EFFECTIVE: SEPTEMBER 2004
CURRICULUM GUIDELINES

Douglas College

A. Division: **Instructional**

Effective Date: September 2004

B. Department / Program Area: **Science and Technology**

Revision: [X] New Course: [ ]

If Revision, Section(s) Revised: **G, K, P**

Date of Previous Revision: **May 16, 1994**

Date of Current Revision: **November 27, 2003**

C: CHEM 2310	D: Physical Chemistry	E: 5
Subject & Course No.	Descriptive Title	Semester Credits

F: Calendar Description:
This course introduces the study of chemical thermodynamics and is intended for students majoring in science. Topics include the First Law of Thermodynamics and thermochemistry, entropy, Gibbs energy, chemical equilibrium, phases, and solutions. The laboratory stresses physical methods in inorganic chemistry.

G: Allocation of Contact Hours to Type of Instruction / Learning Settings

Primary Methods of Instructional Delivery and/or Learning Settings:

Lecture / Laboratory

Number of Contact Hours: (per week / semester for each descriptor)

Lecture **4 hours / week**
Laboratory **3 hours/ week**

Number of Weeks per Semester: **15**

H: Course Prerequisites:

CHEM 1210 (C or better) and MATH 1120

I: Course Corequisites:

J: Course for which this Course is a Prerequisite:

CHEM 2410

K: Maximum Class Size:

18

L: PLEASE INDICATE**:**

[ ] Non-Credit
[ ] College Credit Non-Transfer
[X] College Credit Transfer:

SEE BC TRANSFER GUIDE FOR TRANSFER DETAILS (www.bccat.bc.ca)

M: Course Objectives / Learning Outcomes:

With the aid of tables of thermodynamic data, a periodic table, an equation sheet and a calculator the student will be able to:

1. solve problems of the following types:

    a) ideal gas law and equations of state for non-ideal gases
    b) First Law problems involving gases (ideal and real)
    c) thermochemical problems (e.g., finding ΔU, Δq and w for a given chemical or physical change)
    d) entropy changes in physical and chemical changes
    e) calculation and use of thermodynamic equilibrium constants at various temperatures and pressures for homogeneous and heterogeneous equilibria
    f) calculation of Gibbs and Helmholtz energy changes for physical and chemical processes
    g) application of thermodynamics to solutions (eg. Raoult's Law, chemical potential, mixing, activities and colligative properties)

2. give mathematical and written statements of the first, second, and third laws of thermodynamics

3. define or explain any of the terms used in the course (eg. State function, reversible process)

4. given the balanced equation for a reaction, predict whether the reaction is spontaneous or not.

5. derive some of the simpler equations used in the course (eg. $W = - \int P_{ex}dV$).

6. explain the molecular interpretation of a given thermodynamic function (e.g. entropy, internal energy)

7. draw and interpret the phase diagram of a one component system, or a two component system involving two volatile components.

8. explain or interpret a given chemical or physical process using thermodynamic arguments.

N: Course Content:

1. Introduction and Review
S.I. units; mathematical review, use of calculators and computers in physical chemistry.

2. The Nature of Physical Chemistry and the Behavior of Gases
Definitions, energy, review of the properties of ideal gases: absolute temperature scale, kinetic theory of gases, collision frequency, collision number and mean free path; real gases: compressibility factor, deviations from ideal gas behaviour, real gas isotherms, van der Waal's equation, other equations of state, critical phenomena, continuity of states.

3. The First Law of Thermodynamics
Definitions, P-V work, expansion of an ideal gas, heat, heat capacity, latent heat, path dependent functions, statements of the first law, constant V processes, C_v, enthalpy, C_p, reversible processes, w_{rev}, adiabatic and isothermal processes, heat capacities of ideal monatomic and diatomic gases.

4. Application of the First Law: Thermochemistry
   Standard states, measurement of ΔH, calorimetry, relationship between ΔU and ΔH, temperature dependence of ΔH, enthalpies of formation, bond strengths.

5. The Second and Third Laws of Thermodynamics
   Carnot cycle, efficiency of heat engines, entropy, calculation of ΔS, temperature and volume dependence of S, molecular interpretation of S; the Third Law and absolute entropies.

6. The Gibbs Energy
   Gibbs and Helmholtz functions, Gibbs energies of formation, pressure and temperature dependence of ΔG, fugacity, thermodynamic limits to energy conversion.

7. Chemical Equilibrium
   Thermodynamic equilibrium constant, K_c,K_p, calculations involving equilibrium in homogeneous and heterogeneous systems, degree of dissociation, temperature dependence of K.

8. Phases and Solutions
   Phase equilibria in one-component systems, Clapeyron, and Clausius-Clapeyron equations; ideal solutions: Raoult's and Henry's Laws, partial molar properties, chemical potential, thermodynamics of mixing; nonideal solutions: activity and activity coefficients; review of colligative properties: ΔT_f, ΔT_b, ΔP, and osmotic pressure.

Laboratory Context

The following experiments will be performed during the laboratory period.

1. Gravimetric Analysis: Determination of Aluminum
2. Preparation and Analysis of a Coordination Compound
3. Solution Calorimetry
4. The Bomb Calorimeter
5. Determination of Al^{3+}, Ni^{2+} and Fe^{3+} by Ion Exchange
6. Determination of Iron in Multivitamin Tablets by Atomic Absorption Spectroscopy
7. Volumetric Analysis of Household Bleach
8. Thermodynamic Study of a Donor-Acceptor Complex
9. Vapour pressure of a Liquid

O: Methods of Instruction:

The course will be presented using lectures, problem sessions and class discussions. Films and other audio-visual material will be used where appropriate. Problems will be assigned on a regular basis and handed in for evaluation. In the laboratory, experiments will be performed individually or by pairs of students and reports submitted for evaluation.

P: Textbooks and Materials to be Purchased by Students:

Text: Laidler, K.J., Meiser, J.H., and Sancturary, B.C. *Physical Chemistry 4th Edition*, Houghton Mifflin Company 2003.

Douglas College, *Chemistry 310 Laboratory Manual*, 2003/2004

Q: Means of Assessment:

The student's performance in the course will be based on the following evaluations:

1. **Lecture Material (70%)**

   a) Two in-class tests will be given during the semester, each worth 15%

   b) A final comprehensive examination will be given during the exam period (30%)

   c) Problems will be assigned on a regular basis to be handed in and marked (10%)

2. **Laboratory (30%)**

   Nine experiments will be performed during the semester and the grade for this portion of the course will be based on (a) the accuracy of the results and/or (b) the written report of each experiment.

R: Prior Learning Assessment and Recognition: specify whether course is open for PLAR

No

Course Designer(s):

Education Council / Curriculum Committee Representative:

Dean / Director:

Registrar;

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