

# Chem 3250: Chemical Thermodynamics

Instructor:

Xueyu Song

Meeting Time and Location: MWF 1:10-2:00pm, Gilman 1051

Office Hours: MW:4-5pm at Gilman 2758 or by appointment  
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Grader: Jayme Brickley, jaymeb@iastate.edu, Office: 310 Wilhelm Hall  
Office Hour: Thur:3-4pm or by appointment

Syllabus:

## Learning Objective

In Chem 325 you will learn three laws of thermodynamics and their molecular foundations, and their applications to various thermodynamic systems, especially problems related to chemical reactions and phase transformations of materials.

### I The Properties of Gases

- Ideal gas law
- Van der Waals equation of state
- Virial expansion of equation of state and interaction potential

### II The First Law of Thermodynamics

- Work, heat and energies
- State function and reversible processes
- Enthalpy and applications to chemical reactions

### III The Second Law of Thermodynamics

- Entropy and spontaneous process
- Entropy and the disorder
- Statistical meaning of entropy

### IV The Third Law of Thermodynamics

- The determination of entropy and the third law
- Calculation of entropy

### V Statistical Thermodynamics

- The energy levels of atoms and molecules

- Boltzmann factor and partition functions
- Simple examples of partition functions
- Molecular picture of three laws of thermodynamics

## VI Helmholtz and Gibbs Energies

- The meaning of free energies
- Maxwell relations
- The standard state and calculation of thermodynamic functions
- Fugacity as a measure of nonideal behavior of gases

## VII Phase Equilibria

- Chemical potential and Gibbs phase rule
- Typical phase diagram of matter
- Clausius-Clapeyron relation

## VIII Solutions

- Partial molar thermodynamic properties
- Gibbs-Duhem equation
- Ideal solution and activity of real solutions
- Calculation of thermodynamic properties of solutions

## IX Chemical Equilibrium

- Application of thermodynamics to chemical reactions
- Equilibrium constant and its calculations

## X Thermodynamics of Electrochemical Cells

- What is an electrochemical cell
- Thermodynamical Measurements of electrochemical cells
- Thermodynamic properties of individual ions
- Batteries

## Course Mechanics:

- Attendance is required.

- **Problem Sets:** Assignments will be posted on Canvas with due dates. Problems are due at the end of class on the due date - no exceptions, no excuses, unless the Dean of Students notifies me that you have a personal emergency. No credit will be received for homework sets handed in late. Feel free to work with other students on the homework, but you must turn in your own individual set of solutions. No plagiarism is allowed. Answers to problem sets will be posted to Canvas after the class when the assignment is due.
- **Examinations:** There will be **three** hour examinations and a final. The three hour exams will be on , **Sept 27, Oct 25 and Nov 22** . The date/time for the final exam will be determined by the registrar's office and will be announced as soon as the information is available. Make-up exams will be administered only in exceptional cases, which must be discussed with the instructor and which absolutely requires documentation. In some cases, at the instructor's discretion, in lieu of a make-up exam, the final grade may be comprised of the remaining requirements, each taking on a proportionally higher weighting.

*For each examination, including the final, you are permitted to use one 8.5×11" sheet of paper bearing information you deem useful on both sides. A calculator is also permitted. No other aids or texts are allowed.*

**Note: Illegible exams or problem sets will NOT be graded. All work must be presented reasonably neatly and logically.**

- **+/- grading will be used.** The grade will be determined as the following: home work(10%), hour exams (20% each) and final(30%). There is no curve for the course. Grades will tentatively be assigned as follows: 100-90:A, 89-75:B, 74-50:C, 49-40:D, < 40:F.

Required Book: D.A. McQuarrie and J.D. Simon, Molecular thermodynamics,required textbook.

**Student Learning Outcomes.** Students completing Chemistry 324 are expected to understand at an intermediate level the topics listed above in the syllabus.

**Canvas,** <https://canvas.iastate.edu/>. This site provides access to the syllabus, general resources, announcements, answer keys, and other miscellaneous class materials.