MISSISSIPPI COLLEGE
A CHRISTIAN UNIVERSITY

# Chemical Dynamics (Physical Chemistry I)

CHE 317 Section A | Fall 2025
Total Credit Hours: 4 Lecture and Lab
Classroom: Hederman Science Room 312 | Lab: Hederman Science Rooms 405 & 408
Meeting Time: MWF 10:00 – 10:50 am | Lab: Wednesday 12:30 – 3:20 pm.

## Instructor

David H. Magers, Ph.D.
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Campus Mail: Box 4036
Office Location: Hederman 418
Office Hours: Monday 2:00 – 3:30 pm, Tuesday 2:00 – 3:30 pm,
Thursday:3:30 – 4:30 pm, other times by appointment

## Course Description

A study of the thermodynamics and kinetics of chemical processes.

## Rationale for Course

Physics is the fundamental science, while chemistry is the central science. Thus, this first course in physical chemistry is a study of the fundamentals of the central science. It not only presents the underpinnings for much of the chemistry which a student has already encountered, it provides a foundation in physical chemistry for all future chemical study. Development of problem solving and critical thinking skills are stressed.

## Prerequisites

Differential and integral calculus, general physics, and CHE 241. The latter may be taken as a co-requisite.

## Instructional Materials

The required texts are *Thermodynamics, Statistical Thermodynamics, and Kinetics, 4$^{th}$ edition* by Thomas Engel and Philip Reid. In addition to this text you will need a scientific calculator. General procedures for individual laboratory experiments will be distributed as well as many of the class notes.

## Methods of Instruction

Class will consist primarily of lectures and working problems.

## Course and Lab Overview:

The course covers material presented in chapters 1-9, 12-13, and 16-20 of the textbook. The laboratory provides the opportunity to measure physical and chemical constants related to the theory studied in class. In addition to demonstrating established principles and reinforcing and expanding one's understanding of the basic concepts; the lab should help to develop research aptitudes by providing experience with the types of experiments and instrumentation that can yield new results in a given field. In addition, statistics will be emphasized in determining how precisely a given physical or chemical constant was measured. In short, the aim is to train not lab techs, but research scientists.

## Brief Course Outline:

I. Mathematical Review
II. Equations of State
III. Critical Behavior of Fluids
IV. Partition Functions
V. First Law of Thermodynamics
VI Second Law of Thermodynamics
VII. Third Law of Thermodynamics
VIII. Free Energy
IX. Phase Equilibria
X. Chemical Equilibria
XI. Ideal and Real Solutions
XII. Kinetic Theory of Gasses
XIII. Chemical Kinetics

## Required Practices:

You are expected to read the appropriate sections of your text and work any problems assigned before coming to class. Periodically throughout the semester special problem sets or sets of questions will be distributed which must be completed for a grade. These grades will be added to any quiz grades recorded. Also, as previously mentioned, you will need a good scientific calculator and be fairly proficient with it.

## Methods of Evaluation:

Two or three tests will be given during the semester, each with a value of 100 points. These tests will most likely be given after the study of the first law, after the study of chemical equilibria, and after the study of chemical kinetics. Announced and unannounced quizzes are occasionally given, the total number of quiz points and points from homework assignments will be approximately 75. Quizzes that are missed are **not** made up. The final exam is comprehensive and is worth 150 points. Laboratory participation, laboratory computer assignments, and lab reports together total 125 points. The course grade is determined by dividing your grand total by the total possible points. Final letter grades are determined on an 11-point scale. Please refer to the *Mississippi College Undergraduate Bulletin* for a discussion of the university's grading system and how quality points are assigned.

## MC Syllabus Statement:

The MC Syllabus contains all policies and procedures that are applicable to every course offered by Mississippi College, both on campus and online. The policies in the MC Syllabus describe the official policies of the University as they relate to instruction and will take precedence over those found elsewhere. It is the student's responsibility to read and be familiar with every policy. The MC Syllabus may be accessed at any time on the MC website at the following: https://www.mc.edu/provost/mcsyllabus.

## MC Honor Code

A fundamental principle of academic, business, and community life is honesty. Mississippi College has adopted an Honor Code that applies to all members of our academic community. The code is as follows: “As a member of the Mississippi College community, I will live, speak, and work in a way that honors myself and others around me. I will hold myself and others to the highest standards of virtue and truth.” Upon accepting admission to Mississippi College, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor Code. As such, academic dishonesty is not tolerated. Students will be required to affirm this statement on examinations, research Academic Affairs—2.19 Academic Honesty 2 papers and other academic work. Ignorance of the rules does not exclude any member of the Mississippi College community from the requirements or the processes of the Honor Code. For additional information, please visit: https://mc.edu/provost/honorcode.

## Additional Course Policies:

1. Cellphones are a distraction to everyone. Do not have your phone out and/or in use during class.
2. Computers/tablets are acceptable in class for course work and taking notes. These should not be used for shopping, streaming videos and/or messaging.
3. Please ask for permission before recording lectures. You are welcome to take pictures of the board at any time during class.
4. Lecture exams may not be made up. If there is a school related event that conflicts with an exam date, please make arrangements so that the assessment can be taken in advance. If the missed exam is due to a documented illness, the instructor and student can determine the best possible resolution.
5. The final exam date is published by Mississippi College. Any changes to the schedule must be approved by the Dean of the college.

## Disclaimer:

The instructor reserves the right to modify the schedule proposed in the syllabus as necessary. Modifications will be provided in writing.

## Important Dates:

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| Mid-term | Wednesday, October 8, 2025 |
| Last Day to Drop a Class | Friday, October 24, 2025 |
| Homecoming | Saturday, October 25, 2025 |
| National Chemistry Week<br>Theme: The Hidden Life of Spices | October 19-25, 2025 |
| Mississippi ACS Awards Banquet and Research Symposium at MC | November 13, 2025 |
| Thanksgiving Break | November 22-30, 2025 |
| Final Exam | Monday, December 8th from 8 – 11 am. |

## Learning Objectives: (*This is not an exhaustive list.*)

1) Learn to use differential and integral calculus in chemical and physical problems.
2) Learn how to expand a function as a power series.
3) Learn how to regress experimental data with a calculator and with a spreadsheet to find the line of best fit and the correlation coefficient.
4) Learn how to numerically integrate experimental data.
5) Learn how to find roots of equations numerically.
6) Learn how to determine partial derivatives.
7) Learn how to find the total differential of a function of several variables.
8) Learn the difference between exact and inexact differentials and how these relate to thermodynamic functions.
9) Learn how to compute state functions from various equations of state, particularly for gases.
10) Learn about the virial equation and learn how to compute second virial coefficients.
11) Learn about the critical temperature, the critical pressure, and critical volume of fluids and how the behavior of different fluids are related through the Law of Corresponding States.
12) Learn what the Boltzmann Distribution is and its physical meaning
13) Learn how heat and work are related through the First Law of Thermodynamics.
14) Learn what the heat capacity of a substance is, how the heat capacity of a substance is related to the vibrational modes of the molecules which compose a substance, and learn the difference between the heat capacity at constant volume and the heat capacity at constant pressure.
15) Learn the true definition of entropy, how entropy is related to the Second Law of Thermodynamics, and how entropy is related to disorder and randomness.
16) Learn how to calculate heat, work, internal energy, enthalpy, and entropy for different chemical and physical processes.
17) Learn how to solve partial differential equations related to the First and Second Laws of Thermodynamics.
18) Learn how the Third Law of Thermodynamics defines both a zero point for entropy measurements and an absolute zero temperature.

19) Learn what is meant by free energy, how it is related to energy and entropy and to the spontaneity of a process.
20) Learn how the Gibbs free energy is related to the chemical potential of a pure substance and how the chemical potential relates to phase equilibria.
21) Learn how to approximate the activities of species in a chemical reaction and how these activities are related to the equilibrium constant.
22) Learn how the Gibbs free energy of a process is related to the equilibrium constant.
23) Learn how to solve for the extent of a reaction using the equilibrium constant.
24) Learn about Raoult's Law and what is meant by an ideal solution.
25) Learn how deviations from ideality in solutions lead to azeotropes.
26) Learn about Henry's Law and the solubility of gases.
27) From the kinetic theory of gases, learn how to compute the most probable speed, the average speed, and the root-mean-square speed of molecules of a gas.
28) Learn what is meant by the order and the half-life of a reaction.
29) Learn how to derive and use the integrated rate laws for simple kinetic reactions.
30) Learn how mechanistic reactions are related to the overall stoichiometric reaction.
31) Learn the difference between a transition state and a reaction intermediate.
32) Learn how a catalyst speeds up a reaction by lowering the activation energy.
33) Learn how to compute activation barriers by measuring how rate coefficients vary with temperature.
34) Learn about complex reaction mechanisms and their rate laws.
35) Learn the difference between photophysical and photochemical processes.
36) Learn what a Jablonski diagram is.
37) Learn the difference between fluorescence and phosphorescence.
38) Learn how Marcus theory relates to electron transfer.
39) Learn the levels of macromolecular structure.
40) Learn how macromolecules are usually characterized.