CHEM 541: PHYSICAL CHEMISTRY
Chemical Thermodynamics and Kinetics

SYLLABUS AND COURSE OUTLINE

COURSE CONTENT

The course develops core concepts of classical physical chemistry, in particular:

1. Properties of gases: ideal gas law and departures therefrom
2. The laws of thermodynamics
3. Phase transformations of pure substances
4. Properties of simple mixtures
5. Chemical & electrochemical equilibrium
6. Kinetics of chemical reactions

CLASS TIME

Lecture: Tu/Th 10:05 – 11:20 AM, PSC 006

Recitation: Tues. 1:15 – 2:05 PM, PSC 104

CREDITS

3

PREREQUISITES

Grade of C or better in CHEM 112 (or CHEM 142), and in PHYS 212 (or PHYS 207), and in MATH 241; or consent of instructor

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SPECIAL NOTICES

Together with Chemistry 542, this course completes the Physical Chemistry lecture portion of the **Chemistry** degree requirements. **Chem 541 is not a prerequisite for Chem 542**. Both courses are offered each semester and you may take them **in either order**.

Together with Chemistry 545, this course completes the Physical Chemistry lecture portion of the Biochemistry and Molecular Biology degree requirements. **Chem 541 is a prerequisite for Chem 545**.

Lab course: **Chem 541L** is a corresponding laboratory course. It is run independently and can be registered as a 2-credit course.

INSTRUCTOR

Prof. Andrew B. Greytak
Office: GSRC 409
Office Hrs: Wed. 1:00–2:30 PM, Th. 1:00–2:00 PM, or by appointment at a mutually agreeable time.
Telephone: 777-0672
Email: greytak@sc.edu

GRADER / TA

Mr. Abhishek Mitra
Office: GSRC 506
Office Hrs: TBA
Email: amitra@email.sc.edu

REQUIRED TEXTBOOK & EQUIPMENT

Physical Chemistry, P. Atkins and J. de Paula, 9th ed. (Required*)

Student Solutions Manual for Physical Chemistry, P. Atkins and J. de Paula, 9th ed. (Optional)

* We will use Chapters 1-6 and 20-22. These chapters are also available separately as "*Physical Chemistry Volume 1: Thermodynamics and Kinetics*", however, the other chapters are used in Chem 542. Note that the 10th edition of Atkins has recently been released. We will continue to use the 9th edition to the extent possible (it is on reserve); you may be able to obtain a used copy at a significant discount.

You will need a **scientific calculator** for use on exams and you should bring it to class every day. I encourage you to learn to use the polynomial (e.g. quadratic) equation solver function, if your calculator has one.

COURSE GRADING

Based on 550 points total:

Three Mid-term Exams (100 points each):	300 points
Final Exam:	150 points
Homework:	100 points
	550

Final letter grades for the course will be assigned on the basis of point totals using a curve no more strict than the one below. The grading curve may (or may not) be adjusted based on overall class performance. Following midterm exams, approximate letter grade scales for the exam may be discussed. However, final grades will be assigned on the basis of point totals for the course as a whole.

A	≥ 90 %	used:	475 (86.3%)
B+	≥ 87 %		446 (81.1%)
B	≥ 80 %		410 (74.6%)
C+	≥ 77 %		385 (70.0%)
C	≥ 70 %		354 (64.4%)
D+	≥ 67 %		330 (60.0%)
D	≥ 60 %		300 (54.6%)
F	< 60 %		

For both homework and exams, the correct method of solution is more important than the numerical answer. For credit, every answer must be supported by a clear and complete explanation of the method used to obtain it.

LECTURE

Attendance and participation in lecture is expected of all students. The University attendance policy specifies that students may miss up to 3 class meetings (10% of class time) without penalty. Important information including changes in the class schedule will be presented. Students are responsible for getting notes and information from any missed lectures.

Note: Lectures are **by far** more effective if you have read the relevant material in the textbook ahead of time, so that you can use the lecture to cement your knowledge and ask questions.

Lecture quizzes will be given from time to time; these are scored as extra credit and cannot be made up.

RECITATION

A **mandatory** session with practice of problem-solving techniques through worked examples. Student questions are welcome. No new material is presented.

Students will have the opportunity to work together on example problems and extra credit may be available for participation and presentation of solutions; we may experiment with different ways of implementing this.

MIDTERM EXAMS

There will be three midterm exams, taken during normal class time. Tentatively:

Exam I: Thursday Sept. 17
Exam II: Thursday Oct. 15
Exam III: Thursday Nov. 19

For each of these exams, please bring:

1. One 8″ × 5″ card that you may decorate with notes and formulas you desire
2. A calculator (that does not have pre-existing programs)
3. Pencils
4. ID card

No other notes, books, or materials may be used and calculators may not be shared. There are no make-up exams: see the Final Exam policy below.

FINAL EXAM

Thursday, December 10, 9:00 – 11:30 AM

The final exam is comprehensive, includes new material on chemical kinetics, and is required of all students. The exam will include sections that correspond to the material covered on each of the three midterm exams. The score from one (at most one) section of previously tested material may be substituted for a low or missing score on one of the midterm exams. This policy will be used to deal with both excused and unexcused absences during the midterm exams.

HOMEWORK

Graded homework will be assigned on an approximately weekly basis and will normally be due at the beginning of lecture on the indicated due date.

IMPORTANT NOTE!

This is a perceived as difficult course by many students. The primary difficulty is in learning *how to set up problems* in terms of textbook and lecture material. **Homework** is designed to give you experience with this. Study groups and discussion of the problems with other students, the TA, or the instructor can be helpful are encouraged, but if you want to succeed, you need to try solving the problems on your own **first** (and without the solution manual). The material turned in should represent the student's own work and understanding.

Late homework will suffer a penalty of 25% per day late and no credit can be received after the solutions are posted. In the event of a medical or other situation that prevents you from turning in homework on time, late homework may be excused if you alert me or the TA **before** it is due.

UNITS AND NOTATION

On both homework and exams, as in real life, correct numerical answers must **include appropriate units**. Also please make appropriate use of **significant figures** in your final answers.

You may lose points for answers that lack units, have an inappropriate level of precision based on the information provided, or are illegible to tired graduate students. Nonetheless, a correct *method* of solution is more important than the numerical answer. For credit, every answer must be supported by a clear and complete explanation of the method used to obtain it, unless otherwise indicated.

EXTRA CREDIT

A student may earn up to 25 points of extra credit during the term based on

1. Lecture quizzes (up to 5 points each … there will be at least 3)
2. Presenting correct solutions to recitation questions … implementation TBD
3. You are encouraged to write and submit a 1-page report of any extracurricular activities, seminars, service, research or integrative learning that you've participated in that is relevant to physical chemistry; explain what it is and why it is relevant. (up to 5 points each, no more than 1 per week or two total; all must be submitted prior to last lecture). *One such activity is the 3rd USC Sustainability Research and Practice Showcase, taking place Sept. 22.*

Details will be described in class. Extra credit points are added to your score for the course but do not change the 550 point basis for the course.

GRADUATE CREDIT

This course cannot be used to meet the Chemistry graduate degree requirements but may qualify for graduate credit in other disciplines.

Additional work consisting of two graded written assignments worth 75 points each must be completed to receive graduate credit for the course. Please notify the instructor if you are taking this class for a graduate degree (Masters or Doctorate).

INTERNET

Grades, course information, handouts, and homework assignments, and sample exams will be available via secure hypertext transfer protocol at:

https://blackboard.sc.edu

Greytak's research group (& other courses):

http://www.chem.sc.edu/faculty/greytak/

NOTICE ON INTEGRITY

All required elements of the course are to be completed within the normal term. Failure to complete all the elements on time will result in a grade of F. Incompletes will only be assigned in unusual circumstances.

Cheating is not tolerated!!! Students (and instructor) are obliged to abide by the USC Honor Code of academic integrity. Students are encouraged to teach each other, but **all graded assignments must be completed individually**. For example, discussing the concepts needed to solve a homework problem is encouraged. Solving someone else's homework problem, or copying someone else's answers, is considered cheating. Incidents of academic dishonesty will be reported to the University's Office of Academic Integrity, which can assign disciplinary actions.

DISABILITY STATEMENT

Reasonable accommodations are available for students with a documented disability. If you have a disability and may need accommodations to fully participate in this class, contact the Office of Student Disability Services: 777-6142, TDD 777-6744, email sasds@mailbox.sc.edu, or stop by LeConte College Room 112A. All accommodations must be approved through the Office of Student Disability Services.

LEARNING OUTCOMES

Students will learn concepts of thermodynamics and kinetics that are essential preparation for careers in chemistry, biology, medicine, and engineering. In particular, students will:

- Develop quantitative descriptions of the energies and rates associated with chemical and physical transformations of matter
- Derive new thermodynamic results from the basic laws of thermodynamics
- Solve realistic problems in chemistry using the principles of thermodynamics and kinetics together with appropriate use of reference data.
- Learn to express a physical question as a mathematical problem and use methods up to and including multivariable calculus to solve that problem

TENTATIVE COURSE SCHEDULE

Date			#	Topic			Due
AUG	20	Th	1	Ch. 1	Sec 1,2; also F3	Properties of Gases	
	25	T	2		Sec 3,4		
	26	W				*Last day to add or drop w/o* W	
	27	Th	3	Ch. 2	Sec 1-3	First Law	HW 1
SEP	1	T	4		Sec 4	Enthalpy and Heat Capacity	
	3	Th	5		Sec 5,7,8	Reaction Enthalpies	HW 2
	8	T	6		Sec 6,9		
	10	Th	7	MB2		Exact Differentials	HW 3
	15	T	8	Ch. 2	Sec 10-12	Physical Properties	
	17	Th		**Exam I**			
	22	T	9	Ch. 3	Sec 1	Second Law	
		6:30p				*Sustainability Research & Practice Showcase*	
	24	Th	10		Sec 2,3	Heat Engines	HW 4
	29	T	11		Sec 5,8	Third Law and reaction entropies	
OCT	1	Th	12		Sec 6,7,8	Thermodynamic Potentials	HW 5
	6	T	-			*Flood*	
	8	Th	-			*Flood*	
	13	T	13		Sec 6-9		
	15	Th	15	Ch. 4	Sec 1-4	Phase Equilibrium	HW 6
	19	M				*Last day to drop without receiving* WF	
	20	T		**Exam II**			
	22	Th		No class – Fall Break			
	27	T	16	Ch. 4	Sec 4,5		
	29	Th	17	Ch. 5	Sec 1-5	Simple Mixtures	
NOV	3	T	18		Sec 5	Colligative Properties of Solutions	HW 7
	5	Th	19		Sec 5,10,11	Activities of Solvents and Solutes	
	10	T	20	Ch. 6	Sec 1-4	Chemical Equilibrium	HW 8
	12	Th	21-22		Sec 5-9	Equilibrium Electrochemistry	
	17	T	23	Ch. 21	Sec 1-3	Chemical Kinetics – review	HW 9
	19	Th		**Exam III**			
	24	T	24	Ch. 21	Sec 4, 6-7	Chemical Kinetics – multi-step reactions	
	26	Th		No class – Thanksgiving			
DEC	1	T	25	Ch. 21 Ch. 22	Sec 5 Sec 4-5	Transition State Model	
	3	Th				Review / Outlook	HW 10
DEC	**10**	**Th**		**Final Exam: 9:00–11:30 AM, PSC 006**			

Reading assignments, lecture topics, and homework due dates may deviate from the tentative schedule shown above, but exam dates will remain firm.