Douglas College

EFFECTIVE: MAY 2002

CURRICULUM GUIDELINES

A: Division:	**Academic**	Date:	**13 November 2001**
B: Department/ Program Area:	**Science and Technology**	New Course [ ]	Revision [X]
		If Revision, Section(s) Revised:	**M,N,R**
		Date Last Revised:	**27 June 2001**

C:	**D:**	**E:**
CHEM 210	**Chemical Energetics and Dynamics**	**5**
Subject & Course No.	Descriptive Title	Semester Credits

F: Calendar Description: Topics studied will include liquids, solids, a review of redox reactions, solutions, electrochemistry, the laws of thermodynamics, equilibrium, acids and bases, ionic equilibria and chemical kinetics.

G: Allocation of Contact Hours to Types 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 hour/week

Number of Weeks per Semester:

14

H: Course Prerequisites:
CHEM 110, C Grade or better. MATH 120 must precede or be taken concurrently.

I. Course Corequisites:

J. Course for which this Course is a Prerequisite:
CHEM 303 and CHEM 310 and CHEM 320

K. Maximum Class Size: 36

L: PLEASE INDICATE:

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

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

M: Course Objectives/Learning Outcomes

The student will be able to:

1. Define or explain any of the chemical terms used in the course (e.g. anode, state function, Lewis acid).
2. Draw the unit cells for the three cubic lattices.
3. Given the unit cell of an ionic compound, predict the simplest formula.
4. Describe the experimental method for obtaining the dimensions of the unit cell.
5. Explain the differences between cubic and hexagonal closest packing of spheres.
6. Describe (or draw) the crystal structures of NaCl, diamond, graphite, CsCl, ZnS.
7. Describe the types of possible defects in crystalline material.
8. Describe the method of calculating lattice energies using the Born-Haber cycle.
9. Solve problems of the following types, given a list of selected equations and log tables;
   a) determination of the amount of material produced in an electrolytic cell
   b) calculation of the e.m.f. of a galvanic cell
   c) calculation of)G from electrochemical data
   d) calculations involving use of the First Law of Thermodynamics
   e) enthalpy changes in a chemical or physical process
   f) Hess's Law
   g) relationship between bond energies and)H
   h) calculation of)S from absolute entropies
   i) calculation of)G for a chemical reaction
   j) calculation of K from)G°
   k) equilibria in gaseous systems
   l) equilibria in aqueous acid-base systems (pH, weak acids, hydrolysis, buffers)
   m) equilibria involving slightly soluble salts, and coordination complexes
   n) order, rate constant and activation energy of a chemical reaction
   o) amounts of material involved in redox reactions based on gram equivalent weights
10. Calculate the oxidation of an atom in any ion or molecule
11. Identify any changes in oxidation number of an atom in a chemical equation.
12. Balance redox equations for reactions occurring in acid or basic solutions.
13. Determine the gram equivalent weight of a substance involved in a redox reaction.
14. State Faraday's Law of Electrolysis.
15. Determine whether chemical reactions will occur spontaneously under standard conditions, given a table of standard electrode potentials.
16. Using a table of standard electrode potentials, compare the relative strengths of oxidizing agents or reducing agents.
17. Discuss the electrochemical basis of the lead-acid storage battery.
18. Distinguish between the various types of heats of reaction and be able to write the corresponding chemical equation.
19. Interpret the signs of enthalpy changes.
20. Describe both qualitatively and quantitatively the contributions of)H and)S to reaction spontaneity.
21. Predict the sign of)S for various chemical and physical processes.
22. Interpret equilibrium in terms of the thermodynamic driving forces.
23. Write the chemical equation for the equilibrium involving weak acids and bases in aqueous solution.
24. Classify various aqueous salt solutions as acid, basic or neutral and write the corresponding equation.
25. Relate acid strength to molecular structure for a series of oxy-acids.
26. Explain how an acid-base indicator works and choose suitable indicators for various acid-base reactions.
27. Using the relevant solubility data, decide whether a precipitation reaction will occur and write a net ionic equation for the reaction.
28. Verify that the proposed mechanism of a chemical reaction is consistent with the experimentally determined rate law.
29. Describe the Kinetic Molecular Theory as applied to gases and associated concepts (e.g. molecular velocity distributions and the meaning of temperature).
30. Explain the concepts of diffusion and effusion and use Graham's law of effusion to solve various associated

31. Discuss the reasons and conditions under which real gases behave nonideally.
32. Interpret the meaning of the terms in the van der Waals equation and use this equation (given along with appropriate constants) to solve for the pressure of real gases under nonideal conditions.

<u>Laboratory Objectives</u>

The student will be able to:

1. Give the name and describe the use of some of the more common laboratory equipment.
2. Perform accurately standard laboratory techniques using the accepted methods, such as titration, weighing, pipetting.
3. Give the random and systematic errors inherent in each of the common quantitative techniques which are used in the laboratory.
4. Given an experimental problem, state the series of steps and the accepted techniques required to solve that problem in the laboratory.
5. Write a report based on observations and data obtained in the laboratory using a standard report format.
6. Given a set of experimental data or using data obtained in the laboratory, apply the appropriate mathematical techniques (e.g. graphical analysis, solution of equations, etc.) necessary to obtain a numerical result.
7. Using the data, observations or results of an experiment, determine the relationship between experimental variables.
8. Analyse the overall laboratory experiment with respect to errors inherent in the method or techniques.
9. Give the theory upon which the experiment is based.

N: Course Content

1. **Gases**
   (Review:simple gas laws) Ideal gas law, Kinetic-Molecular (KM) Theory, diffusion/effusion, Graham's Law, real gases.
2. **Liquids and Solids**
   Phases, KM Theory for liquids, vaporization, boiling, vapour pressure, Clausis-Clapeyron equation, other phase changes, phase diagrams (one component) and associated concepts; crystalline solid types, X-ray diffraction, close packing of spheres model, hexagonal and cubic lattices, associated calculations; lattice energies (enthalpies) and Born-Haber cycles.
3. **Solutions**
   (Review: types of solutions, solution concentrations) The solution process and associated energetics, Henry's Law, Raoult's Law (one and two volatile components) and deviations, fractional distillation; colligative properties of non-electrolyte solutions: vapour pressure lowering, boiling point elevation, freezing point depression, osmotic pressure, colligative properties of electrolyte solutions, activities.
4. **Electrochemistry**
   (Review: redox, electrochemical cells, half-cell potentials, standard reduction potential tables and uses) concentration effects and Nernst equation, relationship between E_{cell} and)G/K, electrolysis, commercial cells, batteries, corrosion, quantitative electrolysis.
5. **Chemical Kinetics**
   (Review: basic factors affecting reaction rates) concept and definitions of chemical reaction rates, differential rate law and rate constant, integrated rate laws for zero, first and simple second order reactions, half-life; collision theory and activation energy, reaction profile diagrams, mechanism and rate equations, steady state approximation, SN_1 and SN_2 reaction mechanisms, homo- and heterogeneous catalysis.
6. **Equilibrium**
   (Review: basic principles of chemical equilibrium, equilibrium constant (K) and expressions, magnitude of K, basic Le Chatelier's principle) K_c versus K_p, reaction quotient, homogeneous (K_p focus) and heterogenous equilibrium calculations (including approximations), detailed examples of Le Chatelier's principle.
7. **Thermodynamics**
   (Review: basic concepts of thermochemistry, simple heat capacity problems) First Law of Thermodynamics, calorimetry (constant pressure and volume), enthalpy, Hess's Law, standard enthalpies of formation, entropy, standard molar entropies, Third Law, Second Law and derivation of Gibbs free energy, standard free energies of formation, free energy and spontaneity, relationship between free energy and equilibrium, thermodynamic equilibrium constants, temperature dependence of equilibrium constants.
8. **Acids and Bases**
   (Review: Arrhenius and Bronsted-Lowry theory, auto-ionization of water and K_w, pH, strong/weak acids and bases, K_a, K_b, qualitative hydrolysis of salts) quantitative hydrolysis of salts, polyprotic acids, common ion effect, buffer solutions, titration curves (strong and weak acids/bases), indicators, solubility product (K_{sp}).

Lab Course Content

1. Redox Reactions
2. Solids
3. Electrochemistry
4. Thermodynamics
5. Equilibrium
6. Spectrophotometric determinations
7. Thermochemistry
8. Quantitative analysis
9. Kinetics
10. Inorganic chemistry: preparation of a coordination compound
11. Acids and bases.

O: Methods of Instruction

The course will be presented using lectures, problem sessions and class discussions. Films and other audio-visual aids as well as programmed material will be used where appropriate. Problems will be assigned on a regular basis which are to be handed in and marked. The laboratory course will be used to illustrate the practical aspects of the course material. Close coordination will be maintained between laboratory and classroom work whenever possible. This will be accomplished by discussing laboratory experiments in class and when necessary, by using the lab period for problem solving.

P: Textbooks and Materials to be Purchased by Students

R.H. Petrucci & W.S. Harwood: General Chemistry 7th Ed. Maxwell MacMillan Canada, Toronto; 1997
Douglas College Laboratory Manual Chemistry 210

Q: Means of Assessment

The student's performance in the course will be evaluated in the following fashion:

1. Laboratory work (30%)
   a) Laboratory reports: 14%
   b) Laboratory Practical: 8%
   c) Unknowns: 8%

2. Examinations (70%)
   a) A final comprehensive examination during the exam period: 30%
   b) A minimum of two in class tests will be given throughout the semester: 30%
   c) Any or all of the following evaluations, at the discretion of the instructor: problem assignments, quizzes, class participation [5% maximum] (10% in total)

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

Not open for PLAR at this time.

Course Designer(s)

Education Council/Curriculum Committee Representative

Dean/Director

Registrar