Meets (4 cr) *Lecture:* MWF 9:10 –10:10 (HS–212). *Lab:* M 1:50–5:10 (HS–428).

Instructor Dr. Gutow Office: HS–412 Phone: 424–1326 E-mail: gutow@uwosh.edu
Web: https://cms.gutow.uwosh.edu/Gutow
Office Hours: MWF 10:15 –11:15, T 10 – 11, Th 12:15 – 1:15 *or by appointment.*

Required Texts and Supplies

Readings will be from the LibreText Physical Chemistry Library (links provide with specific assignments), plus additional instructor provided material as necessary.

Gutow, *Chem 371 Lab Manual Fall 2025.*

Bound duplicating lab notebook; calculator; safety goggles.

Course Description: This course follows the combined Biophysical and Physical Chemistry 1 course taught last semester. This semester we will be returning to many topics from Chem 370 to add additional depth. Some topics usually covered in Chem 371 were already covered in last semester. The added depth will replace the topics already covered.

Chem 371 (from bulletin): A continuation of Chemistry 370. Lecture topics include quantum chemistry, atomic and molecular spectra, and chemical kinetics. Laboratory includes experiments that are designed to illustrate the lecture material. Prerequisites: Mathematics 273, Chemistry 311, and Chemistry 370.

Course Overview: This semester we will learn some more advanced applications of thermodynamics and phase diagrams. We will see how the results of quantum mechanics can be used via statistical mechanics to predict macroscopic properties. We will extend our understanding of quantum mechanics and apply quantum mechanics to the detailed explanation of molecular spectra and how lasers work. Statistical mechanics will also be used to develop more detailed models of intermolecular collisions, plus photochemical and catalyzed reactions. We will also take a more detailed look at stochastic methods for modeling chemical kinetics.

After taking this course you should be able to:

- describe the structure and composition of matter;
- apply theoretical and mechanistic principles to the study of chemical systems employing both qualitative and quantitative approaches;
- use theories of microscopic properties to explain macroscopic behavior;
- explain the role of energy in determining the structure and reactivity of molecules;
- use mathematical representations of physical phenomena;
- extract information from resources such as books, the web and databases.

The anticipated schedule of topics is provided in the last section of this syllabus.

Reading Assignments and Homework *will have parts due at the beginning of most class meetings*. Assignments will not be accepted late, but some of your lowest scores will be dropped.

You are encouraged to discuss the homework with your classmates, but copying answers will not provide sufficient practice for exams. You need to study the material so that ultimately you can answer the questions independently. If you get stuck, ask the professor for help!

Reading assignments will come primarily from the LibreText website. Other sources will be used as necessary.

Homework will be *due for most class meetings* and consist of up to three sections. The first two sections will focus on material we will be discussing during the class meeting for which the assignment is completed.

Critical Thinking Exercises/Discussion Questions: The questions are designed to help you learn how to use the text and other reference sources to prepare for class. For example, you might be asked to find definitions, compare two models and explain when it is appropriate to use each or work through some 'what if' calculations. These will be graded as full credit for *honest effort* even if incorrect. Make sure to show work.

Practice Exercises: The goal is to help you figure out what you need to ask about in class. These will be graded as full credit for *honest effort* even if incorrect. Make sure to show work.

Problems: These problems will be a little more challenging and based on material discussed in previous class meetings. Partial credit will be given on problems. To receive full credit you must show your work and get the correct result.

In Class Exercises will typically be worksheets/group exercises. You will receive 100% credit for putting in *honest effort* on the exercise during class.

Exams: There will be three one hour in class exams (see schedule), worth 200 points each (plus 20 points of extra credit distributed throughout the exam). The material requires that exams be cumulative, but primary emphasis will be on the material covered since the previous exam. The goal of this course is not to memorize formulas, but to learn how to use models to make predictions. You will be provided with an equation sheet for each exam consisting of the fundamental equations of each model. Additionally, you will be allowed to bring a 3" x 5" card of ***handwritten*** notes to the exam.

Lab will concentrate on making measurements related to the topics covered in the class and analyzing the data using the quantitative models discussed during the semester. Laboratory will provide opportunities to assess your chemical knowledge and document your ability to:

- read and follow experimental protocols;
- properly set up and safely manipulate laboratory equipment;
- plan and execute experiments, including the use of the chemical literature;
- maintain accurate records of experimental work;
- perform error propagation and assess reliability of results;

- prepare effective written scientific reports;
- use mathematical representations of physical phenomena;
- use and understand modern instrumentation;
- use computers for chemical applications;
- retrieve specific information from the chemical literature;
- work cooperatively in problem solving situations.

The experiments this semester will cover: thermodynamic measurements (calorimetry); non-ideal gases (vacuum line); spectroscopy (rovibrational, lasers and fluorescence); quantum calculations; surface science (quartz crystal microbalance). See the last section for a more detailed schedule.

The detailed laboratory schedule and grading specifications are included in the lab manual. In addition to in lab performance you will be evaluated on (see the lab manual for details):

- *Laboratory Notebooks*: These will include pre-lab, during the experiment and analysis notes.
- *Lab Reports*: You will be preparing formal reports, a posters, a web poster, and an oral report. You will have a chance to rewrite some of these to improve your grade.
- *Peer Reviews*: You will get credit for reviewing some of your peers' work in a timely manner so that your input can be used by your peers to rewrite their work.
- *SciFinder Searches*: You will do a number of literature searches to find articles related to the experiments you do.
- *Final Lab Quiz*: This will focus on your understanding of concepts from lab, and some simple data analysis including error propagation.

Grading:

Homework & group exercises:	25%
Exams:	50%
Lab:	25%

Course Attendance Policy: Students are expected to attend every scheduled class meeting. If you miss a lecture you should get class notes from a classmate or the professor. You are responsible for informing your instructor of absences and making arrangements to make up any missed work.

Additional Resources:

Web: Class content and useful links will be in the course CANVAS site: https://uwosh.instructure.com/courses/796007. A public class website with limited content (syllabus and some links) is at: https://cms.gutow.uwosh.edu/Gutow/classes/current-classes/physical-chemistry-2.

Computer aides to help with p-chem problem solving: In this class you are encouraged to use computer assistance for algebra, calculus and numerical computations. There are lots of options (e.g. Maple™, MathCAD™, Mathematica™, SageMath, and others), but the *Python* programming language plus a web interface called *Jupyter* has recently been widely adopted for scientific computing and mathematics, so we will learn to use that. The software is available on a server at:

https://math.gutow.uwosh.edu. You will be provided with server log-in information during class. This software is open-source and can also be installed on your own computer. Dr. Gutow will provide instructions for installation.

University Policies:

It is the policy and practice of UW Oshkosh to create an inclusive learning environment. If there are aspects of the instruction or design of this course that result in barriers to your inclusion, please notify me as soon as possible. For more information about **accommodations**, visit the Dean of Students Office's Accessibility Center (https://www.uwosh.edu/cadr/).

The University of Wisconsin Oshkosh is built upon a strong foundation of integrity, respect, and trust. All members of the university community have a responsibility to be honest and the right to expect honesty from others. Any form of academic misconduct is unacceptable to our community and will not be tolerated. See the Dean of Students Office's Academic Misconduct site for more information (https://www.uwosh.edu/deanofstudents/student-conduct/academic-misconduct/).

Students are advised to see the following URL for disclosures about essential consumer protection items required by the Students Right to Know Act of 1990: https://uwosh.edu/financialaid/consumer-information/.

Approximate Course Schedule
Tentative Lecture Schedule F25:

Topic	**Lectures**
I. Thermodynamics and Statistical Mechanics	
Thermo fundamentals and useful measurables	9/3, 9/5
Gas behavior and phase diagrams	9/8, 9/10, 9/11
Statistical Mechanics	9/15, 9/17, 9/19, 9/22, 9/24, 9/26, 9/29
Wrap-up/Review	10/1
Exam 1 (Unit I)	Friday, October 3
II. Quantum, Spectroscopy and Lasers	
Quantum	10/6, 10/8, 10/10, 10/13
Spectroscopy	10/15, 10/17, 10/20, 10/22, 10/24
Lasers	10/27, 10/29
Wrap-up/Review	10/31
Exam 2 (Unit II)	Monday, November 3
III. Molecular Interactions, Transport and Kinetics	
Behavior of Gases	11/5, 11/7, 11/10
Molecular Dynamics and Chain Reactions	11/12, 11/14
Surfaces and Catalysis	11/17, 11/19, 11/21
Photochemistry	11/24, Thanksgiving, 12/1, 12/3
Stochastic Kinetic Modeling	12/5, 12/8
Wrap-up/Review	12/10
Exam 3 (Unit III)	Friday, December 12

Tentative Lab Schedule F25:

Week of	In Class	Complete before Class (how turned in)
9/1	No Lab (classes start 9/3)	
9/8	Checkin Bomb Calorimetry	☐ Pre-lab Bomb Calorimetry (turn in duplicate pages from notebook at beginning of class).
9/15	Bomb Calorimetry Analysis	☐ SciFinder Search Bomb Calorimetry (online).
9/22	Non-Ideal Gases	☐ Formal Report on Bomb Calorimetry (online). ☐ Pre-lab Non-ideal Gases (duplicate pages).
9/29	Non-Ideal Gases Analysis	☐ Review of peer's Bomb Calorimetry (online). ☐ SciFinder Search Non-Ideal Gases (online).
10/6	Quantum Worksheets	☐ Formal Report on Non-Ideal Gases (online). ☐ Pre-lab Rovibrational Spectroscopy (duplicate pages).
10/13	Rovibrational Spectroscopy	☐ Review of peer's Non-Ideal Gases (online). ☐ Rewrite of Bomb Calorimetry (online). ☐ Pre-lab Rovibrational Spectroscopy (duplicate pages).
10/20	Rovibrational Spectroscopy Analysis	☐ SciFinder Search Rovibrational Spectroscopy (online). ☐ SciFinder Search Rovibrational Spectroscopy (online). ☐ Rewrite of Non-Ideal Gases (online).
10/27	Lasers and Spectroscopy Part 1 – Learn about lasers and spectrometer parts. Part 2 – Design procedure to measure fluorescence of carbon dots.	☐ Pre-lab Lasers, Spectroscopy and Carbon Dots (duplicate pages). ☐ Formal Report on Rovibrational Spectroscopy (online, no option to rewrite).
11/3	fluorescence measurements Analysis of measurements	☐ SciFinder Search, Lasers, Spectroscopy and Carbon Dots (online).
11/10	Quantum computations of potential energy surfaces. Begin designing web presentation	☐ Pre-lab Quantum of potential energy surfaces. (duplicate pages). ☐ Poster on Lasers, Spectroscopy and Carbon Dots (online).
11/17	Complete building of web presentation.	☐ SciFinder Search Quantum (online).
11/24	QCM experiment	☐ Pre-lab QCM (duplicate pages). ☐ Web Poster on Quantum
12/1	QCM analysis	☐ SciFinder Search QCM (online).
12/8	Lab cleanup. Oral report. Lab quiz.	☐ Prepare for lab quiz ☐ Oral Report Slides (online).