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Upperclass Environmental Offering
Environmental Analysis 1997-98
(Given in conjunction with Dave Milne.)

Solutions to problems in Aquatic Chemistry, 3rd ed. by Stumm and Morgan
Exams/with solutions
Programming workshops using True BASIC

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INTRODUCTORY

In-Class Workshops, Exams for Environmental Chemistry (1993-1995)
(solutions provided for all exercises)

Air pollution, action spectra, skin cancer, kinetics(steady state approximation), chemical kinetics, log C diagrams, pe-pH diagrams, titrations, redox chemistry, Olympia's LOTT Treatment Plant, entropy diagrams, Lewis structures, LCAO theory, mole concept, graphite-diamond phase diagram, molecular orbital theory, Lewis structures, formal charge, Nyholm-Gillespie rules, introductory quantum mechanics,

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Upperclass Experiments

Vibrational Analysis of cis- N_2F_2
This is an experiment I devised with the help of Ian Mills (University of Reading, UK) for use at Carleton College. I felt this was too advanced for Evergreen students since you really need to have had a year of P. Chem. before you could tackle this.

Analysis of the Iodine Spectrum
AMR students should be able to handle this. It involves obtaining a high resolution spectrum of iodine – only possible with the Cary spectrophotometer. Analysis of the spectrum allows thermodynamic quantities to be measured. The flash photolysis apparatus (which I don't think we have anymore) allowed the kinetics of recombination of iodine atoms to form $I_2(g)$ to be measured.

The Emission Spectrum of Sodium
Students are able to calculate the orbital energies of sodium from the spectra obtained using HP diode array spectrometer and McKee-Pedersen scanning monochromator.

H_2^+ Experiment
Students calculate and plot electron density contour maps for the H_2^+ molecule: the simplest molecule that can exist.

Upperclass Projects/ Matter and Motion Lab

Theory
Construction of atomic orbital electron density diagrams using MathCad, simulating the kinetics of chemical reactions using Acuchem

Laboratory Experiments
A study of the gaseous NO_x System, kinetics of the $NO + O_2$ reaction

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Geology and Chemistry of Pollution (1991-92)
And
Rocks, Water and Chemistry (1993)

Exams and Workshops

RWC
Topics covered: stratosphere/troposphere chemistry, pe-pH diagrams for aquatic systems, acid rain

GCP
Environmental toxicology (text: Principles of Environmental Toxicology by S. Zakrzewski), logC diagrams, geochemistry of Puget Sound, thermodynamics, alkalinity of seawater

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Special Projects/Experiments
X-Ray Crystallography and X-Ray Diffraction

Upperclass Projects/Experiments for an AMR-like Class Involving X-Ray Diffraction
and Crystal Structures
AMR – 2000
Exams and Experiments(including solutions)
   Determination of crystal structure of alkaline earth halides from X-ray diffraction data
   Patterson projections
   Space groups
   Bravais lattices
   Hermann-Mauguin symmetry operations
   stereograms
   Bragg equation
   construction of unit cell models
   original X-ray photographic records of the aragonite form of $CaCO_3$ taken by FDT at
the University of Reading, U.K.
   goal is that students can construct a model of the unit cell based on X-ray photos

Upperclass – Chemistry – 1979
Powder diffraction records taken on Evergreen's X-ray diffraction apparatus are used to
determine the unit cell structure of KCl.
Original solutions of mine for problems in the text we were using: Introduction to
Crystallography by Donald E. Sands, 1969 (as well as excerpts from the text).

X-ray diffraction reprints from J. Chem. Ed as well as
Optical Transform Kit for Simulating Diffraction Experiments in Introductory Courses
(Institute for Chemical Education)

Contains transparencies for overhead projectors of hkl layer X-ray photos.

INTRODUCTORY
Matter and Motion Level Experiments/Calculations

Elastomer Heat Engine – extensive notes ranging from 1997 M&M to 2010 AMR
Using Lycra and wheels stored in second floor telephone room students, in groups,
design and construct engines whose performance is judged on speed (rpm) and
force/torque. A wide range of performances are produced.

Mariotte Tube Titrations
Using self built Mariotte tubes students are able to undertake acid/base titrations in which
the results (pH vs. volume) are plotted using LoggerPro.

Gran Titration
Samples taken from Budd Inlet or other natural aquatic systems are titrated which allows
the alkalinity of the sample to be calculated.

Electrochemistry – Thermodynamics of Galvanic Cells
Half cells are combined to see if potentials predicted from thermodynamic calculations
agree. Also includes using aluminum cans as electrochemical energy source.

Oscillating Reactions – Liesegang Rings
Belousov-Zhabotinsky reactions are tracked and plotted from electrode potential
measurements, Liesegang ring experiments are carried out in test tubes for development
in the following weeks.

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INTRODUCTORY

Matter and Motion (1979-1991)-based on
Principles of Modern Chemistry, Oxtoby and Nachtrieb
Chemistry Exams both in class and take home, both weekly and final (with solutions)

kjinetics
thermodynamics
chemical equilbrium
acids/bases
phase diagrams
X-ray crystallography
ideal solutions
heat engines
elementary quantum theory

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Upperclass Environmental Chemistry – summer 1993

A compilation of all exams given in the class with solutions.

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Upperclass Physical Chemistry – AMR
Based on class given at Carleton College 1985-86

Vibrational spectra, symmetry, X-ray diffraction
Quantum mechanics solutions for Atoms and Molecules by Levine
Exams and solutions
Lectures and in-class quizzes

Introductory Core Program -Water 1995

Workshops and Exams covering
nautical charts
aquatic CO_2 chemistry
physical geology
graphite-diamond phase diagram
redox chemistry – sediments
geology- dissolving mountains

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Introductory Workshops
Matter and Motion 1989-90, 1993-94, 1996-97
Based partly on Craig's *Entropy Analysis*

stoichiometry
Lewis structures
LCAO – H_2+
NO_x gaseous equilibria
Enthalpy of formation of MgO
acid/base equilibria
titrations, buffers, indicators
qualitative inorganic analysis
Balmer spectrum
law of multiple and definite proportions
gas laws and kinetic theory
thermodynamics of aluminum and zinc
chemical equilibrium
VSEPR
fdree energy and equilibrium constants
chemical kinetics – iodine
logC diagrams
graphite-diamond phase diagram

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Upperclass Exams, Labs, Workshops and Exams
Atoms, Molecules and Research 2000
(contains 1994 ACS exams in thermodynamics, dynamics

kinetics experiments – ozone shield
real gases, compressibility and equations of state
thermodynamics
real gases
rubber as a heat engine medium
sodium spectrum analysis
Schrodinger H atom
Molecular models/bomb calorimetry – azulene and naphthalene
Rydberg series
quantum mechanics
numerical methods/ MathCad
bomb calorimetrty
point groups, space groups
X-ray crystallography
Pagtterson projections

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Post Retirement Classes

Water and Fire, summer 2007
daily schedule, exams. lab results

Introduction to Environmental Chemistry, Winter 2008
Experiments:
sunscreen/auto exhaust
H_2CO_3-CO_2 equilibrium
ozone-I_2 experiment
Chapman mechanism – effect of OCl-Cl and NO_2-NO on ozone in stratosphere

AMR winter 2009/spring 2010 Lab Experiments
Ni-Cd and Li-H rechargeable battery thermodynamics
Superconductivity - Meissner effect
Elastomer heat engines

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Physical Chemistry Reprints of Interest

F. D. Tabbutt, D.N. Craig

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Youtz-Tabbutt Manual
For
Evergreen Computer Scientific Graphics

Geology and Chemistry of Pollution, Spring 1992
Swartzman and Kaluzny

FORTRAN Computer Simulations

hydrologic cycle
old field succession in central Oklahoma
prey-predator
eutrophication at San Joaquin River
integration algorithms

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Upperclass Physical Chemistry
Chemical Systems (1988) – AMR level

quantum chemistry based on film loop simulations:
  particle on a ring, partcle in a finite, one dimensional well, quantum bouncing ball, harmonic oscillator, particle in a sine well

thermodynamics based on text by Klotz and Rosenberg

spectroscopy and statistical mechanics drawing from data provided in journal papers

contour diagrams for H_2^+

Population Simulations Political Ecology 1971-72

Limits to Growth
Forrester's World II Model

Polar coordinate experiment using ISL (Interactive Simulation Language)

Core Program Environmental Chemistry (Water – 1996)

Computer Simulations of Environmental Systems using True BASIC
prey-predator(Lotka-Volterra model)
rate equations for single reservoir system