CHEM 265 - Quantitative Analysis
Spring 2025

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Lecture: M, W, F 8:00-8:50 am (Roddy 149)
Labs: **A-** Tue 1:10-4:00 pm (Caputo 223)
B- Wed 2:00-4:50 pm (Caputo 223)

Office Hours: Mon 9:00-10:30 am, Wed 9:00-10:30 am, Thu 1:00-2:00 pm, Fri 9:00-10:00 am
* Alternative times can be scheduled by appointment for an in-person or Zoom meeting.

Course Materials:

Lecture

1. Text: Quantitative Chemical Analysis by Daniel C. Harris 10th Edition (Publisher W. H. Freeman), **ISBN: 978-1319164300 (Required).**

2. Scientific Calculator: An inexpensive one is sufficient. It should be capable of doing square roots, logarithms (log, ln), and exponentials (10^x, e^x, y^x).

Lab

3. Lab Manual - no purchase is required: CHEM 265 Quantitative Analysis Manual by Drs. T. Greco/J.K. Mbindyo - (**experiments and other documents will be available on D2L**)

4. Chemistry Laboratory notebook: Perfect Bound - 101 pages – 8 x10 inch / Author: smART bookx, smART, **ISBN: 9781512033663 (Required)**.

5. Safety goggles or industrial **safety glasses** approved by instructor.

6. Regular access of Desire to Learn (D2L) and University e-mail is required.

Course Description/Student Learning Outcomes:

This course is an integrated study of advanced chemical equilibrium, activity, experimental uncertainty and accepted practice in the analytical chemistry laboratory. Titrimetry, potentiometry, extraction theory, introductory spectroscopy and chromatography are discussed. By the end of the course, students should be able to:

(a) Describe and implement the different steps of an analytical process.
(b) Solve calculations involving concentrations, solutions and stoichiometry and apply them in chemical analysis.
(c) Demonstrate the proper technique for using common laboratory equipment.
(d) Identify the sources of experimental error and calculate standard deviations and error from experimental data.
(e) Perform statistical analysis of data including t, F and Grubbs test and normal distribution.
(f) Generate calibration curves and perform calculations involving Beer's law.
(g) Solve chemical equilibrium problems including acid-base and solubility product.
(h) Demonstrate safe laboratory practices.
(i) Discuss different techniques for analytical separations.
(j) Keep a properly documented laboratory notebook.
(k) Prepare well organized reports using experimental data.

Course Policies:

Class Attendance - Policy link: Class Attendance Policy | Millersville University
Students are expected to attend all classes. Students are responsible for all material covered. It is the responsibility of the student to obtain information on the material discussed during class. If you need to be excused for a valid reason (college activities), please see me in advance in order to be allowed to arrange the make-up of any missed assignments. In unexpected cases (illness, death in the family), contact me as soon as possible by e-mail or phone and follow up in person.

Academic Honesty - Policy link: Governance Manual (millersville.edu)
Students are expected to conduct all CHEM 265 work in an honest and ethical manner. Cheating on coursework bypasses the learning process and will **NOT** be tolerated. Anyone caught cheating will be assigned a score of zero on the work. Habitual academic dishonesty will be penalized to the maximum.

Weather Delays and Cancellations – Policy link: Policy on Delays & Cancellations | Millersville University

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Course format:

The course format consists of three 50 minute lectures/discussions per week. Course grades will be based on the completion of assigned worksheets/homework, 3 exams, 1 comprehensive standardized ACS final exam, and the laboratory grade.

Worksheets/Homework

Homework will be graded and is to be worked on, individually or with your study/lab partner. Bouncing a problem off a study/lab partner can greatly help you move towards solving it correctly. Also do not hesitate to stop by my office hours or make appointment to come and see me if you have further questions. It is also advisable to work/practice on any other recommended textbook problems (not collected for grading) given by the instructor.

Exams/Comprehensive ACS Final

Three exams will be given during the semester. Exams will be announced at least a week in advance. Be prepared by going through all the lecture notes and assigned worksheet/homework or suggested textbook problems. **A Comprehensive standardized ACS final exam will be given on Friday, May 9th (2:45-4:45 pm).**

Laboratory

The laboratory grade will come from the completion of all laboratories and the submission of laboratory reports. All labs need to be completed and all lab reports need to be submitted to pass the course. Details about laboratory report grading are given on page 5.

Grading Criteria:	**Points**
Graded Worksheets/Homework	15 %
Exams (3)	45 % (each exam is equally weighted)
Laboratory	25 %
Final ACS Exam **(May 9th – 2:45-4:45 pm)**	15 %
Total for the class	**100 %**

Note: **You have to score at least 60% or higher in the lecture portion in order to count your lab grade towards your overall course grade.**

Grading Scale:

Grade	Percentage
A	92-100
A-	90-91.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	73-76.9
C-	70-72.9
D+	67-69.9
D	63-66.9
D-	60-62.9
F	< 60

Important dates to remember

January 28th: Last day to drop/add a class

April 4th: Last day to withdraw - W grade

May 9th (Friday): Final ACS Exam - 2:45-4:45 pm

Note: Behavior issues (tardiness, excessive talking, cell phone disturbance, leaving early) during lecture and laboratory will be considered when calculating your final grade!!!

Tentative Order of Topics:

1. The Analytical Process, Chemical Measurements, Tools of the Trade – **Chapters:** 0, 1, 2
2. Experimental Error - **Chapter:** 3
3. Statistics - **Chapter:** 4
4. Quality Assurance and Calibration Methods - **Chapter:** 5

Exam I

5. Fundamentals of Spectrophotometry - **Chapter:** 18
6. Chemical Equilibrium - **Chapter:** 6
7. Activity and Systematic Treatment of Equilibrium - **Chapter:** 8
8. Monoprotic Acid-Base Equilibria – **Chapter:** 9

Exam II

9. Let the Titrations Begin, Acid-Base Titrations – **Chapters:** 7, 11
10. Polyprotic Acid-Base Equilibria - **Chapters:** 10
11. Fundamentals of Electrochemistry - **Chapter:** 14

Exam III

12. Electrodes and Potentiometry - **Chapter:** 15
13. Introduction to Analytical Separations, Gas Chromatography, High-Performance Liquid Chromatography - **Chapters:** 23, 24, 25

Possible Chapters to be covered if there is enough time:

14. Redox Titrations - **Chapter:** 16
15. EDTA Titrations - **Chapter:** 12
16. Electroanalytical Techniques, Applications of Spectrophotometry - **Chapters:** 17, 19
17. Spectrophotometers, Atomic Spectroscopy, Mass Spectroscopy, Chromatographic Methods and Capillary Electrophoresis - **Chapters:** 20, 21, 22, 26

Laboratory Schedule and Procedures:

Mastering proper laboratory skills and safety procedures is an important part of this course. You are expected to review in detail the safety procedures described in the lab experiments and the course text and to strictly follow them in the lab. It is important for you to be systematic and thorough. These are traits that will be helpful in your career as a scientist. A good part of your lab grade will be based on the accuracy and reproducibility of your data. It is not easy to achieve this if work is done hastely.

Pre-lab preparation – (prepared by students)

1. Read related materials in the lab experiments/documents and textbook.
2. Read and understand the experiment for the day.
3. In your lab notebook, write down your lab partner's name, the date, title of experiment, purpose and a brief summary of the procedure. Points will be subtracted from the lab grade if these items are missing in the lab notebook. The purpose should be no more than half a page.

Pre-lab lecture (given by instructor)

A pre-lab lecture will be given before each lab covering the major highlights in the experiment and the theoretical background. It will be assumed that you have read and understood the lab in advance. Be aware that some concepts may be introduced through lab exercises then discussed in the lecture later. This is not unusual since the lab exercises are widely varied and they can be used as a learning tool.

During the lab (performed by students)

Work diligently. Observe lab safety policies. For most experiments, you will work as a team, consisting of two or three students. In some labs, two teams may be combined to form a group. Thus, a team is a set of 2 or 3 students that work together throughout the semester while a group consists of two teams combined. Teams are numbered 1,2,3…etc. Groups are numbered A,B,C, etc. Each team member should participate actively in the experiment.
Treat your lab partner(s) with courtesy and respect at all times. Record data in your notebook as you make observations. Follow the guidelines in the "Introduction to Analysis" document posted on D2L about keeping a good laboratory notebook. For each lab, your notebook recordings will be checked by the instructor before you leave the lab. Make sure you clean your lab area and any common areas used, especially balances. Burettes must be returned to the burette rack and filled with dilute HCl or deionized water during the course duration. Burette clamps should be returned to the storage area. Follow the directions given for each experiment about waste disposal.

Lab reports (prepared and submitted by students)

All reports must be typed and handed in 1 week after the experiment is complete, before we begin the next lab session. Lab reports will be in a short format. Present your data in neatly arranged tables and clearly labeled graphs. A significant portion of the lab grade will be on accuracy, precision, and interpretation of your data, including correct calculations. **You will hand in one report per team.** If you wish to write separate reports, then you need to request that from the instructor.

1) The first page of the report should include the title of the experiment, identify the team members who performed the experiment, and the date the experiment was completed.
2) In the second page, you need to include few sentences (no more than half a page) of the lab purpose, a brief summary of the lab procedure, the outcomes/numeric results, your

conclusions/evaluation of your results with possible errors occurred including justification of those errors.

3) Following that, present your data in a table format.
4) Sample calculations should always be included (with correct units and significant figures for numerical values). Those can be typed, or they can be written by hand on a separate page and attached to the report.
5) Graphs, done in Excel, should be also attached to the report when applicable.

Lab Performance and Report Grading Criteria:

Criteria	Variables	pts
Pre-lab & During lab items	**Pre-lab:** title, names, date, lab purpose, a brief summary of the lab procedure **During lab:** demonstrate proper procedures, observe lab safety, record data, keep a tidy work area, exhibit team effort	**10**
Results	Data presentation, format, tables, units, significant figures, graphs	**5**
Data Interpretation	Calculations, units, significant figures, accuracy, reproducibility/precision, overall accomplishment	**6 or 10**
Post-lab questions (when applied)		**4 or 0**
Total per Lab Report		**25**
Total - 10 Lab Reports x 25		**250 pts or 25 %**

Note: All laboratories and lab reports must be completed in order to pass the course!!!

Tentative Laboratory Schedule:

Wk	Dates	Lab No.	Experiments and Background Readings will be posted on D2L
1	1/21, 1/22		**Check-in lab drawers – Safety in the Lab!**
2	1/28, 1/29	1	Calibration of Glassware/ Discussion of Statistics
3	2/4, 2/5	2	Experimental error and uncertainty/Youden plots
4	2/11, 2/12	3	Spectrophotometric determination of iron in vitamin tablets
5	2/18, 2/19	4a	Analysis of Co(II)-Cr(III) mixture
6	2/25, 2/26	4b	Analysis of Co(II)-Cr(III) mixture
7	3/4, 3/5	5a	Potentiometric titrations - HCl
8	**3/11, 3/12**	**Spring Recess-No Labs**	
9	3/18, 3/19	5b	Potentiometric titrations - Soda Ash
Beginning of week 10, labs will be done in groups and rotation. See schedule in table below.			
10	3/25, 3/26	6	Determination of pKa of an indicator
11	4/1, 4/2	7	Vitamin C in commercial tablets
12	4/8, 4/9	8	Atomic Absorption Spectroscopy - Metals
13	4/15, 4/16	9	Analysis of unknown in KHP by titrating against aqueous NaOH
14	4/22, 4/23	10	GC-MS analysis of alcohol mixture
15	**4/29, 4/30**		**Make-up labs/Clean-up/Check-out**
16	**5/6, 5/7**	**Finals' Week – No Labs**	

Group Rotation:

Lab Rotation Schedule:		**Waste Hood**		**Coat Rack**	
Week	**Dates**	**A**	**B**	**C**	**D**
10	3/25, 3/26	6	6	7	7
11	4/1, 4/2	7	7	8	8
12	4/8, 4/9	8	8	9	9
13	4/15, 4/16	10	10	6	6
14	4/22, 4/23	9	9	10	10
15	**4/29, 4/30**	**Make-up labs/Clean-up/Check-out**			
16	**5/6, 5/7**	**Finals' Week – No Labs**			

Note

To pass CHEM 265, you must have a passing grade in the lecture component (at least D-). A Grade of C or better is required to enroll in CHEM 341 for chemistry majors.

Peer Learning Hours/Tutoring:

Chemistry tutoring is primarily available via drop-in Peer Learning Hours. You can just show up to these sessions to work on and get help with chemistry. The schedule is available below and at https://www.millersville.edu/chemistry/tutoring.php

- Tues. 5 – 7 pm in Caputo 211
- Wed. 5 – 7 pm in Caputo 211
- Thur. 5 – 7 pm in Caputo 211

Starting January 28th and continuing through the Spring Semester.

Title IX Statement

Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to comply with the requirements of Title IX of the Education Amendments of 1972 and the University's commitment to offering supportive measures in accordance with the new regulations issued under Title IX, the University requires faculty members to report to the University's Title IX Coordinator incidents of sexual violence shared by students. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. ***Faculty members are obligated to report to the person designated in the University Protection of Minors policy sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred.***