Chemistry 111. General Chemistry I: Structure and Equilibrium

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 TEXT: Martin S. Silberberg, *Chemistry*: *The Molecular Nature of Matter and Change*, 4th Edition, Boston: McGraw Hill, 2006.

OTHER REQUIRED MATERIALS: (1) A pair of safety goggles (buy at the Lampert Building Bookstore). Macalester College and the State of Minnesota both require that you wear goggles during all laboratory sessions. **You will not be allowed to work in lab if you do not bring your own pair of goggles.** (2) **Two** composition books (5 x 5 Quad Ruled, 10" x 7 7/8"; buy at the Highlander Store) to use as lab notebooks (3) A scientific calculator. Bring this to lecture and to lab.

DESCRIPTION: This course, along with Chemistry 112 offered in the spring semester, lays the foundation for all subsequent study in chemistry. During this semester, we will focus on the key chemical themes of structure and equilibrium. We start with a quick review of typical high school topics like atoms and molecules, mass and mole relationships, stoichiometry, and writing and balancing chemical reactions (Chapters 1-4). The first four lab experiments also help review this material.

The rest of the semester fleshes out these topics in greater detail. First, we introduce key concepts about light and quantum mechanics and use them to explain the properties of atoms and the structure of the periodic table (Chapters 7 and 8). Next, we develop a set of powerful models that explain how atoms form chemical bonds, and how macroscopic, observable properties result from the three-dimensional structures of molecules (Chapters 9, 10, 11, and 23). We conclude with a rigorous mathematical treatment of chemical equilibrium—that is, the mixture of reactants and products spontaneously sought in a chemical reaction. We pay particular attention to gas-phase reactions relevant to atmospheric chemistry, and the solution-phase reactions of acids and bases, whose properties are critical for understanding biological systems. Chemistry 112 will pick up the theme of spontaneity in chemical reactions, explaining equilibrium in terms of the laws of thermodynamics.

LECTURES: MWF from 10:50 a.m. to 11:50 a.m. in Olin-Rice 350. Attendance is not mandatory, but highly encouraged. It is your responsibility to read the assigned sections of Silberberg (see p. 3) before lectures on the material begin. Doing the reading will help you understand the lectures a lot more, and equip you to ask questions during class.

LABORATORIES: Usually in OR 343. Attendance every week is mandatory. If special circumstances preclude your attendance at a session, you must notify your instructor beforehand and make arrangements to make that session up no later than one week after the original lab session. Please see p. 4 for the schedule of experiments. More details will be provided separately by your lab instructor.

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 p. 3 for the due dates.) Homework will be due by 5 p.m., and **no late homework will be accepted for any reason.** However, I will drop your lowest two homework scores in computing your course grade.

Doing the assigned homework is an essential part of learning the material and doing well on exams. You cannot learn chemistry without repeated problem solving. 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.

You should show in writing the process by which you have obtained your answers. Explanations should be clear and concise. In addition, final numerical answers must contain the correct number of significant figures (see pp. 25-29 of Silberberg 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.

You should also make time to do additional problems as you study for this course. Answers to the end-of-chapter problems numbered in blue can be found in Appendix E of your text. Please feel free to ask me about any problem, assigned or unassigned.

Note that Problem Sets 2 and 4, which are due the class periods immediately before tests, will not be graded by the student assistant before the tests are administered. However, my solutions for these (and all other) problems sets will be posted on the course web page to help you study.

TESTS: There will be four hour examinations consisting of math problems, short answer questions, essay questions, and a few multiple-choice questions. You will be responsible only for material from lecture and problem sets. These four tests will be held during the normal lecture time slot. Test 1, which covers the introductory material from Chapters 1-4, will be worth less than the other three hour exams.

The final exam will be **Wednesday, December 21, 8:00-10:00 a.m. The final will not be administered at any other time--make your travel plans accordingly!** One half of the final will test material covered after the fourth hour exam, and the other half will be a comprehensive, standardized multiple-choice exam from the American Chemical Society. (Note that Macalester chemistry students have an excellent track record on these standardized exams!)

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

GRADING: **Homework: 10%** **Lab Work: 20%** **4 Hour Exams: 50%** **Final: 20%**
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 hour exams only

GETTING HELP: I will be available in my office Monday 1:30-2:30 p.m., Tuesday 4:00-5:00 p.m., Wednesday 2:30-3:30 p.m., and Thursday 9:00-10:00 a.m. If you cannot make one of these scheduled office hours, you can also make an appointment with me, or just come by—I'll usually be somewhere in Olin-Rice during the day. Other helpful people include the chemistry major tutors in the department computer lab (OR 341, hours to be announced), the MAX Center tutors, and the other Chemistry 111 instructor, Prof. Paul Fischer. 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 the Macalester Student Handbook, I will report any clear violation of the above integrity standards to Ellen Guyer, the Dean of Academic Programs.

COURSE SCHEDULE

Date	Day	What's Due?	Topics/Event--Silberberg reading assignments in ( )
9/7	W		Fundamentals of Chemistry (skim Ch. 1 and 2)
9/9	F		(Fundamentals of Chemistry continued)
9/12	M		(Fundamentals of Chemistry continued)
9/14	W	**PS 1**	Stoichiometry and Chemical Reactions (skim Ch. 3 and 4)
9/16	F		(Stoichiometry and Chemical Reactions continued)
9/19	M		(Stoichiometry and Chemical Reactions continued)
9/21	W	**PS 2**	Light, Quantum Mechanics, and the Atom (Ch. 7)
9/23	**F**		**TEST 1: Lectures thru 9/19; PS 1 and 2 (75 Points)**
9/26	M		(Light, Quantum Mechanics and the Atom continued)
9/28	W		(Light, Quantum Mechanics, and the Atom continued)
9/30	F		(Light, Quantum Mechanics, and the Atom continued)
10/3	M	**PS 3**	Multi-Electron Atoms; Periodic Table (Ch. 8; skim 8.5)
10/5	W		(Multi-Electron Atoms; Periodic Table continued)
10/7	F		(Multi-Electron Atoms; Periodic Table continued)
10/10	M	**PS 4**	Chemical Bonding (9.1, 9.3, 9.5, 10.1; skim 9.2)
10/12	**W**		**TEST 2: Lectures thru 10/7; PS 3 and 4 (100 Points)**
10/14	F		(Chemical Bonding continued)
10/17	M		(Chemical Bonding continued)
10/19	W	**PS 5**	Molecular Shape and VSEPR Theory (10.2-10.3)
10/21	F		(Molecular Shape and VSEPR Theory continued)
10/24	M		(Molecular Shape and VSEPR Theory continued)
10/26	W		Molecular Orbital Theory (11.3)
10/27	Th		**Fall Break (no class)**
10/28	F		**Fall Break (no class)**
10/31	M	**PS 6**	(Molecular Orbital Theory continued)
11/2	W		(Molecular Orbital Theory continued)
11/4	F	**PS 7**	Hybridization (11.1 and 11.2)
11/7	M		(Hybridization continued)
11/9	**W**		**TEST 3: Lectures thru 11/2; PS 5, 6, and 7 (100 Points)**
11/11	F		Coordination Compounds (8.5, 23.4, 23.5; skim 23.1)
11/14	M		(Coordination Compounds continued)
11/16	W		(Coordination Compounds continued)
11/18	F	**PS 8**	Chemical Equilibrium (Ch. 17)
11/21	M		(Chemical Equilibrium continued)
11/23	W		(Chemical Equilibrium continued)
11/24	Th		**Thanksgiving Break (no class)**
11/25	F		**Thanksgiving Break (no class)**
11/28	M		(Chemical Equilibrium continued)
11/30	W	**PS 9**	Acid-Base Chemistry (18.1-18.5; 18.7)
12/2	F		(Acid-Base Chemistry Continued)
12/5	**M**		**TEST 4: Lectures thru 11/28; PS 8 and 9 (100 Points)**
12/7	W		(Acid-Base Chemistry Continued)
12/9	F		(Acid-Base Chemistry Continued)
12/12	M	**PS 10**	Acid-Base Buffers (19.1)
12/14	W		Polyprotic Species, Solubility Equilibrium (pp. 786-788;19.3)
12/16	F		(Polyprotic Species, Solubility Equilibrium continued)

Wednesday, December 21, 8:00 a.m.-10:00 a.m—Comprehensive Final Examination

LAB SCHEDULE

		7	8	9
12	13 Exp. 1: Excel Lab with Isotope Theme (no ASA)	14	15 Exp. 1: Excel Lab with Isotope Theme (no ASA)	16
19	20 Exp. 2: Ion Recovery	21	22 Exp. 2: Ion Recovery	23
26	27 Exp. 3: Investigating Stoichiometry	28	29 Exp. 3: Investigating Stoichiometry	30
Oct. 3	4 Exp. 4: Reaction of Al and Zn with HCl	5	6 Exp. 4: Reaction of Al and Zn with HCl	7
10	11 Exp. 5: Periodic Trends	12	13 Exp. 5: Periodic Trends	14
17	18 No lab	19	20 No lab	21
24.	25 Exp. 6: Molecular Shapes (Thursday students)	26	27 Midterm	28 Break
31	Nov. 1 Exp. 6: Molecular Shapes	2	3 Exp. 7: Visualizing Molecular Orbitals	4
7	8 Exp. 7: Visualizing Molecular Orbitals	9	10 Exp. 8: Synthesis of a Coordination Compound	11
14	15 Exp. 8: Synthesis of a Coordination Compound	16	17 Exp. 9: Analysis of a Coordination Compound	18
21	22 Exp. 9: Analysis of a Coordination Compound	23	24 Thanksgiving	25 Break
28.	29 Exp. 10: Chemical Equilibrium	30	Dec. 1 Exp. 10: Chemical Equilibrium	2
5	6 Exp. 11: Unknown Acid Titration	7	8 Exp. 11: Unknown Acid Titration	9
12	13 Exp. 12: pH and Buffers	14	15 Exp. 12: pH and Buffers	16