Chemistry 311. Physical Chemistry I

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 Julio de Paula, *Atkins' Physical Chemistry*, 8th ed., W. H. Freeman, New York, 2006. (Buy at the Lampert Building Bookstore.) (2) Jennifer Giaccai, Thomas D. Varberg, and Keith T. Kuwata, *A Laboratory Manual for Physical Chemistry I.* (Provided free of charge!)

OTHER REQUIRED MATERIALS: (1) A pair of safety goggles. 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) A composition book (5 x 5 Quad Ruled, 10" x 7 7/8") to use as a lab notebook. You may use goggles and a partially filled notebook from previous courses, or buy new ones from the Science Division Stockroom. (3) A scientific calculator.

DESCRIPTION: This course involves a rigorous and mathematical treatment of the physical and chemical properties of matter, with an emphasis on describing and predicting macroscopic quantities. We begin by providing concise equations to model the properties of matter, particularly gases (Chapter 1). We then delve into the intellectually rich world of thermodynamics, including the First Law and the concepts of internal energy, heat capacity, and enthalpy (Chapter 2), the Second Law and the concepts of efficiency, entropy, and free energy (Chapter 3), the consequences of thermodynamics for physical properties and transformations (Chapters 4, 5, and 6), and predicting chemical reactivity (Chapter 7). We close with a detailed consideration of chemical kinetics, including the empirical modeling of reaction rates (Chapters 22 and 23) and the theoretical interpretation of reaction mechanisms (Chapters 21 and 24).

More than any other course in the chemistry curriculum, Chemistry 311 (and 312 in the spring) require you to apply concepts and techniques from calculus and physics, particularly mechanics. Please review (or learn!) pp. 965-968 (on calculus, especially partial derivatives) and pp. 979-981 (on mechanics) in your text. This course will also assume that you have mastered basic ideas of structure, chemical equilibrium calculations, simple thermochemical calculations, and molecular thermodynamics concepts taught in Chemistry 111, 112, and 115. Little class time will be spent reviewing this material.

LECTURES: MWF from 8:30 a.m. to 9:30 a.m. in Olin-Rice 100. Attendance is not mandatory, but highly encouraged. It is your responsibility to read (or at least skim) the assigned sections of your textbook (see pp. 3-4) 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: In OR 378. The lab experience will reinforce and extend your understanding of the theory we discuss in class, expose you to novel experimental techniques, and challenge you to write and speak clearly about chemistry. More details will be provided separately by your lab instructor, Rob Rossi.

PROBLEM SETS: Assignments (usually problems from your text) will be handed out at least a week before they are due (see pp. 3-4 for due dates). Homework will be due by 4:00 p.m. **There will be a 20% per day penalty for late homework, and problem sets will not be accepted after the test on that material.** Unlike in my other courses, the problem sets will not be equally weighted; your cumulative homework score will be simply the total number of points earned on the eight problem sets during the semester. My solutions for the problems sets will be posted on the course web page to help you study.

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 (the rules for which you have learned in previous chemistry classes) 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. Please come talk with me if you have any questions on the homework. You are encouraged to work with other people, but what you turn in must be your own work. I also highly recommend you make time to do additional problems as you study for this course; the answers to (b) exercises and odd-numbered problems are in the back of Atkins and de Paula.

TESTS: There will be three tests consisting largely of math problems and short answer questions. You will be responsible only for material from lecture and problem sets. These tests will be held during the normal lecture time slot. **We will start class at 7:30 a.m. on these days**; this will give you the additional time you need to tackle more substantial and challenging questions.

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.

The final exam will be **Wednesday, December 19, 7:30-10:15 a.m. The final will not be administered at any other time--make your travel plans accordingly!** One half of the final will cover chemical kinetics, and the other half will be a comprehensive, standardized multiple-choice exam on thermodynamics from the American Chemical Society. (Note that Macalester chemistry students have an excellent track record on these standardized exams!)

GRADING: **Homework: 15%** **Lab Work: 20%** **3 Hour Exams: 45%** **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.

GETTING HELP: I will be available in my office Monday 2:30-3:30 p.m., Tuesday 8:30-9:30 a.m., Wednesday 1:30-2:30 p.m., and Thursday 9:30-10:30 a.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. Also, one of the teaching assistants will have tutoring hours the night before each problem set is due, and Rob Rossi is available for any questions about lab work. 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 (Reading from Atkins and de Paula)
9/5	W		Properties of Gases and Equations of State (1.1-1.4; pp. 747-749)
9/6	Th		LAB (BOTH SECTIONS): Safety and Orientation
9/7	F		Properties of Gases and Equations of State continued
9/10	M		Properties of Gases and Equations of State continued
9/11	Tu		TUESDAY LAB: Unit 1, Session 1
9/12	W		Properties of Gases and Equations of State continued
9/13	Th		THURSDAY LAB: Unit 1, Session 1
9/14	F		Properties of Gases and Equations of State continued
9/17	M	**PS 1**	1st Law of Thermodynamics and Thermochemistry (2.1-2.11)
9/18	Tu		TUESDAY LAB: Unit 1, Session 2
9/19	W		1st Law of Thermodynamics and Thermochemistry continued
9/20	Th		THURSDAY LAB: Unit 1, Session 2
9/21	F		1st Law of Thermodynamics and Thermochemistry continued
9/24	M		1st Law of Thermodynamics and Thermochemistry continued
9/25	Tu		TUESDAY LAB: Unit 1, Session 3
9/26	W		1st Law of Thermodynamics and Thermochemistry continued
9/27	Th		THURSDAY LAB: Unit 1, Session 3
9/28	F		1st Law of Thermodynamics and Thermochemistry continued
10/1	M	**PS 2**	Second Law of Thermodynamics (2:12; Chap. 3)
10/2	Tu		TUESDAY LAB: Unit 1, Session 4
10/3	W		Second Law of Thermodynamics continued
10/4	Th		THURSDAY LAB: Unit 1, Session 4
10/5	F		**TEST 1: Lectures thru 9/28; PS 1 and 2 [start at 7:30 a.m.]**
10/8	M		Second Law of Thermodynamics continued
10/9	Tu		TUESDAY LAB: Unit 1, Session 5
10/10	W		Second Law of Thermodynamics continued
10/11	Th		THURSDAY LAB: Unit 1, Session 5
10/12	F		Second Law of Thermodynamics continued
10/15	M		Second Law of Thermodynamics continued
10/16	Tu		TUESDAY LAB: Unit 1, Session 6
10/17	W	**PS 3**	Phase Changes in Pure Substances (4.1-4.6)
10/18	Th		THURSDAY LAB: Unit 1, Session 6
10/19	F		Phase Changes in Pure Substances continued
10/22	M		Phase Changes in Pure Substances continued
10/23	Tu		THURSDAY LAB: Unit 2, Session 1
10/24	W	**PS 4**	Thermodynamics of Mixtures (Chap. 5)
10/25	Th		**Fall Break (no class)**
10/26	F		**Fall Break (no class)**
10/29	M		Thermodynamics of Mixtures continued
10/30	Tu		TUESDAY LAB: Unit 2, Session 1
10/31	W		**TEST 2: Lectures thru 10/22; PS 3 and 4 [start at 7:30 a.m.]**
11/1	Th		THURSDAY LAB: Unit 2, Session 2
11/2	F		Thermodynamics of Mixtures continued
11/5	M		Thermodynamics of Mixtures continued
11/6	Tu		TUESDAY LAB: Unit 2, Session 2
11/7	W		Thermodynamics of Mixtures continued

11/8	Th		THURSDAY LAB: Unit 2, Session 3
11/9	F	**PS 5**	Phase Diagrams (Chap. 6)
11/12	M		Phase Diagrams continued
11/13	Tu		TUESDAY LAB: Unit 2, Session 3
11/14	W		Phase Diagrams continued
11/15	Th		THURSDAY LAB: Unit 2, Session 4
11/16	F	**PS 6**	Thermodynamics of Chemical Equilibrium (7.1-7.4)
11/19	M		Thermodynamics of Chemical Equilibrium continued
11/20	Tu		TUESDAY LAB: Unit 2, Session 4
11/21	W		Thermodynamics of Chemical Equilibrium continued
11/22	Th		**Thanksgiving Break (no class)**
11/23	F		**Thanksgiving Break (no class)**
11/26	M	**PS 7**	Chemical Kinetics (Chap. 22; 21.1; selected topics from Chaps. 23 and 24)
11/27	Tu		TUESDAY LAB: Unit 3, Session 1
11/28	W		Chemical Kinetics continued
11/29	Th		THURSDAY LAB: Unit 3, Session 1
11/30	F		**TEST 3: Lectures thru 11/21; PS 5, 6, and 7 [start at 7:30 a.m.]**
12/3	M		Chemical Kinetics continued
12/4	Tu		TUESDAY LAB: Unit 3, Session 2
12/5	W		Chemical Kinetics continued
12/6	Th		THURSDAY LAB: Unit 3, Session 2
12/7	F		Chemical Kinetics continued
12/10	M	**PS 8**	Chemical Kinetics continued
12/11	Tu		TUESDAY LAB: Unit 3, Session 3
12/12	W		Chemical Kinetics continued
12/13	Th		THURSDAY LAB: Unit 3, Session 3
12/14	F		Chemical Kinetics continued

Wednesday, December 19, 7:30 a.m.-10:15 a.m.—Comprehensive Standardized Exam on Thermodynamics + Unit Exam on Chemical Kinetics