

**UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
FALL 2021**

1. Course: CHEMISTRY 371, Physical Chemistry: Thermodynamics

| LEC | DAYS | TIME | ROOM | PROFESSOR | OFFICE | EMAIL | OFFICE HOURS |
|-----|------|-------------|---------|----------------|--------|----------------------|-----------------------------|
| L01 | MWF | 10:00-10:50 | ENE 239 | Dr. R. Jackson | SA 258 | rjjackso@ucalgary.ca | by appointment (see D2L) |

Students should use their U of C account for all course correspondence. Please include "CHEM 371" as part of the Subject line of the e-mail.

Desire 2 Learn (D2L): CHEM 371 L01 - (Fall 2021) – Physical Chemistry: Thermodynamics
<https://d2l.ucalgary.ca/d2l/home/401296>

Departmental e-mail: chem.info@ucalgary.ca

- 2. Course Description: Lectures:** A study of the states of matter. The basic laws of thermodynamics and their applications. Development of the concept of chemical potential. Changes of state and phase diagrams of pure substances and mixtures. Equilibrium electrochemistry. **Laboratory:** Experimental measurements, analysis, and interpretations relating to the topics discussed in lectures.
- 3. Recommended Textbook:** Physical Chemistry, 4th Edition, by Thomas Engel and Philip Reid, Pearson (available from the Bookstore)
- 4. Topics Covered and Suggested Readings:**

Course Contents

Chapter in Textbook
(not all sections will be covered)

Fundamental Concepts of Thermodynamics

Chapter 1

- 1) Introduction to Thermodynamics
- 2) Fundamental concepts
- 3) Pressure and temperature
- 4) Review phase behaviour and intermolecular interactions

Behaviour of Gases

Chapters 1 and 7

- 1) Ideal gas law and partial pressures
- 2) Real gases
- 3) van der Waals equation of state
- 4) Critical behaviour and law of corresponding states

First Law of Thermodynamics and Implications

Chapters 2 and 3

- 1) Energy and the First law
- 2) Work
- 3) Heat
- 4) State functions and path functions
- 5) Heat capacity and calorimetry
- 6) Enthalpy
- 7) V and T dependence
- 8) Cp and Cv

Thermochemistry

Chapter 4

- 1) Standard states
- 2) Standard enthalpies
- 3) Hess's Law
- 4) Reaction enthalpies and temperature dependence

Second Law of Thermodynamics

Chapter 5

- 1) Entropy
- 2) Direction of spontaneous change – the Second law
- 3) Thermodynamic cycles
- 4) Reversible and irreversible processes
- 5) Calculating entropy changes
- 6) Third law and standard entropies

Free Energy and Chemical Equilibrium

Chapter 6

- 1) Gibbs energy (G) and Helmholtz energy (H)
- 2) Free energy and spontaneity
- 3) Standard Gibbs energy and Gibbs energy of reaction
- 4) Temperature and pressure dependence
- 5) Chemical equilibrium and Gibbs energy
- 6) Standard states and K
- 7) Heterogeneous equilibria and condensed phases
- 8) Chemical potential

Phases and Equilibria

Chapter 8

- 1) Phase diagrams
- 2) Relative stabilities of solids, liquids and gases
- 3) Describing phase equilibria
- 4) Vapour pressure
- 5) Surface tension

Ideal and Real Solutions

Chapter 9

- 1) Chemical potential and mixtures
- 2) Phase diagrams of mixtures
- 3) Ideal solutions
- 4) Raoult's Law
- 5) Henry's Law
- 6) Non-ideal behaviour

5. Laboratory Experiments: (8 weeks, 3 hours/week)

See lab manual posted on D2L for details for the CHEM 371 labs.

1. Data Analysis for Physical Chemistry Laboratory - An Introduction to Microsoft Excel
2. Real Gas Behaviour and Equations of State
3. Measurements of Entropy Changes
4. Thermodynamics - Laws of Disorder
5. The Dependence of Vapor Pressure on Temperature
6. Freezing Point Depression
7. Decomposition of Ammonium Carbamate
8. The Calorimetric Determination of the Heats of Mixing

6. Tutorials: (10 weeks, 1 hour/week)

Students are required to attend.

Tutorials will follow a bi-weekly schedule of exercises and quizzes. At the beginning of each biweekly cycle, a set of assigned tutorial exercises will be posted on D2L, and students are expected to work on trying to solve these problems. Then during the first tutorial meeting of that cycle, students will work in small groups that share possible solutions, discuss strategies for solving the problems, and get help if they become stuck. During the second tutorial of that cycle, students will write a quiz based on the material in the set of tutorial exercises.

Department Approval _____ Date _____