

Chem 2103

Syllabus

Title

Physical Chemistry I

Course Description

Basic principles of thermodynamics. Development of the laws of thermodynamics, enthalpy, entropy, and free energy, and their applications to phase equilibria, electrochemistry, and kinetics. A brief introduction to quantum mechanics.

Prerequisite

CHEM 1006 with a minimum grade of B-, or [CHEM 1002](#)

[MATH 1004](#), [MATH 1107](#)

[PHYS 1007](#) and [PHYS 1008](#) or [PHYS 1003](#) and [PHYS 1004](#)

Lecture

Monday and Wednesday, 4:05 – 5:25 pm, Tory 236

The lectures will be offered *in person* only.

Laboratory

The lab is run by Daniel Sun, and he has an extensive website about it on Brightspace

Tutorial

Monday 8:35 – 9:25, Tory 236

The tutorial will be offered *in person* only. The TA will take up the previous week's assignment in the tutorial and answer any questions you have. Please email your questions in advance so she can offer a considered (and coherent) answer.

Exams

This is the [equation sheet](#) provided on all exams

Grading Scheme

The laboratory is worth 30% of your final mark. The other 70% is split up as follows:

Assignments 20%

In-term exam 30%

Final exam 50%

Text

Engel and Reid, Physical Chemistry: Thermodynamics, Statistical Thermodynamics and Kinetics; Pearson: ISBN-13: 9780137403066

Topics

1. Fundamental Concepts; Ideal and Real Gases

- What is thermodynamics?
- Basic definitions
- Thermometry
- Ideal gas law
- Kinetic molecular theory
- Velocity distributions in one dimension
- Maxwell's distributions of molecular speeds
- Average, most probable and mean speeds
- Gas effusion
- Molecular collisions
- Mean free path
- Real and ideal gases
- Equations of state, critical point, critical constants
- Compression factor, Boyle temperature
- Reduced variables and corresponding states

- Fugacity

2. First Law of Thermodynamics

- Fundamentals of internal energy, heat, work
- Doing work on the system and changing the system energy from a molecular perspective
- Heat capacity
- State and path functions
- Equilibrium, Change, and Reversibility
- Reversible and irreversible work
- Internal energy and enthalpy
- q , w , ΔH and ΔU for ideal processes
- Adiabatic processes

3. State Functions U and H

- Basic mathematical relationships
- Internal energy: $U(V, T)$, internal pressure
- Enthalpy: $H(T, \text{const } p)$
- C_p and C_v
- Enthalpy $H(p, \text{const } T)$
- Joule Thompson experiment and coefficient
- Isenthalpic expansion

4. Thermochemistry

- Generalities
- Hess' law
- Kirchoff's law
- Experimental thermochemistry

5. Second and Third Laws of Thermodynamics

- Entropy and entropy changes, the second law of thermodynamics
- Absolute entropies and the third law of thermodynamics

6. Chemical Equilibrium

- Gibbs (G) and Helmholtz (A) energies
- Differential forms of U, H, A and G
- Other aspects of chemical equilibrium

7. Molecular Motion

- Relative mean speed
- Collision frequency
- Collision cross-section
- Mean free path

8. Atomic Orbitals

- “Particle in a Box” theory
- Orbital energy and nodes
- Probability and shape
- Quantum numbers
- Radial vs. Angular nodes
- Overlap integral

Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated and its survivors are supported through academic accommodations as per Carleton’s Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: carleton.ca/sexual-violence-support

Requests for Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. Please contact your instructor with any requests for academic accommodation (pregnancy, religion, disability, etc.) during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist.

For an accommodation request, the processes can be found here:

carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf

Academic Accommodations for Students with Disabilities

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to

send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting an accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. carleton.ca/pmc

Accommodation for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist.

<https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>

For more information on academic accommodation, please contact the departmental administrator or visit: students.carleton.ca/course-outline

Caveat

Obviously, I reserve the right to make adjustments or changes throughout the semester. Remember that you are responsible to learn about these changes, which will be posted on this website.

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