Illinois State University
Department of Chemistry
CHE 401.05
Advanced Chemistry Demonstrations: Redox, Electrochemistry and Solutions
3 credit hours

Catalog Description:
Advanced Chemistry Demonstrations: Redox, Electrochemistry and Solutions
3 F, S, Sum *CHE 301 or 401 (any other topics) or 402 or 403 or equivalent as prerequisite.* Topical analysis of current best practices in teaching redox, electrochemistry and solutions 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
Email: wjhunte@ilstu.edu

Materials:

Required: Access to the ISU Canvas Website

Required: Access to the Advanced Chemistry Demonstrations: Redox, Electrochemistry and Solutions Video Website (link available in Canvas Modules)

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 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 Redox, Electrochemistry and Solutions. 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 demonstrations and teaching activities which engage them in a detailed examination of the ways in which current chemistry teachers deliver redox, electrochemistry and solutions 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 redox, electrochemistry and solutions?
2. What are the safety considerations and risks associated with teaching redox, electrochemistry and solutions? How may redox, electrochemistry and solutions be taught safely in schools?
3. What is the role of the Next Generation Science Standards in determining how redox, electrochemistry and solutions are taught in schools?
4. What pedagogical techniques are appropriate for teaching redox, electrochemistry and solutions in secondary schools?
5. What are the challenges associated with teaching redox, electrochemistry and solutions?

Required Student Tasks/Assignments:

Students will be required to watch the following 11 video packages and supplemental assignments within the Canvas course. The video packages can be found on the Flinn Scientific website and consist of three topics: Redox, Electrochemistry, and Solubility.

Redox

1. *Oxidation States*
    a. Fantastic Four Color Oscillator
    b. The Redox Rainbow
    c. Redox and the Goddess of Beauty
    d. Colorful Iron Complexes
2. *Activity Series of Metals*
    a. Reactions of Alkali Metals
    b. The Floating Tin Sponge
    c. Foiled Again
    d. Redox on Filter Paper
    e. Can Ripper
3. *Copper, Silver, and Gold Redox Reactions*
    a. Silver Mirrors
    b. Ruby Red Colloidal Gold
    c. Alchemy: A Cross-curricular Activity
    d. The World's Smallest Christmas Tree

Electrochemistry

1. *Voltaic Cells*
    a. Six-Way Galvanic Cell
    b. Hot Dog Clock
    c. Redox Analogies
    d. Electrochemistry Buzzer
2. *Electrolysis Reactions*
    a. Tin Man Electrolysis
    b. Electrolysis of Potassium Iodide
    c. Petri Dish Electrolysis

3. *Electrolysis of Water*
    a. Simple Electrolysis
    b. Electrolysis of Water in Living Color

Solutions and Solubility

1. *Saturated, Unsaturated, and Supersaturated Solutions*
    a. Saturated, Unsaturated, and Supersaturated Solutions
    b. Quick Freeze
    c. Supersaturated Sodium Acetate Solution
    d. Solubility of Gases
2. *Properties of Solutions*
    a. Aloha Chemical Sunset
    b. Freezing Point Depression
    c. Salting Out Effect of Water and Methyl Alcohol
    d. Blowing out a Light Bulb
    e. Soda Pop Shower
3. *Concentration of Solutions*
    a. Molarity versus Molality
    b. Determination of Copper in Brass
    c. Blue + Blue does not equal Blue
    d. Effect of Concentration on Conductivity of Solutions
    e. Cereal Dilution

4. *Solubility Equilibria*
    a. Common Ion Effect
    b. Dilution Effect on Solubility
    c. Common Ion Effect Revisited
    d. Silver "One-Pot" Demonstration
5. *Precipitation Reactions and Solubility Rules*
    a. Colorful Stalactites and Stalagmites
    b. Solubility Patterns
    c. Overhead Precipitation
    d. Keep Your Eyes on the Ions

The following articles are also ***RECOMMENDED*** and may serve as supplemental material for the discussion prompts, and can be found inside ReggieNet.

Bazzi, A.; Bandyopadhyay, K.; Bazzi, J.; and Stewart, O. Analysis of Mineral Water: A General Chemistry Laboratory Experiment *Chem. Educator* **2012**, 17, 73-77
http://chemeducator.org/papers/0017001/17120083.pdf
DOI: 10.1333/s00897122418a,

Anderson, L.; Wittkopp, S.M.; Painter, C.J.; Liegel, J.J.; Schreiner, R.; Bell, J.A. and Shakhashiri, B.Z. What Is Happening When the Blue Bottle Bleaches: An Investigation of the Methylene Blue-Catalyzed Air Oxidation of Glucose *J. Chem. Educ.*, **2012**, *89* (11), pp 1425–1431 DOI: http://pubs.acs.org/doi/pdf/10.1021/ed200511d

Hines, W.G.; and de Levie, R. The Early Development of Electronic pH Meters *J. Chem. Educ.*, **2010**, 87 (11), pp 1143–1153 DOI: http://pubs.acs.org/doi/pdf/10.1021/ed100407u

Ibanez, J.G.; Vazquez-Olavarrieta, J.L.; Moran-Orozco, M.E; Garcia-Pintor, E.; Köhler-Krützfeldt, A.; Anderson, M.P.; and Mattson, B. The Spark(L)ing Vinaigrette: A Demonstration That Produces Flames. *J. Chem. Educ.*, **2011**, *88* (10), pp 1404–1405 DOI: http://pubs.acs.org/doi/pdf/10.1021/ed100583g

Jensen, W.B. The Proper Writing of Ionic Charges *J. Chem. Educ.*, **2012**, *89* (8), pp 1084–1085 DOI: http://pubs.acs.org/doi/pdf/10.1021/ed2001335

Laranjo, M.T.; and Amaral, S.T. *Chem. Educator* 2013, 18, 24–27, Determining the Solubility Product of Silver Acetate and Verifying the Common-Ion Effect – A General Chemistry Experiment *Chem. Educator*
http://chemeducator.org/papers/0018001/18130024.pdf
DOI 10.1007/s00897132458a

Lichter, J. Using YouTube as a Platform for Teaching and Learning Solubility Rules *J. Chem. Educ.*, **2012**, *89* (9), pp 1133–1137 DOI: http://pubs.acs.org/doi/pdf/10.1021/ed200531j

Luck, L.A. and Blondo, R.M. The Grapes of Class: Teaching Chemistry Concepts at a Winery *J. Chem. Educ.*, **2012**, *89* (10), pp 1264–1266 DOI: http://pubs.acs.org/doi/pdf/10.1021/ed300158c

Macrakis, K.; Bell, E.K.; Perry, D.L.; and Sweeder, R.D. Invisible Ink Revealed: Concept, Context, and Chemical Principles of “Cold War” Writing *J. Chem. Educ.*, **2012**, *89* (4), pp 529–532 DOI: http://pubs.acs.org/doi/pdf/10.1021/ed2003252

Palomar-Ramírez, C.F.; Bazán-Martínez, J.A.; Palomar-Pardavé, M.E.; Romero-Romo, M.A.; and Ramírez-Silva; Taking Advantage of a Corrosion Problem To Solve a Pollution Problem
J. Chem. Educ., **2011**, *88* (8), pp 1109–1111
DOI: http://pubs.acs.org/doi/pdf/10.1021/ed9000365

Laura E. Slocum and Erica K Jacobsen Predictions and Explanations
J. Chem. Educ., **2010**, *87* (12), pp 1282–1283
DOI: http://pubs.acs.org/doi/pdf/10.1021/ed1009514

Garon C. Smith, Md. Mainul Hossain, and Patrick MacCarthy
J. Chem. Educ., **2012**, *89* (11), pp 1416–1420
Why Batteries Deliver a Fairly Constant Voltage until Dead
DOI: http://pubs.acs.org/doi/pdf/10.1021/ed200211s

Sabrina G. Sobel, Skyler Cohen Spectator Ions ARE Important! A Kinetic Study of the Copper−Aluminum Displacement Reaction *J. Chem. Educ.*, **2010**, *87* (6), pp 616–618
DOI: http://pubs.acs.org/doi/pdf/10.1021/ed1001703

Overall, the course will consist of the following four components and are outlined in more detail below:

1. Quizzes (3 x 25 points)
2. Discussion Member Postings (7 x 10 points)
3. Discussion Leader (1 x 40 points)
4. Final Project (1 x 50 points)

1. **Quizzes (3x25=75 points)**
   You will be responsible for completing a quiz over each of the redox video packages. Each quiz will consist of 25 questions. Approximately half the questions will focus on content and the other half will focus on pedagogy and safety.

2. **Discussion Member (7x10=70 points)**
   As a discussion member in your group, you are expected to respond to the initial prompt **by the date and time listed on the Course Schedule.** You are also required to post at least 4 responses in each discussion. The required responses will be spread throughout the duration of the discussion prompt, so be sure to check discussion postings frequently. ***Please wait until the initial posting deadline has passed before posting your comments to other responses.*** See the course schedule for details. Discussion leaders are expected to post as well.

   Your responses should reflect your ability to apply the knowledge that you acquire from the Flinn videos and provided supplemental material to events that take place in your classroom or other educational setting. They should also reflect your ability to confirm or refute other ideas based on research findings discussed in your materials or from external resources. Please check the discussion member rubric under the "Resources and Materials" section in ReggieNet before you post your response. **Five points will be deducted if the responses are not posted by the required deadlines. Five points will be deducted if the minimum number of postings is not posted by the end of each week.**

3. **Discussion Leader (40 points)**
   Each group member will serve as a weekly discussion leader. Discussion leader assignments and discussion prompts will be provided by the instructor with the goal of allowing students to show their understanding of the course materials. As the discussion leader, you will have 3 tasks: (1) Stimulate group members' thinking and help to reveal their understanding of course material; (2) Contribute to and monitor the discussion, check for questions or concerns, and ask for clarification, and comment in response to others' contributions; (3) Write a summary of the responses and subsequent comments to your prompt.

   You will be assessed on your ability to stimulate group members' thinking, the quality of the summary, and if comments and clarifications were made in an effort to monitor the discussion. Please check the discussion leader rubric under the "Assignments" section in ReggieNet. You will submit your summary as an assignment ***WITHIN SEVEN DAYS FOLLOWING THE FINAL RESPONSE DEADLINE FOR THAT DISCUSSION.***

   Discussion leaders are also members of the discussion group and are expected to post a response to the discussion prompt. **Ten points will be deducted if the post to the prompt of your discussion is not posted by the date/time listed on the Course Schedule.**

4. **Final Project (50 points)**
   The Next Generation Science Standards are designed to encompass the minimum expectations for what all students should know leaving high school. The topics of this course are likely beyond the *explicit* scope of NGSS. However, the NGSS and its Science and Engineering Practices and Cross-Cutting Concepts provide a good foundation and

framework for teaching these concepts. The final project will focus on integrating course topics with NGSS.

Grading Scale

The point breakdown for the course is as follows:

Video assessments:	3x25	75 points
Discussion Member:	7x10	70 points
Discussion Leader:		40 points
Final Project:		50 points
Total Points:		235 points

Letter Grades

90% or higher = A
80% to 89% = B
70% to 79% = C
60% to 69% = D
59% or lower = F