CHEMICAL ANALYSIS | CHEM 225 | FALL SEMESTER 2026

Lectures: Tuesdays 8:00-9:15 am at FB 544
Labs: FB 549: Section 11 Tuesdays, 9:30 am - 1:45 pm
Section 12 Wednesdays, 12:15 - 4:30 pm
Instructor: Dr. Tykhon Zubkov
FB 404 (office) or FB 449 (lab)
E-Mail: use Canvas course inbox or tzubkov@bsu.edu
Office Hours in FB 404: Mondays 4:00-5:00, Tuesdays 4:00-5:00 Other times by appointment
Schedule of labs and lecture topics will be posted in Canvas separately.

COURSE INFORMATION

Course Description
Lecture and intensive laboratory treatment of the theory and practice of representative quantitative chemical measurements, including gravimetry, visual and potentiometric titrations, ion exchange, coulometric and conductometric titrations, and visible spectrophotometry. One and one-half hours of lecture and four and one-half hours of laboratory weekly.
The skills you would learn are used in many typical analytical procedures in commercial laboratories. Chemical analysis experiments assembled in this course provide you with hands-on experience tied to real-life applications.

Prerequisites
CHEM 112

Course Learning Objectives
After successful completion of the course, students will be able to:
- Acquire experimental data using wet chemical and instrumental methods
- Perform statistical validation of experimental data
- Describe the principles of various analytical methods including gravimetry, titrations and redox reactions
- Develop problem-solving techniques to estimate the concentrations of chemical species at equilibria in relation to acid-base chemistry, oxidation-reduction reactions and precipitation reactions
- Describe chemical equilibria and electrochemistry in relation to chemical thermodynamics, and to be able to predict reaction spontaneity from thermodynamic data
- Describe the underlying principles of the measurement by various laboratory techniques with an emphasis on quantitative analysis of data, including statistical and error analysis
- Communicate complex scientific information effectively in writing as evaluated in the lab reports and laboratory notebook.

COURSE MATERIALS

All required course materials can be obtained through the Ball State First Day program. All students are automatically enrolled each semester. Please check your bsu.edu email for information about delivery of physical and digital materials. Students who wish to opt out during the **Fall 2026** semester must do so by **August 30, 2026**. Students who opt out are responsible for obtaining all required course materials on their own through the Ball State Bookstore or another retailer. If you opt out, your digital access will expire shortly after, and you will lose access to publisher-provided course content, online assignments, quizzes, and exams.

Textbook: Open-source books (e.g., Analytical Chemistry by Harvey, 2.1 ed). Alternative textbooks:
Analytical Chemistry, by Christian, Dasgupta, Schug, 7th ed. – on reserve in the Foundational Sciences Library (FB141)
Exploring Chemical Analysis by Harris, 5th ed. – e-book accessible through the Achieve online platform (see below)
Fundamentals of Analytical Chemistry by Skoog, 10th ed. – e-book accessible through the Achieve online platform

Homework platform: Achieve - Essentials for Analytical Chemistry (Macmillan Learning). It is part of the Ball State First Day program. If you opted out of it, you may purchase the access code (1 term) from the campus bookstore using ISBN number: 8220127206167. Enroll the first week using the temporary free grace period. Instructions on Canvas.

iClicker in-class response system: Free when using Achieve homework platform. Download the app onto a smartphone or computer. Instructions on Canvas.

Lab Notebook: Any **bound** notebook (not spiral-bound) for raw data recording. It should be designated specifically to this course and have at least 50 pages, but it does not require duplicate pages (such as carbon copy). All lab reports must be typed and prepared according to the posted "Lab Report Format" document.

Personal Equipment:

- TI-30x series calculator (or equivalent approved by the instructor) for quizzes and exams
- 3 ring binder, recommended for organizing printed course materials
- Safety goggles (that is splash goggles, not shop goggles), required, available at campus area bookstores.
- Lab coat (with long sleeves and covering knees, any color), required, available at campus area bookstores.
- Combination lock (no key-only entries), combination must be given to lab instructor.

Hardware requirements for your personal computer can be found in Computer Recommendations by College. Select College of Sciences and Humanities.

Software installed on your personal computer:

- Microsoft Word and Excel installed on your personal device (not the web-based version). You can either (1) purchase *Microsoft Office* or (2) use a subscription-based *Microsoft Office 365 ProPlus*, which you can use for free as a BSU student (see installation instructions).
  Caution: *Microsoft 365 for the web* is a free version of Microsoft 365 that is used within a web browser. Its Word app may be sufficient for most formatting. However, its Excel app is significantly reduced compared to the desktop version of Excel and could be insufficient for some data processing.
  If your personal computer or other device does not support the desktop version of Excel, you can use Excel in the BSU computer labs associated with libraries.
- PDF viewer/converter: You need a capability to view PDF files and to convert Word documents to PDF. All lab reports, pre-labs, and other possible assignments must be submitted on Canvas as PDF documents. To view PDF files, you can download free *Adobe Acrobat Reader* from Adobe.com. To convert a Word document to PDF, you can use embedded Print-to-PDF option. Both tasks can also be achieved in *Adobe Acrobat*, which you can download as a part of *Adobe Creative Cloud* at no cost as a BSU student (see download instructions).
- For small documents, if you legibly fill them by hand, you can scan them to PDF using various smartphone PDF-maker apps: Notes (on iOS), PDF element (on iOS and Android), Google Drive or CamScanner (on Android), etc.

COURSE FORMAT AND ASSESSMENTS

This course will be a combination of lecture, homework, and laboratory.

1. **In-class polling sessions:** You will participate in iClicker in lecture and receive credit for your answers to make our class time more engaging and to provide you with real-time feedback on how well you are comprehending the course concepts. These polling activities cannot be made up if missed.

2. **Quizzes and Final Exam:** Over the course of the semester, you will have three (3) 25-minute quizzes in lecture scheduled and announced in advance. Quiz questions will follow the announced coverage for each quiz. The final exam is comprehensive. Quizzes and final exam will be based on:
   - Learning objectives (posted on Canvas)
   - Lecture material
   - Lecture activities, homework and reading assignments
   - Practical concepts learned in Lab.

3. **Homework assignments:** You will receive weekly homework assignments in the Achieve platform. If deemed appropriate, you may occasionally receive a paper-based homework. It is your duty to check the assignment due dates on Canvas and attempt to complete on time. Late homework will be not be accepted. (Exceptions to this rule will only be made with official documentation. When this is the case, let me know as soon as possible.)

4. **Laboratory:** The laboratory is a significant portion of this class (50% of your grade). Performing all experiments with adequate accuracy and writing detailed lab reports are critical for your excellence in this course. All lab reports MUST be typed in Microsoft Word and prepared according to the template posted on Canvas. You will submit your completed lab report on Canvas. *TURNITIN IS ACTIVATED FOR THE LAB REPORTS. SIMILARITIES HIGHER THAN 30% WILL RESULT IN A ZERO GRADE FOR THE ASSIGNMENT.* All pre-lab worksheets and lab reports are submitted on Canvas by the posted due dates. Late assignments will be penalized 5% deduction for every 24 hours. (Exceptions to this rule will only be made with official documentation. When this is the case, let me know as soon as possible). *No late pre-labs will be accepted.*

Course Grade Calculation

This is a course about data and data handling. It is your duty to keep a record of all your grades. This syllabus, and every assignment, lab, quiz, etc. should be kept in a folder or a three-ring binder and you should have a running Excel sheet of all scores.

Grading Scale (traditional rounding)

A	100-93%
A-	93-90%
B+	90-87%
B	87-83%
B-	83-80%
C+	80-77%
C	77-73%
C-	73-70%
D+	70-67%
D	67-63%
D-	63-60 %
F	< 60 %

Percent Breakdown (categories will be normalized)

Final Exam	20%
Quizzes	10%
iClicker	5%
Homework	15%
Lab Reports	48%
Lab Notebook	2%
Total Percent	100%

Example with mock numbers:

Final Exam	= 81%	×0.20 =	16.2%
Quizzes	= 83%	×0.10 =	8.3%
iClicker	= 92%	×0.05 =	4.6%
Homework	= 86%	×0.15 =	12.9%
Lab Reports	= 84%	×0.50 =	42.0%
Lab Notebook (several checks)	= 92%	×0.05 =	4.6%
Total			88.6% (B+)

If you are on the border, will I bump your grade to the next bracket? I will give a consideration, if you can answer "yes" to all of the following questions: (1) Have all exams and quizzes been taken? (2) Have all homework assignments and laboratory reports been completed? (3) Have you exhausted all other avenues for earning the credit?

COURSE STATEMENTS AND POLICIES

Attendance Policy

- You are required to attend all lectures and laboratories in this class. I intend to take attendance in every lecture. While I do not assign points for the attendance per se, in-class activities contribute to your course grade. These activities cannot be made up if missed.
- Please contact me in advance if you will have an absence due to a scheduled conflict (for example, school-related activities, religious holy day observations, etc.).
- If you must miss due to illness, helping ill roommate, family emergency, severe weather, or other valid reasons, please contact me by e-mail as soon as you are able.
- I will follow University policies regarding student absences.

Communication Plan

- Please obtain your BSU computer login privileges if you haven't already.
- Canvas Inbox or email (tzubkov@bsu.edu) are the best ways to reach me. Expect a response within 24 hours, or within 48 hours on weekends, but I do my best to respond sooner.
- Call the Chemistry Front Office (285-8060) if you need to reach me while I'm teaching.
- Ask questions in lecture; chances are that others have the same questions.
- Visit my office hours! Or arrange an individual appointment at a different time.
- Give me feedback! If at any time you feel I need to be doing more or less of something, let me know. I strive to make sure you learn as much as you can. You may do this by emailing me, coming to my office, or anonymously putting a note in my mailbox. Make sure you speak up! I can only fix issues that I know about.
- All course materials, assignments, and announcements related to the lecture part will be posted through the Canvas site. It is recommended that you log into your course 3 to 4 times a week and check your official Ball State email account daily to view announcements and prepare for class.

Grading Policy: It is my policy that appropriate evaluation of your academic performance is an integral part of your learning experience. In the absence of mistake, fraud, bad faith or incompetence, I will be the key decision-maker on the assignment of grades. For information concerning grade appeals, consult the University Grade Appeal Policy and Process

Electronics in lecture: The use of cell phones, computers, and other electronic devices during lecture or laboratory is permitted only for class-related purposes. No electronic recording of lectures is permitted.

Laboratory Regulations:

1. The Safety Rules sheet must be read, signed, and returned before ANY lab work will be allowed. Departmental safety rules will be enforced strictly.
2. Material Safety Data Sheets (MSDS Sheets) for all chemicals used in lab are readily available online in room CP 306.
3. **SAFETY GOGGLES AND FACE MASK MUST BE WORN AT ALL TIMES** in the lab—No Exceptions! You will receive 1 warning before being asked to leave.
4. Familiarize yourself with the locations of the safety showers, fire extinguishers, eye wash stations, fire blanket, as well as with the proper method for laboratory evacuation in the event of an emergency. This will be discussed further in the first laboratory period.
5. Proper attire must be worn in the lab. Lab coats as well as clothing that COMPLETELY covers the body from the underarms down must be worn. Shoes must also completely cover the foot. No ankles should be exposed. Long hair should be tied back or tucked into your lab coat.
6. Personal belongings must be stored in the balance rooms, rather than the bench-tops or floor.
7. Drinking and/or eating in the lab is not permitted at any time. If you need a break, wash your hands, and take a break in the hall.
8. Pipets must be filled with pipet filler pumps and from a secondary container. **NO PIPETTING DIRECTLY FROM REAGENT BOTTLES** and **DO NOT PUT REAGENTS BACK INTO STOCK BOTTLES FOR ANY REASON!**
9. All lab desks, reagent shelves, and balances are to be maintained in the state of CLEANLINESS in which you found them on the first day of lab. This will be strictly enforced. The sinks are to be used for washing glassware only. Dispose of waste paper or other solids in waste cans, and broken glass into the designated container.
10. Each lab station will be kept clean throughout the lab period and will be cleaned and wiped down by that student at the conclusion of each lab.
11. You should be very conscious of the environment and should conserve as many chemicals as possible. Take ONLY WHAT YOU NEED, and DO NOT DIP into reagent bottles with spatulas or pipets. You will be made aware of the hazardous materials that you unavoidably have to use for that particular week. Waste jugs will be provided to collect any hazardous materials. Details of their safe use will be given in each lab, and modifications to each lab have been made to lower the quantity used. Pay attention to what you are using and are doing, both for your own health and safety, and that of everyone else in the lab. **ANYONE ACTING UNSAFELY OR**

PERFORMING UNAUTHORIZED PROCEDURES WILL BE ASKED TO LEAVE THE LAB IMMEDIATELY and will receive a zero for that particular lab.

12. Lab drawers are equipped with all of the glassware and equipment needed for the labs. Extra equipment will not be checked out to students. Only broken glassware that is presented as damaged will be replaced/exchanged.
13. All original experimental data must be recorded directly into your lab notebook IN PEN, NOT on loose sheets or scraps of paper. **Lab books will be signed by your Lab Instructor before leaving each week.**
14. Formal lab reports are required for each lab experiment and are due at the start of the next lab period unless otherwise specified by the instructor. See "due dates" above.
15. Each lab is to be read and studied BEFORE each lab period. You must complete the pre-lab sheet prior to entering the lab. **NO LATE PRELABS WILL BE ACCEPTED**. You are expected to understand the experimental steps to be performed. Lab instructor will not be explaining the procedure unless a deviation from the Lab Manual procedure is necessary.
16. Safety procedures will be covered at the beginning of the lab, therefore, **if you are more than 15 minutes late to lab, you will not be allowed to participate.**
17. Labs will begin and end promptly. Be on time and work efficiently. Preparation is key.
18. Concepts learned in the labs can be included on the tests.

Chemical Use and Safety: Students enrolling in this course will be working with a variety of chemicals, some of which could be irritating or hazardous. Proper and accepted good laboratory practice will always be utilized to minimize or eliminate any adverse contact. Individuals are required to wear flat-soled shoes that cover the entire foot (no ballet flats, sandals, flip flops or high heels) and clothes plus lab coat should fully cover your body from shoulders to feet. However, individuals with sensitive medical conditions (including pregnancy) should take precautions such as wearing additional protective garments, delaying enrollment, or not enrolling in this course. Chemical Safety Data Sheets can be searched on Risk and Safety Solutions by logging in with your BSU credentials. Please consult with your instructor and health care professional if you have any concerns.

Academic Misconduct Statement: Academic misconduct will not be tolerated under any circumstances. In all instances of cheating, this professor pursues the harshest penalties available. Please read the Student Academic Ethics Policy and Code of Student Rights and Responsibilities. All work submitted for credit in this course must be your own. You are encouraged to collaborate in the learning process. But on the tests and assignments you will work as individuals. *You are not allowed to confer or converse with any other student, faculty, internet/social media site, or generative AI to seek answers on any material to be graded, unless specifically permitted. Doing so will result in triggering established University procedures regarding academic dishonesty.*

Artificial Intelligence (AI) Usage: You may use AI programs e.g. ChatGPT to practice or study. However, you should note that the material generated by these programs may be inaccurate, incomplete, or otherwise problematic. Beware that use may also stifle your own independent thinking and creativity.
Generative AI must not be used to complete any portion of the assignments. You may not submit any work generated by an AI program as your own. You must cite any AI-generated material that informed your work. Using an AI tool to generate content without proper attribution constitutes a violation of Ball State University's Student Academic Ethics Policy.

Teacher Education Statement: If you are a teaching major, or if you think you will ever decide to be a teaching major, then you should save the required assignments, exams, and laboratories (also known as artifacts) from this course for a teaching portfolio. For more information, check Education Majors.

Freedom of Expression
The world of scientific knowledge is ever evolving.
In this course, we are committed to fostering a learning environment that values intellectual diversity, encourages free expression, and promotes open inquiry. As members of the Ball State Community, we treat each person in the Ball State community with civility, courtesy, compassion, and dignity and respect and learn from differences in people, ideas, and opinions. Please review Ball State University's Statement on Freedom of Expression, the resources on Ball State's Freedom of Expression webpage, and Ball State's Beneficence Pledge.

UNIVERSITY POLICIES

University Statement
We are committed to ensuring that all members of the community are welcome, through valuing the various experiences and worldviews represented at Ball State and among those we serve. We promote a culture of respect and civil discourse.

Disability Services Statement
If you need course adaptations or accommodations because of a disability, please contact the instructor of record as soon as possible. Ball State's Disability Services office coordinates services for students with disabilities; documentation of a disability needs to be on file in that office before any accommodations can be provided. Disability Services can be contacted at 765-285-5293 or dsd@bsu.edu.

Attendance Policy
Faculty are required to establish attendance policies for their courses and ensure that they communicate these policies through their course syllabi. In some cases, faculty may be asked to provide the last date of attendance for a student in association with financial aid requirement. Therefore, faculty should take attendance even if not assigning points for attendance.
Students are expected to review course syllabi regarding absence guidelines and follow those guidelines. Course attendance policies must be consistent with University policy. The University has a number of specific policies regarding student absences that are housed within different areas. Explore Ball State course attendance policies.

The Learning Center offers free Tutoring and Academic Coaching for many courses at Ball State. Students can make appointments for online (Zoom) or in-person (NQ 350) appointments. To make an appointment, visit myballstate.bsu.edu and click on "Navigate" in the Academic Tools section, or just go directly to bsu.navigate.eab.com.
Testing accommodations for students with disabilities are available for students who have received the appropriate documentation from Disability Services. Tests may be administered in the Learning Center.
For more information about Learning Center programming, visit bsu.edu/learningcenter or call 765-285-1006. Follow us on Instagram: BallStateLC.

The Writing Center: All writers improve with practice and feedback, so as a student in this course, you are encouraged to use the Writing Center (in Robert Bell 295 during weekdays, Bracken Library First Floor West in the evenings, or online during any of our regularly scheduled hours) to get additional feedback on your writing. The Writing Center offers free planning, feedback, and accountability sessions (in person and online) to all students composing essays, reports, reflections, research projects, web content, lesson plans, slideshows, poster presentations, resumes, and other digital or print texts. To schedule a free appointment to discuss your writing, go to bsu.edu/writing center. Online and in-person appointments are available; however, plan ahead because appointments book quickly!

The Counselling Center offers free and confidential services to all students. The Counseling Center is located in Lucina Hall, Room 320. To schedule an appointment, you can contact us at 765-285-1736. Ball State also offers a 24/7 Crisis Line, which can be reached at 765-285-HOPE (4673). The Crisis Line is a mental health resource for those who are struggling with any mental health concerns, including thoughts of self-harm and/or suicide. At the Ball State Counseling Center, we see students for a variety of reasons, some of which include homesickness, relationship concerns, anxiety, and depression. At your first appointment, you will work with a therapist to create a plan that will connect you with resources that best fit your needs. We assist students with getting connected to therapy at our Center as well as connecting students to self-help resources, other on-campus resources, and community-based resources. All Ball State students also have access to several on-demand, self-help resources through a variety of different platforms. All these resources, including a direct link to our website, can be found here: https://www.bsu.edu/campuslife/counseling-center

The Basic Needs Hub: If you are having difficulty affording enough food, do not have a safe and reliable place to sleep, and/or experiencing an emergency or crisis, help is available through the Basic Needs Hub. The Basic Needs Hub has information, resources, and provides individualized support to students. To talk with a supportive staff member about your experience, receive one on one assistance, or learn more about resources, you can submit a Basic Needs Assistance Form.