

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

**1. Course: CHEMISTRY 371, Physical Chemistry: Thermodynamics**

LEC	DAYS	TIME	ROOM	PROFESSOR	OFFICE	EMAIL	OFFICE HOURS
L01	MWF	12:00-12:50	Online	Dr. P. Kusalik	SB 331	pkusalik@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 - (Winter 2020) – Physical Chemistry: Thermodynamics  
<https://d2l.ucalgary.ca/d2l/home/358283>

Departmental e-mail: [chem.info@ucalgary.ca](mailto: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:** (12 weeks, 1 hour/week)

*Students are required to attend.*

The first week of tutorials will involve a math review. For the remainder of the term, 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 \_\_\_\_\_