Syllabus - Chemistry 109H
Fall, 2017

Class meeting	8:50 am MWF, 1361 Chemistry
Instructor	Professor Randall Goldsmith 3309 Chemistry Chem109HProf@chem.wisc.edu
Teaching Assistants	Zachary Dyott Office Hours in 1201 Chemistry dyott@wisc.edu Summer Sherman Office Hours in 1201 Chemistry slsherman3@wisc.edu
Office Hours	Randall: Mon 10-11am, Tue 5-6pm, and by appointment. Summer: Wed 6-7pm, and by appointment. Zach: Thur 6-7pm, and by appointment.
Course Website	Go to canvas.wisc.edu and select Chemistry 109 003 (login with your UW NetID if prompted)

Chemistry 109H is the honors version of Chemistry 109, a modern introduction to chemical principles that draws on current research themes. The honors section is for students with particularly strong backgrounds in chemistry and good preparation in physics and mathematics. Although the course involves only small amounts of formal calculus, familiarity with calculus and at least concurrent enrollment in calculus is important. Students who have NOT taken AND are NOT currently enrolled in calculus have done well in the class, but it is more difficult, please contact Professor Goldsmith if you are in this category.

The plan for the course is to develop the organizing principles of chemistry and apply them to questions of energy and global climate change. The unifying theme in the course is using fundamental concepts to think critically about energy production and consumption as well as their impact on the environment.

The course begins with a discussion of energy and moves to a rigorous description of thermodynamics, a topic that sits at the heart of energy production and use. After developing the concepts of entropy and free energy, the next step is applying them to spontaneous change and equilibrium, in both gases and solution. The combination of solution equilibrium and free energy leads into electrochemistry, a topic central to solar energy conversion and storage. All of these concepts turn on the interaction of molecules with light, and the course moves on to examine light, atoms, and molecules. Combining these ideas makes it possible to discuss atmospheric photochemistry. Because understanding the rates of processes is important to both energy production and reactions in the atmosphere, the course develops and applies

ideas of chemical kinetics. Nuclear reactions and their connection to energy production are the final topics in the course.

The course will move at a fast pace, and the presentation assumes a good familiarity with the language of chemistry, chemical calculations, and introductory physics. (There will be resources for individual review, but the elementary topics are not part of the coverage in class or discussion.)

Materials

Text — *University Chemistry: In the Context of Energy at the Global and Molecular Level* by James G. Anderson. This book is a preprint of a new text. The book will be sold in 1375 for $~75 (WISCARD only). It comes in two volumes. We will also make PDF files of the text available on the website. Purchase of a physical copy of the textbook is recommended but not required. Since we are using an unfinished textbook, we're going to offer extra credit points for finding errors in the book. One extra point will be awarded for each identification, up to a maximum of five extra credit points. We will keep a running list of identified errors. Errors can be reported by clicking on the Textbook Errors link on the course website.

Lab Manual — *Laboratory Manual for Chemistry 109H, 2017* (sold in room 1375, pay by WISCARD only). It will be $20.

Top Hat — We will be using the Top Hat app for in-class discussions and questions. Our course ID is 532631.

Notebook — Carbonless laboratory notebook with duplicate pages. Available at local bookstores or from Alpha Chi Sigma (a bit cheaper, cash only).

Safety Goggles — *You are required to wear safety goggles when in the laboratory.* We cannot admit you to the laboratory without goggles (safety glasses are not good enough!). Alpha Chi Sigma (a bit cheaper, cash only) and local bookstores sell safety goggles that will fit over regular glasses.

Calculator — A scientific calculator. Graphing calculators are acceptable for use in the course.

Procedures and Policies

Website — The website for the course (which uses the Canvas course management system) is the place for you to obtain current information about the course, to find links to the material presented in the course, to find reference materials and resources, and to take online quizzes, and to check your grades.

The website lists all assignments, and it is important that you use it to see when quizzes and problems sets are due. You can navigate to the website from the URL http://canvas.wisc.edu/ by selecting the link to Chemistry109: Advanced General Chemistry (003). You may need to login with you UW NetID.

Email — Your UW email address is our primary means of contacting you during the semester. We will send messages to the entire class and to individuals using those addresses. Please be sure to check that account or have it forwarded to an account you see regu-

larly. All emails to Professor Goldsmith should be sent to Chem109HProf@chem.wisc.edu

Class Meetings Your attending class is important. The class meeting will expand on material in the text, point to the most important aspects of the material, and, if things go well, stimulate discussion. I will post copies of the notes I use in class, including the Top Hat questions and answers, on the course website (as a pdf file you can view and print) shortly after the lecture. These notes are detailed enough for you to revisit points you missed in class, but they are not a substitute for the text or for your own notes.

Quizzes There will be an online quiz most weeks on the material that we will cover in roughly the following three class meetings. You will need to read the assigned chapter in the text and complete the online quiz at the website. The quiz deadline will be 8 am on either a Monday or a Wednesday. You must check the assignment for the coming week to learn the due date. I strongly urge you to complete the quiz prior to the absolute deadline. Two attempts will be allowed for each quiz. NO EXCEPTIONS will be made for late quizzes. You will be allowed to drop one quiz grade (because everyone has a bad day).

Problem Sets There will be eleven problem sets during the semester that we will post on the website (usually on Fridays). Your solutions are due at the *end of class* the following week, NO EXCEPTIONS. You will be allowed to drop one homework grade (because everyone has a bad day).

The teaching assistants will grade your solutions of selected problems and will post copies of the solutions. You will receive partial credit for attempting all of the problems. *We encourage you to discuss the problems with each other and work together.* (See the information below on *Tutorials*.) *You must generate, hand-in, and take responsibility for your own solutions. Do not copy another student's work. Any consultation of previous years' solutions sets is explicitly forbidden and will result in severe consequences.*

Top Hat You will use a personal response system operating on your phone to answer clicker questions posed in class. You must download the Top Hat App and register. Students who do not intend to use a smartphone should contact Professor Goldsmith.

You will receive up to 50 points for responding (not necessarily getting them right!) to the clicker questions. Responding to more than 75% of all the questions during the semester earns you the maximum. Responding to between 50% and 75% of the questions earns you 25 points. Responding to fewer than 50% earns you no points. The threshold is set at 75% to allow for the times you forget your phone, are ill or absent for any other reason, or just don't push the button. These are easy points to get!

Examinations There are three examinations during the semester and a final examination, as listed in the course outline. The three examinations will be at 7*:15 pm on Thursdays, September 28, October 26, and November 30.* The examinations will last one and one-half hours.

The two-hour final exam is on *Friday December 18th, at 5:05 pm.* Note, this date/time is determined by the Registrar.

I will announce and post the location of the exams prior to their dates. Please inform me *during the first week of class* if you have a conflict with any of the examination times.

Discussion You will meet with your teaching assistant for a discussion period each Thursday. Your teaching assistant will answer questions, discuss the material, and guide you through assignments that expand on the material discussed in the class meeting.

Tutorials There will be two-hour tutorial sessions for this course in Room 1371 on Wednesday and Thursday evenings from 7.00 to 9.00 PM. One of the teaching assistants will be available to help with problem sets and other questions you have from 8-9 PM. We encourage you to come to a tutorial to work with others in the class as well, particularly for the first hour, and get help from a teaching assistant. Additional review sessions and extra office hours will be announced prior to exams.

Laboratories The teaching assistants supervise the laboratories and direct your work. They will discuss related material, demonstrate unfamiliar techniques, and answer questions. The goal of the laboratory is to provide experience with a variety of techniques and to illustrate the principles we are discussing in lecture. We especially want you to learn to generate quantitative results and to interpret them critically.

You must come to laboratory prepared. Before coming to the laboratory, you must read and understand the procedure and complete the preparations described by your teaching assistant. Your teaching assistants will give you more detailed instructions for the pre-laboratory assignments. Lab write-ups will be due 24 hours after the lab ends.

Conflicts If a religious observance or an official University activity conflicts with any scheduled activity in this course, please notify me at the beginning of the semester. We will schedule a makeup date or otherwise accommodate you.

Illness If you are ill or have another unexpected reason that you are unable to attend an exam or laboratory please inform your teaching assistant and Professor Goldsmith as soon as possible. Sending an email message is the best means of informing us of the problem.

Grading We grade the exams on a numerical scale and provide letter grade guidelines for each exam. Problem sets, quizzes, and laboratory reports also receive numerical grades. The aggregate of the points you accumulate on these assignments determines your grade. The points for the various components are

Exams (3@100 each)	300
Final exam	150
Problem sets, 1 dropped (11-1=10@15)	150
Quizzes, 1 dropped (11-1=10@10)	100
Clicker participation	50
Laboratory	250
Total Points	**1000**

You must complete the laboratory to pass the course. There is no set quota of any particular grade. You can see the distribution of grades from the last several years under the *Exams* link on the website. I will assign final course grades, in consultation with your teaching assistants, taking into account participation in discussion and laboratory activities along with your numerical score.

Course Schedule

Week 1	**4 Sep - 10 Sep** **Wed 6 Sep** **Fri 8 Sep**	**Topic** **Energy Concepts and Demand (Chapter 1)** 1. Population growth, energy, and power 2: Energy scales and Newton's Laws	**Laboratory** Labs will not meet Week 1	**Assignments** Read Chapter 1 (1.1 - 1.30) Register Top Hat Practice Quiz (to test your computer - no points)
Week 2	**11 Sep - 17 Sep** **Mon 11 Sep** **Wed 13 Sep** **Fri 15 Sep**	**Topic** 3: Light and blackbody radiation **Thermodynamics and the First Law (Chapter 3)** 4: Radiative energy transfer 5: Heat, work, internal energy	**Laboratory** Orientation, Check-in Online Safety Quiz Academic Integrity Quiz	**Assignments** Read Chapter 1 (1.30-1.62) Review Chapter 2 (as needed) **Quiz Week 2** (Chapter 1, due 8 am, Monday 11 Sep) **Problem Set 1** (due end of class, Friday, 15 Sep)
Week 3	**18 Sep - 24 Sep** **Mon 18 Sep** **Wed 20 Sep** **Fri 22 Sep**	**Topic** 6. Enthalpy of reaction, enthalpy, calorimetry 7: Isochoric, isobaric processes 8: Isothermal, adiabatic processes	**Laboratory** Solution Calorimetry	**Assignments** Read Chapter 3 **Quiz Week 3** (Chapter 3, due 8 am Monday, 18 Sep) **Problem Set 2** (due end of class, Friday 22 Sep)
Week 4	**25 Sep - 1 Oct** **Mon 24 Sep**	**Topic** 9: Carnot cycle and engine efficiency **Energy, Spontaneity, Second Law (Chapter 4)** 10: Probability and entropy	**Laboratory** Heat and Light	**Assignments** Read Chapter 4 No quiz No problem set

	Wed 27 Sep	**Exam 1 - 7:15 pm - Rm 1361 Chemistry**		
	Thu 28 Sep	11: Spontaneous change and Second Law		
	Fri 29 Sep			
Week 5	**2 Oct - 8 Oct**	**Topic**	**Laboratory**	**Assignments**
	Mon 2 Oct	12: Gibbs free energy, Third Law **Equilibrium and Free Energy (Chapter 5)**	Capturing Light	Read Chapter 5 **Quiz Week 5** (Chapter 4, due 8 am, Monday, 2 Oct)
	Wed 4 Oct	13: Equilibrium, equilibrium constants		
	Fri 6 Oct	14: Reaction quotient, Le Chatelier's principle		**Problem Set 3** (due end of class, Friday, 6 Oct)
Week 6	**9 Oct - 15 Oct**	**Topic**	**Laboratory**	**Assignments**
	Mon 9 Oct	15: Gibbs free energy and equilibrium contants **Solution Equilibrium (Chapter 6)**	Equilibrium and Le Chatelier	Read Chapter 6 **Quiz Week 6** (Chapters 5 & 6, due 8 am, Monday 9 Oct)
	Wed 11 Oct	16: Weak acids and bases		
	Fri 13 Oct	17: Polyprotic acids, buffers		**Problem Set 4** (due end of class, Friday, 13 Oct)
Week 7	**16 Oct - 22 Oct**	**Topic**	**Laboratory**	**Assignments**
	Mon 16 Oct	**Electrochemistry (Chapter 7)** 18: Oxidation-reduction , half reactions	Thermodynamics of Ligand Substitution	Read Chapter 7 **Quiz Week 7** (Chapter 7, due 8 am, Monday, 16 Oct)
	Wed 18 Oct	19: Free energy, cell potentials		
	Fri 20 Oct	20: Nernst equation and equilibrium constants		**Problem Set 5** (due end of class, Friday, 20 Oct)
Week 8	**23 Oct - 29 Oct**	**Topic**	**Laboratory**	**Assignments**
	Mon 23 Oct	**Quantum Mechanics, One-electron Atoms (Chapter 8)** 21: Blackbody radiation, photoelectric effect	Titrations	Read Chapter 8 No quiz No problem set
	Wed 25 Oct	22: Emission spectra, Bohr atom		
	Thu 26 Oct			

	Fri 27 Oct	**Exam 2 - 7:15 pm - Rm 1361 Chemistry** 23: Wave mechanics		
Week 9	**30 Oct - 5 Nov** **Mon 30 Oct** **Wed 1 Nov** **Fri 3 Nov**	**Topic** 24: Probability in quantum mechanics 25: Particle-in-a-box, Schrödinger equation 26: One-electron atoms	**Laboratory** Electrochemical Cells	**Assignments** Read Chapter 9 **Quiz Week 9** (Chapter 9, due 8 am, Monday, 30 Oct) **Problem Set 6** (due end of class, Friday, 3 Nov)
Week 10	**6 Nov - 12 Nov** **Mon 6 Nov** **Wed 8 Nov** **Fri 10 Nov**	**Topic** **Multielectron Atoms (Chapter 9)** 27: Multielectron atoms 28: Aufbau principle, periodic trends 29: Electron sharing and polarity	**Laboratory** Emission Spectroscopy	**Assignments** Read Chapter 10 **Quiz Week 10** (Chapter 10, due 8 am, Monday, 6 Nov) **Problem Set 7** (due end of class, Friday, 10 Nov)
Week 11	**13 Nov - 19 Nov** **Mon 13 Nov** **Wed 15 Nov** **Fri 17 Nov**	**Topic** 30: Molecular shapes, VSEPR **Quantum Descriptions of Bonding (Chapter 10)** 31: Valence Bond Theory and Hybridization 32: Molecular orbitals	**Laboratory** Molecular Structures	**Assignments** Read Chapter 11 **Quiz Week 11** (Chapter 11 pt 1, due 8 am, Monday, 13 Nov) **Problem Set 8** (due end of class, Friday, 17 Nov)
Week 12	**20 Nov - 26 Nov** **Mon 20 Nov** **Wed 22 Nov** **Fri 24 Nov**	**Topic** 33: Orbital energies, bond strengths 34: Electronic excitation No class (Thanksgiving)	**Laboratory** No lab	**Assignments** **Quiz Week 12** (Chapter 11 pt 2, due 8 am, Monday, 20 Nov) **Problem Set 9** (due end of class, MONDAY, 27 Nov)

Week 13	27 Nov - 3 Dec	Topic	Laboratory	Assignments
	Mon 27 Nov	35: Potential energy curves 36: Vibrations, infrared excitation	Kinetics of Crystal Violet	Read Chapter 12 No quiz
	Wed 29 Nov	**Exam 3 - 7:15 pm - Rm 1361 Chemistry**		No problem set
	Thu 30 Nov	**Kinetics (Chapter 12)** 37: Rates of reactions		
	Fri 1 Dec			

Week 14	4 Dec - 10 Dec	Topic	Laboratory	Assignments
	Mon 4 Dec	38: Rate expressions, integrated expressions	Neutron Activation of Silver	Quiz Week 14 (Chapter 12, due 8 am, Monday, 4 Dec)
	Wed 6 Dec	39: Activation energy, reaction profiles		
	Fri 8 Dec	40: Elementary reactions, mechanisms		Problem Set 10 (due end of class, Friday, 8 Dec)

Week 15	11 Dec - 15 Dec	Topic	Laboratory	Assignments
		Nuclear Chemistry (Chapter 13)	No lab	Read Chapter 13
	Mon 11 Dec	41: Binding energy, fission 42: Fusion, radioactivity		Quiz Week 15 (Chapter 13, due 8 am, Monday, 11 Dec)
	Wed 13 Dec			Problem Set 11 (due end of class, Wednesday, 13 Dec)