Grade, Subject: Chemistry	
Unit: Introduction to Chemistry	
Big Idea: Is it important to be able to do calculations and measurements in chemistry using internationally accepted methods?	
PA STEELS Standards: 3.2.9-12.A, 3.2.9-12.B, 3.2.9-12.C	
Essential Questions: **How is experimental data collected and analyzed in chemistry?**	**Understandings (CCCs):** - **Patterns** - **Cause and Effect** - **Scale, Proportion, and Quantity**
Knowledge (DCIs): - **Chemists collect data to determine relationships.** - **Chemists display data in graphs.** - **Chemists design experiments by manipulating variables.**	**Skills (SEPs):** - **Design experiments by determining independent and dependent variables.** - **Design and draw graphs (scatter plots and bar graphs) online and by hand.** - **Determine the most appropriate graph based on lab data.** - **Draw tables to collect and sort data.** - **Organize data into tables for graphing and analysis.** - **Conclude relationships (directly/indirectly) between collected data.** - **Solve complex problems using dimensional analysis**

Vocabulary: **Quantitative and qualitative data** **Independent and dependent variables** **Significant figures** **Dimensional analysis** **Conversion factor** **Graphing** **Scatter plot** **Bar graph** **Directly proportional** **Inversely proportional** **Measurement**	**Core Resources:** **Google sheets**
Assessments: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **Authentic Assessments:** **Collecting and interpreting data**	**Supplemental Resources:** **Chemistry Concept Builders: https://www.physicsclassroom.com/**

Grade, Subject: Chemistry	
Unit: Matter	
Big Idea: Chemical and physical properties of matter can be explained by the structure and the arrangement of atoms, ions or molecules and the forces between them.	
PA STEELS Standards: 3.2.9-12.C, 3.2.9-12.D	
Essential Questions: **How is matter classified?** **How are chemical and physical changes/properties distinguished?** **How can you know that a chemical change is occurring?**	**Understandings (CCCs):** - **Patterns** - **Structure and Function** - **Energy and Matter** - **Systems and System Models**

	- **Scale, Proportion, and Quantity**
<u>Knowledge (DCIs)</u>: - **Matter can be classified into different categories.** - **Changes in matter are chemical or physical.** - **Matter can be described by physical and chemical properties** - **There are concrete signs that indicate a chemical change.**	**<u>Skills (SEPs)</u>:** - **Classify matter.** - **Identify changes in state.** - **Differentiate between states of matter.** - **Distinguish between chemical and physical changes.** - **Distinguish between chemical and physical properties.** - **Identify the signs of a chemical change in order to classify changes.**
<u>Vocabulary:</u> **Solid** **Liquid** **Gas** **Plasma** **Physical change** **Chemical change** **Physical property** **Chemical property** **Boiling** **Melting** **Evaporation** **Sublimation** **Deposition** **Condensation** **Homogeneous mixture** **Heterogeneous mixture** **Element** **Compound** **Suspension** **Solution** **Colloid** **Density** **Phase changes** **Changes of state**	**<u>Core Resources</u>:** - **20 X 100 mm test tubes** - **Copper (II) nitrate solution** - **250 mL beakers** - **Hot plate/stirrers** - **Stir bars** - **NaOH solution** - **HCl solution** - **Litmus paper** - **Aluminum foil** - **Thermometers** - **Ice** - **400 mL beakers**

Assessments: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **Authentic Assessment:** **Identifying unknowns from a mixture (plant pigments and ink)** **Identifying the chemical and physical changes that occur during a camping trip**	**Supplemental Resources:** **Chemistry Concept Builders: https://www.physicsclassroom.com/** **Ck-12 simulations:** **https://interactives.ck12.org/simulations/chemistry.html**

Grade, Subject: Chemistry	
Unit: Atomic Theory	
Big Idea: Atoms are so small they are difficult to study directly; atomic models are constructed to explain experimental data on collections of atoms.	
PA STEELS Standards: 3.2.9-12.H	
Essential Questions: **How was the atomic theory developed?** **What does the modern model of the atom look like?** **How is the existence of isotopes significant?**	**Understandings (CCC):** - **Energy and Matter** - **Structure and Function** - **Stability and Change** - **Cause and Effect**
Knowledge (DCIs): - **Atomic theory is a collaborative effort that takes place over a period of years.** - **The modern atom describes electrons in a cloud surrounding a positively charged nucleus.** - **Unstable isotopes lead to nuclear decay.**	**Skills (SEPs):** - **List the parts of Dalton's atomic theory.** - **Critique Dalton's theory for validity.** - **Identify the work of JJ Thomson and Ernest Rutherford.** - **Label the parts of an atom.** - **Determine the number of protons, neutrons, and electrons in an atom.** - **List what isotopes have in common and how they differ.** - **Write balanced nuclear decay equations.** - **Differentiate between nuclear decay particles.** - **Calculate half-life for isotopes.**

Vocabulary: **Dalton's atomic theory** **JJ Thomson** **Plum pudding model** **Proton** **Neutron** **Electron** **Nucleus** **Ernest Rutherford** **Niels Bohr** **Energy level** **Electron cloud model** **Isotopes** **Nuclear decay** **Alpha particle** **Beta particle** **Gamma radiation** **Half life**	**Core Resources:** - **Planchets containing samples of elements undergoing alpha, beta and gamma decay** - **Handheld radioactivity detectors (beta and gamma)** - **An alpha decay detector** - **Example of naturally radioactive substance (smoke detector, fiesta ware, pitchblende)** - **Lead shielding disks** - **Plastic shielding disks**
Assessments: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **Authentic Assessments:** **Using radiocarbon dating to determine age of artifacts** **Determining radiation in Fiestaware**	**Supplemental Resources:** **Chemistry Concept Builders: https://www.physicsclassroom.com/**

Grade, Subject: Chemistry	
Unit: Quantum Theory	
Big Idea: The atoms of each element have unique structures arising from the interactions between electrons and atomic nuclei.	
PA STEELS Standards: 3.2.9-12.A, 3.2.9-12.T, 3.2.9-12.V	

Essential Questions: **How do we describe the locations of electrons in an atom?** **Why is it necessary to know where the electrons in an atom are?** **How are atomic emission spectra used by chemists?**	**Understandings (CCC):** - **Electrons fill orbitals in a particular order described by quantum theory.** - **Atoms produce unique atomic emission spectra.** - **Atom stability is determined from the number of electrons in the outermost energy level.** - **Electrons use energy when moving to a higher energy level and release energy when moving from a lower energy level within an atom.**
Knowledge (DCIs): - **The likely position of electrons in an atom is determined by the quantized energy levels of the atom.** - **Atoms with the same number of valence electrons share properties.** - **Emission spectra are produced by electron transitions within an atom from high to low quantized energy levels.** - **Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.**	**Skills (SEPs):** - **Identify elements based on their atomic emission spectra.** - **Observe and draw atomic emission spectra.** - **Write electron configurations.** - **Draw orbital diagrams for elements.** - **Determine the number of valence electrons an element has.**
Vocabulary: **Electromagnetic radiation** **Speed of light** **Frequency** **Wavelength** **Radio waves** **Microwaves** **Infrared waves** **Visible light** **Ultraviolet light** **X-rays** **Gamma rays** **Ionizing radiation** **Energy levels** **Ground state** **Excited state** **Emission spectra** **Continuous spectra** **Electron configuration**	**Core Resources:** **Spectrophotometers** **Metal nitrates for flame tests** **q-tips/cotton balls for flame tests** **Bunsen burners**

Orbital diagram **Valence electrons** **Ions** **Aufbau principle** **Pauli exclusion principle** **Hund's rule** **Quantum** **Electron spin** **Principle quantum number** **Orbital** **Electron shells**	
<u>Assessments</u>: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **<u>Authentic Assessments:</u>** **Identifying elements from atomic emission spectra** **Aurora Borealis - identifying elements based on colors emitted** **Star identification using their emission spectra**	**<u>Supplemental Resources:</u>** **Chemistry Concept Builders: https://www.physicsclassroom.com/**

<u>Grade, Subject</u>: Chemistry	
<u>Unit</u>: Periodic Table	
<u>Big Idea</u>: The chemical elements are the fundamental building materials of matter; periodicity of elements is a useful principle for understanding properties and predicting trends in properties of elements.	
<u>PA STEELS Standards</u>: 3.2.9-12.A, 3.2.9-12.C, 3.2.9-12.L	
<u>Essential Questions</u>: **Why do elements exhibit periodicity?** **How is the periodic table of the elements organized?**	**<u>Understandings (CCC)</u>:** - **Properties of elements repeat in a periodic fashion.** - **Elements' properties can be predicted from their location on the periodic table.**

Knowledge (DCIs): - **The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns.** - **The periodic table can be used to predict and explain trends in properties of elements.**	**Skills (SEPs):** - **Determine the number of valence electrons that an atom has from its location on the periodic table.** - **Identify trends in electronegativity, atomic radius, and ionization energy.** - **Connect the trends of element properties on the periodic table to their chemical behavior.** - **Compare elements and their properties (i.e. larger radius between two atoms, etc).** - **Measure the density of element samples**
Vocabulary: **Alkali metals** **Alkaline earth metals** **Halogens** **Noble gases** **Transition metals** **Inner transition metals** **Lanthanides** **Actinides** **Ionization energy** **Atomic radius** **Electronegativity** **Density** **Period** **group**	**Core Resources:** **Various elemental metal cubes (aluminum, brass, steel, copper)** **Digital calipers** **Graduated cylinders (various sizes)** **Density cans** **Other elements (carbon, silicon, tin) of various irregular shapes**
Assessments: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **Authentic Assessments:** **Organizing everyday items by trends and describing periodicity** **Replacing tin on cans** **Predicting the density of an element by measuring and analyzing the density of elements in the same group**	**Supplemental Resources:** **Chemistry Concept Builders: https://www.physicsclassroom.com/**

Grade, Subject: Chemistry	
Unit: Chemical Bonding	
Big Idea: Forces of attraction between particles are important in determining many macroscopic properties of a substance.	
PA STEELS Standards: 3.2.9-12.B	
Essential Questions: **How do bond types predict the properties of chemical substances?** **How does electron arrangement affect the polarity of a molecule?**	**Understandings (CCC):** - **Elements form different types of bonds based on their properties (electronegativity, ionization energy, etc).** - **Chemical bonding is the culmination of quantum theory.** - **Different bond types lead to different chemical behavior.** - **Bonding is responsible for the many properties of chemical substances.**
Knowledge (DCIs): - **Ionic, covalent and metallic compounds have different properties** - **The type of intermolecular forces between molecules affects the melting and boiling points of molecules.** - **Energy is needed to break bonds and overcome intermolecular forces** - **The structure and interactions of matter is determined by electrical forces within and between atoms.**	**Skills (SEPs):** - **Draw dot diagrams of ionic and covalent compounds.** - **Determine if molecules are polar or nonpolar.** - **Identify the type of bond that will occur between two atoms.** - **Differentiate between properties based on bond type.**
Vocabulary: **Ionic bonds** **Covalent bonds** **Metallic bonds** **Electron dot diagrams** **Polar covalent** **Nonpolar covalent** **Electron sea model** **Valence electrons** **Malleable** **Dutile**	**Core Resources:** **Aluminum sample pans** **Hot plates** **Various samples of ionic and covalent compounds** **Infrared thermometers**

Crystal lattice **VSEPR theory** **Boiling point** **Melting point** **Conductivity** **Electrolyte** **Molten** **alloy** **Atom** **Molecule** **Ion** **Formula unit** **Hydrogen bonds** **Exothermic** **endothermic**	
<u>Assessments</u>: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **<u>Authentic Assessments</u>:** **Making models of chemical compounds** **Properties of chemical bonds labs** **Ionic/covalent bonding in food labels**	**<u>Supplemental Resources:</u>** **Chemistry Concept Builders: https://www.physicsclassroom.com/**

<u>Grade, Subject</u>: Chemistry	
<u>Unit</u>: Chemical Reactions	
<u>Big Idea</u>: All matter can be understood in terms of rearrangement of atoms.	
<u>PA STEELS Standards</u>: 3.2.9-12.C, 3.2.9-12.D, 3.2.9-12.E, 3.2.9-12.F, 3.2.9-12.G	
<u>Essential Questions</u>:	**<u>Understandings (CCC)</u>:**

How are chemical reactions classified? **How do chemists use reaction types to predict products of a reaction?** **How are chemical equations balanced?**	- **Both mass and the types of atom are conserved in a chemical reaction.** - **Chemical equations are balanced to meet the Law of Conservation of Mass.** - **Reactions are classified into five types.** - **Reaction products can be predicted from chemical reactants.** - **At equilibrium the rate of the forward chemical reaction is equal to the rate of the reverse chemical reaction.** - **When the equilibrium of a reaction is disturbed by changing the pressure, temperature or concentration of the reactants or products, the position of equilibrium shifts to counteract the change to reestablish an equilibrium.** - **Changes in the concentration, volume, temperature, and surface area of reactants and whether or not a catalyst is present will affect the number of collisions of particles in a reaction, which will affect the rate of the reaction.**
<u>Knowledge (DCIs):</u> - **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.** - **Concentration, temperature and surface area of reactants will all affect the rate of a chemical reaction.** - **A catalyst speeds up the rate of a reaction without being changed or altered in the process.** - **Changes in the parameters (concentration of reactants and products, pressure or temperature) of a chemical reaction can change the equilibrium of the forward versus reverse reaction.**	**<u>Skills (SEPs)</u>:** - **Balance chemical equations.** - **Classify chemical reactions.** - **Determine pH of solutions using indicators.** - **Differentiate between acids and bases.** - **Predict products of chemical reactions.**
<u>Vocabulary:</u> **Synthesis reaction** **Decomposition reaction** **Single replacement reaction** **Double replacement reaction** **Combustion reaction** **Law of Conservation of Mass** **Law of Definite Proportion** **Law Multiple Proportions** **Acid** **Base** **Neutralization** **pH**	**<u>Core Resources</u>:** - **Ionic compounds for using in single replacement and double displacement reactions: $MgSO_4$, $ZnSO_4$, $CuCl_2$, $AgNO_3$, $SnCl_4$, $Fe(NO_3)_3$, NaCl, NaOH, $ZnSO_4$, Na_2CO_3, Na_3PO_4, $CuSO_4$, HCl** - **Metals for using in single replacement reactions: Mg, Fe, Zn, Sn, Cu** - **12 well plastic reaction plates** - **Large metal forceps** - **pH paper** - **Universal pH indicator** - **Phenolphthalein pH indicator**

Coefficients **Collision theory** **Le Chatelier's Principle** **equilibrium**	
<u>Assessments</u>: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **<u>Authentic Assessments:</u>** **Identifying unknowns/qualitative analysis** **Predicting products of chemical reactions** **Use pH indicators to determine the pH of solutions.**	**<u>Supplemental Resources:</u>** **Chemistry Concept Builders: https://www.physicsclassroom.com/**

<u>Grade, Subject</u>: Chemistry	
<u>Unit</u>: The Mole and Stoichiometry	
<u>Big Idea</u>: The mole is the fundamental unit for counting numbers of particles at the macroscopic level and allows quantitative connections to be drawn between laboratory experiments at the macroscopic level and chemical processes, which occur at the microscopic level.	
<u>PA STEELS Standards</u>:3.2.9-12.G `	
<u>Essential Questions</u>: **How are quantitative problems solved that involve chemical equations?** **How are molecules and atoms counted?**	**<u>Understandings (CCC)</u>:** - **Avogadro's number (6.02x10^23) is used to count atoms, molecules and ions.** - **Molar mass is a bridge to calculate the number of atoms from their mass.** - **Mole ratios relate quantities of compounds in the same chemical reaction.** - **Compounds always have the same percentage of elements by mass.**

Knowledge (DCIs): - **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.** - **Analyze and interpret data sets, using the mole concept, to mathematically determine amounts of representative particles in macroscopic, measurable quantities.**	**Skills (SEPs):** - **Calculate numbers of atoms using Avogadro's number as a conversion factor.** - **Calculate molar mass.** - **Complete calculations between mass and moles.** - **Determine mole ratio from a balanced equation.** - **Complete stoichiometry calculations.** - **Determine the percent of elements by mass in a compound.**
Vocabulary: **Avogadro's number** **Molar mass** **Percent composition** **Stoichiometry** **Mole ratio** **Mole** **Mole conversion**	**Core Resources:**
Assessments: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **Authentic Assessments:** **Making fudge and cookies** **Mole Airlines** **Making solutions**	**Supplemental Resources:** **Chemistry Concept Builders: https://www.physicsclassroom.com/**

Grade, Subject: Chemistry	
Unit: Chemical Nomenclature	

Big Idea: It is important to use the internationally accepted naming system to write chemical names from formulas and formulas from chemical names.	
PA STEELS Standards: 3.2.9-12.C	
Essential Questions: **How are chemical compounds named?**	**Understandings (CCC):** - **There are different sets of rules for naming chemical compounds.** - **Bond types distinguish how compounds are named.**
Knowledge (DCIs): - **Names for ionic and covalent compounds** - **Formulas for ionic and covalent compounds**	**Skills (SEPs):** - **Categorize compounds into ionic, molecular, or acidic based on the first element.** - **Write chemical names from chemical formulas.** - **Write chemical formulas from chemical names.** - **Determine when metals require a Roman numeral for charge.**
Vocabulary: **Ionic** **Covalent** **Acid** **Roman numerals** **Subscripts** **Numerical prefixes** **Ions** **Cations** **Anions**	**Core Resources:**

Assessments: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **Authentic Assessments:** **Reading ingredient labels** **Identifying compounds in everyday items and writing formulas for them**	**Supplemental Resources:** **Chemistry Concept Builders: https://www.physicsclassroom.com/**

Grade, Subject: Chemistry	
Unit: Gases	
Big Idea: Rates of chemical reactions are determined by the details of the molecular collisions.	
PA STEELS Standards: 3.2.9-12.E	
Essential Questions: **What are the relationships between pressure, temperature, volume and the amount of a gas in a system?** **What are the important units necessary to quantify gases?**	**Understandings (CCC):** - **Gases are measured by their volume, pressure, number of moles, and temperature.** - **There are relationships between volume, pressure, temperature, and number of moles for a gas.** - **Ideal gases follow the Kinetic Molecular Theory.** - **STP refers to standard temperature (0°C) and pressure (1 atm).**
Knowledge DCIs: - **Utilize mathematical relationships (Gas Laws) to predict changes in the number of particles (moles), the temperature, the pressure, and the volume in a gaseous system.** - **A real gas act like an ideal gas at STP.** - **The kinetic molecular theory describes how ideal gases act.**	**Skills (SEPs):** - **Calculate volume, pressure, temperature, and number of moles using Boyle's law, Gay-Lussac's law, Charles' law, the combined gas law, and the ideal gas law.** - **Convert pressure units between atm and kPa.** - **Convert temperature units between degrees Celsius and Kelvin.** - **Identify relationships between variables for gases as directly or inversely proportional.**

Vocabulary: **Boyle's law** **Charles' law** **Gay-Lussac's law** **Combined gas law** **Ideal gas law** **Kinetic molecular theory** **Pressure** **Volume** **Temperature** **Moles** **kPa** **atm** **Kelvin** **Ideal gas** **Real gas** **Elastic collision** **STP**	**Core Resources:** - **Vernier® gas pressure sensor** - **Vernier® Labquest handheld** - **Alka Seltzer® tablets**
Assessments: **Formative assessments** **Laboratory reports** **Quizzes** **Summative Unit test** **Authentic Assessments:** **Why do scuba divers get the bends?** **What is the difference between low versus high pressure systems in weather forecasting?**	**Supplemental Resources:** **Chemistry Concept Builders: https://www.physicsclassroom.com/**