

# CHM 594 Modeling Instruction in High School Chemistry

## July 10 – 28, 2006

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**Description:** The workshop focuses on key concepts in high school chemistry from a model-centered perspective.

**Prerequisites:** In-service teacher of chemistry or physics, or instructor approval. CHM 480, PHY 480 (PHS 530) or instructor approval.

**Course Objectives:** The emphasis is on plans and techniques for helping students to learn concepts in chemistry from the perspective of systematically developed particle models for matter. Instructional strategies include a coherent approach to the role of energy in phase change and chemical change.

### Grading:

Each student is expected to spend 45 hours per semester hour.

*Letter grade vs. satisfactory-fail:* satisfactory grades may not transfer.

*A-B-C grades:* B means average; a 3.0 GPA is minimum requirement for MNS and other graduate degrees.

*Incomplete:* only for special circumstances.

*Attendance:* Grades are based on attendance, journal, and participation.

*Journal:* a daily log book or notebook of problems solved, labs done, reflections on classroom activities and assigned readings; journals will be evaluated periodically.

**Course Content** (Major topics in bold. Suggested topics below each major topic.)

### **I Particulate structure of matter**

Macroscopic vs microscopic descriptions. compounds, elements and mixtures.

Explanation of (observed) macroscopic properties using microscopic models.

Systematic explanation of details with models of increasing complexity.

Macroscopic evidence for microscopic structure (ionic vs molecular substances).

### **II Energy and Kinetic Molecular Theory**

Visualizable models (macroscopic analogs) for solids, liquids and gases.

Energy storage modes and transfer mechanisms.

Role of energy in phase change.

Distinction between heat and temperature.

### III Stoichiometry

The mole concept – relating how much to how many.  
Using equations to represent chemical change.  
Non-algorithmic approaches to chemical calculations.

### IV. Energy and chemical change

Attractions vs chemical bonds.  
Chemical potential energy and  $\Delta H$ .  
Activation energy and rates of chemical reactions.

(if time permits)

### V Molecular models

Diagrammatic representations of molecular structure.  
3D models of molecular shapes.  
Macroscopic behavior based on molecular structure.

### Suggested resources and readings:

Beyond Appearances: Students' misconceptions about basic chemical ideas.  
A report prepared for the Royal Society of Chemistry, by Vanessa Barker.  
Online in pdf format at <<http://www.chemsoc.org/pdf/LearnNet/rsc/miscon.pdf>>

Testing for Conceptual Understanding in General Chemistry. Craig W. Bowen and Diane M. Bunce. *The Chemical Educator*, Volume 2 Issue 2 (1997), S1430-4171(97)02118-3  
<<http://chemeducator.org/bibs/0002002/00020118.htm>> [Abstract only]

Improving Teaching and Learning through Chemistry Education Research: A Look to the Future. Dorothy Gabel. *JChemEd*, Vol 76 No 4 April 1999

Secondary Students' Mental Models of Atoms and Molecules: Implications for Teaching Chemistry. Allan G Harrison and David F Treagust, *Science Education* 80(5) (1996)

A Modeling Method for high school physics instruction, Malcolm Wells, David Hestenes, Gregg Swackhamer, *Am J Physics* 63 (7), July 1995

Modeling Methodology for Physics Teachers, David Hestenes, *Proceedings of the International Conference on Undergraduate Physics Education* (College Park, August 1996)

Cognitive Resources for Understanding Energy, G Swackhamer, (2003)

Any of the CHEM-Study high school curricula, e.g.

Chemistry; J Dudley Herron, David Frank, et al, D.C. Heath 1993 ISBN 0-669-20367-X

Chemistry: Experimental Foundations (3rd ed). Robert W. Parry, Herb Bassow, Phylliss Merrill, and Robert L. Tellefsen. Prentice Hall, 1982. ISBN 0-13-129254-4.