douglas college **Course Information**

A: Division: ACADEMIC

DATE: May 16, 1994

B: Department: SCIENCE & MATHEMATICS

New Course: ____

Revision of Course Information form: X

DATED: June 15, 1984

C: CHEM 310	D: Physical Chemistry	E: 5
Subject & Course No.	Descriptive Title	Semester Credit

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.

Summary of Revisions:
(Enter date & section)
Ex: Section C,E,F, &R

H,K,M,O,P

G: Type of Instruction: Hours Per Week/ Per Semester

Lecture	4	Hrs.
Laboratory	3	Hrs.
Seminar		Hrs.
Clinical Experience		Hrs.
Field Experience		Hrs.
Practicum		Hrs.
Shop		Hrs.
Studio		Hrs.
Student Directed Learning		Hrs.
Other		Hrs.

TOTAL 7 HOURS

H: Course Prerequisites:
CHEM 210 (C or better) and MATH 120

I: Course Corequisites:

J: Course for which this course is a pre-requisite
CHEM 410

K: Maximum Class Size:
Lecture 36, Laboratory 18

L: College Credit Transfer X

College Credit Non-Transfer ____

M: Transfer Credit:
Requested ____
Granted X

Specify Course Equivalents or Unassigned Credit as Appropriate

U.B.C.	(with CHEM 410) Chem 201 and 202, or Chem 205 or Chem 208
S.F.U.	Chem 261 and Chem (2)
U. Vic.	(with CHEM 410) Chem 245 (1.5) and 200 level (1.5).

COURSE DESIGNER(S)

DIRECTOR/CHAIRPERSON

DIVISIONAL DEAN

REGISTRAR

N: Textbooks and materials to be purchased by students
(Use Bibliographic Form):

Laidler, K.J. and Meiser, J.H. *Physical Chemistry*; Addison Wesley; Don Mills, ON, 1982.

White, J.E.; *HBJ College Outline Series: Physical Chemistry*, Harcourt Brace Jovanovich, San Diego, 1987.

Douglas College, *Chemistry 310 Laboratory Manual*, 1994.

Complete Form with Entries Under the Following Headings:

O. Course Objectives; P. Course Content; Q. Method of Instruction;

R. Course Evaluation

O. Course Objectives:

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 (eg, finding ΔU, ΔH, q and w for a given chemical reaction)
   (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 (eg 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.

P. Course Content

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

2. <u>The Nature of Physical Chemistry and the Behavior of Gases</u>
   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. <u>The First Law of Thermodynamics</u>
   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. <u>Application of the First Law: Thermochemistry</u>
   Standard states, measurement of ΔH, calorimetry, relationship between ΔU and ΔH, temperature dependence of ΔH, enthalpies of formation, bond strengths.

5. <u>The Second and Third Laws of Thermodynamics</u>
   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. <u>The Gibbs Energy</u>
   Gibbs and Helmholtz functions, Gibbs energies of formation, pressure and temperature dependence of ΔG, fugacity, thermodynamic limits to energy conversion.

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

8. <u>Phases and Solutions</u>
   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 Content

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

Q. Method 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.

R. Evaluation

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.