NEW JERSEY CENTER
FOR TEACHING & LEARNING

Progressive Science Initiative® (PSI®)
CHEM6741: Learning and Teaching Honors Chemistry:
Periodic Table and Chemical Bonding

Primary Student Contact:	Dan Reinhold	daniel@njctl.org
Faculty Team:	Dr. Bob Goodman	bob@njctl.org
	Dr. Jayasree Sankar	jayasree@njctl.org
	Rebbeca Barrett	rebbeca@njctl.org
	John Ennis	john@njctl.org
	Dan Reinhold	daniel@njctl.org
	Debra Kalapodakis	debra@njctl.org

Course Credit: 3.0 NJCTL credits

Dates & Times:
This is a 3-credit, self-paced course, covering 8 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 introductory course is for teachers to learn the atomic structure & chemical bonding topics of PSI Chemistry and how to teach them to students. These topics include atomic origins; atomic structure; the periodic table & electron configuration; periodic trends; ionic bonding & ionic compounds, covalent bonding & Lewis diagrams, and lab safety. This mathematically rigorous chemistry course reinforces student understanding of Algebra I and Geometry while providing a foundation for the future study of chemistry, physics, and biology.

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

1. Demonstrate an understanding of the Periodic Table and chemical bonding, 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 NGSS standards and allow for differentiation based on the needs of learners.

TEXTS, READINGS, INSTRUCTIONAL RESOURCES:
Required Texts:

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

Recommended Texts:

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

Holton, G. J., Brush, S. G., & Holton, G. J. (2001). *Physics, the Human Adventure: From Copernicus to Einstein and Beyond*. New Brunswick, N.J: Rutgers University Press. ISBN-13: 9780813529080

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.

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 RUBRIC:

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
	7 points	***5 points***	***3 points***	***1 point***
Content	• Demonstrates excellent knowledge of concepts, skills, and theories relevant to topic.	• Demonstrates fair knowledge of concepts, skills, and theories.	• Demonstrates incomplete or insubstantial knowledge of concepts, skills, and theories.	• Demonstrates little or no knowledge of concepts, skills, and theories.
Depth of Reflection	• Content is well supported and addresses all required components of the assignment.	• Content is partially supported; addresses most of the required components of the assignment.	• Content contains major deficiencies; addresses some of the required components of the assignment.	• Content is not supported and/or includes few of the required components of the assignment.
Evidence and Practice	• 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.	• 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.	• 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.	• 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.
	4 points	***3 points***	***2 points***	***1 point***
Writing Quality	• Writing is well-organized, clear, concise, and focused; no errors.	• Some minor errors or omissions in writing organization, focus, and clarity.	• Some significant errors or omissions in writing organization, focus, and clarity.	• 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**
	7 points	***5 points***	***3 points***	***1 point***
Completeness	• Lab write-up is complete with no missing fields.	• Lab write-up has 1-2 missing fields.	• Lab write up has 3-5 missing fields.	• There are more than 5 missing fields on the lab write-up.
Calculations	• All answers are calculated correctly.	• Most answers are calculated correctly, but there are 1-2 minor calculation errors.	• Most answers are calculated correctly, but there are multiple minor calculation errors, or 1-2 gross miscalculations.	• 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
0 – Optional Physics Review	• Review electricity topics. • Review modern physics topics.	• None
1 – Atomic Origins	• Describe the Big Bang and evidence that supports the Big Bang theory • Describe synthesis of elements through nuclear fusion following the Big Bang • Understand the applications of electricity, magnetism, and radiation that led to the discovery of protons, electrons, and the nucleus • Identify the major contributions of J.J. Thompson, Ernest Rutherford, and Niels Bohr to the development of atomic structure • Determine the numbers of protons, neutrons, and electrons in a given isotope of an atom. • Calculate average atomic mass	• Short Answer Assignment • Lab • Mastery Exercises • Module Exam

	• Balance nuclear reactions: fusion, fission, radioactive decay reactions • Calculate half-life	
2 – Atomic Structure	• Describe problems with Rutherford's nuclear atomic model that led to the basic principles of the Bohr model • Interpret the lines on an emission spectrum and calculate the energy and wavelength of a photon of light emitted by an excited electrons • Describe major contributions to wave-particle duality of matter that lead to the quantum mechanical model of the atom • Distinguish between the "classical" view and the "quantum mechanical" view of the atom • Define and describe quantum number solutions to the Schrodinger equation • Write electron configurations	• Short Answer Assignment • Lab • Mastery Exercises • Module Exam
3 – Periodic Table & Electron Configuration	• Describe how elements are arranged in the periodic table. • Relate the electron configuration of an element to its position on the periodic table.	• Short Answer Assignment • Mastery Exercises
4 – Effective Nuclear Charge & Periodic Trends	• Interpret atom diagrams to determine shielding constant, effective nuclear charge, and electric force between protons and electrons in an atom. • Describe trends in atomic radius, ionization energy, electronegativity, and metallic character using the concept of electronic shielding and effective nuclear charge (Z_{eff}).	• Short Answer Assignment • Lab • Mastery Exercises • Module Exam
5 – Ionic Bonding & Ionic Compounds	• Define the octet rule for orbital filling and determine the number of valence electrons of an element • Describe the formation of cations and anions and determine the resulting charge on an atom that has gained or lost electrons • Describe the formation of an ionic bond between metal cations and nonmetal anions due to a large difference in electronegativity • Write names and formulas for binary and tertiary ionic compounds • Learn the names, charges, and naming trends for common polyatomic ions	• Short Answer Assignment • Lab • Mastery Exercises • Module Exam

6 – Covalent Bonding & Lewis Diagrams	● Describe the formation of a covalent bond between when atoms share electrons due to a small difference in electronegativity. ● Draw Lewis structures for covalent compounds and polyatomic ions. ● Use prefixes to write names and formulas for covalent compounds. ● Describe properties of covalent compounds and strength of multiple covalent bonds. ● Determine if a molecule or polyatomic ion exhibits resonance and draw the resonance structure. ● Explain the physical basis for violation of the octet rule and draw Lewis structures from compounds that violate the octet rule. ● Use the valence-shell electron-pair repulsion (VSEPR) theory to predict the electron-domain geometry, approximate bond angles, and molecular shape of a molecule or polyatomic ion. ● Determine whether a molecule or polyatomic ion is polar or nonpolar	● Short Answer Assignment ● Mastery Exercises ● Module Exam
7 – Lab Safety	● Identify and describe how to safely use lab equipment. ● Learn to safely use chemicals in the chemistry lab.	● Short Answer Assignment ● Mastery Exercises
8 – Reflection & Final Exam	● Review topics as desired in *The Joy of Chemistry and Physics, the Human Adventure* (recommended) ● Zoom meeting with instructor, as needed	● Discussion Board ● Reflection Paper ● Final Exam