

**UNIVERSITY OF MANITOBA
DEPARTMENT OF CHEMISTRY**

CHEM2290, Winter 2012:

Chemical Energetics and Dynamics: Macroscopic Descriptions

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Lecture: M, W, F 9:30am – 10:20am, 111 Armes
Office Hours: immediately after classes: M, W, F 10:20-10:45am; drop in at other times when available; or make appointment
Laboratory Instructor: Dr. Carl Bartels (*contact: Parker 350; phone: 480-1038; E-mail: bartels@cc.umanitoba.ca*)

General Course Outline:

This course covers the fundamentals of *chemical thermodynamics* with applications to topics such as chemical potential, solution chemistry, phases and electrochemistry. The course consists of three components, (i) lecture, (ii) laboratory, and (iii) problem solving (covered by assignments, suggested problems and a regular optional tutorial session.)

Course Objectives:

Students will gain a solid understanding of and appreciation for the physical principles of chemical thermodynamics and electrochemistry.

Students will be able to apply thermodynamic principles to chemical questions.

Students will be able to apply the equations and formulas of thermodynamics and electrochemistry to practical, numerical problems.

Students will increase their understanding of and appreciation for the scientific approach.

Textbooks: T. Engel, P. Reid, Physical Chemistry, 2nd edition, Prentice Hall (*required textbook*)
We have chosen the book by Engle and Reid in order to have the same text for CHEM2280 AND CHEM2290.

Supplementary textbooks: - P. Atkins, J. de Paula, Physical Chemistry, Freeman

- K. J. Laidler, J. H. Meiser, B. C. Sanctuary Physical Chemistry, 4th ed., Houghton Mifflin

- Other physical Chemistry texts as available.

I shall place some of these into the reserve section of the library.

Tentative Course Outline:

1. Introduction (*1 lecture*)
 - Mathematical tools (Engel, appendix B2, B4, B6)
2. Equations of state (Engel, chapters 1 and 7) (*1 week*)
 - Definitions, ideal gases, van der Waals equation, Virial equation, corresponding states
3. Zeroth and First Laws of thermodynamics (Engel, chapters 2 to 4) (*1 ½ weeks*)
 - Work, heat, internal energy, First Law of thermodynamics, heat capacity, enthalpy, thermochemistry
4. The Second Law of thermodynamics (Engel, chapter 5) (*1 week*)
 - Carnot cycle, entropy, Second Law
5. The Third Law of thermodynamics (Engel, chapter 5) (*1 lecture*)
6. Fundamental concepts of thermodynamics (Engel, chapter 6) (*1 ½ weeks*)
 - Gibbs and Helmholtz energies, Maxwell relations, Gibbs-Helmholtz equation, chemical potential
7. Chemical Equilibrium (Engel, chapter 6) (*½ week*)
 - Equilibrium constant, le Chatelier's principle, van't Hoff equation
8. Phases (chapter 8) (*1 ½ weeks*)
 - Phase diagrams, phase rule, Clapeyron equation, Clausius-Clapeyron equation
9. Solutions (Engel, chapters 9 and 10) (*1 ½ weeks*)
 - Partial molar quantities, ideal and non-ideal solutions, Gibbs-Dunhem equation, Raoult's Law, Henry's Law, colligative properties, solvent and solute activity
10. Electrochemistry (chapters 10 and 11) (*1 ½ weeks*)
 - Electrolytes, electrochemical cells, Nernst equation, batteries, fuel cells

This is a tentative outline that can still change in some of the details as we go along. The timings are likewise approximate.

Evaluation/ Course Grade:

Problem Sets:	10%
Two Midterm Exams:	20%
Lab	25%
Final Exam:	45%

Note: There are separate passing criteria for the lab (50%) and the lecture components (50%) of the course.

Examinations: There will be three (3) formal examinations,

- (i) Two Midterm Exams (in class tests, Feb. 13, 12 and Mar. 12, 12) and
- (ii) A Final Exam after the end of classes, during the regular exam period.

Examinations are closed-book but I provide extensive formula sheets.

If a student is absent from one of the midterm examination, he/she must produce a written excuse appropriately signed (such as by a medical doctor or an employer) on the appropriate letterhead paper. This letter must be delivered to the instructor as soon as possible but **no later than one (1) week after the Exam**. The Department will determine the validity of the absence. If there is no valid excuse, the student will receive a mark of zero for the respective exam. No make-up exams for the midterms will be written. When the absence is valid, the final grade for the course will be based solely on the (pro-rated) marks obtained in the other components.

Laboratory Experiments: Labs start during the second week of classes (week of Jan. 9, 12) with an information session. Please note that the labs are an important part of the course. Therefore, attendance is mandatory. *Further details from Dr. Carl Bartels (laboratory instructor).*

Remark on Mathematical Tools: Physical Chemistry is, in general, the application of the principles of physics to chemistry. In order to describe the physics (and thus the physical chemistry) appropriately, a *good command of the language and tools of mathematics is necessary!*

In this course, we will, specifically, make frequent use of (i) integrals, (ii) differentiation, and (iii) partial derivatives, as well as, to a lesser degree, of differential equations. These mathematical tools will be reviewed *briefly* in class. Reviews are also available in the textbooks.

Problem Solving and Problem Sets: As stated above, **problem solving** is one of three major components of the course. Thus, numerical problems will be part of about every problem set and exam. I will also provide extensive lists of *suggested problems* from different sources. Moreover, Dr. Bartels has offered to run regular (non-mandatory) problem solving sessions, date and time to be determined (probably Friday afternoon).

Approximately *five* problem sets will be distributed throughout the semester. *Pre-selected problems* out of each set will be corrected and marked. For the problem sets, I have no issues with people working together, however, each student must submit his or her own assignments.

Remark on Numerical Problems: Obviously, the answer to numerical problems consists of some numerical value for a certain physical property. Physical properties have *units* and *significant digits!* (Regarding the significant digits, a final result has only as many meaningful significant digits as the least accurate input value. It is, however, useful to carry a few more digits for intermediate values, and to round off the final result only.)

Course Website:

http://home.cc.umanitoba.ca/~schrecke/teaching/CHEM_2290.html

(This page is also linked from the departmental webpages and from my homepage.)

The course website is used for communication such as to post suggested problems or sample exams. I will update it frequently throughout the term.

Lab website: *on ANGEL*

Academic Integrity: We take academic integrity seriously, and do not tolerate behavior like cheating or plagiarism. The Faculty of Science has created a website dedicated to the subject of academic integrity (and to the – obviously related – subject of academic dishonesty.) See: <http://umanitoba.ca/faculties/science/undergrad/resources/webdisciplinedocuments.html>

Review of Final Exam Script: The Faculty of Science has established a policy to permit students the opportunity to review their final exam script prior to the end of the Grade Appeal period. The Department of Chemistry has developed a procedure, which requires that students complete an online application form.

Last but not least: I appreciate input, both formally and informally!