Illinois State University
Department of Chemistry
CHE 401.04
(Previously CHE 489.05)
Advanced Chemistry Demonstrations: Atomic and Molecular Structure.
3 credit hours

Catalog Description:

Advanced Chemistry Demonstrations: Atomic and Molecular Structure.

3 F, S, Sum *CHE 301 or equivalent as prerequisite.* Topical analysis of current best practices in teaching Atomic and Molecular Structure as they pertain to secondary school classrooms. A particular emphasis will be to connect content knowledge to modern demonstrations and teaching activities.

Instructor:

Dr. Willy Hunter

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Materials:

Required: Access to the ReggieNet Course Website

Required: Advanced Chemistry Demonstrations: Atomic and Molecular Structure Course Videos (available at https://www.flinnsci.com/atomic-and-molecular-structure/che401.04/)

Contact Hours:

This course is a structured course available online for 8 *(summer term)* or 16 *(fall/spring term)* weeks from the start date of the course. Each assignment, except the midterm and final project, will be available at the start of the course but will have specific deadlines for when they need to be completed.

Accommodations:

Any student needing to arrange a reasonable accommodation for a documented disability should contact Student Access and Accommodation Services at 350 Fell Hall, 438-5853 (voice), 438-8620 (TTY).

Course Overview and Objectives:

This course constitutes a survey course of ways in which we can understand and teach Atomic and Molecular Structure. Particular emphasis will be to connect content knowledge to modern demonstrations and teaching activities. Students will improve their chemistry content knowledge from the resource materials, as well as be expected to search local and internet-based resources for current best practices. Students will be introduced to 51 demonstrations and teaching activities which engage them in a detailed examination of the ways in which current chemistry teachers deliver Atomic and Molecular Structure demonstrations and class activities. Students will be exposed to and expected to master the demonstration activities taught in the course.

This course seeks to provide some answers to the following questions:

1. What is our current best understanding of Atomic and Molecular Structure?
2. What are the safety considerations and risks associated with teaching the Atomic and Molecular Structure? How may Atomic and Molecular Structure be taught safely in schools?
3. What is the role of the National Standards and State Standards in determining how Atomic and Molecular Structure are taught in schools?
4. What pedagogical techniques are appropriate for teaching Atomic and Molecular Structure in secondary schools?
5. What are the challenges associated with teaching Atomic and Molecular Structure?

Required Student Tasks/Assignments:

1. Students are expected to read each of the following articles from the Journal of Chemical Education and The Chemical Educator. For each article, there is a set of assessment questions within ReggieNet that must be answered.

Battle, G. M., Allen, F. H., & Ferrence, G. M. (2010). Teaching three-dimensional structural chemistry using crystal structure databases: 1. An interactive web-accessible teaching subset of the Cambridge Structural Database. *Chemical Educator, 87* (8). DOI: 10.1021/ed100256k

Bergman, J. M., Boesdorfer, S. B., Carver, J. S., Mumba, F., & Hunter, W. (2010). Student learning on atomic theory using the PES data method. *Chemical Educator, 15*, 370-374. DOI: 10.1333/s00897102308a

Glazier, S., & Marano, N., Eisen, L. (2010). A closer look at trends in boiling points of hydrides: Using an inquiry-based approach to teach intermolecular forces or attraction. *Journal of Chemical Education, 87* (12), 1336-1341. DOI: 10.1021/ed100691n

Shane, J. W., & Bodner, G. M. (2006). General chemistry students' understanding of structure-function realationships. *Chemical Educator, 11*, 130-137. DOI: 10.1333/s00897061010a

Sun, X. (2007). An integrated approach to the Lewis Model, Valence Bond Theory, and Molecular Orbital Theory: A new model for simple molecular orbitals and a quicker way of learning covalent bonding in general chemistry. *Chemical Educator, 12*, 331-334. DOI: 10.1333/s00897072076a

Vlassi, M, & Lymperopoulou-Karaliota, A. (2009). Why do students have to learn about molecular structure and chemical bonding? *Chemical Educator, 14* (5), 209. DOI: 10.1333/s00897092221a

2. Students are expected to watch each of the following 13 videos packages. For each video episode within the package there are a series of questions that must be answered.

Each video episode has six content questions associated with it. The lowest order (Knowledge and Comprehension) of the content questions are designed to ensure that students watch the video. The medium-order (Analysis and Application) and higher-order (Synthesis and Evaluation) questions may require the use of outside resources to

generate correct answers. The second set of questions are pedagogical questions. The lowest order (Knowledge and Comprehension) of the content questions are designed to ensure that students watch the video. The medium-order (Analysis and Application) and higher-order (Synthesis and Evaluation) questions may require the use of outside resources to generate correct answers or to consider the use of activity in their own classroom to determine the correct answer. Finally, there are questions that link the episode to the National Science Education Standards.

Atomic and Electron Structure / Light, Energy, and Electron Structure

Wave Generator
Energy in Photons
Atomic Emission Spectra
Absorption of Light Energy

Atomic and Electron Structure / Solving The Structure of the Atom

What's in that Tube?
Rutherford Scattering
Atomic Target Practice
Refrigerator Magnet Analogy of Scanning Probe Microscopy

Atomic and Electron Structure / Isotopes and Atomic Mass

Ropes and Isotopes
Mass Spectrometry
Average or Apparent Mass of an Element

Atomic and Electron Structure / Flame Tests

Flame Tests for Unknowns
Flame Test Demonstration
Methyl Alcohol Flame Test
Is There Sodium in Bananas?
The Hungry Dragon

Atomic and Electron Structure / Electron Configuration

The Atom Dazer
Orbital Chart Overhead
A 3-D Aufbau Diagram
Paramagnetic Transition Metal Ions
Standing Wave Generator

Periodic Table / Periodic Trends and the Properties of the Elements

Periodic Activity of Metals
Active Metals in the Periodic Table

Periodic Table / Periodic Table Demonstrations and Activities

Paramagnetic Transition Metal Ions
Solubility Patterns in the Periodic Table
Making Glass

Chemical Bonding / Polar vs Nonpolar Compounds

Density Bottles
Graphite Disk Demonstration
Dyes and Dyeing
Polar and Nonpolar Molecules

Chemical Bonding / Covalent, Ionic and Metallic Bonding

Electronegativity Demonstration Device
Putting Ions in Their Hands
Heat Treatment of Steel
Models to Illustrate Ionic and Metallic Solids
Colorful Copper Compounds

Chemical Bonding / Intermolecular Forces

Viscosity Race
Evaporation and Intermolecular Attractions
Anti-Bubbles
Bonding Bottles
Floating Clip

Chemical Bonding / Hydrogen Bonding

Volumes Don't Always Add Up
Soap Film Demonstrations
The Magic Air Bubble
Spoons, Newspaper, and Hydrogen Bonding

Chemical Bonding / Molecular Geometry

Simple Structures
Bonding and Balloons Lab
Shapes of Carbon Compounds

Chemical Bonding / Transition Metal Complex Ions

The Mellow-Yellow Reaction
A "Dry" Complex
Colorful Iron Complexes

Grading Scale

Grades in the course are based upon timely completion of each assessment associated with the Research articles and Video episodes.

90% – 100% = A
80% – 89% = B
70% – 79% = C
60% – 69% = D
0% – 59% = F

The point breakdown for the course is as follows:

Video assessments:	300 points
Article assessments:	90 points
Midterm:	100 points
Final Project:	198 points
Total Points:	688 points

Assessment Schedule (Summer 2021)

All assignments are due at midnight central time on the following days unless otherwise specified within the course calendar in ReggieNet.

Due Date:		Assignment:
June	11	Article 1, Quiz 1 & 2
	18	Article 2, Quiz 3 & 4
	25	Article 3, Quiz 5 & 6
July	02	Article 4, **Midterm**
	09	Quiz 7 & 8, *Midterm Peer Review*
	16	Article 5, Quiz 9 & 10
	23	Article 6, **Final Project**
	30	*Final Peer Review*