C. Harris, W.H. Freeman and Company, 2016.
- **Lab Manual:** A Manual of Experiments for Analytical Chemistry – Fall 2018, Department of Chemistry, UW- Madison. Lab manuals will be sold in Chemistry room 1375 beginning Wednesday, September 5. WiscCard only – *no cash sales*.
- **Lab Notebook:** Carbonless laboratory notebook with numbered, duplicate pages. Alpha Chi Sigma (AXE), a professional co-ed chemistry fraternity founded here at UW-Madison, will be selling suitable lab notebooks in chem 1375.
- **Calculator:** A scientific or graphing calculator is required. Only calculators that are permitted on SAT or ACT tests may be used on exams. You may NOT use any stored information, programs, or applications on exams unless given explicit permission.
- **Personal Protection Equipment:** Industrial quality eye protection is required at all times when you are in the lab. Indirectly vented safety goggles that completely seal around the eyes and fit over regular glasses can either be purchased from local bookstores or from Alpha Chi Sigma in chem 1375. You're also required to wear a laboratory coat at all times in lab; lab coats will be available for WiscCard purchase in chem 1375 if you need one. You should transport your lab coat in a sealed plastic bag, such as a 1-gallon Ziploc.
- **USB Drive:** A USB flash drive that will hold at least 2 GB is required for laboratory.

## EXAMS, QUIZZES, PAPERS & OTHER MAJOR GRADED WORK

Exam 1: Thursday, October 11, 1:20-3:20 pm (room TBA)

Exam 2: Tuesday, November 13, 1:20-3:20 pm (room TBA)

Exam 3: Thursday, December 20, 12:25-2:25 pm (room TBA)

Exams are cumulative in the sense that many of the concepts covered in this course build on one another and a good understanding of earlier material is required for mastering later material.

## HOMEWORK & OTHER ASSIGNMENTS

Homework is critical to success in this class and on the exams. When doing homework assignments, you may work independently or collaborate with others. If you choose to collaborate, you must still work out and hand in your own solutions. If you worked with other students, you must indicate on your paper who you worked with. In order to receive credit for homework you must clearly communicate your thought process and show all of your calculations. Write your TAs name and your section number on your assignment.

There will be 9 homework assignments. Each assignment has two parts. The first part is a list of suggested problems from the textbook. These problems are not graded and their solutions can be found in the *Solutions Manual for Quantitative Chemical Analysis*. The second part of the assignment will have problems that are to be worked out and turned in for grading.

Homework assignments are typically due at the ***beginning of lab***. To discourage late submissions, 8 points will be deducted from homework turned in after this time and before 5:00 pm the following day. Homework turned in later than this will receive a zero. Late homework assignments must be handed directly to your TA or placed in Dr. Zelewski's mailbox before 5:00 pm. Mailboxes are in located in room CHEM 1146. If there are extenuating circumstances, such as a serious illness or family emergency, please email Dr. Zelewski (and copy your TA) as soon as possible. Dr. Zelewski may consider an extension for extenuating circumstances.

## ATTENDANCE POLICY

Your attendance at all scheduled classes (lecture, discussion and lab) is mandatory and essential for success in the course. However, circumstances occasionally occur where you may need to miss a class.

**Planned Absences:** If you need to miss class for a religious observance, a UW athletic commitment, graduate school interview or some other legitimate reason, you must make arrangements to make up the missed work ***a minimum of one week before the absence occurs***, otherwise, the absence will be unexcused and you will receive a zero on the missed work.

***Homework must be turned in before the deadline if you will be absent on the day it is due.***

**Serious Illness/ Family Emergency:** If you are seriously ill or experiencing a family emergency and are unable to attend lab, inform your TA via email and copy Dr. Zelewski. If you need an extension on your homework due to a serious illness or family emergency, arrangements must be made with Dr. Zelewski ***before*** the homework due date. Late homework cannot be accepted for any reason once the answer key is posted.

## RULES, RIGHTS & RESPONSIBILITIES

See the Guide's to [Rules, Rights and Responsibilities](#)

## ACADEMIC INTEGRITY

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in

disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to [studentconduct.wiscweb.wisc.edu/academic-integrity/](http://studentconduct.wiscweb.wisc.edu/academic-integrity/).

## **ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES**

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform Dr. Zelewski and their TA of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. We will work either directly with you or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA.

## **DIVERSITY & INCLUSION**

**Institutional statement on diversity:** “Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world.” <https://diversity.wisc.edu/>

## CHEMISTRY 327 LECTURE OVERVIEW\*

WEEK	DAY & DATE	TOPIC
1	Th Sep 6	The Analytical Process
2	Tu Sep 11	Chemical Measurements
	Th Sep 13	Experimental Error
3	Tu Sep 18	Statistics
	Th Sep 20	Statistics
4	Tu Sep 25	Quality Assurance & Calibration Methods
	Th Sep 27	Quality Assurance & Calibration Methods
5	Tu Oct 2	Spectrophotometry
	Th Oct 4	Spectrophotometry
6	Tu Oct 9	Spectrophotometry
	Th Oct 11	Chemical Equilibrium & Solubility <b>EXAM 1 (during Lab)</b>
7	Tu Oct 16	Ionic Strength and Activity
	Th Oct 18	Monoprotic Acid-Base Equilibria
8	Tu Oct 23	Monoprotic Acid-Base Equilibria
	Th Oct 25	Polyprotic Acid-Base Equilibria
9	Tu Oct 30	Polyprotic Acid-Base Equilibria
	Th Nov 1	Polyprotic Acid-Base Equilibria
10	Tu Nov 6	Acid-Base Titrations
	Th Nov 8	Acid-Base Titrations
11	Tu Nov 13	Systematic Treatment of Equilibria <b>EXAM 2 (during Lab)</b>
	Th Nov 15	Electrochemistry
12	Tu Nov 20	Electrochemistry
	Th Nov 22	<i>Thanksgiving – No Classes</i>
13	Tu Nov 27	Electrodes and Potentiometry
	Th Nov 29	Electrodes and Potentiometry
14	Tu Dec 4	Analytical Separations
	Th Dec 6	Analytical Separations
15	Tu Dec 11	Chromatography
FINAL	Th Dec 20	<b>EXAM 3 (12:25-2:25 PM)</b>

\*See Learn@UW for specific reading, homework, and laboratory assignments and due dates.

Week	Date	601 Lisa George	602 Jiabao Guo	603 Elizabeth Bayne	604 Eli Larson	605 John Pavek
1	4-Sep	<b>Last Day off! First meeting of class is Discussion, 7:45 AM Wednesday. See course guide for location details.</b>				
	6-Sep	Check-in/Weighing Lab	Check-in/Weighing Lab	Check-in/Weighing Lab	Check-in/Weighing Lab	Check-in/Weighing Lab
2	11-Sep	Volumetric Apparatus	Volumetric Apparatus	Volumetric Apparatus	Volumetric Apparatus	Volumetric Apparatus
	13-Sep	Standardization of HCl	Standardization of HCl	Standardization of HCl	Standardization of HCl	Standardization of HCl
3	18-Sep	Standardization of NaOH	Standardization of NaOH	Standardization of NaOH	Standardization of NaOH	Standardization of NaOH
	20-Sep	% KHP in a Mixture	% KHP in a Mixture	% KHP in a Mixture	% KHP in a Mixture	% KHP in a Mixture
4	25-Sep	Ascorbic Acid Method	Ascorbic Acid Method	Ascorbic Acid Method	Ascorbic Acid Method	Ascorbic Acid Method
	27-Sep	Spike Recovery and MDL	Spike Recovery and MDL	Spike Recovery and MDL	Spike Recovery and MDL	Spike Recovery and MDL
5	2-Oct	Spec. Det. Of a Mixture	Spec. Det. of a Mixture	Spec. Det. of a Mixture	Spec. Det. of a Mixture	Spec. Det. of a Mixture
	4-Oct	A Study of Fluorescein	A Study of Fluorescein	A Study of Fluorescein	A Study of Fluorescein	A Study of Fluorescein
6	9-Oct	<b>Finish Labs</b>	<b>Finish Labs</b>	<b>Finish Labs</b>	<b>Finish Labs</b>	<b>Finish Labs</b>
	11-Oct	<b>EXAM 1</b>				
7	16-Oct	Project Introduction	Project Introduction	Project Introduction	Project Introduction	Project Introduction
	18-Oct	Project	Project	Project	Project	Project
8	23-Oct	Project	Project	Project	Project	Project
	25-Oct	Project	Project	Project	Project	Project
9	30-Oct	Project	Project	Project	Project	Project
	1-Nov	Adventures with Buffers	Adventure with Buffers	Adventure with Buffers	Adventure with Buffers	Adventures with Buffers
10	6-Nov	Study and ID of a Weak Acid	Study and ID of a Weak Acid	Study and ID of a Weak Acid	Study and ID of a Weak Acid	Study and ID of a Weak Acid
	8-Nov	<b>Finish labs</b>	<b>Finish labs</b>	<b>Finish labs</b>	<b>Finish labs</b>	<b>Finish labs</b>
11	13-Nov	<b>EXAM 2</b>				
	15-Nov	Study of BCG	Study of BCG	Study of BCG	Study of BCG	Study of BCG
12	20-Nov	High Pressure LC	Gas Chromatography	Chemical Oxygen Demand	Chemical Oxygen Demand	Chemical Oxygen Demand
	22-Nov	<b>Thanksgiving Day--No Lab</b>				
13	27-Nov	Chemical Oxygen Demand	Chemical Oxygen Demand	Gas Chromatography	High Pressure LC	Fluoride Ion Electrode
	29-Nov	Gas Chromatography	High Pressure LC	Fluoride Ion Electrode	Fluoride Ion Electrode	Silver Electrode
14	4-Dec	Fluoride Ion Electrode	Fluoride Ion Electrode	High Pressure LC	Silver Electrode	Gas Chromatography
	6-Dec	Silver Electrode	Silver Electrode	Silver Electrode	Gas Chromatography	High Pressure LC
15	11-Dec	<b>Finish labs/Check out</b>	<b>Finish labs/Check out</b>	<b>Finish labs/Check out</b>	<b>Finish labs/Check out</b>	<b>Finish labs/Check out</b>
	13-Dec	<b>Study Day--No Classes Scheduled</b>				