Chemistry 115. Accelerated General Chemistry

INSTRUCTOR: Prof. Keith T. Kuwata, Olin-Rice 318, 696-6768, kuwata@macalester.edu.
Web page: www.macalester.edu/~kuwata (for class handouts, overheads, and answer keys)

REQUIRED TEXTS: (1) Peter Atkins and Loretta Jones ("AJ"), *Chemical Principles*: *The Quest for Insight*, 4th Edition, New York: W. H. Freeman, 2008. (Buy at the Lampert Building Bookstore). (2) Robert M. Hanson and Susan M. E. Green ("HG"), *Introduction to Molecular Thermodynamics*, Sausalito, California: University Science Books, 2008. (Also buy at the Lampert Building Bookstore) (3) *Chemistry 115 Laboratory Manual*. (Already paid for with the course fee; you will receive this in lab.)

OTHER REQUIRED MATERIALS: (1) A pair of safety goggles. Macalester College and the State of Minnesota both require that you wear goggles during all "wet" laboratory sessions. (They are not required when working in a computer lab.) **You will not be allowed to work in lab if you do not bring your own pair of goggles.** (2) One composition book (5 x 5 Quad Ruled, 10" x 7 7/8") to use as a lab notebook. Both (1) and (2) have already been paid for with your course fee, and you will receive them in lab. (3) A scientific calculator. Bring this to lecture and to lab.

DESCRIPTION: This course lays the foundation for all subsequent study in chemistry. You will learn to think about phenomena as chemists by using the key paradigms of structure, energetics, and their interrelationship. The first half of the course focuses on structure. First, we use fundamental ideas about light and quantum mechanics to rationalize and predict the properties of atoms (AJ Chapter 1). Next, we develop powerful classical and quantum mechanical models for understanding chemical bonding and the three-dimensional structures of molecules (AJ Chapters 2 and 3). We then switch our focus to energetics, using an experimental textbook (HG) that grounds the mathematics of thermodynamics in structural concepts. We learn basic ideas about the distribution of energy in matter (HG Chapters 2 and 3), and then apply these ideas to the key thermodynamic properties of internal energy (HG Chapters 4 and 5), entropy (HG Chapters 7 and 8), enthalpy (HG Chapter 9), and free energy (HG Chapter 10). We then learn how thermodynamics controls the outcomes of chemical reactions (HG Chapter 11 and AJ Chapter 9), particularly those involving electron transfer (AJ Chapter 12).

Both lecture and lab work will assume mastery of elementary concepts from high school chemistry like nomenclature, simple chemical reactions in solution, and stoichiometry, as well as the standard AP/IB topic of chemical equilibrium. We will not take time in class on this material. However, the first problem set, taken from Atkins and Jones' *Fundamentals* section, will give you the opportunity to review on your own.

LECTURES: MWF from 8:30 a.m. to 9:30 a.m. in Olin-Rice (OR) 301. Attendance is not mandatory, but highly encouraged. It is your responsibility to read (or at least skim) the assigned sections of your textbooks (see pp. 3-4) before lectures on the material begin. Doing the reading will help you understand the lectures a lot more, prepares you to ask questions during class, and equip you to benefit from in-class problem solving activities we will do periodically. Also, please bring your calculator to class.

LABORATORIES: Thursdays from 1:20 to 4:30 p.m., often in OR 380 or one of the Humanities Building computer labs. You must attend every "wet" and computer lab during the semester. If special circumstances preclude your attendance at a session, you must notify me beforehand to make arrangements to make that session up no later than one week after the original lab session. Please see pp. 3-4 for the schedule of experiments. I will provide more details in lab. Lab work starts on September 10.

PROBLEM SETS: You will be required to turn in solutions to selected problems, usually at the end of a chapter. Assignments will be handed out at least one week before they are due (see pp. 3-4 for the due dates.) Homework will be due by 4:00 p.m., and **no late homework will be accepted for any reason.** However, I will drop your lowest homework score in computing your course grade.

You should show in writing the process by which you have obtained your answers. Explanations should be clear and concise. Final numerical answers must contain the correct number of significant figures (see pp. A5-A6 of Atkins and Jones for rules) and have the right physical units attached to receive full credit. I will hold you to the same standards when I grade your exams.

Doing the assigned homework is essential for you to learn the material and do well on exams. However, do not expect the specific problems I assign to be a targeted rehearsal for, or preview of, test questions. The goal is for you to master concepts and principles on which you will be tested. You are encouraged to work with other people, but what you turn in must be your own work. My solutions for the problems sets will be posted on the course web page to help you study for exams. You should also make time to do additional problems as you study for this course. Answers to the end-of-chapter odd-numbered problems are in Appendix C of Atkins and Jones, and answers to selected problems are at the back of Hanson and Green. Please feel free to ask me about any problem.

TESTS: There will be four unit tests consisting largely of calculations and short answer questions. You will be responsible only for material from lecture and problem sets.

If you have a legitimate reason for missing the scheduled time for a test, such as an athletic event, you must take the test before you leave for the event. If you are seriously ill the day before a test, I may grant you a postponement if you contact me before the exam. If I grant you a postponement, you must make up the test before the next class period, when I will usually hand the graded exams back.

I will provide appropriate testing accommodations for students with documented disabilities. Please make an appointment with the Associate Dean of Students, Lisa Landreman (x6220). It is important to meet with Dean Landreman early in the semester to ensure that your accommodations are approved before the first test.

The final exam will be **Monday, December 17, 7:30 – 10:00 a.m. This is not negotiable--make your travel plans accordingly!** One half of the final will test material covered after the fourth unit exam, and the other half will cover material from throughout the semester.

GRADING: **Homework: 20%** **Lab Work: 20%** **4 Unit Exams: 45%** **Final: 15%**
Grades will be assigned using a curve based on your cumulative percentage of points. However, everyone who earns at least 90% is guaranteed an A or an A-. Typically, if your cumulative score is close to the class average, you will receive a B. Note that non-permanent midterm grades will be assigned based on the first two unit exams only

GETTING HELP: I will be available in my office Monday noon-1:00 p.m., Tuesday 1:30-2:30 p.m., Wednesday noon-1:00 p.m., and Friday 1:30-2:30 p.m. If you cannot make one of these scheduled office hours, you can also make an appointment, or just come by—I'll usually be somewhere in Olin-Rice during the day. Other helpful people include the tutors in the department computer lab (OR 341, hours to be announced) and the MAX Center tutors. We are all eager to help you master the material in this course!

ACADEMIC INTEGRITY: Obtaining copies of tests prior to their administration, using unauthorized materials during tests, sharing or stealing information during an exam, alteration of a graded exam and then requesting a re-grade, copying another student's lab data, lab report, or homework, or copying homework keys from past years, all constitute cheating and are forbidden. As per official Macalester policy, I will report any clear violation of the above integrity standards to Ann Minnick, the Director of Academic Programs.

COURSE SCHEDULE

Date	**Day**	**What's Due?**	**Topics/Event** (Reading from Atkins/Jones (AJ) or Hanson/Green (HG))
9/9	W		Light, Quantum Mechanics, and the Atom (AJ 1.1-1.11; skim 1.7)
9/10	Th		LAB: Check-In, Safety, **Exp 1--**Ion Recovery [in Olin-Rice 380]
9/11	F		Light, Quantum Mechanics, and the Atom continued
9/14	M	**PS 1**	Light, Quantum Mechanics, and the Atom continued
9/16	W		Light, Quantum Mechanics, and the Atom continued
9/17	Th	**Exp 1**	LAB: **Exp 2--**Using Excel to Analyze Chemical Data [in Humanities 304]
9/18	F		Light, Quantum Mechanics, and the Atom continued
9/21	M	**PS 2**	Multi-Electron Atoms and the Periodic Table (AJ 1.12-1.19)
9/23	W		Multi-Electron Atoms and the Periodic Table continued
9/24	Th	**Exp 2**	LAB: **Exp 3--**Investigating Periodic Trends [in OR 380]
9/25	F		Multi-Electron Atoms and the Periodic Table continued
9/28	M		Multi-Electron Atoms and the Periodic Table continued
9/30	W	**PS 3**	Chemical Bonding (AJ Chap. 2)
10/1	Th		LECTURE: Chemical Bonding continued [at 3:00 p.m. in OR 301]
10/2	F		**TEST 1: Lectures thru 9/28; PS 1, 2, and 3**
10/5	M	**Exp 3**	Chemical Bonding continued
10/7	W		Molecular Shape and VSEPR Theory (AJ 3.1-3.3)
10/8	Th		LAB: **Exp 4--**An Exploration of Molecular Shapes [in Humanities 302]
10/9	F	**PS 4**	Molecular Orbital Theory (AJ 3.8-3.11)
10/12	M		Molecular Orbital Theory continued
10/14	W		Molecular Orbital Theory continued
10/15	Th	**Exp 4**	LAB: **Exp 5--**Visualizing Molecular Orbitals [in Humanities 302]
10/16	F		Molecular Orbital Theory continued
10/19	M		Molecular Orbital Theory continued
10/21	W	**PS 5**	Distributing Energy in Atoms and Molecules (HG 2.3-2.5; 2.7-2.10)
10/22	Th	**Exp 5**	LECTURE: Distributing Energy continued [at 3:00 p.m. in OR 301]
10/23	F		**TEST 2: Lectures thru 10/19; PS 4 and 5**
10/26	M		Energy Levels in Atoms and Molecules (HG 3.1-3.10)
10/27	Tu		LAB: **Exp 6--**Synthesis and IR Spectroscopy of Aspirin [in OR 380]
10/28	W	**PS 6**	Energy Levels in Atoms and Molecules continued
10/29	Th		**Fall Break (no class)**
10/30	F		**Fall Break (no class)**

(course schedule continues on the next page)

11/2	M		Energy Levels in Atoms and Molecules continued
11/4	W	**PS 7**	Internal Energy and the 1st Law (HG 4.1-4.10; 4.13)
11/5	Th		LAB: **Exp 7--**Molecular Vibrations and IR Spectroscopy [in Hum 302]
11/6	F		Internal Energy and the 1st Law continued
11/9	M		Internal Energy and the 1st Law continued
11/11	W	**PS 8**	Chemical Bonding and Internal Energy (HG Chap. 5)
11/12	Th		LAB: Finish **Exp 6**; **Exp 8--**Calorimetry [in OR 380]
11/13	F	**Exp 6 and 7**	Entropy and the 2nd Law (HG 7.1-7.4; 7.6-7.8; 7.10-7.12; Ch. 8; skip 8.5)
11/16	M		**TEST 3: Lectures thru 11/9; PS 6, 7 and 8**
11/18	W		Entropy and the 2nd Law continued
11/19	Th	**Exp 8**	LECTURE: Entropy and the 2nd Law continued [at 3:00 p.m. in OR 301]
11/20	F		Entropy and the 2nd Law continued
11/23	M	**PS 9**	Enthalpy (HG Chap. 9)
11/25	W		Enthalpy continued
11/26	Th		**Thanksgiving Break (no class)**
11/27	F		**Thanksgiving Break (no class)**
11/30	M		Free Energy (HG Chap. 10)
12/2	W	**PS 10**	Free Energy continued
12/3	Th		LECTURE: Free Energy continued [at 3:00 p.m. in OR 301]
12/4	F		**TEST 4: Lectures thru 11/25; PS 9 and 10**
12/7	M		Electrochemistry (AJ Chap. 12)
12/9	W	**PS 11**	Electrochemistry continued
12/10	Th		LAB: **Exp 9—**Voltaic Cells [in OR 380] and Checkout
12/11	F		Electrochemistry continued
12/14	M		Electrochemistry continued

Thursday, December 17, 7:30 – 10:00 a.m.—Comprehensive Final Examination