CHE 349, Fall 2009: Physical Chemistry for Life Science

Instructor: Jochen Autschbach

Syllabus Revision 17. Last updated: August 21, 2009

Time, Dates, Location, Office Hours, Contact Info

Class Room: NSC 228, North Campus
Lecture Times: Tue, Thu 11:00 - 12:20
First lecture: Tue, Sep. 1
Last lecture: Thu, Dec. 10

Office Hours: Mon 4:30 to 5:30 pm, Tue 4:00 to 5:00 NSC Room **313**

Fall Recess: Wed, Nov. 25 – Sat, Nov. 28

Deadline for course resignation: Fri, Nov. 13, 11 pm (**double check with official academic schedule**)

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Please use the office hours instead of sending email for questions and problems that require an elaborate answer. Feel free to call me if you cannot attend the office hours, or make a special appointment at a different time. I also usually have some time right after class to answer questions.

Course web site at UBLearns, https://ublearns.buffalo.edu. The course web site will contain downloadable (PDF) versions of the syllabus, homework, and announcements regarding the course.

Students with special needs: Please inform me of any special needs and register with the Office of Disability Services (ODS) as soon as possible. See http://www.student-affairs.buffalo.edu/ods/ details.

I frequently send email about upcoming exams, grades posted, etc. to everyone who is enrolled in the course. Please make sure the email address you provided to UB is up to date, and check your email in particular before and after the mid term exams.

Textbook

The required textbook for the course is:
Tinoco, Sauer, Wang, Puglisi, *Physical Chemistry: Principles and Applications in Biological Sciences*, 4th Ed., Prentice Hall (2002).

Before *each lecture you need to to study the relevant pages in the textbook as indicated in the* ***Schedule*** *section below.* This will take an estimated 2 hours on average per lecture. You are strongly encouraged to work through the examples in each chapter yourself.

Overview, Goals

Physical Chemistry covers many topics that are important in Life Sciences. Why do some reactions proceed in one direction and not backwards? How can we quantify a chemical equilibrium? How fast are chemical reactions in living organisms? How can we measure this? How much energy does an organism consume? How can we detect bio–chemically relevant molecules? How can we measure their properties? How do we know the mass and the shape of a protein? Physical Chemistry provides the methods and the theoretical background to answer these and related questions.

By the end of the course you should have a clear understanding of the first and second law of thermodynamics, and of the methods of chemical kinetics by which to determine and analyze the rates of chemical reactions, in particular of enzyme reactions. Further, you will have acquired some basic knowledge of the theory of molecular structure and interactions, and of various spectroscopic methods that are used to detect molecules and to investigate their properties.

Please note: This course covers most of the undergraduate physical chemistry topics in one semester instead of the usual two semester course *and* has additional life–science related topics. Although we will not discuss many of these topics in as much depth as in the regular two–semester course, our one–semester course proceeds at a fast pace. **It is therefore essential that you prepare each lecture as mentioned above and do your homework.** We won't have much time to review mathematical techniques. There is a Math section at the end of most chapters in the textbook that you should consult in case you forgot how to take, e.g., derivatives and simple integrals or how to calculate with logarithms.

Schedule

Week 1: Molecular Structure and Interactions: Theory. **Chapter 9**, pages 436 – 479.

Week 2: Molecular Structure and Interactions: Theory. **Chapter 9**, pages 479 – 523.
Begin with **Chapter 10**, pages 530 – 543.

Week 3: Molecular Structure and Interactions: Spectroscopy. **Chapter 10**, pages 543 – 579.

Week 4: Molecular Structure and Interactions: Spectroscopy. **Chapter 10**, pages 579 – 601.

Week 5: Finish discussion of Chapters 9 and 10.

Week 6: **Mid Term Exam #1 on Oct. 6 (Tue of Week 6)**.
On Thu begin 1st law of Thermodynamics, **Chapter 2**, pages 14 – 36.

Week 7: 1st law of Thermodynamics, **Chapter 2**, pages 36 - 61.
2nd law of Thermodynamics, **Chapter 3**, pages 68 – 87.

Week 8: 2nd law of Thermodynamics, **Chapter 3**, pages 87 – 113.

Week 9: The Gibbs Energy, **Chapter 4**, pages 120 – 165.

Week 10: Physical Equilibria, **Chapter 5**. Pages 186 – 244.

Week 11: **Mid Term Exam #2 on Nov. 10 (Tue of Week 11)**.
On Thu begin Molecular Motion and Transport Properties, **Chapter 6**, pages 252 – 266.

Week 12: Molecular Motion and Transport Properties, **Chapter 6**, pages 266 – 306.

Week 13: Kinetics: Rates of Chemical Reactions, **Chapter 7**, pages 314 – 371.

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Week 14: Kinetics: Rates of Chemical Reactions, **Chapter 7**, pages 371 – 387.
Enzyme Kinetics, **Chapter 8**, pages 400 – 412.

Week 15: Enzyme Kinetics, **Chapter 8**, pages 412 – 426.
Mid Term Exam #3 on Dec. 10 (Thu of Week 15)

Exams, Homework, Grades, Policies, Miscellaneous

The course's grade will be based on average percentage scores of the three mid–term exams (see below for details). The exams will cover course material up to the lecture before the test. Each class builds upon the material covered until that point. Thus, you can expect serious difficulties if you do not attend the lectures. And you might actually learn something interesting during class. The textbook was written for a two–semester course and contains much more material than what is relevant for the exams. You have to attend the lectures to find out which topics were emphasized and which ones were skipped. I might use attendance as a criterion to decide if a student with an 'in between' score will receive the higher or lower grade (B– versus C+, say).

Over the past few years the grading scheme for the course was established as follows: 85 percent and higher: A, 80 - 85: A-, 75 - 80: B+, 67 - 75: B, 60 - 67: B-, 53 - 60: C+, 45 - 53: C, 40 - 45: C-, 35 - 40: D+ 30 - 35: D below 30: F **The final grading scheme to determine a *letter grade* will be fixed at the end of the course when I have all percentages for the 3 exams available. However, adjustments to the grading scheme listed above will only be made if this year's class performs significantly different from previous years, which is unlikely**. I will *not* assign individual letter grades for the exams.

The three three mid–term exams will last $\sim$ 80 minutes and be scheduled in our classroom during regular class hours. See course schedule. Individual exam scores will be posted as a percentage of the highest possible score. The average used to determine the letter grade will then be a 70–30 per–cent weighted average of (a) the average of the two highest scoring tests and (b) the average of the middle and the lowest scoring test. Example: If you score 80, 70, and 40 % in the three tests I will (a) average 80 and 70 to get 75%, (b) average 70 and 40 to get 55% and then calculate the final percentage score from (a) and (b) as $0.7 \cdot 75.0 + 0.3 \cdot 55.0 = 69.0$ resulting in a 'B' letter grade. Why so complicated? There are several reasons. The main reason is that a particularly low grade in one test, like the 40% score in the example, would severely damage the grade of a student who is otherwise doing well if a simple average of the three tests is taken (in the example above, the straight average is 63.3% or B–). Also, the average I am using rewards *consistent* performance.

How can you get an "A" in this course? You need to learn *and practice, practice, practice, . . .* how to carry out correct calculations. You need to be able to state a correct definition of a physical chemical phenomenon or process that was discussed in class, and understand the qualitative behavior of graphs and equations that were shown in the lectures or that were part of the homework. In addition, you need to understand the *motivation* behind the concepts introduced in this course. You will be able to show that you can *transfer* your knowledge in order to solve problems that are not exactly the same as problems that were discussed in the lecture or as part of an assignment. Most importantly, you will learn from your mistakes made in the homework and the practice exams and not make them again when it really matters (i.e. in the tests).

*For each exam, you are allowed to bring one (1) letter–size page of **hand–written** notes (equations, definitions) and a pocket calculator. You will have to hand in the page of notes along with the exam. **You can write anything you want on this sheet (but on one side only!)**.*

Practice exams will be posted at UBLearns approximately one week before a test is scheduled. *Relevant exam material covers everything mentioned in class or what was part of the homework, not just questions posted in the practice test.* However, the types of problems (e.g. there will be few multiple choice questions) and difficulty levels will be similar.

Bring a pocket calculator to the exam. I do not have spare calculators. You will need the pocket calculator.

Make–up exams may be taken only in exceptional cases (medical emergencies, car accidents on the way to the campus, etc.) in which case you need to provide proper **documentation** (letter from your physician, police report, etc.). *Getting up too late does not qualify for taking a make–up exam! Don't ask me to take*

a make–up exam if don't have a serious excuse — I cannot make any exceptions out of fairness to the other students..

You should finish your homework before the lecture one week after the questions were handed out. I will discuss the answers in class but you will get the most out of the exercises when you have worked on the problems yourself beforehand. Homework is voluntary but nonetheless extremely important — **you need to practice how to do the calculations**. Homework will not count for the course grade. "Bonus work", e.g. additional homework, in order to compensate for low grades will *not* be available for this course. Regarding incomplete grades, see http://undergrad-catalog.buffalo.edu/policies/grading/explanation.shtml#incomplete

Academic integrity as defined in UB's official guidelines will be strictly enforced. Make sure you know what is meant by "academic integrity" according to these guidelines. See http://undergrad-catalog.buffalo.edu/policies/course/integrity.shtml

There is *no final exam* after the last day of classes, even if a time and room assignment is listed (assigned automatically by UB's class scheduling system).

Important: Equal and fair treatment of each student in this class is of paramount importance. Regarding the final grades this has the following consequences: Unless you find an error in my calculation of the grade or the percentages do not ask me to change an assigned letter grade, even if it is infinitesimally close to the cut–off percentage for the next better grade. Likewise, a grade will not be adjusted simply because someone intends to apply to law/medical/dental/etc. school.

Now: sit back, relax, and enjoy the course.