Illinois State University
Department of Chemistry
CHE 401.03
Advanced Chemistry Demonstrations: Kinetics, Equilibrium, and Acids and Bases.
3 credit hours

Catalog Description:

Advanced Chemistry Demonstrations: Kinetics, Equilibrium, and Acids and Bases.
3 F, S, Sum *CHE 301 or equivalent as prerequisite.* Topical analysis of current best practices in teaching Kinetics, Equilibrium, and Acids and Bases as they pertain to secondary school classrooms. A particular emphasis will be to connect content knowledge to modern demonstrations and teaching activities.

Instructor: Dr. William Hunter
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Materials:

Required: Access to the ReggieNet Course Website

Required: Advanced Chemistry Demonstrations: Kinetics, Equilibrium, and Acids and Bases Course Package (available from Flinn Scientific E-Learning)

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 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 and/or medical/mental health condition should contact Student Access and Accommodation Services at 350 Fell Hall, (309) 438-5853, or visit the website: StudentAccess.IllinoisState.edu.

Course Overview and Objectives:
This course constitutes a survey course of ways in which we can understand and teach Kinetics, Equilibrium, and Acids and Bases. 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 59 demonstrations and teaching activities which engage them in a detailed examination of the ways in which current chemistry teachers deliver Kinetics, Equilibrium, and Acids and Bases 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 Kinetics, Equilibrium, and Acids and Bases?
2. What are the safety considerations and risks associated with teaching the Kinetics, Equilibrium, and Acids and Bases? How may the Kinetics, Equilibrium, and Acids and Bases be taught safely in schools?
3. What is the role of the National Standards and State Standards in determining how Kinetics, Equilibrium, and Acids and Bases are taught in schools?
4. What pedagogical techniques are appropriate for teaching Kinetics, Equilibrium, and Acids and Bases in secondary schools?
5. What are the challenges associated with teaching Kinetics, Equilibrium, and Acids and Bases?

Required Student Tasks/Assignments:

1. Students are expected to read each of the following 9 articles from the Journal of Chemical Education and The Chemical Educator. These articles can be obtained within the ReggieNet course and will play a significant role in the two midterm assessments and final assessment for the course.

Ault, A. (1999). Do pH in your head. *Journal of Chemical Education*, *76* (7), 936. DOI: 10.1021/ed076p936

Calatayud, M-L, Bárcenas, S.L., & Furió-Más, C. (2007). Surveying students' conceptual and procedural knowledge of acid-base behavior of substances. *Journal of Chemical Education*, *84* (10), 1717. DOI: 10.1021/ed084p1717

Cokelez, A. (2010). A comparative study of French and Turkish students' ideas on acid-base reactions. *Journal of Chemical Ecuation*, *87* (1), 102-106. DOI: 10.1021/ed800017b

Eagle, C. T., Bearman, B. M., & Goodman A. G. (2003). Chemistry for breakfast: Approaching kinetics and uncovering everyday chemistry by cooking eggs. *Chemical Educator, 8*, 122-124. DOI: 10.1333/s00897030674a

Grafton, A. K. (2009). Determining reaction orders by measuring half-life: A simple introduction to experimental kinetics. *Chemical Educator, 14,* 19-22. DOI: 10.1333/s00897092187a

Lewis, D., Petruševski, V. M., & Trujillo, C. A. (2009). Excel simulations of games: An introduction to kinetics and equilibrium concepts. *Chemical Educator*, *14*, 1-3. DOI: 10.1333/ s00897092183a

Mussel, R., Todebush, P. M., & Braun, J. R. (2007). Chemical demonstration for traditionally difficult high school chemistry topics. *Chemical Educator*, *12*, 270-272. DOI: 10.1333/s00897072052a

Quílez, J. (2008). Students' and teachers' inability to transfer the molar concentration concept to aqueous equilibrium solutions. *Chemical Eduator*, *13*, 61-66. DOI: 10.1333/s00897082119a

Wilcox, C. J. (2001). Modification of small-scale one-pot reactions to an inquiry-based laboratory exercise. *Journal of Chemical Education*, *78* (1), 62. DOI: 10.1021/ed078p62

2. Students are expected to watch each of the following 15 videos packages. For each video episode within the package there are a series of questions that must be answered.

Each video package has a series of questions that cover the individual episodes presented in that package. 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.

Additionally, there 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.

Kinetics / Introduction to Reaction Rates

- Wax Vapor Combustion in a Test Tube
- Sudsy Kinetics
- Silent Lecture
- Blue Bottle Experiment
- Dragon Breath in a Dust Can

Kinetics / Rate Laws

- Rate of Reaction of Sodium Thiosulfate and Hydrochloric Acid
- Iodine Clock Challenge
- How Does a Clock Reaction Work?

Kinetics / Effect of Temperature on Reaction Rates

- Reaction Kinetics in Blue
- Lightstick Kinetics

Kinetics / Catalysis

- Catalytic Decomposition of Hydrogen Peroxide
- Pink Catalyst
- Catalytic Oxidation of Acetone by Copper
- Magic Genie
- Inhibition of Hydrogen Peroxide
- Ostwald Oxidation of Ammonia

Kinetics / Activation Energy

- Smashing Thermit Reaction
- Racquetball Kinetics
- Fuel Cells in Eggshells
- Hand Blasters

Kinetics / Reaction Pathways

- Yellow-Blue Switcheroo
- The Funnel Chain
- Cobalt Catalyst and the Activated Complex
- Clock Reaction Race

Equilibrium / Exploring Equilibrium

Overhead Equilibrium
Common Ion Effect
Common Ion Effect Revisited
Silver "One-Pot" Demonstration

Equilibrium / Models and Simulations

Equilibrium Demonstrations - The Good, the Bad, and the Ugly!
Aquarium Analogy with Two Aquaria
Aquarium Analogy with One Aquarium

Equilibrium / LeChatelier's Principle

Temperature Equilibrium Tubes
Upset Tummy? - MOM to the Rescue
Cobalt Complex Ions
LeChatelier's Principle and the Solubility of Carbon Dioxide

Acids and Bases / Introduction to Acids and Bases

The pH is Right Game
Velcro Gloves and Ball Set
Indicator Sponge

Acids and Bases / Natural Indicators and Household Substances

Red Cabbage Indicator
Natural Indicators
Goldenrod Messages and Name Tags

Acids and Bases / Acid-Base Indicators

The "Rainbow Connection"
Orange Juice and Strawberry Float
The Sodium Spectrum
Phenolphthalein is Pink in Base
Disappearing Ink

Acids and Bases / Neutralization Reactions

Multi-Use for MOM
MOM and pH
Large pH Tube
pH Rainbow Tube
Nonadditivity of Volumes

Acids and Bases / Weak Acids and Bases

Hydrolysis of Salts
Dry Ice Rainbow of Colors
Battle of the Acids
Ammonia Fountain with Bromthymol Blue
Acidic, Basic and Neutral Salts

Acids and Bases / Buffers

Bet on Buffers
Buffering of Lakes
Buffer Balancing Acts

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:	330 points
First Midterm:	100 points
Second Midterm:	100 points
Final Project:	198 points
Total Points:	728 points

Assessment Schedule (Spring 2022)

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

Due Date:		Assignment:
Jan.	26	Quiz 1
Feb.	02	Quiz 2
	09	Quiz 3
	16	Quiz 4, **Midterm 1**
	23	Quiz 5, *Peer Review 1*
Mar.	02	Quiz 6
	09	NO ASSIGNMENTS DUE
	16	Quiz 7
	23	Quiz 8, **Midterm 2**
	30	Quiz 9, *Peer Review 2*
Apr.	06	Quiz 10
	13	Quiz 11
	20	Quiz 12
	27	**Final Project**
May	04	*Final Peer Review*