Chemistry Honors

Curriculum Guide

Dunmore School District

Dunmore, PA

Chemistry Honors

Prerequisite:

- Successful completion of biology.
- Strong algebra skills, including solving for variables, scientific notation, and working with exponents.

This is an introductory course in theories and concepts of modern chemistry. This course is designed to prepare students for college chemistry. Topics will be presented to increase awareness and understanding of the role of chemistry in everyday life and environmental issues. The course emphasizes the atomic and molecular structure, chemical bonding, stoichiometry, properties of gases, solutions, acid-base reactions, thermodynamics, and oxidation-reduction/electrochemistry, all with a strong emphasis on the mathematics of chemistry. The laboratory work will develop students reasoning power, the ability to apply chemical principles; as well as acquaint students with chemical laboratory techniques. This course meets seven periods each week. Two of the periods are dedicated to laboratory experiments. The laboratory experiences are an essential part of the course and are related to the topics and concepts being discussed at the time in class.

This is an honors level chemistry course. As such, more is required than the standard, academic course. This includes, but is not limiting to: memorization of more monatomic and polyatomic ions; knowledge of additional conversion factors; more strenuous prediction of net ionic equations; higher level thinking skills in lab and computational problems; a more inquiry approach to many lab activities; and a more in-depth, faster-paced study of each unit.

Dunmore School District
Curriculum Guide
Year-at-a-glance

Subject: Chemistry Honors	**Grade Level: 11**	**Date Completed: 3/14/2018**

1st Quarter

Topic	Resources	Standards
Measuring	Teacher prepared	A.1.1.2, A.1.1.3
Nomenclature	Teacher prepared	A.1.1.1, A.1.1.5, A.1.2.2
Moles	Teacher prepared	A.1.1.1, A.1.2.4, B.1.1.1, B.2.2.2
More Moles	Teacher prepared	B.1.2.1, B.1.2.2, B.1.2.3

2nd Quarter

Topic	Resources	Standards
Balancing equations and some qualitative chemistry	Teacher prepared	B.2.1.4, B.2.1.5
Predicting products	Teacher prepared	B.2.1.3, B.2.1.4, B.2.1.5
Stoichiometry	Teacher prepared	B.2.1.1, B.2.1.2, B.2.2.2
Atomic Theory Part I	Teacher prepared	A.1.1.4, A.1.2.4, A.2.1.1, A.2.1.2, A.2.2.1, A.2.2.2, A.2.2.3, A.2.2.4, A.2.3.1

3rd Quarter

Topic	Resources	Standards
Coulomb's law, the shell model, and Atomic Theory Part II	Teacher prepared	A.2.2.1, A.2.2.2, A.2.2.3, A.2.2.4, A.2.3.1, A.2.3.2
Periodic trends	Teacher prepared	A.2.2.2, A.2.3.1, A.2.3.2
Introduction to Bonding	Teacher prepared	A.1.2.3, A.1.2.5, B.1.3.1, B.1.3.2, B.1.3.3, B.1.4.1, B.1.4.2

4th Quarter

Topic	Resources	Standards
Introduction to the kinetic theory. Solids and liquids. Heat calculations and calorimetry.	Teacher prepared	A.1.1.1, B.1.4.1
Gas behavior	Teacher prepared	B.2.2.1
Gas laws and math	Teacher prepared	B.2.1.1, B.2.1.2, B.2.2.1, B.2.2.2
Electrochemistry	Teacher prepared	A.1.1.1, B.2.1.2
Review and Final Exam		

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Measuring **This first unit is used as an introduction to chemistry, particularly the lab aspect of chemistry, and how it relates to proper measuring and handling of measurements. We will also learn to deal with conversions.** **MODULE A.1— Structure and Properties of Matter** **Framework Big Idea: Matter can be understood in terms of the**	**Anchor Descriptor** CHEM.A.1.1 Identify and describe how observable and measurable properties can be used to classify and describe matter and energy. **Framework Concept: Stable forms of matter are those in which the electric potential energy is minimized.** **PA Academic Standards: Science:** (The following standards apply to all units, but are not repeated in the document) 3.1.10.D: Apply scale as a way of relating concepts and ideas to one another by some measure. • Apply dimensional analysis and scale as a ratio. • Convert one scale to another. 3.1.10.E: Describe patterns of change in nature, physical and man-made systems. • Describe how fundamental	**Essential Knowledge/Skills:** The scientific method Metrics Measuring techniques Significant digits Scientific notation Dimensional analysis Density Percent Error Graphing Lab Experiments: Proper measuring with significant digits Density of water- inquiry Density of metal cylinder Identifying a metal using density Density by graphing Density of plastics- inquiry Density of metal BB's- inquiry **Eligible Content:** CHEM.A.1.1.2 Classify observations as qualitative and/or quantitative. CHEM.A.1.1.3 Utilize significant figures to	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**13 days**

types of atoms present and the interactions both between and within atoms.	science and technology concepts are used to solve practical problems (e.g., momentum, Newton's laws of universal gravitation, tectonics, conservation of mass and energy, • Recognize that stable systems often involve underlying dynamic changes (e.g., a chemical reaction at equilibrium has molecules reforming continuously). • Describe the effects of error in measurements. 3.2.10.B: Apply process knowledge and organize scientific and technological phenomena in varied ways. • Describe materials using precise quantitative and qualitative skills based on observations. • Develop appropriate scientific experiments: raising questions, formulating hypotheses, testing, controlled experiments, recognizing variables, manipulating variables, interpreting data, and producing solutions. • Use process skills to make inferences and predictions using collected information and to	communicate the uncertainty in a quantitative observation. **Framework Competency:** Utilize significant figures to communicate the precision in a quantitative observation Accuracy discussion: Calculate error and percent error given experimental data and the accepted value. **Vocabulary:** Density Dimensional analysis			

	communicate, using space / time relationships, defining operationally. 3.2.10.C: Apply the elements of scientific inquiry to solve problems. • Generate questions about objects, organisms and/or events that can be answered through scientific investigations. • Evaluate the appropriateness of questions. • Design an investigation with adequate control and limited variables to investigate a question. • Conduct a multiple step experiment. • Organize experimental information using a variety of analytic methods. • Judge the significance of experimental information in answering the question. • Suggest additional steps that might be done experimentally. 3.2.10.D: Identify and apply the technological design process to solve problems. • Examine the problem, rank all necessary information and all questions that must be answered.				

	• Propose and analyze a solution. • Implement the solution. • Evaluate the solution, test, redesign and improve as necessary. • Communicate the process and evaluate and present the impacts of the solution. 3.7.10.A: Identify and safely use a variety of tools, basic machines, materials and techniques to solve problems and answer questions. • Select and safely apply appropriate tools, materials and processes necessary to solve complex problems. • Apply advanced tool and equipment manipulation techniques to solve problems. 3.7.10.B: Apply appropriate instruments and apparatus to examine a variety of objects and processes. • Describe and use appropriate instruments to gather and analyze data. • Compare and contrast different scientific measurement systems; select the best measurement system for a specific situation.				

	• Explain the need to estimate measurements within error of various instruments. • Apply accurate measurement knowledge to solve everyday problems. • Describe and demonstrate the operation and use of advanced instrumentation in evaluating material and chemical properties (e.g., scanning electron microscope, nuclear magnetic resonance machines). 3.7.10.D: Utilize computer software to solve specific problems. • Identify legal restrictions in the use of software and the output of data. • Apply advanced graphic manipulation and desktop publishing techniques. • Apply basic multimedia applications. • Apply advanced word processing, database and spreadsheet skills. • Describe and demonstrate how two or more software applications can be used to produce an output. • Select and apply software designed to meet specific needs.				

	PA Core Standards: Reading for Science and Technical Subjects, 6-12 3.5 Reading Informational Text Students read, understand, and respond to informational text- with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.				

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Nomenclature **In this unit we will begin to learn the language of chemistry, starting with classifying matter and changes in matter, then moving through nomenclature.** **MODULE A.1— Structure and Properties of Matter** **Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both between and**	**Anchor Descriptor** CHEM.A.1.1 Identify and describe how observable and measurable properties can be used to classify and describe matter and energy. CHEM.A.1.2 Compare the properties of mixtures. **Framework Concept: Stable forms of matter are those in which the electric potential energy is minimized.** **PA Academic Standards: Science** 3.4.10.A: Explain concepts about the structure and properties of matter. • Recognize formulas for simple inorganic compounds. • Apply knowledge of mixtures to appropriate separation techniques. **PA Core Standards: Reading for Science and Technical Subjects, 6-12**	**Essential Knowledge/Skills:** Classify matter Heterogeneous Solutions- solute and solvent Compounds Elements Chemical changes Physical changes Chemical properties Physical properties Recognizing ionic vs covalent Writing binary and ternary ionic formulae Naming binary and ternary ionic compounds Writing and naming molecular compounds Writing and naming acids and bases Lab Experiments: Conductivity tests- inquiry Using a Bunsen burner Reaction in a bag- inquiry Separating a mixture- -inquiry Chemical or physical change- inquiry Elements vs compounds-	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**11 days**

within atoms.	3.5 Reading Informational Text Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	inquiry Pure substance vs mixture-inquiry Intro to chromatography Chromatography whodunit-inquiry **Eligible Content:** CHEM.A.1.1.1 Classify physical or chemical changes within a system in terms of matter and/or energy. CHEM.A.1.1.5 Apply a systematic set of rules (IUPAC) for naming compounds and writing chemical formulas (e.g., binary covalent, binary ionic, ionic compounds containing polyatomic ions). CHEM.A.1.2.2 Differentiate between homogeneous and heterogeneous mixtures (e.g., how such mixtures can be separated). --- **Framework Competency:** Apply a systematic set of rules (IUPAC) for naming compounds and writing chemical formulas (e.g.,			

		binary covalent, binary ionic, ionic compounds containing polyatomic ions) **Vocabulary:** Nomenclature IUPAC Cation Anion Polyatomic ion			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Moles **This unit goes back to the quantitative nature of chemistry with an introduction to moles, and the many possible calculations concerning this in chemistry, including our first concentration unit- molarity.** **MODULE A—Structure and Properties of Matter** **MODULE B—The Mole Concept and Chemical Interactions**	**Anchor Descriptor** CHEM.A.1.1 Identify and describe how observable and measurable properties can be used to classify and describe matter and energy. CHEM.A.1.2 Compare the properties of mixtures. CHEM.B.1.1 Explain how the mole is a fundamental unit of chemistry. CHEM.B.2.2 Explain how the kinetic molecular theory relates to the behavior of gases. **Framework Concept: The mole, as a fundamental unit, is used to represent a specific quantity of atomic particles such as atoms, ions, formula units, and molecules.** **PA Academic Standards: Science** N/A	**Essential Knowledge/Skills:** Moles Avogadro's number Atoms to molecules to moles to grams Ions to formula units to moles to grams Molarity Making a solution Dilutions Volume of a gas at STP Lab Experiments: Fundamentals of experimental design Find the hottest part of the Bunsen burner flame- inquiry How many moles of Zn are in a penny?- inquiry Law of conservation of mass- inquiry Making a solution with volumetric flask. Testing the solution by evaporation How many atoms thick is the Al foil?- inquiry	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**11 days**

Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	**PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	**Eligible Content:** CHEM.A.1.1.1 Classify physical or chemical changes within a system in terms of matter and/or energy. CHEM.A.1.2.4 Describe various ways that concentration can be expressed and calculated (e.g., molarity, percent by mass, percent by volume). CHEM.B.1.1.1 Apply the mole concept to representative particles (e.g., counting, determining mass of atoms, ions, molecules, and/or formula units). CHEM.B.2.2.2 Predict the amounts of reactants and products involved in a chemical reaction using molar volume of a gas at STP. **Vocabulary:** Avogadro's Number Molar mass Molar Volume Standard Temperature Standard Pressure			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
More Moles **The relationship between Unit two's nomenclature and Unit three's moles is explored by calculating percentages by mass and ratios of moles. It is a preliminary look at the concept of stoichiometry, but only within a formula.** **MODULE B—The Mole Concept and Chemical Interactions** **Framework Big Idea: Matter can be understood in**	**Anchor Descriptor** CHEM.B.1.2 Apply the mole concept to the composition of matter. **Framework Concept: The mole, as a fundamental unit, is used to represent a specific quantity of atomic particles such as atoms, ions, formula units, and molecules.** **PA Academic Standards: Science** N/A **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects**,	**Essential Knowledge/Skills:** Percentage composition Finding ratios of atoms Empirical formulae Molecular formulae Hydrates % of water Lab Experiments: Burning Mg and purifying MgO Finding the formula of a hydrate Finding the % of O_2 in the air **Eligible Content:** CHEM.B.1.2.1 Determine the empirical and molecular formulas of compounds. CHEM.B.1.2.2 Apply the law of definite proportions to the classification of elements and compounds as pure substances. CHEM.B.1.2.3 Relate the percent composition and	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**10 days**

terms of the types of atoms present and the interactions both between and within atoms.	**6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	mass of each element present in a compound. **Framework Competency:** Analyze and interpret data to apply the laws of definite proportions and multiple proportions, to determine empirical and molecular formulas of compounds, percent composition and mass of elements in a compound. **Vocabulary:** Avogadro's number Empirical Formula Law of definite proportions Law of multiple proportions Molar mass Molar volume Molecular Percent composition Ratio			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Balancing equations and some qualitative chemistry **The law of conservation of mass will be explored by balancing chemical equations, and relating the corresponding chemical reactions. Acids and bases will be discussed, followed by the first attempts to predict chemical reactions: neutralizations.** **MODULE B—The Mole Concept and Chemical Interactions**	**Anchor Descriptor** CHEM.B.2.1 Predict what happens during a chemical reaction. **Framework Concept: The fact that atoms are conserved, together with knowledge of chemical properties of the elements involved, can be used to describe and predict chemical reactions and calculate quantities of reactants and products.** **Framework Concept: Acids and bases are identified by their characteristics and interactions. pH scale is a log scale that reflects the concentration of protons in a solution.** **PA Academic Standards: Science** 3.1.10.E: Describe patterns of change in nature, physical and man-made systems. • Describe how fundamental science and technology concepts are used to solve practical problems (e.g.,	**Essential Knowledge/Skills:** Balancing equations Writing reactions from word equations Review acid/base nomenclature Predict the products of acid/base neutralization Strong vs weak acids and bases The pH scale Lab Experiments: Conservation of mass revisited- inquiry Reaction in a bag revisited- inquiry Tests to identify O_2, H_2, CO_2, and H_2O- inquiry What gas is it? Al + $CuCl_2$- inquiry Balancing reactions bead activity The pH scale and neutralizations. **Eligible Content:** CHEM.B.2.1.4 Predict products of simple chemical reactions (e.g., synthesis, decomposition, single	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**10 days**

Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	conservation of mass and energy, atomic theory, gas laws, feedback systems). • Describe the effects of error in measurements. 3.4.10.A: Explain concepts about the structure and properties of matter. • Describe various types of chemical reactions by applying the laws of conservation of mass and energy. **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text- with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	replacement, double replacement, combustion). CHEM.B.2.1.5 Balance chemical equations by applying the Law of Conservation of Matter. **Framework Competency:** Develop and use models to explain that atoms (and therefore mass) are conserved during a chemical reaction. Models can include computer models, ball and stick models, and drawings. **Framework Competency:** Using models, differentiate between acid and bases and acid-base systems. **Vocabulary:** Balance Mole ratio Neutralization pH Products Proton Reactants			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Predicting products **Predicting the products of a chemical reaction will now be accomplished by learning the five types of reactions. Followed by a mini-unit on net ionic equations.** **MODULE B—The Mole Concept and Chemical Interactions** **Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.**	**Anchor Descriptor** CHEM.A.1.2 Compare the properties of mixtures. CHEM.B.2.1 Predict what happens during a chemical reaction. **Framework Concept: The fact that atoms are conserved, together with knowledge of chemical properties of the elements involved, can be used to describe and predict chemical reactions and calculate quantities of reactants and products.** **PA Academic Standards: Science** 3.4.10.A: Explain concepts about the structure and properties of matter. • Describe various types of chemical reactions by applying the laws of conservation of mass and energy. **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text	**Essential Knowledge/Skills:** The 5 types of reactions Reactions with water Anhydrides The activity series The solubility rules Precipitates Classifying electrolytes Molecular to Ionic to Net ionic reactions. Lab Experiments: Exploring the five types of reactions Precipitate lab Making an activity series Electrolyte? **Eligible Content:** CHEM.A.1.2.1 Compare properties of solutions containing ionic or molecular solutes (e.g., dissolving, dissociating). CHEM.B.2.1.3 Classify reactions as synthesis, decomposition, single replacement, double replacement, or combustion.	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**9 days and 6 days for net ionic equations**

	Students read, understand, and respond to informational text- with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	CHEM.B.2.1.4 Predict products of simple chemical reactions (e.g., synthesis, decomposition, single replacement, double replacement, combustion). CHEM.B.2.1.5 Balance chemical equations by applying the Law of Conservation of Matter. **Framework Competency:** Develop and use models to explain that atoms (and therefore mass) are conserved during a chemical reaction. Models can include computer models, ball and stick models, and drawings. **Vocabulary:** Balance Chemical properties Combustion Decomposition Double replacement Mole ratio Net ionic equations Physical properties Products Reactants Redox Single replacement Synthesis			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Stoichiometry **The unit is a culmination of all of the work done since the start of the course. A quantitative look at chemical reactions will encompass units one to six.** **MODULE B—The Mole Concept and Chemical Interactions** **Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.**	**Anchor Descriptor** CHEM.B.2.1 Predict what happens during a chemical reaction. CHEM.B.2.2 Explain how the kinetic molecular theory relates to the behavior of gases. **Framework Concept: The fact that atoms are conserved, together with knowledge of chemical properties of the elements involved, can be used to describe and predict chemical reactions and calculate quantities of reactants and products.** **Framework Concept: The mole, as a fundamental unit, is used to represent a specific quantity of atomic particles such as atoms, ions, formula units, and molecules.** **PA Academic Standards: Science** N/A	**Essential Knowledge/Skills:** Stoichiometry of a balanced reaction Limiting reactants Grams of an excess reactant left over % yield Lab Experiments: Intro to stoichiometry- inquiry Finding stoichiometric equivalents Limiting reactant lab % yield lab Sodium carbonate production study- inquiry % of CO_2 in a carbonate **Eligible Content:** CHEM.B.2.1.1 Describe the roles of limiting and excess reactants in chemical reactions. CHEM.B.2.1.2 Use stoichiometric relationships to calculate the amounts of reactants and products	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**10 days**

	PA Core Standards: Reading for Science and Technical Subjects, 6-12 3.5 Reading Informational Text Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	involved in a chemical reaction. **Framework Competency:** Develop and use models to explain that atoms (and therefore mass) are conserved during a chemical reaction. Models can include computer models, ball and stick models, and drawings. **Vocabulary:** Balance Mole ratio Products Reactants			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Atomic Theory Part I **A mini-unit on colligative properties introduces this unit, since at this time of the year icing on sidewalks is a problem. Then the scientists and discoveries that led to our current atomic model are studied.** **MODULE A— Structure and Properties of Matter** **Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both**	**Anchor Descriptors:** CHEM.A.1.1 Identify and describe how observable and measurable properties can be used to classify and describe matter and energy. CHEM.A.1.2 Compare the properties of mixtures. CHEM.A.2.1 Explain how atomic theory serves as the basis for the study of matter. CHEM.A.2.2 Describe the behavior of electrons in atoms. CHEM.A.2.3 Explain how periodic trends in the properties of atoms allow for the prediction of physical and chemical properties. **Framework Concept: Stable forms of matter are those in which the electric potential energy is minimized.** **Framework Concept: Each atom has a charged substructure consisting of a nucleus, which is**	**Essential Knowledge/Skills:** Concentration units of molality, mass percent, mole fraction Freezing point depression Boiling point elevation History of atom from the Greeks to today Dalton's atomic theory and its revisions Protons, electrons, and neutrons How are ions formed? Isotopes The atomic models The quantum theory Bohr's model Schrodinger's equation Electron configurations and the periodic table Orbital notations and dot diagrams Hund's rule Lab Experiments: Freezing point depression Boiling point elevation What is the law of multiple proportions?- inquiry Gold foil simulation Atomic map	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**10 days**

between and within atoms.	**made of protons and neutrons, surrounded by electrons. The periodic table orders elements in increasing number of protons and places those with similar chemical properties in columns.** **Framework Concept: Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, and surrounding electrons.** **Framework Concept: The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. Properties of chemical compounds are related to electrostatic interaction between particles.** **PA Academic Standards: Science** 3.1.10.E: Describe patterns of change in nature, physical and man-made systems. • Describe how fundamental science and technology concepts are used to solve practical problems (e.g., atomic	What is an isotope?– inquiry Isotope- beanium **Eligible Content:** CHEM.A.1.1.4 Relate the physical properties of matter to its atomic or molecular structure. CHEM.A.1.2.4 Describe various ways that concentration can be expressed and calculated (e.g., molarity, percent by mass, percent by volume). CHEM.A.2.1.1 Describe the evolution of atomic theory leading to the current model of the atom based on the works of Dalton, Thomson, Rutherford, and Bohr. CHEM.A.2.1.2 Differentiate between the mass number of an isotope and the average atomic mass of an element. CHEM.A.2.2.1 Predict the ground state electronic configuration and/or orbital diagram for a given atom or ion. CHEM.A.2.2.2 Predict			

	theory). 3.4.10.A: Explain concepts about the structure and properties of matter. • Know that atoms are composed of even smaller sub-atomic structures whose properties are measurable. 3.4.10.C: Distinguish among the principles of force and motion. • Describe light effects (e.g., absorption, emission spectra, polarization, interference). • Describe and measure the motion of sound, light and other objects. **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing	characteristics of an atom or an ion based on its location on the periodic table (e.g., number of valence electrons, potential types of bonds, reactivity). CHEM.A.2.2.3 Explain the relationship between the electron configuration and the atomic structure of a given atom or ion (e.g., energy levels and/or orbitals with electrons, distribution of electrons in orbitals, shapes of orbitals). CHEM.A.2.2.4 Relate the existence of quantized energy levels to atomic emission spectra. CHEM.A.2.3.1 Explain how the periodicity of chemical properties led to the arrangement of elements on the periodic table. **Framework Competency:** Construct models showing that stable forms of matter are those with minimum electrical field energy.			

	Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	**Framework Competency:** Use the atomic model and the periodic table to predict and explain trends in properties of elements. **Framework Competency:** Develop a model showing the likely position of electrons as determined by the quantized energy levels of atoms. **Framework Competency:** Analyze and interpret data obtained from measuring the bulk properties of various substances to explain the relative strength of the interactions among particles in the substance. **Vocabulary:** Geometries and orbital shapes Lewis dot structures Molecular Octet rule Configuration Electrons Neutrons Nucleus			

		Orbital diagram Protons Subatomic Bohr Configuration Dalton Energy levels Excited state Ground state Orbitals Quantized Sublevels Rutherford Thomson Boiling Point Colligative Freezing Point Molality			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Coulomb's law, the shell model, and Atomic Theory Part II **This unit begins with an in-depth, inquiry–based look at Coulomb's law using Moog's text on inquiry. It uses an analysis of ionization energies to show experimental proof of the shell model of the atom, culminating with Photoelectron Spectral analysis (PES), and relating it to electron configurations from the previous unit.** **Quantum numbers are introduced, relating to**	**Anchor Descriptor** CHEM.A.2.2 Describe the behavior of electrons in atoms. CHEM.A.2.3 Explain how periodic trends in the properties of atoms allow for the prediction of physical and chemical properties. **Framework Concept: Stable forms of matter are those in which the electric potential energy is minimized.** **Framework Concept: Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, and surrounding electrons.** **Framework Concept: Coulomb's Law provides a mathematical model that describes and predicts the effect of electrostatic forces acting between electrically charged objects.**	**Essential Knowledge/Skills:** Coulomb's law Ionization energy The shell model Sublevels Electron configurations Photoelectron spectroscopy Quantum numbers n, l, m and s Electromagnetic radiation The visible spectrum Wavelength, frequency, and energy Bohr's model of the atom Bohr's equation Electron transitions Lab Experiments: Coulombic potential energy- inquiry The shell model- inquiry PES simulations- inquiry Flame tests Phet simulation- Neon lights and the Bohr model Vision project **Eligible Content:** CHEM.A.2.2.1 Predict the ground state electronic	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**10 days and 11 days**

electron configurations, Schrodinger's equation, and the electron cloud model. **Then the electromagnetic spectrum is introduced, followed by a quantitative analysis of the experimental data behind line spectra. This includes calculations involving: wavelength, frequency, energy, changing energy levels, ground state and excited state electron transitions.** **MODULE A.1— Structure and Properties of**	**Framework Concept: The speed of a wave in any medium is the product of the wave's frequency and wavelength.** **Framework Concept: Electromagnetic waves are particle-like photons that travel through a vacuum at the speed of light and have an energy that is directly proportional to the frequency of the wave.** **PA Academic Standards: Science** 3.1.10.E: Describe patterns of change in nature, physical and man-made systems. • Describe how fundamental science and technology concepts are used to solve practical problems (e.g., atomic theory). 3.4.10.A: Explain concepts about the structure and properties of matter. • Know that atoms are composed of even smaller sub-atomic structures whose properties are measurable. 3.4.10.C: Distinguish among the principles of force and motion.	configuration and/or orbital diagram for a given atom or ion. CHEM.A.2.2.2 Predict characteristics of an atom or an ion based on its location on the periodic table (e.g., number of valence electrons, potential types of bonds, reactivity). CHEM.A.2.2.3 Explain the relationship between the electron configuration and the atomic structure of a given atom or ion (e.g., energy levels and/or orbitals with electrons, distribution of electrons in orbitals, shapes of orbitals). CHEM.A.2.2.4 Relate the existence of quantized energy levels to atomic emission spectra. CHEM.A.2.3.1 Explain how the periodicity of chemical properties led to the arrangement of elements on the periodic table. CHEM.A.2.3.2 Compare and/or predict the properties			

Matter **Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.** **Framework Big Idea: Interactions between any two objects can cause changes in one or both of them.** **Framework Big Idea: Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.**	• Describe light effects (e.g., absorption, emission spectra, polarization, interference). • Describe and measure the motion of sound, light and other objects. **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text- with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	(e.g., electron affinity, ionization energy, chemical reactivity, electronegativity, atomic radius) of selected elements by using their locations on the periodic table and known trends. **Framework Competency:** Construct models showing that stable forms of matter are those with minimum electrical field energy. **Framework Competency:** Develop a model showing the likely position of electrons as determined by the quantized energy levels of atoms. **Framework Competency:** Use mathematical representations of Coulomb's Law to describe and predict the electrostatic forces between objects. **Framework Competency:** Analyze and interpret data to support the claim that the speed of a wave in a medium is the product of the wave's			

		frequency and the wave's wavelength. **Framework Competency:** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. **Framework Competency:** Generate and analyze data to support the claim that the energy of an electromagnetic wave is directly proportional to the frequency of the wave. **Vocabulary:** Coulomb's Law Bohr Configuration Dalton Electronic Emission Energy levels Excited state Ground state			

		Orbitals Quantized Sublevels Rutherford Spectra Thomson Electrostatic force Medium Frequency Wave Wavelength Electromagnetic wave Particle model Photon Wave model Frequency Proportional			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Periodic trends **Using the periodic table as tool to find trends in atomic radius, electronegativity, electron affinity, ionization energy, oxidation state, and various other properties. The properties are used to construct various periodic table puzzles, as well as to identify common uses for elements and element families.** **MODULE A.1— Structure and Properties of Matter** **Framework Big Idea: Matter can**	**Anchor Descriptor** CHEM.A.2.2 Describe the behavior of electrons in atoms. CHEM.A.2.3 Explain how periodic trends in the properties of atoms allow for the prediction of physical and chemical properties. **Framework Concept: Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. The periodic table orders elements in increasing number of protons and places those with similar chemical properties in columns.** **PA Academic Standards: Science** 3.1.10.C: Apply patterns as repeated processes or recurring elements in science and technology. • Examine and describe recurring patterns that form the basis of chemical periodicity. 3.4.10.A: Explain concepts about	**Essential Knowledge/Skills:** Trends Element uses Further investigating the table Lab Experiments: Periodic table activities # 1-5 **Eligible Content:** CHEM.A.2.2.2 Predict characteristics of an atom or an ion based on its location on the periodic table (e.g., number of valence electrons, potential types of bonds, reactivity). CHEM.A.2.3.1 Explain how the periodicity of chemical properties led to the arrangement of elements on the periodic table. CHEM.A.2.3.2 Compare and/or predict the properties (e.g., electron affinity, ionization energy, chemical reactivity, electronegativity, atomic radius) of selected elements by using their	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**13 days**

be understood in terms of the types of atoms present and the interactions both between and within atoms.	the structure and properties of matter. • Explain the repeating pattern of chemical properties by using the repeating patterns of atomic structure within the periodic table. **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text- with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	locations on the periodic table and known trends. **Framework Competency:** Use the atomic model and the periodic table to predict and explain trends in properties of elements. **Vocabulary:** Atomic radius Charge Chemical Configuration Effective nuclear charge Electron affinity Electronegativity Electrons Elements Energy Ionization Neutrons Nucleus Orbital diagram Particles Physical properties Protons Reactivity Shielding effect Subatomic			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Introduction to Bonding **This unit expands on past investigations into the atom, specifically how atoms interact to form compounds. Electronegativity is the focus of the discussion. Molecular geometry, 3-dimensional shapes, and ultimately polarity are explored through the drawing of Lewis structures. The unit ends with a discussion of formal charge to evaluate the concept of resonance.**	**Anchor Descriptor** CHEM.A.1.2 Compare the properties of mixtures. CHEM.B.1.3 Explain how atoms form chemical bonds. CHEM.B.1.4 Explain how models can be used to represent bonding. **Framework Concept: Stable forms of matter are those in which the electric potential energy is minimized.** **Framework Concept: Properties of chemical compounds are related to electrostatic interaction between particles.** **Framework Concept: The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. Properties of chemical compounds are related to electrostatic interaction**	**Essential Knowledge/Skills:** Differences in electronegativity Ionic vs covalent bonding Polar covalent bonds vs polar molecules Molecular motions Drawing Lewis structures Limitations of the VSEPR theory Geometry and bond angles Predicting polarity Drawing 3-dimensional shapes Resonance Calculating formal charge Lab Experiments: Creating molecular models # 1-4 Testing bond properties Identifying ionic vs covalent bonds Making an alloy Shape and polyatomic ions-inquiry **Eligible Content:** CHEM.A.1.2.3 Describe how factors (e.g., temperature,	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**11 days**

MODULE A— Properties and Classification of Matter **MODULE B— The Mole and Chemical Interactions** **Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.**	**between particles.** **PA Academic Standards: Science** 3.4.10.A: Explain concepts about the structure and properties of matter. • Explain the formation of compounds and their resulting properties using bonding theories (ionic and covalent). **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	concentration, surface area) can affect solubility. CHEM.A.1.2.5 Describe how chemical bonding can affect whether a substance dissolves in a given liquid. CHEM.B.1.3.1 Explain how atoms combine to form compounds through ionic and covalent bonding. CHEM.B.1.3.2 Classify a bond as being polar covalent, non-polar covalent, or ionic. CHEM.B.1.3.3 Use illustrations to predict the polarity of a molecule. **Framework Competency:** Construct models showing that stable forms of matter are those with minimum electrical field energy. **Framework Competency:** Use Lewis Structures and VSEPR to predict and explain charge distribution across a particle (atom, ion, molecule or formula unit).			

		Framework Competency: Analyze and interpret data obtained from measuring the bulk properties of various substances to explain the relative strength of the interactions among particles in the substance. **Vocabulary:** Geometries and orbital shapes Lewis dot structures Molecular Octet rule Atoms Covalent bond Electronegativity scale Ions Ionic Bond Metallic Bonding Molecules Polarity VSEPR/shape Boiling point Bonding Dispersion Forces Freezing point Hydrogen Intermolecular "Like dissolves like"			

		London Van der Waals Melting point Polarity Vapor pressure			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Introduction to the kinetic theory. Solids and liquids. Heat calculations and calorimetry. **This unit begins with a discussion of intermolecular forces and what makes a solid a solid, which leads to understanding the dynamics of a beaker of water with and without a lid on it. This continues to the interpretation of a phase diagram and relating it to a heating curve. Heat calculation follow including extensive work with calorimetry.** **MODULE A— Properties and Classification of Matter**	**Anchor Descriptor** CHEM.A.1.1 Identify and describe how observable and measurable properties can be used to classify and describe matter and energy. CHEM.B.1.4 Explain how models can be used to represent bonding. **AP Chemistry Enduring understanding 5.A:** Two systems with different temperatures that are in thermal contact will exchange energy. The quantity of thermal energy transferred from one system to another is called heat. **Framework Concept: A stable molecule has lower energy, by an amount known as the binding energy, than the same set of atoms separated; this energy must be provided to break the bond.** **Framework Concept: The structure and interactions of matter at the bulk scale are**	**Essential Knowledge/Skills:** Solids, liquids, gases The 7 crystal systems A unit cell Bonding in diamonds vs graphite Amorphous material The pitch drop experiment Viscosity Defining temperature Absolute zero Reversible changes Dynamic equilibrium Phase changes Standard pressure values Vapor pressure Phase diagrams Specific heat capacity Enthalpy Calorimetry Lab Experiments: Models of the crystal systems Heating curve Specific heat of a metal Temperature of a Bunsen burner flame **Eligible Content:** CHEM.A.1.1.1 Classify physical or chemical	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**9 days**

MODULE B— The Mole and Chemical Interactions **AP Chemistry Big Idea 5: The laws of thermodynamics describe the Essential role of energy and explain and predict the direction of changes in matter.** **Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.** **Framework Big Idea: Interactions of objects or**	**determined by electrical forces within and between atoms. Properties of chemical compounds are related to electrostatic interaction between particles.** **Framework Concept: The energy an object has within a system depends on the object's motion and interactions with other objects in that system.** **Framework Concept: Any change in an object's energy is the result of interactions with other objects in a system or a transfer of energy between systems, changing in the total energy of the systems involved.** **Framework Concept: Any energy gain or loss in a system will result in a corresponding energy loss or gain in another system.** **PA Academic Standards: Science** 3.1.10.B: Describe concepts of	changes within a system in terms of matter and/or energy. CHEM.B.1.4.1 Recognize and describe different types of models that can be used to illustrate the bonds that hold atoms together in a compound (e.g., computer models, ball-and-stick models, graphical models, solid-sphere models, structural formulas, skeletal formulas, Lewis dot structures). **AP Chemistry Essential knowledge 5.A.1:** temperature is a measure of the average kinetic energy of atoms and molecules. All of the molecules in a sample are in motion. The Kelvin temperature of a sample of matter is proportional to the average kinetic energy of the particles in the sample. When the average kinetic energy of the particles in the sample doubles, the Kelvin			

systems of objects can be predicted and explained using the concept of energy transfer and conservation.	models as a way to predict and understand science and technology. • Distinguish between different types of models and modeling techniques and apply their appropriate use in specific applications (e.g., kinetic gas theory). 3.1.10.E: Describe patterns of change in nature, physical and man-made systems. • Recognize that stable systems often involve underlying dynamic changes (e.g., a chemical reaction at equilibrium has molecules reforming continuously). 3.4.10.A: Explain concepts about the structure and properties of matter. • Describe phases of matter according to the Kinetic Molecular Theory. 3.4.10.B: Analyze energy sources and transfers of heat. • Evaluate energy changes in chemical reactions. **PA Core Standards: Reading for Science and Technical Subjects, 6-12**	temperature is doubled. As the temperature approaches 0 K (zero Kelvin), the average kinetic energy of a system approaches a minimum near zero. The Maxwell-Boltzmann distribution shows that the distribution of kinetic energies becomes greater (more disperse) as temperature increases. **AP Chemistry Essential knowledge 5.A.2:** The process of kinetic energy transfer at the particulate scale is referred to in this course as heat transfer, and the spontaneous direction of the transfer is always from a hot to a cold body. On average, molecules in the warmer body have more kinetic energy than the molecules in the cooler body. Collisions of molecules that are in thermal contact transfer energy. Scientists describe this process as “energy is			

	3.5 Reading Informational Text Students read, understand, and respond to informational text- with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	transferred as heat." Eventually, thermal equilibrium is reached as the molecular collisions continue. The average kinetic energy of both substances is the same at thermal equilibrium. Heat is not a substance, i.e., it makes no sense to say that an object contains a certain amount of heat. Rather, "heat exchange" or "transfer of energy as heat" refers to the process in which energy is transferred from a hot to a cold body in thermal contact. The transfer of a given amount of thermal energy will not produce the same temperature change in equal masses of matter with differing specific heat capacities. **AP Chemistry Enduring understanding 5.B:** Energy is neither created nor destroyed, but only			

		transformed from one form to another. **AP Chemistry Essential knowledge 5.B.3:** Chemical systems undergo three main processes that change their energy: heating/cooling, phase transitions, and chemical reactions. Heating a system increases the energy of the system, while cooling a system decreases the energy. A liter of water at 50°C has more energy than a liter of water at 25°C. The amount of energy needed to heat one gram of a substance by 1°C is the specific heat capacity of that substance. Energy must be transferred to a system to cause it to melt (or boil). The energy of the system therefore increases as the system undergoes a solid-liquid (or liquid-gas) phase transition. Likewise, a system gives off			

		energy when it freezes (or condenses). The energy of the system decreases as the system undergoes a liquid-solid (or gas-liquid) phase transition. The amount of energy needed to vaporize one mole of a pure substance is the molar enthalpy of vaporization, and the energy released in condensation has an equal magnitude. The molar enthalpy of fusion is the energy absorbed when one mole of a pure solid melts or changes from the solid to liquid state and the energy released when the liquid solidifies has an equal magnitude. When a chemical reaction occurs, the energy of the system decreases (exothermic reaction), increases (endothermic reaction), or remains the same. For exothermic reactions, the energy lost by the reacting molecules (system) is gained by the surroundings. The energy is		

		transferred to the surroundings by either heat or work. Likewise, for endothermic reactions, the system gains energy from the surroundings by heat transfer or work done on the system. The enthalpy change of reaction gives the amount of energy released (for negative values) or absorbed (for positive values) by a chemical reaction at constant pressure. **AP Chemistry Essential knowledge 5.B.4:** Calorimetry is an experimental technique that is used to determine the heat exchanged/transferred in a chemical system. **Framework Competency:** Construct models showing that energy is needed to break bonds and overcome intermolecular forces and that energy is released when bonds form.			

		Framework Competency: Analyze and interpret data obtained from measuring the bulk properties of various substances to explain the relative strength of the interactions among particles in the substance. **Framework Competency:** Construct an explanation for the energy of an object has in a system based on the object's motion and the object's interaction with other objects in the system. **Framework Competency:** Develop and use a model to explain how an object's energy is transferred or transformed as objects interact within a system. **Framework Competency:** Identify problems and suggest design solutions to optimize the energy transfer between objects or systems of objects.			

		Vocabulary: Activation Binding Energy Bond Energy Endothermic Energy Enthalpy Exothermic Lattice energy Physical properties Boiling point Bonding Dispersion Forces Freezing point Hydrogen Intermolecular "Like dissolves like" London Van der Waals Melting point Polarity Vapor pressure Kinetic energy Potential energy Energy transfer Model System Design Energy transfer Solution			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Gas behavior **An explanation of what causes pressure starts this unit on gases. Then after learning how pressure is measured, we discuss the relationship between pressure, temperature, and volume of a gas and what makes a gas ideal. Followed by a discussion of diffusion.** **MODULE B— The Mole and Chemical Interactions** **Framework Big Idea: Matter can**	**Anchor Descriptor** CHEM.B.2.2 Explain how the kinetic molecular theory relates to the behavior of gases. **Framework Concept: The kinetic molecular theory and Gas Laws are used to explain and predict the behavior of gases.** **PA Academic Standards: Science** 3.1.10.B: Describe concepts of models as a way to predict and understand science and technology. • Distinguish between different types of models and modeling techniques and apply their appropriate use in specific applications (e.g., kinetic gas theory). 3.1.10.E: Describe patterns of change in nature, physical and man-made systems. • Describe how fundamental science and technology concepts are used to solve	**Essential Knowledge/Skills:** The kinetic theory revisited Hooke Pressure Manometer calculations Absolute zero, again Boyle's law Charles' law Gay-Lussac's law Avogadro's law Diffusion and effusion Graham's law Real gases Joule-Thompson effect Lab Experiments: Determining absolute zero Boyle's law Charles' law Gay-Lussac's law Graham's law Online Gas simulation activities **Eligible Content:** CHEM.B.2.2.1 Utilize mathematical relationships to predict changes in the number of particles, the	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**10 days**

be understood in terms of the types of atoms present and the interactions both between and within atoms.	practical problems (e.g., gas laws). 3.4.10.A: Explain concepts about the structure and properties of matter. • Predict the behavior of gases through the use of Boyle's, Charles' or the ideal gas law, in everyday situations. • Describe phases of matter according to the Kinetic Molecular Theory. **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	temperature, the pressure, and the volume in a gaseous system (i.e., Boyle's law, Charles's law, Dalton's law of partial pressures, the combined gas law, and the ideal gas law). **Framework Competency:** Utilize mathematical relationships to predict changes in the number of particles (moles), the temperature, the pressure, and the volume in a gaseous system (i.e., Boyle's Law, Charles' Law, Avogadro's Law, Dalton's Law of partial pressures, the combined gas law, and the ideal gas law). **Vocabulary:** Absolute Zero Avogadro's law Boyle's law Charles's law Gay-Lussac's law Molar mass Molar volume Pressure STP			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Gas laws and math **The quantitative study of the gas laws, and stoichiometry of gases not at STP.** **MODULE B— The Mole and Chemical Interactions** **Framework Big Idea: Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.**	**Anchor Descriptor** CHEM.B.2.1 Predict what happens during a chemical reaction. CHEM.B.2.2 Explain how the kinetic molecular theory relates to the behavior of gases. **Framework Concept: The kinetic molecular theory and Gas Laws are used to explain and predict the behavior of gases.** **PA Academic Standards: Science** 3.1.10.B: Describe concepts of models as a way to predict and understand science and technology. • Distinguish between different types of models and modeling techniques and apply their appropriate use in specific applications (e.g., kinetic gas theory). 3.1.10.E: Describe patterns of change in nature, physical and man-made systems. • Describe how fundamental	**Essential Knowledge/Skills:** The named laws The combined gas law The ideal gas law Partial pressure and Dalton's law Graham's law Stoichiometry not at STP Lab Experiments: Calculate rate of diffusion Find the value of R Molar mass of butane A gas collected over water **Eligible Content:** CHEM.B.2.1.1 Describe the roles of limiting and excess reactants in chemical reactions. CHEM.B.2.1.2 Use stoichiometric relationships to calculate the amounts of reactants and products involved in a chemical reaction. CHEM.B.2.2.1 Utilize mathematical relationships to predict changes in the	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**11 days**

	science and technology concepts are used to solve practical problems (e.g., gas laws). 3.4.10.A: Explain concepts about the structure and properties of matter. • Predict the behavior of gases through the use of Boyle's, Charles' or the ideal gas law, in everyday situations. • Describe phases of matter according to the Kinetic Molecular Theory. **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused	number of particles, the temperature, the pressure, and the volume in a gaseous system (i.e., Boyle's law, Charles's law, Dalton's law of partial pressures, the combined gas law, and the ideal gas law). CHEM.B.2.2.2 Predict the amounts of reactants and products involved in a chemical reaction using molar volume of a gas at STP. **Framework Competency:** Utilize mathematical relationships to predict changes in the number of particles (moles), the temperature, the pressure, and the volume in a gaseous system (i.e., Boyle's Law, Charles' Law, Avogadro's Law, Dalton's Law of partial pressures, the combined gas law, and the ideal gas law). **Vocabulary:** Avogadro's law Boyle's law Charles's law Combined gas law Dalton's law of density Partial pressures			

	text to convey a well-defined perspective and appropriate content.	Gay-Lussac's law Ideal Gas Law Molar mass Molar volume Pressure STP			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Electrochemistry **In this final unit we will study how electrons drive chemical reactions, specifically those used to create an electrochemical battery.** **AP Chemistry Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.** **Framework Big Idea: Matter can be understood in terms of the types of atoms**	**Anchor Descriptor** N/A **AP Chemistry Enduring understanding 3.B:** Chemical reactions can be classified by considering what the reactants are, what the products are, or how they change from one into the other. Classes of chemical reactions include synthesis, decomposition, acid-base, and oxidation-reduction reactions. **AP Chemistry Enduring understanding 3.C:** Chemical and physical transformations may be observed in several ways and typically involve a change in energy. **Framework Concept: The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.**	**Essential Knowledge/Skills:** Redox reactions Balance redox in acidic and basic solutions Standard reduction potentials Charge produced and stoichiometry Voltaic cells Electrolytic cells **Eligible Content:** **AP Chemistry Essential knowledge 3.B.3:** In oxidation-reduction (redox) reactions, there is a net transfer of electrons. the species that loses electrons is oxidized, and the species that gains electrons is reduced. **AP Chemistry Essential knowledge 3.C.3:** Electrochemistry shows the inter-conversion between chemical and electrical energy in galvanic and electrolytic cells. Electrochemistry	**Teacher prepared**	**Teacher prepared tests, quizzes, etc.**	**10 days**

present and the interactions both between and within atoms.	**PA Academic Standards: Science** 3.4.10.B: Analyze energy sources and transfers of heat. • Evaluate energy changes in chemical reactions. **PA Core Standards: Reading for Science and Technical Subjects, 6-12** 3.5 Reading Informational Text Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. **PA Core Standards: Writing for Science and Technical Subjects, 6-12** 3.6 Writing Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.	encompasses the study of redox reactions that occur within electrochemical cells. The reactions either generate electrical current in galvanic cells, or are driven by an externally applied electrical potential in electrolytic cells. Visual representations of galvanic and electrolytic cells are tools of analysis to identify where half-reactions occur and the direction of current flow. Oxidation occurs at the anode, and reduction occurs at the cathode for all electrochemical cells. **Framework Competency:** Develop and use models to explain that atoms (and therefore mass) are conserved during a chemical reaction. Models can include computer models, ball and stick models, and drawings. **Vocabulary:** Balance Mole ratio Net ionic equations			

		Products Reactants Single replacement Redox			

General Topic	Anchor Descriptor PA Academic and Core Standards	Eligible Content, Essential Knowledge, Skills & Vocabulary	Resources & Activities	Assessments	Suggested Time (In Days)
Review and Final Exams					**15 days**

PA Core Standards:

Reading for Science and Technical Subjects, 6-12

3.5 Reading Informational Text
Students read, understand, and respond to informational text-with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence.

Grades 9-10

CC.3.5.9-10.A.
Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CC.3.5.9-10.B.
Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

CC.3.5.9-10.C.
Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CC.3.5.9-10.D.
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.

CC.3.5.9-10.E.
Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

CC.3.5.9-10.F.
Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

CC.3.5.9-10.G.

Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

CC.3.5.9-10.H.
Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

CC.3.5.9-10.I.
Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

CC.3.5.9-10.J.
By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Grades 11-12

CC.3.5.11-12.A.
Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

CC.3.5.11-12.B.
Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

CC.3.5.11-12.C.
Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CC.3.5.11-12.D.
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

CC.3.5.11-12.E.
Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

CC.3.5.11-12.F.
Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

CC.3.5.11-12.G.
Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CC.3.5.11-12.H.
Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

CC.3.5.11-12.I.
Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

CC.3.5.11-12.J.
By the end of grade 12, read and comprehend science/technical texts in the grades 11–12 text complexity band independently and proficiently.

PA Core Standards:
Writing for Science and Technical Subjects, 6-12

3.6 Writing
Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.

Grades 9-10

CC.3.6.9-10.A.
Write arguments focused on discipline-specific content.

- Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
- Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

- Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- Provide a concluding statement or section that follows from or supports the argument presented.

CC.3.6.9-10B. *
Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

- Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
- Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

CC.3.6.9-10.C.
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CC.3.6.9-10.D.
Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience

CC.3.6.9-10.E.
Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

CC.3.6.9-10.F.
Conduct short as well as more sustained research projects to answer a question (including a selfgenerated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CC.3.6.9-10.G.
Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

CC.3.6.9-10.H.
Draw evidence from informational texts to support analysis, reflection, and research.

CC.3.6.9-10.I.
Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Grades 11-12

CC.3.6.11-12.A.
Write arguments focused on discipline-specific content.

- Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
- Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
- Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- Provide a concluding statement or section that follows from or supports the argument presented.

CC.3.6.11-12. B *Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

- Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

- Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
- Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
- Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic)

CC.3.6.11-12.C.
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CC.3.6.11-12.D.
Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

CC.3.6.11-12.E.
Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

CC.3.6.11-12.F.
Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CC.3.6.11-12.G.
Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

CC.3.6.11-12.H.
Draw evidence from informational texts to support analysis, reflection, and research.

CC.3.6.11-12.I.
Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.