Camosun College

Department of Chemistry and Geoscience

Chemistry 221

Winter 2004

Instructor	Graham Shorthill
Office	Fisher 342C
Phone No.	370-3441
E-mail	Shorthill@camosun.bc.ca
Office hours	See the posted times on the office door

Texts The recommended text for the course is " The Elements of Physical Chemistry " by P.W. Atkins. There is also a laboratory manual and study guide which all students must have; both items can be obtained from the bookstore. In addition, there are approximately ten texts held on reserve in the library for students to loan for 72 hours. You can sign them out at the front desk.

It is a departmental requirement that all students working in a laboratory must wear safety glasses. Students, who normally do **<u>not</u>** wear spectacles, must obtain a pair for themselves before they begin the laboratory experiments.

Topics	**Lectures**
Reaction kinetics	15
Thermodynamics	9
Electrochemistry	6
Solutions and colligative properties	3
Phase equilibria	6

Grades: The final grade in the course will be assigned on the basis of the following components:

a/	Quiz 1	15%
b/	Quiz 2	20%
c/	Comprehensive final	40%
d/	Laboratory	25%

The following percentages refer to the composite total obtained at the end of the course:

A range	85%	to	100%
B range	70%	to	85%
C range	60%	to	70%
D range	50%	to	60%
F	<50%		

N.B. This table is given only as a guideline and the exact equivalency will be determined by the instructor when all the marks are available. In particular, the instructor reserves the right to adjust the final grade, up or down, if a student's preformance on the final examination differs significantly from their overall performance. The passing grade is C and students must obtain passing grades in both the lecture and laboratory portions of the course.

Course Outline

Reaction kinetics

The topics will include:

Factors affecting rates of reaction
Order of reaction
Energy of activation
Consecutive reactions
Reaction mechanisms.
Gas phase kinetics
Solution kinetics
Enzyme kinetics
Catalysis and explosions
Methods of following fast reactions

Thermodynamics

The topics will include:

The first law
Heat and work
Enthalpy
Work done by expansion of a gas
State and non-state functions
Reversible and irreversible changes.
Thermodynamic cycles and thermochemistry

The second law
Entropy and free energy
Free energy changes with pressure and temperature
Clausius - Clapeyron equation
Carnot cycles and energy conversion

The thermodynamics of mixtures
Partial molar volumes
Chemical potential
Gibbs Duhem equation

Electrochemistry

The topics will include:

The Arrhenius theory of dissociation
Ionic conductivity and Kohlrausch's law
The Debye-Huckel theory (ionic strength and activity)

The Nernst equation, cell potentials and cell reactions
Thermodynamics of cells
Fuel cells and energy conversion

Phase equilibria

The topics will include:

Raoult's and Henry's laws
Phase diagrams for one and two component systems
The lever rule

Azeotropes
Eutectic mixtures

Chemical potential and the drive to equilibrium
The phase rule

Colligative proporties

The topics will include:

The elevation of the boiling point
The depression of the freezing point
Osmotic pressure and reverse osmosis

Summary of learning outcomes for Chemistry 221

At the end of this course a student will possess an enhanced ability to:

Kinetics

- Determine the quantitative and qualitative changes in the rate of a chemical reaction produced by changes in concentration, temperature and ionic strength.
- Describe, explain and apply the energy of activation concept to the problems of catalysis.
- Derive reaction mechanisms from experimental data.
- Describe the major methods for following fast reactions and determining the presence of reaction intermediates.
- Use the steady state approximation to explain the mechanisms for reactions in the gas phase and in solutions; apply the same procedures to competitive enzyme kinetics.
- Distinguish between chain reaction explosions and thermal explosions.

Thermodynamics

- Distinguish between the following: heat and work, reversible and irreversible changes, state and non state functions, adiabatic and isothermal changes.
- Define and apply the enthalpy concept to the net energy change in a chemical reaction
- Calculate the work done by a gas when it expands: use the Carnot cycle.
- Use the principles of energy conservation and thermodynamic cycles, to calculate changes in any state function.
- Use the definition of entropy to determine the free energy available from a reaction and to predict the conditions under which the reaction would be spontaneous.
- Derive the Clausius - Clapeyron equation and apply it to the problems of volatile organic liquids.
- Describe, explain and apply the concept of partial molar volumes to the problem of dissolving one liquid in another.
- Define and use chemical potentials to explain the drive to equilibrium in both the quantitative and qualitative terms.

Electrochemistry

- Describe, explain and apply the theory of ionic dissociation to measurements of ionic conductivity.
- Describe the concepts of an ionic atmosphere, the ionic strength of a solution and the activity of an ion: use them to explain the properties of solutions at high solute concentrations.
- Derive and use the Nernst equation for the four major types of electrode.
- Calculate thermodynamic data from voltage measurements at different concentrations and temperatures.
- Describe and explain the processes of energy conversion with reference to the operation of a fuel cell and the role of hydrogen as a fuel.

Phase equilibria

- Describe, explain and apply the laws of Raoult and Henry to liquid-vapour equilibria.
- Differentiate between ideal and non-ideal solutions and predict their behaviour when they are distilled.
- Construct phase diagrams and apply the lever rule at particular points to determine the proportion of a component in each phase.
- Describe and explain the unique properties of azeotropes and eutectic mixtures.

Colligative properties

- Describe and explain the drive to equilibrium by the evaporation and condensation of volatile solvents.
- Predict the change in vapour pressure of a volatile solvent with the addition of non-volatile solutes: use the relationship to explain the elevation of the boiling point and the depression of the freezing point of the solvent.
- Differentiate between the behaviour of ionic and molecular solutes in a solution.
- Describe and explain the production of osmotic pressure across a membrane and the role of reverse osmosis in desalination.