

CH 3300 – Introduction to Physical Chemistry
MWF 10:10 – 11:00
G-033 Jordan Hall

Dr. Brian N. Dominy
Office: 367 Hunter Chemistry Labs
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Syllabus for CH-3300 Introduction to Physical Chemistry

Overview: This class will introduce concepts of physical chemistry particularly relevant to the medicinal and life sciences. While developing the tools to solve quantitative problems in the physical sciences is an integral part of this class, an emphasis will be placed on developing a deeper conceptual understanding of the physics that forms the foundation of chemistry.

Textbook: Physical Chemistry for the Life Sciences; Atkins and de Paula; ISBN: 0-7167-8628-1

Learning Objectives: At the conclusion of this course, students will be able to: 1) Calculate changes in thermodynamic properties associated with both phase transitions and chemical reactions. 2) Calculate changes in thermodynamic properties as a result of changes in the environment (e.g. temperature and pressure) 3) Mathematically derive thermodynamic equations. 4) Mathematically derive chemical reaction kinetics equations for reactions of varying complexity. 5) Calculate changes in chemical reaction rates as a result of changes in the environment.

CT² Learning Objectives: 1) Qualitatively explain the quantitative relationships (equations) between thermodynamic properties. 2) Explain the assumptions underlying fundamental thermodynamic and kinetic models. 3) Deduce the appropriate kinetic model for a broad range of chemical reactions. 4) Describe these typical spontaneous processes using thermodynamic equations. 5) Evaluate different *mechanisms* proposed for quantum mechanical phenomena. 6) Refine definitions of energy, entropy, heat, and work. 7) Reflect on common misconceptions regarding how the universe works.

Late Policy: Students may leave after 15 minutes if the professor or a guest lecturer does not arrive in that time.

Attendance Policy: Attendance will not be taken, but is highly recommended. Occasional, in-class, group exercises will comprise 5% of your final grade. Tentative test dates are listed in this syllabus.

Academic Integrity:

Official Clemson statement: “As members of the Clemson University community, we have inherited Thomas Green Clemson’s vision of this institution as a ‘high seminary of learning.’ Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form.”

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Our Class statement: Academic dishonesty can be a very harmful habit both inside and particularly outside of the university setting. It will benefit everyone, most importantly yourselves, to avoid this destructive habit. As a result, academic dishonesty, including but not limited to cheating and plagiarism, will not be tolerated in this class.

Disability Statement

Students with disabilities requesting accommodations should make an appointment with Dr. Arlene Stewart (656-6848), Director of Disability Services, to discuss specific needs within the first month of classes. Students should present a Faculty Accommodation Letter from Student Disability Services when they meet with instructors. Accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Title IX Statement

Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This policy is located at <http://www.clemson.edu/campus-life/campus-services/access/title-ix/>. Mr. Jerry Knighton is the Clemson University Title IX Coordinator. He also is the Director of Access and Equity. His office is located at 111 Holtzendorff Hall, 864.656.3181 (voice) or 864.565.0899 (TDD).

Grades: Grades will be based on quizzes, homeworks and 4 exams (including the final exam).

Homeworks: 10%
In class quizzes: 5%
Exams: 60%
Final Exam: 25%

If your final exam grade is higher than your lowest regular exam grade, the lowest regular exam grade will be dropped and replaced with your final exam grade. Your lowest homework grade will be dropped. If you have an overall A average (based on the Homework, Quizzes, and 3 regular exams) AND an A average on the 3 regular exams directly prior to the final exam, you will not be required to take the final exam.

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Assessments: (This includes Homeworks, Quizzes, and Exams including the Final exam). What kinds of questions should you expect in the assessments of this course? First, you should expect similar TYPES of questions in each of the 3 formats (homeworks, quizzes, and exams). Approximately 80% of these questions will be conceptual questions and 20% will involve applying mathematical tools to solve a practical/applied problem. The exact percentages will vary, but an emphasis will be placed on assessing *conceptual understanding*.

Homeworks: Homework will be done online through the blackboard system. Questions will include both conceptual and quantitative questions similar in type to those you will encounter on the exams.

Late homeworks: Homeworks will be due by 5:00pm on the day specified. 20% will be deducted from the homework grade after 5:00pm. An additional 20% will be deducted for each 24-hour period thereafter.

Exams: Exams will be multiple-choice exams containing approximately 75% conceptual questions and 25% quantitative questions.

Make-up exams: Make-up exams, quizzes, and/or homeworks are possible ONLY with a written medical or university excuse. It is the student's responsibility to give the professor the written excuse and to arrange for any makeup work to be done BEFORE the exam for that section is taken. All makeup exams will be given on the last day of the semester unless an alternative date is agreed upon.

Quizzes: Quizzes will be group exercises performed in groups of 5 students. They will focus on conceptual questions similar in type to those you will encounter on the exams.

Grade Scale:

90 – 100	A
80 – 89	B
70 – 79	C
60 – 69	D
0 – 59	F

Class Preparation: It is recommended that you read the relevant sections in your textbook prior to coming to class.

Office hours: I am frequently in the office during the day, and you are welcome stop by if you have a question. To ensure I'm in the office when you stop by, feel free to email me to make an appointment.

Tentative Weekly Topical Schedule:

Week 1: Introduction, What does it mean to think critically? What is the difference between training and education? Kinetic theory of gasses, Microscopic basis of macroscopic properties (ex. P and T), *Critical thinking assessment (Pre-“test”)*.

- **Reading:** Fundamentals (Chapter 0) – Atoms, Ions, and Molecules; Bulk Matter; Energy

Week 2: 1st law of thermodynamics (energy conservation), Internal energy and enthalpy, Mechanisms of energy transfer (heat and work), Why are heat and work NOT state variables? Reversibility. Gasses as both a relevant application and a model system, What is energy? What are variables of state? Systems vs. environment.

- **Reading:** The First Law (Chapter 1)

Week 3: 2nd law of thermodynamics (entropy isn't conserved), 3rd law of thermodynamics (Under what conditions is entropy smallest?), Micro and macroscopic descriptions of entropy

- **Reading:** The Second Law (Chapter 2) – Sections 2.1, 2.2, 2.3, 2.4

Week 4: Spontaneity and Equilibrium, Gibbs and Helmholtz energies as useful tools, The relationship between Gibbs energy and work

- **Reading:** The Second Law (Chapter 2) – Sections 2.5, 2.6, 2.7, 2.8

Week 5: *Exam I*, Physical applications of equilibria (Phase equilibria),

- **Reading:** Phase Equilibria (Chapter 3) – Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6

Week 6: Thermodynamics of mixtures, Chemical potential (Equilibrium between gas and solution phases), Ideal solutions (Why is it “ideal”? Relationship to entropy, ideal gases), Activity and Real solutions, Colligative properties (Relationship to entropy)

- **Reading:** Phase Equilibria (Chapter 3) – Sections 3.7, 3.8, 3.9, 3.10

Week 7: Chemical applications of equilibria, Gibbs energy of reactions as a function of composition, Standard Gibbs energy of reaction, Equilibrium constant, The Effects of catalysts/pressure/temperature on Equilibrium

- **Reading:** Chemical Equilibrium (Chapter 4) – Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6

Week 8: Chemical applications of equilibria: Proton transfer examples

- **Reading:** Chemical Equilibrium (Chapter 4) – Sections 4.7, 4.8, 4.9, 4.10, 4.11

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Week 9: *Exam 2*, Rates and Kinetics, Distinctions from thermodynamics, Using differential equations to describe rates, Discovering connections to thermodynamics (approaching equilibrium)

- **Reading:** The Rates of Reactions (Chapter 6) – Sections 6.1, 6.2
- **Reading:** Accounting for the Rate Laws (Chapter 7) – Section 7.1

Week 10: Orders of rate laws, Identifying/validating rate laws through experimental data, Integration of rate laws, Effect of temperature and pressure on reaction rates

- **Reading:** The Rates of Reactions (Chapter 6) – Sections 6.3, 6.4, 6.5, 6.6, 6.7

Week 11: Rate laws for complex (non-elementary) processes, Simplifying/“Idealizing” rate laws and their integration, *Critical thinking assessment (Post-“test”)*.

- **Reading:** Accounting for the Rate Laws – Sections 7.2, 7.3, 7.4, 7.5, 7.6, 7.7

Week 12: Introduction to Quantum Mechanics, The loss of physical intuition and common logic, The reliance on mathematical intuition, How do we think critically about QM? Blackbody radiation and Planck’s tiny (packet) idea. Why do chemists care? A: Electrons, Electrons, Electrons. Is light a particle or a wave? Are electrons particles or are they waves? Double slit experiment.

- **Reading:** Microscopic Systems and Quantization – Sections 9.1, 9.2

Week 13: Schrodinger, a cat, and a “wavefunction”. The uncertainty of Heisenberg. A particle and a box

- **Reading:** Microscopic Systems and Quantization – Sections 9.3, 9.4

Week 14: Using QM to calculate things you can measure, The amazing accuracy of QM

- **Reading:** Microscopic Systems and Quantization – Sections 9.4, 9.5, 9.6

Week 15: Remaining challenges in QM: Entanglement, Collapse, Gravity, *Exam 3*

Exam Dates (Details may change depending on the pace of the class):

Section 1 Exam (chap. 1, 2) – Oct. 2nd

Section 2 Exam (chap. 3, 4, 5) – Oct. 30th

Section 3 Exam (chap. 6, 7, 9) – Dec. 2nd