Illinois State University
Department of Chemistry
CHE 401.02
(previously CHE 489.02)
Advanced Chemistry Demonstrations: Chemical Reactions, Stoichiometry and the Mole
3 credit hours

Catalog Description:
Advanced Chemistry Demonstrations: Reactions, Stoichiometry and the Mole
3 F, S, Sum *CHE 301 or equivalent as prerequisite.* Topical analysis of current best practices in teaching chemical reactions, stoichiometry and the mole as they pertain to secondary school classrooms.

Instructor: Dr. Willy Hunter
Email: wjhunte@ilstu.edu

Materials:

Required: Access to the ReggieNet Website

Required: Advanced Chemistry Demonstrations: Chemical Reactions, Stoichiometry, and the Mole Course Package (available from link within Reggienet)

Catalog Description:
Advanced Chemistry Demonstrations: Reactions, Stoichiometry and the Mole
3 F,S, Sum *CHE 301 or equivalent as prerequisite.* Topical analysis of current best practices in teaching chemical reactions, stoichiometry and the mole as they pertain to secondary school classrooms. A particular emphasis will be to connect content knowledge to modern demonstrations and teaching activities.

Contact Hours:
This course is a structured, self-paced course available online for 8 *(summer term)* or 16 *(fall/spring term)* weeks from the start date of the course. Each assignment, except the midterms 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 Disability Concerns 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 chemical reactions, stoichiometry and the mole. A 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 54

demonstrations and teaching activities which engage them in a detailed examination of the ways in which current chemistry teachers deliver chemical reactions and stoichiometry 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 chemical reactions and stoichiometry?
2. What are the safety considerations and risks associated with teaching the chemical reactions and stoichiometry? How may the chemical reactions and stoichiometry be taught safely in schools?
3. What is the role of the National Standards and State Standards in determining how the chemical reactions and stoichiometry are taught in schools?
4. What pedagogical techniques are appropriate for teaching the chemical reactions and stoichiometry in secondary schools?
5. What are the challenges associated with teaching the chemical reactions and stoichiometry?

Required Student Tasks/Assignments:

1. Students are expected to read each of the following 8 articles from the Journal of Chemical Education and The Chemical Educator. These articles can be accessed within ReggieNet and will play a significant role in the two midterm assessments for the course.

Eichler J. F. *Chem. Educator* 2007, 5, 347–348, Using a Precipitation Reaction in a Guided-Inquiry Stoichiometry Laboratory http://chemeducator.org/papers/0012005/12070347je.pdf

Bird, L. *Chem. Educator* 2006, 6, 380-382 Stoichiometric Calculations Using Equivalent Molar Expressions. http://chemeducator.org/papers/0011006/11060380lb.pdf

Yang, S-P. *Chem. Educator* 2002, 1, 37-39 Household Products Used To Collapse Closed Containers and Demonstrate Avogadro's Law
http://chemeducator.org/papers/0007001/710037sy.pdf

McMinn, D. *J. Chem. Educ.* 1984, 61 (7), p 591 Coffee, coins, and limiting reagents
http://pubs.acs.org/doi/pdf/10.1021/ed061p591.1

Szabadvary, F *J. Chem. Educ* 1962, 39 (5), p 267The birth of stoichiometry.
http://pubs.acs.org/doi/pdf/10.1021/ed039p267

Treptow, R.S. *J. Chem. Educ.,* 2010, 87 (2), pp 168–171 Carbon Footprint Calculations: An Application of Chemical Principles http://pubs.acs.org/doi/pdf/10.1021/ed8000528

Oliver-Hoyo, M.T., Pinto, G., Llorens-Molina, J.A. *J. Chem. Educ.,* 2009, 86 (11), p 127 The Chemistry of Self-Heating Food Products. An Activity for Classroom Engagement
http://pubs.acs.org/doi/pdf/10.1021/ed086p1277

Mills, K.V., Guilmette,L.W., *J. Chem. Educ.,* 2007, 84 (2), p 326
Thermochemical Analysis of Neutralization Reactions: An Introductory Discovery Experiment
http://pubs.acs.org/doi/pdf/10.1021/ed084p326.

2. Students are expected to watch each of the following 12 videos packages. For each video package, there are a series of questions that must be answered.

Each video package has 25-30 questions that cover the individual episodes presented in that package. There are a total of 11 assessments that cover the video packages (*note: the Limiting/Excess Reactants Package and Stoichiometry Package are short packages and have therefore been combined into the same assessment)*. Each assessment has a variety of question sets associated with it. The first set of questions is content 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. The second set of questions is 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 is a set of questions associated with safety and linking the episode to the National Science Education Standards.

Synthesis Reactions

Classifying Chemical Reactions—Synthesis
Fuel Cells in Eggshells
The Chef
Reaction of Iodine and Aluminum
"Underwater Fireworks" Reaction of Chlorine and Acetylene

Decomposition Reactions

Catalytic Decomposition of Hydrogen Peroxide
Simple Electrolysis
Elephant Toothpaste
Production of Sodium Carbonate Lab
Magic Genie

Single Replacement Reactions

The Floating Tin Sponge
Foiled Again
Smashing Thermite Reaction
Safe Swimming with Sodium

Double Replacement Reactions

Classifying Chemical Reactions - Double Replacement
Colorful Stalactites and Stalagmites
Overhead Precipitation
Solubility Patterns
Carbide Cannon

Bob Becker's Favorite Combustion Reaction Demonstrations

Methane Mamba
Flame Tornado & Water Jug Race
An Egg-splosive Demonstration
Flaming Vapor Ramp
Wax Vapor Combustion in a Test Tube

Combustion Reactions

Ditto Rockets

Gun Cotton
The Candle Snuffer
Magnesium and Dry Ice
The Hungry Dragon

Combustion of Alcohols
Extreme Whoosh Bottle Trio
Plenty Powerful Ping Pong Popper
Big Time Ethyl Alcohol Explosion
Canned Heat
Giant Alcohol Cannon

Reactions of Calcium Carbide—Combustion of Acetylene
Instant, Instant Coffee
Flammable Ice
Combustion of Acetylene
Knock Your Socks Off
Getting a Bang Out of Chemistry

Introduction to The Mole Concept
Pie Demo
Mole Lab
Moles in Space
Bomb Bag

Mole Relationships and the Balanced Equation
Decomposition of Baking Soda
Target Mole Lab
Target Stoichiometry Lab
Synthesis of Manganese(II) Chloride

Limiting and Excess Reactants
Micro Rocket Lab
Bottles and Caps - An Analogy to Stoichiometry
Fuel Cell Football

Stoichiometry in Combustion Reactions
Carbide Cannon
Stoichiometry in Combustion of Acetylene
Big Time Ethyl Alcohol Explosion
Ethanol Explosion

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:	315 points
First Midterm:	120 points
Second Midterm:	120 points
Final Project:	140 points

Total Points: 695 points

Assessment Schedule (Summer 2020)

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	19	Quiz 1, 2
	26	Quiz 3, **Midterm 1**
July	3	Quiz 4, 5, *Midterm 1 Peer Reviews*
	10	Quiz 6, **Midterm 2**
	17	Quiz 7, 8, *Midterm 2 Peer Reviews*
	24	Quiz 9, 10, **Final Project**
	31	Quiz 11*, Final Project Peer review*