AB 01108

THE COLLEGE OF THE BAHAMAS

COURSE PROPOSAL FORM

COURSE ABBREVIATION & NUMBER

C	H	E	M		3	4	0

SCHOOL: NATURAL SCIENCES AND ENVIRONMENTAL STUDIES____

DEPARTMENT: CHEMISTRY

COURSE TITLE: CHEMICAL THERMODYNAMICS________

COURSE DESCRIPTION FOR CATALOGUE (50 WORDS MAXIMUM):
This course introduces students to the formalism of thermodynamics through its fundamental equations, providing insight into its logical structure. The central concept throughout is "energy and entropy".

PURPOSE OF COURSE:

University transfer	(x)	External Examination	( )
College Diploma or Certificate	( )	Recreational/General Interest	
College Degree	(x)	(non-credit)	( )

PRE-REQUISITE(S): CHEM 240 & MATH 280 OR PERMISSION OF THE INSTRUCTOR/CHAIRPERSON_

CO-REQUISITE(S): NONE______________________________________

HOURS PER WEEK: Lecture _4_____ Laboratory _____ Seminar/Tutorial ____

SEMESTER HOUR CREDITS: __4_______

SEQUENTIAL COURSE(S): _NONE______________________________________

OTHER COB COURSES HAVING CONTENT OVERLAP: CHEM 225 AND CHEM 240

COURSE DEVELOPED (X)/REVISED ( ) BY:

(1) _GLEN HOLDEN_____ Date: _SEPTEMBER 2001_
(2) ___________________ Date: _____________
(3) ___________________ Date: _____________

APPROVALS: Departmental Head: ________________ Date: _____________

Dean: ____________________________ Date: _____________

Academic Board: __________________ Date: _____________

NOTE:

1. A detailed course description must be attached. This must include course objectives, list of topics covered, prescribed textbooks, reading list, method of evaluation, and external examinations which are prepared for in this course.
2. The course description must be suitable for distribution to students.
3. Only lecturers/instructors approved by The College will be allowed to teach this course.

THE COLLEGE OF THE BAHAMAS
SCHOOL OF NATURAL SCIENCES & ENVIRONMENTAL STUDIES
DEPARTMENT OF CHEMISTRY

CHEM 340 – CHEMICAL THERMODYNAMICS
4 Semester Hour Credits

COURSE DESCRIPTION

This course introduces students to the formalism of thermodynamics through its fundamental equations, providing insight into its logical structure. The central concept throughout is "energy and entropy".

SPECIFIC OBJECTIVES

Upon successful completion of this course, students will be able to

1) develop strategies to solve thermodynamic problems using the energy and entropy fundamental equations as functions of extensive variables in open systems;
2) utilise the expressions for the chemical potential and law of mass action for non-ideal solutions using the concept of activity and activity coefficients;
3) interpret the concept of fugacity for real gases;
4) apply Legendre transformations to predict different thermodynamic potentials as auxiliary functions;
5) apply the expressions for the chemical potential of pure ideal gases, ideal gas mixtures, pure real gases and real gas mixtures;
6) apply the phase rule for systems with chemical reactions;
7) apply the expression for the chemical potential of an ideal solution to derive their mixing properties;
8) analyse the number and nature of independent chemical reactions between a known number of chemicals species;
9) analyse and interpret relations between partial molar quantities;
10) predict fundamental relations given thermodynamic equation of state;
11) derive numerous Maxwell relations and use them to deduce a thermodynamic equation of state;
12) derive the relationship between chemical potentials of different substances in different phases at equilibrium (no chemical reactions);
13) derive the Law of Mass Action of mixtures of gases and heterogeneous systems using the condition of chemical equilibrium in terms of the Gibbs energy of reaction;
14) deduce thermodynamic equations of state from a given fundamental relation and derive the Gibbs-Duhem relation; and
15) deduce the chemical potential of ions in solution and estimate the activity coefficient using Debye Huckel theory.

COURSE CONTENT

1. INTRODUCTION

a. Mathematical Tools
   i. partial derivatives
   ii. differentials of functions
   iii. integrating differentials of functions
   iv. exact and inexact differentials
   v. cyclic and chain rules

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b. Definitions
    i. closed, open, isolated, equilibrium systems
    ii. isobaric coefficient of expansion and isothermal compressibility coefficients
    iii. state functions, cyclic processes
    iv. mathematical properties of state functions
c. First and second law of thermodynamics
    i. reversible and irreversible processes
    ii. work and generalised work
    iii. adiabatic, isothermal, isochoric, isobaric processes

2. THE FUNDAMENTALS

a. Postulates of Thermodynamics
    i. the fundamental equations as homogeneous first order differential functions
    ii. examples of well-known models of ideal gas
b. Partial derivatives of fundamental equations as equations of state
    i definition of temperature
    ii. negative pressure
    iii. chemical potential for open systems
c. Euler's theorem for first order homogeneous functions
    i. derivation
    ii. examples
d. Legendre transformations of differentials forms of extensive variables to yield the important thermodynamic potential
    i. Gibbs energy
    ii. Helmholtz energy
    iii. enthalpy
e. Maxwell's relations and reduction of derivatives
f. Derivation of important thermodynamic relations (i.e. between the constant volume and constant pressure heat capacities). Showing of how these relationships simplify for ideal gases.
g. Pure Substances and Mixtures
    i. molar quantities
    ii. partial molar quantities
h. Thermodynamics of Gases
i. Systems of several phases with no chemical reactions

3. CHEMICAL APPLICATIONS

a. Energetics of Chemical Reactions
    i. the extent of reaction, ξ
    ii. the Gibbs energy of reaction, Δ_r where $\sum \mu_i \nu_i d\xi = \Delta_r G d\xi$.
    iii. systems where several chemical reactions can take place
    iv. standard variables of reaction
    v. heats of formation, review of Hess's Law

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b. Chemical Equilibria
   i. spontaneous reaction and equilibrium conditions
   ii. change in $G(\xi)$ with extent of reaction
   iii. general expressions for a mixture of reacting gases
   iv. equilibrium constants for gases in terms of fugacity and for heterogeneous systems
   v. independent reactions
   vi. mathematical tools
      A. matrix operations
      B. Gaussian elimination
      C. row reduced echleon forms
      D. rank of a matrix
      E. solution sets (unique and infinite)
   vii. phase rule for systems with chemical reactions
   viii. the Van't Hoff equation
   ix. Kirchoff's equation
   x. Le Chatelier's Principle
   xi. a full classic thermodynamics example
c. Thermodynamics of Ideal Solutions
d. Thermodynamics of Non Ideal Solutions

ASSESSMENT

4 Class Tests	60%
Final Examination	40%
TOTAL	100%

Alternate assessment for Semester 012002

1 Final Examination	100%

REQUIRED TEXT

Klotz, Irving M., and Robert M. Rosenberg. Chemical Thermodynamics. 6th ed. New York: John Wiley & Sons, Inc., 2000. ISBN 0-471-33107-4

SUPPLEMENTARY READINGS

Alberty, Robert A., and Robert J. Silbery. Physical Chemistry. 1st ed. New York: John Wiley & Sons, Inc., 1992.
Atkins, P. W., and W.H. Freeman. Physical Chemistry. 6th ed. New York: Oxford University Press, 1998.
Barrow, Gordon. Physical Chemistry. 6th International Edition. New York: McGraw Hill, 1996 .
Klotz, Irving M., and Robert M. Rosenberg. Chemical Thermodynamics. 5th ed. New York: John Wiley & Sons, Inc., 1994.
Rock, Peter A. Chemical Thermodynamics. California: University Science Books, Oxford University Press, 1983.
Woodbury, George. Physical Chemistry. New York: Brooks Cole Publishing Co., 1997.