

**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	ST 145	Dr. P. Kusalik	SB 331	pkusalik@ucalgary.ca	TBA (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/295469>

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, 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 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 _____ Date _____