Illinois State University
Department of Chemistry
CHE 401.04
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:

Instructor: Dr. Sarah Boesdorfer **Phone:** (309) 438-7905
Office: 220 Julian Hall **E-mail:** sbboesd@ilstu.edu

Office Hours: **By Appointment** through Zoom/Phone/Google Chat etc.

Materials:
Required: Access to the Canvas 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. Assignments are available from 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 and/or medical/mental health condition should contact Student Access and Accommodation Services at 308 Fell Hall, Office Phone (309) 438-5853, Video Phone (309) 319-7682 or visit the website at StudentAccess.IllinoisState.edu.

Course Overview and Objectives:
This course constitutes a survey course of ways in which we can understand and teach Atomic and Molecular Structure. 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.

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:
Course Materials to Watch/Read by Module: All materials will be provided in Canvas

Standards for Atomic and Molecular Structure:
Readings: (Discussion 1)

- Mayer, K.& Krajcik, J. (2016) Core Idea PS1 Matter and Its Interactions. From Krajcik, Duncan, & Rivet, (eds). *Disciplinary core ideas: Reshaping teaching and learning.* NSTA Press. (pgs. 13-32)
- HS-PS1-1 Matter and its Interactions Evidence Statement from National Research Council. (2013). Next generation science standards: For states, by states.
- HS-PS121 Matter and its Interactions Evidence Statement from National Research Council. (2013). Next generation science standards: For states, by states.
- HS-PS1-3 Matter and its Interactions Evidence Statement from National Research Council. (2013). Next generation science standards: For states, by states.
- ACS Guidelines and Recommendations for Teaching Middle and High School Chemistry: https://www.acs.org/education/policies/middle-and-high-school-chemistry.html
- AP Chemistry Learning Objectives: College Board.

Teaching and Learning Atomic Structure:

- Light, Waves, and Flames: (Quiz 1)
  - Videos from Flinn Scientific: *Wave Generator, Standing Wave Generator, Flame Tests for Unknowns, Is There Sodium in Bananas?, Absorption of Light Energy*
  - Reading: 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

- Atomic Structure: (Quiz 2)
  - Videos From Flinn Scientific: *What's in that Tube?, Rutherford Scattering, Ropes & Isotopes, Average or Apparent Mass of an Element, Orbital Chart Overhead, and Paramagnetic Transition Metal Ions*

- Periodic Trends: (Quiz 3)
  - Videos from Flinn Scientific: Periodic Activity of Metals, Solubility Patterns in the Periodic Table
  - Video: Helfet, A. (2024). How to keep your chem students engaged when teaching periodic table trends. Youtube, https://youtu.be/Dt4CqxZcQdg?si=GBKN3CyYJWKRNX--

- Reading: Baxley, A. (2019) Periodic Trends Guided-Inquiry Activity. https://www.chemedx.org/activity/periodic-trends-guided-inquiry-activity

- Broader Science Understanding (Discussion 2)
  - Reading: Kwon, S., Lee, G., & Niaz, M. (2020). Toward Understanding the Structure of the Historical Controversy: Atomic Models as an Exemplar. *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(12).
  - McKagan, S. B., Perkins, K. K., & Wieman, C. E. (2008). Why we should teach the Bohr model and how to teach it effectively. Physical Review Special Topics—Physics Education Research, 4(1), 010103.
  - Examples: https://knowledge.carolina.com/discipline/physical-science/chemistry/a-new-approach-to-teaching-atomic-theory/
  - https://www.chemedx.org/activity/atomic-structure-interactive-notebook

Teaching and Learning Molecular Structure and Intermolecular Forces:

- Bonding and Geometry (Quiz 4)
  - Videos from Flinn Scientific: *Electronegativity Demonstration Device, Heat Treatment of Steel, Models to Illustrate Ionic and Metallic Solids Simple Structures, Bonding and Balloons Lab, Shapes of Carbon Compounds*
- Polar/Nonpolar and Intermolecular Forces (Quiz 5)
  - Videos from Flinn Scientific: *Density Bottles, Polar and Nonpolar Molecules, Viscosity Race, Evaporation and Intermolecular Attractions, Bonding Bottles, Volumes don't Always Add Up, Spoons, Newspaper, and Hydrogen Bonding*
- Importance of Structure and Function of matter (Quiz 6)
  - Readings: 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
  - Cooper, M. M., Underwood, S. M., & Hilley, C. Z. (2012). Development and validation of the implicit information from Lewis structures instrument (IILSI): do students connect structures with properties?. *Chemistry Education Research and Practice*, *13*(3), 195-200.
  - Stowe, R. L., Herrington, D. G., McKay, R. L., & Cooper, M. M. (2019). The impact of core-idea centered instruction on high school students' understanding of structure–property relationships. *Journal of Chemical Education*, *96*(7), 1327-1340.

- When it's a Continuum (Discussion 3)
  - Spencer, J. N. (2011). New approaches to process and content in introductory chemistry. Retrieved April 21, 2011, from http://apcentral.collegeboard.com/apc/members/courses/teachers_corner/26065.html
  - Sproul, G. (2001). Electronegativity and bond type: Predicting bond type. Journal of Chemical Education, 78, 387-390. DOI: 10.1021/ed078p387

Required Assignments:

1. **Quizzes (6):**
   You will be responsible for *passing a quiz* over sets of videos and/or chemistry education articles. Each quiz will consist of 25-30 questions. Approximately half the questions will focus on content and the other half will focus on pedagogy and safety. You need a 90% on the quiz to consider it passed. You may take it as many times as you need until you pass or the due date is reached.

2. **Discussions (3):**
   You are expected to engage in a thoughtful conversation with classmates over course materials. *See Canvas for full description of discussion requirements.*

3. **Reflections (4):**
   You will be asked to write so brief reflection at different points in the course to think about your prior knowledge, learning, and application during the course. Prompts for these reflections will be posted within Canvas. These reflections should be thought of as journal entries, no research required, however assignments that are hard to read due to grammatical issues etc. will be returned ungraded.

4. **Lesson Analysis with Peer Feedback (2)**:

5. **Professionalism**
   You are expected to
   - Be positive, patient, and approachable.
   - Work hard- be effective and efficient when assuming responsibilities.
   - Work collaboratively with your peers and educational professionals.
   - Be respectful to your peers, professionals, and students.
   - Be open to advice and suggestions from peers and professionals.
   - Be punctual- Complete assigned tasks on time.

<u>Course Evaluation:</u>
Canvas will be used to post whether an assignment or task has Met Expectations (1 / 1) or Not Met Expectations (0/1) with the exception of quizzes which require a 90% or better to meet expectations (but a 90% or higher will be converted to a 1/1).

To receive **an A** in this course a student will:
- Actively participate in the course by meeting expectations for all quizzes and discussions, though up to one may not meet expectations.
- Complete with full effort all Reflections in the course.
- Complete both Lesson Plan Analyses.
- Provide thoughtful peer feedback on others Lesson Plan Analysis as assigned.
- Display all aspects of professionalism throughout the course.

To receive **a B** in this course a student will:
- Struggle in <u>one</u> of the following areas:

- Actively participate in the course by meeting expectations for all quizzes and discussions, though up to one may not meet expectations. [At Least 6 out of 9 must be at meets expectation levels]
- Complete with full effort all Reflections in the course.
- Complete both Lesson Plan Analyses.
- Provide thoughtful peer feedback on others Lesson Plan Analysis as assigned.
- Display all aspects of professionalism throughout the course.

To receive **a C** in this course, a student will:

- Struggle in <u>two</u> of the following areas
  - Actively participate in the course by meeting expectations for all quizzes and discussions, though up to one may not meet expectations. [At Least 6 out of 9 must be at meets expectation levels]
  - Complete with full effort all Reflections in the course.
  - Complete both Lesson Plan Analyses.
  - Provide thoughtful peer feedback on others Lesson Plan Analysis as assigned.
  - Display all aspects of professionalism throughout the course.

To receive a **D** in this course a student will:

- Struggle in <u>three</u> of the following areas
  - Actively participate in the course by meeting expectations for all quizzes and discussions, though up to one may not meet expectations. [At Least 5 out of 9 must be at meets expectation levels]
  - Complete with full effort all Reflections in the course.
  - Complete both Lesson Plan Analyses.
  - Provide thoughtful peer feedback on others Lesson Plan Analysis as assigned.
  - Display all aspects of professionalism throughout the course.

To receive an **F** in this course a student will:

- Fail to meet the requirements to receive a D.

<u>AND/OR</u>

- Participation in the course through quizzes and discussions is at 4 out of 9 or less at met expectations level no matter what other course work.

<u>Due Dates: All assignments due at 11:59pm CST on dates below</u>

Week	Day	Assignment Due
1 **Jun 9**	 W	Classes Start Reflection 1 Due, Discussion 1 begins
2 **Jun 16**	W F	Discussion 1 Ends Reflection 2 Due
3 **Jun 23**	M F	Quiz 1 Due Quiz 2 Due
4 **Jun 30**	M Thu	Quiz 3 Due, Discussion 2 Starts Discussion 2 Ends (Holiday Weekend so tried for a 4 day one)
5 **July 7**	Tu Th F	Project 1 Due Peer Reviews Due, Reflection 3 Due Quiz 4 Due

6 **July 14**	M F	Quiz 5 Due Quiz 6 Due
7 **July 21**	M F	Discussion 3 Starts Discussion 3 Ends
8 **July 28**	M W F	Project 2 Due Peer Reviews Due Final Reflection (#4) Due