CHEMISTRY 301 - Fall 2012
Aqueous Environmental Chemistry

Introduction to the properties and chemical composition of natural waters with an emphasis on chemical equilibria in controlling solubility and gas exchange. The role of pH, redox, complexation and ion-exchange on chemical speciation, distribution and remediation will be examined. Topics include nutrient ions, heavy metals and organic molecules, acid mine drainage, wastewater treatment and water purification technologies.

Instructor: Dr. Erik Krogh
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Email: erik.krogh@viu.ca

Required Textbook:
Environmental Chemistry: A Global Perspective (3rd Ed), G.W. van Loon; S.J. Duffy, 2011

Prerequisites: CHEM 122
Recommended: CHEM 221

Time and Location: 11:30-12:50  T Th B200-105
1:30-2:20  F B355-103

Office Hours: TBA (check posted schedule at my office)

Course Evaluation:

- Final Exam 40%
- Mid-Terms 20%
- Research Paper 15%
- Case Study/Participation 15%
- Assignments 10%

Additional Texts:
Consider a Spherical Cow: A course in environ problem solving, J. Harte, Univ Sci Books, 1988

Key Periodicals:
Environmental Science and Technology
Water Research
CHEM 301 - COURSE OUTLINE
AQUEOUS ENVIRONMENTAL CHEMISTRY

Introduction:
Environmental Chemistry, Properties of Water, Water Quality and Natural Water Bodies

Review of Important Chemical Principles and Units of Measure
Equilibrium constants: $K_w$, $K_a$, $K_{sp}$
Acids/bases: pH, $pK_a$
Redox: oxidation states, $E^0$
Thermodynamics: $\Delta G^0$

Chemical Composition of Natural Water
Readings: Chapter 9, 15.2 -15.4
Hydrologic and biogeochemical cycles, role of dissolved gases and solids
Introduction to alkalinity, hardness, dissolved organic matter

Distribution of Chemical Species in Aquatic Systems
Readings: Chapter 10
Acid - Base Equilibria: carbonates, phosphates and ammonia equilibria
Redox Equilibria: electrode potentials, Nernst equation and $pE$
$pE$ and pH relationships

Gases in Water
Readings: Chapter 11
Solubility of inert and reactive gases: Henry’s law, temperature effects

Organic Matter in Water
Readings: Chapter 12
Origins, fate and chemical interactions involving humic material: DOM, POM
Anthropogenic molecules: surfactants, complexing agents, biocides

Metals in the Hydrosphere
Readings: Chapter 13
Classifications, complexes, phase interactions
$pE$-pH diagrams

Colloids and Surface Interactions
Readings: Chapter 14
Surface properties, adsorption phenomena, partitioning
Clay minerals and cation exchange capacity

Microbial Catalysis (brief)
Readings: Chapter 15
Oxidation: BOD, COD and TOC
Nitrification and Denitrification reactions: $pE^0(w)$

Water Pollution and Waste Water Treatment Chemistry
Readings: Chapter 16, 19
Types of water pollution
Treatment and disinfection chemistry: chlorination, ozonation and advanced oxidation
Remediation and waste disposal technologies

Case Studies: Various Topics
Fridays, 1:30 - 2:20, B355-102

Handouts will be distributed throughout the course to supplement the course material.
Additional Resources for CHEM 301

Library Holdings

Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters, W Strumm and JJ Morgan
Aquatic Chemistry Concepts, JF Pankow
Aquatic Environmental Chemistry, A Howard
Basic Concepts of Environmental Chemistry, DW Connell
Canadian Water Quality Guidelines
Chemistry of the Environment, TG Spiro and WM Stigliani
Clean Water: Water Quality and Water Pollution Control, KM Vigil [electronic resource]
Environmental Chemistry, C Baird
Environmental Chemistry, SE Manahan
Environmental Chemistry, N Bunce
Environmental Soil and Water Chemistry, VP Evangelou
Freshwater, EC Peilou
Handbook of Chemical Technology and Pollution Control, MB Hocking
Introduction to Natural Water Chemistry, GK Pagenkopf
The Physical Chemistry of Natural Waters, FJ Millero
Water Quality Data: Analysis and Interpretation, AW Hounslo
Water Chemistry, M.M. Benjamin

Personal Holdings
The above titles are also available in my office along with the following:

Introductory Chemistry for the Environmental Sciences, RM Harrison and SJ de Mora,

Environmental Science and Technology, ACS Periodical 1994 – to date
Policy on Cheating and Plagiarism

Cheating and plagiarism are serious offences. There are many forms of beating the system that are considered unacceptable methods of gaining credit. Experience has shown that it is impossible to define every version, and therefore each case tends to be judged separately. The overall aim is to prevent unjustified credit being obtained for work that is not one’s own. The penalties for attempting to gain unjustified credit must necessarily appear harsh. It is just as serious for a lab report as for an exam. All lab instructors must refer suspicious situations to the course instructor. The penalties that will be applied include:

- A mark of zero for the work in question
- Referral to the Vancouver Island University Administration, which may include penalties such academic probation or suspension

For disciplinary actions taken by the administration refer to the General Information section of the Vancouver Island University Calendar and visit the website at [www.mala.ca/policies](http://www.mala.ca/policies).

The notes below give typical chemistry lab examples of situations that may help to clarify the broader definitions given in the Calendar.

- It is unacceptable to
  - record data from samples not prepared by the author without giving due credit to the donor
  - present someone else’s data without acknowledging credit (with or without their knowledge)
  - falsify data
  - submit samples not prepared by the author.

- It is unacceptable to
  - use ideas or facts from any source without proper reference citation
  - copy another report or portions of a report, be it marked or not
  - copy written material (whether from books, journals, or a website) without using quotation marks. However, keep in mind that direct quotation is not a common practice in scientific writing.

- There is a fine distinction between discussing a lab before work is submitted and producing a collaborative effort. Even if collaborative discussion has taken place, the material submitted for assessment must be the result of the author’s individual effort.

- A person supplying material for the purpose of someone else copying or cheating is considered to be equally accountable, and will be subjected to similar penalties.

### VIU Grade Scale

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1 Adapted from *University of Victoria, Chemistry 235 Laboratory Manual, 2003* with the author’s permission.