CHM 3400
Physical Chemistry for the Biosciences
Spring 2025

Class # **22723**

Sections P342

Canvas e-learning site:
All communications must be done through the e-learning site, including homework, deadlines, grades, and announcements. It is your responsibility to check this site for updates. Please do not email the instructors (or the TAs) personal email accounts.

Schedule:
M,W,F: Period 2 8:30 - 9:20 AM, MCCA G186

Professors:
Dr. Alberto Perez. Leigh Hall, Room 240 F

Office Hours: TBA

Graduate Teaching Assistant: Imesh Ranaweera, Binod Perera
Office Hours: TBA

Undergraduate Graduate Teaching Assistant: Ayden Moran, Casey Sun, Nguyen Thanh Tri
Office Hours: TBA

Prerequisites: CHM2210 (or CHM2200), MAC 2312 and two semesters of college physics.

Textbook:
We recommend:
"Physical Chemistry for the biosciences", Raymond Chang

"Physical Chemistry: Principles and Applications in Biological Sciences", Tinoco, Sauer, Wang, Puglisi, Harbison and Rovnyak.

This textbook is not required, but you should have access to an undergraduate Physical Chemistry Book that includes thermodynamics and kinetics.

Homework:

There will be homework assigned nearly every week. Homework is due one week after it is assigned. It has to be turned in before or at the beginning of the lecture class. They will be graded and returned. Solutions will be provided after the deadline. Answers should be turned in on time and should be neat and legible. Write your name and UFID clearly on each page. Computer-typed is preferable. Each problem must be solved in a different page. Each homework problem has to show the full derivation. Units and numerical results will be checked and graded. Several of the homework assignments involve interpretation of computational and experimental data. When preparing graphs, you must use Excel or a comparable graphing program. If you are doing a curve fit you must justify the choice of fitting function. No points will be given for a final result without justification. There will be no partial credit for late homework. If not turned in before or at the deadline, the grade will be zero.
While you might work in groups the homework assignments must be turned in individually, thus you must turn in your own work to receive any credit! Any sort of plagiarism will not be tolerated. You must also reference the other members of your study group. Failure to adhere to these requirements will result in zero credit for the assignment.

Submitting Homework: All homework will be submitted via canvas. Upload as a single pdf file. This can be your scanned hand-written work – but make sure that it is legible (especially if you are writing with a pencil).

Exams: There will be two progress exams. Conflicts with these exams' dates should be resolved with the instructor no later than one week prior to the exam date. The exam dates will be announced shortly. Final Exam: TBA

First midterm Tentative on February 17th
Second midterm Tentative April 16th

Grading: The grade will be determined by Homework (45%), Participation (5%) 2 progress tests (30% total) and a final exam (20%).

There will be 8-10 HW depending on how we progress. Participation score will be based on reviewing a classmates HW: for each HW submitted, you will be assigned 1 random HW to grade based on a rubric we provide. The goal is

Students can decide not to take the final exam. If they choose not to take it, then the two midterms will count for 55% of the grade. If they do decide to take the final, their grades could go up or down, so they should choose carefully. We will not take the better of the grades. This decision can be made as late as the last week of classes. The grades are absolute, there will be no curve grading.

Grading scale:
A > 90

A- 87.5 to 89.99
B+ 82.5 to 87.49
B 77.5 to 82.49
B- 75 to 77.49
C+ 72.5 to 74.99
C 67.5 to 72.49
C- 65 to 67.49
D+ 62.5 to 64.99
D 57.5 to 62.49
D- 55 to 57.49
E <60

Attendance: Lecture attendance is essential for your success in this class. However, we will not take roll. The hand-written notes of each class will be uploaded to canvas at the end of each class.

We will set up automatic class recordings to be uploaded here: https://mediasite.video.ufl.edu/Mediasite/Channel/chm3400/browse/null/title-az/null/0/null
These are automatically done independent from us, do let us know if there are systematic issues (e.g. sound), so we can address it for future classes.

We will also upload class notes to canvas.

Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. Find more information in the university attendance policies.

Disabilities: Students with disabilities requesting accommodations should first register with the Disability Resource Center by providing appropriate documentation. Once registered, students will receive an accommodation letter, which must be presented to the instructor when requesting accommodations. Students with disabilities should follow this procedure as early as possible in the semester.

Counseling: The University of Florida provides counseling services for students, staff, and faculty. See https://counseling.ufl.edu or call (352) 392 1575 during regular service hours (8 am– 5 pm). For other hours or on weekends call the Alachua County Crisis Center (352) 264 6789.

Cell Phones: Please put all cell phones and other digital devices on "silent mode" during all class periods. During exams, your cell phone must be placed on the table in front of you, face down, for the entire test period.

Honor Code: This class will operate under the policies of the student honor code, which can be found at: https://sccr.dso.ufl.edu/process/student-honor-code/
The students, instructors, and TAs are honor-bound to comply with the Honors Pledge: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity by abiding by the Honor Code.

On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied:

THE PLEDGE

"On my honor, I have neither given nor received unauthorized aid in doing this assignment."

Academic Honesty:
Students are expected to obey the University of Florida Honor Code, detailed at http://regulations.ufl.edu/chapter4. Violations, including plagiarism, will be reported to the Office of Students Judicial Affairs.

Learning Objectives:

Chapter 2: First Law

- To understand the difference between state functions and path dependent functions

- To connect the first law of energy conservation with heat and work

- To be able to calculate heat, work, enthalpy and internal free energy in a thermodynamic process

- To relate how thermodynamic cycles help us to calculate unknown quantities (e.g. free energy) through alternative pathways that we know how to calculate.

- To relate free energy changes at constant pressure or volume with the heat capacities.

- To differentiate between reversible and irreversible processes.

Chapter 3: The second law: the entropy of the universe increases

- To relate spontaneity of processes in isolated systems with the entropy change, and spontaneity with free energy changes.

- To calculate the entropy change for a process for the universe, surrounding and system

- To relate the meaning of entropy to the set of microscopic states accessible to the system

- Temperature vs entropy, T vs enthalpy changes across phase changes

- To calculate state functions for a reaction, and how to calcualte for a different temperature than tabulated.

- To calculate changes in free energy with pressure and temperature.

Chapter 4: Free Energy and Chemical Equilibria

- To relate the tabulated standard free energy of a reaction with the equilibrium constant

- To derive the relationship between free energy and chemical potential

- To calculate equilibrium constants at different temperatures through Van't Hoff's equation.

- Definitions of activities for different states of matter, ideal/real gases and solutions.

- To relate the free energy of a reaction with the extent of the reaction, reasoning about direction for spontaneous behavior and equilibrium.

Chapter 9: Kinetic Mechanisms and rate laws

-To derive the rate laws for 0th, first and second order reactions

-To derive the overall rate of a reaction based on the elementary steps and the molecularity of the reaction

-To use plots of concentration, ln(concentration) and 1/concentration vs time to determine the overall rate of a reaction

- To determine the overall rate in situations where competitive and parallel reactions take place.

GatorEvals:

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

Course Syllabus

(Tentative schedule)

Note: Items marked with an asterisk (*) will depend on the time available. References to chapters are based on

Tinoco's Physical Chemistry Book (5th edition).

Class 1: Introduction to CHM3400 -- Physical Chemistry for biosciences [Chapter 1]

Class 2: Definitions: system and surroundings. Work and heat. The first law. [Chapter 2]

Class 3: State and path variables. Ideal gases [chapter 2]

Class 4: Enthalpy. [chapter 2]

Class 5: Processed for Ideal gases (isocoric, isobaric, isothermic, adiabatic). Solids and liquids [Chapter 2]

Class 6: Phase changes. [chapter 2]

Class 7: Chemical reactions [end of chapter 2]

Class 8: Entropy, The Second Law

Class 9: Molecular interpretation of entropy

Class 10: Entropy of a phase change, intro to Gibbs free energy

Class 11: Interpretation of Gibbs free energy

Class 12: Temperature and Pressure dependence of Gibbs Free Energy.

Class 13: Helmholtz Free Energy. Free Energy and Chemical Equilibria.

Class 14: Chemical Potential (Partial Molar Gibbs Free Energy).

Class 15: Activities, Van't Hoff equation

Class 16: Midterm practice review 1

Class 17: Midterm Practice review 2

Class 18: Brief Recap Thermodynamics

Class 19: Intro to Kinetics

Class 20: 0th and 1st order rates

Class 21: Kinetic mechanisms, molecularity, 2nd order rates (Class I)

Class 22: 2nd order (Class 2), parallel reactions, competitive reactions

Class 23: Biochemical Applications of Thermodynamics

Class 24: Kinetics: Rates of Chemical Reactions.

Class 25: Kinetics. Reaction Mechanisms and Rate Laws. Temperature Dependence.

Class 26: Transition-State Theory. Electron Transfer Reactions: Marcus Theory.

Class 27: Ionic Reactions and Salt Effects. Isotopes and Stereochemical Properties.

Class 28: Very Fast Reactions. Diffusion-Controlled Reactions.

Class 29: Photochemistry and Photobiology. Photosynthesis.

Class 30: Enzyme Kinetics. Michaelis-Menten Kinetics. Competition and Inhibition.

Class 31: Spectroscopy principles

Class 32: Molecular dynamics of proteins and nucleic acids: kinetics and relative binding affinities.