



Welcome to Quantitative Analysis!

CHEM 248, Fall 2022

Lecture:

Tuesdays and Thursdays, 12:00 – 12:50 PM (CBB 101)

Laboratory:

Section 1: Tuesdays and Thursdays, 8:00 – 10:50 AM (CBB 466)

Section 2: Mondays and Wednesdays, 2:00 – 4:50 PM (CBB 466)



Dr. Dave Snyder
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Office Location: CBB 445

Office Hours:	Monday	12:00 – 12:50 PM
	Tuesday	1:00 – 1:50 PM
	Wednesday	11:00 – 11:50 AM
	Thursday	1:00 – 1:50 PM
	Friday	9:00 – 9:50 AM

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A Note from the Instructor:



I'm excited about working with you this semester. Quantitative Analysis was one of my favorite classes when I was a student and is one of my favorite courses to teach here at UWSP. During this semester, you will gain key laboratory skills along with the confidence to apply these skills to fundamental problems in analytical chemistry. Whether you plan on working in a laboratory or will be utilizing data derived from an analytical laboratory, a fundamental understanding of the practical and theoretical

basis of chemical analysis will be critically important to you. This course will be challenging, but please be assured that I will be there to support you and guide you along the way. I think (and hope) you will be amazed at the transformation you will undergo during this term!

What is this Course all About?

Pre-requisite: Successful completion of CHEM 106 or CHEM 117 (C+ or better highly recommended)

This course will provide you with the opportunity to learn the fundamental theories and methods of quantitative chemical analysis. The methods that you will learn in this course are currently employed by scientists and laboratory technicians around the world to analyze a wide variety of samples including environmental samples, food and pharmaceutical samples, and tissue samples critical in diagnosing diseases in humans, plants, and animals. Among the topics we will discuss are the effects of chemical equilibrium on quantitative separations, titration curves, polyprotic acid-base systems, and oxidation-reduction processes. You will also be given the opportunity to work with the UWSP Chemistry Department's state-of-the-art analytical instrumentation, including our gas chromatograph (GC), high-performance liquid chromatograph (HPLC), and open-flame atomic absorption spectrometer (FAAS), along with more traditional analytical equipment and instruments.

Learning Outcomes

Here's what you will be able to do after successfully completing this course:

1. Properly document and report the results of chemical analyses and report the relative error associated with these results
2. Predict the results of an analysis given information on the analytical technique(s) employed and the nature of the sample
3. Identify errors associated with chemical analyses and describe and demonstrate methods of minimizing or eliminating these errors
4. Demonstrate the ability to accurately determine the amount of an analyte in a sample using a variety of analytical techniques

Inclusive Excellence

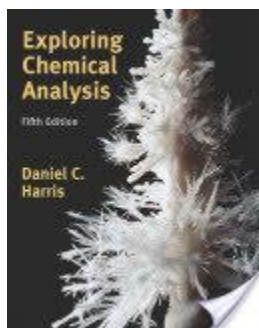
I recognize that students in my classroom may have diverse racial, ethnic, cultural, and religious backgrounds, sexual orientations and gender identities. I further recognized that students in my classroom may face unique challenges due to health conditions, family obligations, current or past military service, and other situations that may result in significant obstacles to learning.

I am committed to providing a civil, respectful, and equitable classroom where all my students have the opportunity to succeed and feel safe and valued. I believe diversity should be celebrated and embraced because it helps to create an optimal environment for shared inquiry and the development of sophisticated graduates who recognize the value of diversity and human dignity.

I welcome your suggestions and ideas on how we can create and maintain an inclusive and equitable learning environment during the semester.

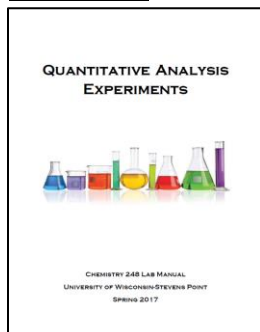
Learning Resources and Required Materials

Textbook



Exploring Chemical Analysis, 5th Edition, by Daniel C. Harris
Available through text rental at the University Store

Lab Manual



Quantitative Analysis Experiments, Summer/Fall 2022
Available for purchase at the University Store. This summer's version has a white cover!

Lab Notebook



You will need (2) permanently-bound notebooks, preferably quadrille ruled. The notebook shown at the left (“the original marble cover 80 sheets”) is *available for purchase at the University Store* and is preferred.

Spiral notebooks, notebooks with detachable pages, and previously-used permanently-bound notebooks are not acceptable

Scientific Calculator



You will need a scientific calculator with log functions. It does not have to be a fancy, expensive one. My trusty Casio fx-300 ES solar (shown at left) costs \$11.49 at Staples®, got me through college and graduate school, and never needs new batteries! Bring your calculator with you to both lecture and lab. Cell phones may not be used as calculators.

Time

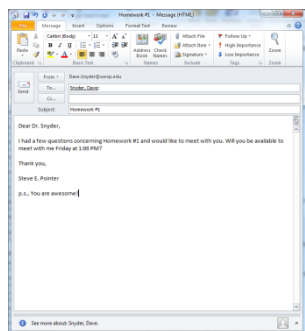


Your education is a significant investment that you should get the most out of. To get the most out of this class and earn a solid grade, you need to be willing (and able) to invest a significant amount of time and energy. How much time? Between readings, homework, and lab preparation/reporting, you will need to set *at least* aside 2 - 3 hours each day. If you have question about how to organize and use your time out of class wisely, please come a talk to me!

Canvas Course Site

All course documents, including assignments, rubrics, the syllabus, and other supporting material, can be found on the course Canvas site (login at <https://www.uwsp.edu/canvas>). Your exam, homework, and lab grades, along with your overall course grade, can be found on this site as well. I will post content and update grades almost every day, so be sure to check Canvas often.

E-Mail



Please feel free to e-mail me at dave.snyder@uwsp.edu if you have any questions or concerns during the semester. While I may not be able to reply to your messages instantly, I will do my best to reply as quickly as possible. E-mail messages should be professionally formatted, should include an appropriate salutation (e.g., "Dear Dr. Snyder"), an appropriate closing ("Sincerely, Steve E. Pointer"), and should be written in Standard English. Sending me e-mails is a good opportunity to develop or improve your professional communication skills.

Support and Help

Instructor Support

Instructor Office Hours: During office hours, I am available to assist you in all aspects of this course. You do not need to make an appointment to stop by during "drop-in" office hours but should contact me in advance for appointments at other times. I expect that you will need help with this course and am always happy to work with you.

Disability Services

The University of Wisconsin Stevens Point is committed to providing students with disabilities the academic accommodations and auxiliary aids necessary to ensure access to all university services, programs, and activities. In addition to the university's campus-wide efforts to promote access and inclusion, students with disabilities are further accommodated based on specific individual needs. The Disability Resource Center (DRC) is responsible for determining these accommodations. They provide services and assistance to enrolled students who are either permanently or temporarily disabled.

- The registration process can take up to 3 weeks to complete, so if you believe you will require accommodations, begin the process as soon as possible. To start the process, contact The Disability and Assistive Technology Center (DRC) at 715-346-3365 or emailing drc@uwsp.edu
- UWSP has many services for students offered by various offices. Although decisions regarding disability specific accommodations are made on a case-by-case basis.
- Visit the Disability Resource Center (DRC) website at: <https://www.uwsp.edu/disability-resource-center/> for information on services offered to students with specific disabilities

Advocacy

In the case of extended illness, family emergencies, or other unforeseen personal situations that present a significant challenge to successfully completing a course, students should contact the Dean of Students (call 715-346-2611, email DOS@uwsp.edu, or visit their office at 212 Old Main). The dean and his staff will provide discreet advocacy and advice for students having academic, personal, or other non-academic concerns. When times are tough, don't go it alone!

Course Policies

Participation and Attendance Policy

You are expected to actively participate in all classroom and laboratory activities. To get the most out of these activities, you must come to class prepared having completed all reading assignments, homework sets, and pre-laboratory work. Course activities have been carefully designed to help you to achieve the learning goals for this course, so missing class or failing to engage in classroom activities will negatively affect your ability to learn course content and thereby achieve a passing grade.

Opportunities to make up missed work will be limited to absences that are excused under university policy, such as serious illness or injury, military or religious obligations, and participation in university-sanctioned events (athletic competitions, class field trips, etc.). I reserve the right to require documentation in these cases. For university-sanctioned events, students must notify me *in writing* at least one week before the absence to qualify for make-up work or additional lab time. I try to be understanding and as flexible as possible about absences; however, some classroom and laboratory experiences cannot be replicated, and I reserve the right to substitute assignments or course requirements as I deem appropriate.

Academic Integrity Policy

The Board of Regents, administrators, faculty, academic staff, and students of the University of Wisconsin system believe that academic honesty and integrity are fundamental to the mission of higher education and of the University of Wisconsin system. Students are responsible for the honest completion and representation of their work, for the appropriate citation of sources, and for respect of others' academic endeavors. Students who violate these standards will be confronted and must accept the consequences of their actions. Please be aware that the penalties for academic misconduct can include suspension or expulsion from the university. More information on UWSP academic standards and disciplinary procedures pertaining to academic misconduct can be found at:

<http://www.uwsp.edu/admin/stuaffairs/rights/rightsChap14.pdf>

Late Work Policy

Meeting deadlines, completing work in a timely manner, and working efficiently are important life and career skills. Additionally, staying on-track with your work reduces stress. For this course, you are expected to complete all assignments, laboratory exercises, and exams on schedule. If you have a personal situation that prevents you from completing your work on time, you will need to discuss this with me *before* the due date. Credit for late homework assignments will not be given. The procedure for requesting an extension for lab reports can be found in the laboratory section of this syllabus. Make-up exams will be given at my discretion and accordance with the attendance policy. Early exams will not be given under any circumstances.

Lecture

Lecture periods will be an interactive mix of discussion, problem solving, and presentation of concepts and examples. I expect you to be an *active* participant in class discussions and activities. I employ many different learning strategies that are research-based and have been shown to improve student learning, but no strategy works unless you are a willing and engaged participant! You are responsible for all material presented during lecture periods and should take careful notes. As is customary in university courses, not all material will be covered in class, so be sure to complete all assigned reading activities and homework assignments. If anything is unclear to you, please come and see me! My role in this course is to facilitate your learning experience, and my favorite part of being a professor is meeting with you, whether it is in the classroom, lab, my office, or walking down the hallway or sidewalk. Don't ever think that you are bothering me when you come to see me – you are the reason why I am here!

Homework Assignments

Homework assignments are designed to give you the opportunity to practice and demonstrate your mastery of skills taught in class and lab. For homework to be an effective learning tool, you must write complete solutions to all problems, including detailed explanations for your solutions where appropriate. Homework assignments may include textbook readings and questions based on these readings. When you receive your graded homework from me, it is vitally important that you review, correct any problems you missed, and meet with me regarding anything you still don't understand.

To receive credit for homework assignments, you must:

1. Write your numerical answers on the submission sheet. Include correct significant figures and units along with your numerical answers.
2. Submit a complete written solution to each problem. Solutions should be legible and should include units and labels. Points will be deducted for missing/incomplete solutions, sloppy/illegible work, and missing units or labels.

Failure to submit answers or solutions will result in a score of zero for the assignment. Late homework assignments are not accepted.

Exams

Homework assignments are an example of *formative* assessments and are designed to help you to learn. Exams are examples of *summative* assessments and are designed for you to demonstrate what you have learned. You will be given three (3) exams during this semester. Each exam will cover material from lecture *and* from the experiments you have completed in lab (in other words, material covered in lab is fair game for an exam). Exam 1 and Exam 2 will be night exams (see the course schedule for details)

Laboratory

The laboratory component of this course is critical to your success in this course. During labs, you will analyze unknown samples and quantify the amounts of specific substances, called analytes, using a variety of analytical techniques. You will work individually and at your own pace with the expectation that all experiments must be completed prior to the last day of lab. Your lab grade will depend on how closely your results match the actual amount of analyte in your unknown (known as the *true value*). *Success in lab depends on being organized and thoroughly prepared for each lab period.* Here are some suggestions that will help you to succeed:

1. **Know which experiment you will be working on at least two (2) lab periods in advance.** This will help you to gather, prepare, and organize necessary reagents and unknowns.
2. **Read the experimental procedure thoroughly before coming to lab** and be sure to speak with the instructor regarding any questions you have about the procedure.
3. **Prepare your laboratory notebook before coming to lab.** Write the purpose and procedure, write and annotate important chemical reactions, list reagents and their purpose, and create data tables before coming to lab. Leave plenty of space for additional data and calculations.
4. **Use lab time for experimental work only.** Do calculations and write-ups outside of lab so that you can stay on, or ahead of, the lab schedule. *Lab time is best used for experimental work.*

Laboratory Results (Accuracy Scores)

You will be graded on the accuracy of your results for each experiment, i.e., how close your experimentally determined value is to the “true” value for the unknown you analyzed. The details of laboratory grading can be found later in this syllabus and on page 145 of the lab manual. It is possible to *redo* one lab with a new unknown, if time permits, and it is also possible to *recalculate* the results of your experiment if you have made a calculation error.

1. *Redo:* A student may repeat one (1) experiment with a new unknown if time permits. The grade for the experiment will be the average of the two scores, and a new lab report must be submitted. Students must be up-to-date with all lab submissions before being eligible to redo a lab.
2. *Recalculation:* In the case of a calculation error, a new report must be submitted along with an indication in your lab notebook of where the error occurred and a new set of calculations. Errors in judgment may not be used to recalculate a result. For example, you may not change your result to a median value from a mean or vice versa. You should discuss recalculations with your lab instructor. Your new score will be determined by subtracting five points from your “recalculated” accuracy score. Recalculations must be submitted within two lab days after the lab has been graded and returned to you.
3. *Due Date Extensions/ Late Reports:* If you are not able to meet the deadline for a laboratory report, speak with your lab instructor about an extension. Together, you and your instructor will

set a new due date. You must also send an e-mail to the lab instructor confirming the new due date. Lab reports submitted after the due date and without an approved extension will incur a five (5) point penalty for each lab period that it is late.

Laboratory Notebook

Your lab notebook is an important record of the work that you have performed. Your lab notebook will be collected and evaluated after each experiment is completed, and laboratory results will not be accepted unless they are accompanied by a complete notebook entry. We will be discussing how to properly prepare and keep a lab notebook during the first week of class. The rubric used to evaluate your notebook appears at the end of this syllabus.

Canvas Laboratory Quizzes

Three laboratory quizzes are available on Canvas. The *Basic Lab Certification Quiz* must be completed before the Soda Ash unknown is issued. The *Cyanide Safety Quiz*, must be completed before the Limestone unknown is issued, and the *Dichromate Safety Quiz* must be completed before the Ethanol by Titration unknown is issued. Details on these quizzes can be found in the lab manual. You must score 100% on all three quizzes in order to receive credit for them and receive your unknown. You may take these quizzes as many times as you need.

Grading

The final course grade will be determined as a weighted percent by category as shown below. The approximate percent per item is based on the number of items in each category (shown in parentheses). Note that grading is evenly split between lecture activates and lab activities.

Category (Items)	Approx. % per Item	% of Final Grade
Exams (3)	13	40
Homework (10)	1	10
Laboratory Quizzes (3)	0.7	2
Lab Results (10)	3.8	38
Lab Notebook (10)	0.5	5
Formal Lab Report (1)	5	5
Total		100

Grading Scale

The following scale will be used to assign letter grades:

Grade	Percent Range	Grade	Percent Range
A	100 – 93	C+	79 – 76
A-	92 – 90	C	75 – 73
B+	89 – 86	C-	72 – 70
B	85 – 83	D+	69 – 66
B-	82 – 80	D	65 – 64
		F	63 – 0

Scoring of Laboratory Experiments

Your lab accuracy score is based on how close you come to the “true” or accepted value for your unknown. This is calculated using the following formula:

$$\text{Accuracy Score} = \left| \frac{\Delta x}{\Delta x_{100}} \right|$$

ΔX is the difference between your reported answer and the “true” or accepted value and represents the accuracy of your experimental results. In other words, $\Delta X = (\text{your value} - \text{“true” value})$

ΔX_{100} is the maximum ΔX allowed for a grade of 100% or 50 points (see page 145 in your lab manual).

Your grade depends on the number of ΔX_{100} 's you are from the correct answer. For example, suppose you determine that the percent sodium carbonate in your soda ash unknown is 35.65% and the “true” value for your unknown is 35.40%.

$$\Delta x = (\text{your value} - \text{“true” value}) = (35.65\% - 35.40\%) = +0.25\%$$

The ΔX_{100} value for soda ash is 0.20% (this value can be found on page 145 of your lab manual), so the accuracy score is calculated as follows:

$$\text{Accuracy Score} = \left| \frac{\Delta x}{\Delta x_{100}} \right| = \left| \frac{0.25}{0.20} \right| = 1.25$$

The accuracy score is then converted to a percent and point score using the following scale:

	Accuracy Score	Grade (%)	Grade (Points)
Your score	1 or less	100	50
falls in this	→ 1 to 1.5	90	45
range	1.5 to 2	80	40
	2 to 3	70	35
	3 to 5	60	30
	5 to 8	50	25
	8 to 12	40	20
	12 to 20	30	15
	20 or more	20	10

Accordingly, your accuracy score would earn you a grade of 90% or 45 points.

Tentative Course Outline

Session	Date	Topic(s)	Chapter in Text
1	Sept. 6	Course Introduction	Syllabus
2	Sept. 8	Statistical Approaches to Error	3
3	Sept. 13	Statistical Approaches to Error	3
4	Sept. 15 ¹	Statistical Approaches to Data Analysis	4
5	Sept. 20	Method Validation	4
6	Sept. 22	Calibration Methods	5
7	Sept. 27	Calibration Methods	5
8	Sept. 29	Spectrophotometry	18
9	Oct. 4	Spectrophotometry	19 & 20
EXAM	Oct. 5	Exam #1: 7:00 – 9:00 PM	EXAM
10	Oct. 6	Advanced Titrations	6
11	Oct. 11	Advanced Titrations	6
12	Oct. 13	Acid-Base Equilibrium	8
13	Oct. 18	Buffers	9
14	Oct. 20	Acid-Base Titrations	10
15	Oct. 25	Polyprotic Acid-Base Equilibrium	11
16	Oct. 27	Polyprotic Acid-Base Titrations	11
17	Nov. 1	Solubility Equilibrium	-
18	Nov. 3	Selective Precipitation	-
19	Nov. 8	Solubility and Activity	12
EXAM	Nov. 9	Exam #2: 7:00 – 9:00 PM	EXAM
20	Nov. 10 ²	Solubility and Activity	12
21	Nov. 15	Coupled Equilibrium	12
22	Nov. 17	Electrochemical Reactions	-
<i>No Class</i>	<i>Nov. 24</i>	<i>Thanksgiving Break</i>	<i>No Class</i>
23	Nov. 29	Electrode Potentials	14
24	Dec. 1	Electrode Measurements	15
25	Dec. 6	Redox Titrations	16
26	Dec. 8	Redox Titrations	16
27	Dec. 13	Separation Methods	22 & 23
28	Dec. 15	Separation Methods	22 & 23
EXAM	Dec. 20	EXAM #3: 10:15 AM – 12:15 PM	EXAM

Notes: ¹The last day to “clear” drop is September 15

²The last day to “W” drop is November 11

Laboratory Schedule

Session	Dates Lab 1	Dates Lab 2	Experiments	Pages in Lab Manual	Due Dates Lab 1	Due Dates Lab 2
1	9/6	9/7	Check-In and Orientation	1 - 20		
2	9/8	9/12	Calibration of Buret and Pipets	39 - 40		
3	9/13	9/14	Calibration of Buret and Pipets	39 - 40		
4	9/15	9/19	Finish Calibrations	39 - 40		
5	9/20	9/21	Sodium Carbonate in Soda Ash	41 - 52	9/29	10/3
6	9/22	9/26	Sodium Carbonate in Soda Ash	41 - 52		
7	9/27	9/28	Nickel in Nickel Oxide	53 - 60	10/6	10/10
8	9/29	10/3	Nickel in Nickel Oxide	53 - 60		
9	10/4	10/5	Manganese in Steel	61 - 80	10/20	10/24
10	10/6	10/10	Manganese in Steel	61 - 80		
11	10/11	10/12	Manganese in Steel	61 - 80		
12	10/13	10/17	Manganese in Steel	61 - 80		
13	10/18	10/19	Vanillin in Vanilla Extract*	81 - 86	11/1	11/2
14	10/20	10/24	Vanillin in Vanilla Extract*	81 - 86		
15	10/25	10/26	Iron in Limestone	87 - 98	11/3	11/7
16	10/27	10/31	Iron in Limestone	87 - 98		
17	11/1	11/2	Mg and Ca in Limestone	87 - 98	11/10	11/14
18	11/3	11/7	Mg and Ca in Limestone	87 - 98		
19	11/8	11/9	Titration of an Acid Mixture	99 - 104	11/17	11/21
20	11/10	11/14	Titration of an Acid Mixture	99 - 104		
21	11/15	11/16	Ethanol by Titration	105 - 112	11/29	11/28
22	11/17	11/21	Ethanol by Titration	105 - 112		
23	11/22	11/23	Ethanol by GC	113 - 118	12/6	12/5
24	11/29	11/28	Ethanol by GC	113 - 118		
25	12/1	11/30	Cu-Zn by Atomic Absorption	119 - 124	12/13	12/12
26	12/6	12/5	Cu-Zn by Atomic Absorption	119 - 124		
27	12/8	12/7	Bleach by Coulometry	125 - 132	12/15	12/14
28	12/13	12/12	Bleach by Coulometry	125 - 132		
29	12/15	12/14	Check-Out**			

*Small group experiment with formal report

**Failure to check out of lab will result in a \$35 charge to your student account

Lab Notebook Grading Rubric

	Item	√	Point Deduction	Page(s)
Do before lab	Updated table of contents			
	Experiment <i>title</i>			
	Experiment <i>purpose</i>			
	Experiment <i>procedure</i>			
	Experiment <i>procedure</i> contains appropriate amount of information			
	<u>Annotated</u> chemical equations			
	Reagents listed along with their <u>purpose</u>			
	Safety/disposal information present for chemical substances			
	Updated page numbers (right hand pages only)			
Do during lab	All data presented in tables with titles, headings, and units			
	Data errors appropriately labeled and footnoted			
	Date and signature present at the top of data page			
	All data entries made in ink			
	All data entries legible			
	No pages removed from notebook			
Do after lab	Sample calculations present and labeled			
	Pertinent calibration curves/chromatograms pasted in notebook*			
	Graph axes labeled and with appropriate units and precision*			
	Conclusions			
	Complete, typed-written report submitted			
	Next lab notebook entry started			
	Points Possible		5.00	
	Total Deduction			
	Points Earned			

*Does not apply to all experiments