Syllabus (Fall 2019)
Chemistry 562: Physical Chemistry II

The policies and regulations contained in this syllabus are subject to change at any point. Such changes will be announced in class and/or posted on the course website. The syllabus has been compiled to be as complete as possible but is by no means a binding document.

General Info
Instructor: Prof. Jörg C. Woehl
Office: Chemistry Building (CHM), Room 343
Office hours: Open door
Email: woehl@uwm.edu
Phone: 414-229-5223

Class Meeting Times: Monday, Wednesday, and Friday, 9:00-9:50 am
Class Location: CHM 197
Discussion Group: Friday, 1:00-1:50 pm in CHM 193
Teaching Assistant: Quintus Owen (qowen@uwm.edu)
TA Office hours: Wednesday, 1:00-2:00 pm in CHM 218
First Day of Class: Wednesday, September 4
Last Day of Class: Wednesday, December 11
Midterm 1 (in-class): Monday, October 14, 9:00-9:50 am
Midterm 2 (take-home): Monday, November 11; due following Monday at 9:00 am
Final Exam: Monday, December 16, 10:00-12:00 noon (CHM 197)

Course Objectives
This lecture course covers quantum mechanics (as it applies to the chemical sciences), chemical kinetics, and statistical mechanics (thermodynamics). In contrast to “Physical Chemistry I” (Chem-561), the approach we take in this course is purely microscopic. Starting with electrons and nuclei, we will arrive at a quantum-mechanical description of the atom, and use the same approach to understand chemical bonding, reactions, and thermodynamic properties.

Individual Particles
Quantum mechanics is used to describe the motion of microscopic particles, and we will introduce the concepts using the historical evolution of quantum theory. The ideas will be tested by looking at the radiation (light) emitted by atoms and molecules (spectroscopy), focusing on vibrational and rotational motion. The energies of electrons and the spectroscopy of the hydrogen atom will be discussed, followed by an examination of atoms with several electrons and the effect of magnetic fields on the energies of the atoms (Zeeman effect).
Chemical Bonding
The ideas of quantum mechanics will be extended to chemical bonding. Simple models that explain the formation of chemical bonds will be discussed.

Treatment of Collections of Molecules
Since chemical reactions are generally carried out with large numbers of atoms or molecules (~$10^{23}$) we will use a statistical approach to examine their properties. This will include a discussion of probability distributions (Boltzmann distribution function). We will use these ideas to calculate thermodynamic functions (internal energy, entropy) and introduce the idea of the Partition Function ($Z$). This will be calculated for a number of systems and we will discuss the ways in which this is applied, in particular, to the calculation of equilibrium constants and its application to chemistry.

Required Textbook

Recommended, but optional:

Supplemental Textbooks

Course Prerequisites
“Chemistry 562: Physical Chemistry II” (Chem-562) requires junior standing and a grade of C or better in Chem-561 (“Physical Chemistry I”). If you do not have the proper prerequisites, you need to obtain my consent to take this course. The prerequisite course Chem-561 may not be taken for credit subsequent to the earning of credit in Chem-562!
In order for you to be successful in this course you will need to be at ease with (elementary and linear) algebra, differential and integral calculus. If you are not
sufficiently familiar with these topics, you should consider taking Chem-562 at a later
time, once you have acquired these skills.

Lectures
You are expected to attend all lectures and discussion groups. There is generally a
strong correlation between students who receive good grades and those who attend
class and discussion groups on a regular basis. Please contact me (preferably by email)
if you are unable to attend a class or discussion group.
Before attending a lecture, you should prepare the material by reading the
corresponding textbook sections so that you can follow the presentation more easily
and ask questions about topics that you have not (or not fully) understood. Also, work
through the example problems scattered throughout the text; then, try to solve them on
your own. Working problems is the best way to learn and check your comprehension of
the material. We will work on problem solving during the discussion sections. I will
sometimes suggest a number of simpler practice problems on the course website.

Course Website
Canvas: uwm.edu/canvas/. For information on how to use Canvas, please visit
uwm.edu/canvas/students/.
Course material will be made available on Canvas. It is expected that you visit the
course website regularly as important information and announcements may be posted
there as well.

Problem Sets
Problems illustrating the use and application of the theory will be discussed during
discussion sections. Homework problems will be assigned on a weekly basis and
collected during class one week later. Some problems will be graded and returned
(typically one week later) and discussed during discussion section. You may work on
homework problem sets either on your own or in groups with other students; I highly
recommend working in groups as it allows you to discuss the topics with others and to
formulate strategies for problem solving, thus reinforcing your understanding of the
material.

Grading
The course will be graded based on problem sets and examinations as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework Problems</td>
<td>20%</td>
</tr>
<tr>
<td>Midterm 1 (in-class)</td>
<td>25%</td>
</tr>
<tr>
<td>Midterm 2 (take-home)</td>
<td>25%</td>
</tr>
<tr>
<td>Final Exam (in-class)</td>
<td>30%</td>
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<tr>
<td>Total</td>
<td>100%</td>
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*Midterm 1* is an in-class exam and will be held during regular lecture time. Only a
calculator (programmable or non-programmable) and a single sheet of paper with
handwritten notes (recto-verso) are allowed. No books or other material are admitted.
If you know that you will miss Midterm 1, please contact me as soon as possible (preferably by email). If you are missing Midterm 1 for a valid and justifiable reason, I will make arrangements so that you can take a make-up exam within one week after the scheduled date. If you miss Midterm 1 without justified excuse, you are not eligible for taking a make-up exam.

*Midterm 2* is a take-home exam and will be handed out and posted to Canvas after the lecture. The midterm will cover all topics discussed in class and problem sets in a format similar to the problem sets. No class will be held on Wednesday during midterm week. **No time extensions or make-up exam will be given for the take-home midterm.** If you are unable to turn it in during class, you may upload it to the Canvas dropbox.

The *Final Exam* is comprehensive. Again, only a calculator (programmable or non-programmable) and a single sheet of paper with handwritten notes (recto-verso) are allowed. No books or other material are admitted. If you are unable to take or complete the final exam due to illness or other unusual and substantiated cause beyond your control, an incomplete (“I”) will be given *if you can provide proof for such cause.* According to UWM policy, a course marked incomplete must be completed (in this case by taking a make-up final exam) during the next succeeding semester, excluding summer sessions and UWinterim; otherwise, the grade of “I” will lapse to “F”.

**Tentative Schedule**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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<tbody>
<tr>
<td>1</td>
<td>Sep 4 - Sep 8 Historic Experiments leading to Development of Quantum Mechanics</td>
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<tr>
<td>2</td>
<td>Sep 9 - Sep 15 Schrödinger Equation</td>
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<tr>
<td>3</td>
<td>Sep 16 - Sep 22 Applications of Schrödinger Equation: Particle-in-a-box Harmonic Oscillator</td>
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<tr>
<td>4</td>
<td>Sep 23 - Sep 29 Applications of Schrödinger Equation: Harmonic Oscillator Rigid Rotor</td>
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<td>Sep 30 Last day to drop full-term courses without “W” on record</td>
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<tr>
<td>5</td>
<td>Sep 30 - Oct 6 Formalism of Quantum Mechanics</td>
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<tr>
<td>6</td>
<td>Oct 7 - Oct 13 Applications of Schrödinger Equation: Hydrogen Atom</td>
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Workload
Besides attending lectures and discussion groups, you should expect to take at least 50 hours over the course of the semester reading the textbook and lecture notes and solving homework and example problems to double-check your comprehension of the material.
Weekly homework problem sets and practice problems will be given, which will take you at least 5 hours each although the exact amount of time will vary by student and by week and will depend largely on your mathematical background.
You should reserve at least 10 hours to study for and take the final exam.
All told, this class is likely to take about 150 hours of your time.
This workload is only an estimate and will vary from student to student. Also, it should be understood that you are assessed on your performance, not on the time put into the course.
Policies
If you will need accommodations in order to meet any of the requirements of this course, please contact me and the UWM Accessibility Resource Center (ARC) as soon as possible. Special accommodations for students with disabilities can be provided, but their timely implementation can only be insured if the ARC is contacted ahead of time. For details see uwm.edu/arc/getting-started/.
Department of Chemistry and Biochemistry policies are posted on bulletin boards in the department.
UWM policies related to students with disabilities, religious observances, students called to active military duty, incompletes, discriminatory conduct, academic misconduct, complaint procedures, grade appeal procedures, and final examination requirements can be consulted at uwm.edu/secu/syllabus-links/.

Academic Misconduct
Cheating on an exam or other graded material will automatically result in a grade of zero (as a minimum consequence); failure in the course and referral to the Dean may also occur. Academic dishonesty in any form will not be tolerated.

“Academic misconduct is an act in which a student seeks to claim credit for the work or efforts of another without authorization or citation, uses unauthorized materials or fabricated data in any academic exercise, forges or falsifies academic documents or records, intentionally impedes or damages the academic work of others, engages in conduct aimed at making false representation of a student's academic performance, or assists other students in any of these acts.”

“Prohibited conduct includes cheating on an examination; collaborating with others in work to be presented, contrary to the stated rules of the course; submitting a paper or assignment as one's own work when a part or all of the paper or assignment is the work of another; submitting a paper or assignment that contains ideas or research of others without appropriately identifying the sources of those ideas; stealing examinations or course materials; submitting, if contrary to the rules of a course, work previously presented in another course; tampering with the laboratory experiment or computer program of another student; knowingly and intentionally assisting another student in any of the above, including assistance in an arrangement whereby any work, classroom performance, examination or other activity is submitted or performed by a person other than the student under whose name the work is submitted or performed.”

(From: Office of the Provost and Vice Chancellor)