Course Title:	Content Area:	Grade Level:	Credit (if applicable)
UConn ECE Chemistry 1127Q and 1128Q	Science	10-12	2.0 BPS 1127Q: 4.0 UConn 1128Q: 4.0 UConn

Course Description:

This course enables students to undertake, in their first year, second-year work in the chemistry sequence at their institution or to register for courses in other fields where chemistry is a prerequisite. Students will attain a depth of understanding of fundamentals and competence in dealing with chemical problems.

Through quantitative and qualitative analysis, students will gain a deeper understanding of matter, and how it changes. Major units of study include: Matter and change, solutions, gasses, heat, electronic structure of the atom, bonding, intermolecular forces, colligative properties, kinetics, equilibrium, thermodynamics, electrochemistry and nuclear chemistry. Through cooperative learning and lab experiences, students will improve communication and critical thinking skills.

Aligned Core Resources:

Textbook
Chemistry: The Central Science, 15th edition
Brown, LeMay, Bursten, Murphy, Woodward, Stoltzfus

Other
- ChemQuiz.net Autogenerated and customizable practice questions
- PhET Interactive simulations
- The Organic Chemistry Tutor - YouTube Chemistry tutorials at a college level
- Khan Academy Video tutorials, practice problems, and articles.
- Chemistry 2e Free online textbook

Connection to the *BPS Vision of the Graduate*

CONTENT MASTERY
- Develop and draw from a baseline understanding of knowledge in academic disciplines from our Bristol curriculum.

CRITICAL THINKING AND PROBLEM SOLVING
- Collect, assess and analyze relevant information
- Reason effectively. Use systems thinking.
- Make sound judgments and decisions. Identify, define and solve authentic problems and essential questions.
- Reflect critically on learning experience, processes and solutions.
- Transfer knowledge to other situations.

Additional Course Information:
Knowledge/Skill Dependent courses/prerequisites
- Must be enrolled in or have taken Algebra 2 ACC.
- Have an"83" average in Biology ACC or a "93" in Biology ACA.
- Students must be concurrently taking Pre-Calculus ACC or have the permission of the instructor.
- Grade 10 students may take concurrently with Biology ACC with teacher recommendation and an "83" average in Physical Science ACC.

Link to *Completed Equity Audit*

Equity Curriculum Review (ECE Chemistry 2024-25)

Standard Matrix

Learning Objective 1: To explain and apply basic principles, definitions, laws and theories of chemistry
Learning Objective2: To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically.
Learning Objective 3: To develop laboratory skills and techniques along with data collection, data analysis and interpretation.
Learning Objective4: To develop logical analytical skills which can be used in real life problem solving and analysis

Common Curriculum objective	Course student learning objective(s)	Course assessment(s)
• LO-1 Students will be able to explain and appropriately utilize basic scientific language and concepts.	• LO 1- To explain and apply basic principles, definitions, laws and theories of chemistry	• Conceptual questions based on the first two domains of Bloom's taxonomy (remembering and understanding) on the exams
• LO-2 Students will be able to design or conduct an experiment or analysis suitable to test a	• LO 3 – to develop laboratory skills and techniques along with data collection, data analysis and	• Pre-lab quizzes, data analysis and conclusion reports submitted after every laboratory

scientific hypothesis and be able to interpret the results. • LO-1 Through application-based experiences utilizing the scientific method, students will be able to identify problems, make observations, analyze data, interpret data, and develop models or explanations	interpretation.	experiment. Required participation in scheduled laboratory activities in person.
• LO-3 Students will be able to solve problems described verbally ,graphically, symbolically, or numerically.	• LO 2- To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically. • LO 4- To develop logical analytical skills which can be used in real life problem solving and analysis	• Open ended quantitative problems on the exams. • Online Homework assignments. • Higher-order comprehensive numerical problems on the exam and online homework. These problems cannot be directly solved by plugging values into a standard equation. Students must critically analyze the problem and combine multiple concepts in a logical manner to solve the problem.

Unit Links

Unit Title:

Unit 1: Matter and Change (1127)

Relevant Standards: Bold indicates priority

LO 1: To explain and apply basic principles, definitions, laws and theories of chemistry.

LO 2: To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically.

LO 3: To develop laboratory skills and techniques along with data collection, data analysis and interpretation.

LO 4: To develop logical analytical skills which can be used in real life problem solving and analysis.

Essential Question(s):

- What is matter, and how is it classified?
- What are the properties of matter, and how can they be measured?
- How does matter change and transform?
- What is the atomic structure of matter, and how does it relate to its properties?
- How do we model and predict changes in matter?

Enduring Understanding(s):

- Matter exists in various forms and states, each characterized by distinct properties and behaviors.
- Classification of matter into elements, compounds, and mixtures helps us understand its composition and structure.
- Physical properties such as mass, volume, and density are intrinsic to matter and can be quantitatively measured.
- Understanding and measuring these properties allow for characterization and comparison of different substances.
- Matter undergoes physical changes (like phase changes) and chemical changes (like reactions) that alter its properties.
- Changes in matter can be observed through indicators such as color change, temperature change, or formation of new substances.
- Matter is composed of atoms, which combine to form molecules with specific chemical and physical properties.
- The structure and arrangement of atoms and molecules dictate the macroscopic properties and behavior of matter.
- Models, such as particle models and atomic models, provide frameworks for understanding and predicting the behavior of matter.
- Knowledge of matter's properties and changes enables the application of scientific principles to real-world scenarios and phenomena.

Demonstration of Learning:

- UConn provided exams
- UConn provided labs
- Teacher created assignments

Pacing for Unit

Approximately 20 classes

Family Overview (link below)

Family Overview ECE Chemistry

Integration of Technology:

- Thin Layer Chromatography simulation for chemical separation lab
- Spectrophotometer (Colorimeter) for aspirin synthesis

Unit-specific Vocabulary:

Unit Specific Vocabulary ECE Chemistry

Aligned Unit Materials, Resources, and Technology (beyond core resources):

N/A

Opportunities for Interdisciplinary Connections:

Math Connection:

Anticipated misconceptions:

- Matter is only something solid and visible.

• Unit conversions and dimensional analysis with math classes Science Connection: • Structure of an atom and the periodic table from physical science.	• All matter can be classified in the same way. • Properties like color, size, or texture are only observable, and cannot be measured scientifically. • Mass and weight are the same. • All changes in matter involve chemical reactions. • Matter only changes when it is heated or cooled. • Atoms are solid and indivisible particles. • All atoms of an element are identical in their arrangement of subatomic particles. • Changes in matter can always be predicted based on appearance or basic knowledge. • Models of matter are always accurate representations of reality.

Differentiation through *Universal Design for Learning*

UDL Indicator	**Teacher Actions:**

Representation:

I can name and write formulas for compounds

- Use diagrams and charts to illustrate chemical structures and formulas. This can include molecular models or flowcharts showing the naming conventions for compounds.
- Incorporate videos that demonstrate chemical reactions and the formation of compounds, allowing students to see the concepts in action.
- Provide written materials that include step-by-step guides for naming compounds, along with examples. Use clear, concise language and highlight key terms.

Supporting Multilingual/English Learners

Related *CELP standards:*	**Learning Targets:**

An EL can conduct research and evaluate and communicate findings to answer questions or solve problems.

I can name and write formulas for compounds

- Level 1: I can verbally describe the parts of a chemical formula
- Level 2: I can interpret and manipulate chemical formulas
- Level 3: I can analyze scenarios (word problems) and choose appropriate equations to solve problems independently. I can explain my problem-solving process and justify my choices of equations.
- Level 4: I can critique and refine problem-solving strategies based on verbal or written feedback.
- Level 5: I can synthesize information from multiple sources to solve real-world problems involving motion and explain my solutions effectively.

The CELP guidance is to **support the development of language; access to course content expectations should not change as a result of MLL status.*

Lesson Sequence	**Learning Target**	**Success Criteria/Assessment/Resources**
1	I can explain the concepts of matter, atoms, and molecules	• I can demonstrate how molecules and the atoms that compose them are represented by molecular models • I can compare and contrast the different states of matter • I can distinguish between elements compounds and mixture
2	I can investigate the properties of matter	• I can distinguish between chemical and physical properties and changes. • I can distinguish between intensive and extensive properties • I can describe how filtration, distillation, and chromatography can be used to separate mixtures.
3	I can measure and perform calculations according to the rules of uncertainty.	• I can convert between the 7 base units used in the metric system. • I can convert between temperature units K, C, F • I can interconvert among mass, volume and density

		• I can calculate energy in Joules • I can differentiate between exact and inexact numbers • I can explain the difference between accuracy and precision • I can demonstrate the use of significant figures in exponential notation and SI units in calculations • I can use dimensional analysis to perform calculations using conversion factors.
4	I can investigate the formation of modern atomic structure	• I can describe the structure of atoms • I can describe the historic discovery of atomic structure • I can describe early investigations to characterize the atom
5	I can understand how to read and utilize the periodic table	• I can describe and calculate the relationship between the atomic weight of an element, and the weights and abundances of a naturally occurring isotope of the same element. • I can infer an element's general properties from its location on the periodic table. • I can describe the differences between groups and periods. • I can relate an element's atomic number and atomic mass with the number of subatomic particles its atoms would contain.
6	I can name and write formulas for compounds	• I can name and write formulas for ions • I can write the formula for binary and ternary ionic compounds • I can name binary and ternary ionic compounds • I can write formulas for and name simple molecular compounds. • I can distinguish between molecular and empirical formulas.
7	I can quantitatively study matter	• I can calculate the molar mass of a compound and relate it to its formula weight. • I can define the mole is 6.022x10^23 • I can interconvert between grams, moles and molecules • I can calculate Empirical and Molecular formulas and percent composition of a compound
8	I can understand chemical reactions in a quantitative manner	• I can write and balance chemical equations • I can describe the proportional relationships between the substances involved in a chemical reaction. • I can describe and determine the limiting and excess reagents in a chemical reaction • I can perform calculations involving percent yield

Unit Title:	
Unit 2: Solutions and Gasses (1127)	
Relevant Standards: Bold indicates priority	
LO 1: To explain and apply basic principles, definitions, laws and theories of chemistry. **LO 2: To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically.** LO 3: To develop laboratory skills and techniques along with data collection, data analysis and interpretation. LO 4: To develop logical analytical skills which can be used in real life problem solving and analysis.	
Essential Question(s):	**Enduring Understanding(s):**
• What are solutions, and how do solutes interact with solvents? • How do we measure and describe the concentration of solutions? • What factors affect solubility, and how does it impact solution behavior? • What are the key properties of gasses, and how are they measured? • How do gas laws describe the behavior of gasses? • What factors influence the behavior of gasses, and what are their real-world applications?	• Solutions are mixtures where solutes dissolve in solvents to form homogeneous mixtures. • Concentration measures like molarity and percent composition describe how much solute is in a solution. • Solubility is influenced by temperature, pressure, and the nature of solute-solvent interactions. • Saturated, unsaturated, and supersaturated solutions have distinct stability and properties. • Gasses have properties like pressure, volume, and temperature, described by gas laws such as Boyle's, Charles's, and the Ideal Gas Law ($PV = nRT$). • Gas behavior is predictable under different conditions due to these laws. • Gasses diffuse rapidly and mix uniformly due to their high kinetic energy and lack of fixed volume or shape. • Understanding gas behavior is crucial in fields like meteorology, engineering, and environmental science.
Demonstration of Learning:	**Pacing for Unit**
• UConn provided exams • UConn provided labs • Teacher created assignments	Approximately 20 classes
Family Overview (link below)	**Integration of Technology:**
Family Overview ECE Chemistry	• pH probe and LabQuest device for gravimetric analysis lab • Pressure sensor and LabQuest device for gas behavior lab
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Unit Specific Vocabulary ECE Chemistry	*N/A*
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Math Connections: • Algebraic Relationships: Solving for variables in equations like the Ideal Gas Law uses skills from Algebra I and II (e.g., rearranging equations, working with formulas). • Ratios and Proportions: Calculating molarity and percent composition involves using ratios to express how much solute is present in a solution—aligned with standards in data analysis	• Solutions are only formed by liquids dissolving in other liquids. • The solute is always completely dissolved in the solvent. • Solvents are always liquid. • Solutes and solvents mix without any change in their properties. • Solubility is the same for all substances at any temperature.

<table>
<tr><td>and problem solving.
Science Connection:
Diffusion and Particle Motion: High school physics explores motion and forces—concepts that relate to how gas particles move and spread out quickly in open spaces.</td><td>Gases do not have mass or volume.</td></tr>
<tr><td colspan="2">Differentiation through Universal Design for Learning</td></tr>
<tr><td>UDL Indicator</td><td>Teacher Actions:</td></tr>
<tr><td colspan="2">Representation:
I can describe the composition of solutions, qualitatively and quantitatively.
Use diagrams and images to show different types of solutions (e.g., homogeneous vs. heterogeneous) and their components. This can include labeled diagrams illustrating solutes and solvents.
Incorporate videos demonstrating how solutions are made, showing real-life examples of solutes dissolving in solvents, which can help students visualize the process.
Provide written explanations with clear definitions of key terms such as "solute," "solvent," "concentration," and "dilution." Use straightforward language and highlight important concepts.</td></tr>
<tr><td colspan="2">Supporting Multilingual/English Learners</td></tr>
<tr><td>Related CELP standards:</td><td>Learning Targets:</td></tr>
<tr><td colspan="2">An EL can conduct research and evaluate and communicate findings to answer questions or solve problems.
I can describe the composition of solutions, qualitatively and quantitatively.
Level 1: I can verbally describe the parts of a solution
Level 2: I can interpret and manipulate solutions
Level 3: I can analyze scenarios (word problems) and choose appropriate equations to solve problems independently. I can explain my problem-solving process and justify my choices of equations.
Level 4: I can critique and refine problem-solving strategies based on verbal or written feedback.
Level 5: I can synthesize information from multiple sources to solve real-world problems involving solutions and explain my solutions effectively.
*The CELP guidance is to support the development of language; access to course content expectations should not change as a result of MLL status.</td></tr>
</table>

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
1	I can describe the composition of solutions, qualitatively and quantitatively.	• I can recognize that substances dissolved in water exist as ions, molecules or a mixture of the two. • I can describe electrolytes and nonelectrolytes • I can describe the concentration of particles in solution using units of molarity • I can dilute a solution to create a new solution of known molarity	
2	I can describe acid/base reactions	• I can explore reactions in which protons, H+ ions are transferred from one reactant to another • I can perform an acid/base titration to determine the concentration of a solution	
3	I can describe precipitation reactions	• I can write complete and net ionic equations. • I can define spectator ions. • I can predict if two solutions will form a precipitate when mixed. • I can perform stoichiometric calculations on precipitation reactions	
4	I can describe oxidation and reduction reactions	• I can determine the oxidation numbers of elements in a compound • I can identify which species are oxidized and reduced in a redox reaction. (and the oxidizing and reducing agents) • I can write oxidations and reduction half reactions	

		• I can write full redox equations in acidic and basic medium
5	I can connect the kinetic molecular theory of gasses to the concept of pressure	• I can describe how the properties of gasses differ from those of solids and liquids • I can define gas pressure and how manometers work, • I can interconvert between units of pressure
6	I can qualitatively and quantitatively use the gas laws	• I can define a direct and indirect relationship in reference to gas behavior • I can relate the ideal gas law to Boyle's, Charle's, and Avogadro's Laws. • I can use the ideal gas law to calculate any variable in the ideal gas equation. • I can perform gas density and molar mass calculations • I can explain avogadro's and molar volume at STP • I can qualitatively and quantitatively describe gas mixtures using Dalton's Law of partial pressures • I can qualitatively and quantitatively describe gas effusion and diffusion using Graham's Law.

Unit Title:	
Unit 3: Heat, Electronic Structure of the Atom , and Bonding (1127)	
Relevant Standards: Bold indicates priority	
LO 1: To explain and apply basic principles, definitions, laws and theories of chemistry. LO 2: To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically. **LO 3: To develop laboratory skills and techniques along with data collection, data analysis and interpretation.** LO 4: To develop logical analytical skills which can be used in real life problem solving and analysis.	
Essential Question(s):	**Enduring Understanding(s):**
• What is heat, and how does it transfer between objects or substances? • What factors influence the transfer of heat, and how is it measured? • How does heat energy affect the properties and states of matter? • What are the basic components of an atom, and how are they organized? • How do electrons occupy energy levels (shells) around the nucleus of an atom? • What determines the stability and reactivity of atoms based on their electron configurations? • What are chemical bonds, and how do atoms form bonds to become stable? • What are the differences between ionic, covalent, and metallic bonds? • How does the type of bonding affect the properties of substances, such as their strength, conductivity, and melting points?	• Heat is energy transferred between objects or substances due to temperature differences. • Heat transfer occurs through conduction, convection, and radiation. • Heat energy influences the physical properties and changes of matter, such as phase transitions and chemical reactions. • Atoms consist of a nucleus containing protons and neutrons, surrounded by electrons in energy levels (shells). • Electrons occupy specific energy levels and orbitals around the nucleus according to principles such as the Aufbau principle, Pauli exclusion principle, and Hund's rule. • The arrangement of electrons determines the chemical properties and reactivity of elements. • Chemical bonds form between atoms to achieve stability by filling electron shells or achieving a stable electron configuration. • Ionic bonds involve transfer of electrons between atoms, covalent bonds involve sharing of electrons, and metallic bonds involve a sea of delocalized electrons. • The type of bonding influences the properties of substances, including their strength, conductivity, and melting points.
Demonstration of Learning:	**Pacing for Unit**
• UConn provided exams • UConn provided labs • Teacher created assignments	Approximately 20 classes
Family Overview (link below)	**Integration of Technology:**
Family Overview ECE Chemistry	• Calorimeter and temperature probe for thermochemistry lab • Digital barometer for vapor pressure lab
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Unit Specific Vocabulary ECE Chemistry	*N/A*
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Math Connections: • Calorimetry Equation: Understanding and applying the calorimetry equation involves algebraic manipulation, reinforcing skills in solving equations and working with variables.	• Heat is the same as temperature. • Heat transfer only depends on the temperature difference between objects. • All substances change state at the same temperature.

• Graph Interpretation: Determining if a reaction is endothermic or exothermic using data or graphs requires skills in data analysis and interpretation of visual information, linking math with scientific inquiry. • Quantitative Descriptions: Describing relationships between speed, frequency, wavelength, and energy of light waves involves using formulas and calculations, which reinforces mathematical concepts such as ratios and direct proportionality. ELA Connection: • Creating Lewis Structures: Writing out and explaining Lewis structures necessitates precise language use and can involve persuasive writing if students need to argue for the most favorable structure based on formal charge or resonance.	• Electrons are located on the surface of atoms. • Electrons orbit the nucleus in fixed paths. • All bonds are identical in strength.

Differentiation through Universal Design for Learning

UDL Indicator	Teacher Actions:

Representation:
I can use the Bohr model and quantum mechanical model of the atom.
- Use diagrams and illustrations of both the Bohr model and quantum mechanical model. Include labeled parts to highlight key features, such as energy levels in the Bohr model and electron clouds in the quantum model.
- Incorporate videos and animations that explain both models, demonstrating how electrons behave in each model, and showcasing their historical context and development.
- Provide clear, concise written descriptions of both models, emphasizing their differences and similarities. Use bullet points or tables to compare key features.

Supporting Multilingual/English Learners

Related CELP standards:	Learning Targets:

An EL can conduct research and evaluate and communicate findings to answer questions or solve problems.
I can use the Bohr model and quantum mechanical model of the atom.
- Level 1: I can verbally describe the parts of an atom
- Level 2: I can interpret and manipulate atomic models
- Level 3: I can analyze scenarios (word problems) and choose appropriate equations to solve problems independently. I can explain my problem-solving process and justify my choices of equations.
- Level 4: I can critique and refine problem-solving strategies based on verbal or written feedback.
- Level 5: I can synthesize information from multiple sources to solve real-world problems involving more modern models of the atom (quantum mechanical model) and explain my solutions effectively.

The CELP guidance is to **support the development of language; access to course content expectations should not change as a result of MLL status.*

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
1	I can use calorimetry concepts to study the heat of a chemical reaction	• I can define heat as a measurement of energy, and distinguish it from temperature • I can use the calorimetry equation to solve for any of its equations. • I can determine, from data or from a graph, if a reaction is endothermic or exothermic	
2	I can use Hess's law	• I can describe the enthalpy of formation from the enthalpy of reaction. • I can calculate the enthalpy of a reaction using the enthalpy of formation values.	
3	I can describe the wave nature of light	• I can qualitatively and quantitatively describe the relationship between the speed frequency and wavelength and energy of the light waves	

		• I can describe the electromagnetic spectrum and order the waves based on energy
4	I can use the Bohr model and quantum mechanical model of the atom.	• I can describe electronic transitions and qualitatively and quantitatively predict properties of light emitted or absorbed • I can state the name, symbols, and allowed combinations of quantum numbers • I can determine the electron configuration (including abbreviated and orbital diagrams) for any atom or ion on the periodic table • I can predict atomic radius, electronegativity, electron affinity, ion size, and ionization energy for an element based on its periodic table location.
5	I can describe the structure and bonding of covalent compounds	• I can describe the types of atoms that participate in covalent bonding. • I can use electronegativity to describe bond polarity and dipole moments. • I can describe the polarity and partial ionic character of a covalent bond
6	I can create and evaluate Lewis structures	• I can use the total number of valence electrons in a formula and the octet rule to determine the appropriate lewis structure • I can create Lewis structures for compounds that are exceptions to the octet rule. • I can calculate formal charge and use it to determine the more likely structure. • I can describe the concept of resonance
7	I can describe the geometry of covalent compounds.	• I can describe VSEPR theory • I can use VSEPR theory to predict and name, shapes,, bond angles, and hybridization • I can differentiate between pi and sigma bonds

Unit Title:	
Unit 4: Liquids and Solids (1127)	
Relevant Standards: Bold indicates priority	
LO 1: To explain and apply basic principles, definitions, laws and theories of chemistry. LO 2: To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically. LO 3: To develop laboratory skills and techniques along with data collection, data analysis and interpretation. **LO 4: To develop logical analytical skills which can be used in real life problem solving and analysis.**	
Essential Question(s):	**Enduring Understanding(s):**
• What are intermolecular forces, and how do they affect the properties of substances? • What are the different types of intermolecular forces (e.g., London dispersion forces, dipole-dipole interactions, hydrogen bonding)? • How do intermolecular forces influence physical properties such as boiling point, melting point, and solubility?	• Intermolecular forces are attractive forces between molecules that determine their physical state and behavior. • London dispersion forces arise from temporary fluctuations in electron distribution and exist between all molecules. • Dipole-dipole interactions occur between polar molecules due to permanent dipoles. • Hydrogen bonding is a special type of dipole-dipole interaction where hydrogen atoms bonded to highly electronegative atoms (such as nitrogen, oxygen, or fluorine) exhibit a strong attraction to lone pairs on neighboring molecules. • Intermolecular forces increase with molecular size and polarity, affecting properties such as boiling point (higher forces require more energy to overcome), melting point, and solubility (like dissolves like principle).
Demonstration of Learning:	**Pacing for Unit**
• UConn provided exams • UConn provided labs • Teacher created assignments	Approximately 20 classes
Family Overview (link below)	**Integration of Technology:**
Family Overview ECE Chemistry	*N/A*
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Unit Specific Vocabulary ECE Chemistry	*N/A*
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Math Connection: • Quantitative Relationships: Relating vapor pressure to the heat of vaporization using the Clausius-Clapeyron equation involves algebraic manipulation and logarithmic calculations, enhancing students' skills in applying mathematical concepts to real-world scenarios. ELA Connection: • Descriptive Writing: Describing hydrogen bonding and differentiating between bond and molecular polarity require students to articulate complex scientific concepts succinctly, enhancing their descriptive writing skills.	• Intermolecular forces are the same as chemical bonds. • All intermolecular forces are equally strong.
Differentiation through *Universal Design for Learning*	

<table>
<tr><th colspan="2">UDL Indicator</th><th colspan="2">Teacher Actions:</th></tr>
<tr><td colspan="4">Representation:
I can relate Intermolecular forces of attraction to physical properties and molecular structures.
• Use diagrams and charts to illustrate different types of intermolecular forces (e.g., hydrogen bonding, dipole-dipole interactions, London dispersion forces) and how they relate to molecular structures and physical properties like boiling point, melting point, and solubility.
• Incorporate videos that explain intermolecular forces, showcasing real-life examples of how these forces affect the properties of substances, such as the behavior of water versus oil.
• Provide written explanations that define key terms and concepts, using clear and straightforward language. Include examples that connect intermolecular forces to observable physical properties.</td></tr>
<tr><th colspan="4">Supporting Multilingual/English Learners</th></tr>
<tr><th colspan="2">Related CELP standards:</th><th colspan="2">Learning Targets:</th></tr>
<tr><td colspan="4">An EL can conduct research and evaluate and communicate findings to answer questions or solve problems.
I can relate Intermolecular forces of attraction to physical properties and molecular structures.
• Level 1: I can verbally describe intermolecular forces
• Level 2: I can interpret and manipulate molecular structures
• Level 3: I can analyze scenarios (word problems) and choose appropriate equations to solve problems independently. I can explain my problem-solving process and justify my choices of equations.
• Level 4: I can critique and refine problem-solving strategies based on verbal or written feedback.
• Level 5: I can synthesize information from multiple sources to solve real-world problems involving IMFs and their effect on physical properties, and explain my solutions effectively.
*The CELP guidance is to support the development of language; access to course content expectations should not change as a result of MLL status.</td></tr>
<tr><th>Lesson Sequence</th><th>Learning Target</th><th>Success Criteria/ Assessment</th><th>Resources</th></tr>
<tr><td>1</td><td>I can relate Intermolecular forces of attraction to physical properties and molecular structures.</td><td colspan="2">• I can differentiate between bond and molecular polarity
• I can use bond polarity and molecular geometry to determine the polarity of the molecule.
• I can compare the strength of intermolecular forces given different structures
• I can describe hydrogen bonding
• I can relate intermolecular forces to freezing point, boiling point, melting point, and vapor pressure.
• I can quantitatively relate vapor pressure to the heat of vaporization using the Clausius-Clapeyron
• I can read and interpret phase diagrams</td></tr>
</table>

Unit Title:	
Unit 5: Colligative Properties and Kinetics (1128)	
Relevant Standards: Bold indicates priority	
LO 1: To explain and apply basic principles, definitions, laws and theories of chemistry. LO 2: To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically. **LO 3: To develop laboratory skills and techniques along with data collection, data analysis and interpretation.** **LO 4: To develop logical analytical skills which can be used in real life problem solving and analysis.**	
Essential Question(s):	**Enduring Understanding(s):**
• What are colligative properties, and how do they depend on the number of solute particles in a solution? • What are the common colligative properties (e.g., vapor pressure lowering, boiling point elevation, freezing point depression), and how are they calculated? • How do colligative properties affect practical applications, such as in freezing point depression in antifreeze or boiling point elevation in cooking? • What is chemical kinetics, and how does it relate to reaction rates? • What factors influence the rate of chemical reactions (e.g., concentration, temperature, catalysts)? • How are reaction mechanisms and rate laws used to describe and predict reaction rates?	• Colligative properties depend solely on the number of solute particles present, not on their identity. • Vapor pressure lowering, boiling point elevation, and freezing point depression are directly proportional to the solute concentration in a solution. • Colligative properties are important in various industrial and everyday applications, such as in pharmaceuticals, food science, and automotive fluids • Chemical kinetics studies the speed at which chemical reactions occur and the factors that influence reaction rates. • Reaction rates increase with higher concentrations of reactants, higher temperatures, and the presence of catalysts. • Rate laws and reaction mechanisms describe how reactants transform into products over time, providing insights into reaction pathways and controlling reaction rates in practical applications.
Demonstration of Learning:	**Pacing for Unit**
• UConn provided exams • UConn provided labs • Teacher created assignments	Approximately 20 classes
Family Overview (link below)	**Integration of Technology:**
Family Overview ECE Chemistry	*N/A*
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Unit Specific Vocabulary ECE Chemistry	*N/A*
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Math Connections: • Calculations of Concentration: Expressing concentrations using mole fraction and molality involves mathematical calculations, reinforcing skills in ratios and proportions, which are fundamental in solving real-world problems in chemistry. • Equations and Graphing: Using mathematical equations to describe colligative effects, such as the van't Hoff factor, requires students to perform algebraic manipulations and graph relationships between variables like solute concentration and boiling point.	• Boiling point elevation and freezing point depression only occur with ionic solutes, not molecular ones. • Adding more solute always results in a greater change in freezing or boiling points. • Colligative properties only have an impact in extreme conditions, not in everyday life. • Chemical kinetics is only concerned with the speed of reactions, not with the factors influencing it. • Reaction rates only depend on temperature and not on other factors such as concentration or catalysts. • Catalysts change the equilibrium of a reaction. • The rate law is only relevant for complex reactions, not for simple ones.

• Reaction Rate Calculations: Calculating reaction rates from experimental data involves applying statistical analysis and understanding rates of change, emphasizing the importance of quantitative reasoning in scientific inquiry. ELA Connection: • Descriptive Explanations: Explaining why some solutions produce or absorb heat when they form requires students to articulate complex scientific concepts clearly, enhancing their ability to write detailed and coherent explanations.	
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Representation: *I can use rate and concentration data to identify reaction orders and derive rate laws.* • Use graphs to illustrate how concentration changes over time during a reaction. Different reaction orders can be represented visually (e.g., linear graphs for first-order reactions) to highlight the relationship between concentration and reaction rate. • Incorporate videos that demonstrate the process of analyzing rate and concentration data, including examples of how to identify reaction orders and derive rate laws from experimental results. • Use simulations that allow students to manipulate concentration values and observe the effects on reaction rates and graphs, providing a hands-on understanding of the concepts.	
Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**
An EL can conduct research and evaluate and communicate findings to answer questions or solve problems. *I can use rate and concentration data to identify reaction orders and derive rate laws* • Level 1: I can verbally describe what is meant by rate of a chemical reaction • Level 2: I can interpret data to determine rate laws • Level 3: I can analyze scenarios (word problems) and choose appropriate equations to solve problems independently. I can explain my problem-solving process and justify my choices of equations. • Level 4: I can critique and refine problem-solving strategies based on verbal or written feedback. • Level 5: I can synthesize information from multiple sources to solve real-world problems involving reaction rates and rate laws and explain my solutions effectively. **The CELP guidance is to **support the development of language**; access to course content expectations should not change as a result of MLL status.*	

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
1	I can describe the basic properties of solutions and how they form	• Predict whether a given mixture will yield a solution based on molecular properties of its components • I can explain why some solutions either produce or absorb heat when they form • I can define and give examples of electrolytes • I can distinguish between the physical and chemical changes that accompany dissolution of ionic and covalent electrolytes • I can relate electrolyte strength to solute-solvent attractive forces • I can describe the effects of temperature and pressure on solubility • I can state Henry's law and use it in calculations involving the solubility of a gas in a liquid • I can describe the idea of "like dissolves like" • I can use the term miscible appropriately	

2	I can qualitatively and quantitatively describe the colligative properties of solutions	• I can express concentrations of solution components using mole fraction and molality • I can describe the effect of solute concentration on various solution properties (vapor pressure, boiling point, freezing point, and osmotic pressure) • I can perform calculations using the mathematical equations that describe these various colligative effects, including the van't Hoff factor • I can describe the process of distillation and its practical applications • I explain the process of osmosis
3	I can calculate and describe how to manipulate reaction rates	• I can define chemical reaction rate • I can derive rates from the balanced equation for a given chemical reaction • I can calculate reaction rates from experimental data • I can describe and explain using collision theory the effects of chemical nature, physical state, temperature, concentration, and catalysis on reaction rates • I can define the concepts of activation energy and transition states, and relate them to a potential energy graph • I can use the Arrhenius equation in calculations
4	I can determine and utilize the rate law and the integrated rate law of a reaction	• I can explain the form and function of a rate law • I can use rate laws to calculate reaction rates • I can use rate and concentration data to identify reaction orders and derive rate laws • I can explain the form and function of an integrated rate law • I can perform integrated rate law calculations for zero-, first-, and second-order reactions • I can define half-life and carry out related calculations • I can identify the order of a reaction from concentration/time data

Unit Title:	
Unit 6: Concepts of Equilibrium (1128)	
Relevant Standards: Bold indicates priority	
LO 1: To explain and apply basic principles, definitions, laws and theories of chemistry. **LO 2: To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically.** LO 3: To develop laboratory skills and techniques along with data collection, data analysis and interpretation. LO 4: To develop logical analytical skills which can be used in real life problem solving and analysis.	
Essential Question(s):	**Enduring Understanding(s):**
• What is chemical equilibrium? • How do we express equilibrium in terms of the equilibrium constant (K)? • What factors affect the position of equilibrium? • How do we calculate equilibrium concentrations or pressures? • How does equilibrium relate to acids and bases?	• Chemical equilibrium is a dynamic state where the rate of the forward reaction equals the rate of the reverse reaction, resulting in no net change in the concentrations of reactants and products over time. • The equilibrium constant (K) expresses the ratio of product concentrations (or partial pressures) to reactant concentrations (or partial pressures) at equilibrium, with each raised to the power of their respective stoichiometric coefficients. • Factors such as concentration, pressure (for gasses), and temperature influence the position of equilibrium according to Le Chatelier's Principle. • Equilibrium concentrations (or pressures) can be calculated using the equilibrium expression and known initial conditions of reactants and products. • Equilibrium concepts apply to acids and bases through the acid dissociation constant Ka and base dissociation constant Kbwhich quantify the strength of acids and bases in aqueous solutions.
Demonstration of Learning:	**Pacing for Unit**
• UConn provided exams • UConn provided labs • Teacher created assignments	Approximately 20 classes
Family Overview (link below)	**Integration of Technology:**
Family Overview ECE Chemistry	• LabQuest and SpectroVis for K of a chemical reaction lab • LabQuest and pH probe for pH measurements lab
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Unit Specific Vocabulary ECE Chemistry	*N/A*
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Math Connections: • Equilibrium Calculations: Calculating equilibrium concentrations and constants involves algebraic manipulations and applying mathematical formulas, reinforcing students' skills in solving equations and working with variables. • Reaction Quotient and Equilibrium Expressions: Deriving expressions for reaction quotients and equilibrium constants requires understanding ratios and exponents, which enhances students' mathematical reasoning and comprehension of proportional relationships.	• Chemical equilibrium means that the concentrations of reactants and products are equal. • At equilibrium, the reaction stops and no further changes occur. • Chemical equilibrium is a one-time event, rather than a dynamic process. • The equilibrium constant (K) is always the same, regardless of temperature or pressure. • Only changes in concentration can affect the position of equilibrium. • The equilibrium constant and rate constant are the same.

• pH Calculations: Calculating the pH of buffer solutions and performing titration calculations involves logarithmic functions and understanding concentration, providing practical applications of math in chemistry. ELA Connection: • Technical Documentation: Writing equations for acid and base ionization reactions and discussing the behavior of amphiprotic substances helps students develop their ability to document scientific processes accurately, enhancing their technical writing skills.	• Acids and bases do not reach equilibrium in water because they dissociate completely.

Differentiation through *Universal Design for Learning*

UDL Indicator	Teacher Actions:

Representation:
I can interpret titration curves for strong and weak acid-base systems and compute sample pH at important stages of a titration.

- Provide clear, labeled graphs of titration curves for strong and weak acids, illustrating the changes in pH at different stages of the titration. Highlight key points such as the equivalence point, buffer region, and initial and final pH values.
- Use diagrams to depict the chemical reactions occurring during titration, showing how the acid and base interact and change in concentration.
- Incorporate videos that explain titration processes, including how to read titration curves and how to calculate pH at various stages. Visual demonstrations can enhance understanding of the concepts.

Supporting Multilingual/English Learners

Related *CELP standards:*	Learning Targets:

An EL can conduct research and evaluate and communicate findings to answer questions or solve problems.
I can interpret titration curves for strong and weak acid-base systems and compute sample pH at important stages of a titration.

- Level 1: I can verbally describe the parts of a titration curve
- Level 2: I can interpret and manipulate the graph to match specific titrations
- Level 3: I can analyze scenarios (word problems) and choose appropriate equations to solve problems independently. I can explain my problem-solving process and justify my choices of equations.
- Level 4: I can critique and refine problem-solving strategies based on verbal or written feedback.
- Level 5: I can synthesize information from multiple sources to solve real-world problems involving titration curves and explain my solutions effectively.

The CELP guidance is to **support the development of language; access to course content expectations should not change as a result of MLL status.*

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
1	I can qualitatively and quantitatively describe reversible chemical reactions	• I can describe the reversible and dynamic nature of equilibrium systems • I can derive expressions for reaction quotients and equilibrium expressions • I can calculate values of reaction quotients and equilibrium constants, using concentrations and pressures • I can relate the magnitude of an equilibrium constant to properties of the chemical system • I can describe the ways in which an equilibrium system can be stressed • I can predict the response of a stressed equilibrium using Le Châtelier's principle	

		● I can identify the changes in concentration or pressure that occur for chemical species in equilibrium systems when a stress is applied. ● I can calculate equilibrium concentrations or pressures and equilibrium constants, using various algebraic approaches
2	I can qualitatively and quantitatively describe acid base equilibria	● I can identify acids, bases, and conjugate acid-base pairs according to the Brønsted-Lowry and Lewis definitions. ● I can write equations for acid and base ionization reactions ● I can describe the acid-base behavior of amphiprotic substances ● I can assess the relative strengths of acids and bases according to their ionization constants ● I can rationalize trends in acid–base strength in relation to molecular structure* ● Carry out equilibrium calculations for weak acid–base systems ● I can predict whether a salt solution will be acidic, basic, or neutral ● I can extend previously introduced equilibrium concepts to acids and bases that may donate or accept more than one proton
3	I can perform acid-base titrations(including weak acids and bases) and qualitatively and quantitatively explain the concept of buffers	● I can describe the composition and function of acid–base buffers ● I can calculate the pH of a buffer before and after the addition of added acid or base ● I can interpret titration curves for strong and weak acid-base systems ● I can compute sample pH at important stages of a titration ● I can explain the function of acid-base indicators and choose appropriate indicators for particular acid base titrations. ● I can describe how the presence of a common ion will effect an acid /base solutions ● I can understand the concept of buffer capacity

Unit Title:
Unit 7: Solubility equilibria, Thermodynamics, and Electrochemistry (1128)

Relevant Standards: Bold indicates priority
LO 1: To explain and apply basic principles, definitions, laws and theories of chemistry. LO 2: To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically. **LO 3: To develop laboratory skills and techniques along with data collection, data analysis and interpretation.** LO 4: To develop logical analytical skills which can be used in real life problem solving and analysis.

Essential Question(s):	**Enduring Understanding(s):**
• What factors affect the solubility of a compound in a solvent? • How do we express the solubility of a compound in quantitative terms? • How do we calculate the solubility of a compound given its Ksp? • How does Le Chatelier's Principle apply to solubility equilibria? • What is the fundamental concept of thermodynamics? • How do we calculate changes in internal energy, enthalpy, and entropy? • What is Gibbs free energy (ΔG) and how is it used to predict spontaneity? • How does thermodynamics apply to phase equilibria and chemical equilibria? • What are redox reactions, and how are they represented? • How do we measure the spontaneity and extent of redox reactions? • What is the relationship between ΔG and Ecell • What are galvanic cells?	• Solubility of a compound in a solvent is influenced by temperature, pressure (for gasses), pH, and the presence of common ions. • Solubility can be expressed quantitatively • Le Chatelier's Principle predicts how changes in concentration, temperature, or pressure affect solubility equilibrium. • Thermodynamics deals with energy transformations within a system and between the system and its surroundings. • Gibbs free energy (ΔG) quantifies the spontaneity of a process; $\Delta G < 0$ indicates spontaneity under standard conditions. • ΔG helps predict the feasibility of reactions and phase changes at constant temperature and pressure • Redox reactions involve electron transfer between species, where oxidation involves loss of electrons and reduction involves gain. • $\Delta G = -nFE_{cell}$ • Galvanic cells (electrochemical cells) convert chemical energy into electrical energy through redox reactions
Demonstration of Learning:	**Pacing for Unit**
• UConn provided exams • UConn provided labs • Teacher created assignments	Approximately 20 classes
Family Overview (link below)	**Integration of Technology:**
Family Overview ECE Chemistry	• LabQuest and temperature probe for thermodynamic measurements lab. • Labquest and voltage meter for voltaic cell lab
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**
Unit Specific Vocabulary ECE Chemistry	*N/A*
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Math Connections: • Equilibrium Computations: Carrying out equilibrium computations involving solubility, equilibrium expressions, and solute concentrations requires algebraic manipulation and understanding of ratios, reinforcing students' mathematical skills in solving equations. • Entropy and Free Energy Calculations: Calculating	• Balancing chemical equations is simply about having the same number of atoms on each side, without understanding the conservation of mass and charge. • Misunderstand the common ion effect, thinking that the presence of a common ion always increases solubility, rather than recognizing that it can actually decrease solubility for certain salts. • Confuse entropy with disorder and think that a

entropy changes for phase transitions and chemical reactions, as well as calculating free energy changes using formation values, involves applying mathematical formulas and principles, enhancing quantitative reasoning. • Nernst Equation: Using the Nernst equation to determine cell potentials under nonstandard conditions involves logarithmic calculations, emphasizing the application of math in real-world chemistry scenarios. ELA Connection: • Technical Writing Skills: Writing chemical equations and equilibrium expressions necessitates careful attention to detail and accuracy in scientific notation, enhancing students' technical writing skills.	process with higher entropy is always "messier," not understanding that it is a measure of the number of microstates and energy dispersal. • Believe that spontaneity means a reaction occurs quickly, rather than understanding that it refers to the thermodynamic favorability of a reaction. • That electrode mass increases at both the anode and cathode, not realizing that oxidation occurs at the anode (mass decreases) and reduction occurs at the cathode (mass increases). • That standard cell potentials apply in all conditions without considering the effects of concentration and temperature, leading to confusion when applying the Nernst equation.

Differentiation through Universal Design for Learning

UDL Indicator	**Teacher Actions:**

Representation:

I can carry out equilibrium computations involving solubility, equilibrium expressions, and solute concentrations.

- Use diagrams to illustrate the concept of chemical equilibrium, showing the forward and reverse reactions, along with visual representations of solubility products and concentration changes.
- Create flowcharts that outline the steps for calculating solubility, equilibrium expressions, and solute concentrations, making the process clearer and more accessible.
- Incorporate videos that explain equilibrium concepts, including solubility and the calculation of equilibrium expressions. Visual aids can help clarify complex ideas and computations.

Supporting Multilingual/English Learners

Related CELP standards:	**Learning Targets:**

An EL can conduct research and evaluate and communicate findings to answer questions or solve problems.

I can carry out equilibrium computations involving solubility, equilibrium expressions, and solute concentrations.

- Level 1: I can verbally describe a saturated solution
- Level 2: I can interpret and manipulate the Ksp expression
- Level 3: I can analyze scenarios (word problems) and choose appropriate equations to solve problems independently. I can explain my problem-solving process and justify my choices of equations.
- Level 4: I can critique and refine problem-solving strategies based on verbal or written feedback.
- Level 5: I can synthesize information from multiple sources to solve real-world problems involving Ksp and saturated solutions and explain my solutions effectively.

The CELP guidance is to **support the development of language; access to course content expectations should not change as a result of MLL status.*

Lesson Sequence	**Learning Target**	**Success Criteria/ Assessment**	**Resources**
1	I can qualitatively and quantitatively describe the equilibria of saturated solutions	• I can write chemical equations and equilibrium expressions representing solubility equilibria • I can carry out equilibrium computations involving solubility, equilibrium expressions, and solute concentrations • I can qualitatively and quantitatively describe how the presence of a common ion will affect the solubility of a salt. • I can use Ksp to predict precipitation.	
2	I can qualitatively and quantitatively describe entropy, and gibbs free energy.	• I can distinguish between spontaneous and nonspontaneous processes • I can differentiate between order and disorder • I can define entropy	

		• I can explain the relationship between entropy and the number of microstates • I can predict the sign of the entropy change (both system and surroundings) for chemical and physical processes • I can state and explain the second and third laws of thermodynamics • I can calculate entropy changes for phase transitions and chemical reactions under standard conditions • I can define Gibbs free energy, and describe its relation to spontaneity • I can calculate free energy change for a process using free energies of formation for its reactants and products • I can calculate free energy change for a process using enthalpies of formation and the entropies for its reactants and products • I can explain how temperature affects the spontaneity of some processes • I can relate standard free energy changes to equilibrium constants
3	I can qualitatively and quantitatively describe electrochemistry	• I can describe defining traits of redox chemistry • I can Identify what has been oxidized/reduced/ oxidizing agent / reducing agent. • I can balance chemical equations for redox reactions using the half-reaction method • I can describe the function of a galvanic cell and its components, and any changes in electrode mass • I can use cell notation to symbolize the composition and construction of galvanic cells • I can describe and relate the definitions of electrode and cell potentials • I can calculate cell potentials • I can qualitatively and quantitatively explain the relations between potential, free energy change, and equilibrium constants • I can use the Nernst equation to determine cell potentials under nonstandard conditions • I can describe the process of electrolysis • I can perform stoichiometric calculations for electrolytic processes

<table>
<tr><th colspan="2">Unit Title:</th></tr>
<tr><td colspan="2">Unit 8: Nuclear Chemistry (1128)</td></tr>
<tr><th colspan="2">Relevant Standards: Bold indicates priority</th></tr>
<tr><td colspan="2">LO 1: To explain and apply basic principles, definitions, laws and theories of chemistry.
LO 2: To apply basic principles to solve real world problems described verbally, graphically, symbolically or numerically.
LO 3: To develop laboratory skills and techniques along with data collection, data analysis and interpretation.
LO 4: To develop logical analytical skills which can be used in real life problem solving and analysis.</td></tr>
<tr><th>Essential Question(s):</th><th>Enduring Understanding(s):</th></tr>
<tr><td>• What is radioactivity, and what causes it?
• How do we quantify radioactive decay?
• What factors influence nuclear stability?
• What are nuclear reactions, and how do they differ from chemical reactions?</td><td>• Radioactivity arises from the instability of atomic nuclei, leading to the emission of radiation in the form of alpha particles, beta particles, and gamma rays.
• Radioactive decay follows exponential decay kinetics described by the decay laws
• Nuclear stability is influenced by the balance between nuclear forces (strong force binding protons and neutrons) and the electrostatic repulsion between protons (Coulomb force)</td></tr>
<tr><th>Demonstration of Learning:</th><th>Pacing for Unit</th></tr>
<tr><td>• UConn provided exams
• UConn provided labs
• Teacher created assignments</td><td>Approximately 20 classes</td></tr>
<tr><th>Family Overview (link below)</th><th>Integration of Technology:</th></tr>
<tr><td>Family Overview ECE Chemistry</td><td>N/A</td></tr>
<tr><th>Unit-specific Vocabulary:</th><th>Aligned Unit Materials, Resources, and Technology (beyond core resources):</th></tr>
<tr><td>Unit Specific Vocabulary ECE Chemistry</td><td>N/A</td></tr>
<tr><th>Opportunities for Interdisciplinary Connections:</th><th>Anticipated misconceptions:</th></tr>
<tr><td>Math Connections:
• Calculating Mass Defect and Binding Energy: Calculating mass defect and binding energy for nuclei involves applying mathematical formulas and performing unit conversions, reinforcing students' skills in quantitative reasoning and algebra.
• Kinetic Parameters: Calculating half-life and other kinetic parameters for decay processes requires an understanding of exponential functions and logarithms, illustrating the mathematical principles behind radioactive decay.
• Balancing Nuclear Equations: Writing and balancing nuclear equations necessitates an understanding of conservation laws and numerical relationships, enhancing students' abilities in algebraic manipulation and problem-solving.
ELA Connections:
• Descriptive Writing: Describing nuclear structure in terms of protons, neutrons, and electrons requires clear and precise language, helping students develop their ability to convey complex</td><td>• Think that binding energy is always a positive quantity and do not recognize that it represents the energy required to disassemble a nucleus into its individual protons and neutrons.
• Believe that all radioactive decay processes are the same, failing to recognize the differences between alpha decay, beta decay, and gamma decay, and their respective characteristics.
• Have difficulty writing or balancing decay equations, believing they can ignore the conservation of mass and charge, leading to incorrect representations of nuclear reactions.</td></tr>
</table>

scientific concepts effectively. • Interpreting Nuclear Decay Reactions: Writing and interpreting nuclear decay equations enhances reading comprehension and analytical skills, as students must understand the implications of nuclear changes and the particles involved.	
Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Representation: *I can qualitatively and quantitatively describe nuclear chemistry.* • Provide information in various formats, such as videos, infographics, and interactive simulations. For example, using animations to illustrate nuclear decay processes helps visualize complex concepts. • Use diagrams, charts, and models to represent nuclear structures, decay equations, and energy changes. Visual aids can help students grasp abstract concepts and enhance understanding. • Offer bilingual materials or glossaries that include key terms in both English and the students' native languages. This support ensures comprehension of scientific vocabulary essential for qualitative and quantitative descriptions.	
Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**
An EL can conduct research and evaluate and communicate findings to answer questions or solve problems. *I can identify common particles and energies involved in nuclear reactions* • Level 1: I can verbally describe the parts of a nuclear chemical reaction • Level 2: I can interpret nuclear chemical reaction • Level 3: I can analyze scenarios (word problems) and choose appropriate equations to solve problems independently. I can explain my problem-solving process and justify my choices of equations. • Level 4: I can critique and refine problem-solving strategies based on verbal or written feedback. • Level 5: I can synthesize information from multiple sources to solve real-world problems involving nuclear equations and reactions and explain my solutions effectively. **The CELP guidance is to **support the development of language**; access to course content expectations should not change as a result of MLL status.*	

Lesson Sequence	Learning Target	Success Criteria/ Assessment	Resources
1	I can qualitatively and quantitatively describe nuclear chemistry	• I can describe nuclear structure in terms of protons, neutrons, and electrons • I can calculate mass defect and binding energy for nuclei • I can Identify common particles and energies involved in nuclear reactions • I can write and balance nuclear equations • I can recognize common modes of radioactive decay • I can Identify common particles and energies involved in nuclear decay reactions • I can write and balance nuclear decay equations • I can calculate kinetic parameters for decay processes, including half-life	