Chemistry Pacing Guide

Unit 0: Intro to Chemistry and Science Basics - 5 Days (7 Days for Honors)

This unit introduces students to the lab, lab materials, measuring skills, and basic scientific writing practices. These will support them in learning future material via labs, engaging in science and engineering practices, and framing their thinking for the crosscutting concepts.

Honors students will also learn significant figures and basics of formal lab reports to help prepare them to take advanced placement classes if they select that for their following science.

Unit 1: Gas Laws - 9 Days

Standards	Science and Engineering Practice	Crosscutting Concepts
CHEM.PS1.5 Conduct investigations to explore and characterize the behavior of gasses (pressure, volume, temperature), develop models to represent this behavior, and construct arguments to explain this behavior. Evaluate the relationship (qualitatively and quantitatively) at STP between pressure and volume (Boyle's law), temperature and volume (Charles's law), temperature and pressure (Gay-Lussac law), and moles and volume (Avogadro's law), and evaluate and explain these relationships with respect to kinetic-molecular theory. Be able to understand, establish, and predict the relationships between volume,	**Planning and carrying out controlled investigations** Students should derive proportionalities and equalities for dependent variables that include multiple independent variables,considering uncertainty, and limitations of collected data.	**Scale, Proportion, and Quantity** Students use proportional relationships to predict how changing one property will affect another in a system.

temperature, and pressure using combined		
CHEM.PS1.6 Use the ideal gas law, PV = nRT, to algebraically evaluate the relationship among the number of moles, volume, pressure, and temperature for ideal gasses.	**Developing and using models** Students can test the predictive abilities of their models in a real-world setting and make comparisons of two models of the same process or system.	**Cause and Effect** Students use cause and effect models at one scale to make predictions about the behavior of systems at different scales.
Unit 2: Thermodynamics - 8 Days		
Standards	Science and Engineering Practice	Crosscutting Concepts
CHEM.PS3.1 Contrast the concepts of temperature and heat in macroscopic and microscopic terms. Understand that thermal energy is a form of energy and temperature is a measure of average kinetic energy of a group of particles.	**Using mathematics and computational thinking** Students can create computational or mathematical models for interactions in the natural world using unit equivalencies.	**Pattern** Students recognize, classify, and record patterns in quantitative data from empirical research and mathematical representations.
CHEM.PS3.2 Draw and interpret heating and cooling curves and phase diagrams. Analyze the energy changes involved in calorimetry by using the law of conservation of energy quantitatively (use of $q = mc\Delta T$) and qualitatively.	**Planning and carrying out controlled investigations** Students plan and perform investigations to aid in the development of a predictive model for interacting variables, considering the quantity of data with respect to experimental uncertainty, and select methods for collection and analysis of data.	**Cause and Effect** Students use cause and effect models at one scale to make predictions about the behavior of systems at different scales.
CHEM.PS3.3 Distinguish between endothermic and exothermic reactions by constructing potential energy diagrams and explain the differences between the two using chemical terms (e.g. activation	**Constructing explanations and designing solutions** Students form explanations that incorporate sources (including models, peer reviewed publications, their own	**Systems and System Models** Students design or define systems in order to evaluate a specific phenomenon or problem.

energy). Recognize when energy is absorbed or given off depending on the bonds formed and bonds broken	investigations), invoke scientific theories, and can evaluate the degree to which data and evidence support a given conclusion.	
CHEM.PS3.4 Analyze energy changes to explain and defend the law of conservation of energy	**Developing and using models** Students can create models for interactions of two separate systems.	**Energy and Matter** Students explain the conservation of energy by discussing the transfer mechanisms between objects or fields as well as into or out of a system.
Unit 3: Atomic Structure and Nuclear Chemistry - 11 Days		
Standards	Science and Engineering Practice	Crosscutting Concepts
CHEM.PS1.9 Draw models (qualitative models such as pictures or diagrams) to demonstrate understanding of radioactive stability and decay. Understand and differentiate between fission and fusion reactions. Use models (graphs or tables) to explain the concept of half-life and its use in determining the age of materials (such as radiometric dating).	**Analyzing and interpreting data.** Students form explanations that incorporate sources (including models, peer reviewed publications, their own investigations), invoke scientific theories, and can evaluate the degree to which data and evidence support a given conclusion.	**Energy and Matter** Students reconcile conservation of mass in nuclear processes.
CHEM.PS1.10 Compare alpha, beta, and gamma radiation in terms of mass, charge, and penetrating power. Identify examples of applications of different radiation types in everyday life (such as its applications in cancer treatment).	**Obtaining, evaluating, and communicating information** (Observe/Evaluate) Students can critically read scientific literature, integrating, extracting, and accurately simplifying main ideas from multiple sources while maintaining accuracy and validating data whenever possible. Students can provide written and oral explanations for phenomena and multipart systems using	**Energy and Matter** Students reconcile conservation of mass in nuclear processes.

	models, graphs, data tables, and diagrams.	
CHEM.PS.11 Develop and compare historical models of the atom (from Democritus to quantum model) and construct arguments to show how scientific knowledge evolves over time, based on experimental evidence, critique, and alternative interpretations	**Engaging in argument from evidence** Students critically evaluate evidence supporting an argument and create written or oral arguments which invoke empirical evidence, scientific reasoning and scientific explanations.	**Systems and System Models** Students create and manipulate a variety of different models: physical, mathematical, computational.
Unit 4: Electrons and the Periodic Table - 7 Days		
Standards	Science and Engineering Practice	Crosscutting Concepts
CHEM.PS1.12 Explain the origin and organization of the Periodic Table. Predict chemical and physical properties of main group elements (reactivity, number of subatomic particles, ion charge, ionization energy, atomic radius, and electronegativity) based on location on the periodic table. Construct an argument to describe how the quantum mechanical model of the atom (e.g., patterns of valence and inner electrons) defines periodic properties. Use the periodic table to draw Lewis dot structures and show understanding of orbital notations through drawing and interpreting graphical representations (i.e., arrows representing electrons in an orbital).	**Constructing explanations and designing solutions** Students form explanations that incorporate sources (including models, peer reviewed publications, their own investigations), invoke scientific theories, and can evaluate the degree to which data and evidence support a given conclusion.	**Patterns** Students recognize, classify, and record patterns in quantitative data from empirical research and mathematical representations.

CHEM.PS4.1 Using a model, explain why elements emit characteristic frequencies of light and how this information is used.	**Developing and using models** Students can test the predictive abilities of their models in a real-world setting and make comparisons of two models of the same process or system.	**Cause and Effect** Students use cause and effect models at one scale to make predictions about the behavior of systems at different scales.
Unit 5: Classification of Matter and Separations - 3 Days (integrated in later units for honors)		
Standards	Science and Engineering Practice	Crosscutting Concepts
CHEM1.PS1.7 - Analyze solutions to identify solutes and solvents, quantitatively analyze concentrations (molarity, percent composition, and ppm), and perform separation methods such as evaporation, distillation, and/or chromatography and show conceptual understanding of distillation. Construct arguments to justify the use of certain separation methods under different conditions.	**Asking questions (for science) and defining problems (for engineering)** Questions should facilitate empirical investigation	**Structure and Function** Students apply patterns in structure and function to unfamiliar phenomena.
CHEM1.PS2.3 - Construct a model to explain the process by which solutes dissolve in solutes, and develop an argument to describe how intermolecular forces affect the solubility of different chemical compounds.	**Engaging in argument from evidence** Students critically evaluate evidence supporting an argument and create written or oral arguments that invoke empirical evidence, scientific reasoning and scientific explanations.	**Cause and Effect** Students use cause and effect models at one scale to make predictions about the behavior of systems at different scales.
CHEM1.PS2.4 - Conduct an investigation to determine how temperature, surface, and stirring affect the rate of solubility. Construct an argument to explain the	**Planning and carrying out controlled investigations** Students plan and perform investigations	**Energy and Matter** Students design or define systems in order to evaluate a specific phenomenon or

relationship observed in experimental data using collision theory.	to aid in the development of a predictive model for interacting variables, considering the quantity of data with respect to experimental uncertainty, and select methods for collection and analysis of data	problem.
Unit 6: Compounds and Bonding - 15 Days		
Standards	Science and Engineering Practice	Crosscutting Concepts
CHEM.PS1.13 Use the periodic table and electronegativity differences of elements to predict the types of bonds that are formed between atoms during chemical reactions and write the names of chemical compounds, including polyatomic ions using the IUPAC criteria.	**Constructing explanations and designing solutions** Students form explanations that incorporate sources (including models, peer reviewed publications, their own investigations), invoke scientific theories, and can evaluate the degree to which data and evidence support a given conclusion	**Cause and Effect** Students use cause and effect models at one scale to make predictions about the behavior of systems at different scales
CHEM.PS1.14 Use Lewis dot structures and electronegativity differences to predict the polarities of simple molecules (linear, bent, trigonal planar, trigonal pyramidal, tetrahedral). Construct an argument to explain how electronegativity affects the polarity of basic chemical molecules.	**Obtaining, evaluating, and communicating information** Students can provide written and oral explanations for phenomena and multi part systems using models, graphs, data tables, and diagrams	**Structure and Function** Students infer the function of a component of a system based on its shape and interactions with other components.
CHEM.PS2.1 Draw, identify, and contrast graphical representations of chemical bonds	**Obtaining, evaluating, and**	**Structure and Function**

(ionic, covalent, and metallic) based on chemical formulas. Construct and communicate explanations to show that atoms combine by transferring or sharing electrons.	**communicating information** Students can provide written and oral explanations for phenomena and multi part systems using models, graphs, data tables, and diagrams	Students apply patterns in structure and function to unfamiliar phenomena.
Unit 7: Chemical Reactions - 10 Days		
Standards	Science and Engineering Practice	Crosscutting Concepts
CHEM.PS1.2 Demonstrate that atoms, and therefore mass, are conserved during a chemical reaction by balancing chemical equations.	**Engaging in argument from evidence** Students critically evaluate evidence supporting an argument and creating written or oral arguments that invoke empirical evidence, scientific reasoning and scientific explanations.	**Energy and Matter** Students demonstrate and explain conservation of mass and energy in systems, including systems with inputs and outputs.
CHEM.PS1.4 Use the reactants in a chemical reaction to predict the products and identify reaction classes (synthesis, decomposition, combustion, single replacement, double replacement).	**Constructing explanations and designing solutions** Students form explanations that incorporate sources (including models, peer reviewed publications, their own investigations), invoke scientific theories, and can evaluate the degree to which data and evidence supports a given conclusion.	**Pattern** Students recognize that different patterns for the same system may be present depending on the scale at which the system is analyzed.
Unit 8: The Mole - 7 Days		
Standards	Science and Engineering Practice	Crosscutting Concepts
CHEM.PS1.1 Understand and be prepared to use values specific to chemical processes: the	**Constructing explanations and designing solutions**	**Cause and Effect** Students use cause and effect models

mole, molar mass, molarity, and percent composition.	Students form explanations that incorporate sources (including models, peer reviewed publications, their own investigations), invoke scientific theories, and can evaluate the degree to which data and evidence supports a given conclusion.	at one scale to make predictions about the behavior of systems at different scales.
CHEM.PS1.3 Perform stoichiometric calculations involving the following relationships: mole-mole; mass-mass; mole-mass; mole-particle; and mass-particle. Show a qualitative understanding of the phenomenon of percent yield, limiting, and excess reagents in a chemical reaction through pictorial and conceptual examples. (states of matter liquid and solid; excluding volume of gasses)	**Developing and using models** Students can test the predictive abilities of their models in a real-world setting and make comparisons of two models of the same process or system	**Systems and System Models** Students create and manipulate a variety of different models: physical, mathematical, computational
Unit 9: Stoichiometry - 8 Days		
Standards	Science and Engineering Practice	Crosscutting Concepts
CHEM.PS1.3 Perform stoichiometric calculations involving the following relationships: mole-mole; mass-mass; mole-mass; mole-particle; and mass-particle. Show a qualitative understanding of the phenomenon of percent yield, limiting, and excess reagents in a chemical reaction through pictorial and conceptual examples. (states of matter liquid and solid; excluding volume of gasses)	**Developing and using models** Students can test the predictive abilities of their models in a real-world setting and make comparisons of two models of the same process or system	**Systems and System Models** Students create and manipulate a variety of different models: physical, mathematical, computational
Unit 10: Properties of Solutions		
Standards	Science and Engineering Practice	Crosscutting Concepts

CHEM.PS1.7 Analyze solutions to identify solutes and solvents, quantitatively analyze concentrations (molarity, percent composition, and ppm), and perform separation methods such as evaporation, distillation, and/or chromatography and show conceptual understanding of distillation. Construct an argument to justify the use of certain separation methods under different conditions.	**Developing and using models** Students can test the predictive abilities of their models in a real-world setting and make comparisons of two models of the same process or system.	**Systems and System Models** Students create and manipulate a variety of different models: physical, mathematical, computational.
CHEM.PS1.15 Investigate, describe, and mathematically determine the effect of solute concentration on vapor pressure using the solute's van 't Hoff factor on freezing point depression and boiling point elevation.	**Planning and carrying out controlled investigations** Students should derive proportionalities and equalities for dependent variables that include multiple independent variables, considering uncertainty, and limitations of collected data.	**Scale, Proportion, and Quantity** Students use proportional relationships to predict how changing one property will affect another in a system.