

**UNIVERSITY OF CALGARY  
FACULTY OF SCIENCE  
DEPARTMENT OF CHEMISTRY  
COURSE SYLLABUS  
WINTER 2019**

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

LEC	DAYS	TIME	ROOM	PROFESSOR	OFFICE	EMAIL	OFFICE HOURS
L01	MWF	12:00-12:50	EEEL 161	Dr. P. Kusalik	SB 331	pkusalik@ucalgary.ca	TBA

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 2019) – Physical Chemistry: Thermodynamics  
<https://d2l.ucalgary.ca/d2l/home/252802>

Departmental Office: Room SA 229, Tel: (403) 220-5341, e-mail: uginfo@chem.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, interpretations, and calculations relating to the topics discussed in lectures.
- 3. Recommended Textbook:** Physical Chemistry, 4th Edition, by Thomas Engel and Philip Reid, Pearson (available in 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

**Electrochemistry****Chapter 11**

- 1) Cell potentials
- 2) Connection to Gibbs energies and equilibrium
- 3) Concentration and temperature dependence

**5. Laboratory Experiments:** (8 weeks, 3 hours/week)*Students must also attend an initial lab orientation.*

1. Data Analysis for Physical Chemistry Laboratory - An Introduction to Microsoft Excel
2. Equations of State of Gases
3. Measurements of Entropy Changes
4. The Dependence of Vapor Pressure on Temperature
5. Thermodynamics - Laws of Disorder
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.*

Department Approval \_\_\_\_\_ Approved by Department Head \_\_\_\_\_ Date \_\_\_\_\_ January 7, 2019 \_\_\_\_\_