



NEW JERSEY CENTER
FOR TEACHING & LEARNING

Progressive Science Initiative® (PSI®)

CHEM6756: Learning and Teaching PSI Advanced Chemistry IV: Aqueous Equilibria, Thermodynamics, & Electrochemistry

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Course Credit: 3.0 NJCTL credits

Dates & Times:

This is a 3-credit, self-paced course, covering 9 modules of content. The exact number of hours that you can expect to spend on each module will vary based upon the module coursework, as well as your study style and preferences. You should plan to spend approximately 15 hours per credit working online, and up to 30 hours per credit working offline.

Graduate Student Handbook: www.njctl.org/graduate-handbook/

COURSE DESCRIPTION:

This advanced chemistry course is for teachers to learn the content of PSI AP Chemistry and how to teach that course to students. The student course is designed to be taught to students who have taken PSI Chemistry prior to this course. This is a mathematically rigorous chemistry course that builds upon foundational topics in physics and leads to a better understanding of biology. Topics include aqueous equilibria, thermodynamics, and electrochemistry.

STUDENT LEARNING OUTCOMES:

Upon completion of the course, the student will be able to:

1. Demonstrate an understanding of advanced topics related to aqueous equilibria, thermodynamics, and electrochemistry, detailed in the module learning outcomes below.
2. Integrate PSI materials (including presentations, labs, practice problems, etc.) to support student learning and deliver effective instruction.
3. Create a social constructivist learning environment through the use of formative assessment questions, interpreting the results of this assessment to effectively facilitate student-led discussions that support deeper understanding of the content.
4. Integrate multiple attempts to demonstrate student mastery of content knowledge, as encouraged/fostered by the PSI pedagogy.

5. Implement learning plans that are aligned to College Board standards that allow for differentiation.

TEXTS, READINGS, INSTRUCTIONAL RESOURCES:

Required Texts:

- PSI Chemistry uses a free digital textbook accessible at: <https://njctl.org/courses/science/ap-chemistry/>
- Participants will download SMART Notebook presentations, homework files, labs, and teacher resources from the PSI Chemistry Courses

Recommended Texts and Resources:

Cobb, C, Fetterolf, M. (2010). *The Joy of Chemistry: The Amazing Science of Things*. Amerherst, NY: Prometheus Books. ISBN-13: 978-1591027713

Strathern, P. (2001). *Mendelyev's Dream: The Quest for the Elements* (1st ed.). Thomas Dunne Books. ISBN-13: 978-0312262044

PhET (simulations) - <https://phet.colorado.edu/en/simulations/category/chemistry>

COURSE REQUIREMENTS:

In order to receive a Passing grade, the participant must complete the following course requirements:

1. Activities: A number of different learning activities will ensure participant engagement and learning in the course. These include:
 - Engage in video module lessons which demonstrate minimized direct instruction followed by frequent formative assessment
 - Completion of formative assessments aligned to learning objectives which include detailed analysis when answered incorrectly.
 - Interaction with module discussion boards that allow conversation with peers and course instructors about the module's content, delivering that content to students. Discussion boards also serve as a place to ask and answer questions related to the module's content.
2. Short Answer Assignment: Each module requires one (1) original response to a given prompt. These prompts are typically based upon course lessons and require teachers to analyze, reflect, and make connections between the module's content and their own classroom practice.
3. Mastery Exercises: For each module, these multiple-choice question quizzes assess the content knowledge gained in a module. Participants have the opportunity to retake; random questions are pulled from a larger question bank on each attempt ensuring varied questions.
4. Virtual Labs: In each module, a virtual lab write-up will be submitted. Virtual Labs are interactive lab simulations that promote a deeper understanding of the content knowledge being learned through real-world applications and analysis.
5. Module Exam: One is completed at the end of each module. It is a culminating exam consisting of multiple choice and free response questions aligned to the standards and objectives of the module.
6. Reflection Paper: At the end of the course, participants are required to reflect on the knowledge taught in the course, make connections, and compare/contrast their current pedagogy with new strategies gained in this assignment.
7. Final Exam: At the end of the course, a comprehensive exam consisting of Multiple Choice and Free Response questions assesses the content knowledge learned throughout the course and aligns to AP College Board Exams.

GRADE DISTRIBUTION AND SCALE:

Grade Distribution:

Module Exams 70%

Final Exam	10%
Labs	6%
Short Answer Assignments	6%
Mastery Exercises	6%
Reflection Paper	2%

Grade Scale:

A	93 – 100
A-	90 – 92
B+	86 – 89
B	83 – 86
B-	80 – 82
C+	77 – 79
C	73 – 76
C-	70 – 72
D	60.0 – 69.9
F	59.9 or below

GRADING RUBRICS:

The following rubric is used to score:

- Short Answer Assignment – 6% of grade
- Reflection Paper – 2% of grade

The minimum possible score for this rubric is 4 points, and the score will be converted to the minimum grade available in this module (which is zero unless the scale is used). The maximum score 25 points will be converted to the maximum grade.

Intermediate scores will be converted respectively and rounded to the nearest available grade. If a scale is used instead of a grade, the score will be converted to the scale elements as if they were consecutive integers.

	Meets Expectation	Approaches Expectation	Below Expectation	Limited Evidence
	<i>7 points</i>	<i>5 points</i>	<i>3 points</i>	<i>1 point</i>
Content	<ul style="list-style-type: none"> • Demonstrates excellent knowledge of concepts, skills, and theories relevant to topic. 	<ul style="list-style-type: none"> • Demonstrates fair knowledge of concepts, skills, and theories. 	<ul style="list-style-type: none"> • Demonstrates incomplete or insubstantial knowledge of concepts, skills, and theories. 	<ul style="list-style-type: none"> • Demonstrates little or no knowledge of concepts, skills, and theories.
Depth of Reflection	<ul style="list-style-type: none"> • Content is well supported and addresses all required components of the assignment. 	<ul style="list-style-type: none"> • Content is partially supported; addresses most of the required components of the assignment. 	<ul style="list-style-type: none"> • Content contains major deficiencies; addresses some of the required components of the assignment. 	<ul style="list-style-type: none"> • Content is not supported and/or includes few of the required components of the assignment.

Evidence and Practice	<ul style="list-style-type: none"> Response shows strong evidence of synthesis of ideas presented and insights gained throughout the entire course. The implications of these insights for the respondent's overall teaching practice are thoroughly detailed, as applicable. 	<ul style="list-style-type: none"> Writing is mostly clear, concise, and well organized with good sentence/paragraph construction. Thoughts are expressed in a coherent and logical manner. There are no more than five spelling, grammar, or syntax errors per page of writing. 	<ul style="list-style-type: none"> Response is missing some components and/or does not fully meet the requirements indicated in the instructions. Some questions or parts of the assignment are not addressed. Some attachments and additional documents, if required, are missing or unsuitable for the purpose of the assignment. 	<ul style="list-style-type: none"> Response excludes essential components and/or does not address the requirements indicated in the instructions. Many parts of the assignment are addressed minimally, inadequately, and/or not at all.
	<i>4 points</i>	<i>3 points</i>	<i>2 points</i>	<i>1 point</i>
Writing Quality	<ul style="list-style-type: none"> Writing is well-organized, clear, concise, and focused; no errors. 	<ul style="list-style-type: none"> Some minor errors or omissions in writing organization, focus, and clarity. 	<ul style="list-style-type: none"> Some significant errors or omissions in writing organization, focus, and clarity. 	<ul style="list-style-type: none"> Numerous errors in writing organization, focus, and/or clarity.

The following rubric is used to score:

- Labs – 6% of grade

The minimum possible score for this rubric is 2 points, and the score will be converted to the minimum grade available in this module (which is zero unless the scale is used). The maximum score of 14 points will be converted to the maximum grade.

Intermediate scores will be converted respectively and rounded to the nearest available grade. If a scale is used instead of a grade, the score will be converted to the scale elements as if they were consecutive integers.

	Meets Expectation	Approaches Expectation	Below Expectation	Limited Evidence
	<i>7 points</i>	<i>5 points</i>	<i>3 points</i>	<i>1 point</i>
Completeness	<ul style="list-style-type: none"> Lab write-up is complete with no missing fields. 	<ul style="list-style-type: none"> Lab write-up has 1-2 missing fields. 	<ul style="list-style-type: none"> Lab write up has 3-5 missing fields. 	<ul style="list-style-type: none"> There are more than 5 missing fields on the lab write-up.
Calculations	<ul style="list-style-type: none"> All answers are calculated correctly. 	<ul style="list-style-type: none"> Most answers are calculated correctly, but there are 1-2 minor calculation errors. 	<ul style="list-style-type: none"> Most answers are calculated correctly, but there are multiple minor calculation errors, or 1-2 gross miscalculations. 	<ul style="list-style-type: none"> There are calculation errors throughout the lab.

The remaining types of assignments are not scored using a rubric. These assignments are scored using percentage correct to assign a letter grade. The assignments in this manner are as follows:

- Mastery Exercises – 6% of grade
- Module Exams – 70% of grade
- Final Exam – 10% of grade

Mastery Exercises can be retaken as many times as desired to ensure a high score. Due to the nature of these assignments, each time they are taken, they will be composed of unique questions pulled randomly from a larger question bank.

Module and Final Exams are scored using a curve, which allows us to keep content exams rigorous. Module Exams can be retaken one time. Final Exams cannot be retaken.

ACADEMIC STANDING:

NJCTL has established standards for academic good standing within a student's academic program. Students enrolled in any NJCTL online course must receive an 80 or higher to successfully complete a course and receive credit for that course. An 80 is equivalent to a GPA of 2.7 or B-. Additionally, students in an endorsement program must receive a cumulative GPA of 3.0 for all courses combined in order to successfully complete the program.

ACADEMIC INTEGRITY:

Students must assume responsibility for maintaining honesty in all work submitted for credit and in any other work designated by the instructor of the course. Academic dishonesty includes cheating, fabrication, facilitating academic dishonesty, plagiarism, reusing /repurposing your own work, unauthorized possession of academic materials, and unauthorized collaboration.

CITING SOURCES WITH APA STYLE:

All students are expected to follow proper writing and APA requirements when citing in APA (based on the APA Style Manual, 6th edition) for all assignments.

DISABILITY SERVICES STATEMENT:

We are committed to providing reasonable accommodations for all persons with disabilities. Any student with a documented disability requesting academic accommodations should contact the Dean of Students, Melissa Axelsson, for additional information to coordinate reasonable accommodations for students with documented disabilities (melissa@njctl.org).

NETIQUETTE:

Respect the diversity of opinions among the instructor and classmates and engage with them in a courteous, respectful, and professional manner. All posts and classroom communication must be conducted in accordance with the student code of conduct. Think before you push the Send button. Did you say just what you meant? How will the person on the other end read the words?

Maintain an environment free of harassment, stalking, threats, abuse, insults or humiliation toward the instructor and classmates. This includes, but is not limited to, demeaning written or oral comments of an ethnic, religious, age, disability, sexist (or sexual orientation), or racist nature; and the unwanted sexual advances or intimidations by email, or on discussion boards and other postings within or connected to the online classroom.

If you have concerns about something that has been said, please let your instructor know.

CLASS SCHEDULE:

Module	Module Learning Outcomes	Assignments
1 – Acids & Bases Part 1	<ul style="list-style-type: none">• Discuss the properties of acids & bases.• State the three definitions of acids & bases: Arrhenius, Bronsted-Lowry and Lewis.• Calculate the acid/base strength in terms of pH.• Differentiate between a weak & strong acid & base.• Discuss the effects of a buffer on a solution.	<ul style="list-style-type: none">• Short Answer Assignment• Lab• Mastery Exercise
2 – Acids & Bases Part 2	<ul style="list-style-type: none">• Discuss the characteristics of weak acids & bases.	<ul style="list-style-type: none">• Short Answer Assignment• Mastery Exercise• Module Exam
3 – Buffers	<ul style="list-style-type: none">• Discuss how a buffered solution resists changes to its pH when small amounts of acid or base are added.• Identify the pH of a buffer solution based on the identity and concentrations of the conjugate acid-base pair used to create the buffer.• Explain the relationship between the buffer capacity of a solution and the relative concentrations of the conjugate acid and conjugate base components of the solution.	<ul style="list-style-type: none">• Short Answer Assignment• Lab• Mastery Exercise• Module Exam
4 – Titrations	<ul style="list-style-type: none">• Define titration.• Discuss how a titration is prepared.• Identify the equivalence point in a titration based on the amounts of the titrant and analyte, assuming the titration reaction goes to completion.• Explain the results from the titration of a mono- or polyprotic acid or base solution, in relation to the properties of the solution and its components.	<ul style="list-style-type: none">• Short Answer Assignment• Lab• Mastery Exercise• Module Exam
5 – K_{sp} & Solubility	<ul style="list-style-type: none">• Identify the solubility of a salt, and/or the value of K_{sp} for the salt, based on the concentration of a common ion already present in solution.• Calculate the solubility of a salt based on the value of K_{sp} for the salt.• Discuss how the dissolution of a salt is a reversible process that can be influenced by environmental factors such as pH or other dissolved ions.	<ul style="list-style-type: none">• Short Answer Assignment• Lab• Mastery Exercise• Module Exam
6 – The 4 Laws of Thermodynamics	<ul style="list-style-type: none">• Explain why the Zeroth Law of Thermodynamics which describes temperature and how to measure it, must precede the 1st and 2nd Laws.• Describe what happens when 2 objects with different temperatures are in thermal contact.• Define entropy and identify the sign and relative magnitude of the entropy change associated with chemical or physical processes.• Contrast the 1st Law which states energy is conserved with the 2nd Law which describes the entropy of the universe.• Calculate the entropy change for a chemical or physical process based on the absolute entropies of the species involved in the process.	<ul style="list-style-type: none">• Short Answer Assignment• Lab• Mastery Exercise• Module Exam

<p>7 – Gibbs Free Energy</p>	<ul style="list-style-type: none"> • Calculate the Gibb’s Free Energy change for a chemical or physical process using standard Gibb’s Free energy of formation values. • Explain whether a physical or chemical process is thermodynamically favored based on an evaluation of the relationships between enthalpy, H°, S° and T as they impact the value of ΔG°. • Determine the temperature above which a nonspontaneous reaction becomes spontaneous. • Explain, in terms of kinetics, why a thermodynamically favored reaction might not occur at a measurable rate. • Explain whether a process is thermodynamically favored using the relationships between K, ΔG°, and T. • Explain the relationship between external sources of energy or coupled reactions and their ability to drive thermodynamically unfavorable processes. 	<ul style="list-style-type: none"> • Short Answer Assignment • Lab • Mastery Exercise • Module Exam
<p>8 - Electrochemistry</p>	<ul style="list-style-type: none"> • Explain the relationship between the physical components of an electrochemical cell and the overall operational principles of a cell. • Explain whether an electrochemical cell is thermodynamically favored, based on its standard cell potential and the constituent half-reactions within the cell. • Explain the relationship between deviations from standard cell conditions and changes in the cell potential. • Calculate the amount of charge flow based on changes in the amounts of reactants and products in an electrochemical cell. 	<ul style="list-style-type: none"> • Short Answer Assignment • Lab • Mastery Exercise • Module Exam
<p>9 – Reflection & Final Exam</p>	<ul style="list-style-type: none"> • Review topics as desired • Zoom meeting with instructor, as needed 	<ul style="list-style-type: none"> • Reflection Paper • Final Exam