Curriculum Map: Conceptual Chemistry

MASH

Science Department

Course Description: This year long course is specifically designed for the student who wants to experience chemistry utilizing a strongly focused "hands on," environment. This course will focus on nature of chemistry and the impact it has on everyday life.

Implementation Guideline: The length and scope of the class is too long to fit the one-year timeframe. It is the framework of the text which will allow the instructor to select any particular unit to present. Each unit is designed to be a "stand alone" body of work. The text however should be implemented by first covering the Unit 0 and then Unit 1 as an opening sequence. This will establish fundamental background for both the functional structure of the text and basic science (chemistry) concepts that will be built upon in the subsequent units. After completing Units 0 and 1, instructors may select additional units according to the resources available or allow students the opportunity take an active role in deciding the direction of their curriculum work in the course, based on their interest in the topics available in the remaining units of the text.

Unit Title: Unit 0 – Getting to Know *Chemistry in the Community*

Suggested time frame: (approximately 2 weeks)

Standards: PA Academic Standards for Science and Technology and Engineering (secondary)

Big Ideas:

Big Idea 1: The chemical elements are fundamental building materials of matter, and all matter can be understood in terms of arrangements of atoms. These atoms retain their identity in chemical reactions.
Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.
Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
Big Idea 6: Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations.

Essential Questions:

What is chemistry?
What is community?
How do scientists investigate?
How is *ChemCom* designed to help you learn and apply chemistry?

Competency	Vocabulary	Strategy	Resource
• Define chemistry and recognize its presence all around you. • Develop a concept of community. • Understand the roles and responsibilities required when working in a group. • Know and apply safety guidelines in the laboratory and be able to recognize safety concerns in an investigation. • Begin to become familiar with the structure of investigations within *ChemCom*. • Identify characteristics and expectations of features within *ChemCom*. • Begin to use tools and strategies to assess your learning in chemistry.	• •	○ Putting It All Together (PIAT) activity. ○ Laboratory experiments and research (both physical and digital). ○ Skill Building Exercises ○ Online topical research ○ Articles & publications	✓ Textbook – Chemistry in the Community (ed. 6) 2012 ✓ Laboratory equipment ✓ Media presentation software and technology ✓ Websites - various

Unit Title: Unit 1 - Materials: Formulating Matter

Suggested time frame: (approximately 10 weeks)

Standards: PA Academic Standards for Science and Technology and Engineering (secondary)

Big Ideas:

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Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.
Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
Big Idea 6: Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations.

Essential Questions:

How do chemists describe matter?
How can the periodic table be used to help explain and predict the properties of chemical elements?
What is the role of chemistry in the life cycle of metals?
How is conservation of matter demonstrated in the use of resources?

Competency	Vocabulary	Strategy	Resource
• Make predictions and observations of chemical and physical changes. Record observations in organized data tables. • Distinguish between chemical and physical properties. Classify specific examples as either chemical or physical changes. • Recognize chemical symbols and formulas that represent elements and compounds. Use chemical symbols and formulas to describe the composition of materials. • Interpret and create models that represent elements and compounds at the particulate level. • Classify selected elements as metals, nonmetals, or metalloids based on observations of chemical and physical properties. • Use the periodic table to predict physical and chemical properties, identify elements by their atomic number, and locate periods and groups of elements. • Recognize and distinguish characteristics of the basic subatomic particles (protons, electrons, neutrons). • Describe what constitutes an ion. Indicate the electrical charge of an ion containing a specific number of protons and electrons.	▪ Currency ▪ Data ▪ Observation ▪ Inference ▪ Physical properties ▪ Physical change ▪ Chemical properties ▪ Chemical change ▪ Combustion ▪ Luster ▪ Ductile ▪ Particulate level ▪ Matter ▪ Atoms ▪ Element ▪ Compound ▪ Substance ▪ Molecule ▪ Chemical bond ▪ Chemical symbol ▪ Chemical formula ▪ Subscript ▪ Chemical equation ▪ Chemical reaction ▪ Reactant ▪ Product ▪ Balanced ▪ Macroscopic ▪ Models ▪ Metals ▪ Non-metals ▪ Metalloids ▪ Conductor	○ Team project – Putting It All Together (PIAT) Presentation. "**Making the Case for Currency**." A rubric based team activity which includes group presentations and brochures. ○ Laboratory experiments and research (both physical and digital). ○ Skill Building Exercises ○ Online topical research ○ Articles & publications	✓ Textbook – Chemistry in the Community (ed. 6) 2012 ✓ Laboratory equipment ✓ Media presentation software and technology ✓ Websites - various

• Use the basic structure of the atom to explain the organization of the periodic table. • Collect, organize, and represent data. • Explore periodic trends of groups of elements. • Write the formula and name of an ionic compound, given compound's anion and cation names and electrical charges. • Describe and recognize factors that determine feasibility of mining an ore at a specific site. • Gather and evaluate information from a variety of resources. • Describe Earth's atmosphere, hydrosphere, and lithosphere, including the distribution of resources among them. • Apply the mole concept to calculations, including finding the molar mass of a compound given its formula and average atomic masses of its elements. • Calculate the percent composition by mass of a specified element in a given compound. • Define oxidation and reduction in terms of electron loss or gain. Identify and distinguish between oxidation and reduction processes. • Represent oxidation and reduction processes using chemical equations and electron-dot structures.	▪ Non-conductor ▪ Malleable ▪ Brittle ▪ Periodic table ▪ Proton ▪ Electron ▪ Neutron ▪ Atomic number ▪ Nucleus ▪ Mass number ▪ Isotopes ▪ Periods ▪ Periodic relationship ▪ Group ▪ Family ▪ Alkali metal ▪ Noble gas ▪ Halogen ▪ Periodic properties ▪ Ionic compounds ▪ Ions ▪ Polyatomic ▪ Monatomic ▪ Activity series ▪ Life cycle ▪ Atmosphere ▪ Hydrosphere ▪ Lithosphere ▪ Ore ▪ Deposits ▪ Minerals ▪ Percent composition ▪ Mole ▪ Molar mass		

• Explain why minerals of more reactive metals are more difficult to refine and process than are minerals of less reactive metals. • State and apply the Law of Conservation of Matter. • Relate balanced chemical equations to the Law of Conservation of Matter. • Write and explain balanced chemical equations. • Distinguish between renewable and nonrenewable resources. • Identify methods of conserving Earth's resources. • Describe how alloys and their constituent elements differ in their chemical and physical properties.	▪ Refined ▪ Reduction ▪ Reduced ▪ Oxidation ▪ Redox ▪ Oxidized ▪ Reducing agent ▪ Oxidizing agent ▪ Electron-dot structure ▪ Cathode ▪ Anode ▪ Material life cycle ▪ Diatomic molecules ▪ Law of conservation of matter ▪ Balanced chemical equation ▪ Coefficients ▪ Alloy ▪ Superconductivity ▪ Sustainability ▪ Renewable resources ▪ Non-renewable resources		

Unit Title: Unit 2 - Air: Designing Scientific Investigations

Suggested time frame: (approximately 10 weeks)

Standards: PA Academic Standards for Science and Technology and Engineering (secondary)

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Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.
Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
Big Idea 6: Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations.

Essential Questions:

What information can investigations provide about gas behavior?
How are model and theories useful in explaining and predicting behavior of gases?
What does evidence reveal about properties of Earth's atmosphere?
How are claims about air quality supported by experimental evidence and chemistry concepts?

Competency	Vocabulary	Strategy	Resource
• Define and apply the concept of pressure, using various units. • Describe and apply the relationship between pressure and volume of a gas sample at constant temperature. • Describe and apply the relationship between kelvin temperature and volume of a gas sample at constant pressure. • Describe and apply the relationship between pressure and kelvin temperature of a gas sample at constant volume. • Identify and write good scientific questions. • Explain processes of and reasoning for designing scientific investigations. • State and apply postulates of the kinetic molecular theory. • State and explain Avogadro's Law for gases. • Use the Ideal Gas Law in problems involving gases. • Describe conditions under which the assumptions of the Ideal Gas Law are not valid. • Distinguish between temperature and heat. • Describe changes matter undergoes as energy is added or removed. • Describe similarities and differences among scientific laws, theories, and models.	▪ Pressure ▪ Force ▪ Area ▪ Meter (m) ▪ International System of Units ▪ Base units ▪ Derived units ▪ Newton (N) ▪ Pascal (Pa) ▪ Boyle's Law ▪ Scientific questions ▪ Evidence ▪ Experimental design ▪ Independent variable ▪ Dependent variable ▪ Kelvin temperature scale ▪ Absolute zero ▪ Scientific theories ▪ Kinetic energy ▪ Postulate ▪ Elastic ▪ Kinetic molecular theory (KMT) ▪ Ideal gas ▪ Scientific theory ▪ Scientific model ▪ Avogadro's Law ▪ Ideal Gas Law ▪ Molar volume ▪ Heat ▪ Condensation ▪ Vaporization	○ Team project – Putting It All Together (PIAT) Presentation. "**Investigating Air Quality Claims**." A rubric based team activity which includes group presentations and brochures. ○ Laboratory experiments and research (both physical and digital). ○ Skill Building Exercises ○ Online topical research ○ Articles & publications	✓ Textbook – Chemistry in the Community (ed. 6) 2012 ✓ Laboratory equipment ✓ Media presentation software and technology ✓ Websites - various

• Describe the major components of Earth's atmosphere. • Describe the relationships among electromagnetic radiation's energy, frequency, and wavelength and identify types of electromagnetic radiation. • Explain how Earth's atmosphere interacts with solar radiation, including how the greenhouse effect works. • Apply Avogadro's Law in calculations, including stoichiometric problems. • Explain the effect of a catalyst on a reaction using collision theory. • Describe how evidence gathered from scientific investigations is used to make claims about the natural world. • Identify primary and secondary air pollutants and their sources. • Identify factors and contaminants that contribute to photochemical smog. • Describe personal and global strategies that may help reduce air pollution. • Explain why precipitation is naturally acidic and can become more acidic due to atmospheric contaminants. • Describe effects of acidic precipitation (acid rain) and p*H* changes on natural systems. • Describe the implications of experimental results.	▪ Specific heat capacity ▪ Heat capacity ▪ Atmosphere ▪ Troposphere ▪ Concentration ▪ Homogeneous mixture ▪ Mixture ▪ Homogeneous ▪ Catalyst ▪ Collision theory ▪ Activation energy ▪ Catalytic converter ▪ Nuclear fusion ▪ Electromagnetic radiation ▪ Photons ▪ Electromagnetic spectrum ▪ Frequency ▪ Wavelength ▪ Infrared (IR) ▪ Greenhouse effect ▪ Greenhouse gases ▪ Climate ▪ Claim ▪ Evidence ▪ Pollutants ▪ Primary air pollutants ▪ Volatile organic compounds (VOC's) ▪ Secondary air pollutants ▪ Particulate pollutants ▪ Criteria pollutants ▪ Hazardous air pollutants		

	▪ Accuracy ▪ Precision ▪ Smog ▪ Synergistic interactions ▪ Temperature inversion ▪ Photochemical smog ▪ Acid rain ▪ Acid precipitation ▪ p*H* scale ▪ alkaline ▪ bases		

Unit Title: Unit 3 - Petroleum: Making and Breaking Bonds

Suggested time frame: (approximately 12 weeks)

Standards: PA Academic Standards for Science and Technology and Engineering (secondary)

Big Ideas:

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Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.
Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
Big Idea 6: Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations.

Essential Questions:

How can the physical properties of petroleum be explained by its molecules and their interactions?
Why are carbon based molecules so versatile as chemical building blocks?
What are the benefits and consequences of burning hydrocarbons?
What alternatives to petroleum are available for burning and building?

Competency	Vocabulary	Strategy	Resource
• Describe the chemical makeup of petroleum and how it is refined. • Describe the use of distillation as a separation technique and the application of fractional distillation to petroleum refining. • Identify and write formulas for alkanes. • Define *isomer* and draw structural formulas for possible isomers of a particular hydrocarbon. • Predict and explain relative boiling points of hydrocarbons in terms of their intermolecular forces. • Describe the life cycle of a polymer and identify everyday items that are made from petroleum-based polymers. • Define and distinguish *monomer* and *polymer*. • Describe and represent electron arrangements between covalently bonded atoms. • Explain how molecular structure affects physical properties of a polymer. • Give examples of how functional groups, including rings and multiple bonds, impart characteristic properties to organic compounds. • Identify and describe the roles of addition and condensation reactions in polymerization. • Identify and give examples of kinetic energy, potential energy, and the law of conservation of energy.	▪ Viscosity ▪ Crude oil ▪ Hydrocarbons ▪ Fossil fuels ▪ Carbon footprint ▪ Distillation ▪ Distillate ▪ Fractions ▪ Fractional distillation ▪ Bottoms ▪ Intermolecular forces ▪ Ball-and-stick models ▪ Space-filling models ▪ Alkanes ▪ Tetrahedron ▪ Molecular formulas ▪ Condensed formulas ▪ Extrapolation ▪ Polar molecules ▪ Straight-chain hydrocarbons ▪ Branched-chain hydrocarbons ▪ Structural isomers ▪ Isomer ▪ Monomer ▪ Organic chemistry ▪ Carbon chain ▪ Shells ▪ Valence electrons ▪ Covalent bond ▪ Single covalent bond ▪ Electron-dot formula	○ Team project – Putting It All Together (PIAT) Presentation. "**Getting Mobile**." A rubric based team activity which includes group presentations and brochures. ○ Laboratory experiments and research (both physical and digital). ○ Skill Building Exercises ○ Online topical research ○ Articles & publications	✓ Textbook – Chemistry in the Community (ed. 6) 2012 ✓ Laboratory equipment ✓ Media presentation software and technology ✓ Websites - various

• Describe endothermic and exothermic reactions in terms of total energy involved in bond breaking and bond making using words, equations, and potential energy diagrams. • Use experimental data to compare fuels and calculate molar heats of combustion. • Write balanced equations for combustion of hydrocarbon fuels, including energy involved. • Discuss the carbon cycle and how natural of human factors can affect it. • Consider the impacts of personal and community behavior on global climate.	▪ Lewis dot structures ▪ Lewis structures ▪ Structural formula ▪ Petrochemical ▪ Double covalent bond ▪ Addition reaction ▪ Addition polymers ▪ Branched polymers ▪ Cross-linking ▪ Saturated hydrocarbons ▪ Alkenes ▪ Unsaturated hydrocarbons ▪ Substituted hydrocarbons ▪ Hydrogen bonds ▪ Alkynes ▪ Dimer ▪ Cycloalkanes ▪ Aromatic hydrocarbons ▪ Alcohols ▪ Functional group ▪ Carboxylic acids ▪ Esters ▪ Condensation reaction ▪ Condensation polymer ▪ Potential energy ▪ Kinetic energy ▪ Chemical energy ▪ Thermal energy ▪ Endothermic ▪ Exothermic ▪ Law of conservation of energy		

	▪ Heat of combustion ▪ Molar heat of combustion ▪ Limiting reactant ▪ Carbon cycle ▪ Global warming ▪ Cellular respiration ▪ Biomolecules ▪ Energy efficiency ▪ Cracking ▪ Octane rating ▪ Isomerization ▪ Oxygenated fuels ▪ Oil shale ▪ Oil sands ▪ Biodiesel ▪ Compressed natural gas (CNG) ▪ Liquified petroleum gas (LPG) ▪ Fuel cell ▪ Hybrid vehicles		

Unit Title: Unit 4 - Water: Exploring Solutions

Suggested time frame: (approximately 11 weeks)

Standards: PA Academic Standards for Science and Technology and Engineering (secondary)

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Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.
Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
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Essential Questions:

What makes water unique?
Why do some substances readily dissolve while others do not?
How do we describe chemical behavior in aqueous solutions?
How is chemistry applied to produce safe drinking water?

Competency	Vocabulary	Strategy	Resource
• Explain the relationship between the chemical structure of water and its unique properties. • Distinguish several types of mixtures (solutions, colloids, and suspensions). • Interpret and create models that represent mixtures at the particulate level. • Analyze personal and community uses of water, including direct and indirect uses. • Use the concepts of polarity and intermolecular forces to account for water's ability to dissolve many ionic and molecular substances. • Use words, pictures, and chemical equations to describe the process of dissolving ionic and molecular substances in water. • Quantitatively describe and predict solution variables, including concentration, volume, temperature, mass and moles of solute, and solubility. • Interpret and use solubility curves. • Describe the effects of temperature on the solubility of gaseous substances. • Describe and write equations for precipitate reactions. • Use solubility rules to predict the formation of a precipitate and design tests for dissolved ions.	▪ Aqueous solutions ▪ Electronegativity ▪ Cohesive forces ▪ Mixture ▪ Heterogeneous ▪ Suspension ▪ Tyndall effect ▪ Colloid ▪ Homogeneous ▪ Solutions ▪ Solute ▪ Solvent ▪ Water cycle ▪ Hydrologic cycle ▪ Direct water use ▪ Indirect water use ▪ Histogram ▪ Range ▪ Mean ▪ Median ▪ Mode ▪ Surface water ▪ Ground water ▪ Aquifer ▪ Solution concentration ▪ Colorimetry ▪ Absorbance ▪ Standard solutions ▪ Calibration curve ▪ Dilution ▪ Saturated solution ▪ Solubility ▪ Solubility curve	○ Team project – Putting It All Together (PIAT) Presentation. "**Fish Kill – Finding The Solution. – Town Council Meeting.**" A rubric based team activity which includes group presentations and brochures. ○ Laboratory experiments and research (both physical and digital). ○ Skill Building Exercises ○ Online topical research ○ Articles & publications	✓ Textbook – Chemistry in the Community (ed. 6) 2012 ✓ Laboratory equipment ✓ Media presentation software and technology ✓ Websites - various

• Distinguish among strong and weak acids and bases. • Calculate and compare concentrations of hydronium and hydroxide ions and p*H* values in acidic, basic, and neutral aqueous solutions. • Describe the composition and chemical behavior of a buffer. • Purify a sample of contaminated water. • Describe the movement of water in Earth's hydrologic cycle including how water is purified by natural processes. • Analyze steps of municipal water purification and identify contaminants removed by each process. • Compare natural, municipal, and home water purification. • Assess the risks and benefits of water disinfection methods. • Evaluate the causes of and responses to the Riverwood fish kill.	▪ Metabolism ▪ Total ionic equation ▪ Spectator ions ▪ Net ionic equation ▪ Solubility rules ▪ Confirming test ▪ Qualitative tests ▪ Quantitative tests ▪ Blank ▪ Reference solution ▪ Neutralization ▪ Hydronium ion ▪ Reversible reaction ▪ Neutral solutions ▪ Acidic solutions ▪ Basic solutions ▪ Ionize ▪ Strong acid ▪ Strong base ▪ Weak acid ▪ Dynamic equilibrium ▪ Buffer ▪ Titration ▪ Filtration ▪ Filtrate ▪ Adsorbs ▪ Adhesive forces ▪ Percent recovery ▪ Drinking-water treatment ▪ Trihalomethanes (THMs) ▪ Carcinogens		

Unit Title: Unit 5 – Industry: Applying Chemical Reactions

Suggested time frame: (approximately 9 weeks)

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Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.
Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
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Essential Questions:

What role does nitrogen chemistry play in agriculture?
What chemical principles can be used in the responsible manufacture of ammonia?
How is chemical energy transformed into electrical energy?
What challenges must be met to optimize production and use of batteries?

Competency	Vocabulary	Strategy	Resource
• List the main elements found in fertilizer. • Describe the effect of each ingredient in a typical fertilizer on plant growth. • Describe the nitrogen cycle, specifically referring to processes by which nitrogen gas is fixed (converted into nitrogen-containing compounds). • Predict relative electronegativity trends among several elements. • Determine whether covalently bonded atoms exhibit positive or negative oxidation states, based on their electronegativity values. • Explain how temperature, reactant concentration(s), and the absence or presence of a catalyst affect reaction rates. • Describe characteristics of a system in dynamic equilibrium. • Use Le Châtelier's Principle to predict shifts in equilibria caused by perturbations to a system. • Describe the Haber-Bosch process for industrial production of ammonia. • Explain why many nitrogen-based compounds are effective chemical explosives. • Describe how the production of ammonia can illustrate the goals and principles of green chemistry. • Describe the design of a voltaic cell.	▪ Nitrogen cycle ▪ Haber-Bosh process ▪ Oxidation state ▪ Positive oxidation ▪ Negative oxidation state ▪ Zero oxidation state ▪ Chemical kinetics ▪ Reaction rate ▪ Collision theory ▪ Dynamic equilibrium ▪ Le Châtelier's principle ▪ Complex ion ▪ Green chemistry ▪ Electrochemistry ▪ Electrical potential ▪ Voltaic cell ▪ Half-cell ▪ Electrodes ▪ Electric current ▪ Salt bridge ▪ Anode ▪ Cathode ▪ Spontaneous ▪ Electrolysis ▪ Batteries ▪ Dry cell ▪ Primary battery	○ Team project – Putting It All Together (PIAT) Presentation. "**A Chemical Plant For Riverwood? – Town Council Meeting**." A rubric based team activity which includes group presentations and brochures. ○ Laboratory experiments and research (both physical and digital). ○ Skill Building Exercises ○ Online topical research ○ Articles & publications	✓ Textbook – Chemistry in the Community (ed. 6) 2012 ✓ Laboratory equipment ✓ Media presentation software and technology ✓ Websites - various

• Use the activity series of metals to predict the direction of electron flow within a particular voltaic cell. • Use the illustrations and half-reactions describing oxidation and reduction to explain chemical processes by which voltaic cells convert chemical energy to electrical energy. • Apply the concepts of equilibrium and spontaneity to voltaic cells. • Describe the function and composition of primary and secondary batteries • Calculate the electrical potential produced by a voltaic pile or battery • Analyze the life cycle of a battery. • Use burden-benefit analysis in decisions about implementing chemical technologies.			

Unit Title: Unit 6 – Atoms: Nuclear Interactions

Suggested time frame: (approximately 9 weeks)

Standards: PA Academic Standards for Science and Technology and Engineering (secondary)

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Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
Big Idea 3: Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.
Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
Big Idea 6: Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations.

Essential Questions:

What evidence led to a modern understanding of the composition of the atom?
How do we detect and describe the products of nuclear decay?
Why and how are radioactive isotopes useful?
What burdens and benefits accompany uses of nuclear energy?

Competency	Vocabulary	Strategy	Resource
• Define and describe radioactivity. • Distinguish between ionizing and non-ionizing radiation. • Describe Rutherford's gold-foil experiment, including how its results led to a new model of the atom. • Define isotope and radioisotope. • Interpret a given isotope in terms of its atoms' protons, and neutrons. • Calculate the average molar mass of an element, given isotopic molar masses and abundance data. • Identify sources of background radiation. • Describe effects of ionizing radiation on human tissue and identify factors that determine the extent of damage. • Distinguish among alpha particles, beta particles, and gamma rays and describe the effects of their emission on the composition of the nucleus. • Write, complete, and balance nuclear equations. • Describe methods for detecting and measuring ionizing radiation. • Define and describe half-life. • Using its half-life, calculate the amount of a particular isotope that remains undecayed after a specific time. • Describe how radioisotopes are used as diagnostic tracers in medicine. • Explain how radioisotopes are used to kill cancerous cells.	▪ Background radiation ▪ Fluorescence ▪ Cathode rays ▪ X-rays ▪ Non-ionizing radiation ▪ Radiation ▪ Ionizing radiation ▪ Radioactive decay ▪ Nuclear radiation ▪ Alpha particles ▪ Beta particles ▪ Gamma rays ▪ Subatomic particles ▪ Radioisotopes ▪ Dose ▪ Gray ▪ Sievert ▪ Rad ▪ Mutations ▪ Beta decay ▪ Metastable ▪ Decay series ▪ Scintillation counters ▪ Solid state detectors ▪ Cloud chamber ▪ Half-life ▪ Diagnostic ▪ Therapeutic ▪ Tracer ▪ Positron emission tomography (PET) ▪ Positrons	○ Team project – Putting It All Together (PIAT) Presentation. "**Informing Others About Nuclear Science and Technology**." A rubric based team activity which includes group presentations and brochures. ○ Laboratory experiments and research (both physical and digital). ○ Skill Building Exercises ○ Online topical research ○ Articles & publications	✓ Textbook – Chemistry in the Community (ed. 6) 2012 ✓ Laboratory equipment ✓ Media presentation software and technology ✓ Websites - various

• Describe the process of nuclear transmutation. • Write, complete, and balance nuclear transmutation equations. • Describe and define nuclear fission. • Write and balance nuclear equations for fission reactions. • Describe how nuclear energy is used to generate electricity in a nuclear power plant. • Define and describe nuclear fusion. • List and describe types of radioactive waste, including their sources. • Describe and evaluate methods for disposal of radioactive wastes, including burdens and benefits of each. • Explore alternate fission reaction cycles for less wasteful and more efficient processes.	▪ Magnetic resonance imaging (MRI) ▪ Transmutation ▪ Transuranium ▪ Cyclotrons ▪ Nuclear fission ▪ Strong force ▪ Chain reaction ▪ Critical mass ▪ Nuclear power plants ▪ Nuclear fusion ▪ High-level radioactive waste ▪ Low-level radioactive waste ▪ vitrification		

Unit Title: Unit 7 – Food: Matter and Energy for Life

Suggested time frame: (approximately 10 weeks)

Standards: PA Academic Standards for Science and Technology and Engineering (secondary)

Big Ideas:

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Big Idea 2: Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
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Big Idea 4: Rates of chemical reactions are determined by details of the molecular collisions.
Big Idea 5: The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
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Essential Questions:

How is food energy stored, transferred, and released?
What role does molecular structure play in metabolism of carbohydrates and fats?
Why are protein molecules essential to living organisms?
What roles do vitamins, minerals, and additives play in foods we eat?

Competency	Vocabulary	Strategy	Resource
• Use calorimetry to determine the energy stored in a particular food. • Trace the flow of energy in food back to its sources and forward to its uses and dispositions. • Analyze how the balance between energy intake and expenditure affects body mass and health. • Describe the general structure of a carbohydrate molecule. • Describe the general structure and composition of a fat molecule. • Distinguish between saturated and unsaturated fats. • Explain how structural differences in fat and carbohydrate molecules account for their different properties and energy content. • Identify a limiting reactant, given the equation and reaction conditions. • Describe the general structure of a protein molecule. • Describe how amino acids in food are linked by peptide bonds to form proteins within the body. • Describe how some protein molecules (enzymes) serve as catalysts. • Explain why complete or complementary proteins are an essential part of the human diet. • List key vitamins and describe their importance to the human body.	▪ Food groups ▪ Calorimetry ▪ Calorimeter ▪ Calorie ▪ Photosynthesis ▪ Cellular respiration ▪ Carbohydrate ▪ Monosaccharides ▪ Disaccharides ▪ Polysaccharides ▪ Glycogen ▪ Fats ▪ Triglyceride ▪ Fatty acid ▪ Saturated fat ▪ Unsaturated fat ▪ Monounsaturated fat ▪ Polyunsaturated fat ▪ Arterial plaque ▪ Atherosclerosis ▪ Hydrogenation ▪ Cis-trans isomerism ▪ Enzymes ▪ Protein ▪ Amino acid ▪ Peptide bonds ▪ Dipeptide ▪ Essential amino acid ▪ Complete protein ▪ Complementary proteins ▪ Substrate ▪ Active site ▪ Vitamins	○ Team project – Putting It All Together (PIAT) Presentation. "**Guiding the PTSA's Decisions**." A rubric based team activity which includes group presentations and brochures. ○ Laboratory experiments and research (both physical and digital). ○ Skill Building Exercises ○ Online topical research ○ Articles & publications	✓ Textbook – Chemistry in the Community (ed. 6) 2012 ✓ Laboratory equipment ✓ Media presentation software and technology ✓ Websites - various

• Explain why daily intake requirements of vitamins depend on the function and solubility properties of the vitamins as well as characteristics (such as age and gender) of individuals. • List key minerals and explain their importance to health. • List and describe main uses of food additives. • Describe how titration and chromatography can be used to analyze food products.	▪ Coenzymes ▪ Endpoint ▪ Titrant ▪ Minerals ▪ Macrominerals ▪ Trace minerals ▪ Microminerals ▪ Food additives ▪ Paper chromatography ▪ mutagens		