Chem-UA 127 Advanced General Chemistry I

Semester: Fall, 2016

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Course Information

This dry but (hopefully) useful handout contains basic information about the course, how it will be run, when and where things will happen, grading policy, etc. Barring unforeseeable disasters or administrative whims (giving rise to remarkably predictable disasters), this information should not change. However, I will keep you informed should any changes occur.

Basic Information

This is the first semester of Advanced General Chemistry, CHEM-UA 127. It is assumed that you have passed the entrance examination for the course or have special permission to be enrolled. If neither of these is the case, see me or Carol Hollingsworth in the Chemistry Department on the 10th floor of Silver.

The text for the course is Oxtoby, Gillis, and Butler, Principles of Modern Chemistry, Eighth Edition. This book is required. A less technical overview of what we will be discussing this term can be found in the lighter but still fun recommended book Absolutely Small by Michael D. Fayer.

Lectures are scheduled to meet from 8:00 am to 9:15 am on Mondays and Wednesdays in room C14 of the 25 West 4th Street building. Please note that I did not select this time for our lecture period. Rather it is what CAS assigned for this class. As I am sure you can imagine, this is far worse for me, being the one who has to be alert and in information delivery mode, than for you who can sit passively half awake, trying to absorb the information.

In addition to the lecture periods, all students must sign up for the Friday recitation section, which will be held at 9:30 to 10:45 am in room 369 Waverly and the laboratory, which is held from 2:30 pm to 6:45 pm in Brown 455.

Midterm exam dates: Midterm exam dates are scheduled for Friday, October 21 and Friday, November 18, both from 2:00 pm to 4:00 pm. Locations will be announced when they are known.

Final exam date: The final exam is scheduled for Friday, December 23 at 8:00 am. Location will be announced. I realize that this is just about the worst possible day and time for the final, it being the last day of the fall semester. Unfortunately, since final exam dates are set by a central office at NYU, there is nothing I can do about it. Anyway, you may find solace in the fact that once you are finished with the exam, my task of grading it and figuring out everybody’s final grade for the course will just be starting. Also note that the lab final will take place on Tuesday, December 20 at 12:00 pm.

Course content and math/physics background

The course will cover chapters 1-7 and 19-21, and 23 of the text (see attached course schedule). Thus, we will cover the basic postulates of chemical reactions, the classical theory of chemical bonding, quantum theory and its applications to atomic and molecular structure, bonding in organic molecules, nuclear chemistry,
interaction of light and matter, structure and bonding in solids, and soft condensed matter. As you look through the book, you will discover that the book assumes you have a basic knowledge of vectors, calculus, and functions of several variables. It is assumed that you either have previously encountered these topics. If you have not, you should speak to me as soon as possible. Calculus, vectors, and functions of several variables will be used in lecture, especially where it helps to see how something is derived, and you are likely to see these things on exams and in homework assignments. Math is an integral (no pun intended) part of science and will, therefore, figure prominently in the course. You will find, if you should go on in science or any other technical field, that facility in math will give you a competitive edge and make new opportunities available.

It is also assumed that you have some prior knowledge of basic physics. Since much of the material we will cover this semester constitutes an introduction to physical chemistry, we will pay particular attention to the physical principles that underly many of the chemical concepts we will discuss. This interdisciplinary approach will introduce you to a trend that is becoming more and more prevalent in science, namely, that the boundaries between the traditional disciplines, e.g. physics, chemistry and biology, are becoming blurred as researchers refocus their efforts in fields such as materials design, nanoscience, rational drug design, proteomics, etc. which require knowledge of several of the traditional disciplines.

In light of the preceding, I want to make clear at the outset that the material in the book is a subset of the material to be covered in the course. This means that we will cover material in class that you will not find in the book. Supplementary topics are intended to give you a more modern perspective. Much of this supplementary material will come from current research and has been selected to clue you in to some of the most recent exciting discoveries and newest methods in modern chemistry.

My coordinates, office hours, and all that

My office is located in Room 1166E Waverly. I will hold regularly scheduled office hours each week at a time to be agreed upon by the class based on availability. During scheduled office hours, you are welcome to show up whenever you like. If you cannot make it to office hours or need to see me at another time for some reason, I will be happy to set up an appointment with you, where I can give you my undivided attention. I am often in my office and generally like to maintain an open-door policy. You should not feel intimidated about coming during office hours, and I do not mind if you drop by outside of office hours. I enjoy interacting with new students and want to get to know you better. However, just keep in mind that outside of office hours, there is a good chance that I will not be immediately available and that you might have to wait to have your question answered. Apart from teaching this class and a graduate class this semester, I am also running a full-time research group and have numerous research projects of my own, serve on several university and external committees, and am affiliated with NYU Shanghai. Thus, you will often find me talking with one of my graduate students or postdocs, analyzing data myself, preparing a grant proposal, writing a paper, or dealing with some administrative problem. This does not mean that I do not take teaching seriously, but we professors lead active lives. In fact, part of what makes research-active professors effective teachers is the emphasis they place on research.

You can always reach me by e-mail if you need to. I will be happy to answer your questions or set up appointments this way. If I don’t respond to your e-mail right away, it either means that I am out of town (which is often the case) or simply unable to respond to your inquiry at that moment. Be patient! I will get back to you as soon as I am able do to so.

There is a web page for the course. The URL is:

http://www.nyu.edu/classes/tuckerman/adv.chem

Lecture notes are posted there as well as homework assignments, this introductory material and the course schedule. Later, you will be able to download previous exams for the course from the site. We will also make user of nyuclasses for other useful functionality it can provide.
Grading

This is an *advanced* course. This means that the material covered and the homework are more challenging than the regular course. However, as honors students, I am assuming that you are up to such a challenge. The main thing I want to see is that you are thinking about the material and trying to solve the homework problems (see below). The course may not come easily to you. However, keep in mind that I will grade on the expectation that you are an A/A- student. This does not mean that you will receive such a grade. But there are no grade quotas, so in principle, everyone can earn an A.

The grading will be as follows: The midterms will count for 20% each, the final for another 20%, quizzes, 15% and homework 25%. Yes, you read that correctly: Homework, at least part of it (see below), will be graded and count for a full one-quarter of your grade. Why is this? It is to encourage you to do the homework. Science and math courses cannot be taken as “spectator sports.” The only way to learn the material is to solve problems.

As I said above, you are bright students. This means that more is expected of you and that you can meet larger challenges. The course moves quickly and covers a lot of material in a short period of time. Thus, *expect to work much harder than you ever did in high school!* If you do, you are likely to do well. If you don’t, you will find yourself quickly falling behind the rest of the class.

If you do find yourself falling behind, or having trouble with a homework assignment, exam, or quiz, contact me as soon as possible. Although I will already know that you are having trouble, the onus is on you to do something about it. I will do everything I can to help you catch up, address specific issues, or clear up any misunderstandings.

Homework and quizzes

Homework will be divided into two parts. For each chapter, I will assign a small number of problems from the book. These should be regarded as practice problems, by which you can gauge how well you have understood the basic concepts covered in that chapter. Although you will be required to turn these in, they will not be graded. I will simply check to see that you have done them. In total, these practice problems will count for 5% of the 25% homework grade. This means that you will receive full credit simply for doing them.

Then, for each chapter, there will be a separate set of typically 3-5 problems designed to make you think more deeply about the material and to stretch you beyond just the basic concepts. These must also be turned in and will be graded. In total, these separate problem sets will count for the remaining 20% of the 25% homework grade. I encourage you to work together on these more difficult problems. Form study groups and discuss the problems together. Even if you feel that you have mastered the problems, you will benefit by having to explaining your ideas and your solutions to others. Working in groups, however, should not be a substitute for thinking about the problems independently, and everyone is expected to turn in their own work. Copying someone else’s work is not only plagiarism (see below) but will only hurt you when you are finally asked to demonstrate your problem-solving skills on exams. After the problem sets have been turned in, I will post the solutions on the bulletin board across from Room 1001R Silver. Problem sets will generally be given out on Thursdays and due one week later at lecture, but, I will specify the due date with each assignment. Late problem sets will be graded down 1 full letter grade per week overdue unless a valid, documented excuse is presented.

According to this schedule, recitations will focus on going over the problem set just handed in.

There will be roughly one quiz per week, given either in recitation or at the beginning of the lecture period. They may be less frequent than this. In any case, they will be announced one or two days before they are given. Quizzes will be of a more straightforward nature, on the level of the practice problems, mainly so that I can monitor your basic mastery of the material.
Lecture/recitation attendance, missed exams, and other unpleasantries

Although attendance will not be taken at lectures or recitations, by not attending, you run the risk of missing possible quizzes, important announcements, homework assignments and other mundane but essential things. You also run the risk of missing something interesting. Lectures will not simply be recapitulations of the book. Remember that the book is only a subset of the course material. In addition, I look at things quite differently from the authors and will present an alternative perspective as well as supplementary material. Also, numerous visual demonstrations based on computer simulations from actual research problems will be presented. Therefore, I encourage you to attend both lectures and recitation sections.

On a more grim note, there is no makeup for the midterm exams. Students who miss a midterm for a valid, documented reason will have the exam dropped from their final grade, while the second midterm will count for 40%. Students who miss a midterm and who do not have a valid, documented excuse will receive a 0 for the midterm, and this will be averaged into your final grade for the class. Standard CAS policy is to allow a makeup final exam for students with documented proof of serious illness. Students who manage to miss both midterms and the final will fail the course. Under certain very limited circumstances, I will allow quizzes to be made up. Again, a valid, documented excuse must be presented. A quiz can only be made up within 1 week of the original date of the quiz. Students who fail to make up a quiz within this time frame but who nevertheless have a valid excuse will simply have that quiz dropped from their final grade. In all other cases, students will receive a 0 for the missed quiz.

If you experience medical problems during the term or if, for some other valid reason, must miss a number of lectures, please come and talk to me as soon as you can. Often something can be worked out.

Cheating

Cheating is a SERIOUS issue. This includes any form of plagiarism, copying, or collusion during quizzes, the midterm or the final. Anyone caught cheating will be severely punished. It is your responsibility to avoid any hint of cheating.

It is an unfortunate fact that students cheat in college and sometimes get away with it. This department is particularly adept at catching cheaters. If you are caught cheating, you can expect:

1. an F in the course,
2. to be brought up on charges before the Dean of the College,
3. possibly to be thrown out of school with a notation on your record as to why.

In case you do not fully comprehend what this means, a notation on your record means no medical school, no graduate school and, quite possibly, severe difficulties finding a job.

Reread the above before you consider cheating.

You are all excellent students who have no need to cheat. You can do the work on your own, and if you find you are having difficulties, come talk to me. If you feel that you cannot do that, go to the Student Services section of the CAS Dean’s Office on the 9th floor of Main.

Getting the most out of the course

Work together! It is quite possible to do very well on your own, but collaborative efforts often make greater breakthroughs. Not only can you learn from someone else and how they think about the material, but also answering someone’s questions helps you arrange the material logically on your own mind. Come to lectures, and keep in mind that the TA and I are here to help you learn. Clearly, we cannot do this for you, but we can make it easier. Work hard and come talk to us when you need. Ultimately, we want everyone to do very well, enjoy the course, and get something out of it, for then we know that we have done our job.
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Syllabus

Week 1: September 7
Introduction and origins of atoms and molecules

Week 2: September 12, 14

Chapter 1: The nature and conceptual basis of modern chemistry.
Chapter 2: Chemical formulae, algebraic balancing and reaction yields.
Problem set 1 given out on 9/14.
Quiz 1 given at recitation.

Week 3: September 19, 21

Chapter 3: The classical theory of chemical bonding – energetics and bond classification
Problem set 1 due on 9/21.
Problem set 2 given out on 9/21.
Quiz 2 given at recitation.

Week 4: September 26, 28

Chapter 3: The Lewis model.
Chapter 4: Introduction to quantum theory – failures of classical physics.
Problem set 2 due on 9/28.
Problem set 3 given out on 9/28.
Quiz 3 given at recitation.

Week 5: October 3, 5

Chapter 4: Introduction to quantum theory – the Schrödinger equation and its interpretation; particle-in-a-box model.
Problem set 3 due on 10/5
Problem set 4 given out on 10/5.
Quiz 4 given at recitation.
**Week 6**: October 12 (no class on Monday, October 10)

**Chapter 5**: Quantum theory of atomic structure – the hydrogen atom.
- Problem set 4 due on 10/12
- Problem set 5 given out on 10/12.
- Quiz 5 given at recitation.

**Week 7**: October 17, 19

**Chapter 5**: Quantum theory of atomic structure – hydrogenic orbitals; approximations for multi-electron atoms.
**Chapter 6**: Quantum theory of molecular structure – the Born-Oppenheimer approximation; exact solution for $\text{H}_2^+$
- Problem set 5 due on 10/17
- **Midterm 1** on 10/21.

**Week 8**: October 24, 26

**Chapter 6**: Quantum theory of molecular structure – linear combination of atomic orbitals; bonding in homo- and heteronuclear diatomics.
- Problem set 6 given out on 10/24
- Quiz 6 given at recitation.

**Week 9**: October 31, November 2

**Chapter 6**: Quantum theory of molecular structure – valence bond theory and orbital hybridization for bonding in polyatomic molecules; predicting molecular geometry.
- Problem set 6 due on 11/2,
- Problem set 7 given out on 11/2.
- Quiz 7 given at recitation.

**Week 10**: November 7, 9

**Chapter 7**: Bonding in organic molecules – alkanes, alkenes, alkynes; long-chain hydrocarbons; HOMOs and LUMOs; predicting reaction mechanisms.
- Problem set 7 due on 11/9,
- Problem set 8 given out on 11/9.
- Quiz 8 given at recitation.

**Week 11**: November 14, 16

**Chapter 20**: Molecular spectroscopy – Introduction and experimental methods.
- Problem set 8 due on 11/14.
- **Midterm 2 given on 11/18**

**Week 12**: November 21 (no class on November 23)
Chapter 20: Molecular spectroscopy – Rotational, vibrational, NMR, electronic.
Problem set 9 given out on 11/21.

Week 13: November 28, 30
Chapter 21: Structure and bonding in solids – Crystal symmetry and unit cells; crystal structure and space groups, crystals in pharmaceuticals, energetics, and explosives; predicting crystal structures.
Problem set 9 due on 11/30.
Problem set 10 given out on 11/30.
Quiz 9 given at recitation.

Week 14: December 5, 7
Chapter 23: Polymeric materials and soft condensed matter – polymeric materials and their uses as energy materials; liquid crystals; natural polymers.
Problem set 10 due on 12/7.
Problem set 11 given out on 12/7.
Quiz 10 given at recitation.

Week 15: December 12, 14
Chapter 19: Nuclear chemistry – mass-energy relations; radioactive decay; applications to medicine, biology, and energy.
Problem set 11 due on 12/14.
Quiz 11 given at recitation.

Week 16: December 20, 23
Lab final on 12/20 at 12:00 pm.
Final exam on 12/23 at 8:00 am.