Chemistry 346   **Section M001**   **Fall 2021**

Class Schedule: MWF 11:40 -12:35, 105 Life Sciences

Instructor: Prof. Chaiken, Office 2-010 CST, jchaiken@syr.edu telephone ext. 4285; office hours: Monday 1:00 - 2:00, and by appointment.

Teaching Assistants: Alec Beaton aabeaton@syr.edu and Minh Quan Hoang Dinh midinh@syr.edu. Office meetings for all TAs are by appointment and please use email to set up appointments etc.

Textbook: Thermodynamics, Statistical Thermodynamics & Kinetics, third edition by Thomas Engel and Philip Reid (Pearson, 2013). This can be obtained in many ways that we will discuss on the first day of class.

Syllabus

Background: This is the first course in physical chemistry. Physical chemistry is the branch of chemistry that describes, analyzes, and explains chemical phenomena in a general way. It is not concerned with describing specific chemical reactions or particular properties of individual chemical substances. Rather, it seeks to explain how properties are related and how they can be explained on the basis of general laws. Some of these laws are macroscopic, like thermodynamics, and some are molecular, like quantum mechanics. Because these laws are usually general and sometimes abstract, they are almost always in mathematical form. The good thing about mathematical laws, as compared to specific chemical properties, is that there is less to remember. On the other hand, memorizing isn't enough: one has to understand what the laws mean in order to know when and how to use them.

The branches of physical chemistry include thermodynamics, reaction kinetics, quantum chemistry, and statistical mechanics. In this first semester, CHE 346, we are concerned with thermodynamics and its chemical applications. Thermodynamics describes the interactions of energy and matter or, if you take the name literally, the relation between heat and energy. Everybody has heard of the Laws of Thermodynamics, and we will have plenty to say about them in this course. We will discuss the three main laws and try to clarify their meaning by giving chemical applications.

Although it is interesting to think about what the laws "really mean", understanding of the Laws comes more from using them rather than from thinking about them. It should be emphasized that only when you can apply thermodynamics to specific problems can you say you really understand it. Thus, it is important to be able to work out problems. We will do some problems in class in the limited time we have, and there are worked problems in the text for you to look at, but you must do problems yourself in order to adequately understand the subject. The automated problem/answer system "Mastering Chemistry" will be used in this course as a way for you to study the material. This system provides hints for each problem.

The treatment of thermodynamics of the first 2/3 of this class will follow the usual treatment

derived directly from experiments at the macroscopic level. This will be followed by what is called "statistical thermodynamics" the derivation of the laws of thermodynamics from a microscopic point of view. If this is attempted using classical mechanics, it's found that there are discrepancies with macroscopic observations. The use of quantum mechanics removes these difficulties. This will be followed by the related subject of chemical kinetics and a variety of special topics TBA.

Pre/Co-Requisites: The mathematics we need to use the laws is mostly algebra, with a little trigonometry and a little calculus (like knowing how to differentiate and integrate, and understanding when to do one rather than the other). **MAT 286 or MAT 296 are required for registration for CHE 346**.

PHYS 212 is a co-requisite, i.e., either you have had or are taking this course. Some students have more trouble with the mathematics than with physical chemistry itself. Even though they can do the mathematical manipulations, they have trouble when the variables are called S and T instead of x and y. Often, remembering what the symbols mean is helpful when deciding what to do with them. We will emphasize the meaning of equations and formulas when we present and use them.

Midterm Exams: There will be three one-hour examinations and a comprehensive two-hour final exam (see schedule below). The final examination will be Dec 16, 12:45pm-2:45, in our regular classroom, 105 Life Sciences. The exams will consist mostly of problems and there may also be some short-answer or multiple-choice questions. There *may* be a question or two on each examination that will require the student to show work to get the answer allowing partial credit to be given when appropriate.

There will be **no make-ups** for the hourly exams. A student with a valid medical excuse, a valid student-athlete excuse or a valid religious observance excuse (travel periods before and after the actual observance are not considered excusable by SU) who has missed one hourly exam, and who has promptly provided written documentation related to the missed exam, can have the averages of the remaining two hourly exams used as the score for the missed hourly exam. ("Prompt" means *before* the exam, except for medical excuses.) It must be clear from the excuse why the student could not take the exam at the scheduled date and time. No more than one hourly exam can be missed. I will make special arrangements for a student with a second or third missed hourly exam(s).

All examinations will be conducted with students using Chemistry Department provided calculators. These calculators can be examined and used for practice in advance asking the TAs. **No other electronic devices will be operating during exams**, not phones, tablets or any others. Exams will be provided on hardcopy and answers will be bubbled onto Scantron sheets.

Final Exam: There is no excuse for missing the comprehensive final exam. A student failing to take the comprehensive final exam at the scheduled date and time may gain the right to take a make-up final exam provided that the following conditions are met *in advance*. The student must have a valid medical excuse, a valid student - athlete excuse or a valid religious observance excuse (travel periods before and after the actual observance are not necessarily considered excusable periods). The documentation pertaining to the missed final exam must be promptly

presented and reasonable time must be allotted for preparing the make - up final exam. In this case, a comprehensive make up final exam, 2 hours in length, may be taken in place of the excused final exam.

Grades: Final course grades will be assigned based on total points earned on the student's best two of the three midterm examinations and the Final exam which *must* be counted. **Assume** that each of the three hourly exams will have a total of 100 points. On that basis the final exam will count 200 points for a total of 400 possible points. In recent previous years, to get a grade of A or A-, it took *about* 350/400 total points. It took 275 points to get a grade between B- and B+, and 150 points to get a grade between C- and C+. If your total score is trending towards less than 100 points, you will not pass this course. Since we grade *on a curve*, the absolute points required change, but not significantly year to year, these projections should be considered "guesstimates" at best. We will discuss grading on the first day of class.

Academic Integrity: Academic honesty is expected of all students. Any incidence of academic dishonesty, as defined by the SU Academic Integrity Policy (http://academicintegrity.syr.edu), will result in both course sanctions and formal notification to the relevant College. In this course, students are allowed and encouraged to work and study together. However, copying on exams or consulting outside sources of information during an exam is not tolerated.

Disability Accommodation: Students with a disability who may need special accommodations should notify the instructor during the first week of class and have an updated accommodation letter. To obtain authorized accommodations, the student must register with the Office of Disability Services (ODS), 804 University Avenue, Room 309, 315 - 443 - 4498. Accommodations and related support services such as exam administration are not provided retroactively and must be requested in advance.

Religious observances policy: http://supolicies.syr.edu/emp_ben/religious_observance.htm, recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holy days according to their tradition. Under the policy, students are required to notify their instructors of any work that may be missed due to a religious observance. **For fall and spring semesters, an online notification process is available through MySlice/Student Services/Enrollment/My Religious Observances, from the first day of class until the end of the second week of class.** Note that travel periods before and after the actual religious observance are not considered excusable periods for missed work.

Syllabus Topics: The topics I will cover are shown in the calendar below. The chapter numbers refer to the **Engel & Reid textbook**, which we will follow somewhat closely. The dates of exams, and the dates on which specific topics are covered are noted but can change as I see fit. (See next page for schedule).

CHE 346 Schedule

1	M AUG 30	INTRODUCTION & CHAPTER 1
2	W SEP 1	CHAPTER 2 First Law I
3	F SEP 3	CHAPTER 2 First Law II
	M SEP 6	LABOR DAY HOLIDAY NO LECTURE
4	W SEP 8	CHAPTER 3 State Functions I
5	F SEP 10	CHAPTER 3 State Functions II
6	M SEP 13	CHAPTER 4 Thermochemistry
7	W SEP 15	CHAPTER 5 Entropy & the Second Law I
8	F SEP 17	CHAPTER 5 Entropy & the Second Law II
9	M SEP 20	CHAPTER 5 Entropy & the 2nd & 3rd Laws III
10	W SEP 22	PROBLEM SESSION
11	F SEP 24	FIRST EXAM
12	M SEP 27	CHAPTER 6 Chemical equilibria I
13	W SEP 29	CHAPTER 6 Chemical equilibria II
14	F OCT 1	CHAPTER 6 Chemical equilibria III
15	M OCT 4	CHAPTER 8 Phase diagrams I
16	W OCT 6	CHAPTER 7 Real gases CHAPTER 8 Phase
17	F OCT 8	CHAPTER 9 Solutions I
18	M OCT 11	CHAPTER 9 Solutions II
19	W OCT 13	CHAPTER 10 Electrolyte solutions
20	F OCT 15	PROBLEM SESSION
21	M OCT 18	CHAPTER 11 Electrochemical cells, etc. II
22	W OCT 20	CHAPTER 11 Batteries, Fuel Cells
23	F OCT 22	SECOND EXAM
24	M OCT 25	CHAPTER 12 Probability
25	W OCT 27	CHAPTER 13 Boltzmann Distribution
26	F OCT 29	CHAPTER 14 Ensembles, Partition Functions I
27	M NOV 1	CHAPTER 14 Ensembles, Partition Functions
28	W NOV 3	CHAPTER 14 Ensembles, Partition Functions
29	F NOV 5	CHAPTER 15 Statistical Thermodynamics I
30	M NOV8	CHAPTER 15 Statistical Thermodynamics II
31	W NOV 10	CHAPTER 16 Kinetic Theory of Gasses I
32	F NOV 12	CHAPTER 16 Kinetic Theory of Gasses II
33	M NOV 15	CHAPTER 17 Transport phenomena
34	W NOV 17	PROBLEM SESSION
35	F NOV 19	THIRD EXAM
36	M-F NOV 22-NOV 26	THANKSGIVING BREAK
37	M NOV 29	CHAPTER 18 Elementary chemical reactions
38	W DEC 1	CHAPTER 19 Complex reaction mechanisms I
36	F DEC 3	CHAPTER 19 Complex reaction mechanisms II
39	M DEC 6	Special Topics
40	W DEC 8	Special Topics
41	F DEC 10	FINAL REVIEW

FINAL EXAMINATION: Thursday DECEMBER 16 from 12:45pm-2:45pm

For additional help or questions, please contact me, either by email (jchaiken@syr.edu) or come by my office with your question.